







**SCIENCE, TECHNOLOGY AND INNOVATION FOR  
SUSTAINABLE DEVELOPMENT  
IN THE ISLAMIC WORLD:**  
*The Policies and Politics Rapprochement*



# SCIENCE, TECHNOLOGY AND INNOVATION FOR SUSTAINABLE DEVELOPMENT IN THE ISLAMIC WORLD: *The Policies and Politics Rapprochement*

Proceedings of the 16<sup>th</sup> IAS Science Conference on  
**Science, Technology and Innovation for Sustainable Development  
in the Islamic World:**  
*The Policies and Politics Rapprochement*  
organised in Kazan/ Tatarstan, Russia;  
25-28 August 2008

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and  
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*Published by*



ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)  
AMMAN, JORDAN.

*Publication sponsored by*



ISLAMIC DEVELOPMENT BANK (IDB)  
JEDDAH, SAUDI ARABIA



OPEC FUND FOR INTERNATIONAL  
DEVELOPMENT (OFID)  
VIENNA, AUSTRIA

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First published in 2013 by  
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Type-setting at the Secretariat of the Islamic World Academy of Sciences, Amman, Jordan

Printed in Jordan by the National Printing Press, Amman.

Jordan National Library Classification Deposit Number: 2009/8/3713  
Descriptors: / Sustainable Development\\Technology\\Scebces\\Political\\

**ISBN 978-9957-412-19-7**

Price: US\$ 30-00.

*The views expressed in this book are of the authors, and not necessarily of the editors, or the Council or the General Assembly of the Islamic World Academy of Sciences (IAS). The Islamic World Academy of Sciences, by providing a free forum for the exchange of scientific opinions and being a non-political organisation, does not hold itself responsible for the statements made or ideas expressed by the contributors.*

**Cover design by Abdel Latif Bouab.**

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**Some of the participants in the 16<sup>th</sup> IAS Science Conference;  
Kazan, Tatarstan/ Russia; 25-28 August 2008.**

## PREFACE

The Organization of Islamic Co-operation (OIC), formerly known as the Organization of the Islamic Conference (OIC) was founded in 1969 as a political organization grouping Islamic countries. In 1981, the heads of state of the OIC decided to establish a number of specialized organs to enhance co-operation between the OIC-Member countries in the fields of culture, trade and science and technology, the latter assignment being the responsibility of COMSTECH; the Standing Committee on Scientific and Technological Co-operation, based in Islamabad (Pakistan). In 1984, the heads of state of the OIC approved a proposal of COMSTECH to launch the Islamic World Academy of Sciences (IAS) as an independent autonomous S&T Think Tank of the OIC located in Amman, Jordan. Of the issues that the IAS has been concerned with since its launch has been 'Environment and Development,' as well as trying to bridge the divide that has historically existed between the science community and the decision-making community in OIC-Member countries.

Today, there are many issues plaguing the world, foremost among which are global poverty and environmental degradation, which are interlinked to sustainable development.

Back in the 1990s, sustainable development was put squarely on the world agenda. In 2002, in South Africa, the international community met at the World Summit on Sustainable Development and more was achieved. However, in truth, we are still not meeting the scale of the challenge.

In thirty years' time, there will be two billion more people on the planet. Already 40% of the population is short of fresh water; on current trends this will rise to 50% by 2030, in west Asia it will be 90%. One-third of the world's fish stocks and one-quarter of the world's mammals are threatened with extinction. The World Summit did much to address these issues however, it is becoming clear that we have a profound choice as the international community to continue to make modest progress or act decisively.

A new international mindset is required that enables us as nations, acting collectively, to address such issues: to help the poorest countries to develop and to promote a fairer allocation of wealth and opportunity. We also need a new international consensus to protect our environment and combat the devastating impacts of climate change.

Mindful of these realities, the IAS has decided to convene a multi-theme conference in the city of Kazan in Russia at the invitation of His Excellency President Shaymiev, the President of Tatarstan, and Prof. Akhmet Mazgarov,

President of the Tatarstan Academy of Sciences, to address such scientific themes and re-establish harmony between scientists, the decision-making community and the public, particularly in the domain of the environment. This is a particularly relevant issue for countries of the South, where many decision-makers have not seen the 'light of science,' in their quest to realise sustainable development. The conference also aimed to raise some questions on the storyline of Islamic science in the Islamic civilisation, and the relationship between science and the media.

This book includes the majority of the papers that were presented at the 16<sup>th</sup> IAS Conference, which was held in Kazan (Tatarstan/Russia), during August 2008. A conference in which over 200 participants including IAS Fellows and invited speakers from outside Russia, academics, decision-makers, scientists, researchers as well as presidents/representatives of academies of sciences from all over the world, took part.

It is divided into eight parts.

**Part One** includes the statements of the two patrons of the IAS, the statements of IAS President and OIC representative, as well as the statements of the officials of the host country; Tatarstan; that were made during the inaugural session of the conference. **Part Two** embraces a keynote address by Prof. Zakri Abdul Hamid, the former Director, United Nations University, Institute of Advanced Studies in Japan and the current Science Advisor of the Prime Minister of Malaysia, who presented a policy paper entitled 'Science, Technology and Innovation for Sustainable Development;' a keynote by Prof. Maria da Graca Carvalho, of the Bureau of European Policy Advisers of the European Commission, who presented an overview paper on 'Europe of Knowledge: The Knowledge Society and the Role of Universities;' as well as a keynote entitled 'Sustainable Development: A Global Imperative,' presented by Prof. Michael Clegg of the US National Academy of Sciences and a regular participant in IAS Conferences. This part also includes an overview presentation by the Minister of Industry and Trade of Tatarstan, Mr Aleksandr Kogogin on the 'Industrial Potential' of Tatarstan; a presentation by Prof. Sajjad Alam on international co-operation in the field of physics and a presentation by Prof. A. Latif Ibrahim (FIAS/Malaysia) on 'Selangor as an Islamic Centre of Indigenous and Scientific Biological Knowledge for Sustainable Development.'

**Part Three** is dedicated to the papers presented in the session on the 'Role and Functions of Academies of Sciences,' in which the representatives of no less than ten academies of sciences from around the world including the French, American, Palestine, and the Tatarstan academies of sciences as well as TWAS presented short overviews of their academies and their respective outlooks for the future.

**Part Four** includes a presentation by Prof. Noor M. Butt on 'Nanotechnology and Developing Countries,' a presentation by IAS Fellow Prof. S. N. Khadzhiev on 'Nanotechnology for Sustainable Development of Oil Refining and Petrochemistry,' as well as a presentation by Mahmoud Reza Sajjadi on 'Nano-Tec in Iran.'

**Part Five** addresses Sustainable Development Issues and includes papers by Prof. Ishfaq Ahmad on ‘Climate Change,’ a presentation by Prof. A. G. Babaev on ‘Environmental Aspects of Sustainable Development in Central Asia,’ a presentation by the late Prof. Kamal El Din El Batanouni on ‘Islam and the Conservation of Nature,’ and a short communication by Prof. M. Asghar.

**Part Six** includes the papers which were presented in the session entitled ‘Science, Policy and the Media, including a broad policy paper by Prof. Anwar Nasim on ‘Scientific Networking for Sustainable Development,’ a short communication by Dr Abbas Sadri, a presentation by Ehsan Masood on ‘The Intellectual and the State,’ a presentation by Prof. Nadir Devlet on the ‘Influence of New Technologies on Social Sciences,’ a short communication by Dr Y. N. Khaliullin on ‘The Muslim World as the Center of Geopolitical Gravity,’ a presentation by Dr Nadia El-Awadi on ‘Science and the Media: Bridging the Gap,’ and a presentation by Mr Jean Marc Fleury on ‘Journalism Training: Impacting Media to Impact Science.’

**Part Seven** comprises some of the papers that were presented at the symposium which was organised by the IAS in collaboration with the UNESCO and the Kazan State University on the question of why the Islamic civilisation – which enjoyed almost five centuries of scientific superiority – did not undergo a European-type renaissance. It includes some introductory remarks by Academician Lee Yee Cheong on the topic of ‘Islamic Science, Technology and Innovation (ISSTI) for the Future,’ as well as papers by Dr M. Kh. Salakhov on ‘The Role of Kazan University in the Development of Domestic and World Science,’ a presentation by Prof Mehdi Golshani on ‘The Rise and Decline of Science in the Muslim World,’ a presentation by Dr Charles Falco on ‘Ibn al-Haytham’s Contributions to Optics, Art, and Visual Literacy,’ a presentation by Prof. Mazhar Qurashi entitled ‘Science as a Component of the Overall Intellectual Activity in the Early Muslim World,’ as well as a short communication on the subject by Dr Abbas Sadri of ISESCO.

**Part Eight** of the book is the appendix that includes the list of participants in the conference, the conference scientific and organising committees, the names of IAS Fellows and Council members, as well as other details about the Islamic World Academy of Sciences.

**Mehmet Ergin**  
**Moneef R. Zou’bi**





## ACKNOWLEDGEMENTS

The Islamic World Academy of Sciences (IAS) is grateful to His Excellency Mr Mintimer Shaymiev, the President of the Russian Republic of Tatarstan, for his patronage of the 16<sup>th</sup> IAS Conference and the outstanding speech he delivered during the opening session. The support and encouragement of His Excellency the President of the Islamic Republic of Pakistan, IAS Patron; and His Royal Highness Prince El-Hassan Bin Talal of Jordan, Founding Patron of the IAS, are also thankfully acknowledged.

The IAS extends its gratitude to all the organisations that sponsored the convening of the conference, foremost among which was the Tatarstan Academy of Sciences, Kazan, Tatarstan. The IAS is also grateful to the United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France; the Islamic Development Bank (IDB), Jeddah, Saudi Arabia; the OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan; the OPEC Fund for International Development (OFID), Vienna, Austria; the Perdana Leadership Foundation, Putrajaya, Malaysia; the Arab Gulf Programme for Development (AGFUND), Riyadh, Saudi Arabia; Fouad Alghanim & Sons Group of Companies, Safat, Kuwait; Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia; Islamic Educational, Scientific and Cultural Organisation (ISESCO), Rabat, Morocco; Arab Potash Company, Amman, Jordan; World Islamic Call Society, Tripoli, Libya; and Royal Jordanian Airlines, Amman, Jordan ; for sponsoring the conference.

We are very grateful to all the eminent speakers who participated in the conference and to all the specialists and the various participants who made the effort to take part in this international scientific activity.

The preliminary work done by the IAS Council, and the efforts volunteered by IAS Fellow from Tatarstan, Prof. Ahmet Mazgarov; IAS Treasurer, Dr Adnan Badran; IAS Secretary General, Dr Mehmet Ergin; Dr Ahmed Marrakchi and Dr Moneef R. Zou'bi, IAS Director General; during the meetings of the scientific committee and the conference itself are gratefully accredited. The IAS Council headed by Dr A S Majali has too done a lot to help realise this activity.

The dedicated staff at IAS Secretariat in Amman including Ms Lina Jalal, who was responsible for the unenviable task of preparing the manuscript, Ms Taghreed Saqer, IAS Executive Secretary; Mr Habis Majali, Mr Saleh Asa'ad, and Mr Hamza Daghestani, deserve our thanks and appreciation. So do Mr George Anz, Ms Amal Mizher and Mr Abdellatif Bouab, who have so unwearyingly prepared the manuscript of this book.

**Mehmet Ergin  
Moneef R. Zou'bi**





**IAS 2008 CONFERENCE**  
**on**  
***Science, Technology and Innovation for Sustainable  
Development in the Islamic World: The Policies and  
Politics Rapprochement***

**SPONSORS OF THE IAS 2008 CONFERENCE**

- (1) Islamic World Academy of Sciences (IAS), Amman, Jordan;
- (2) Tatarstan Academy of Sciences, Kazan, Tatarstan;
- (3) United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France;
- (4) Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
- (5) OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
- (6) OPEC Fund for International Development (OFID), Vienna, Austria;
- (7) Perdana Leadership Foundation, Malaysia;
- (8) Arab Gulf Programme for Development (AGFUND), Riyadh, Saudi Arabia;
- (9) Fouad Alghanim & Sons Group of Companies, Safat, Kuwait;
- (10) Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia;
- (11) Islamic Educational, Scientific and Cultural Organisation (ISESCO), Rabat, Morocco;
- (12) Arab Potash Company, Amman, Jordan;
- (13) World Islamic Call Society, Tripoli, Libya; and
- (14) Royal Jordanian Airlines, Amman, Jordan.



**IAS 2008 KAZAN DECLARATION**  
**on**  
***Science, Technology and Innovation***  
***for Sustainable Development in the Islamic World:***  
***The Policies and Politics Rapprochement***

Adopted at Kazan, Tatarstan/Russian Federation

on

26 Sha'ban 1429 Hijri

27 August 2008

**PREAMBLE**

- (a) Islam upholds a balance between all living creatures and their life-sustaining environment, whereas realizing prosperity and socioeconomic advancement for humanity lies at the heart of the Islamic governance philosophy.
- (b) Organisation of Islamic Conference (OIC) and other developing countries differ in their science, technology and innovation (STI) outlooks. Some have linked their advancement to their STI development. Others, due to a number of considerations including the lack of political will, have not given due priority to this issue.
- (c) Science, technology and innovation are not exogenous factors that determine a society's evolution independently from its historical, social, political, cultural, or religious backgrounds. They are *the* tools within humanity's reach for the fulfillment of human needs while maintaining the natural environment indefinitely, i.e. the means to master the socioecological process that has been defined as 'Sustainable Development.'
- (d) Vision 1441 and the various resolutions of the Organisation of the Islamic Conference (OIC) accentuate that OIC- Member states must strive to become a community that values knowledge; a community that is competent in utilizing S&T to achieve the socioeconomic well-being of the '*Ummah*.'

**ON THE THEME OF ‘SUSTAINABLE DEVELOPMENT,’ THE PARTICIPANTS IN THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS) 2008 KAZAN CONFERENCE DECLARE THAT:**

- (i) The linkage between economic growth and the natural environment that supports it lies at the heart of sustainable development. Economic growth contributes to higher levels of human welfare, and provides the resources to tackle a range of environmental objectives. However, economic expansion can also lead to excessive degradation of environmental resources. Today, maintaining functioning ecosystems that can support economic and social development is recognized as crucial for development to be sustained;
- (ii) A coherent approach is required to address the environmental threats that face humanity today. Due to the global nature of some of the challenges, such as global warming, individual countries cannot reverse adverse trends. For other challenges, such as biodiversity and water shortages, consequences of continued degradation spill over national borders;
- (iii) Policies in place in many OIC and other developing countries have failed to match the urgency of some of the environmental challenges. Measuring progress towards sustainable development has addressed specific issues such as climate change; rather than measuring sustainable development at an aggregate level which requires an integration of indicators of economic, environmental and social changes;
- (iv) An immediate comprehensive strategy is needed to overcome the various knowledge and implementation divides. Governments of OIC countries need to show leadership as progress requires a focused agenda, with special priority given to areas where the risks of non-sustainable patterns of development are highest – such as climate change and sustainable use of natural resources,

**AND RECOMMEND THE FOLLOWING MEASURES TO OIC AND OTHER DEVELOPING COUNTRIES’ DECISION-MAKING COMMUNITY:**

- (a) OIC and other developing countries’ governments must lead by example in promoting sustainable development and should focus their internal policy and implementation processes on effectively integrating the three dimensions of sustainable development (economic, environmental, and social); and improve their own capacity to support sustainable development; and develop transparent mechanisms for interacting with civil society;

- (b) Improve the capacity for policy integration at all levels of government by:
- *Ensuring that key economic, environmental and social considerations are integrated into sectoral policy analysis, design and implementation, before decisions are taken;*
  - *Ensuring that the best scientific advice - as for example may be provided by academies of sciences - on sustainability issues is coordinated at the highest level within government, and communicated to decision-makers;*
  - *Cooperating internationally to develop common approaches for making economic, environmental and social policies mutually supportive; and*
  - *Clearly identifying sustainable development policy targets and timetables and conducting regular reviews of progress.*
- (a) As new technologies offer significant promise for de-coupling economic growth from long-term environmental degradation, then OIC and other developing countries' governments need to create an environment that is favourable to innovators, to fund basic research, provide incentives to innovate and diffuse technologies that support sustainable development objectives,

**THE PARTICIPANTS IN THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS) 2008 KAZAN CONFERENCE MOREOVER CALL UPON THE INTERNATIONAL COMMUNITY TO:**

- (i) Support opportunities for developing countries to develop in a way that reinforces environmental protection and social development by increasing market access to developing countries, especially in sectors where sustainable development is likely to gain from economic liberalization;
- (ii) Review economic and environmental policies from the perspective of the goal of poverty reduction;
- (iii) Promote universally accepted development yardsticks such as the MDGs and to allocate sufficient resources to help developing countries achieve these goals;
- (iv) Continue to help poor countries to improve their capacity to participate in the sustainable development of the global economy, including launching the policy and institutional frameworks required to attract private capital to those countries while minimizing adverse environmental or social impacts associated with such flows;

- (v) Address again climate change as this is a particularly pressing challenge that requires international cooperation, a challenge that must be addressed rapidly to achieve the mitigation levels envisaged under the Kyoto protocol; and
- (vi) Improve the knowledge base for decision making by promoting research on environmental thresholds from renewable resources, and on technologies that more efficiently use or recycle natural resources.

**ADDITIONALLY, THE PARTICIPANTS IN THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS) 2008 KAZAN CONFERENCE ACKNOWLEDGE THAT:**

- (a) A salient feature of modern science is its greater autonomy from the public. This has resulted in the codification and institutionalization of the scientists' professional role and the emergence of a divide between scientists on the one hand, the polity and well as the media and the public on the other;
- (b) The media has a considerable role in promoting science and technology and scientists need to communicate with the general public, policy-makers, and the media while scientific institutes need to open communication lines with the outside world;
- (c) Universities in OIC countries have to examine the possibility of teaching science communication as a specialized discipline while science conferences and seminars need to engage more with journalists and the media;
- (d) Newspapers and broadcasters should employ more science graduates, while scientists and science graduates should be encouraged to undertake media training;
- (e) The role, functions and activities of academies of sciences are multifaceted and multilayered; at the heart of which lies the promotion of science and technology and the application thereof to increase knowledge, improve socioeconomic conditions in society;
- (f) Academies of sciences ought to be further involved in promoting science and the scientific endeavour and act as active advocates of science and technology to overcome the array of problems that humanity faces;
- (g) Academies of sciences are expected to act as 'sovereigns' of science in their catchment area, unequivocally taking the moral high ground on all issues that face humanity;
- (h) It is imperative that OIC countries establish national academies of sciences, or where such entities exist strengthen them;

- (i) Historians of science have propagated a number of theories related to the rise and possible decline of Islamic science. A need to revisit this issue has developed not only to highlight the contribution that the Islamic civilization has made to world civilization, but also to learn about the deep rooted underlying reasons for this decline in order to learn from the lessons of the past and, in today's tension ridden world, promote harmony between cultures and peoples; and
- (j) It is imperative that interest of the OIC science community, and ultimately the public, is rejuvenated in what has become known as the alternative narrative of the 'Rise and Decline of Islamic Science,' and the need to question what has been described as the classical narrative related to the subject and the various theories related thereto,

**FURTHERMORE, THE ISLAMIC WORLD ACADEMY OF SCIENCES:**

**Expresses** its deep concern for the safety and well-being of all Iraqi scientists, academics and educationalists both inside and outside Iraq;

**Reaffirms** its support for the implementation of the recommendations and action plan of Vision 1441, urges all OIC-Member countries to contribute generously to the OIC Science and Technology Fund, and commends the efforts of the OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH) in launching this and other similar initiatives; and

**Extends** its appreciation to the Republic and President of Tatarstan for hosting the conference; to the Tatarstan Academy of Sciences, for undertaking local arrangements; the Islamic Development Bank, COMSTECH, OPEC Fund for International Development (OFID), Perdana Leadership Foundation, Arab Gulf Programme for Development (AGFUND), Fouad Alghanim & Sons Group of Companies, Saudi Basic Industries Corporation (SABIC), Islamic Educational, Scientific and Cultural Organisation (ISESCO), United Nations Educational, Scientific and Cultural Organisation (UNESCO), Arab Potash Company, World Islamic Call Society, Tripoli, Libya; and Royal Jordanian Airlines, for generously supporting this international scientific congregation.





**IAS 2008 Kazan Conference**  
**on**  
***Science, Technology and Innovation***  
***for Sustainable Development in the Islamic World:***  
***The Policies and Politics Rapprochement***

Kazan, Tatarstan/Russian Federation  
26 Sha'ban 1429 Hijri  
27 August 2008

**CONFERENCE REPORT**

**General**

Under the patronage of His Excellency Mr Mintimer Shaymiev, President of the Republic of Tatarstan, the Islamic World Academy of Sciences (IAS) convened its 16<sup>th</sup> Conference in Kazan, the capital of the autonomous Republic of Tatarstan in the Russian Federation, from 25-28 August 2008. The conference addressed the theme of *Science, Technology and Innovation for Sustainable Development in the Islamic World: Politics and Policies Rapprochement*.

Organized at the Kazan Korston Hotel, the conference was an open international scientific activity in which over 130 participants representing over 25 countries participated. Among the participants were the representatives of over 20 academies of sciences from around the world including the American, French and Russian academies of sciences; as well as the majority of academies of sciences in the OIC.

Alongside the conference, the IAS and the UNESCO organised a special symposium at Kazan State University on the 'History of Islamic Science, Technology and Innovation.'

The 17<sup>th</sup> Meeting of the General Assembly of the Islamic World Academy of Sciences as well as the 32<sup>nd</sup> and 33<sup>rd</sup> Meetings of the IAS Council were also arranged in conjunction with the conference.

The conference was jointly organised by the following organisations:

- Islamic World Academy of Sciences (IAS), Amman, Jordan;
- Tatarstan Academy of Sciences, Kazan, Tatarstan; and
- United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, France.

It was sponsored by the following organisations:

- Islamic Development Bank (IDB), Jeddah, Saudi Arabia;
- OIC Ministerial Committee on Scientific and Technological Co-operation (COMSTECH), Islamabad, Pakistan;
- OPEC Fund for International Development (OFID), Vienna, Austria;
- Perdana Leadership Foundation, Putrajaya, Malaysia;
- Arab Gulf Programme for Development (AGFUND), Riyadh, Saudi Arabia;
- Fouad Alghanim & Sons Group of Companies, Safat, Kuwait;
- Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia;
- Islamic Educational, Scientific and Cultural Organisation (ISESCO), Rabat, Morocco;
- Arab Potash Company, Amman, Jordan;
- World Islamic Call Society, Tripoli, Libya; and
- Royal Jordanian Airlines, Amman, Jordan.

Tatarstan is an autonomous republic that forms part of the Russian Federation. It is a Muslim-majority country that boasts a strong and diversified economy, as well as reputable science, technology and innovation system; at the heart of which lies a highly structured academy of sciences with a multifaceted role.

Apart from learning about the rich and often – ill presented – history of Tatarstan and the Tatar people, the 16<sup>th</sup> IAS Conference aimed to establish contact with the science and technology community in the country. The conference was also designed to showcase the status of science and technology in some of the republics of the Russian Federation and the various institutions that also belong to the Russian Academy of Sciences which are world leaders in a number of fields including nanotechnology.

Furthermore, an attempt was made to compare the views of politicians, scientists as well as academicians both from Russia and outside on the issue of ‘Sustainable Development,’ and its various components.

Another objective of the conference was to explore the strong link that should exist between the science community and the media.

The inaugural session of the conference was held at the historic Tatarstan Academy of Sciences Building in Kazan. The chief guest was the President of the Republic of Tatarstan; Mintimer Shaymiev, who delivered his speech at the start of proceedings. That was followed by the speech of the President of the IAS and the messages of the two IAS Patrons; H E the President of the Islamic Republic of Pakistan and H R H Prince El-Hassan Bin Talal of Jordan. The inaugural session of the conference concluded with an award ceremony in which newly elected Fellows of the IAS received their Certificates of Fellowship from the President of the Republic of Tatarstan. That was followed with the President of Tatarstan receiving his Certificate of Honorary Fellowship of the IAS from the President of the IAS.

## **Presentations**

The first day of the conference included keynotes by; Prof. R. I. Nigmatulin, Director of the P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, who presented a paper entitled *Ecology and Energy: Myths, Reality and Prospects*; Prof. A. H. Zakri FIAS, Director, United Nations University, Institute of Advanced Studies in Japan who presented a policy paper entitled *Science, Technology and Innovation for Sustainable Development*; and Prof. Maria da Graca Carvalho, Director General, Bureau of European Policy Advisers of the European Commission, who presented an overview paper on *Europe of Knowledge: The Knowledge Society and the Role of Universities*.

Two other keynotes were also presented on the first day of the conference; *The Kyoto Protocol: The Pros and Cons* which was presented by Prof. Mikhail Zalikhanov, Fellow of the Islamic World Academy of Sciences and Chairman of the Subcommittee on Sustainable Development in the Russian State Duma; and *Sustainable Development: A Global Imperative*, which was presented by Prof. Michael Clegg, Foreign Secretary of the US National Academy of Sciences and a regular participant in IAS Conferences.

The first day also included the Ibrahim Memorial Award Lecture which this year (2008) was delivered by the Award Laureate of 2007; Dr Mohammad Al-Qattan, who is an outstanding plastic surgeon from Saudi Arabia. It was mainly on his main field of research and carried the title *Obstetric Brachial Plexus Palsy*.

The second day of the conference included a special session on nanotechnology in which presentations were made by speakers from Russia, including Prof. Salambek Khadzhiev, Fellow of the Islamic World Academy of Sciences and former Minister of Petroleum Industries in the former Soviet Union; as well as speakers from Iran and Tatarstan.

The IAS has long realised that the relationship between scientists and journalists remains difficult, sometimes even hostile. There are complaints on both sides - scientists doubt the ability of journalists to report accurately and responsibly on their work, while journalists complain that scientists are bad communicators, hiding behind argot. It was principally for this reason that a special session was arranged on the second day of the conference in which a number of science journalists, including representatives of the World Federation of Sciences Journalists (WFSJ), presented short communications on how they thought science and the scientific endeavour were perceived by the media. The main conclusion drawn from the session was that scientists who used the media effectively saw advantages in having a media presence for themselves, their projects, and their research organisations. The media, it was reiterated, was an effective means to popularise science, reach research funders, bureaucrats, and other scientists around the world.

The 'Role and Functions of Academies of Sciences' was the theme chosen by

the conference organising committee for an exciting session which was organised in the afternoon of the second day in which the representatives of no less than ten academies of sciences from around the world including the French, American, Malaysian, Pakistan, Palestine, Tatarstan, and the Romanian academies of sciences presented short overviews of their academies and their respective outlooks for the future.

The main objective of this session was to compare the different models of academies of sciences that exist worldwide; the Soviet style academy of sciences, the Anglo-Saxon model as well as the international or the global model as classified by the InterAcademy Panel; which includes the Islamic World Academy of Sciences and TWAS.

A major objective of the specialised symposium which was organised by the IAS in collaboration the UNESCO and the Kazan State University on the third day of the conference, was to address the question of why the Islamic civilisation – which enjoyed almost five centuries of scientific superiority – did not undergo a European type renaissance. This issue was addressed at this special symposium by a number of world-class speakers who represented a number of schools of thought and included; George Saliba, Mehdi Golshani, Charles Falco and Mazhar Qurashi. The symposium was chaired by a good friend of the IAS; Academician Dato Ir Lee Yee Cheong, who has been the force behind this series of ISSTI (International Islamic STI) Symposia, with IAS Fellow Prof. Shamsheer Ali rapporteur.

At the conclusion of the three-day conference, which also included a number of side-meetings and site visits, the IAS adopted the IAS 2008 Kazan Declaration on *Science, Technology and Innovation for Sustainable Development in the Islamic World: Policies and Politics Rapprochement*.

## **Declaration**

The declaration stressed that Islam promotes a balance between all living creatures and their life-sustaining environment and that realizing prosperity and socioeconomic advancement is at the core of the Islamic governance philosophy. It further emphasized that some Organization of the Islamic Conference (OIC) and developing countries have developed a vision that links their future to their STI development, while others have not given due priority to this issue.

The declaration emphasized that science and technology are not exogenous factors that determine a society's evolution independently from its historical, social, political, cultural, or religious backgrounds. They are *the* tool within humanity's reach for the fulfillment of human needs while maintaining the quality of the natural environment indefinitely, i.e. the means to master that socioecological process that has been defined as 'Sustainable Development.'

The significant obstacles to science and technology in OIC-Countries were again highlighted in the declaration, including; lack or inadequacy of up-to-date STI policies, lack or inadequacy of resources, infrastructure and institutions; and gender imbalance in science and technology. Steps to facilitate the transfer of resources to enhance domestic capacity building in developing economies were called for.

The declaration urged the international community to support opportunities for developing countries to grow in a way that reinforces environmental protection and social development by increasing their market access, especially in sectors where sustainable development is likely to benefit from economic liberalization.

The IAS Kazan Declaration moreover called on the international community to again address climate change describing it as an urgent challenge that requires international cooperation to achieve the mitigation levels envisaged under the Kyoto protocol.

The declaration acknowledged that the media has a significant role to play in promoting science and technology. Scientists need to communicate with the general public, policy-makers, and the media while scientific institutes need to open communication lines with the outside world. It called upon universities in OIC countries to examine the possibility of teaching science communication as a specialized discipline while science conferences and seminars need to engage more with journalists and the media.

On the topic of the ‘History of Islamic Science,’ the declaration recognized that historians of science have propagated a number of theories related to the rise and possible decline of Islamic science.

A need to revisit this issue has risen not only to highlight the contribution that the Islamic civilization has made to world civilization, but also to learn about the deep rooted underlying reasons for this decline in order to learn from the lessons of the past, as well as promote harmony between cultures and peoples in today’s tension ridden world, the declaration re-iterated.

The IAS 2008 Kazan Declaration pronounced that it was imperative that the interest of the OIC science community, and ultimately the public, is rejuvenated in what has become known as the accepted narrative of the ‘Rise and Decline of Islamic Science,’ and perhaps to question what has been described as the classical narrative including some theories related to the subject.

Furthermore, the IAS, in the declaration, expressed its deep concern for the safety and well-being of all Iraqi scientists, academics and educationalists both inside and outside Iraq.

As part of the follow-up action to the conference, the IAS will circulate the IAS 2008 Kazan Declaration to concerned individuals and relevant agencies throughout OIC and developing countries, so that measures are taken to put into action the ideas proposed at the conference.

The Academy will also publish the complete proceedings of the conference in

a quality volume that will be distributed internationally.

Through IAS Fellows, personal contact and correspondence, the IAS will promote the concepts promulgated at the conference among the decision making circles of the Islamic world, and will provide whatever help it can to get the various recommendations implemented.

**PART ONE**  
**STATEMENTS AT THE INAUGURAL SESSION**





# **Address of**

## **His Excellency Mintimer Shaymiev**

### **President of the Republic of Tatarstan**

**Doctor Abdes Salam Majali**

#### **Participants and Guests of the Conference**

With all my heart, I welcome you to the hospitable land of the ancient capital of Tatarstan

It is for the first time that we are hosting such a representative Islamic Forum in the Russian Federation, and we are grateful to the Islamic World Academy of Sciences for choosing Kazan as a place of for the conference



I am confident that this choice is not accidental. Tatarstan successfully develops scientific-technical, trade and economic and cultural relations with many Muslim countries. We are united by centuries-old historical and spiritual traditions that advance understanding and constructive dialogue

In AD 922, our ancestors adopted Islam due to the active efforts of envoys of the Baghdad caliph al-Muqtadir Billah to Volga Bulgaria. Because of its advantageous geographical position Volga Bulgaria had a wide range of contacts with Arab countries in the Middle East. The Islamic civilization became a foundation for spiritual and material development of Tatars and many Turkic peoples in Eurasia. The evidence of that manifests itself in the many beautiful items of our cultural heritage

The orientalist, academician Vasily Bartold called our land; the northernmost outpost of the Islamic World. It was so for centuries, and today - in the condition of globalization - Tatarstan is trying to make its contribution to strengthening of relationships between Russia and the Islamic World, between the West and the East

In 2005, Russia obtained observer status in the Organization of the Islamic Conference (OIC). Tatarstan is rightly proud of its contribution to the development of relationships between the Russian Federation and this influential organiza-

tion and takes the lead in joint undertakings and projects. Our republic is an active participant in the work of the Group of the Strategic Vision “Russia – the Islamic World.” We interact with the Arab League, IRCICA, the Research Centre for Islamic History, Art, and Culture, and other organizations. We promote stronger collaboration with the Muslim World in every possible way, reconfirming our mission as Russia’s Eastern Gate. We see the international conference of the Islamic World Academy of Sciences with its 57 OIC member countries as an opportunity to consolidate our joint efforts in order to create new conditions for development of science and technology. This event is an example of unity of scientists from all over the world in the name of successful joint actions and achievement of common goals

Today, Tatarstan is one of the dynamically developing regions of the Russian Federation, a large centre of Russian industry, engineering, oil production, petrochemistry, aircraft and automobile construction and agriculture. Last year saw the extraction of the three billionth ton of crude oil being extracted in the republic. Tatarstan manufactures heavy trucks (Kamaz) that are well known as winners of the Dakar Rally, our helicopters are in demand in many eastern countries. The republic is the largest producer of synthetic rubber, polyethylene, polystyrene and other polymers and chemical products

Scientific research centres and universities are also the pride of the republic. Starting from the 10<sup>th</sup> -11<sup>th</sup> centuries, maktabas and madrasas (Muslim educational institutions) operated in big cities and villages of Volga Bulgaria, then the Kazan Khanate, where principles of the Holy Qur’an, philosophy and natural sciences were taught, and treatises of Al-Kindy, Ar-Razi, Al-Khorezmy, At-Tabari and other great authors of the Arab world were studied

Tatar scientific thought of the 17<sup>th</sup> -18<sup>th</sup> centuries gained international reputation. Its representatives: Qayum Nasyri, Shihabuddin Marjani, Rizaetdin Fakhreddin and others had influence on the development of Islamic theology, education and history. The Tatar theological school was truly established and further development of religious education and charity took place

In the 1820s, the great mathematician and the head of Kazan Imperial University Nikolai Lobachevsky made a discovery of universal importance in developing non-Euclidean geometry. It was Kazan where Soviet organic chemistry came into existence as a worldwide scientific school, thanks to the efforts of the university graduates: N. Zinin, A. Butlerov, G. Kamay and others

Kazan physicists discovered the effect of paramagnetic resonance that underlies construction of medical tomographs

Since 1807, the Oriental Division, the first educational institution of oriental studies in Russia, operated in Kazan State University, having become the largest

.such centre in Europe and home to domestic Arab and Turkic studies

Educational institutions, ethnic and cultural variety, traditional high level of education of Tatars created favorable environment for professional linguists and .large-scale research

Today, activities of our leading institutes of higher learning and research centres coordinated by the Tatarstan Academy of Sciences are aimed at solving issues of innovative development of the republic, developing advanced manufacturing sciences, active integration of science, education and economy as well as establishing international contacts and relations including the scientific community of .the Islamic world

I believe that prospects of the Muslim community first of all exist in the sphere of new knowledge and innovative technologies. During the Golden Era, Arab scientists played a key role in the development of civilization and world science. While guided by rich experience and religious traditions accumulated through many centuries, it is important to continue to develop and multiply them as a .source of knowledge

Herein we should strictly follow the covenant of Prophet Mohammed: “learned persons on the Earth is comparable with stars on the sky.” May these stars shine brightly, radiating warmth and reviving hope in people’s hearts for a peaceful, .bright and safe future of humankind

I hope our conference will give strong impetus for creating a model of constructive endeavour and collaboration, integration into united scientific and technical space, accomplishing scientific investment policy directed to science intensive economy and high-technology production

Today, the process of spiritual renaissance is in progress in the Russian society .as well as in Tatarstan and Islamic theological ideas are developing quickly

Over the last 10-15 years, studying history and the current state of Islam has developed into one of the important scientific trends. Three big institutes of humanities operate under the Tatarstan Academy of Sciences focusing on study of tangible and intangible culture of the Tatars, their centuries-old history in the context of Russian, Islamic and world civilizations. We are also opening a special .research centre for Islamic studies under the Tatarstan Academy of Science

Russian Islamic University plays a significant role in developing traditional .teaching of Islam and preparing its own scientific and teaching personnel

This March, in my speech at the King Faisal Centre for Research and Islamic Studies, I offered to organize an international Islamic conference in Kazan next year and devote it to the creative role of Islam in the modern world and dialogue

between Eastern and Western cultures. I hope that this initiative will find understanding and will be supported by the Organization of the Islamic Conference

Participants of the conference, guests of Tatarstan! Today in this hall, we are having outstanding representatives of Islamic countries who work on resolution of global problems, who appreciate values shared by all humankind, peace and harmony, preserving friendly relations with all countries and peoples

I am sure that consolidation of intellect, talent, greatness of spirit of Islamic scientists aimed at the well-being of science and progress will bring its fruitful result

I sincerely wish you successful work, good health and prosperity

**Message of**  
**His Excellency Mr Mohammad Mian Soomro<sup>1</sup>**  
**President of the Islamic Republic of Pakistan**  
**Patron of the Islamic World**  
**Academy of Sciences**



Spectacular advances in science and technology in the last several decades are rapidly changing our lives in almost every sphere of human endeavour

The development of agricultural biotechnology has allowed the production of high yielding and disease-resistant crop varieties. New varieties of cotton have been developed (Bt-cotton) which have the ability to naturally produce pesticides from within the plants.

Genes from bacteria with the ability to producing vitamin-A have been incorporated into a number of edible crops, thereby addressing the problem of night blindness in those children who do not receive doses of this vitamin

New varieties of crops, resistant to drought and salinity are being developed, opening up possibilities of growing edible crops in saline soils. Advances in health biotechnology are allowing the mapping of the entire human genome rapidly and relatively cheaply, thereby heralding an era of pharmaceuticals tailored to individual human genomics profiles

Advances in stem cell research have opened up possibilities of curing damaged tissues in the heart, liver, kidney and other human organs. New composite materials lighter and stronger than metal alloys are being developed which are being increasingly used in aircrafts, automobile and other industries

Information Technology has transformed the world into a global village, and Pakistan is one of the few countries in the world today benefiting from these advances. Every student in all public sector universities in Pakistan has access to 23,000 international journals and 45,000 textbooks and research monographs

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<sup>1</sup> Delivered by Dr M. A. Mahesar, Assistant Co-ordinator General, COMSTECH, Islamabad, Pakistan.

.through the Digital Library programme of the Higher Education Commission  
The installation of video-conferencing facilities in universities in Pakistan by the Higher Education Commission has also resulted in lectures being delivered daily from technologically advanced countries in real time, with students having the ability to ask questions face-to-face interactively from a professor who may be thousands of miles away. These and other exciting advances talking place are .opening up huge possibilities for the development of the Ummah  
Unfortunately it is a stark reality that we in OIC member countries have failed to invest in knowledge, with the result that we are paralytically dependent on the West for most of our needs, be they pharmaceuticals, engineering goods, industrial .machinery or our defence needs  
It is high time that we created world-class universities and Centres of Excellence within the OIC member countries so that we can transition to knowledge economies .where innovation determines progress  
I hope that the 16<sup>th</sup> IAS Conference will deliberate on some of these issues and the scientific community in OIC member countries will be able to mobilize support and create the necessary political will amongst our leaders to invest mas- .sively in higher education, science and technology

**.Thank you**

**Address<sup>1</sup> of**  
**His Royal Highness Prince El Hassan Bin Talal**  
**of Jordan,**  
**Founding Patron of the**  
**Islamic World Academy of Sciences**

بسم الله الرحمن الرحيم والسلام عليكم ورحمة الله  
وبركاته

**Dear Friends,**

The world needs new ways of thinking about current challenges, and we need the wisdom of illumination coming from the East to affirm our shared humanity and uphold our unity in diversity, a movement parallel to what Karen Armstrong referred to as the wisdom of the ancient 'Axial Age' when humanity conflicts came into being through the insights of diverse yet complementary traditions. It is this new value base that I attempted to present to the United Nations General Assembly this year in the context of the 60<sup>th</sup> anniversary of the Declaration of Human Rights.

In our interconnected world and with the need for all to share the planet resources, it is essential for us to realize that the solutions for our problems require a consensus on a global code of conduct and ethic of human cooperation. As a member of the Independent Commission for International Humanitarian Issues and with representatives from twenty-eight nationalities, we presented the United Nations General Assembly in 1983 with a document entitled Winning the Human Race?, in which emphasis was made on multilateralism as a means to strengthen hope for a better future for all.

In May of this year I addressed the United Nations General Assembly with



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1 Via video-link.

the aim of shifting focus from state security to human security. In an intra-independent world security issues such as population growth, poverty, food, resources, ecology, migration, energy, peace and cultural understanding need to be addressed not just through the public and private sectors, but through engaging a third sector as well, the Commons, a powerful countervailing force dedicated to ensuring human security, cooperation, and sustainability across borders. The responsibility for such transnational issues must be taken on by individuals, communities, and civil society as well as international organizations, regional systems, and networks, to develop a common global action plan. The third sector exists in the interconnectedness of Global Commons – in the intersection of society and nature, education and employment.

The Coalition for Global Commons was launched in March 2008 in Berlin with a vision of an intra-regional citizens' conferencing so that conversations would not just be held between the intelligent few but rather be developed through collective knowledge and collective wisdom. In this context I would like to say that it is essential for us today to develop collective intelligence to enable our region, that is to say the West Asia region, and our neighbouring regions, South Asia and indeed Southeast Asia, to develop an Asian response to the systemic development of science and technology on the one hand, and research and development on the other.

Educating for life is an essential answer to educating for employment, and in this regard emphasis should be made on the importance of supra-national thinking, that is to say teaching by analogy – an approach of the Erasmus Mundus programme – where we place the rich in the shoes of the poor, and where we think of our neighbours' resources in the context of a regional call for a supra-national community of water and energy for the benefit of humanity. This is how Europe spoke of building bridges after two devastating world wars, with a community of Coal and Steel.

In an attempt to address environmental issues and climate change, in particular the ILO-initiated the "Green Jobs Initiative" to emphasise the importance of a green foundation. Important for that issue is Paul Volcker's emphasis on an asymmetric approach, that is, not only looking at investment per se as a yardstick of development, but looking at the importance of investment in human capital. Climate change is accelerating due to human activity, affecting all life on earth. It is with this in mind that I express my belief in the intersection of society and nature and the importance of speaking of global warming in the context of human warning as a form of exercising our responsibility towards the other, whether society or nature.

The human dignity deficit is widening by the day, and not least is the gap between the rich and poor. Yet when examining the impact of globalisation, it is not only good economic governance that is to be addressed, but the importance of making the law work for everyone as well. In looking at the Millennium Development Goals I look forward in September to addressing this subject once again at the General Assembly, that is to say empowering the poor. As a member of the



Commission on the Legal Empowerment of the Poor it is important to say that legal empowerment is the eradication of legal illiteracy in order to protect the poor and enable them to advance their interests as citizens.

I do want to emphasise that we are seeking not science as a franchise from the rich to the poor, but science as a partnership in developing our own resources and with hope participating in Global Commons in 2012 in the context of probity and answering clearly with our own convictions where we have failed and where we have succeeded. Only through this broad conversation, promoting the noble art of listening, can we overcome the fragile confrontation of cultures where we speak of Islam and the West or Islam and the rest.

In terms of our Islamic humanistic approach, it is essential to develop a democracy of doers and to move from the intelligent few to the intelligent many. In this context it is essential to develop collective intelligence in the many disciplines that are affecting us through attempting to close the human dignity deficit and emphasizing that economy means developing the grassroots capabilities of participation by future generations.

It is essential to create a basis for a culture of peace within a context of just law, and although some may say that law does not address the poor, it is essential to emphasise that the time has come to live up to international standards and international criteria of accreditation and of dissemination of knowledge in the context of an interconnected world. The time has come to interconnect our objectives in promoting science as a template for progress.

I shall not address science as a mere objective, conceptual image of reality divorced from its cultural context, but rather as the essence of this great cultural movement which we normally call modernity, which has by no means spent itself, despite post-modernism.

In a sense science is an objective enterprise, but not wholly so. In view of its internal mechanisms and methodologies it is a quintessentially intentional activity in two senses, in that it is intensely oriented towards its object and structurally determined by it. Otherwise, it would not be science – i.e., the systematic production of knowledge. However, even though mature science is determined by its object in its essential content, it is existentially determined by society and culture. By that I mean that science can only exist within specific socio-cultural contexts, and dies out without them.

Hitherto, the context within which mature (modern) science has existed is so-called modernity, which is a comprehensive cultural movement that characterizes the modern epoch (1492 to the present). In fact, science constitutes the soul and essence of modernity. Science has become the prime productive force and generator of cognitive structures in society. All other productive forces are increasingly becoming dependent on science and generated by it. All cognitive structures are imprinted by science, whether positively or negatively.

The challenge facing Muslims today is not appropriating science as such, or in isolation, but in appropriating modernity with all that this entails for Muslim cultures and religious values and ways of thought. This is the real challenge that

should be met without losing sight of Islamic humanism and its lofty ideals.

Modernity is alien to us today. It will remain so as long as we fail to come to terms with the rational kernel of our own heritage. That is not to say that modern rationality is a mere replica of Arabic Islamic rationality. The former is a veritably new and revolutionary cultural phenomenon. However, there is a genuine affinity between the two, both historical and spiritual, and reclaiming our rationalist, humanist heritage, which has been banished for too long from our cultural space, could be a starting point and catalyst to accept and meet the challenges of modernity.

## **Development and the Ontology of Social Being**

Development, sustainable or otherwise, can never be an automatic, purely technical and mechanical process. It is not markets that create development, but consciously acting groups and classes of human beings. Thus, the way such active groups and classes view themselves and their societies enters in an integral manner into the very fabric of their developmental schemes and actions. To put it in a more philosophical manner of speaking, the ontology of our social being is an essential ingredient of our developmental plans. In social action, the subjective is an essential ingredient of the objective, even if it is often veiled with a barrage of technicalities. Basically, from the point of view of sustainable development, there are two broad perspectives on the ontology of social being: the Fetishistic and the Humanistic.

Fetishism tends to view society as being, in essence, a complex machine that runs in total indifference to human action, which it views as a mere cog in this machine. Of course, it is difficult to escape this conclusion regarding modernity or modernistic society. However, the problem does not reside in recognizing this essential dimension of modernity, but rather in ontologising it – i.e., in considering it not as a passing historical phase, but as a necessary ontological basis of the human condition as such. Basically, fetishism tends to ‘thingify’ social relations, and endow these ‘thingified’ relations, such as commodity, money and capital, with human traits and powers. Thus capital, rather than human labour and action, are viewed as the subject and object of social development and modernization. It also leads to an atomized view of society, which tends to foster atomisation in reality. Society is fetishistically viewed as an ensemble of atomized individuals related via the ‘eternal’ market. This tends to deprive society of its historicity, cultural specificity and materiality. For example, Southern social formations are treated as though they differed from Northern societies in degree only. Thus, the same ‘universal’ recipes are applied to them in total disregard of their cultural and socio-economic specificities, wreaking havoc and confusion in the process.

The principal defects in these fetishistic views and development plans are: (i) their reduction of the process of development from a grand historical project to a mere appendage of government policy; (ii) their total disregard of social consciousness and the necessity of its modernization for modernizing the whole of society.

Viewed humanistically, society is not a mere ‘mechanistic universe’ – a machine running on its own in total disregard of human volition and action – but is a structure of human practices, which means that the essence of society is human practice and relations. From this humanistic perspective, the importance of mass action guided by social consciousness is revealed. Any social change is effected through social consciousness and practice. Thus, the latter enters the processes of social change as a necessary ingredient. A genuine process of modernization must entail the modernization of social consciousness. However, the latter is not isolated from the overall process of development and historical change; it is a product of countless leaps and breaks, both direct and indirect.

### **Science and Social Consciousness**

By social consciousness, we mean the ways social groups in a given society view their world, respond to it, and act on it – i.e., the cultural and intellectual mechanisms that inform social action. By the modernization of social consciousness, we mean the creation of a scientific, rational, social consciousness capable of meeting the challenges of modernity, including the problems of poverty, unemployment, productivity and social peace. It is a social consciousness that has acquired its post-scientific essence and rationality via suffering modern, scientific, and intellectual revolutions both structurally and internally – a consciousness that has been shaken and revolutionized by the cultural challenges with which scientific rationality confronts all pre-modernistic traditions. In fact, scientific rationality is a permanent revolution, a constant questioning, both theoretical and practical, which constantly negates the actual in favour of the potential. It is this critical essence which traditional societies find hard to assimilate but cannot do without, in view of its essential link to modernity.

However, assimilating this critical, rational kernel is not a matter of governmental decrees and policies, but rather a complex cultural revolution in the context of a complex transitional historical process. The most notable model of this process is the modern European (Western) model. The modern West has modernized itself – i.e., achieved the transition from pre-modernity to modernity – via a series of turns which may be classified into three types: economic (agricultural and industrial revolutions), political (Dutch, English, American, and French Revolutions), and cultural (Renaissance, Reformation, seventeenth century Scientific Revolution, the Enlightenment). A pivotal role in shaping modern Western consciousness has been played by the scientific revolution of the seventeenth century. This revolution was not a mere revolution in physical theory, but rather a fundamental socio-cultural revolution that ushered in new relations of force and a new perspective and philosophy. It was a comprehensive critique of all aspects of life, via which the scientific method was given prominence at all societal levels, and materialized into production-related institutions. In particular, this revolution succeeded in transforming Western cultural discourse from the pre-scientific, pre-Modernity variety to the post-scientific, post-modernity variety. The latter are

not necessarily embodiments of scientific rationality as defined by the Enlightenment, but even its irrational discourses are imbued with the spirit and techniques of the scientific method.

This irreversible transformation left its mark on all aspects of Western life and distinguished it unmistakably from all other cultures. In particular, the Arab world has markedly failed in effecting such a transformation in the last two centuries. Its intelligentsia and cultural discourses are still pre-scientific and pre-modernity. Thus, a fundamental and urgent task facing the contemporary Arab world is how to modernize social consciousness (cultural discourse, the Arab intelligentsia) within the context of modernizing society at large? It is my contention in this paper that one of the crucial mechanisms for modernizing Arab social consciousness is Occidentalism, the antithesis of Orientalism.

### **Occidentalism versus Orientalism**

If we define Orientalism as the mechanism whereby the Occident prepared its social consciousness for appropriating, colonizing and reshaping the Orient, Occidentalism may be defined as the contrary mechanism, whereby the Orient would prepare its social consciousness for appropriating, critically digesting, and reshaping its relationship with the Occident.

However, the marked disjunction between subject and object in the Occidental-ist mechanism makes the latter a dangerous, explosive, yet necessary, adventure. The pre-scientific Oriental subject is basically an ahistoric, finite, constrained, and impotent (passive) subject. When it engages the modern Occident, it encounters a historically dynamic, infinite, self-centered and creative subject-object, which ascribes to man all the powers and traits that were previously ascribed to God, including infinity and the power to create. The Oriental subject is most likely shattered by this overwhelming experience. It fails miserably to grasp its subject-object. It is given a choice; either it rejects the Occident and imprisons itself in its imagined emaciated past, or it reconstitutes itself at a higher level to meet the challenge again. The latter path is the path of Occidentalism. It is a continual process of deconstruction, reconstitution, and critical appropriation, oriented towards absolute negation and infinite openness. Of course, the danger of nihilism is always present, but this constant striving could lead to a modernized, modernistic, critical, scientific social consciousness, endowed with modernistic powers of knowing and acting, and capable of meeting the challenges of modernity, including the construction of a dynamic polity, state and productive base.

The Orient is crushed under the spell cast by both its ancient heritage and modern Occidental culture. To remove this spell, it has to critically appropriate both its heritage and the Occidental other.

This is the path of Occidentalism. The alternative is to remain a mere appendage to a pre-scientific imagined past, or a pre-modernistic image of modernity, or to both.

## **Islamic Humanism**

One of the lasting contributions of the Algerian philosopher Muhammad Arkoun is his penetrating excavations of Islamic heritage and his illumination of humanist trends in the golden age of Islamic civilization. In fact, this broad and deep humanism runs through many intellectual currents in Islamic civilization before the advent of Islamic decline and strict theological dogmatism. The essence of this Islamic humanism is a deep and broad acceptance of the world and a deep and broad love for, and affinity with, the human essence qua human. This humanism sunk so deeply into the Islamic psyche that it turned into a distinctive literary and intellectual style and way of thinking, evident in such writers and thinkers as: Ibn Muqafa, Jahiz, Tawhidi, Ibn Maskaway, Farabi, Ikhwan Al-Safa, Biruni, Suhrawardi and Ibn Araby amongst many, many others. It is this universal spirit, very much reminiscent of the humanism of the Illiad and Tolstoy, that was dismantled, together with Islamic theoretical reason, some five or six centuries ago. And it is this spirit that we should reclaim for Muslims and the world at large. Our Occidentalist project should simultaneously entail both the critical appropriation of modernity and the critical reclaiming of a lost spirit-Islamic humanism. This Great Spirit has been completely lost by Muslims and partially lost by modernity, as was realized principally by the late Roger Garaudy. Modernity has transcended traditional cultures, opening up an infinite space of possibilities, but has simultaneously limited and narrowed down certain important dimensions of human existence. From this perspective, Occidentalism is not a mere appropriation of modernity in its permanent solidity, but is fundamentally a transformative process that simultaneously transforms modern Islamic consciousness and modernity itself towards a modern version of Islamic humanism. This is a golden opportunity for the Islamic World to contribute towards solving the perennial problems of modern man, by modernizing the Islamic World and humanizing modernity simultaneously.

## **Sustainable Development via Democracy**

Sustainable or humanistic development (in the sense of Farabi, Biruni or Ibn Araby) turns into its destructive opposite if it is not organically and necessarily accompanied by the empowerment of ordinary people, the ordinary man or woman in the street, the worker, blacksmith, carpenter and mason. Thus, the crucial question in this respect is: How do we empower the common man or woman?

Of course, this question is the fundamental question of democratic discourse, at least in its original Athenian form. Unfortunately, it has been smothered in modern democratic discourse by an emphasis on mechanisms and formalities, including the election process, parliament and free enterprise.

We should revive this lost question, both on the economic and political levels. The first step towards genuine democracy – empowering the ordinary man or woman – is building an institutional framework for protecting the individual citizen from the tyranny of both the market and the state. The latter might very

well be necessary evils in the modern world, but they should be delimited and constrained. The essence of democracy is constraining potentially repressive economic and political structures. Creating a network of NGOs and civil societies within the framework of a global civil society could be an effective means to curb the tyranny of both the state and the market, and create conditions for empowering the people, the individual working citizen.

This vision could be extended to sustainable development. We have witnessed many cases of development based purely either on the state or the market. To what extent have they actually succeeded? A quick survey would show their successes have been very uneven, relative and short-term. However, all of them share this evil, that their human cost has been exorbitant. The greater their output in material terms, the greater their human cost and the greater the degree of dehumanization they have wreaked. The real challenge facing us today is how to effect development with a human face; how to reconcile material with spiritual well-being; how to humanize development and modernity; how to develop without compromising our human essence; how to progress without having to pay such a high spiritual price. Creating this third sphere of empowerment, and having it play an active role in global development, could be a step forward in the right direction. By cooperating positively with states and markets and delimiting their tyranny at the same time, this sphere could start a new type of development that will further the cause of man, instead of nihilistically negating his human essence. I believe that the Islamic World could play a major role in realizing this new project of sustainable development. But first, it must meet the challenge of modernity and learn how to modernize its cultural and intellectual forms, whilst working towards reclaiming its lost humanist, rationalist soul for itself and for the entire world.



**Address of  
His Excellency Prof. Abdel Salam Majali FIAS  
President of the  
Islamic World Academy of Sciences**

**Your Excellency Mintimer Shaymiev-  
President of the Republic of Tatarstan,  
Excellencies,  
Fellows of the Islamic World Academy of  
Sciences,  
Distinguished Guests,  
Ladies and Gentlemen**

السلام عليكم ورحمة الله وبركاته

It is an honour for me to greet you all here in Kazan. We are here at the invitation of His Excellency President Shaymiev, whose patronage we highly appreciate. We also salute Prof. Akhmet Mazgarov, President of the Tatarstan Academy of Sciences, who deserves the utmost praise for joining us to convene this landmark international scientific event.



Our assembly in this historical city, which is embraced by the great Volga and Kama Rivers, aims to address a number of scientific themes. The title of today's conference clearly states our goal: to re-establish harmony between scientists, the decision-making community and the public. This is particularly relevant in countries of the South, where many of our decision-makers have not seen the 'light of science,' in their quest to realise sustainable development.

Luckily, this goal is not too difficult to achieve. All those present here today firmly believe, I am sure, in the power of science and research. We believe in the benefits of knowledge creation and dissemination for the advancement of our societies and for reaching sustainable growth.

**Excellencies**

**Dear Colleagues**

Of the many issues plaguing the world today is global poverty and environmental degradation. These come together in the cause of sustainable development. Have we been bold enough to tackle the causes of poverty and degradation? I think not.

At Rio, in 1992, sustainable development was put squarely on the world agenda. In 2002, in South Africa, the international community met again at the World Summit on Sustainable Development and more was achieved. However, in truth, we are still not meeting the scale of the challenge.

In thirty years' time, there will be two billion more people on the planet. Already 40% of the population is short of fresh water; on current trends this will rise to 50% by 2030, in west Asia it will be 90%. One-third of the world's fish stocks and one-quarter of the world's mammals are threatened with extinction. There are already over a billion urban slum dwellers with the population of the world's cities due to rise by another billion by 2010. The World Summit did much to address these issues. But, it is becoming clear that we have a profound choice as an international community to continue to make modest progress or act decisively.

We need a new international mindset that enables us as nations, acting collectively, to address these issues: to help the poorest countries develop and to promote a fairer allocation of wealth and opportunity. And, we also need a new international consensus to protect our environment and combat the devastating impacts of climate change.

The essence of sustainable development lies in tackling climate change and other environmental challenges without compromising economic growth or the quest for higher living standards for the poorest in the developing world. Economic development, social justice and environmental modernization must go hand in hand. Through science and technology, the world has realized that it is possible to break the relationship between economic growth and ever-rising pollution.

I would add that we must again highlight the ways in which science can help in developing and promoting the specifically human dimension of man, society, and the environment. At the same time, we should also discuss the ways in which, in certain situations, use, misuse and abuse of science can be responsible for a decline in the quality of life, as happens in the case of damage done to the environment, the consequences of the invention and use of sophisticated weapons, etc. Here, I would highlight UNESCO's commendable efforts in developing the Biological Weapons Convention (BWC), and the Code of Conduct for Scientists.

## **Excellencies**

### **Dear Colleagues**

Worldwide, the cost of the damage from extreme weather events last year reached billions of dollars. UNEP has estimated that economic losses from severe weather events have doubled every decade. At this rate annual losses will reach \$150 billion within ten years.

What else? The latest report from the Intergovernmental Panel on Climate Change indicates that global warming went up by up to 6 degrees this century - the impacts are devastating, particularly in the developing world. We might face a situation in which 50 million people in Asia could be killed or displaced



by floods, South of Africa could be reduced to desert, and we will have massive deforestation in central and South America, and huge increase in diseases, particularly malaria.

In Kyoto, 1998, world leaders signed up to targets and timetables to address climate change. That was an enormous achievement, but it was not enough. Global emissions of greenhouse gases have risen 10% since 1990, with a 35% increase in the countries of the South.

And then, there is the question of energy. I come from an oil poor solar rich semi-arid country in the Middle East: Jordan. During the last 12 months, we have witnessed huge increases in oil prices, although abundant oil resources exist all around us.

At the IAS Sarawak Conference of 2003, we learnt about the ability of hydrogen to replace fossil fuels, especially in transport. This discovery will also transform our energy system - and offers a vision of a transport system that is completely clean - with no exhaust emissions. Of course, this is still some way off. We need to make further advances in technology and infrastructure before it can become a reality. The possibility exist now to manufacture hydrogen from natural gas or biofuels, which coupled with fuel cell technology, could offer a reduction in emissions of up to 50% compared to conventional vehicles. The possibilities for scientific advance are there but they do require urgent investment.

Are these solutions expensive? Not against the scale of the problem. And, it is a myth that reducing emissions makes rich countries poorer. The majority of European economies grew while emissions have decreased.

## **Excellencies**

### **Dear Colleagues**

We now witness intensified conflicts on a global scale – congestion, clash of cultures, terrorism and social turmoil – apart from the ever present competition for resources and conflict for the control of finite resources.

While clashes on a regional scale have been common throughout history, the increasing intensity as well as frequency of global conflicts may partly be attributable to our immense success in harnessing science and technology. The conflicts may have come about because the pace of technological change far exceeds the pace of social and cultural adaptation.

The 2007 Budapest World Science Forum, in its final declaration, highlighted a number of needs that we have to address on the current global science and technology scene. I will highlight only three. These, I feel, are pivotal elements in our quest to re-establish harmony between the scientists and decision-makers for sustainable development and more international co-operation:

- *A need to face clearly the challenges of sustainable development. We need further efforts to define what it is meant by sustainability, and to*

- *see what limitations to growth sustainability entails;*
- *A need to see clearly the place of competition and cooperation in the development of global science. Both for scientists and for practitioners of science policy, it is crucial to see the relative merits of the two, it is vital to clarify when and where to compete and when and where to cooperate;*
- *Freedom and mobility in science. That entails the need to support movement of people, ideas, a free access to journals, patents, and infrastructures.*

## **Excellencies**

### **Ladies and Gentlemen**

As scientists, and as scientists who belong to the Islamic World, we are aware of what advancement means. Our civilisation is amply endowed with examples of prolific scientific achievements that had an impact on life. From Al-Khawarizmi's Algebraic theories to Al-Zahrawi's surgical techniques. Indeed from the very early days of Islam when simple science was put to serve the cause of *Aqeedah*, concepts rose of how technological advancement affected our lives. It is this ideology and worldview that provided a most powerful source of inspiration, especially for man's quest for knowledge.

Recently, the question of why our civilisation – which enjoyed almost five centuries of scientific superiority – did not undergo a European type renaissance was raised again. This, in a typical multi-disciplinary fashion, is what we will also try to answer in this conference with the help of such eminent figures as George Saliba, Mehdi Golshani, Charles Falco and Mazhar Qurashi. What is the problem? Why has this drawback persisted for so long? In OIC countries, are we today in similar state of fragmentation as we were in the post dark ages era?

Perhaps in revisiting the issue, we can better navigate our way through our science and technology future.

## **Excellencies**

### **Ladies and Gentlemen**

Science for sustainable development has become the template for scientific organizations, academics, ministries of science and technology, and science academies. The knowledge that science can generate is a prerequisite for a sustainable and bright future. For this, we need research – research that takes a holistic perspective and brings together different disciplines and research communities.

It is the intention of the IAS to be a champion for stimulating and engaging the basic sciences in support of sustainable development, especially through capacity-building, knowledge-sharing and promotion of international and regional cooperation. As one of a number of academies of sciences promoting interest in basic sciences on a regular basis, the IAS has a unique role to play in

this area, not only by identifying and disseminating best practices but also by fostering synergies between modern science and local knowledge systems.

Academies of sciences realize that they have a serious role to play in raising the awareness of the decision-maker and the public, and in helping people understand the importance of development and scientific advancement, and indeed helping in achieving socio-economic progress.

Yet, even today, the concept of an assemblage of brain power in the service of society, i.e. an academy of sciences, is still alien to many if not all those in the higher echelon of power in our world. Here in Kazan, here in countries of the former Soviet Union, the concept is better known than other countries. This is why in this conference, we want to again explore why and how we should view the role and functions of academies of sciences today, and in the future.

In 2006, a report by the Social Market Foundation (SMF) in the UK accused the UK media of sensationalising science. The report was particularly harsh on newspapers and journalists who tended to seek black and white stories and looked for certainties that could not be provided by science. The report made several recommendations for improving scientific understanding among the public:

- *Newspapers and broadcasters should employ more science graduates;*
- *Scientists and science graduates should be encouraged to undertake media training; and*
- *Universities should offer multidisciplinary science degrees which include issues of ethics.*

Dare I say that the bottom line is that we should try hard to bridge this divide between scientists and the media.

## **Fellow Scientists**

### **Dear Friends**

I have often said that the new millennium is only new in name. I dare say that this is no longer the case. Since the turn of the new millennium, the world has changed. New international dynamics asserted by the UNESCO Science Report of 2005 showed us that countries of the so-called ‘newly industrialized Asian economies,’ together with China and to a lesser extent India, have become serious contributors to the world’s R&D. They have joined the bandwagon of the production of scientific knowledge. In the USA, a country which is often cited as model in terms of science and research investment, companies ‘are running harder to succeed against global competitors in technology.’

One of Europe’s famous scientists, Nikola Tesla, once said: ‘The practical success of an idea, irrespective of its inherent merit, is dependent on the attitude of the contemporaries. If timely, it is quickly adopted; if not, it is apt to fare like a sprout lured out of the ground by warm sunshine, only to be injured and retarded in its growth by the succeeding frost.’

It is my hope that our gathering today is a timely one and that the sprout will grow up and succeed in making a significant contribution towards generating changes that are both necessary and desirable for the future of developing countries.

As a citizen belonging to this fast-evolving world, and as a medical doctor, I realize that intolerance, prejudice and bigotry can also be seen as forms of illiteracy and ignorance, eroding social values, eating away at our humanity and stamping on our sense of ethical obligations and duties - to one another and to the world as a whole.

Thank you for joining the IAS in its efforts in a spirit of open-mindedness.

**Address of  
His Excellency Prof. Ali Salehi  
(Assistant Secretary General (S&T  
of the  
(Organisation of Islamic Cooperation (OIC**

**Bismillah Arahman Arrahim  
Your Excellency Mintimer Shaymiev, the  
President of the Republic of Tatarstan  
Fellows of the Tatarstan academy of  
sciences  
Distinguished Guests and Participants of  
the 16<sup>th</sup> International Science Conference  
Excellencies Ladies and Gentlemen**



It is an honour for me and a privilege to represent His Excellency the Secretary General of the Organization of Islamic Cooperation (OIC) on the occasion of the 16<sup>th</sup> International Science Conference organized by the Islamic World Academy of Sciences and the Tatarstan Academy of Sciences under the patronage of His Excellency Mintimer Shaymiev, the President of the Republic of Tatarstan.

Let me begin by conveying to you the greetings and best wishes, for a successful conference, from His Excellency Prof. Ekmeleddin Ihsanoglu, the Secretary General of the OIC. Although, he was very much eager to attend this landmark event, however, due to pressing commitments, it was not possible for him to take part in this august gathering.

On behalf of the Organization of Islamic Cooperation and on my own behalf, I would like to once again express my profound gratitude to His Excellency Mintimer Shaymiev, the President of the Republic of Tatarstan, for kindly sparing his invaluable time to personally grace this occasion. His august presence at this ceremony is a clear manifestation of his keen interest in the activities of the Islamic World Academy of Sciences and the OIC in general and in the development of science and technology in particular.

My special appreciation goes to the sponsors of the conference namely; Professor Majali, President of the Islamic World Academy of Sciences; Professor

Mazgarov, President of the Tatarstan Academy of Sciences and my dear and dedicated friend Professor Zou'bi; for choosing a timely and pertinent theme; "Science, Technology and Innovation for Sustainable Development in the Islamic World," for this Conference.

**Excellencies,  
Ladies and gentlemen**

On the one hand, today, as we meet, the world, including the Muslim Ummah, is passing through a critical time. Its population as a whole is coping with various issues such as increase of energy cost, shortage of energy, climate change, environmental degradation, lack of access to clean drinking water, epidemics, regional conflicts and most lately shortage of food supply and the rising prices of food items, to name just a few. Never in the history of mankind were so many issues confronted globally and concurrently.

On the other hand, the dawn of the new millennium has been a historic turning point for mankind.

It has marked the beginning of a new era of globalization and knowledge based economy, which confer very high priority to the role of Science, Technology and Innovation. In this highly competitive world, the youth of the Islamic Ummah must be equipped with the necessary knowledge and expertise, especially in the area of new and cutting edge technologies. Therefore, special emphasis must be given to the education programmes in disciplines such as basic sciences and engineering in order to boost technological research and industrial development.

This conference lends us the opportunity to discuss and address some of the most important issues, namely those related to the 'Science, Technology and Innovation in the Islamic World for the benefit of the Ummah.'

Clearly, every generation has its own challenges. The main challenge for the current generation is global warming leading to climate change. According to recent expert information, the global temperature is expected to rise between 1.8 and 4 degrees C by the end of the century and sea levels are likely to rise by 28-43 cm.

Therefore, climate change is a global problem in its causes and consequences and involves complex interactions between climatic, environmental, economic, political, institutional, social and technological processes and systems.

It requires a global response that could be achieved through international co-operation and local promotion of science, technology and innovation.

**Excellencies,  
Ladies and Gentlemen**

Fortunately, the 11<sup>th</sup> OIC Summit Conference held in Dakar, Senegal in March 2008, adopted a new Charter for the OIC. Most importantly, for the first time, the charter has a clause relevant to the development of science, technology and innovation included in its objectives and principles. The charter says "to enhance

and develop science and technology and encourage research and cooperation among member states.”

The new charter gives us new impetus to further strengthen the initiatives already taken to implement strategies in the domain of Science and Technology adopted by the OIC Summit Conferences such as the Vision 1441 H and the Ten Year Programme of Action.

I would like to inform this august body on the most recent initiative taken by the OIC to map the potentially available and actually existing capabilities and capacities in the domain of science, technology and innovation in the Islamic World.

We have come to realize the need to come up with an innovative way of documenting such needed information based on current international experience. Therefore, the OIC working together with *Demos*, one of the United Kingdom’s most influential think-tanks and *Nature* the world’s foremost weekly scientific journal is launching an Atlas of Islamic-World Innovation project.

The Atlas maps key trends and trajectories in science and technology-based innovation across the 57-country membership of the OIC; in particular looks in detail at a geographically and economically diverse sample of fifteen OIC countries, and offers a detached, independent and authoritative assessment of how their innovation capabilities are changing, and the opportunities and barriers to further progress; explores how relationships between science, innovation, faith, culture and politics are unfolding within these sample countries, and across the wider Islamic world; identifies new opportunities for collaboration between scientists, policymakers and companies in the Islamic World and Europe, particularly directed towards shared global challenges of climate change, poverty reduction and sustainability; produces a series of agenda-setting articles, publications and events which spark scientific, policy and media discussion and debate in the Islamic world and beyond; and builds the skills and capacity of science and innovation decision-makers across the Islamic world, and creates new networks for the exchange of ideas, policies and good practice both within the Islamic world, and between the Islamic world and Europe.

On 13-15 July, 2008 in Istanbul, Turkey; the first kick-off meeting for focal persons on the Atlas of the Islamic World Innovation was successfully convened. The OIC calls upon all its Members to participate more actively in the elaboration of the Atlas and hopes that this pertinent initiative will be pursued seriously and meticulously.

### **Excellencies, Ladies and Gentlemen**

The Putrajaya Declaration issued at the 10th Session of the Islamic Summit Conference in October 2003 stated that we must recognize the leading role of Science and Technology for the advancement of Ummah and the need to bridge the gap between the Islamic and the industrialized countries. Therefore, it is expected that all the OIC Member States fulfil their pledge to invest at least 1.4



percent of their GDP in research and development. Such actions will contribute to the improvement of the quality of human capital and reduction in the technology gap between the OIC community and the developed world.

It was also recognized that there was an urgent need for Muslim countries to enhance cooperation among themselves by creating linkage and establishing environment conducive for partnership.

It is ardently hoped that such coordinated, focused and regular interaction between the OIC Member States materializes.

Moreover, the 10<sup>th</sup> Session of the Islamic Summit conference also adopted Vision 1441 on Science and Technology. A vision on the need for Muslim countries to rededicate themselves to mastering science, technology and innovation to ensure that they can face the challenges of the global economy with confidence.

OIC Member countries are committed to become a community that values knowledge and competent in utilizing and advancing science, technology and innovation in order to enhance their socio-economic well-being of the Ummah. It is imperative upon all of us to take the challenges for joint actions within the framework of the OIC, based on common values and ideals so as to revive the Muslim Ummah's pioneering role as a fine example of tolerance and enlightened moderation, and force for international peace and harmony.

The glory of Muslims in the scientific fields has to be revived.

Therefore, the emphasis given by the 16<sup>th</sup> Science Conference on Science, Technology and Innovation for Sustainable Development in the Islamic World, is very timely.

I am confident that, as you move forward with your deliberations, you will continue to challenge the minds through brainstorming and as a result change our Islamic world for the better.

We are at the same time mindful of course that change is never easy. Resistance must always be expected. The inertia of the status quo is very strong and this is especially true when the situation is serious and the changes required are huge.

There will be the ever-present temptation to undertake just incremental and cosmetic modifications. We need to recognize that these are not sufficient to revitalize and renew the state of science, technology and innovation. More is required.

Finally, I would like to once again express my gratitude to the Tatarstan Academy of Sciences for the excellent arrangements as well as the warm and welcoming hospitality, in this beautiful and gifted land. I wish you all success in your deliberations and hope that these noble endeavors of yours shall not go in vain.

. Thank you



## **Address of Prof. Akhmet Mazgarov FIAS President of the Academy of Sciences of the Republic of Tatarstan**

**Bismilla irrakhmani irrakhim  
Dear Dr Abdes Salam Majali  
Dear president of Tatarstan Mintimer  
Sharipovich Shaymiev  
Dear participants and guests of the conference  
Dear ladies and gentlemen**

Allow me to welcome you - our dear guests  
- on Tatarstan soil on behalf of all scientific  
community of the republic.

I would like to express my gratitude to all of  
you for your consent to participate in the 16<sup>th</sup> IAS  
Scientific Conference, to support our initiative to  
strengthen scientific and intellectual ties between  
Russia, Tatarstan and the Islamic World.

Let this conference become an important step  
in broadening cooperation in the field of science, economy and improvement of  
the welfare. Scientists note that there are necessary recurrences in the life of a  
person, countries and peoples.

In the beginning of AD 10<sup>th</sup> century, Volga Bulgaria, where our ancestors  
lived, was visited by an emissary from Baghdad and Islam was adopted as the  
official religion. Turks became a part of the Muslim civilization and this event  
determined their subsequent cultural development.

Development of professional knowledge in Volga Bulgaria was provided by  
the great scientific achievements in the Muslim world of that time. Monuments of  
religious canon were perceived as common property of all peoples of the region  
and the Arabic language - as "above-ethnic language" of all cultural area.

Bulgarian scientists wrote in Arabic. Therefore, their works acquired general  
Muslim significance. "Dar al-gyilem" (Houses of science), academies of sciences  
of their way, organized in towns of Muslim East, gathered intellectual people  
from all the world, consolidated Muslims in the field of science and culture.

Educational-scientific academies, organized in the 11<sup>th</sup> century in Isfahan,



Baghdad, Damask, Gazna, Basra and many other towns of the Muslim East by the vezir Nizam al-Mulk. They were called Nizamias in his honour. These academies integrated science into the educational curriculum of the medrese.

Under contemporary conditions these functions of a coordinating center were taken up by the Islamic World Academy of Sciences.

The emissary of the Caliph Al-Mukhtadir spent almost one whole year to reach to our ancient capital. His arrival manifested the cultural and ideological unity of the Ummah and ushered in an age of creativity.

Today, we accept representatives of the Islamic intellectual elite as ambassadors of goodwill. Times have changed: you can fly to Kazan in a few hours. But the aims remain the same - consolidation of the Muslim world in the name of progress and good, sustainable development of human society.

In the Middle Ages, the influence of the Muslim world on the culture of other peoples was the most impressive in the field of a scientific thought, theory of knowledge, logic, mathematics, geometry, algebra and medicine, geography, astronomy, philology and other sciences. Arabic natural-scientific knowledge became a scientific superstructure, theoretic guidance for Turkic-language scientists.

Names of Al-Gazali, Ibn-Arabi, Ibn-Rushd, Ibn-Sina (who was called Abugalisina by Tatars and revered as a saint and whose treatise on medicine "Kanun at-Tyib" written in 980 remained a classic manual for inquisitive minds until the beginning of the 20th century) became classic in Turkic-Tatar science.

Even in the second half of the 19th century - in the Age of Enlightenment of Tatars - and in the beginning of the 20th century-Renaissance, the Tatar scientific-social thought synthesized in itself the best achievements of the East and the West. Science is international in its essence.

But major tendencies of its development depend upon features of national mentality and historical past.

Under conditions of globalization, each nation and each country requires to understand reasons of change, which take place in the political and economic life of the world, and to preserve its own cultural identity and traditions.

This is imperative both for Tatarstan and for all Russia.

The Eastern prospect is also an internal challenge for Russia.

Subsequent development of the Russian society is impossible without preservation and development of cultural and socio-political traditions of peoples of a multinational country.

Delving in to the civilisational memory can lead to working out a new paradigm of the society development, because each generation actualizes scientific heritage in a new way. Moments of explosion in scientific and social thought always confirm internal unity (consensus) within the bounds of common civilization.

For example, a great Tatar scientist of the 19th century Shigabuddin Marjany, an ancestor of the national humanities, is known as a successor of the traditions of Al-Biruni, At-Tabari, Ibn-Batuta, and Ibn-Khaldun.

Also, the Tatarstan scientists are proud of the achievements of Rashid Sunyaev, a bright star of the world's astrophysical science. In this connection, we recollect sources of this science: an observatory of the 11th century under the guidance of the great scientist-mathematician and poet Omar Khayam, who proposed a new system of chronology to the world. Also, the astronomic laboratory of the 15th century of Ulugbek, the Samarkand ruler, who stated theoretical principles of astronomy.

Or the third example; the founder of poems with a well-defined overall metric pattern was an Arabian scientist of the 8th century; Khalil Ibn Akhmad al-Farikhidi. Together with the Islamic religion, this science ("gyilme garuz") penetrated into the Turkic world; works in Farsi and Turkish of Alisher Navoi and Zakhiraddin Babura subsequently appeared.

Not only wonderful Arabian and Persian but also Turk-Tatar poetry "spoke" Garuz for ages, provoking admiration. There are many such parallels in the history of science and culture.

Deeds, creations and ideas, in spite of political cataclysms and prohibitions in a society, remain in the historical memory of peoples. Science in present Tatarstan is a source of national pride and it has not lost its international authority in many trends.

This is manifested to a great extent by establishment in 1991 of Academy of Sciences of TR by the decree of President of the Republic of Tatarstan M. Sh. Shaymiev.

Today, the Academy of Sciences of TR and all scientific societies of the republic exist under the conditions of reformation of science and scientific-innovation activity.

Lately, particular attention is being paid to cooperation with foreign countries: Iran, Turkey, Kazakhstan, Azerbaijan, Uzbekistan, etc. Joint fundamental investigations and researches are being carried out in the field of natural and technical sciences.

Our scientists participate actively in international research projects. Every year, a number of concluded contracts increases. In the field of humanities, particular attention is given to exchange of scientific information. It is planned to start a project on the search of archived documents, manuscripts and publications about the history of the Tatar people in foreign archives, libraries and private collections and get them in originals and copies.

Every year, scientists of TAS go abroad for scientific business trips to give lectures, take part in prestige scientific forums, and visit foreign scientific centers. Many of these scientists are honorary members of foreign academies and international scientific societies, and they acquire prestige grants.

In the Tatarstan Republic, we see that science has become the subject of dialogue with various states. Such states are engaged in scientific-industrial and trade-and-economic cooperation with near-by and far-away foreign countries, and member countries of OIC.

These mutually advantageous ties are based on the common culture, economic and geopolitical interests. Such exchanges of socially significant information between scientific bodies and individual scientists result in increased scientific contracts and scientific-and-technical cooperation in the fields of new technologies, and highly profitable production.

We are open for cooperation with the Muslim world. Today, it becomes possible for Islamic countries to use with maximal efficiency their rich natural and manpower resources for the welfare of scientific progress.

I invite our foreign guests and scientists to take active part in the implementation of large-scale scientific-investment projects, planned currently in the Republic of Tatarstan and Academy of Sciences of TR.



.The Opening Session of the 16<sup>th</sup> IAS Science Conference; Kazan, Tatarstan/Russia; 25-28 August 2008



**PART TWO**  
**THE KEYNOTES**





# **Science, Technology and Innovation for Sustainable Development**

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‘Sustainable Development’ has been the buzzword in our global vocabulary since its introduction by the Brundtland commission in their 1987 seminal report, “Our Common Future.” Since then, it has become widely accepted as an organizing principle used by enlightened governments, the private sector, and civil society in their quest to develop a more sustainable future. To be sure, the concept of sustainable development is not exactly a novel one. Many years earlier, the idea had been inadvertently referred to by none other than the great Indian icon, Mahatma Ghandi, when he said, “the world has enough for everyone’s need but not enough for everyone’s greed.”

**Mr President**

**Distinguished Guests**

**Ladies and Gentlemen**

Before leaving office in 2005, Mr Kofi Annan, the former secretary-general of the United Nations in a lecture at Princeton University remarked that the world is increasingly becoming insecure and a less happy place to live in. He said, “Almost everyone in today’s world feels insecure - insecure about poverty, environmental degradation, infectious disease, armed conflict and, of course, terrorism. In truth, all these threats are interconnected, and all cut across national frontiers.”

Former American vice-president turned Nobel peace prize laureate Al Gore, in his latest book, “The Assault on Reason” (2007) argued that: “First and foremost, our security is threatened by the global environmental crisis, which could render all our other progress meaningless, unless we deal with it successfully. Already, the increase in severe droughts, severe flooding, and stronger storms is having a harsh impact.”

Gore is of course referring to global warming.

**Mr President  
Ladies and Gentlemen**

The science of geology has always taught us that earth processes were so large and powerful that nothing humans could do would change them; that human chronologies were insignificant compared with the vastness of geological time; that human activities were insignificant compared with the force of geological processes. Once upon a time they were. But, not any more. With forests being cleared at an unprecedented pace and cars, factories and other modern amenities burning so many billions of tons of fossil fuels, *we have indeed become geological agents ourselves*. We have changed the chemistry of our atmosphere, causing sea level to rise, ice to melt, and climate to change.

Global warming is one major consequence of unsustainable development and is currently receiving much attention from our political leaders.

Of no less importance is the state-of-health of our environment.

**Mr President  
Ladies and Gentlemen**

It took the international community 15 years (since 1987) - at the world summit on sustainable development in Johannesburg in 2002 - to identify five issues that would hold us hostage if they are not solved within the foreseeable future. Mr. Annan called them by their acronym – WEHAB – “we must rehabilitate our one and only planet.” To be sure, the acronym stands for water, energy, health, agriculture and biodiversity.

These are five areas in which progress would offer all human beings a chance of achieving prosperity that will not only last their own lifetime, but can be enjoyed by their children and grandchildren too: in other words, the opportunity for the global community to live in a sustainable world.

All too often that issue is overshadowed in the policy-making process by more immediate problems, such as conflicts, globalization, and most recently, terrorism.

New efforts are needed because the present model of development, which has brought privilege and prosperity to about 20 per cent of humanity, has also exacted a heavy toll by degrading the planet and depleting its resources. Yet at discussions on global finance and the economy, the environment is still treated as an unwelcome guest. High-consumption lifestyles continue to tax the earth’s natural life support systems or ecosystems, research and development are under-funded and neglectful of the problems of the poor, and developed countries have not gone far enough to fulfil either of the promises they made at the earth summit in Rio in 1992 to protect their own environments and to help the developing world defeat poverty.

**Mr President  
Ladies and Gentlemen**

The issue is not environment versus development, or ecology versus economy. Contrary to popular belief, we can integrate the two.

The goals that we would like to achieve in the above five areas with the resources and technologies at our disposal today could be summarized as follows:

- Water - provide access to at least one billion people who lack clean drinking water and two billion people who lack proper sanitation;
- Energy - provide access to more than two billion people who lack modern energy services; promote renewable energy; reduce over-consumption; and ratify the Kyoto protocol to address climate change;
- Health - address the effects of toxic and hazardous materials; reduce air pollution and lower the incidence of malaria and African guinea worm, which are linked with polluted water and poor sanitation;
- Agricultural productivity - work to reverse land degradation, which affects about two-thirds of the world's agricultural lands; and
- Biodiversity and ecosystem management- reverse the processes that have destroyed about half of the world's tropical rainforest and mangroves, and are threatening 70% of the world's coral reefs and decimating the world's fisheries.

This was the aspiration of world leaders when they met at the UN Millennium summit in September 2000 and adopted the Millennium Development Goals (MDGs), a set of common objectives that focus on the central challenges of our time such as halving extreme poverty to halting the spread of HIV/aids and providing universal primary education, all to be met by the target date of 2015. They form a set of simple but powerful objectives that every man and woman in the street, from New York to Moscow to Kazan, can easily comprehend and support.

Reaching the goals requires us to tap into human creativity, resourcefulness and innovation to the fullest extent possible. This is where science, technology and innovation come in. It is imperative that we should mobilize the best scientific minds of our time, and put their expert knowledge and advice at the service of the world's peoples.

However, all is not well with the developing countries, in particular Islamic countries where most of the Fellows of the Islamic World Academy of Sciences reside.

In recent years, the UNDP has categorized countries into 'high human development,' 'medium human development' and 'low human development.' Of the 57 OIC members, only five have been placed amongst countries with 'high human development.' Their high standing is fundamentally due to abundant natural resources such as oil and gas, which have allowed them to invest heavily in the social sector, and thus raise the quality of life of their populations. There is very little in these countries which exists in the form of a strong S&T infrastructure. They are high consumers of borrowed technology. Even the universities and research institutes found in these countries are nowhere comparable to those found in other so-called high human development countries. Having said all these, let me now refer to the very recent developments in the Middle East, in particular in

the Gulf states, of building spectacular educational structures involving leading universities from the United States. We would like to wish them well although there is no guarantee that what works in America will work somewhere else as someone recently quipped, “a good school does not just borrow a curriculum or a few teachers from another prestigious university.”

Today’s Muslim societies have generated few scientists of international status, despite accounting for roughly one-fifth of the global population, only two scientists from Islamic states have won Nobel prizes: Abdus Salam, a Pakistani (for physics in 1979) and Ahmed Zewail, an Egyptian (for chemistry in 1999). Both carried out their research outside Islamic countries.

In a landmark publication released in 2004, the InterAcademy Council recommends that every nation develops a science and technology strategy. For the developing countries, enhancing S&T capacity is truly a necessity and not a luxury.

The report, entitled “Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology” argues that all nations – industrialized or developing – face an array of challenges that require the application of up-to-date scientific knowledge and technology to address them. Of course, the challenges are greater for the Islamic world.

Enhancing local S&T capacity is essential, the report states, because trends in the development and use of new technologies have left a growing gap between “have” and “have not” nations. The world is experiencing a vicious cycle in which developing countries that lag in S&T capacity fall further behind, as industrialized nations with financial resources and a trained scientific work force exploit new knowledge and technologies more quickly and intensively.

Stark differences exist in R&D budgets. Wealthy industrialized nations spend between 1.5% and 3.8% of their gross domestic product (GDP) on research and development (R&D). Most developing nations devote less than 0.5 percent of GDP to R&D. Similarly, in high-income nations, the number of scientists and engineers averages 3,281 per million population. In middle-income nations, there is an average of 788 scientists and engineers per million. However, in most developing nations, the number is too small to be reliably calculated. These types of deficits, in the case of rapidly emerging fields such as biotechnology and nanotechnology, can leave entire developing economies behind. Moreover, when nations need to respond to diseases such as HIV or SARS, or make decisions about issues such as stem-cell research or genetically modified foods, this lack of S&T infrastructure can breed unfounded fear and social discord.

In my view it is not possible to seriously achieve the MDGs without ensuring that science, technology and innovation generally thrive in the developing world. I would like to highlight some key practical suggestions as to how this can be done. They are well known to us in this room. They are in my view a clear and simple, yet comprehensive set of actions that provide a road map for our discussions over the next three days. They demonstrate that action is required by individuals, universities, academies of sciences, governments, and international organisations.

First, we need to create and strengthen centres of leadership and excellence,

especially in least developed countries (LDCs), by identifying leaders and research teams, providing them with autonomy, financial stability, modern equipment and access to information technologies and international peer groups.

Second, we need to support fellowships and training programmes that keep researchers up-to-date with the latest information and connected with other research and educational centres around the world.

Next, we need to promote cooperation in the South through South-South exchange fellowships for doctoral and postdoctoral researchers. In particular, the major developing countries should make significant contributions towards the development of least developed countries.

Fourth, we need to create institutional networks to address common problems relating to issues of regional concern or common interest. These networks should promote joint research projects and conferences, workshops and symposia that allow for the constant exchange of ideas.

Fifth, we need to publicize and share successful experiences. Sharing such experiences provides models for the involvement of researchers, policy makers and planners in using research for national development. Successful experiences in one country often inspire and motivate other countries. Efforts should highlight that, despite problems, researchers in the South have developed many creative answers to address and solve critical development issues.

Next, we need to create and support merit-based academies in the South that will help promote and sustain scholarship, recognize and reward good work, interact with other academies and scholastic bodies, serve as role models for the young and engage governments in matters where R&D and policy meet.

We also need to mobilize expatriates and institutions in the North enabling the 'brain drain' to be converted, in part, into a 'brain gain'. Researchers in the North, particularly those from developing countries, should be encouraged to work on major Third world problems, and institutions in the North should be encouraged to assist in building capacity and excellence in the South.

We also need to provide equitable access to knowledge. This means promoting internet access, creating international networks among teams of research scientists and making sure that intellectual property rights do not limit access in developing countries.

We also need to engage the private sector as agents for national development by supporting R&D through in-house research, training, recruitment and related modes of support.

Finally, we need to persuade governments to commit to R&D by investing more in education. For example, the millennium project, the Academy of Sciences of the Developing World (TWAS), the African Panel on Biotechnology and the InterAcademy Council, called for setting a target for the science sector to receive at least 1 percent of the Gross Domestic Product (GDP) within 10 years. We also need to recognise that long term funding is critical for promoting R&D. Successful R&D is not achieved in one or two years – it requires decades to properly nurture.

**Mr President  
Ladies and Gentlemen**

None of the actions I have outlined above is beyond us. Never before had we had such an opportunity to promote sustainable development through science, technology and innovation in developing countries. I say this because I see great opportunities in this regard in terms of political support, finance and networking.

For example, the UN Decade of Education for Sustainable Development demonstrates that there is political interest in addressing this issue at the highest level. This 16<sup>th</sup> IAS Conference is another reflection of this support.

International financial assistance is growing. Official aid to developing countries (ODA) has increased to \$106.5 billion in 2005, its highest level ever. ODA is expected to rise to \$130 billion in 2010. This represents a \$50bn increase over 2004. Private aid, which has also played an important role in supporting R&D in the Developing world, is predicted to increase significantly in the next decade.

Modern IT connects the world as never before. Collaborating, networking and researching is possible on a scale not imaginable a decade ago. Now every researcher with internet access is truly part of a global community and has access to more colleagues and information than ever before.

Yet with opportunity comes responsibility. Developing the right national science policy is a responsibility we cannot ignore. We must build R&D in developing countries if we are to tackle poverty and achieve the MDGs. R&D fuelled the Industrial Revolution and the Green Revolution. R&D is the basis of the IT and biotech revolutions we are in the midst of today. Without R&D capacities, no country can expect to benefit from any of these revolutions.

The Millennium Declaration sets out a bold vision for a “larger freedom.” That vision holds out the promise of a new pattern of global development built on the foundations of a greater equity, social justice, and respect for human rights.

It is the responsibility of the scientific community to be more relevant and contribute more directly to the successful creation of this new pattern. It is the responsibility of governments, international organisations and meeting such as this to support this push for relevance. Should we fail our responsibilities, research will wither, our academic fraternities will falter, and the poor will remain rooted in poverty and inequity.

# **Europe of Knowledge: The Knowledge Society and the Role of Universities**

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## **1 ABSTRACT**

Our society has significantly been changing and will continue to change. For the citizens of tomorrow, knowledge will be the primary asset to find better jobs and the ability to learn will be one of one's primary sources of social security. Being able to constantly learn will be the key to find a new job, or to progress along one's career. As has been outlined by many studies, this is witnessed by a clear and increasing positive correlation between the education level attained by an individual and the level of one's salary.

A major political process, the so-called Lisbon Strategy, has recognized these changes and has called on Europe to be the first mover in contributing and shaping this new society. The Lisbon Agenda has put forward a simple but powerful vision: Europe should be the most competitive knowledge based society. Our capacity to face the challenges of this changing world, both as a system, and as individuals, shall and will be rooted in our knowledge. The challenge is not only to provide more knowledge but also a different type of knowledge and to learn differently.

This paper aims at describing the importance of research, education and innovation in the process of building the knowledge society. It underlines the role of the higher education institutions in the promotion of modernization and excellence to face global challenges and the role of regional, national and European policy makers in promoting this reform.

## **2 THE NEED TO CROSS THE BOUNDARIES**

In order to face the challenges of the twenty first century (e. g. climate change and ageing related diseases) the citizens of today and tomorrow need to have the ability, the skills and the capacity to cross boundaries at all levels. Of course, the first barriers to be removed are geographic. Too many of our research assets are secluded within national or regional boundaries instead of being open and exposed to a European and world level competition. Many have already called

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<sup>1</sup> The content of the paper is the sole responsibility of the author.



for the need to have a more interdisciplinary approach in research and education, as new ideas are increasingly located at the boundary, rather than the core of existing disciplines. But besides this challenge, that is almost internal to the research environment, there are others that require the dialogue between worlds that have been traditionally and more drastically separated.

First, we are constantly demanded to cross the boundaries that divide knowledge as theory from knowledge as practice. Up to now, our society has seen a marked separation between the places where knowledge is produced, notably universities and research organizations, and those where it is actually used, notably enterprises and society in general. And if the research sector knowledge has been primarily seen as valuable independently from its use, in the business world, it has been seen too often as valuable only if immediately usable.

This situation is no longer viable. The boundaries between those worlds and views are today increasingly blurring: universities are increasingly required to produce usable knowledge and employable students. Enterprises are increasingly demanded to take an active role in the production of knowledge and to be involved, from the outset, in research and education endeavors. But knowledge will also be of a different nature to allow the citizens of tomorrow to live in a world which is increasingly globalized, differentiated, multipolar, and thus that requires possessing the skills needed to continuously face 'the different.' In their working environments, in their social lives, the citizens of tomorrow will be primarily required to establish a dialogue with people that belong to different cultures, with different value systems and social habits.

This is especially important for us as Europeans, as we build on the richness of diversity of our fundamental social, cultural and political values. The Lisbon agenda, the vision about knowledge, is not just about economics; it is first and foremost about developing a better society. The citizens of tomorrow are primarily boundary spanners between sectors, organizations, disciplines, cultures. To be so, they need an entire set of new skills and abilities.

### **3 TRADITIONAL PROGRAMMES IN THE KNOWLEDGE TRIANGLE**

The need to cross boundaries is summarized in the European Commission's vision that the knowledge society can be achieved if we integrate the traditionally separated three sides of the so called knowledge triangle: the research, education and innovation systems. Up to now, the Commission has supported these systems through various programmes each addressing specific goals.

'Framework Programmes' (FPs) have been the main financial tools through which the European Union supports research and development activities covering almost all scientific disciplines. They bundle all research-related EU initiatives together under a common roof playing a crucial role in reaching the goals of growth, competitiveness and employment. The main goal of the Framework Programmes has been funding cooperative research across Europe, allowing the



creation of networks of researchers and research organizations to pool together resources that would be otherwise fragmented. These networks had the goal to integrate research efforts or to promote the development and demonstration of new technologies. But through the framework programme, the European Union has also promoted the creation of common infrastructures where the capacity of each Member State was not sufficient, intense mobility programmes to create trust among the various research communities, or the coordination of regional and national funding instruments to achieve a European scale and impact as well as the possibility to collaborate with researchers that operate in non Member States but in associated countries. Those are third countries, such as Albania, Montenegro or Turkey, that signed an international agreement with the European Community, under which it makes a financial contribution to Framework Programme 7. Others, like the Russian Federation, have been already part of agreements to be involved in the Framework Programmes and are now on the way to become full associated countries.

On the innovation side, the Competitiveness and Innovation Framework Programme (CIP) aims to encourage the competitiveness of European enterprises. With small and medium-sized enterprises (SMEs) as its main target, the programme supports innovation activities, provide better access to finance and deliver business support services in the regions.

On the Education side, the Life Long Learning programme aims to foster interaction, cooperation and mobility between education and training systems within the Community, so that they become a world quality reference. The Erasmus programme, among the most successful and known instruments of this programme, allowed European students to experience and be exposed to different national education systems and cultures; or the Erasmus Mundus, that attracts a considerable number of students from third countries to study in Europe. For the academic year 2008/2009, students coming for example from Iran, Russia, Kazakhstan, or Jordan will be involved, together with nearly 2000 colleagues from all over the world, an Erasmus Mundus Master Programme.

Finally, the Structural Funds allow the European Union to grant financial assistance to resolve structural economic and social problems. These include productive investments leading to the creation or maintenance of jobs; infrastructure; local development initiatives and the business activities of small and medium-sized enterprises. Through the Structural Funds, an increasing amount of resources are dedicated to capacity building especially in less R&D intensive regions. The aim is to allow each knowledge player to develop the needed skills and infrastructure to be able to compete and collaborate at a European level.

#### **4 THE NEW CHALLENGES**

Today we face new challenges that are requiring us to bring these instruments a step forward to realize the vision of the knowledge triangle. First of all, it is clear

that in the EU exists an R&D funding gap when compared with US, South Korea or Japan. While the US devotes nearly 2.7% of GDP to R&D, Europe spends just 1.9%. The situation is also very diverse inside the European Union with Sweden investing more than 4% of GDP and several countries, like Portugal, Greece and several of the new Member States investing less than 1% of GDP in R&D.

In Higher Education, the European Union invests in average 1.1% of GDP, a figure much lower than the one for the US (2.7%) or South Korea (2.7%) or Canada (2.5%) . On average, American Universities invest per student 2 to 5 times than the European Universities.

The European Commission has defined as a target to invest 2% of GDP in Higher Education by 2014 and 3% of GDP in Research by 2010.

What is rather telling is that these gaps are not due to a lack of public resources. Rather, they are mainly rooted in the lack of private R&D investment that counts for almost all the difference. This is true both in absolute terms, but also in relative ones as the private sector investment in public research and Higher Education is much lower than in other world regions. For example, while the contribution from the public sector in Higher Education is almost the same in the European Union and US, around 1% of GDP, the contribution coming from the private sector to higher education is seven times higher in the US than in Europe.

This lack of trust of the private sector in research in general, and in public research in particular, mirrors a poor capacity of public research organizations to establish structured collaborations with companies as well as to transform research outcomes in economic or social value.

In this sense, some have claimed that there is a European paradox whereby Europe performs excellent research but there are barriers to transfer it to the market. The main figures tell us that the EU has lost ground also in terms of scientific excellence. Whatever the indicator or source of data we look at, when compared to our main global competitors, we always notice a similar trend. European universities perform well both in world rankings and citation indexes. However, they are under represented in the top layer of the research and education league table. While in the top 500 universities near half are European, when looking at the first 10 just two are from the union, and both from the same member state. European Universities are good on average but they are very fragmented and lacking the critical mass to compete at global level.

## **5 THE EUROPEAN RESEARCH AREA**

The challenges that Europe is facing require the removal of barriers to the free circulation of knowledge and the development of the ability, skills and capacity to cross boundaries at all levels. It is for these reasons that the European Commission is now promoting the creation of a European Research Area (ERA), a unified area all across Europe, in which we should:

Enable researchers to move and interact seamlessly, benefit from world-class infrastructures and work with excellent networks of research institutions;

- Share, teach, value and use knowledge effectively for social, business and policy purposes;
- Optimize and open European, national and regional research programmes in order to support the best research throughout Europe and coordinate these programmes to address major challenges together;
- Develop strong links with partners around the world so that Europe benefits from the worldwide progress of knowledge, contributes to global development and takes a leading role in international initiatives to solve global issues.
- Such a goal has been gaining an increasing political momentum if you consider that the March 2008 European Council conclusions as well as the Lisbon Treaty call for the establishment of the fifth freedom, to allow for the free circulation of knowledge Europe wide.

## **6 THE ROLE OF UNIVERSITIES IN THE MAKING OF THE ERA**

Universities play a pivotal role in this vision, as they are by nature institutions devoted to the production and diffusion of knowledge. This is particularly true for Europe, where universities, more than in other world regions, play a dominant role in the knowledge fabric. If in the US only 14% of the total research expenditure is spent on universities, in Europe it is almost 22%.

In Europe, the role of universities in the building of the knowledge society has been increasingly recognized at the highest political level. Now, universities are a key topic in the agenda of the Heads of State and Government. This role has been first recognized at the Hampton Court Informal Council in 2005. But the same recognition of such a role has been going hand in hand with a growing awareness that to play this role, universities have to change. At Hampton Court, the modernization of universities has been set as a key priority as a response to global challenges. Following this, the European Commission has issued a Communication outlining a modernization agenda for universities. The 2006 Spring Council called for a stronger action at the European level to drive forward this modernization agenda, followed by the 2008 Spring Council in which Member States and the European Union are called to remove barriers to the free movement of knowledge and to move forward the process of reform.

Beyond the European Union, at the meeting of OECD Education Ministers held in Athens in June 2006, ministers recognized that pressures for continued change on universities are unlikely to abate and agreed ‘that higher education cannot escape major change, that such a change may be sometimes difficult, and that a clear signal is needed about our determination to lead the necessary changes rather than be driven by them.’

## **7 THE NEED TO REFORM THE HIGHER EDUCATION SYSTEM**

There are many reasons why reforms are the keyword in order to have a European university system able to make its full contribution to the Lisbon agenda. First, universities need more funding and given the current budgetary constraints in public finances in most of Members States, such a gap cannot be plausibly filled by tax payers' money; this bears a simple message, although rich of implications: if European universities want more resources, they need to attract them from the private sector.

Researchers are requested to transform their ideas into value, business experiences, collaborations and mobility with the business world. The need to cross the boundary that too often separates universities from society requires involving stakeholders in the governance of universities, providing input and support in defining strategies and programmes. But also, at the operational level, to recognize new profiles such as knowledge transfer professionals that too often have been seen as primarily concerned with administrative rather than managerial tasks. Knowledge transfer is not about drafting contracts; it is about managing and supporting the complex dialogue needed to engage researchers and entrepreneurs in a common endeavor.

Reforms are also needed to foster research excellence. European universities are under represented in the top layers of the research and education league tables. To be pursued, excellence needs to be rewarded. This implies that researchers should be able to progress their careers on the bases of the quality of their results and that mobility should be promoted at all levels to realize the vision of the circulation of knowledge as the fifth European freedom.

To modernize universities, many policies and new initiatives are ongoing both on the initiative of the stakeholders and promoted by governments and the European Commission.

## **8 INITIATIVES IN THE FIELD OF UNIVERSITY REFORM**

For example, at the intergovernmental level, the well known Bologna process has as main goal to reform students' curricula to rethink teaching towards a student centered approach in which they are seen as primary 'customers' of universities. The Bologna Process aims to create a European Higher Education Area by 2010, in which students can choose from a wide and transparent range of high quality courses and benefit from smooth recognition procedures. The Bologna Declaration of June 1999 has put in motion a series of reforms needed to make European Higher Education more compatible and comparable, more competitive and more attractive for Europeans and for students and scholars from other continents. Today, the Bologna process involves 46 countries including the Russian Federation, Ukraine, Albania, Bosnia Herzegovina, Georgia, Moldova and Turkey.

To support a more profound process of reform, the European Commission has

put forward a modernization agenda for universities to set the broad principles that will drive this process of reform. Of the items proposed:

- To break down the barriers around universities in Europe;
- To ensure real autonomy and accountability for universities;
- To adopt new internal governance systems based on strategic priorities and on professional management of human resources;
- To provide incentives for structured partnerships with the business community;
- To enhance interdisciplinarity and transdisciplinarity to reconfigure teaching and research agendas; and
- To reward excellence at the highest level.

Similar policies are promoted by Member States also through programmes aimed at supporting the modernization and consolidation of the higher education system. In Germany, the federal and state governments agreed in 2005 on an initiative to promote top-level research in Germany and to encourage cooperation of universities with non-university research institutions. As an example of the selected initiatives, is the creation of the Karlsruhe Institute of Technology, merging the University and the Research Centre of Karlsruhe. The KIT will have 8000 employees and an annual budget of more than half a billion Euros.

Similar initiatives are ongoing in France where the government has launched the operation campus in March 2008 to provide extra funding to the 10 top proposals from universities that create local agglomerates and MIT style campuses. Among the 6 selected for the first round, the Grenoble University of Innovation pulls together 4 universities, a school of management and 3 local branches of national research centres.

In Finland, the Minister of Education and Science recently signed the charter of the foundation of a new university, the innovation university, which will be created through a merger of Helsinki University of Technology, Helsinki School of Economics and the University of Art and Design. The foundation has a basic capital of 280 million Euros donated by the founders. The Finnish Government will contribute with 200 million Euros, and the other founders with 80 million Euros towards the basic capital.

In the same spirit the European Commission, among various instruments, has recently launched two novel initiatives to support the competitiveness of European universities: The European Research Council (ERC) and the European Institute of Innovation and Technology (the EIT).

The European Research Council (ERC) is the first European funding body set up to support investigator-driven frontier research. Its main aim is to stimulate scientific excellence by supporting and encouraging the very best, truly creative scientists, scholars and engineers to be adventurous and take risks in their research. The scientists are encouraged to go beyond established frontiers of knowledge and the boundaries of disciplines.

The European Institute of Innovation and Technology (the EIT), on the innovation side, aims at representing the European flagship of this effort to

renovate research, education and innovation system. The European Institute of Innovation and Technology (EIT) is a new institute that will pool together the best European and non European talents and organizations to perform top level research, education and innovation activities. Besides being an operator, the EIT will also seek to stand out as a world-class innovation-orientated reference model, inspiring and driving change in existing education and research institutions.

The EIT will be based on an innovative two level structure. There will be an autonomous Governing Board, located in Budapest, made of high level personalities of both the academic and the business world. This board will have at its disposal a considerable amount of resources to select pan European partnerships of research organizations, universities and businesses, the so called Knowledge and Innovation Communities, which will carry a joint programme of activities to address a European or global challenge. As examples of the possible areas in which the Knowledge and Innovation Communities will operate we can think of Climate Change, Renewable Energy, or the next generation of Information and Communication Technologies. We should look at EIT as a locus of experimentation and not just as 'yet another operator.' The EIT will produce publications, patents and new types of higher education programmes. Existing organizations will design and test new models of collaboration that aim at crossing boundaries at all levels: across disciplines, across sectors, across organizations. EIT will become a reference model to inspire and drive change at the knowledge triangle European landscape.

## **9 CONCLUSION**

The role of universities in all dimensions of the Lisbon Strategy is clearly fundamental. As they represent the primary institution devoted to the production and dissemination of knowledge, they shall play a pivotal role in fostering future growth, better jobs, social integration and citizenship. But the nature and magnitude of today's challenges cannot be faced by higher education institutions just doing more of what they already did in the past. They also need to change and reform to be able to move swiftly and effectively in an increasingly complex and dynamic knowledge society. They are today demanded to provide new services, to establish a dialogue with the business, to be more autonomous and accountable to society. On the other hand, they need to preserve their public mission to ensure that knowledge is a right for all and not a privilege for the few. In this sense, the role of governments and local authorities is crucial in facilitating and supporting this delicate process and providing the necessary tools and framework conditions.

In this context, the European Commission plays and will increasingly play the role of supporting these efforts to ensure that these are implemented with a European perspective. This is why tertiary education and youth-related policies are a high priority for the European Commission. More investments in research, higher education, vocational training, and measures to reduce youth unemployment are of utmost importance. Broadening access to higher education and focusing on life-long learning will also be central to Europe's future development.

# **Sustainable Development: A Global Imperative**

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*US National Academy of Sciences*

## **1 INTRODUCTION**

In 1983 the United Nations established the World Commission on Environment and Development to report on the deterioration of the environment and natural resources. The term sustainable development, coined by the Commission, refers to using resources in a way that preserves their utility for future generations. In the 25 years since the appointment of the Commission, the global human population has increased by approximately 30% (relative to its 2008 size) or by another two billion people and human demands on environmental resources have grown at least proportionately. Today there is urgent concern about climate change, water resource demands, energy sustainability, food production, biodiversity loss and a host of other challenges that suggest that current environmental demands are unsustainable. At the same time the advances from science and technology (S&T) in this era are unprecedented. There is reason to hope that S&T advances may provide a route to a sustainable future. Science academies can play a crucial role in assisting national policy makers in developing sustainable solutions to current resource challenges through the use of contemporary S&T knowledge. The IAP and IAC, that embody a global network of science academies, can assist individual national academies in developing policy positions on resource and other issues. Some academies, such as the US National Academy of Sciences (US NAS), have a long tradition of providing advice to policy makers and their experiences and reports can also be utilized by sister academies around the world.

## **2 WHAT IS SUSTAINABLE DEVELOPMENT?**

What is meant by sustainable development and why is it important? In answering this question it is helpful to consider the history of the term. The World Commission on Environment and Development (WCED) also known as the Brundtland Commission coined the term *sustainable development*. The Brundtland Commission defined sustainable development as “*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*”



The Brundtland commission was created in 1983 by the United Nations in response to a growing concern about environmental deterioration and the consequences of that deterioration for economic and social development. From this history, it appears that two key elements need to be considered: the trajectory of environmental change, and the trajectory of social and economic health. These two elements are generally thought to be functionally related and subject to common underlying variables such as population growth, or the effective use of human resources in science, technology and innovation. Moreover, there appears to be an implicit assumption that environmental deterioration will have a negative relationship with the economic and social development of future generations. If this assumption is correct, we can use measures of environmental deterioration as surrogates for future trends in social development. But let us first consider direct measures of the recent trajectory of social development.

### **3 THE MILLENNIUM DEVELOPMENT GOALS AS OBJECTIVE MEASURES OF THE TRAJECTORY OF SOCIAL DEVELOPMENT**

The term development implies a process that unfolds over time. When used in the context of economic development, it includes broad measures of human well being such as literacy, health status, and access to basic resources such as clean drinking water and other essential resources. How can we evaluate progress, or the lack of progress, in social development? One approach to this question can be found by considering the MDGs. In conjunction with the World Summit on Sustainable Development held in the year 2002 in Johannesburg, South Africa, the United Nations established an ambitious set of Millennium Development Goals (MDGs) that aimed to achieve certain minimal standards for all humans. There are eight general goals, each with a subset of specific goals, to be achieved by specified dates in the future (mostly by 2015). The general goals include the eradication of extreme hunger and poverty, the provision of universal primary education, the promotion of gender equity, the reduction of child mortality, improving maternal health, combating HIV/AIDS, malaria and other diseases, ensuring environmental sustainability, and establishing a global partnership for development. Two examples of specific goals are the reduction by 2015 of mortality among children under age five by two-thirds and the reduction by 2015 of the number of people without access to safe drinking water and sanitation by half.

The MDGs are important for their specificity and for the explicit time horizons, because these allow an assessment of the trajectory of progress at the mid point between 2000 and 2015. The MDG monitor web site <http://www.mdgmonitor.org/index.cfm> and other sources provide information on progress towards the MDGs and a series of annual reports on the MDG status present much useful statistical information.

There has been real progress towards attaining the MDGs by most measures, but not surprisingly progress is heterogeneous over the world, so for example, according to the 2007 report the reduction in extreme poverty since 1990 has been



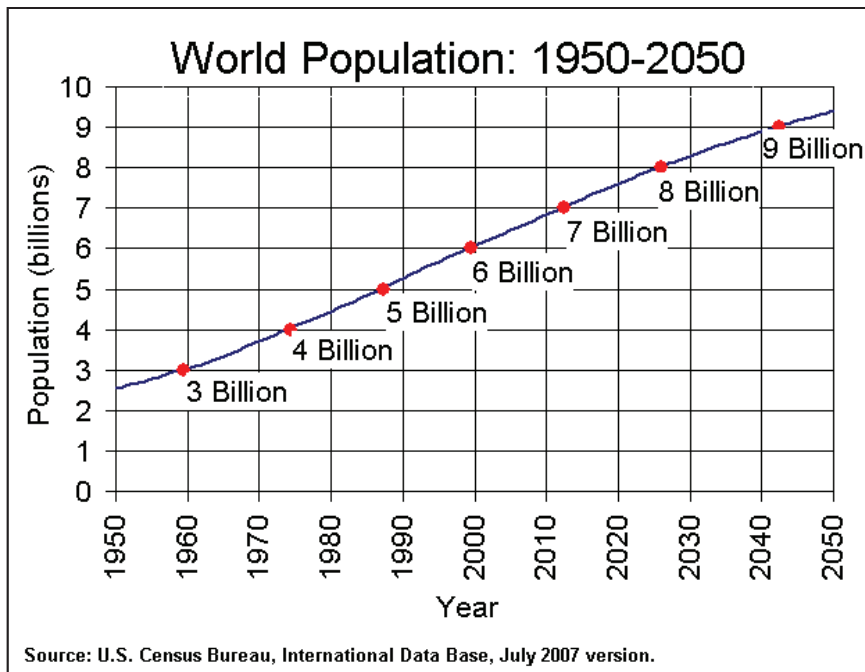
substantial in Southeast Asia, but little progress has been made in Latin America. It is also unlikely that goals related to clean drinking water or goals related to deforestation or biodiversity loss will be met by the specified target dates, because relatively little progress has been made on these important goals since 2000. Most observers doubt that the MDGs will be met by the target dates and some take this to reflect inadequate global investments in social and economic development.

#### **4 POPULATION GROWTH AND INCREASING ENVIRONMENTAL DEMANDS**

Certainly one major underlying variable driving environmental deterioration is the burden of a rapidly increasing human population. To put population growth into perspective, it is instructive to consider the past 25 years that mark the period since the formation of the Brundtland Commission. As can be seen from Figure 1, since 1983 the human population has increased from approximately 4.5 billion to over 6.6 billion today. So the world resource base must accommodate the demands of over 2 billion (or 30%) more people in little more than a generation. The global human population more than doubled between 1950 and 2000 and it is projected to reach approximately 9.3 billion by mid century (US Census Bureau).

This means that in the past 50 years human driven resource demands at least doubled and will have more than tripled in the hundred years between 1950 and 2050. (A linear extrapolation underestimates actual demands assuming enhanced standards of living are achieved by more of the world's inhabitants.) Owing to population growth, the amount of arable land to support each person has been reduced twofold since 1950 and many essential resources are exhibiting some signs of strain. For example, there is clear evidence of strains in the global energy supply, in water resources, in ocean fisheries and in other essential resources (see below).

What are some of the implications of increasing resource demands? First it is important to note that concerns about human population demands have been voiced since Malthus, but the history has been one where unanticipated technological innovations have expanded the human carrying capacity. In Malthus' time humans learned to exploit steam power and this set the stage for the industrial revolution. In the 1950s and early 60s there was much concern about food security, because certain regions of the world were not self sufficient in food production and were threatened with periodic famines (e.g. India). The green revolution changed this equation for at least the two ensuing generations. Now however, concerns about food security have again begun to appear, and in parts of the world, the rate of increase in food production is not keeping pace with the rate of increase in population. But new biotechnologies have the potential to further enhance agricultural production. So as always it is hard to predict the future, but it is clear that investments in science and technology and the implementation of policies that favor innovation are the best hedges against an uncertain future.



**Figure 1. Growth in human population since 1950.**

## **5 CITIES: CONCENTRATORS OF SOCIAL AND ECONOMIC ACTIVITY**

A discussion of global population growth obscures other important demographic trends. First, population growth is not homogeneous over the world, rather almost all growth over the next 50 years will occur in developing countries (National Research Council, 2003). A second major trend is increasing urbanization in developing countries. It is estimated that more than 50% of the population increase in the next half-century will be accounted for by urban dwellers and at least a fourth of these will live in extreme poverty.

Despite this there are advantages to urbanization. Cities are concentrators of human activity and as a result urban dwellers have better access to health services, schools, piped water, waste disposal and electricity. Another advantage is reduced fertility, owing to better education, communication and other services. Moreover, the per capita environmental footprint of the human population may be less under increased urbanization.

There are also significant urban disadvantages including a greater threat from epidemics, owing to the interaction between human density and disease transmission. Increased rates of economic inequality and poverty are likely to be at least a transitory consequence of urbanization. In addition, demographic studies

project that much urban growth will occur in smaller cities ill equipped to deal with population demands. This implies increased social stress while financial, health and education systems evolve in smaller cities. Moreover, smaller cities of the developing world typically lack the professionalism to manage urban systems effectively, including sanitation, safe drinking water, effective transportation systems, education systems and coping with disasters and hazards. All of these considerations are compounded by the fact that almost all population growth will occur in the cities of developing countries least equipped to deal with the demands of a rapidly growing population.

## 6 ENVIRONMENTAL CHALLENGES

Thoughtful observers (e.g. Cohen, 1995) believe that the earth can support a population of nine billion people with proper environmental management. So how are we doing and is there objective evidence of environmental deterioration?

*Climate change:* The question of climate change has received much attention over the past two decades. According to the Intergovernmental Panel on Climate Change (IPCC, 2007) global temperature has risen by 0.74 Deg C over the last 100 years and based on careful analysis the IPCC judges this to be “unequivocal” evidence of global warming. The IPCC identifies anthropogenic greenhouse gas emissions, principally CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O, as the major drivers of climate change.

The impacts of climate change will be uneven over the globe and some areas may benefit from warmer temperatures, but it is unlikely that positive effects in some regions will cancel negative effects elsewhere. So for example, polar ice melts have accelerated and these contribute to rising sea levels. Low lying countries such as Bangladesh are likely to experience significant flooding and are at greater risk from major storm events. Storms are also likely to be more severe as are episodes of extreme drought. Substantial biodiversity loss is expected to accompany climate change as the natural ranges of many plant and animal species are forced to shift to higher latitudes.

Future projections provide little basis for optimism. Emissions of CO<sub>2</sub> and other greenhouse gases are unlikely to be reduced in the short term, owing to our dependence on coal and petroleum to power the global economy. Political efforts to move away from carbon dependence have had at best modest success and technological solutions like carbon sequestration are still unproven. At present the rate of greenhouse gas emissions into the atmosphere is increasing rather than stabilizing and future warming is inevitable. So on balance it appears that future climate trends will drive environmental deterioration.

*Ocean health:* The oceans have long been an important source of human food. Until relatively recently ocean harvests were regarded as inexhaustible. The annual value of marine fisheries is at least \$100 billion USD and for many peoples who live along marine estuaries this source of food is essential. Now, however, there is substantial evidence of over harvesting. A partial list of over

exploited ocean species would include the cod from Newfoundland, groundfish from New England, Walleye pollock from the Bering Sea, blue fin tuna and some salmon species in the Pacific Northwest (Mooney et al., 1996).

Oceans offer other valuable products. According to a recent NRC report (Targett et al., 2002) on marine biotechnology, oceans are the most promising frontier for sources of new drugs. But polluted ocean environments present disease threats and various marine toxins can be a threat. For example, algal blooms that threaten shellfish industries also produce toxins can threaten the human health.

Scientific principles of ocean management can be applied and these can mitigate ocean declines, but this is difficult owing to the commons nature of oceans fisheries. The economic incentives favor over exploitation and creating other incentives will require unprecedented international cooperation.

*Water resources:* Fresh water is vital to human life, it underpins agriculture, it provides sanitation, and it is the source of many other essential services. Jury and Vaux (2007) classify fresh water into three broad sources: rainfall, accessible groundwater and surface water. All together these sources represent about 0.6% of the earth's water supply, the rest being saline. An obvious fact is that water availability is heterogeneous over the earth. Some regions have ample sources, either from rain or large rivers or lakes. Other regions are chronically short of water, such as northern Africa or parts of the southwestern US.

An important conflict arises between ecosystem needs and the demands to support an ever-growing human population. It is self-evident that humans cannot use all available fresh water without doing irreparable damage to the ecosystems upon which we also depend, so some sort of balance needs to be maintained. Consider, for example, wetland ecosystems. These play a vital role in water storage, nutrient cycling, water quality improvement, food production and other services, yet more than 50% of the world's wetlands have been destroyed or degraded in the past century (Jury and Vaux, 2007).

It is estimated that greater than 1700 m<sup>3</sup> per person/year are needed, on average, for food production and all other services for human and ecosystem health. Of this, about 1200 m<sup>3</sup> per person/year are required for food production alone. Yet, in 1995 eighteen countries had less than 1000 m<sup>3</sup> per person/year of available water. Owing simply to population growth the number of countries with severe water deficits has certainly increased over the last decade. It is relatively straightforward to estimate the global fresh water supply and to calculate the demand of 9.3 billion people. Such calculations suggest that it is possible to maintain sustainable systems with proper scientific management of global fresh water resources. But doing so will require major changes in the economic and legal systems that govern water use. For example, a major current problem is persistent ground water over drafting. Frequently the commons nature of ground water resources provides an incentive for excessive exploitation thus undermining future water supplies. India for example, has a significant problem with massive and unsustainable ground water over drafting for agriculture. Urban over drafting is also a significant problem in major cities such as Beijing and Mexico City.

Another problem that threatens water resource sustainability is industrial and urban pollution. The list is long, but proper management can do much to mitigate these threats to sustainability.

*Food security:* World food production peaked in 2003 (Jury and Vaux, 2007) and has declined slightly since then. Today for the first time since the 1960s, there is real concern about food security. As noted above, the “Green Revolution” introduced a suite of technologies that moved some parts of the world from chronic food shortages to an adequate supply and, despite a doubling of the world human population, the benefits persisted for more than two generations. As is the case with all technological innovations, the potentialities of the green revolution are now largely exploited and the rate of gain has declined. Perhaps newer biotechnologies will replace the green revolution and will enable a continued gain in agricultural productivity. However, the challenges associated with land degradation, water resource scarcity and energy all impact food production capabilities.

*Is present consumption compromising the resource base of future generations?* The answer to this fundamental question about sustainability appears to be yes. When climate change, water resource issues, over exploitation of ocean fisheries, biodiversity loss and other indicators are added together it is hard to conclude that future generations will be better off in a resource sense. At the same time, the endless capabilities of science and technology to provide new solutions to old problems and to provide new ways to meet human needs should not be underestimated. So how can we make full use of our science capabilities in building a sustainable future? One answer is to mobilize and fully engage the scientific community. An important and powerful element of the science community is the Academy of Science.

## **7 WHAT CAN ACADEMIES DO TO ADVANCE SUSTAINABILITY SCIENCES?**

Science academies are relatively old institutions dedicated to scientific communication and to advancing the practice of science within individual countries. Most academies elect members based on scientific achievement and include among their membership a nation’s scientific leadership. Academies thereby symbolize the scientific community within a country and speak with authority on issues related to science, technology and health. International opinion polls consistently reveal that science is one of the most esteemed human activities. This respect for science and for the institutions of science makes it attractive for policy makers to turn to respected science institutions in attempting to formulate choices among difficult policy options. The academies of a few countries have formalized processes for bringing detailed science policy advice to national decision-makers. These reports can be influential when they are seen as credible and as offering the best scientific options for the solution of difficult public policy questions.

US National Academy of Sciences (US NAS) has a well-evolved process for delivering policy advice to decision makers. The process is based on convening

committees of experts on critical issues and reviewing the state of scientific knowledge relevant to the problem at hand. The review is then used as a basis to make policy recommendations for actions that address the problem. Several US NAS reports have been cited in previous paragraphs. An important example in the sustainability arena is a report published in 1999 entitled “*Our Common Journey: A Transition toward Sustainability*”. This report examined strategic connections between scientific research, technological development, and societies’ efforts to achieve environmentally sustainable improvements in human well being. The report concluded that societies should approach sustainable development not as a destination but as an ongoing, adaptive learning process.

## 8 A GLOBAL NETWORK OF SCIENCE ACADEMIES

In recent years the academies of the world have joined together into a global network aimed at making science academies more relevant in every country. The network, known as the InterAcademy Panel on International Issues (IAP), now includes academies from approximately 100 countries. According to the IAP website (<http://www.interacademies.net>) the primary goal is to strengthen the capacity of science academies to “advise citizens and public officials on scientific aspects of critical global issues.”

In 2000 a second organization called the InterAcademy Council (IAC, <http://www.interacademycouncil.net/>) was created under the umbrella of the IAP to produce authoritative “reports on scientific, technological, and health issues related to the great global challenges of our time.” The IAC has now issued four influential reports, the first of which addressed the importance of capacity building in science, technology and health. This report entitled “*Inventing a Better Future*” was released in 2003 and it set forth five major areas for action:

- **Science, technology, and society:** To achieve societal goals, governments must develop national S&T strategies; the S&T community should provide knowledge and advice for addressing critical issues; and the public must be informed about and engaged in national S&T policymaking.
- **Human resources:** New efforts are required for the attraction, development, and retention of scientific and technological talent in all nations.
- **Institutions:** Centers of excellence are needed for S&T to flourish. Virtual networks of excellence, linking professionals from different locations working on similar problems through the power of ICT, can multiply the potential effectiveness of individual centers, as can regional cooperation between countries.
- **The public-private interface:** The private (and the literally “productive”) sector is now the primary global force in R&D for S&T, and clear distinctions between public goods and proprietary interests would help in the establishment of true public-private partnerships.
- **Financing:** To complement national efforts, creative new mechanisms are

needed to ensure adequate funding for S&T capacity-building.

The second major IAC report, “*Realizing the Promise and Potential of African Agriculture*” dealt with the decline in African agricultural production. The major conclusions of this report were:

- A production ecological approach can identify problems and the potential solutions for increasing agricultural productivity in priority farming systems.
- The correct and diligent application of a range of technology options can increase crop and animal production, while making more effective and efficient use of land, labor and capital.
- African nations must create and retain a new generation of agricultural scientists.
- A vibrant market economy and effective economic policies are essential in making poor families income and food secure.

The most recent IAC report addressed the global energy transition. This report, entitled “*Lighting the Way: Toward a Sustainable Energy Future*”, was released in the fall of 2007 and it called for immediate and simultaneous action in three areas:

- Concerted efforts should be mounted to improve energy efficiency and reduce the carbon intensity of the world economy, including the worldwide introduction of price signals for carbon emissions.
- Technologies should be developed and deployed for capturing and sequestering carbon from fossil fuels, particularly coal.
- Development and deployment of renewable energy technologies should be accelerated in an environmentally responsible way.

The work of the IAC represents the very early stages of an effort by the international scientific community to provide an S&T blueprint for policy makers in addressing key issues. Much remains to be done to extend the advice contained in these reports to national decision making communities. But the work of the IAP and IAC demonstrate that the international science community has the capacity to band together to address the critical sustainability challenges of our times.

## **9 ACADEMIES AND THE G8 SUMMITS**

The international science community has also become active in trying to influence the views of the G8 governments that represent the major global economies. By virtue of their economic power, the G8 governments have disproportionate influence over the use of global resources. Over the past four years a series of statements endorsed by the science academies of the G8 + 5 nations have been released in conjunction with the G8 meetings. (G8 + 5 refers to the G8 nations



plus five of the major emerging economies, Brazil, China, India, Mexico and South Africa). Sustainability issues were addressed in the following statements that can be accessed at most of the participating academy websites.

- Global Response to Climate Change (2005);
- Energy Sustainability and Security (2006);
- Growth and responsibility: sustainability, energy efficiency and climate protection (2007); and
- Climate Change Adaptation and the Transition to a Low Carbon Society (2008)

These statements have had some influence on the G8 process and on the final communiqués issued by the summit participants. But it is difficult to measure impacts and to say whether the efforts of the science community have moved policy. The formulation of international policy on such large issues occurs slowly as consensus is formed and as publics begin to demand effective action. This illustrates one final aspect of the sustainability question. Is there time? The pace of population growth and the associated demands on the physical and biotic environments have been accelerating and will continue to accelerate until at least mid century. Is it possible for science to invent and explore the utility of new technologies quickly enough to assure an adequate future? The answer to this question depends in part on effective communication with publics and with policy makers. The process of expanded communication has only just begun.

## 10 CONCLUSION

So where do we stand? The record of the past half century suggests that some level of environmental deterioration has occurred and projections into the next half century suggest that negative trends will continue or accelerate. For example, climate change is almost certainly going to continue because of the economic momentum behind the use of carbon emitting energy sources and because of the long half-life of CO<sub>2</sub> in the atmosphere. Similarly, biodiversity loss and water resource issues show no sign of stabilizing. At the same time, the global science community has become increasingly engaged in finding science-based solutions to resource problems.

Major international agreements are essential, but ultimately much of the hard work will fall on national governments, because they make the policies that affect citizens and that spill over into surrounding nations. An effective plan of action by science communities must recognize that most solutions will be implemented at the local level and that science must speak with a clear and credible voice to national decision makers. This means that global organizations like the IAP and IAC must find a way to assist their members to affect local policies.



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<sup>1</sup> As listed by the author.



# **Industrial Potential of the Republic of Tatarstan: Achievements and Opportunities**

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## **1 ABSTRACT**

The Republic of Tatarstan is one of the most sustainable components of the Russian Federation. Favourable geographic location, rich natural resources, highly qualified scientific and technical personnel, stable political situation and well developed regulatory framework, all create necessary prerequisites for successful development of Tatarstan, consistent integration into the system of international economic relations.

## **2 THE ECONOMY OF TATARSTAN: A SNAPSHOT**

At present there are 10,000 industrial enterprises successfully operating in the republic, including the enterprises of small and medium-sized businesses with 400,000 employees working there.

GDP in the Republic of Tatarstan in 2007 was \$30 billion. (for reference: RUR713 billion or \$29.39 billion at the rate of 24.26 roubles per 1 dollar). The republic ranks 5<sup>th</sup> among the constituents of the Russian Federation in terms of industrial production output. At that the most substantial contribution into acceleration of production growth is made by the processing industries. Processing industry gain in 2007 made up 116.3% compared with 2006, which exceeds Russia's average level by 7% (for reference – in the Russian Federation it is 109.3%). The share of the production sector is the largest in the production of GDP, being 50% in 2007.

Today, more than half of the production output (it is 60%) is shared among three types of activities – mineral extraction with 31%, chemical production, accounting for 12%, transportation vehicles and equipment, for 17%.

Oil, gas and chemical complexes of the Republic of Tatarstan have been developing by cluster type. All its industries, namely oil production, oil processing,

chemistry and petrochemistry are functioning as a single unit.

In 2007 some 32 million tons of oil was produced in the Republic of Tatarstan, 80% of which was produced by OAO Tatneft, and 20%, by small companies. In the republic, the decision was made to attract into the industry natural bitumen, the explored reserves of which according to expert evaluation make up 2 - 7 billion tons (Russia's total amount of oil is 30 billion tons).

In the oil refining industry of the Republic of Tatarstan, there has been a substantial investment in technological and institutional changes over the last few years.

Today, in Tatarstan, 7 million MT of oil is refined every year. There commenced the implementation of a large project namely the construction of oil refining and petrochemical complexes for the refining of carbon-containing oil in the volume of 7 million MT. Some \$320 million was invested for the implementation of the project.

In 2007, the republic chemical and petrochemical production output exceeded \$4.5 billion, accounting for 11% of all-Russia petrochemical production output.

The republic enterprises manufacture some 40% of Russia's polystyrene, polyethylene and polypropylene as well as 33% of the rubber and tires.

By 2010, the petrochemical production output is set to increase by 1.4% compared to 2007. Investments in the basic capital of the chemical and petrochemical enterprises are expected at the level of \$5 billion from the year 2008 to 2010.

Besides major industrial sites, an industrial park named Khimgrad has been set up in Kazan, which allows ample opportunities for the implementation of innovation-oriented investment projects.

In 2007, commodity output by the mechanical engineering sector accounted for nearly \$7.6 billion, and, in 2008, the commodity output is expected to exceed \$9 billion, while the industrial production index is predicted to increase by 15.7%.

In the total output of machine-building sector, over 50% is attributed to the automotive industry. Heavy-duty trucks manufacturers Kamaz and Sollers are the core of the automotive cluster. Kamaz factory dominates with 10% of all industrial production and with some 40% of commodity output in the machine-building sector of the republic. In the last year, the volume of products manufactured and sold by the enterprises of Kamaz group made up over US\$3 billion, expected to grow to over US\$5 billion by 2010.

Sollers company runs its business in Tatarstan particularly the production of modern motor cars and FIAT multifunctional minibuses, SSANGYONG off-road vehicles and ISUZU trucks.

Such high rate of automobile production in Tatarstan and Russia creates necessary conditions for the development of auto components' production within techno-industrial parks.

A 'pioneer' in this field is Kamaz, which together with the Government of

the Republic of Tatarstan set up Kama Industrial Park, where one can find 130 enterprises with the total number of 1700 people and total annual sales of more than \$130 million.

To provide the appropriate innovation milieu of this nature, and in partnership with small and medium-sized businesses, 14 technoparks and 7 business incubators were created by the Government of the Republic of Tatarstan.

Moreover, the aircraft industry plays an important role in maintaining and multiplying innovative potential of the industry and is represented by the 'Kazan Aircraft Industrial Association,' which produces long-range passenger aircrafts TU-214 and multipurpose supersonic weapon carrier bombers TU-160; as well as the 'Kazan helicopter plant,' which produces helicopters of MI series, which are exported to more than 80 countries of the world, and also produces a new class of Ansat helicopters.

Aircraft cluster is constituted by enterprise, which produces constituent parts for aircraft plants.

Another branch of industry which is of high priority is ship-building. OAO Zelenodolsk Plant n.a. Gorky produces cruisers for the needs of the Ministry of Defence of the Russian Federation, different commercial ships of 'river-sea' class with displacement of up to 10,000 tons, high speed passenger ships with the capacity of 100 persons. The quantity of output in ship-building by the year 2010 will amount to more than US\$190 billion.

In the republic, there are large manufacturers of household appliances, refrigerating engineering, compressor equipment, electro-pumping equipment for oil-extracting, tractors and other production of machinery building, woodworking enterprises and food industry with sound investment potential.

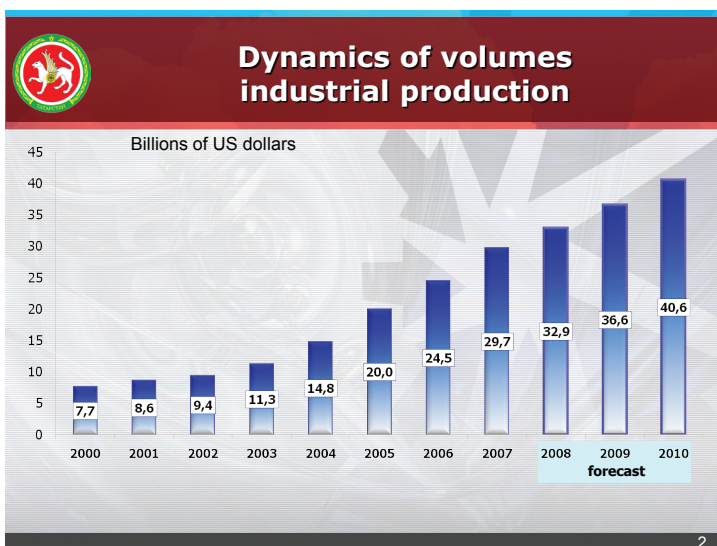
The integration of the Russian economy to the global community raises the quality questions as the most important factor for competitiveness assurance, successful promotion of the production to consumer market. This is why Tatarstan was one of the first regions of the Russian Federation to adopt the various quality standards outlined in the program called Production and Services Quality Improvement in the Republic of Tatarstan.

Furthermore, in the last three years the foreign trade turnover of the Republic of Tatarstan has grown by 2.5 times. In 2007, the foreign trade turnover of the Republic of Tatarstan amounted to US\$15.3 billion, including about 90% -US\$13.8 billion- export supply of the republic.

Tatarstan cooperates with more than 100 countries from near and far abroad and trade and economic cooperation with Arab and Asia region countries is developing rapidly. Tatarstan cooperates with member countries of the Organisation of Islamic Cooperation (OIC), and hopes to further develop economic relations with such countries.



**Figure 1. Republic of Tatarstan.**



**Figure 2. Dynamics of Volumes: Industrial Production.**

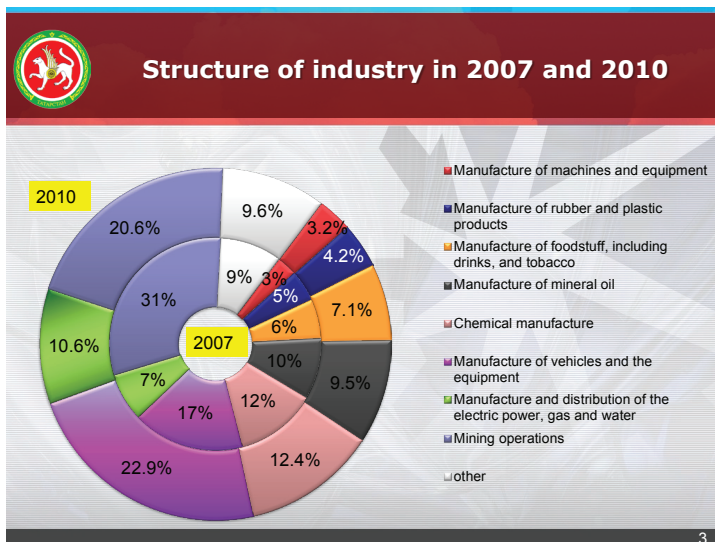


Figure 3. Structure of Industry in 2007 and 2010.

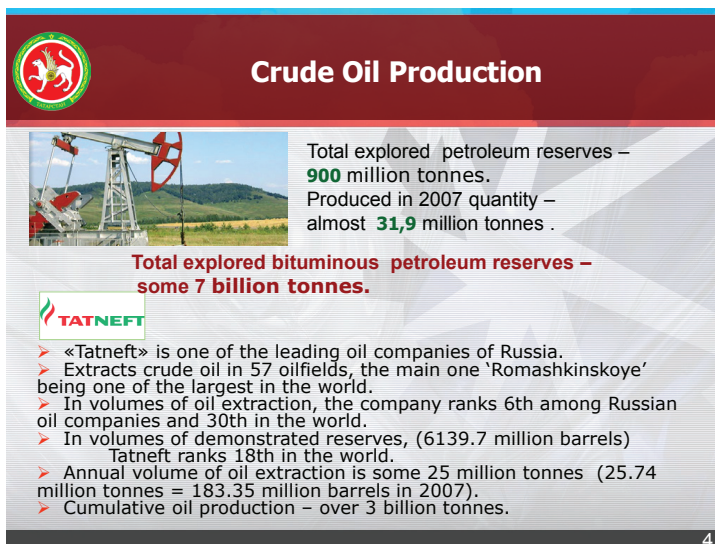


Figure 4. Crude Oil Production.





Figure 5. Complex of Oil-Refining and Petrochemical Plants in Nizhnekamsk.

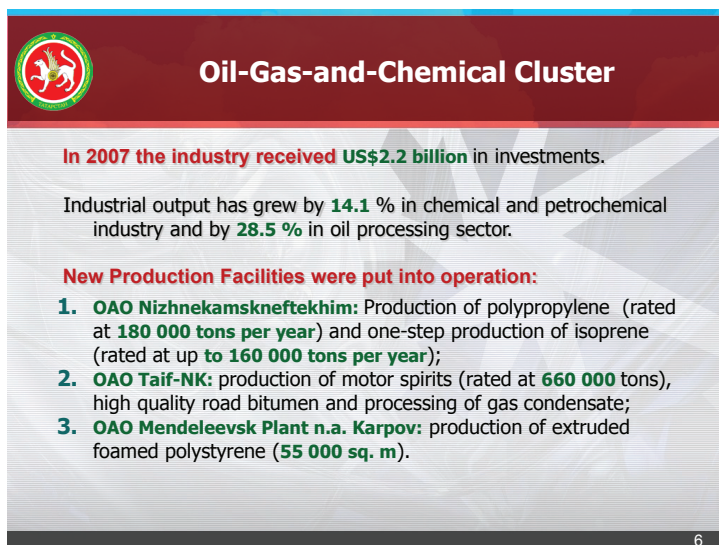


Figure 6. Oil-Gas-and-Chemical Cluster.



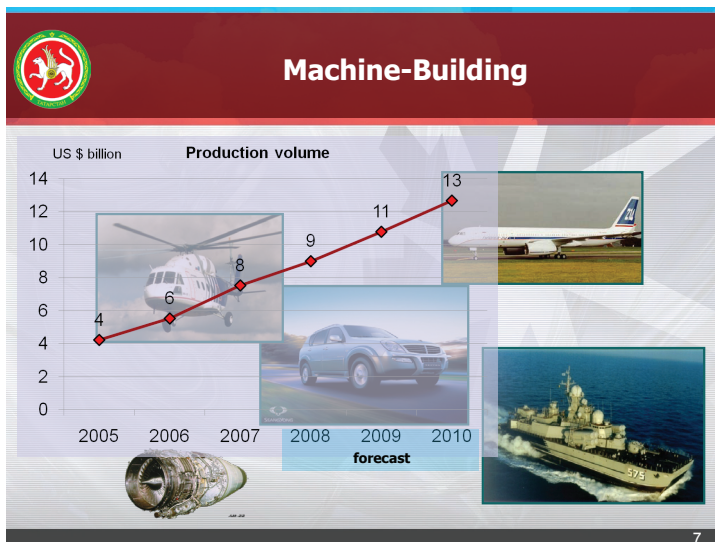


Figure 7. Machine-Building.

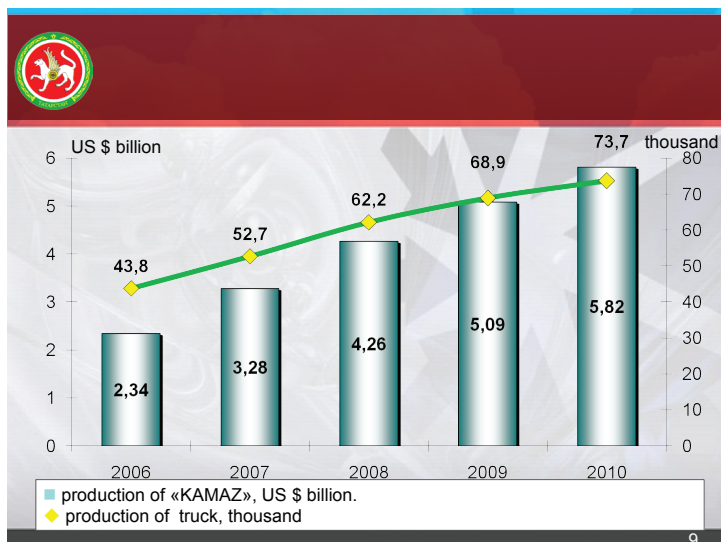
**KAMAZ**

❖ «KAMAZ» is widely known in Russia and abroad.  
 ❖ The enterprise is engaged in development, production, assembly and after-sales services of trucks and cars, diesel engines, parts, assemblies and components of motor vehicles, manufacturing of tools, machining attachments, tailored equipment.

Images of KAMAZ vehicles: crane truck, off-road truck, tanker truck, tractor, dump truck, and bus.

[www.kamaz.net](http://www.kamaz.net)

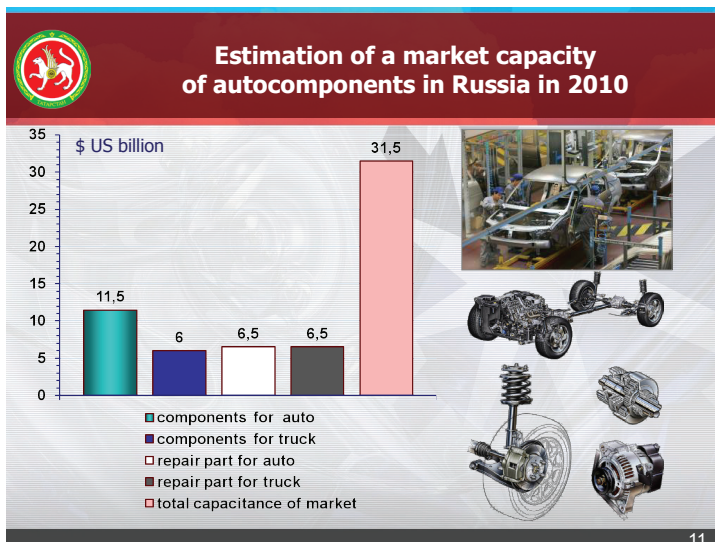
Figure 8. KAMAZ.



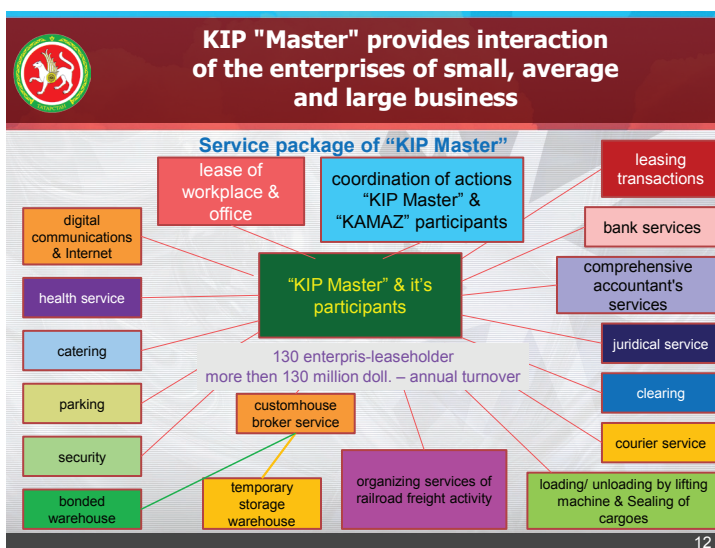
**Figure 9. Prospects of Development of 'KAMAZ' until 2010 in Cost and Natural Expansion.**



**Figure 10. List of the Basic Priority Projects of Group of Companies: Sollers.**



**Figure 11. Estimation of a Market Capacity of Auto-components in Russia in 2010.**



**Figure 12. KIP 'Master' Provides Interaction of the Enterprises of Small, Average and Large Business.**



**Figure 13. Kazan Aircraft Production Association named after S. P. Gorbunov.**



**Figure 14. Kazan Helicopters.**





Figure 15. Unpiloted Aircrafts.



Figure 16. Zelenodolsk Shipbuilding Yard named after Gorky.



Figure 17. Industrial Association Plant named after Sergo.

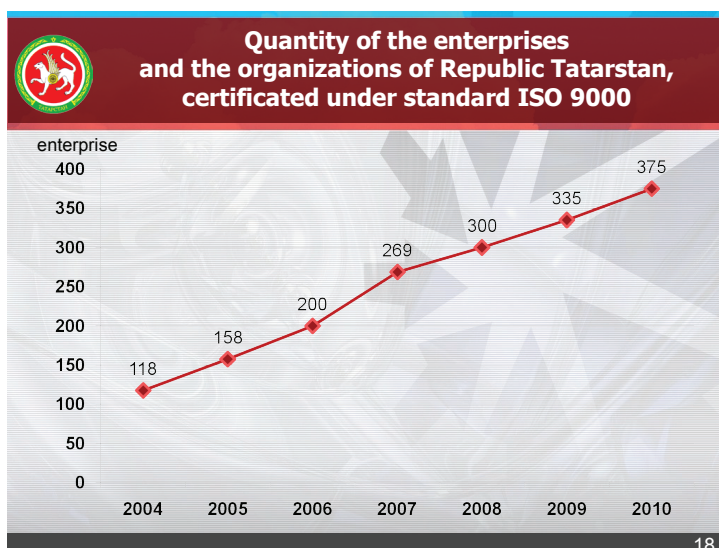


Figure 18. Quantity of Enterprises and Organizations of Tatarstan certificated under ISO 9000.

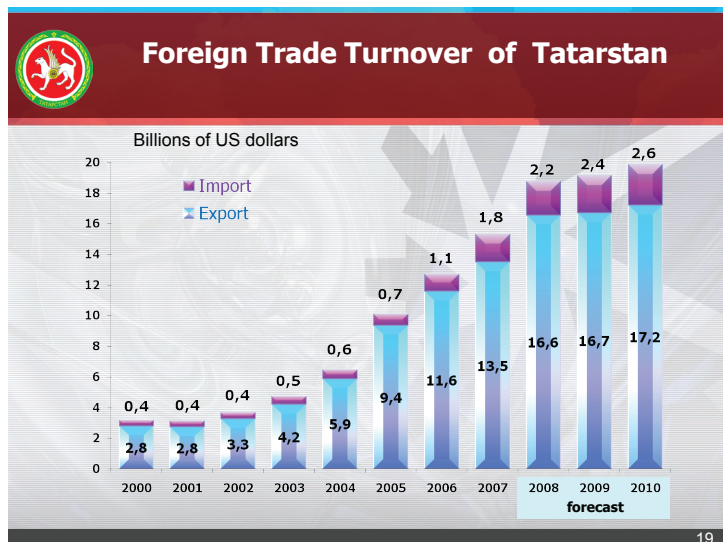


Figure 19. Foreign Trade Turnover of Tatarstan.

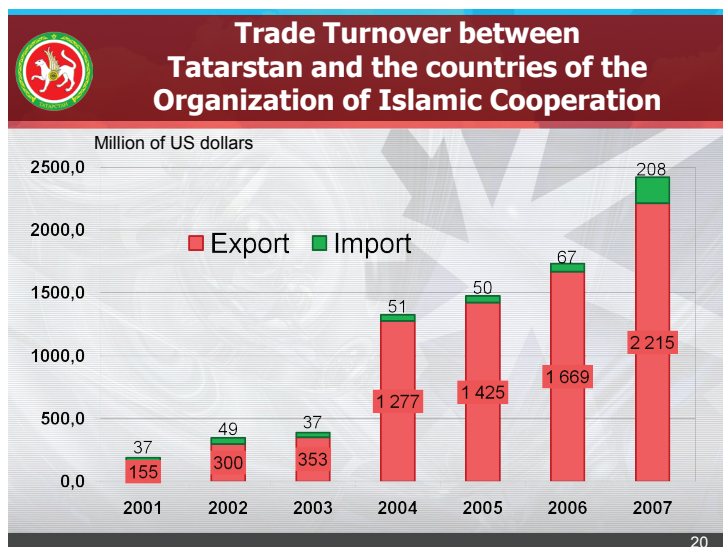


Figure 20. Trade Turnover between Tatarstan and the Countries of the Organization of Islamic Cooperation.





# **The Large Hadron Collider (LHC) at CERN Geneva: The Ultimate Example of International Collaboration**

MOHAMMAD SAJJAD ALAM FIAS  
*University at Albany, NY*  
*USA*

## **1 ABSTRACT**

This summer of 2008, bunches of 115 billion protons moving in opposite directions inside the underground accelerator ring of 27 kilometer circumference will collide with each other to recreate the conditions close to the beginning of the universe. Sampling the proton-proton collisions at an energy of 14 TeV (trillion electron volts), the highest energy ever achieved by mankind, will be the four world experiments called ATLAS, CMS, LHCb, and ALICE. More than ten thousand scientists and engineer from 40 countries and hundreds of institutions have toiled for over a dozen years to bring into existence four world-class mammoth electronic detectors.

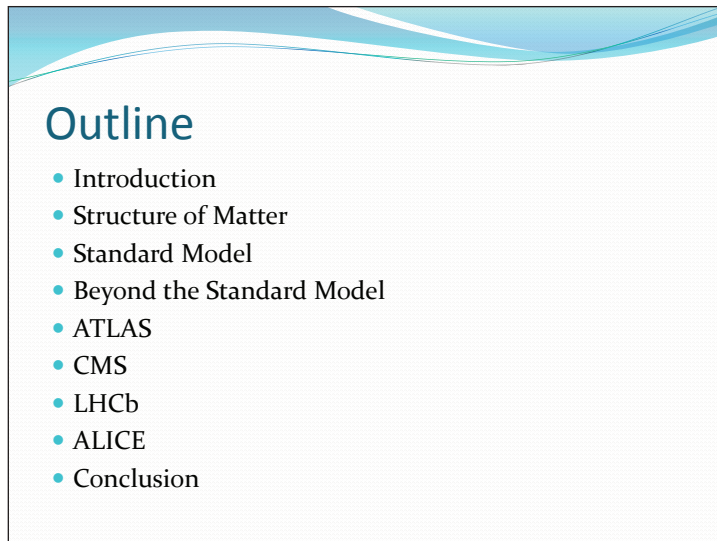
What is the world made up of and what is the glue that holds the pieces together? Only 5% of the total universe is hot, luminous and visible. This part is made of spin  $\frac{1}{2}$  mass-carrying fermions and integral spin force-carrying bosons. Leptons and quarks are the mass-carrying particles. There are four sets of force carrying particles: (a) the photon, which mediates the electromagnetic force, (b) the  $W^+$ ,  $W^-$ , and  $Z^0$  particles, which mediate the weak interaction, (c) eight colored gluons, which mediate the strong force between the quarks, and (d) the graviton, which mediates the ubiquitous gravitational force. There are six different kinds of leptons and an equal number of antileptons, which carry the conserved lepton quantum number. There are also six quarks and six antiquarks, which each carry another conserved  $\frac{1}{3}$  baryon quantum number and come in three different colors. Further, the quarks have either  $+\frac{2}{3}$ ,  $-\frac{2}{3}$ ,  $-\frac{1}{3}$  or  $+\frac{1}{3}$  electrical charge relative to that of the electron. Leptons may be elementary and have been observed as free particles such as electrons, positrons, etc

We do not understand the hierarchy of lepton and quark masses. One solution is the Higgs particle and quarks and leptons acquire masses through interaction

with the field of this particle. The mass carriers are fermions while the force carriers are bosons. Is there a super symmetric world, where the mass carriers are bosons and the force carriers are fermions? Are there more dimensions beyond those of space and time? Quarks and leptons may not be elementary; they may be composite. There may be more exotic particles such as magnetic monopoles, free quarks and even mini black holes.

Apart from the scientific and technological adventure that the LHC experiments present, the sociological adventure is no less daunting. The ATLAS and CMS experiments are two comparable general purpose experiments, which seek the answers to questions raised earlier. The LHCb experimental design is optimized to study CP violation in  $B$  mesons decays, which explains why the world is all particles and not antiparticles. The aim of the fourth experiment ALICE is to study the formation of a new phase of matter, the quark-gluon plasma. The LHC experiments are world experiments, since the participation is indeed worldwide. Every country, which has a scientific infrastructure worth mentioning, is participating in one of the experiments. The model for participation requires the country to make money contributions so its people can then contribute. It is clear that particle physicists, more than any group of people, are showing the world how to collaborate at the international level. Muslim countries such as Pakistan, Iran, Turkey, etc are quite visible players.

## 2 PRESENTATION



**Figure 1. Outline.**

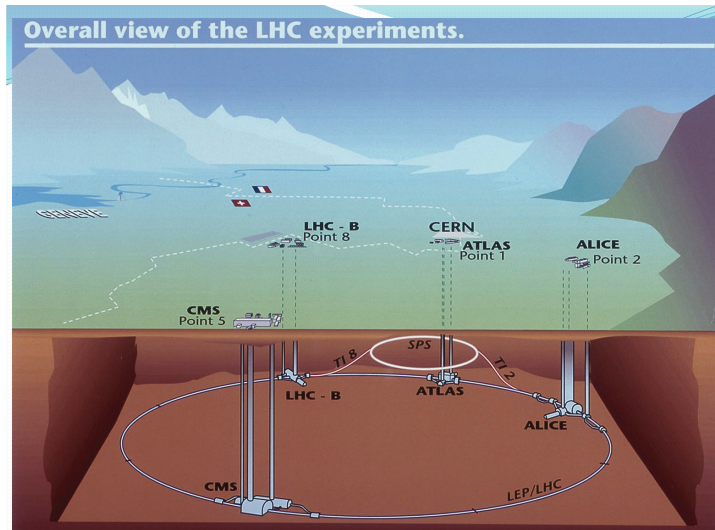
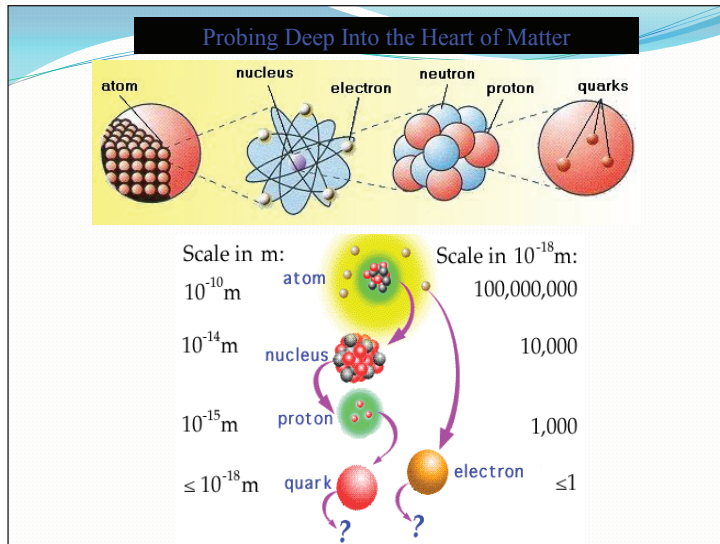


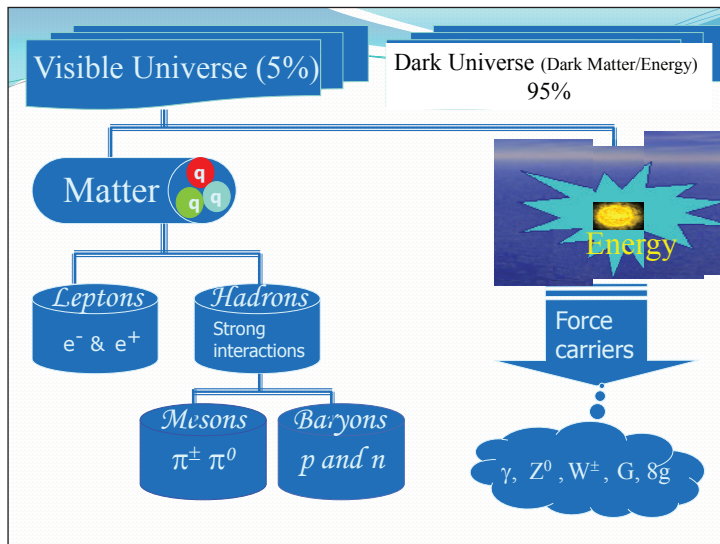
Figure 2. Overall View of the LHC Experiments.



Figure 3.



**Figure 4. Probing Deep into the Heart of Matter.**



**Figure 5.**

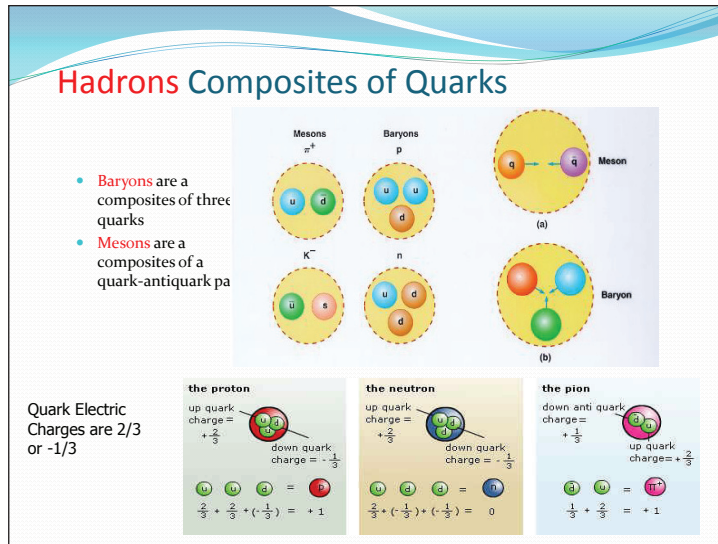


Figure 6. Hadrons Composites of Quarks.

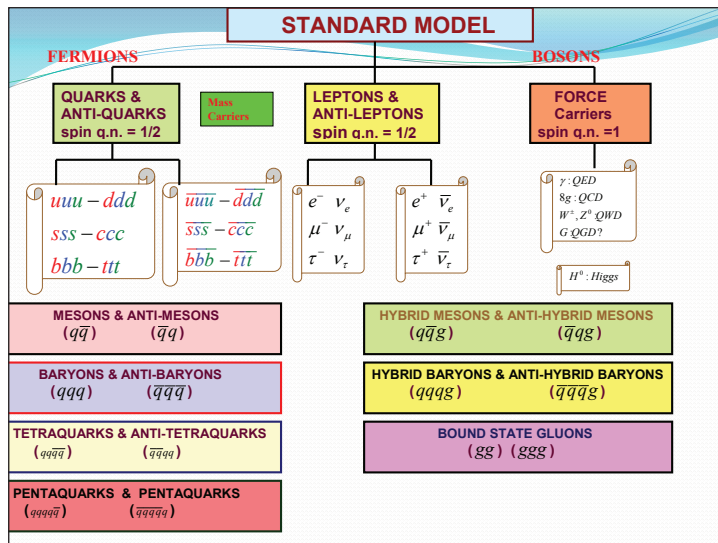


Figure 7. Standard Model.

## Questions that Arise

- How do particles acquire mass? Higgs Field/ Particle :120 – 200 GeV
- Why are there quarks and leptons?
- Why only three generations of quarks and leptons
- What is baryon and lepton number? Why are they so strictly conserved?
- What is quark color? Why are they non-integrally charged?
- Why are there four forces with such differing strengths?
- Why is CP violated? Is it the answer of matter-antimatter asymmetry?
- Why are mass carriers fermions and force carriers bosons? Is there a supersymmetric world of mass carriers as bosons and force carriers as fermions?
- Why do we not see free quarks? Why only integrally charged combinations of quarks exist in nature?
- Are there extra dimensions? Does gravity leak into the extra dimensions?
- Do magnetic monopoles exist?

Figure 8. Questions that Arise.

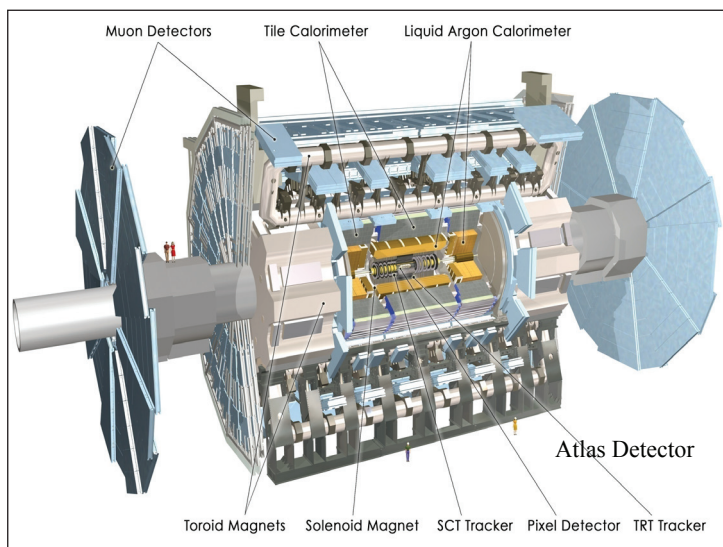
## To Answer These Questions

- Build more and more powerful particle accelerators: the Large Hadron Collider (LHC)
- Study more collisions at the highest center-of-mass energy: Proton-Proton Collisions at 14 TeV
- Build more and more sophisticated particle detectors: a) ATLAS, (b) CMS, (c) LHCb, (d) ALICE, (e) TOTEM, and (f) LHCf
- Record larger and larger samples of data: Petabytes of data a day
- Build cheap supercomputers to analyze tons and tons of data to construct the theory of everything: Hundreds of Clusters with thousands of PC's forming a world grid
- So the quest goes on. Now the world must join us if they want the answers
- Every Country, every scientific and engineering institutions must come together to form multi-thousand big collaborations.
- We will teach the world to work together, no matter what your religion, no matter what your race, no matter what your language!
- So let me show what the world excitement is about!!!!

Figure 9. To Answer These Questions.



**Figure 10. The ATLAS Collaboration at CERN Office.**



**Figure 11. ATLAS Detector.**



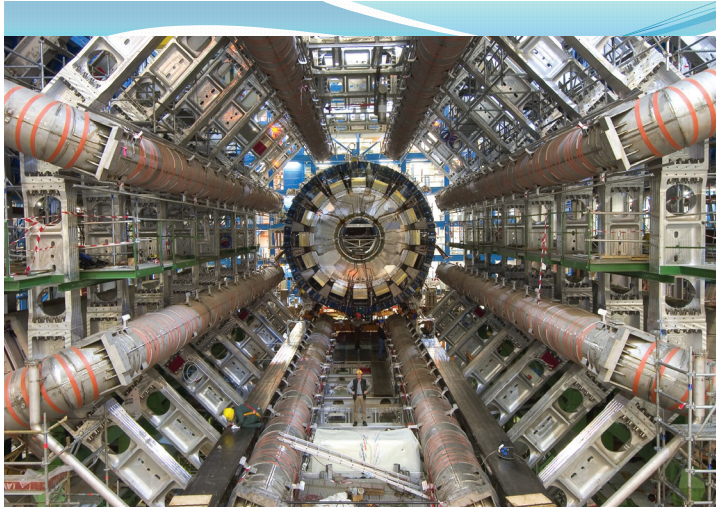



Figure 12.



# ATLAS Physics

<http://atlas.ch>

### The unknown

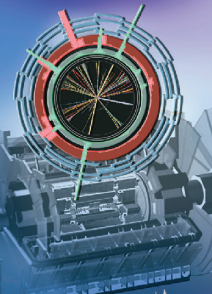
ATLAS brings experimental physics into new territory. Theoretical ideas predict new discoveries, but nobody knows for sure what new phenomena may be discovered. Here, looking for the completely unknown, or rather, new phenomena and particles will change our understanding of energy and matter and of the basic things that were created our universe since the beginning of time.

### Dark matter

ATLAS will represent the conditions of this universe and will try to find out to understand why the universe is like it is today. It is looking for the matter of the universe is dominated by an unknown form of matter called dark matter. Scientists are looking for particles that are invisible to the instruments of dark matter. If such particles exist, ATLAS should discover them and therefore should clarify the mystery of dark matter.

### Antimatter

At the very beginning of the universe, equal amounts of matter and antimatter existed. If not, our world would not exist. Some forms of matter and antimatter have annihilated one another and energy. But why some parts of the matter left over to create everything we see on earth, the solar system and the galaxy? ATLAS will look for the tiny differences that may exist between matter and antimatter.

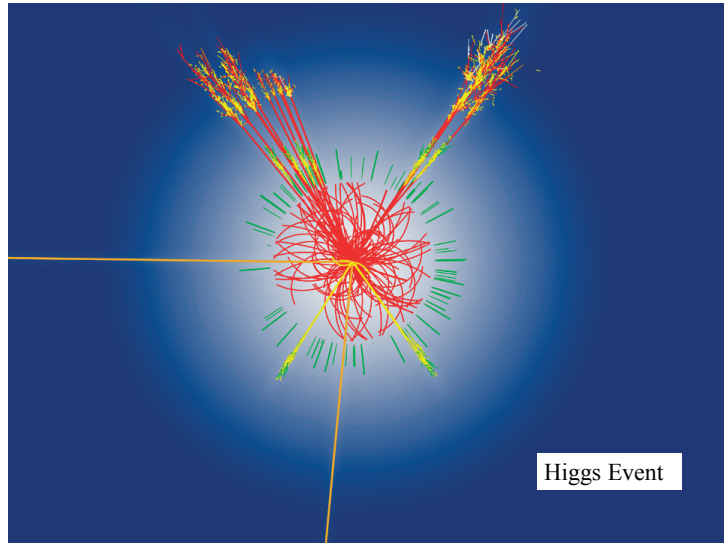


### Mass

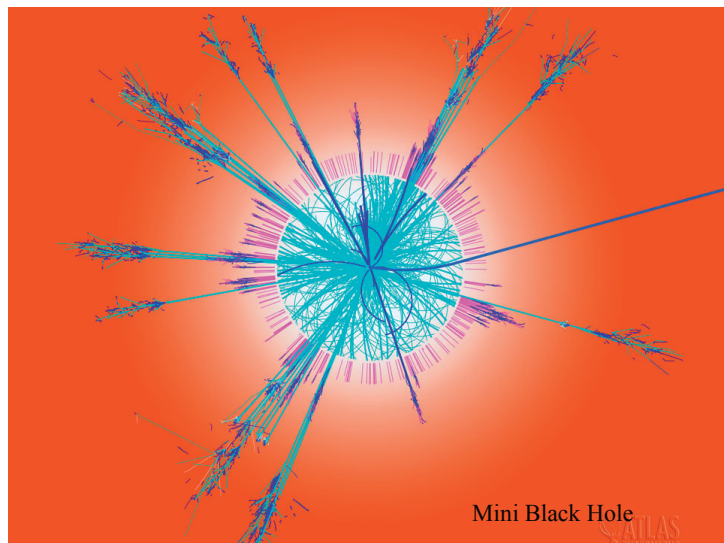
Why do fundamental particles have such different masses? Two of the greatest mysteries in the particle physics are how mass and energy are related. To explore these mysteries, theorists predict a new particle, the Higgs particle. If this particle exists, ATLAS will discover it and will therefore solve the problem of masses.

Figure 13. Atlas Physics.





**Figure 14. Higgs (the 2013 Physics Nobel Laureate) Event.**



**Figure 15. Mini Black Hole.**

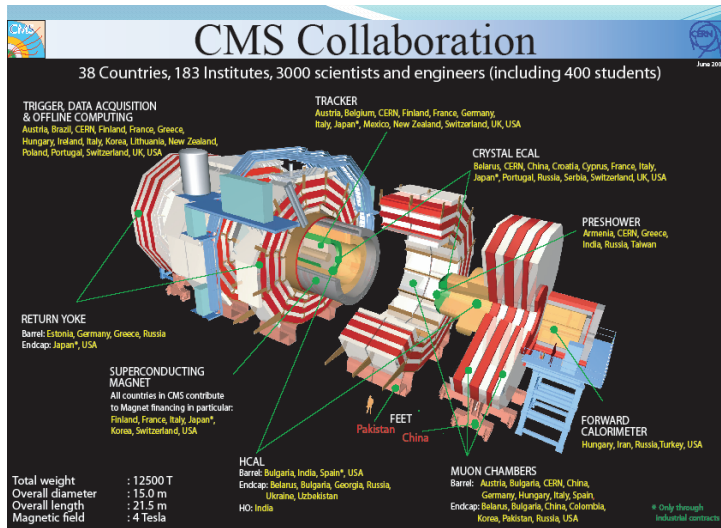


Figure 16. CMS Collaboration.

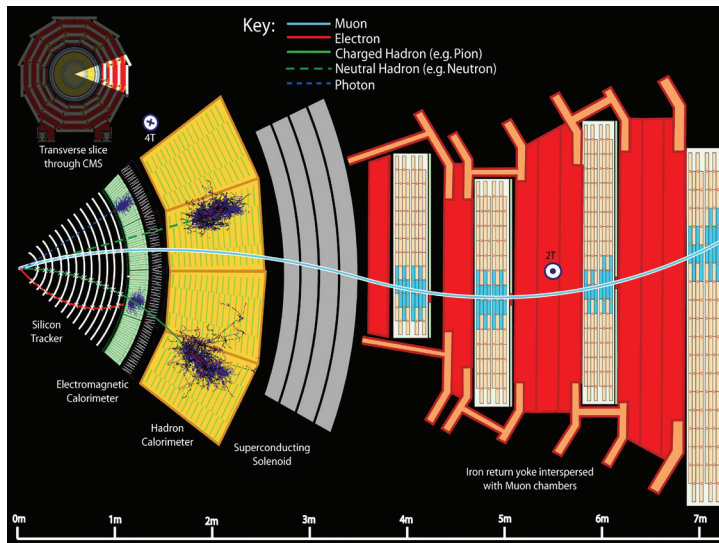


Figure 17.

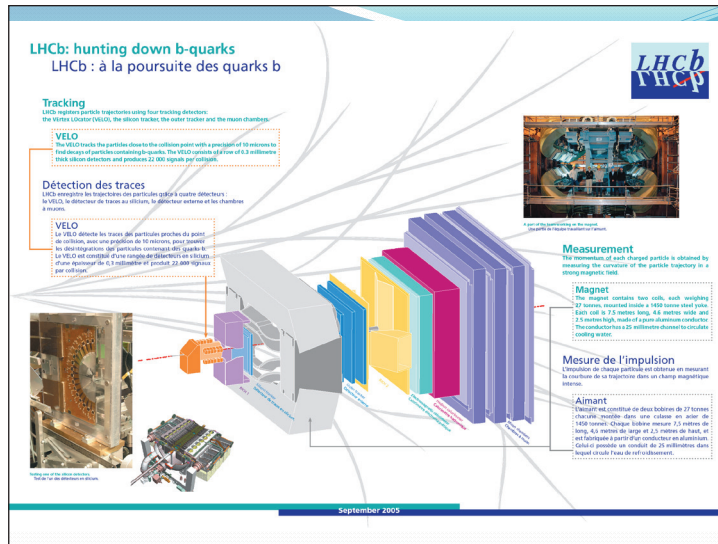


Figure 18. LHCb: Hunting Down b-quarks.

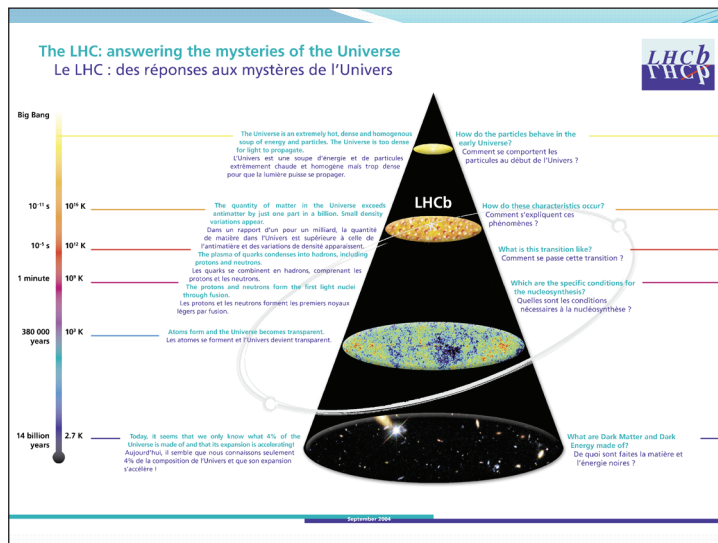


Figure 19. The LHC: Answering the Mysteries of the Universe.



Figure 20.

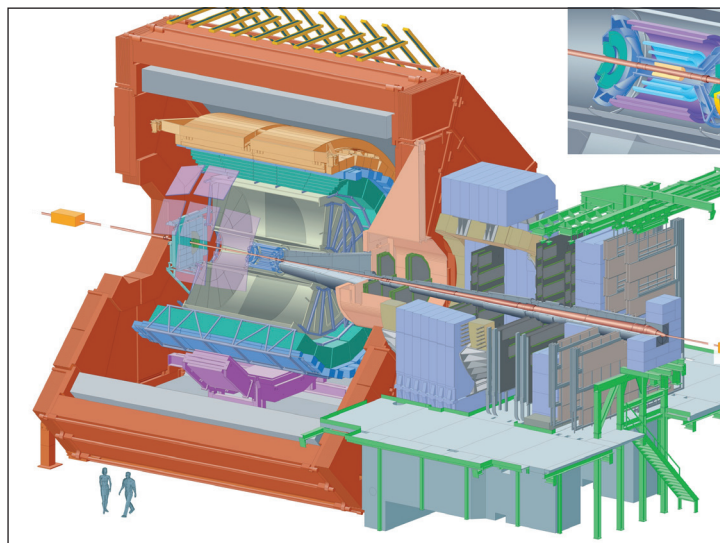


Figure 21.



Figure 22.

## 1995 – 2008 Waiting

- So shall we find the answers to our questions ?
- We shall be looking at the universe a few microseconds after its creation!!!
- As we stand at the threshold of creation, then shall we see the footprints of God?
- Or shall we say the universe created itself and there is no design or purpose. For me:
- Allah-o-Akbar, Allah-ho-Akbar
- Allah is the greatest!!
- Wa-Lil-Allah-il-Hamd !!!!!!!!!!!!!
- All praise belongs to Allah
- Rab-ul-Alameen
- Creator and Sustainer Supreme

Figure 23. 1995-2008 Waiting.



# **Selangor as an Islamic Centre of Indigenous and Scientific Biological Knowledge for Sustainable Development**

A. LATIF IBRAHIM FIAS, HALIMAH ALI, NADZIRAH ABU SAMAH *and*  
SUWAIBAH MOHAMED

*International Islamic Academy for Life Sciences and Biotechnology (IAB)*  
*Selangor, Malaysia*

## **1 ABSTRACT**

Indigenous Knowledge (IK) is the accumulative body of knowledge and belief handed down through generations through the culture of transmission and relationships of living beings among themselves and with their environment. There is an increasing recognition that indigenous knowledge of national biological resources will play an important role in national development as such knowledge is being employed in the creation of sound sustainable environmental management programme. It is often said that the driving force behind the advances in modern biotechnology and growth of the biotechnology industry is the result of the utilization of indigenous biological resources in mega biodiversity countries and in many cases based on indigenous knowledge associated with the biological resources.

Selangor as one of the 13 states in Malaysia plans to play an important role in the development of biotechnology and life sciences in Malaysia by capitalizing on existing strengths and opportunities. Selangor will develop the climate for wealth creation and social well-being and provide the complementary and catalytic role for the national science agenda. Selangor boasts world class communication, transport and energy infrastructure as well as an educated population and skilled multilingual workforce. Selangor is not only a great place to live but also a perfect location for biotechnology research and education particularly in agriculture. It has an impressive research and education infrastructure which includes 7 universities including Selangor State University: Universiti Industri Selangor, 5 research institutes and a number of world class hospitals. As a developed Islamic state, one of Selangor's major missions is to revive the glory of the golden age of Islam by mobilizing Muslim scholars, scientists, researchers and students and providing them with infrastructures and facilities that promote advancement in research and education in sciences and technology. What is needed is an organization and infrastructure that can offer scientists and students access to advanced research facilities and equipment to conduct leading edge research the outcome of which is



essential for the industrial competitiveness of Muslim countries. To facilitate the development of advanced research and education programmes, the International Islamic Academy for Life Sciences and Biotechnology (IAB) has been established.

## **2 INTRODUCTION**

Selangor recognizes that indigenous knowledge of national biological resources will play an important role in national development as such knowledge is being employed in the creation of sound sustainable environmental management programme. Selangor realizes that Malaysia is one of the twelve mega biodiversity countries, her indigenous biological resources and the indigenous knowledge associated with the bio-resources are important source of food and in many cases foods that have health and medicinal value. In addition to their contribution to increasing food production, their roles in preserving environmental degradation are considerable.

Since biotechnology is an important technology in the conservation and utilization of biodiversity, it is most appropriate that indigenous biological knowledge and research be incorporated into modern biotechnology for food production and drug discovery. A strategy should be developed to add value to indigenous knowledge and to apply it together with science and technology under the context of sustainable utilization of our bio-resources for the good of society.

## **3 INDIGENOUS BIOLOGICAL KNOWLEDGE**

It is often said that the driving force behind the advances in modern biotechnology and growth of the biotechnology industry is the result of the utilization of indigenous biological resources of the mega biodiversity countries and in many cases based on indigenous knowledge associated with the biological resources. There is also a growing awareness of the role that indigenous knowledge can play in synergy with modern scientific and economic development. Therefore, it is very important that research is done to recover or discover the value of indigenous knowledge of biological resources and to make a record of the indigenous intellectual property for future generations. This is to enable a country to claim the rightful ownership of the biological resources (plant or animal species) and the indigenous knowledge associated with them. There is a need to evaluate and examine the value of indigenous knowledge and to demonstrate that there is no dichotomy between indigenous knowledge and science but rather a mutual exchange and coexistence involving reciprocal interaction. A strategy should be developed to add value to indigenous knowledge and to apply it together with science and technology under the context of sustainable utilization of bio-resources for the good of society.

Since biotechnology is an important technology in the conservation and utilization of biodiversity, it is most appropriate that indigenous biological



knowledge and research is incorporated into modern biotechnology for food production and drug discovery. As more studies of indigenous knowledge become more available and its application in modern biotechnology more relevant, its importance in national development will become obvious. Such studies should be conducted by a national organization and information derived from such studies must be achieved in databases. Once the knowledge and techniques are scientifically recorded and become public domain, it will be difficult for any individual or groups to misappropriate them and unfairly acquire intellectual property right. The collection and storage of indigenous knowledge should be supplemented with adequate dissemination and exchange mechanism. Such activities will enhance the role of indigenous biological knowledge and research for national development.

It is proposed that a National Biodiversity Research and Development Programme is established at the national level in Islamic countries. One of the activities of such a programme would be the conservation and the utilization of indigenous biological knowledge and research for national development. Other activities include:

1. Auditing, documenting and supporting research on ways of protecting and promoting the use of indigenous knowledge and technologies;
2. Preparation of comprehensive guidelines and methodologies for auditing and documenting indigenous knowledge and technologies;
3. Building and enhancing public understanding of the nature and contribution of indigenous knowledge and techniques;
4. Promoting the application of indigenous knowledge in R & D institutions;
5. Integrating indigenous knowledge and technologies in formal universities programme relating to biodiversity and sustainable development.

#### **4 NETWORKING AND PARTNERSHIP**

Selangor aims to develop networking and partnership in life sciences and biotechnology by mobilizing Muslim scholars, scientists, researchers and students and providing them with the infrastructure and facilities that promote advancement in research and education in sciences and technology. What is needed is an organization and infrastructure that can offer scientists and students access to advanced research facilities and equipment to conduct leading edge research whose outcomes are essential towards industrial competitiveness of the Muslim countries. To facilitate the development of advanced research and education programmes, an International Islamic Academy for Life Sciences and Biotechnology (IAB) has been established in Selangor.

The IAB is an initiative developed by Selangor State in collaboration with the Islamic World Academy of Sciences (IAS) to facilitate the implementation of the Selangor Biotechnology Strategy and to complement the National Biotechnology Policy. It is a virtual non-profit institution established by Selangor as part of the

State agenda to promote Selangor as a model of a progressive Islamic economy and a hub of Islamic innovation. The IAB is managed by BioIT Centre Selangor with the participation of scientists from Biotechnology Centre of Excellence Network Selangor (BioCENet) and International Bioalliance Programme. The aim of the IAB is to facilitate the utilization of life sciences and biotechnology in the spirit of knowledge sharing for the advancement of the international Islamic scientific community and benefit of mankind.

The IAB is open to scientists, scholars, academics, researchers and entrepreneurs and their organisations who have the desire to pursue the mission of the IAB for the benefit of mankind.

The IAB represents a new initiative for Malaysia's programme in life sciences and biotechnology. Malaysia through Selangor will take a pro-active approach in harnessing the potential for biotechnology by utilizing the expertise that is available among the Muslim *Ummah* and taking advantage of existing strengths and opportunities of biodiversity and biotechnology in Selangor and Malaysia. The result of this initiative will be the creation of forward-looking educational and research programme, accelerated development of education, broadening of research and learning environment thus enhancing educational quality. Such an initiative will not only benefit Malaysia but also the Islamic countries and international community. Selangor is committed to working in partnership with international organizations especially universities and research organizations and to play an important role in the development of biotechnology in the Muslim world. It has established a bio-alliance with scientists from the University of Oxford, University of Cambridge and MIT in research and education.

## 5 CONCLUSION


The focus of the conference on sustainable development and utilization of indigenous biological knowledge research clearly demonstrate a long overdue issue which requires the attention of governments. By acknowledging the possible contribution of indigenous knowledge in national development, mega biodiversity countries such as Malaysia can play an important role in establishing direction of research and research programme in utilization of bio-resources for social well being and wealth creation. The participation of these countries from the beginning and at all levels is crucial. This includes the responsibility, trust and cooperation and not just consultation to help implement outside innovation more efficiently. It is very important for everyone involved in conservation and utilization of our bio-resources to understand the difference between science (as a research method to acquire knowledge and understanding) and indigenous knowledge (as a method to acquire knowledge and understanding).

**PART THREE**  
ROLE AND FUNCTIONS OF ACADEMIES OF  
SCIENCES




# TWAS: The Academy of Sciences of the Developing World and its Associated Organizations

MOHAMED H. A. HASSAN FIAS  
*Former Executive Director of TWAS*  
*IAP Co-Chair*




## Establishment




- Founded 1983 in Trieste, Italy, by Abdus Salam and 40 other eminent scientists from the South (incl. 10 Nobel Laureates)
- Inaugurated 1985 by the Secretary General of the United Nations, Javier Perez de Cuellar
- First global conference on South-South and South-North Collaboration in Science

2


Figure 1. Establishment.



## Headquarters



- Located at the Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy
- Administered by the United Nations Educational, Scientific and Cultural Organization (UNESCO)



3

Figure 2. Headquarters.



## Membership

- **873 Members in 90 countries**
- 740 'Fellows' in 73 countries in the South
- 133 'Associate Fellows' in 17 countries in the North
- 15 Nobel Laureates
- 152 Members in OIC countries









4

Figure 3. Membership (in 2008).




## Objectives



- Recognize, support and promote **excellence** in scientific research in the South
- Respond to the **needs of scientists** working under unfavourable conditions
- Support **South-South** scientific exchange and collaboration
- Promote **South-North** cooperation between individuals and centres of excellence
- Promote **dissemination of scientific information** and sharing of innovative experiences

5

Figure 4. Objectives.



## Promoting Excellence

- Academy membership granted to the most distinguished scientists in the South
- TWAS prizes given for significant contributions by scientists in the South
- Prizes for young scientists awarded on behalf of TWAS by organizations in the South

6

**Figure 5. Promoting Excellence.**




## Responding to Needs





- Merit-based competitive research grants in basic sciences given to young scientists
- TWAS research units in LDCs
- Spare parts for scientific equipment supplied to laboratories in need

7

**Figure 6. Responding to Needs.**



### Supporting South-South Collaboration



Dr. H.M.I. Ahmed from Egypt at the Universidade Federal de Viçosa in Brazil (CNPq Fellowship for Postdoctoral Research)

- Postgraduate and postdoctoral fellowships for young scientists (Brazil, China, India, Mexico, Pakistan)
- Associateships for regular visits to centres of excellence in the South (with UNESCO)

8

**Figure 7. Supporting South-South Collaboration.**



### Promoting South-North Cooperation


- Support international meetings held in the South
- Support visits of internationally renowned scientists to institutions in the South (with ICSU, UNESCO and UNU)



9

**Figure 8. Promoting South-North Cooperation.**





## TWAS General Conferences/Meetings

- **Characteristics**
  - **Purpose:** To review status and prospects of science in different regions of the South and promote strategies for South-South and South-North cooperation
  - **Participants:** Members of TWAS, S&T ministers and presidents of research councils from developing countries; presidents of academies from South and North; world-renowned scientists to give keynote talks (e.g. Nobel laureates); talented young scientists
  - **Invitation** by host country's ministry, research council or academy
  - **Inauguration** of event by the host country's head of state / government
  - Local **expenses** entirely covered by the host, including accommodation of participants as well as travel grants for major keynote speakers and researchers from poor countries

10

Figure 9. TWAS General Conferences/ Meetings.



## TWAS General Conferences/Meetings





China 1987  
Venezuela 1990  
Kuwait 1992  
Nigeria 1995  
Brazil 1997  
Senegal 1999  
Iran 2000  
India 2002  
China 2003  
Egypt 2005  
Brazil 2006  
Mexico 2008








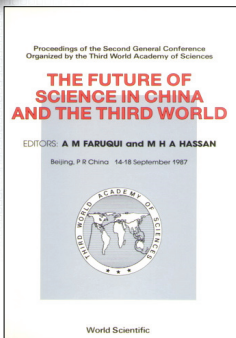


11

Figure 10. TWAS General Conferences/ Meetings.



## September 1987: Beijing, China



- First Conference in the South
- Theme: Future of Science and Technology in China. Presented first comprehensive analysis of S&T development in China
- Agreed that all future TWAS conferences be held in the South

12

**Figure 11. September 1987: Beijing, China.**



## September 2006: Angra dos Reis, RJ, Brazil



- Latest conference
- Largest gathering of ministers of science and technology from developing countries attending a TWAS conference
- Theme: Scientific Research in Developing Countries – Building a New Future

13

**Figure 12. September 2006: Angra dos Reis, RJ, Brazil.**



## Dissemination of Information






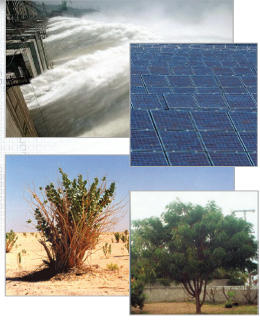

- Quarterly newsletter, TWAS Research Updates, proceedings
- Reports

14

Figure 13. Dissemination of Information.



## Sharing Innovative Experiences



**Address Specific Problems**

- Conservation, management and sustainable use of **water** resources in the South
- Application of innovative renewable **energy** technologies in the South
- Sustainable utilization of **biodiversity** in arid and semi-arid lands
- Sustainable use of medicinal and indigenous **food** plants in developing countries

15

Figure 14. Sharing Innovative Experiences.



Figure 15. Sharing Innovative Experiences.

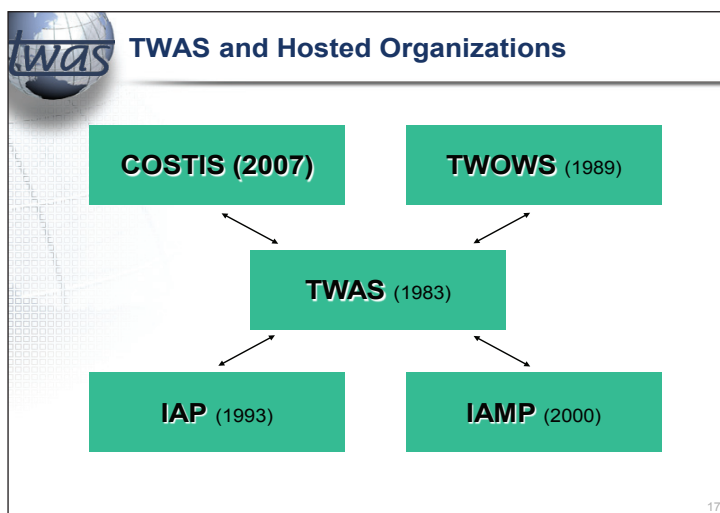


Figure 16. TWAS and Hosted Organizations.

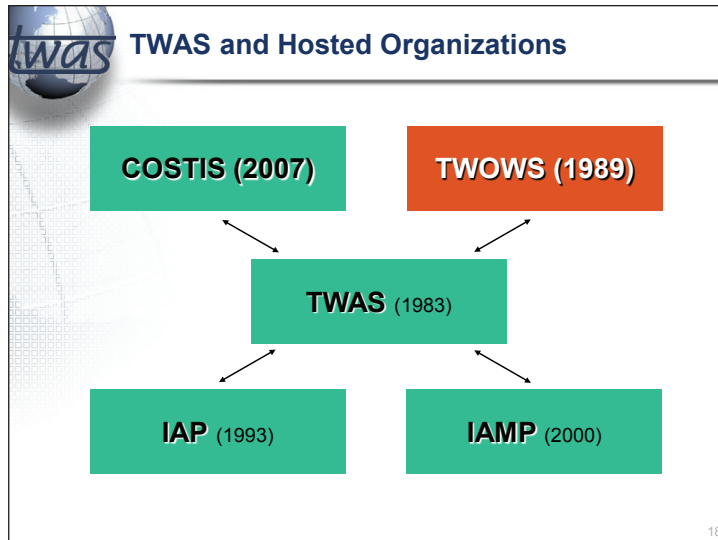




Figure 17. TWAS and Hosted Organizations.

**twas Hosted Organizations: TWOWS**


- Established in 1993, the **Third World Organization for Women in Science** unites more than 3,000 women scientists in 89 developing nations and 21 countries in the North




Trieste Conference 1988



Cairo Conference 1993



Cape Town Conference 1999



Bangalore Conference 2005

19

Figure 18. Hosted Organizations: TWOWS.



## Hosted Organizations: TWOWS

- With funds from the Department for Research Cooperation (SAREC) of the Swedish International Development Cooperation Agency (Sida), TWOWS offers **fellowships** for postgraduate training to young **women** scientists from **sub-Saharan African and Least Developed Countries** (LDCs) at centres of excellence in the South.



20

Figure 19. Hosted Organizations: TWOWS.

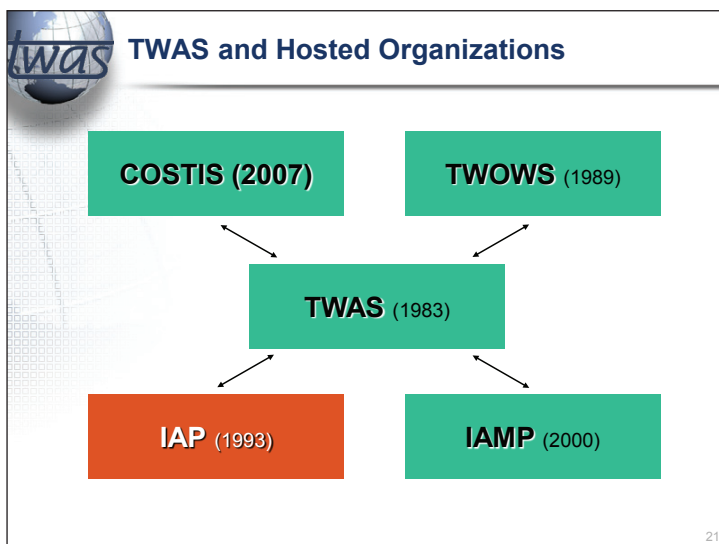


Figure 20. TWAS and Hosted Organizations.

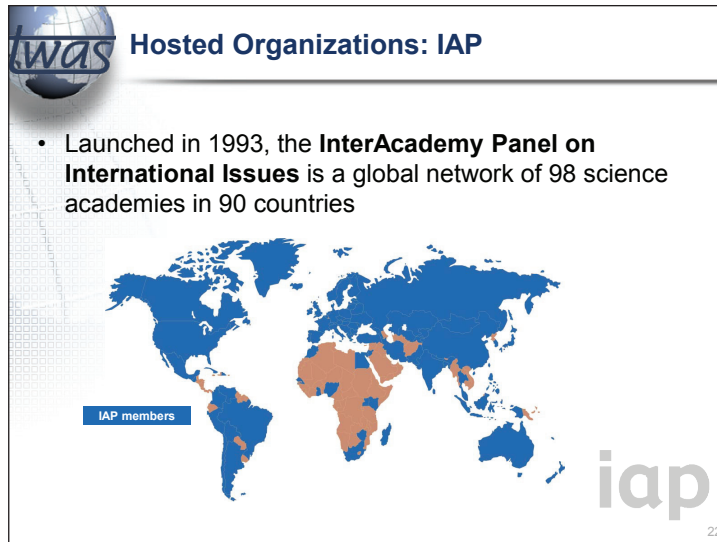



Figure 21. Hosted Organizations: IAP.



Figure 22. Hosted Organizations: IAP.



## Hosted Organizations: IAP

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- IAP promotes:
  - cooperation between member academies on science-related issues of global concern
  - the role of academies as independent, credible advisors to governments on policies and critical decisions based on S&T



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**Figure 23. Hosted Organizations: IAP.**



## Hosted Organizations: IAP

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- In particular, IAP:
  - Assists academies in developing countries to build their capacities
  - Serves as a forum for discussions on the complex relationship between science, society and media




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**Figure 24. Hosted Organizations: IAP.**






## Hosted Organizations: IAP

- Organizes conferences for young scientists: Linking Knowledge to Action (first IAP/WEF conference: New Champions, September 2008, Tianjin, China)
- Sustains efforts to reform science education
- Helps scientific communities to establish new merit-based academies
- Supports regional networks of academies in Africa (NASAC), Asia (FASAS, AASA), the Americas (IANAS), the Caribbean (CSU) and OIC countries (NASIC)



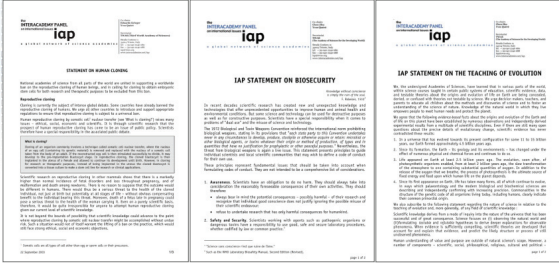
26


Figure 25. Hosted Organizations: IAP.



## Hosted Organizations: IAP

- Issues statements on topics of global concern (e.g., human cloning, biosecurity, evolution)



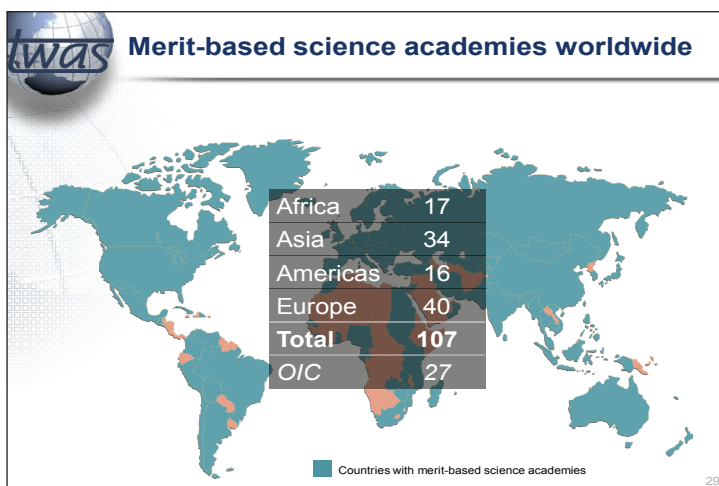


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Figure 26. Hosted Organizations: IAP.



**Figure 27. Hosted Organizations: IAP.**



**Figure 28. Merit-based Science Academies Worldwide.**

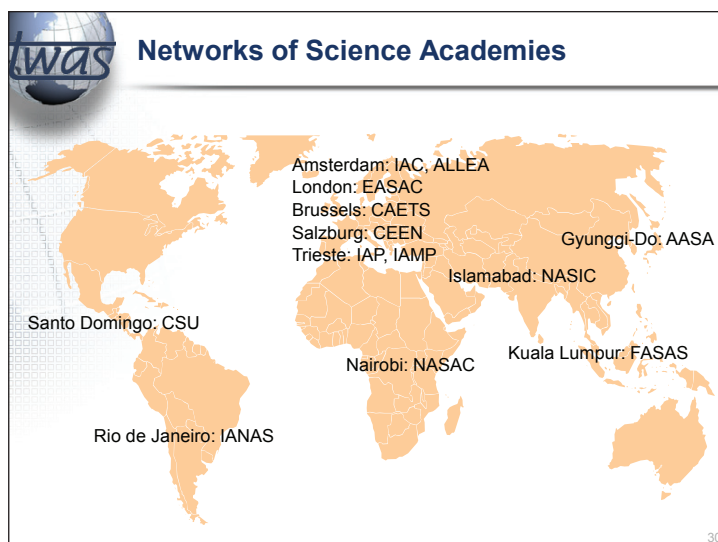


Figure 29. Networks of Science Academies.

**Merit-based OIC science academies**

in colour: **NOI** a NASIC Member (13)

|  |  |
|--|--|
| 1. Academy of Sciences of Afghanistan                  | 15. Akademi Sains Malaysia                               |
| 2. Albanian Academy of Sciences                        | 16. Hassan II Academy of Science and Technology, Morocco |
| 3. The Azerbaijan National Academy of Sciences         | 17. Academy of Sciences of Mozambique                    |
| 4. Bangladesh Academy of Sciences                      | 18. Nigerian Academy of Sciences                         |
| 5. Cameroon Academy of Sciences                        | 19. Pakistan Academy of Sciences                         |
| 6. Egyptian Academy of Sciences                        | 20. Palestine Academy for Science and Technology         |
| 7. Indonesian Academy of Sciences                      | 21. Académie des Sciences et Techniques du Sénégal       |
| 8. Academy of Sciences of the Islamic Republic of Iran | 22. Sudanese National Academy of Sciences                |
| 9. Iraq National Academy of Sciences                   | 23. Academy of Sciences, Tajikistan                      |
| 10. Arab Academy of Sciences, Jordan                   | 24. Turkish Academy of Sciences                          |
| 11. Islamic-World Academy of Sciences, Jordan          | 25. Academy of Sciences of Turkmenistan                  |
| 12. National Academy of Sciences of Kazakhstan         | 26. The Uganda National Academy of Sciences              |
| 13. National Academy of Sciences of Kyrgyzstan         | 27. Uzbekistan Academy of Sciences                       |
| 14. National Academy of Sciences, Lebanon              |  |

Figure 30. Merit-based OIC Science Academies.


|  <b>Merit-based science academies in Africa</b> |                |              |                |  |
|--|----------------|--------------|----------------|--|
| <div>in colour: <b>NOT</b> a NASAC Member (4)</div>  |                |              |                |  |
| Academy  | Country        | Est.         | Members (2006) |  |
| 1. Cameroon Academy of Sciences  | Cameroon       | 1990         | 62             |  |
| 2. Institut d'Égypte<br>Egyptian Academy of Science  | Egypt<br>Egypt | 1798<br>1948 |                |  |
| 3. Ghana Academy of Arts and Sciences (GAAS)   | Ghana          | 1959         | 90             |  |
| 4. Kenya National Academy of Sciences (KNAS)   | Kenya          | 1983         | 120            |  |
| 5. African Academy of Sciences   | Kenya          | 1985         | 134            |  |
| 6. Madagascar's National Academy of Arts, Letters and Sciences (AcNals)  | Madagascar     | 1902         | 160            |  |
| 7. Mauritius Academy of Science and Technology (MAST)  | Mauritius      | 2007         |                |  |
| 8. Hassan II Academy of Science and Technology   | Morocco        | 2006         |                |  |
| 9. Mozambican Academy of Science   | Mozambique     | 2007         |                |  |
| 10. Nigerian Academy of Sciences   | Nigeria        | 1977         | 100            |  |
| 11. Académie des Sciences et Techniques du Sénégal   | Senegal        | 1999         | 60             |  |
| 12. Sudanese National Academy of Science   | Sudan          | 2005         | 35             |  |
| 13. Academy of Science of South Africa (ASSAf)   | South Africa   | 1996         | 265            |  |
| 14. Tanzania Academy of Sciences (TAAS)  | Tanzania       | 2005         | 16             |  |
| 15. The Uganda National Academy of Sciences (UNAS)   | Uganda         | 2000         | 200            |  |
| 16. Zambia Academy of Sciences   | Zambia         | 2005         |                |  |
| 17. Zimbabwe Academy of Sciences (ZAS)   | Zimbabwe       | 2004         | 45             |  |

Figure 31. Merit-based Science Academies in Africa.





|  <b>Promoting the role of NASAC</b> |  |
|--|--|
|                                    | <ul style="list-style-type: none"> <li>• Working visits by representatives of NASAC member academies to           <ul style="list-style-type: none"> <li>▪ National Academy of Sciences, USA (2003)</li> <li>▪ Royal Netherlands Academy of Sciences (2006)</li> <li>▪ Royal Society, United Kingdom (2006)</li> </ul> </li> </ul> |
|  | 33   |

Figure 32 A. Promoting the Role of NASAC.



## Promoting the role of NASAC

- Joint statement by academies of G8 countries and NASAC to **G8 summit in Scotland** in June 2005
- NASAC statement to **AU summit in Addis Ababa**, Ethiopia, in January 2007
- NASAC statement to **G8 summit in Germany** in June 2007
- NASAC statement to **TICAD and G8 summit in Japan** in May and June 2008



Joint statement by the Network of African Science Academies (NASAC), the Inter-American Network of Academies of Sciences (IANAS) and the Science Council of Asia (SCA) to the G8 on the role of science, technology and innovation in promoting global development.

On the occasion of the G8 Summit in Hokkaido, Japan, 7-9 July 2008, we, the members of the Network of African Science Academies (NASAC), the Inter-American Network of Academies of Sciences (IANAS) and the Science Council of Asia (SCA), submit the following statement to the leaders of the G8+5 countries on the role of science, technology and innovation in promoting global development, fostering human welfare and reducing global poverty as called for in the Millennium Development Goals (MDGs).

Recent global economic growth has been placed at risk by turbulence in financial markets. Yet, between 1980 and 2007, global gross domestic product (GDP) more than doubled. Between 2004 and 2007, it increased at an annual rate of nearly 4 percent. Moreover, for one of the first times in history, economic growth in the developing world exceeded economic growth in the developed world.

Sub-Saharan Africa, the world's poorest region, has actively participated in and benefited from these recent trends. Between 2000 and 2003, sub-Saharan Africa's GDP rose 3.7 percent annually. Between 2004 and 2006, the region's annual growth in GDP accelerated to 5.6 percent a year, and in 2007 GDP growth reached 8 percent. This represents the most sustained period of economic growth in sub-Saharan Africa in more than three decades.

This good news nevertheless does not hide the troubling news coming out of Africa. More than 60 percent of Africans live in extreme poverty. More than 70 percent live on less than US\$2 a day. Some 26 million Africans are infected with HIV, and an estimated 3.6 million are of AIDS death. More than 40 percent of Africans do not have access to safe drinking water. More than 70 percent do not have access to electricity. According to recent assessments made by the

The disparities are due partly to historical circumstances and partly to misguided economic policies that have resulted in weak institutions and rendered a large number of less privileged countries unattractive places for investment. But the disparities are also due to another factor: massive differences in the ability to generate, master and utilise science, technology and innovation.

One of the most critical issues that the global community faces is to continue to foster GDP growth and, at the same time, to make growth and human welfare more equitable. Building broad-based capacity in science, technology and innovation is fundamental to addressing these issues.




Figure 32 B. Promoting the Role of NASAC.



## Promoting the role of NASAC




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Figure 32 C. Promoting the Role of NASAC.

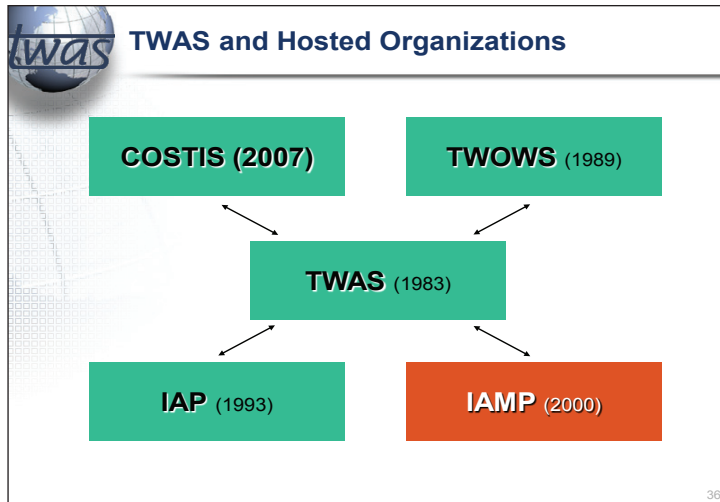



Figure 33. TWAS and Hosted Organizations.

**Hosted Organizations: IAMP**

- Established in 2000, the **InterAcademy Medical Panel** is a global network of the world's medical academies or the medical divisions of science academies.

  
 INTERACADEMYMEDICALPANEL

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Figure 34. Hosted Organizations: IAMP.



## Hosted Organizations: IAMP

- The 64 members of IAMP seek to:
  - Improve global health, especially among the world's poorest nations.
  - Build capacity of academies to address health-related issues.
  - Provide independent scientific advice to national governments and international bodies for the promotion of health science and health care policy.

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Figure 35. Hosted Organizations: IAMP.



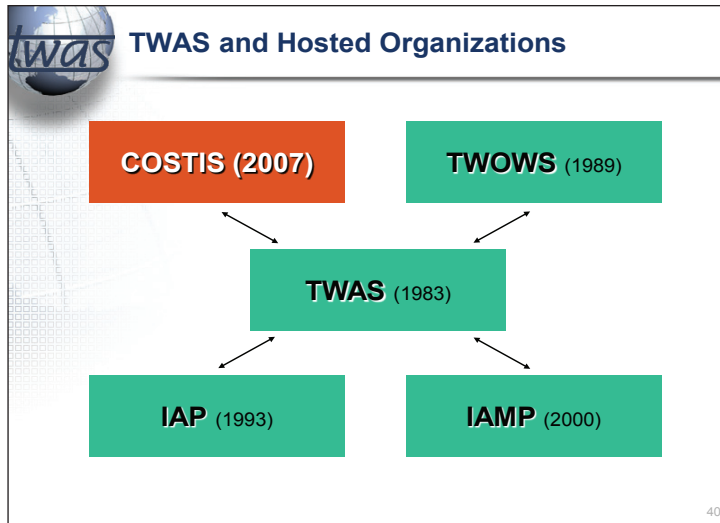
## Hosted Organizations: IAMP

- 2nd Global Meeting of IAMP in Beijing, China, in April 2006, together with the launch of the publications of the Disease Control Priorities Project (DCPP)
- Workshop on Reducing Maternal and Perinatal Mortality, 14-15 December 2007



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Figure 36. Hosted Organizations: IAMP.



**Figure 37. TWAS and Hosted Organizations.**

**twas** **Hosted Organizations: COSTIS**

- Established in September 2006 by Ministers of S&T and Ministers of Foreign Affairs of G77 as successor to the Third World Network of Scientific Organizations (TWNSO)



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**Figure 38. Hosted Organizations: COSTIS.**






### COSTIS Membership

- Ministers responsible for S&T
- National Research Councils
- National Science Foundations
- National Science Academies
- Science-based private sector institutions




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Figure 39. COSTIS Membership.



### COSTIS Goals

- Provide unique platform for governmental agencies responsible for policy and for funding research to interact strongly with leadership in academies and science-based industry
- Exchange information on best practices in integrating science policy into national development plans



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Figure 40. COSTIS Goals.



Figure 41. COSTIS Goals.



Figure 42. TWAS' Regional Offices.



### **TWAS's Regional Offices: Objectives**

- Promote regular activities of TWAS in the region and assess their vitality and effectiveness
- Strengthen collaboration between TWAS Members and facilitate their contacts with young scientists in the region
- Organize annual regional conferences of young scientists
- Promote public awareness and understanding of science in the region

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**Figure 43. TWAS' Regional Offices: Objectives.**



# Science Academies as Advisors to Government: The US Experience

MICHAEL T. CLEGG  
*US National Academy of Sciences*  
*and*  
*Donald Bren Professor of Biological Sciences*  
*University of California*  
*Irvine, CA*

## 1 INTRODUCTION

The development of modern science occurred over many centuries and owes its present elaboration to many cultures. Humans have practiced science from at least Neolithic times by experimenting with different explanations for the causes of natural phenomena and by constructing theories to explain casual relationships. Modern science traces its roots to the philosophers of ancient Greece, to the great scholars of Islam and to the thinkers of the enlightenment such as Galileo and Newton. Why is science so important to human culture?

Science is the world's most successful means of creating knowledge about the physical, biological and social environments that we inhabit. It is widely acknowledged that more than 50% of the economic growth of the 20<sup>th</sup> century can be directly attributed to advances in science (including medicine, agriculture, engineering). Average life spans have been extended by approximately one third and standards of living have improved for many peoples, although approximately one third of the world's peoples remain mired in poverty. Why is science so effective?

Science deals exclusively with arguments based on evidence. Scientific theories must be subject to test against empirical evidence and they must be discarded or modified when they fail to conform to empirical observations. Moreover, the results of science must be subject to independent confirmation by others. Finally, the results of science must be communicated to the wider community of scholars. New discoveries have no value if they are not incorporated into the wider societal system of knowledge. These simple principles form the foundations of modern science and they are the basis for the success of scientific predictions. It is also clear from these principles that science is practiced in a social context.

Modern systems for the creation and transmission of scientific knowledge include universities, government research organizations, private sector research, the publishing industry and various scientific associations. Scientific associations are typically voluntary nongovernmental professional organizations that seek to

communicate scientific advances at the professional level and to promote the utilization of scientific advances by the wider society. Science academies typically fall into this category of organization.

Science academies are self-renewing organizations that elect members based on scientific achievement. They frequently include among their membership the most distinguished scientists of a country (or state or region depending on the particular circumstances of the organization). Based on the achievements of their members, academies can be influential within countries (or at other political levels). Academies also typically provide a means of scientific communication via public lectures, publication of scientific journals, newsletters or other by means such as the internet. Academies attempt to promote the health of the scientific enterprise within countries by promoting the improvement of science education, the wide dissemination of new discoveries and the promotion of policies that advance the scientific enterprise.

A goal shared by many academies is the incorporation of contemporary scientific knowledge into governmental decision-making. The focus of this chapter is on the methods employed by the US National Academy of Sciences to introduce scientific knowledge into governmental policy making. The relatively recent development of international organizations that seek to advance the incorporation of scientific knowledge into policy formation will also be discussed.

## **2 THE PUBLIC SERVICE MISSION OF THE US NATIONAL ACADEMY OF SCIENCES**

### **2.1 Advice on Scientific Issues**

The US National Academy of Sciences has a long history of providing science policy guidance at the national level. The organization was founded in 1863, during the US civil war, with the dual purpose of recognizing scientific achievement through election to membership and of providing advice to government on issues of science and technology. In the original words of the Congressional Charter establishing the US National Academy of Sciences, “the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art”

Today the ‘Academies’ (including the science, engineering and medical components), provide objective non-partisan advice to policy makers on issues of science and technology that impact public policy. This is done through the National Research Council (NRC), the working arm of the Academies. The NRC draws on the entire US STH (science, technology and health) community, often also drawing on expertise from outside the US as well, to provide experts for service on committees that study, define and make recommendations on major issues, usually but not always, at the request of the US government. The experts serve without compensation, except that they are reimbursed for expenses. This

service role has evolved over the more than 140 years of our existence and it is still evolving. But, the record clearly shows that US society has profited from the integration of sound scientific advice in the development of public policy.

Historically, Academy advice has ranged over a diversity of areas, including how to build the best transportation system for the nation, how to set standards for food safety, strategies for controlling nuclear weapons, setting standards for science education, safety of genetically engineered foods, human contributions to terrestrial carbon fluxes, how best to dispose of nuclear waste, the hydrogen economy and much more.

## **2.2 The Role of the NRC**

The NRC issued approximately 200 reports on the above and a diversity of other topics. Recommendations of many NRC reports are incorporated into legislation and some prevent unwise legislation. The NRC process has evolved into an effective national model for the integration of science and public policy.

But the advice of the science community takes time to be formulated and to have an impact. It is often takes a decade or more before the full impact of a NRC report can be assessed. It takes time for the policy and legislative communities to assimilate the findings of a NRC report and to ultimately incorporate the report's recommendations into regulations or legislation. To illustrate the impact of Academy reports let us briefly consider a few typical examples from the past decade.

## **2.3 Examples of US National Academies Reports**

The issue of climate change is one of the most pressing problems of our time. Accordingly, the US government has asked the Academies to study this issue and to evaluate the types of evidence used to support predictions of climate change several times over the past 10 years. An influential study released in 2001 entitled "*Climate Change Science*" addressed the central questions of whether climate change is real, and if so, whether the cause is predominantly human based activities.

These questions are complex because climate change science is new and it uses evolving methodologies. To address these questions, a committee composed of 11 experts and two staff reviewed the existing literature and evaluated the methodologies employed. Based on their work, the committee concluded that temperatures are rising more than can be accounted for by natural climatic variation and that the predominant cause is human activity.

A new administration had taken the reins of government in the US at the time of this report and its leadership was skeptical that climate change was real. As a consequence of this report, the administration accepted that climate change was real, although they remained concerned about the economic costs of mitigating climate change. Today, eight years later, the current Administration is working

to obtain legislation to begin a process of reducing carbon emissions in the US.

Another recent report in the climate change area deals with some of the problems in assessing evidence of past climates from periods prior to written temperature records. This report entitled "*Surface Temperature Reconstructions for the Last 2,000 Years*" illustrates a few of the issues in evaluating historical evidence of climate change. In this case an expert committee was asked evaluate the reliability of proxy evidence of past temperatures from a wide variety of sources such as tree rings, corals, ocean and lake sediments, cave deposits, ice cores, boreholes, and glaciers. Questions had been raised about the reliability of such evidence however, the committee showed that many different kinds of proxy indicators of temperature were consistent in reconstructing past temperature estimates. This consistency provided a strong validation of the methodologies for the reconstruction of past climate and the controversy was considered settled.

In a different arena, a number of NRC reports have evaluated the scientific basis for various categories of forensic evidence. Thus, for example, the validity of DNA based forensic evidence was evaluated in the early 1990s and this provided the foundation for the court acceptance of this category of scientific evidence. More recently, the reliability of polygraph evidence has been the subject of a NRC report that found that polygraph evidence was not reliable. Likewise a NRC report on the analysis of bullet lead found problems with accepted methods of forensic analysis.

An issue with large economic implications is the establishment of fuel economy standards for cars by the US government. In 2001 the US government asked the Academy to study the standards for fuel economy. This resulted in a report entitled "*Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*" known as the CAFE report. The CAFE report was controversial, owing to the large economic stakes of the auto and allied industries. Since its release the report has been very prominent in legislative debates and is frequently cited by both major political parties. In the intervening years, petroleum costs have soared and the report is providing the basis for current regulatory actions in the US.

The reports described above fall into a category that can be described as *science for policy* in the sense that they show how policy issues can be illuminated or even resolved through the provision of contemporary scientific knowledge. Another category that figures importantly in the NRC portfolio is *policy for science*. That is -- what kinds of national policies are needed to encourage the growth of a healthy scientific enterprise?

For example, a recent report considered the comparative trajectory of the US scientific enterprise relative to other parts of the world. This report, entitled "*Rising Above the Gathering Storm*", found that most trends were negative and urged a series of corrective actions focused on science education, the development of a new generation of scientists and engineers and increasing federal support for basic research. These recommendations are now in the process of implementation.

Other reports in the policy for science area focus on the needs of specific fields. Examples include extending the life of the Hubble space telescope, the plant genome initiative, polar biology in the genomic era, and visualizing



chemistry. There are also a host of reports aimed at improving various aspects of science education.

All NRC reports are available on the web and PDFs can be down loaded for free in most developing countries. An important aim of the Academies is to extend its findings to the world, because most of the challenges of our time transcend international borders and require concerted international action.

## **2.4 Impact of Reports**

Academy reports are seen as definitive and independent of political or economic interests. This makes their recommendations credible with all elements of the political spectrum. The Academy is able to obtain the service on its committees of the best scientists without compensation and thereby to provide the highest quality advice. Moreover, the norm is to provide a consensus report thereby circumscribing the body of information on which all experts agree. Finally, other experts carefully review Academy reports prior to their release. An important standard for review is that the evidence supporting any recommendation must be set out in the report. Owing to these factors, the public accepts Academy reports as authoritative and in fact the Academy has assumed an informal status as the court for STH related issues in the USA.

## **3 THE INTERACADEMY COUNCIL: A SYSTEM FOR INTERNATIONAL ADVICE**

In 2000, the international network of science academies (IAP) created an allied organization known as the InterAcademy Council (IAC) to provide NRC like advice to world governments. To quote from the IAC website, (<http://www.interacademycouncil.net/>)” The InterAcademy Council (IAC) produces reports on scientific, technological, and health issues related to the great global challenges of our time, providing knowledge and advice to national governments and international organizations.” The IAC is modeled after the National Research Council of the US National Academies in that it assembles expert panels from throughout the world to produce high quality in depth studies of major science policy issues.

To date the IAC has produced reports on the importance of science capacity building in every country (*Inventing a Better Future*), African food security (*Realizing the Promise and Potential of African Agriculture*), *Women in Science*, a report that argues that the full utilization of human resources is essential for future success, and a report on the global energy transition (*Lighting the Way: Toward a Sustainable Energy Future*). This most recent report, released on October 22, 2007, is typical in that a fifteen member expert panel composed of scientists from 12 different countries, including Austria, Brazil, Canada, China, Egypt, India, Iran, Japan, Kenya, Russia, Sweden, and the USA formed the study group. This broad international representation demonstrates that it is possible for scientists

to arrive at consensus recommendations on the major issues of our time. These recommendations are meant to assist those in decision-making communities in all countries in selecting the best policy options to deal with one of the major challenges of the 21<sup>st</sup> century.

#### **4 THE INTERNATIONAL COUNCIL FOR SCIENCE (ICSU)**

Another important international science organization that seeks to influence global policy on science related issues is the International Council for Science (ICSU). ICSU is composed of a matrix of national members (about two thirds of whom are national science academies) and disciplinary unions. The stated mission of ICSU is to strengthen international science for the benefit of society. ICSU achieves this by (1) agreeing on the international language of science (nomenclature) and by fostering international scientific cooperation in areas such as the maintenance of global databases and other research resources; (2) articulating global science projects such as the just completed International Polar Year; and (3) representing the science community with major UN bodies such as UNESCO.

#### **5 CONCLUSION**

Why are science academies important in the provision of solutions to societal challenges? Academies typically include the most distinguished scientists of a nation and are thus regarded as authoritative voices on matters of science and technology. Because academies include within their membership the scientific leadership of a nation, they often have access to high-level decision makers and can communicate their advice effectively. Finally, academies are usually freestanding entities that are largely independent of government bureaucracies. This independence enhances the credibility of academy advice in the eyes of the public

The world faces many challenges that require our best scientific thinking to resolve. There is still a large distance between those who formulate public policy and those who possess contemporary scientific knowledge. Narrowing that gap will be essential if we are to implement the wisest policies for our future. The NRC processes, and its global analogs described in this paper, represent one approach to the problem of knowledge transmission. However, as we have seen, these processes can be slow and sometimes cumbersome. There is an urgent need to move forward with effective science advice mechanisms because the pace of global challenges will accelerate during the next 50 years.

# Do We Need Academies of Sciences in the 21<sup>st</sup> Century?

YVES QUÉRÉ  
*Former IAP Co-Chair  
Paris, France*

## 1 WHAT ARE ACADEMIES OF SCIENCES?

Are the Academies of Sciences – such as they originate from Plato’s garden of *Akademós*, and such as we know them now – necessary in our world? Are they even useful?

In a country where scientific research has reached a significant critical value (presence of at least a few research-oriented universities, links created with the international community...) the presence of an academy is *useful* for reason (1) (see below) ; and it should be considered as *necessary* for reasons (2) and (3).

- (1) One expects in principle, from an academy of sciences, to gather *high quality scientists* of the country: quality in science, quality in human values and quality in activity. This is not in contradiction with the fact that a number of excellent scientists may not be members of the academy, due for instance to a too small number of seats opened to the votes. But, this necessitates of course a reliable selection procedure, with the necessity that the various fields of science are as well represented as possible, and that the system of election be uniquely driven by scientific argument with strictly no other considerations, be they political, philosophical, religious, or economical. Both genders should be well represented;
- (2) A major characteristic of an academy is its *independence*, by which we mean that it must allow itself a complete freedom of speech, writing and action in the face of the various powers in place, governments or other. In fact, academies may be submitted to political and financial pressures which one has to learn to counter. They must not lose their soul. They must speak with authority and conviction (to the public, to the ministers, to the members of the parliament...) about science- or technology- related questions, giving loud and clear expressions to whatever seems to them to be the message of *reason*, in terms of expertise or scientific policy, and the message of *dignity*, in terms of ethics and human rights. One significant example of this was the refusal of the Academy of Sciences of the USSR to expel the physicist

Andrei Sakharov, who had become a dissident, despite the strong pressures exerted by the political powers of the day.

- (3) An important quality of an academy is its *stability*, resulting from the election of members generally for life. This is an invaluable advantage in societies where the ruling authorities fluctuate, political figures come and go, and a variety of doctrines coexist with no attempt at consistency. As an example of this positive effect, let us cite the decisive role played by this stability in the expansion of Inquiry Based Science Education (IBSE). In France for instance, the *Académie* has had to deal, in ten years, with six Ministers of Education, each of whom took office with his/her own ideas (sometimes negative) on the issue. But inside of this changing landscape, the *Académie* could bring continuity in its action. The negative side of such stability is obvious: some academies, if one is not careful, may become homes for the aged. This is why a number of them have modified their election procedures in order to admit a growing number of "young" scientists, for example by selecting half of their new members from among the under 55s.

Anyhow, criteria (1)-(3) for being a "good" academy of sciences (scientific quality, independence, and stability) do not make it certain that it will be an "efficient" one, that is one which really disseminates scientific good practices and public understanding of science in the country, and one which is listened to, and respected, by the governing bodies for decisions where science is involved. In many cases, academies nowadays have not much influence, even less than in the past. Let us remember, from this point of view, how and why academies of sciences have been created.

## 2 THE HISTORY

It is in Athens that tradition locates the foundation of academies, when Plato brought together his disciples in the garden of a man called Akademos in order to have them practice the art of reasoning by discussing freely philosophy and science (both being mixed).

Then, for ourselves, mature people at the end of our careers, it is refreshing – and challenging – to remember that the first re-appearance – in modern history – of an academy of sciences was the idea of an 18 year-old young Roman, Federico Cesi, who developed it in a text whose title brims with life, "*Il natural desiderio di sapere*"<sup>1</sup>, thus creating, in 1603, the first Academy of Sciences of modern times, namely the *Accademia dei Lincei*. The idea, here, was to gather scientists (including Galileo) for the purposes of dialogue and discussion.

From then on, a number of academies, both provincial and national, were founded, which were all to become kinds of parliaments for the sciences and the humanities, forums for debates and, for a long time, privileged centres for

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<sup>1</sup> The natural desire to know.

the divulgation of discoveries. In the 18<sup>th</sup> and 19<sup>th</sup> centuries, most of scientific discoveries were first reported to the main academies of the time, be they especially German, English, French, American or other. Of course, princes would often wish to control or channel these debates, or even to use the academies to prevent an overflowing of ideas, in their eyes a dangerous phenomenon. Nevertheless, they would still most often see them as centres of intellectual influence and, in a very modern way, as homes of innovation and, possibly, social progress <sup>2</sup>.

### 3 THE MODERN COUNTER-PART

Transposed to contemporary societies, academies of sciences should always find themselves, nationwide, on the leading front of the creation of knowledge (il desiderio di sapere), take the initiative of major science-related debates, and be the flagship of the fight for more reasoning and more ethics in decision-taking, for more respect towards the facts (versus vague ideas and/or dogma), and more comprehensive knowledge about our world. There are a lot of subjects about which the academies of sciences have no right to remain silent: they must have their say, do it with vigour, and throw their whole weight behind it. Among many other of those subjects, let us cite, in an arbitrary order:

- Food and Energy Security;
- Violations of professional codes of ethics and lack of scientific integrity in research;
- Use of science to develop weapons of mass destruction;
- Lack of elementary rules of ethics in the exploitation of particular technologies;
- Harmful precautionary principle without counterweight of a principle of progress;
- Insane waste of energy in the *North* and imperilling of biodiversity in the *South*;
- Inventoried dietary imbalances;
- Vaccination;
- Pollution of underground water by agricultural fertilizers;
- Fundamental Research; and
- Lack of positions and mediocre salaries, in many countries, for scientific careers.

So many questions (some of them agonising) for which the academies of sciences often possess elements of analysis, reliable numerical data and sometimes

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2 For example, in 1670, the French Minister Louvois, in spite of being very sycophantic and not at all liberal, asked the 4-year old *Académie des Sciences* in Paris “to work on subjects which may be useful to the public and to contribute to the glory of the King,” giving the former precedence over the latter. Indeed, the said *Académie* was soon invited to study such topics as the water supply in Paris, the reform of the hospitals and that of the prisons and lighting in towns.

answers, and upon which their silence – out of inertia or timidity – would call into question their credibility and involve guilt by omission.

## 4 ARE ACADEMIES OF SCIENCES EFFICIENT?

### 4.1 The image

Under the previous conditions (1)-(3), some academies of sciences play a major role in their country in promoting scientific research, fighting for the funding of laboratories, giving advice to the government on problems of urgent importance, launching reforms in the system of education, and being present on the international stage by taking part in the debates of global importance like defence of fundamental research, water management, climate change, clean energy etc.

Unfortunately, in many other cases, academies of sciences remain in the shadow, being relatively *unknown* in their country, or acting with undue *timidity* at both domestic and international levels.

First, they are quite frequently unknown, essentially due to a lack of communication. When I recently asked to a group of teenagers what they thought an academy of sciences was, one boy after a long silence of the group ventured: “I think that it is a club of old gentlemen.” A *club*, why not? *Old*, that is often true, in body and sometimes in mind (see (3) above). As to *gentlemen*, here, the boy touched a raw nerve since most of our academies house a proportion of women scandalously close to 5%, or even less. Anyhow, the silence of the group of teenagers and the final answer of one of them proved essentially a total ignorance. As long as academies are recognized as nothing more than ‘clubs for old men,’ they will not be considered, by laymen, as significant actors of the intellectual, or the economic life of the country.

Second, many academies have a definitely timid behaviour, particularly in front of the political bodies in the country. Many of them dare not speak loudly about questions of which science is the main ingredient. Without exhibiting any kind of knowledge-induced arrogance, they should however deliver their statements with clarity, conviction and strength, and behave in such a way that these statements are disseminated – in a style as pedagogical as possible – to the public. A good example of this behaviour has been the action exerted by the US National Academy of Sciences about the ozone hole. This phenomenon had first been discovered by Sherwood Rowland, a founder of the IAP – see below – and a member of the NAS, and Mario Molina, both later Nobel Prize laureates. The result of this action has been no less than an international ban of the use of CFC gases, a major ecological decision.

#### 4.2 Why are academies of sciences often shy in joining those endeavours?

- 1) *Possibly* because some of them have not ceased thinking that science is still leading the world (when finance or ideology are more and more present on the battle fronts); and that science is still a beloved province of the human landscape (when an increasing number of young people withdraw from this field);
- 2) *Possibly* because some of them, although conscious of the existence and counteractions of the opponents to the scientific methods and way of thinking, consider them as negligible or transitory actors and believe that the present turmoil will go as fast as it has come, eventually defeated by the irresistible conquests of science; and
- 3) *Possibly* also because, on the contrary, they feel lonely and outrun in a battle which involves power (like that of globalization) too strong to be opposed.

### 5 INTERNATIONAL COOPERATION: THE CREATION OF THE IAP

#### 5.1 Background

At a conference held in New Delhi in 1993, the founders of InterAcademy Panel (IAP) had the very fruitful idea of creating a global assembly of academies of sciences. There already existed a “*Représentation mondiale de la science*,” which had become ICSU (*International Council for Science*) in 1931, and with which there was no intention of competing. But the academies of sciences, also members of ICSU, have a more specific role to play in the international concert, a score which stems from the characteristics which they have acquired and which they have a duty to develop and use in the defence and illustration of science.

#### 5.2 Objectives

The founders of IAP had a double objective:

- 1) To help academies to undertake more determined and articulate actions *in their own countries*. Faced with the growing role of science and technology in our societies, academies are too often timid, silent and non-influential. They should have a presence on all fronts where exist debates related to science and technology, where discoveries are to be made known, where actions are to be undertaken, explanations to be given, or where false and irrational ideas to be denounced;
- 2) To induce them to *cooperate* with sister academies and share their efforts, initiatives and good practices – what the universality of science should



make ideally easy – with a particular concern on the North-South dialogue in view of reducing S&T capability divide. Science lends itself well to respectful listening to one another and to the development of relationships of trust. The rapprochement between China and the USA at the start of the 1970s has often been attributed to ping-pong; but, in fact, science and technology played a less high-profile but much more important role <sup>3</sup>.

### 5.3 Activities

In Tokyo (2000), the IAP adopted provisional *statutes* and elected two Co-Chairs, a host academy for the *Secretariat* (TWAS in Trieste) and an *Executive Committee* with 11 Member Academies, 5 from the “North” and 6 from the “South.” From 75 in 2000, the IAP membership has grown to 98 in 2008. Thanks to the committed efforts of Paolo Budinich and Mohamed Hassan acting as Executive Director, the Italian Parliament decided to give IAP legal status in Italy and thus to provide it with a substantial and regular grant. Soon in 2001, it was realised that only a programme of action could induce the academies to cooperate effectively and a few themes were selected by the Executive Committee.

The work topics of our 98 Member-Academies are now numerous, and they are coordinated by the Executive Committee. They consist mainly of *Programmes* (long-term actions), *Initiatives* (actions on a shorter timescale) and *IAP Statements*

An example of a programme, launched in *Les Treilles* (France) as early as 2001, is the one on Science Education, lead by *Academia Chilena de Ciencias* (Jorge Allende) and essentially consisting in expanding the IBSE way of teaching children (Inquiry Based Science Education). Here the active implication of academies (around 15 of them) shows that high-level scientists are more and more expected to work hand in hand with teachers. This has given rise to a number of lively and intensive symposia and, in particular, to a study on the delicate subject of assessment.

An example among IAP-initiatives has been the study on *Access to Scientific Information*, lead by the US-National Academy of Sciences. Those may be concluded by a formal statement which is proposed to the agreement of member-academies and which becomes an IAP Statement if a majority of signatures is reached. Important IAP Statements have been published on such topics as *Biosecurity* <sup>4</sup>, *Teaching of Evolution*, *Human Reproductive Cloning*, *Science Education*, *Science and the Media*.... All of them were endorsed by  $\approx 70$  academies and sent to the UN and to the governments.

Moreover, the IAP has encouraged the creation or reform of several academies of sciences or technology ; the dusting-off or rewriting of some of their statutes ;

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3 N. P. Neureiter, *Technology in Society*, 26, 303, 2004.

4 It is remarkable that as many as 68 Academies of Sciences endorsed a sentence like «*Scientists should refuse to undertake research that has only harmful consequences for human-kind*», which clearly claims that some doors of research should be kept closed in spite of, and in some kind of contradiction with, our “natural desire to know”.



the launching of local initiatives; the adoption of “good practices” borrowed from others; the creation of *Foreign Secretary* positions where none existed before; the signing of bilateral agreements; the establishing or re-activation of various networks of academies, AASA, CSU, FASAS, IANAS, NASAC, NASIC, (not forgetting, in Europe, ALLEA and EASAC), important networks because they transpose and adapt, at regional level ideas, practices and actions of proven value at worldwide level, and, conversely, raise questions which have been neglected elsewhere.

From all that, it should be clear that the IAP is not a cosy and sleepy club where the major problems of the world are discussed between friends in leather arm-chairs. It wants to be a lively forum of reflection and concrete action where the academies of sciences can share their expertise in order to require, without arrogance but with conviction, that science and technology be given a greater place in the development plans of societies as well as in the minds of decision makers ; a forum in which the academies can share what they are doing, with a view to induce among our contemporaries – including scientists – critical examination, free discussion, depth of investigation, reasoning and openness to the world, instead of relying upon vague preconceived ideas, blinkered vision, arguments of authority, chauvinism, verbal intimidation, maybe even violence.

## 6 CONCLUSION

Science is a necessary, if not sufficient, driving force for development, and therefore a source of hope for the most deprived people on our planet. In the decades and centuries to come, it may be recognized as the only effective tool we have to defend this planet against the stresses we place upon it.

In its unity and in its thirst for knowledge which is its *raison d’être*, science is one of the most beautiful areas of human culture. Indeed, scientific discoveries populate the field of knowledge in an admirable way; but equally, they make us aware of what we do not know, guiding forever our curiosity towards new questions in a sort of endless branching process: a beautiful and stimulating prospect for our grandchildren and for our grandchildren’s great-grandchildren. And also a useful warning, for scientists, against the sin of arrogance of which they are not always innocent: the purpose of science is not to dictate *the truth* about the world but to discover scattered elements of it, among other equally valuable ones. Those will be found in philosophy, art, religion, humanities, poetry..., helping – together with science – women and men to live better and teaching them to search, to open their minds, to look, to reason, sometimes to doubt, and often to admire. That is to live in liberty and dignity.

Academies of sciences are necessary as potentially major actors in the development of the world, intellectually, technically and ethically speaking. But for this to become a reality, many (not to say all) of them have to behave in a more active way, to be more open to the present problems of the world (for instance

by electing more women, more young scientists among their members...) and to fight more vigorously for freedom, for human rights, for peace, as well as for the expansion of scientific research and the development of technology.

From all these points of view, I wish a beautiful and fruitful future to the IAS.

# **Tatarstan Academy of Sciences: History, Development and Prospects**

A. M. MAZGAROV FIAS

*President*

*Tatarstan Academy of Sciences*

The Tatarstan Academy of Sciences was founded following a decree of H.E. President of the Republic of Tatarstan, Mintimer Shaymiev in 1991. It was time of transformation as the country had come to a state of deep economic, political and social crisis. Government agencies no longer carried out research, and this led to the stagnation of scientific investigations and the emigration of a great number of scientists. Many research institutes in the territory of Tatarstan fell into decay or were closed or became private. To reactivate the research scene, it was necessary to solve financial and organizational problems such as finding new ways of development of fundamental and applied science, its integration into the real economy.

H. E. Mintimer Shaymiev, the President of the Republic. Stepped in and made the right decision namely the founding of a scientific coordination center which was named Tatarstan Academy of Sciences. This, in order to keep and multiply the scientific workforce and concentrate the intellectual potential to the solution of critical socio-economic issues faced by the republic.

At all times, Kazan was famous as a center of education and science. In the historical memory of the people, the city remained as the capital of the powerful Kazan Khanate, where there were a great number of 'madrasas' and rich libraries. During all the posterior period Tatars hoped for the revival of the earlier existed glory in the field of science and culture. In the second half of the 19<sup>th</sup> century famous scientists as Shihabuddin Marjani, Riza-addin Fakhraddin, Qayum Nasri, Husein Faizhanov etc. in their books informed the Islamic World of the existence of Muslim component in the Russian scientific field. They prepared the society for the accelerated development of Tatar culture in the early 20<sup>th</sup> century.

The opening of the university in 1804 contributed to the birth of worldwide known schools of mathematics, chemistry, astronomy, physics, astronomy and oriental studies. The great mathematician – N. I. Lobachevskiy; the one who built and presented an observatory to the Kazan University – V.P.Engelgardt; Arabist, the founder of oriental numismatics in Russia – H. D. Fren; the turkologist – A. K. Kazembek; the founder of the linguistics school – Baudouin de Courtenay; the chemists - Karl Ernst Claus, Nikolay Nikolaevich Zinin, Aleksandr Mikhailovich Butlerov and many others earned their academic recognition from the university. During the whole period up to 1917, in the Russian Academy of Sciences, there were 19 Fellows and 43 Honorary Fellows from Kazan, which

was considered as the third scientific center after Moscow and Saint Petersburg.

During the World War II, it was Kazan, where the significant scientific potential of the Soviet Union was concentrated: 33 scientific establishments of the USSR Academy of Sciences, 85 Fellows and Corresponding members, about 2000 research workers. In 1945, the Kazan branch of the USSRAS, currently named Kazan Scientific Center, which closely collaborates with TAS; was established.

When TAS was founded, there were 700 doctors of sciences in Tatarstan. The scientific potential of the Republic struck the keynote and set the bar high on requirements for the newly established Academy of Sciences. Today, in the scientific field of the republic, there are more than 1100 doctors of sciences. TAS has 40 Fellows, 87 Corresponding members, 28 Honorary Fellows (including 4 foreigners). The mean age of the Fellows is 60.7 years old. TAS consists of 7 divisions: the Humanities; Socio-Economic; Medicine and Biology; Agriculture; Mathematics; Physics, Energy and Earth Sciences; Chemistry and Chemical Technology. The scientific activity of TAS is carried out at 34 research institutes, centers and laboratories, the most important ones are: Institute of Tatar Encyclopedia; G.Ibragimov Institute of Linguistics, Literature and Arts; Sh. Marjani Institute of History; Center of Advanced Economical Studies; Institute of the Problems of Ecology and Subsurface Management etc.

The total number of research workers at TAS institutes is 800 people. During the last years, there was a need to create the legal and organizational basis of TAS activities and the peculiarities of its functioning were regulated as a superior scientific establishment of the Republic. Modern TAS is different from the model of the science academies of 1990s and the way of its development is identical to those academies founded in post-soviet period.

When TAS was established, its role was determined as the 'promotion of the fundamental research on the most important trends of natural sciences, engineering and humanities.' In modern conditions the intensification of innovative activities of TAS is considered as the essential issue.

In this respect, the main objective of the Tatarstan Academy of Sciences was specified as an organization that carries out the oriented fundamental and applied research that helps in providing accelerated sustainable socio-economical, spiritual and technological development of the Republic of Tatarstan.

Today, we are trying to introduce the clustered model of science management that significantly strengthens the role and importance of TAS in the socio-economic development of the republic. The reform has reflected on the structure of TAS: 51% of the Presidium (the superior board) members are elected from among the TAS Fellows and corresponding members while 49% are appointed by the Tatarstan President from among the public authorities and businessmen.

Today, the major objective is to promote the science, technology and innovation in the republic. In the field of oil recovery, the hookup of the Romashkinskiy field development foresees oil production with recovery of 0.526 by 2066. Tatarstan scientists have increased the oil recovery up to 0.60 and it will prolong the commercial development of the field for 100 years.

Another essential issue is processing the natural energy resources. One of the latest projects in this area is the technology of hydrogen sulfide stripping and demercaptanisation (DMC-1 process) introduced by Chevron Oil Company for Tengiz oil refining in Kazakhstan. All the 13 million tons of the oil here are refined on the DMC-1 plants. In 2008, the technology of the plants will be changed to DMC-2 and their annual capacity will increase up to 16 millions tons. Amazing results were shown while operating DMD-2 M process for refining light naphta (300 thousands annually) on the plant of JSC "TAIF" in Nizhnekamsk. The mentioned process flow sheet allowed decreasing the content of mercaptans in liquefied gas to 1-2 ppt. and receiving stable concentration level of total sulfur in the commercial gasoline within 30-40 ppm. In this area, we successfully collaborate with Islamic countries. For instance we have sold the licenses for the technology of DMC and DMD refining oil, petroleum products and odorant production (DMD-2 odorant process), production of thiophene from disulfide oil and butane.

Today, there are many successful scientific schools in Kazan working on: oncology, traumatology and orthopedy, allergology and immunology, neuroradiology, neurology, pediatrics etc. The break out trends for Tatarstan and Russia in general are in the introduction of stem cell transplantation methods that aim at treating the cirrhosis and vessel diseases and enhancing the methods of genetic modification of stem cells from the umbilical blood that significantly increase the efficiency of the cellular therapy.

One of the good examples of supporting the fundamental research and its integration into the global science is the investigations of Kazan astrophysicists. With the support of the Tatarstan Government, they have created telescope 1.5 metres in diameter and installed it in the mountains of Turkey. The research team participates in large scale space projects, such as INTEGRAL. Tatarstan scientists using this telescope identified dozens of gamma-bursts – grandiose "energy machines" which radiate energy equal to the billion galaxies. They have discovered some interesting objects and 'black holes.' This has enhanced the attempt by Tatars scientists to understand the three most mysterious phenomena in the universe: accelerated expansion, dark energy and dark matter. USA and many European countries are involved in the project as well as Tatars academicians Roald Sagdeev and Rashid Syunyaev.

The above can be evidence for the fact that Tatarstan has serious scientific experience in natural and technical trends. In this context, TAS must have more academic science, creativity, professionalism and most of all, it must protect the interests of the scientists. TAS needs to provide the freedom for scientific creativity and support the essential trends of fundamental science that contribute to improving the quality of life of mankind. The Academy must develop programs in Russia as well as worldwide and take an active part in them.

Special attention in TAS is paid to the Humanities. The Russian Federation is a multinational country where every nation has its original traditions. Tatars are the second ethnic group after Russians in population volume in Russia. Their vital activity faces all the problems that face the ethnic minorities all over the

world. It includes the protection of native language, development of national culture and education, confrontation with assimilation. In the current situation many Tatars living out of the republic are waiting for help in solution of critical problems of ethnic and cultural development. Kazan is the intellectual center for reviving the national culture. A great job was done by the research establishments of TAS in this area.

Indeed collaboration resulted in a six-volume Tatar Encyclopedia. For the first time, Tatars were given a chance to announce to the world community their original material and spiritual culture and their noble representatives in the form of encyclopedia. Another important event in the national historiography was the execution of the project on publishing seven-volume Tatar National History from the earliest times to our days.

In recent years, archaeologists had been working in different regions out of the republic trying to uncover new data of the Middle Age of Tatar history. The writing heritage of Tatars in Arabic graphics accumulated for almost one thousand years is studied today as a source for development of national history. TAS, in the same context, is planning to open the Museum of Tatar Writing, soon.

In this context, close collaboration with the Islamic countries will allow TAS scholars to study the philosophical, theological, literary and scientific heritage of the Tatar people. In particular, TAS counts on receiving copies of the historical and cultural sources of the Turkic Tatars from the archives, the libraries and the museums of OIC member countries.

In Russia people have accumulated centuries-long experience in peaceful co-existence and integration of Muslims into the European cultural and economic community. In the modern geopolitical situation, pluralism of cultures is a pledge of stability and peace on Earth. The aspect of intercultural dialogue, in TAS' view, is essential for the Muslim world and for western countries as well. TAS therefore aims to organize scientific measures in different formats on studying and promotion of tolerant coexistence in polycultural space.

The future of TAS first of all is connected with training highly qualified specialists. When TAS finds talented youth in science, it can be confident of its future well-being. To better integrate with the international community, young Tatars scientists must speak foreign languages; this requirement became one of the key elements of science and education modernization. The talented, qualified scientists open for collaboration are the main value and basis of development of academic science.

The growth of the relevance of research studies includes the collaboration of the academic establishments, higher schools, business-incubators, industrial areas and even secondary schools.

Today, TAS institutes closely cooperate with university departments and laboratories; the contribution of TAS in the education area is important, development of intellectual potential of the republic helps in building a competitive system of youth selection. The cooperation model aimed for includes the coordination and supporting the fundamental research at the universities.

Science in Tatarstan is an integral part of Russian and World science. After the cataclysm of the post-Soviet period, new conditions prevailed which led to TAS receiving an opportunity for self-actualization.

It must be noted that, since 1992 TAS has concluded a number of treaties for cooperation with the national academies of CIS and non-CIS countries as well as with scientific centers of the Russian Federation. It is believed that the creation of international research centers in the future, virtual laboratories for carrying out definite scientific work, will take collaboration to a new height and will promote the integration of Tatarstan into the world scientific space.





# **Promoting Science, Technology and Innovation in Palestine: Palestine Academy for Science and Technology (PALAST)**

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## **1 INTRODUCTION**

In 2001, the Palestine Academy for Science and Technology (PALAST) drafted its strategy and associated action plan based on numerous meetings, workshops, and focus-expert-group meetings with overwhelming participation of science, technology and innovation (STI) stakeholders. This process was preceded by a Knowledge-Assessment Study that identified the potential of STI in the sustainable development of the Palestinian society. Stakeholders also identified priorities for basic and applied scientific research that needed to be addressed by the national research centres and units. Finally, recommendations regarding the role of the PALAST were proposed. These incorporated the PALAST in the league of reputable science academies around the world. With regard to the strategy, three scenarios were determined as possible frameworks, which PALAST would implement over a period of several years.



**Figure 1. Destruction incurred at PALAST office in Ramallah by Israeli soldiers.**

The first and most conducive was the scenario in which political stability prevailed and PALAST had access to government grants that would allow the recruitment of experienced professionals. The second framework envisioned political stability but without secure government grants available to ensure PALAST actions. The third and most unfavourable scenario, in which the harsh political situation intensified and government grants became scarce, turned out to be the framework for PALAST to conduct its assigned activities. When well-known academies froze their activities in similar circumstances until the situation on the ground improved, PALAST continued, even after the physical destruction of its offices in 2002 (Figure 1) and the harsh following years, to managed and build a trustworthy reputation on both the national and international scenes. PALAST's successes, since its establishment until today, to sustain its good work in many activities it has initiated and implemented, whether on bilateral or multilateral extensions, is reflected in the trust and respect it has gained on both national and international levels. On the international level, PALAST has become an active member in several respected consortia, such as:

- Inter Academy Panel on International Issues (**IAP**);
- Inter Academy Medical Panel (**IAMP**);
- The Human Rights Network of Academies and Scholarly Societies (**HRN**);
- The Network of Academies of Sciences in the countries of the Organization of the Islamic Conference (**NASIC**); and
- The Consortium of Science, Technology and Innovation for the South (**COSTIS**).

On the national level, the Presidential Decree (Number 13), which was

issued in August 2004, reaffirmed PALAST status as an independent, non-profit organization and outlined the role of PALAST in promoting and coordinating the development of STI that is reflected on the welfare of the Palestinian people and the emerging Palestinian State. In order to promote science, technology and innovation PALAST has implemented several activities and initiatives on multilateral levels with overwhelming participations from stakeholders. In response to the overall recommendations made by the STI stakeholders, the well-defined roles of academies of sciences in many countries and the Palestine Academy, being an independent umbrella organization for science, technology and innovation, PALAST proposed in 2002 the establishment of science fund (SF). The SF was meant to embrace a pool of funds that would support the process of activating and developing science, technology and innovation. The SF is administered by PALAST and managed by an *ad-hoc* committee represented by the higher education institutions, professional associations and federations, governmental institutions, and non-governmental institutions. During the last eight years, PALAST has managed to implement several initiatives that promote and enhance the role of STI in developing relevant sectors in Palestine.

## 2 PALAST SET-UP

PALAST was first established in 1992 by the Palestine Liberation Organization (PLO) at that time to address STI in Palestinian society. Later in 1997, a presidential decree number 117 was issued followed later in 2004 by a second presidential decree number 13 that reaffirm the status of PALAST as an independent, non-governmental public body having its headquarters based in Jerusalem and has the right to open branches in different Palestinian districts. The Decree has also assigned specific tasks to PALAST, which are:

1. Support the scientific research and innovation morally and financially and help in preparing relevant policy and strategy documents;
2. Network among STI stakeholders on the national level and between national STI institutions and those counterparts in the international dimension;
3. Conduct scientific activities that address the national needs;
4. Build and develop STI databases and associated information; and
5. Act as an advisory institute for governmental institutions on issues related to STI.



PALAST has four different divisions to implement the assigned roles, they are:

1. The administrative and financial division;
2. The public and international relations division;
3. The publications and R&D centres' affairs division; and
4. The STI studies and policy division.

In order that PALAST overcome the tough measures imposed by the Israeli occupation forces, three offices have been established; in East Jerusalem, Ramallah (West Bank) and in Gaza city (Gaza Strip). In addition PALAST has established the Environmental Field Centre<sup>1</sup> (EFC) over an area of 20,000 m<sup>2</sup> in the Jericho district and at a natural reservation. EFC was established to serve the researchers, university and school students and the public. In addition, PALAST has established the Museum of Natural Life (Figure 2) and the Aquarium (Marine Life) (Figure 3) in Gaza city and both serve as educational tools for schoolchildren.

In addition, PALAST has 45 fellows who are considered distinguished Palestinian scientists. They serve in eight science committees representing the different fields of natural and human sciences. PALAST is also proud to have eight distinguished honorary fellows<sup>2</sup> from different countries who support PALAST and help it perform its role and open opportunity windows for cooperation.



**Figure 2. PALAST Museum.**



**Figure 3. The Aquarium.**

### **3 ACTIVITIES CARRIED OUT TO DEVELOP AND PROMOTE STI**

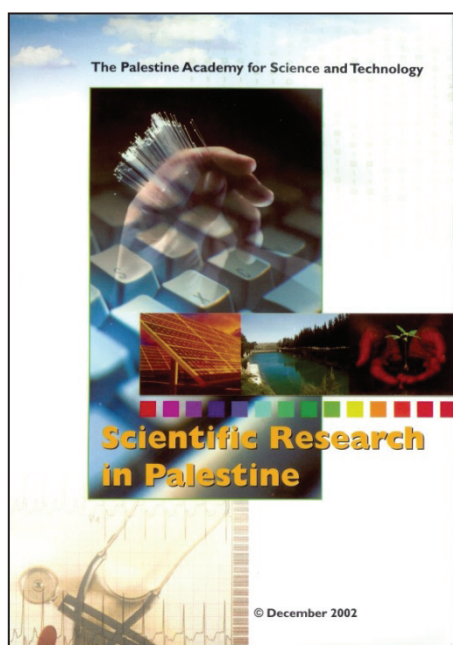
In early 2002, Palestine Academy for Science and Technology finalized a survey study on the status of scientific research in Palestine<sup>3</sup> (Figure 4). The study, which was funded by the British Foreign Department Fund, was conducted over

1 <http://www.pal-efc.org>

2 <http://www.palestineacademy.org/honoraryfellows>

3 <http://www.palestineacademy.org/publications>

a half-year period. A number of workshops and focus group meetings in the West Bank and Gaza Strip took place with overwhelming participation from the national science and technology stakeholders. Those included higher education institutions, research centers, non-governmental institutions, and governmental related institutions. The outcomes of the study showed that the potential in scientific research exists in human resources and available institutions.



**Figure 4. The PALAST Report entitled ‘Scientific Research in Palestine.’**

However, to activate scientific research potential, indicators showed that several actions should take place at the governmental and other institutional levels. Furthermore, it was concluded that an independent science fund would be a crucial necessity to establish a backbone for scientific research and innovation. Consequently, the fund would flourish and positively influence the development and advancement of all sectors. The participating stakeholders were asked to draw possible roles for the Palestine Academy, in particular with regard to activating the research and innovation processes on the national level. A consensus was reached over two major issues: the first one suggested that PALAST should work as an umbrella institute and hence work cooperatively in developing the national STI policy and in defining priorities in scientific research. The second issue was to establish independent funding opportunities that would address the national policy and research priorities. The mandate of PALAST declared in the

presidential decree granted it a broad opportunity to embark on a process through which directed scientific research and innovation could be activated.

Based on the effort, initiated in 2002, PALAST was commissioned in 2005 by the EU to participate in the multilateral Euro-Mediterranean project **ASBIMED** “*Assessment of the bilateral scientific co-operation between the European Union Member States (MS), the Accession Countries and the Associated Countries, and the Mediterranean Partner Countries (MP)*”, which was funded by the Sixth Framework Programme of the European Commission. The Project aimed at analysing the results of the scientific and technological Euro-Mediterranean bilateral co-operation, between each of the 25 Member States, and the Associated Countries, on one hand, and Morocco, Algeria, Tunisia, Egypt, Syria, Jordan, Lebanon and Palestine on the other. The suggested period was 1998-2006, in order to contribute to the general strategic objective of implementing the European Research Area in the field of Euro-Mediterranean Cooperation and the MEDA Agenda in research and development cooperation, according to the Monitoring Committee for Euro-Mediterranean Cooperation (MoCo) recommendations. The results of the survey and analyses done were useful and important, since they contributed to the debate of the Seventh Framework Programme’s priorities definition and planning. In early 2006, the EU has again approached PALAST through the “*Institut de Recherche pour le Développement*”, (IRD); a French public and technological establishment, to take part in the EU funded project **ESTIME**<sup>4</sup>. PALAST was commissioned to conduct four major tasks: The first task was an institutional survey of research institutions in Palestine, following the guidelines of the previously issued survey published by PALAST in 2002 using the same questionnaire and the same methodological guidelines. The objective was to analyse survey aspects, describing scientific research in Palestine, from as many institutes as possible. In the second task, PALAST conducted a series of twenty qualitative interviews with known researchers following the interview guide of ESTIME. The outcome of the project, in the third task, was a report on the research system that drew information from the survey of research institutions, interview material and known facts on the historical, social and political development of scientific institutions and research in Palestine, including bibliographical references and literature on science and technology development in Palestine.

The ongoing fourth task addresses the development and updating of the bibliographical database, which does not yet exist, in Palestine. PALAST supervises a preliminary recollection of bibliographical material, which permits to an extent the measurement of the research activity in Palestine. The database is designed for a full-fledged bibliometric database.

PALAST has gained the expertise and trust through the past several years, which are well acknowledged by the national science, technology and innovation

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4 <http://www.asbimed.net>



stakeholders and by the European Commission. These continue to emerge through other multilateral activities. PALAST, as an example, participated in a professional workshop titled “*Regional Workshop on R&D & Innovation Statistics*” in the context of the Euro-MEDA project **MED-IBTIKAR**, which was supported by the European Commission, and the UNESCO to promote the development of the innovation systems in the MEDA region and to provide the MEDA countries with new instruments in respect to competitiveness and innovation, to reinforce their development, achieve a good level of services and create an effective link between research and industry. The workshop added more depth and knowledge to the process of measuring, promoting, activating and initiating scientific research and innovation on the national level that PALAST is pursuing.

Realizing the Information and Communication Technology (ICT) has powerful capabilities in the processes of activating, developing and promoting STI, PALAST has implemented several activities in partnership with national and international institutions. During 2003 – 2005, PALAST participated in Euro-Mediterranean project titled; “*Enhancing Environmental Management System (EMS) in the Small and Medium Enterprises using Information Technology*”. In 2007, PALAST was commissioned by the EU with funds from the EU – Framework Program 7 to participate in the Euro-Mediterranean program MED-IST, which is directed to building national Scientific Research Agenda (SRA) in the field of ICT. PALAST has prepared the national ICT-SRA with direct involvement of ICT stakeholders and with partnership with the ministry of telecommunication and information technology. The project is expected to finalize on July 2009 with a directory ICT stakeholders exposed to their counterparts in the world and an agenda (SRA) that define the priorities in ICT research and innovation challenges.

In a joint effort between PALAST and the ministry of national economy a survey on innovation in the private industrial and service sectors were undertaken. The survey is based on the European community Innovation Survey (CIS). The survey objectives are to measure the degree of awareness among surveyed premises on the importance of innovation and to promote the cooperation between the private sector and the R&D sector, including the higher academic institutions.

#### **4 THE SCIENCE FUND**

It is crystal clear that STI have played historically a major role in bringing welfare to peoples. The Palestinians are no exception especially with the very limited natural resources, unstable political situation and implications on all sorts of life they have been suffering. Still, science, technology and innovation can bring enhancement of competitive assets of the Palestinian economy; improve their quality of life, and build the proper capacities of institutions and the human resources.

Today, international funding institutions are still dealing with the Palestinian case, more or less as a humanitarian one. They have prioritized services sectors, emergency issues, conflict-emerging situations, and capacity building in democratization and institutionalization of governmental and non-governmental sectors. Consequently, the process of investing in activating STI and their potential use in the process of sustainable development, have all been compromised. That, in turn, was reflected in the quality and quantity of the productivity of science and innovation, which are rated as very low. 'Productive' researchers publish their papers, either while doing their postgraduate studies abroad, or because of bi- or multi-lateral scientific cooperation funded usually by an international or foreign funding institution. Furthermore, scientific productivity has been mostly related to the subject-specific-domain rather than solid national needs. Funds, coming from foreign funding institutions, have been set in advance to limited priorities and guidelines with consequent marginalization to nationally identified priority issues. During the last fifteen years, scientific funding involved mobilization of scientists without an emphasis on building the proper scientific research and innovation infrastructures. That in turn has resulted in an unfulfilled sustainability and accumulation of the research development and experience on the national level.

In order to improve the situation and stimulate the process of *Innovation in Serving the Nation*, the roles of PALAST must be fulfilled, and in particular the ones that deal with supporting STI activities. PALAST has in 2002 initiated the establishment of the Science Fund and later in 2005 PALAST has proposed the establishment of the Journal of STI. While the Science Fund would provide the driving force for activating the research and innovation process, encourage the cooperative linkages among research institutions, and direct research and innovation to serve the national needs, the Journal of STI would present a recognized peer-reviewed platform for scientists and researchers to publish their work and achievements in a multidisciplinary series of the Journal. Until now, the fund has been established and administered by PALAST and managed by an *ad hoc* committee, which consists of nineteen members representing STI stakeholders. All official papers concerning the grant applications, guidelines, review documents, etc. were prepared and extensively reviewed. PALAST is working closely with the Palestinian National Authority to activate the fund.

## **5 WORKSHOPS, SYMPOSIA AND CONFERENCES**

Since its establishment, PALAST has convened several workshops, symposia and conferences (Figure 5) of national and international dimensions that tackle STI fields and issues. In the framework of the funded Euro-Mediterranean projects and programs, that PALAST participated in and several workshops have been



organized. In addition, PALAST has organized several science meetings and workshops during its endeavour to prepare country papers, reports and studies in water research, biodiversity, environmental awareness, tele-medicine, micro-nutrition, information technology, scientific research and innovation, climate change, etc. Some of these documents were prepared in cooperation with the US-National Academy of Sciences, the British Foreign Ministry, the German Ministry Education and Research, the United Nations Development Programs, the United Nations Environment Program and the Palestinian National Authority.



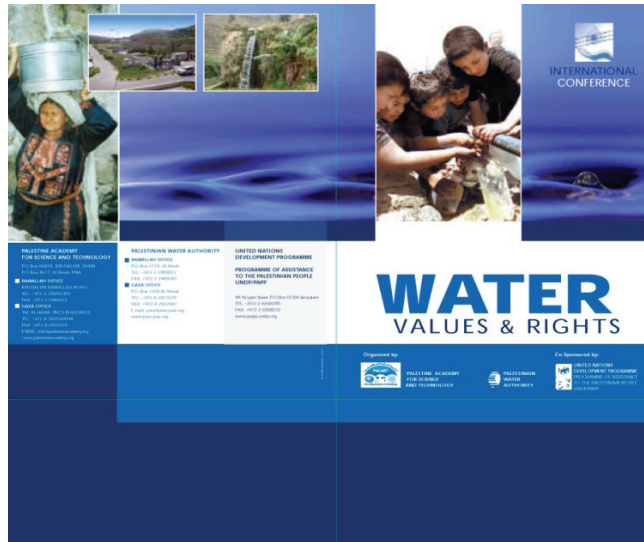
**Figure 5. One of the PALAST meetings in Ramallah.**

PALAST has also contributed to activities in basic research in natural science. In 2008, the UNESCO chair of Mathematics and Theoretical Physics at Birzeit University, the UNESCO and several other national universities cooperated with PALAST as a national STI umbrella, to jointly organize the International Conference on Mathematics and Theoretical Physics. Many international scientists participated in the conference and aside of the event, several cooperation activities have been initiated.

As water is one of the crucial and sensitive issues that need to be addressed scientifically as well as in the context of hydro-politics and rights. PALAST has initiated the international conference ‘Water: Values and Rights’ (Figure 6) and held the first conference<sup>5</sup> in 2005 in cooperation with the Palestinian Water Authority (PWA) and the United Nations Development Program (UNDP) and is currently organizing the second conference<sup>6</sup> which will take place in Jericho during the international celebration of Water Day in March and April of 2009.

5 <http://www.palestineacademy.org/wconf/>

6 <http://www.waterrightsconference.org/>



**Figure 6. Proceeding Covers of a Water Conference.**

## 6 PUBLICATIONS

Over the last six years, PALAST published many documents in many areas. In addition, PALAST publishes its Newsletter that summarizes STI activities taking place at Palestinian institutions. Downloadable issues are available for public on the web site <http://www.palestineacademy.org>.

## 7 CONCLUSION: FUTURE PLANNED ACTIONS

PALAST has prepared its action plan for the period 2008 – 2013. During the six years period, PALAST plans to implement initiatives that fall within several pivotal fields. The studies on national STI indicate that there are several crucial actions that need to be taken in order that a STI system, relevant to Palestine, could be formed. These actions are:

1. Strengthening human capacities and knowledge generation;
2. Building the capacity of the STI infrastructure;
3. Preparing relevant STI policies and strategies and building and providing proper STI databases and information;
4. Securing national funds for STI activities;
5. Networking and cooperating on regional and international levels to gain proper experiences on issues of common interests;
6. Promoting publications of STI documents, papers, reposts, etc., and
7. Enhancing national cooperation among scientists, experts and institutions working on STI issues.

**PART FOUR**  
NANOTECHNOLOGY



# Nanotechnology in Developing Countries

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## 1 ABSTRACT

Nanotechnology is the fastest of the developing technologies of the world. It is the technology of handling and controlling atoms and molecules and making useful materials and devices out of these materials. The sizes of atoms and molecules are in the range of nano-meters, one nanometer (nm) being one billionth of a meter and one atom being about 0.1nm is some 80,000 thousand times thinner than a human hair. Using materials at nano-scale causes enormous changes to occur in the properties of the same material as compared to the same properties at the bulk-scale. These properties could be mechanical, electrical, magnetic or electronic properties. The devices thus made out by the control and use of nano-size materials are smaller in size but much more efficient. The studies of materials of nano-scale, the preparation and use of such materials in making devices with size range below 100nm by accepted convention is normally referred to as Nanotechnology. The smaller size of material also makes the reactivity or catalytic properties of the particle increase enormously.

The change in such properties of a material when the particle sizes used are in the nano-meter (or of atoms and molecules range) have led to the applications of nanotechnology in many areas of strategic and public utility. These areas for example are Medicine, Environment and many industrial areas like pharmaceuticals and drugs, electronic, auto industry, textile industry and food and agriculture industry, information system, computer industry and defence, etc.

Nanotechnology is highly commercial and business oriented. The business community in the world is so active that over 2500 companies the world over, with about 700 in USA alone, are doing business in nanotechnology. This makes obvious the commercial importance of nanotechnology; as a company will not venture into investments unless there is profit insight. The business community estimates that by 2012, the world over, there will be a business of about  $1-2 \times 10^{12}$  \$ (1-2 trillion dollars) in nanotechnology. In terms of business it is a huge market.

Consequently, a lot of countries, particularly the advanced countries of Europe, the USA and Japan are giving serious importance to this area. The political leadership of these countries is so supportive that special funds and public

resources are allocated to pursue nanotechnology. Recently the US president allocated US\$ 3.7 billion for four years for nanotechnology initiatives. In Taiwan a project of setting up a 'Nano-Park' with funding of about \$600 million with \$94 million of the funds coming from Industry, is well underway. This shows the seriousness of developing nanotechnology. There are about 300 laboratories on nanotech in US universities and centres alone. This again shows the extent of seriousness of the US nanotech. To mention the strategic importance of the subject, the former US secretary of state Collin Powel, while the addressing the national academy of science and engineering of the US 'in the year 2000' said that one of the technologies to counter terrorism will be nanotechnology. Not only the US political leadership is keen on nanotechnology even the president of the developing countries of India and Iran have been making open statements on the need of nanotechnology for development of their countries. The former President of India, Dr Abul Kalam, made the statement that 'nanotech is one of the two technologies which will take India to the level of advanced countries by 2015.' European countries are striving hard to compete with the US and Japan in efforts to support Nanotechnology.

Some of the complex applications of nanotechnology include the treatment of serious diseases like cancer and aids at the start of the disease at the cell size without side effects such as damaging the healthy cells. A program of US\$44 million has been instituted by the US to treat cancer and AIDS at the cell level in 5 years. A group of 17 professors are busy on this project of NIH (USA).

Thus nanotechnology has a vital role to play for the economic and human welfare of a country. There are however some ethical and safety requirements for nanotechnology programs which also need to be looked into.

In Pakistan, we need to be supportive and active for the rapid development and use of nanotechnology for the welfare of the people, to solve the problem of poverty and welfare. Conscious of this need the government of Pakistan has already established a Commission of Nano Science and Technology (NCNST). Several projects of nanotechnology have been launched at some universities and centres of research.

## **2 NANOTECHNOLOGY: WHAT IT TAKES?**

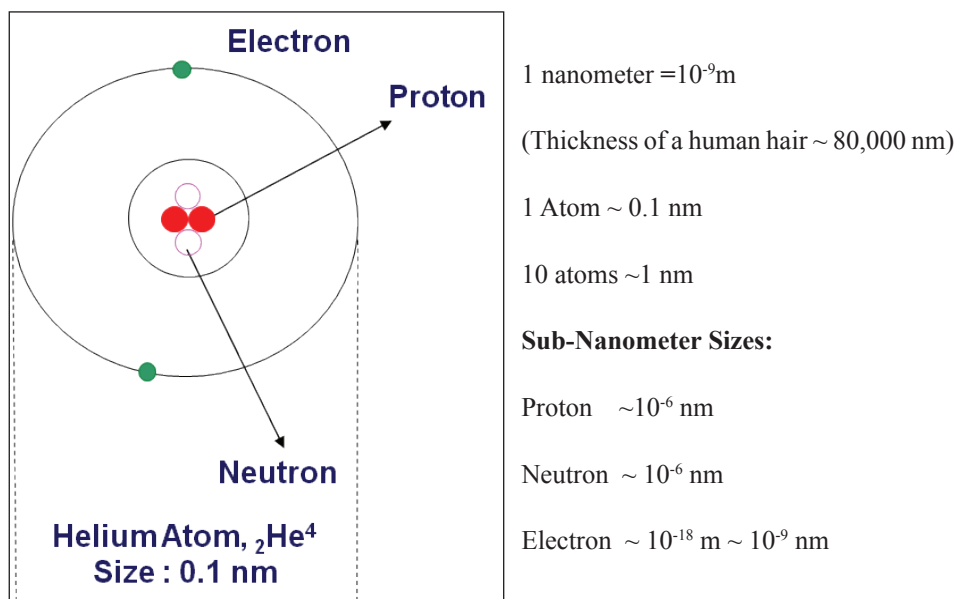
### **2.1 General**

Nanotechnology is the most recent of the important emerging technologies with enormous socio-economic impact and a wide S&T canvas for decades to influence our lives. It is the fastest growing technology with extensive vista available for research and for immediate industrial applications, thus having great market potential for influencing the economy of the countries involved in supporting nanotechnology. Advanced countries are therefore, investing billions of dollars annually on nanotechnology and experts are expecting 1-2 trillion dollars market

in nanotechnology by 2015. Nanotechnology is thus leading to another *Industrial Revolution*. Developing countries obviously need to take serious view of these developments to draw the benefits of nanotechnology for their own people.

Nanotechnology involves the study, control, synthesis and manipulation of materials at nanoscale sizes and their consequent uses for making industrial products. The physical properties of materials, whether mechanical, chemical, electrical or magnetic etc. at nano sizes are greatly improved compared to the properties of materials at bulk or macro scale. Nanotechnology applications therefore, in addition to miniaturization of devices, improve their performance and efficiency as well as lead to increased production and better quality of industrial products.

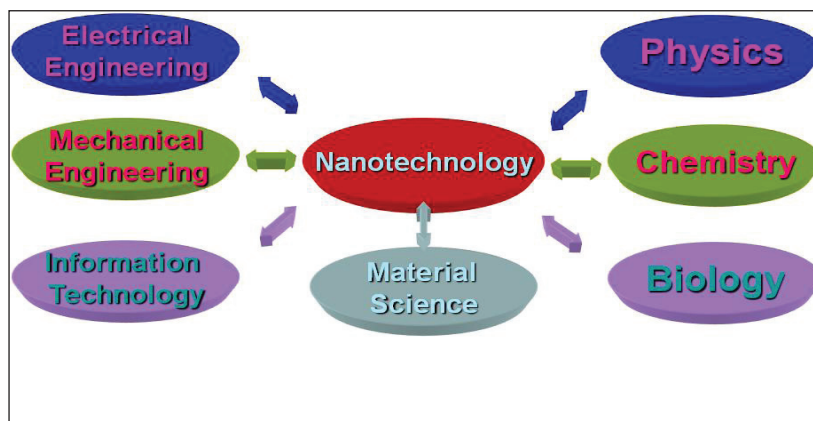
Further, the nano-scale is comparable to the sizes of atoms and molecules. An atom of Helium, for example, is about 0.1 nanometer (nm) and of course the part of an atom, the protons, neutron and electrons etc. are much smaller than nm (Figure 1).



**Figure 1. Sizes of Neutron, Proton, Electron and Helium atom.**

Therefore, nanotechnology involves the study control, manipulation and use of atoms and molecules in fabrication of such devices. The nanoscale measurement of materials is expressed in nano-meters, one nanometer (nm) being one billionth of a meter and to visualize such a small size, we would say that a human hair is some 80,000 nm thick. The materials synthesized investigated and used with sizes below 100 nm in fabrication of devices, by convention, fall in the domain of nanotechnology. Atoms and molecules being the basis of all biological or

non-biological nano-materials, which are studied by a variety of precise S&T techniques, therefore, involve multidisciplinary of very high order (Figure 2).



**Figure 2. Nanotechnology as a multidisciplinary subject.**

The key reason of usefulness of nanotechnology is that the use of ‘nano-scale materials’ increases the performance of devices and products made out of these. Further, nanotechnology has very useful applications in many areas of our need whether, energy, water, agriculture, environment, medicine, engineering and industrial products of all kinds etc.

In the reference to live-stock, the nanotechnology applies via medicines and drugs, Semen improvement, improving the environment of their living, sensing their movements, nutrients in foods and treatment of their diseases. In this way, the nanotechnology also helps in the alleviation of poverty by rearing better and healthy living animals. It helps to solve the food problem by provision of better and increased production of meat and milk availability.

Some other applications are based on the fact that many of materials which we are confronted in daily life, whether for environment, healthcare or industrial products etc., have sizes in the range of nano-meters and this leads to some useful applications [Tables No. 1 and 2].



**Table 1. Some Nanoscale Materials**

| No. | Item                       | Size (Approx.),<br>Scaling down $\mu\text{m}$ to<br>nm | Size (Approx.),<br>on nm Scale |
|-----|----------------------------|--|--------------------------------|
| 1.  | Human hair (diameter)      | 60 – 120 $\mu\text{m}$                                 | 60,000 – 120,000               |
| 2.  | Pollen                     | 10 – 100 $\mu\text{m}$                                 | 10,000 – 100,000               |
| 3.  | Asbestos fibres (diameter) | < 3 $\mu\text{m}$                                      | < 3,000                        |
| 4.  | Diesel exhaust particles   | < 100 nm – 1 $\mu\text{m}$                             | < 100 nm – 1000                |
| 5.  | Soot                       | < 10 nm – 1 $\mu\text{m}$                              | < 10 nm – 1000                 |
| 6.  | Quantum dots               | 2 – 20 nm  | 2 – 20                         |
| 7.  | Nanotubes (diameter)       | ~1 nm  | ~ 1                            |
| 8.  | Fullerenes                 | ~ 1 nm   | ~ 1                            |
| 9.  | Atoms                      | 1-3 Å ~ 0.1 nm   | 1-3 Å ~ 0.1                    |

**Table 2. Typical Nanosizes of Cellular Species**

| Biological Species | Example                      | Typical Size (nm) | Typical Molecular Weight |
|--------------------|------------------------------|-------------------|--------------------------|
| Small assemblies   | Ribosome                     | 20 (sphere)       | $10^5 - 10^7$            |
| Nucleic acids      | tRNA                         | 10 (rod)          | $10^4 - 10^5$            |
| Small proteins     | Chymotrypsin                 | 4 (sphere)        | $10^4 - 10^5$            |
| Large proteins     | Aspartate trans-carbamoylase | 7 (sphere)        | $10^5 - 10^7$            |

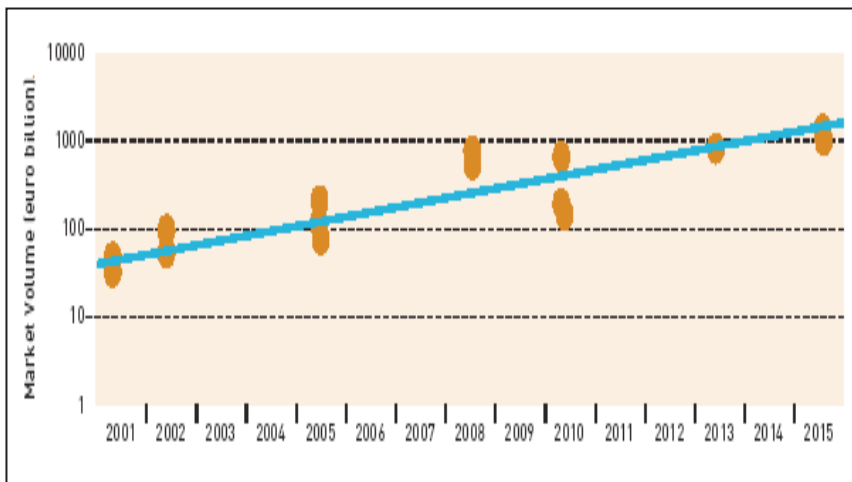
## 2.2 Importance of Nanotechnology

Nanotechnology has many benefits of economy of a country. For this reason nations are investing heavily in nanotechnology to the extent that several countries, particularly the advanced countries, are investing millions and billions of dollars annually on nanotechnology (Table 3).

**Table 3. Nanotechnology Investments**

| S. No. | Country  | \$m   |
|--------|--|---|
| 1      | USA, NNI (2008)<br>USA, NNI (2009)Proposed<br>(www.nano.gov)                       | 1,444.2<br>1,527.0<br>[8.3 b \$ SINCE 2001] |
| 2      | EU (2008)<br>(www.nanowerk.com)  | 1,200<br>3.5 b € [2007-2013]                |
| 3      | RUSSIA (2008)<br>(www.nanowerk.com)  | 5,000<br>(7.7 b\$ up to 2015)               |
| 4      | TAIWAN (Market value)<br>(Investintaiwan.nat.gov)                                  | 578   |
| 5      | INDIA (2008)<br>(www.scidev.net)   | 255   |
| 6      | PAKISTAN (2008)<br>National Commission on Nano-sci-<br>ence and Technology (NCNST) | 15<br>(MoST about 6 and HEC about 9)        |

Due to such huge investments it is estimated that by 2015, the market value of Nanotechnology would be some 1-2 trillion dollars. This is going to shake up the world as nanotech products would indeed be a dominating factor (Figure 3).



**Figure 3. Time Variation of Market Volume of Nanotechnology.**

## 2.3 Applications

Apart from its economic importance, nanotechnology has found direct applications in the following areas of industry and health care of benefits to the society.

1. **Medical / Nanomedicine:** Anti-cancer drugs, Bio-sensors, Implants, Dental Pastes;
2. **Energy:** Solar, Fuel cells, Bio-fuels, Batteries;
3. **Automobiles:** Lubricants, Glass Coatings, Resins, Phosphors;
4. **Industry:** Ceramics, Insulation Materials, Phosphors, Hard Materials, Mechanical Systems, Spray, Sensors;
5. **Computer/Information Technology:** Bio-molecules, Large Memories;
6. **Defence:** Special Materials, Censors, Clothing, Bullet Proof Fabrics;
7. **Cosmetics:** Skin Creams;
8. **Agriculture/Livestock:** Food Safety, Quality Assurance, water purification;
9. **Environment:** Filters, anti-toxicants;
10. **Textiles:** Special clothes, Wrinkle free and Stain free;
11. **Sports:** Sunglasses, Rackets, Tennis balls and Golf Clubs;
12. **Aerospace:** Communication, High strength light weight materials;
13. **Oil and Gas:** Nanotechnology in Exploration, Sensing Devices etc.

## 2.4 Relative applications

Most of the investment in nanotech is in the area of pharmaceuticals and drugs. The relative distribution of nanotechnology products in the market is given below (Figure 4).

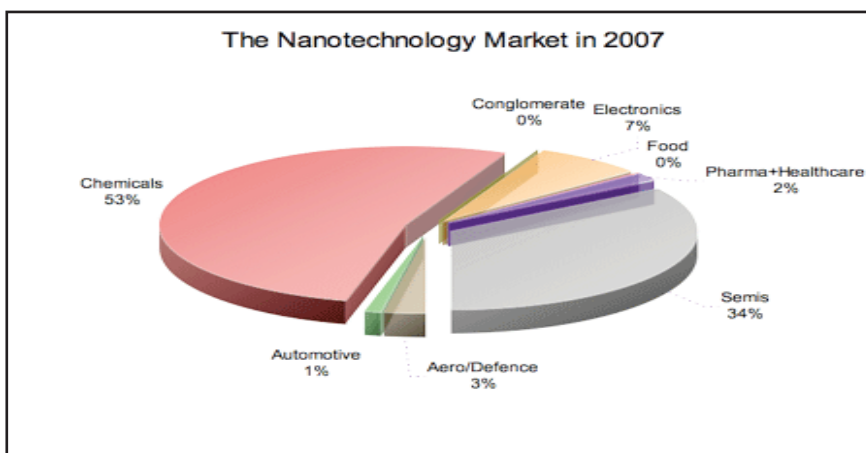


Figure 4. Nanotechnology Market.

## 2.5 Instrumentation for Characterization of Nanomaterials

The quality and type of nanoparticles produced in the area of Nanotechnology is an important matter. To qualify the specifications of the nanomaterials produced are characterized by precision instruments mostly involving high level physics.

A well used instrument which characterizes the material sizes in the nano-tech range of, 1-100 nm, is STM, the Scanning Tunnelling Microscope. Other precise instruments are Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM), Transmission Electron Microscope (TEM) and X-Ray diffraction instruments, etc. (Figure 5).



**Figure 5. JEOL 5800LV Scanning Electron Microscope (SEM).**

All these precise physics instruments are well used in the semi-conductor technology and precision methods of nuclear and atomic science. Some of the chemical methods like Sol Gel methods are also well used for production of nano-particles. Thus, the nano-technology requires knowledge of several disciplines of science and engineering, such as Physics, Chemistry, Biology, Electrical, Chemical or Mechanical Engineering etc. it is the technology of highly Multidisciplinary. With this introduction of the applications of nano-technology in various aspects of human welfare, we shall now discuss its applications with reference to the priority of developing countries.

## 3 NANOTECHNOLOGY IN THE DEVELOPING COUNTRIES

### 3.1 Nanotechnology Strategy for Developing Countries

If a developing country has already good experience in a specific high-tech area, it is worthwhile to concentrate on the use of nanotechnology in such an area. This is possible in several developing countries of the OIC like Iran, Turkey, Pakistan, Egypt, Malaysia and others where in certain disciplines high –technology and precision S&T is already being done. The following suggestions in this regard are made:

- a) For the Middle East, the priority areas are applications of nanotechnology in oil and gas exploration and water management and drinking water provision;
- b) For Pakistan, for example, the priority areas to focus attention on use of nanotechnology would be agriculture, sports goods, textiles, water, while problems of energy, healthcare/medicine, environment and some other industrial applications of nanotechnology would be of overall benefit for the majority of the countries;
- c) The other important strategy of benefit to a developing country would be to invest in those high technology areas, to an extent of a critical size of specialization in nanotechnology to protect against the exploitation due to ignorance of nanotech applied expensive products. The country may not import-substitute certain high tech expensive items because of lack of high investment in funds or in manpower, a small critical size expert group should be available which can properly assess the cost of purchase of essential items of import to the extent of avoiding and safeguarding the exploitation in the form amplified prices by the advanced countries' suppliers;
- d) The third important strategy for developing countries is to form cooperative nano-networking to make best use of their funds and human resources; and
- e) Organizations like the OIC and ECO can form nano-networks to share each other's funding and expertise of human resources. Even advanced countries of Europe are having cooperative nanotech programmes under EU cooperative networks on nanotechnology.

This would be a good strategy of sharing the resources of similarly weak countries in high technology. Recent attempts by Iran to set up nano-network in ECO Countries are a welcome effort. Pakistan has already supported this network. Iran is very keenly concentrating on nanotechnology. This can be gauged from the fact that the office of the President of Iran is directing the programme on nanotechnology and coordinating the linkage with various ministries like Health, Energy, Industries etc.

Through such nano-network several benefits will accrue to the ECO member countries.

### **3.2 Potential Benefits of Nanotechnology to Developing Countries**

Several studies have been made on the requirements of nanotechnology for developing countries. In a recent study, Salamanca-Buentello *et al.*, ranked nanotechnology applications according to their potential benefit for developing countries; water treatment, disease diagnosis, screening and drug delivery systems respectively rated 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup>, behind energy storage, production, and conversion (1<sup>st</sup>) and agricultural productivity enhancement (2<sup>nd</sup>) [1]. Salvarezza believes that nanotechnology offers an area such as developing country healthcare, 'safer drug

delivery, new methods for prevention, diagnosis and treatment of diseases' [2]. In rural areas, Harper argues that pulmonary or epidermal drug delivery applications utilizing nanotechnology, 'have the potential to free up the large numbers of trained medical personnel who are currently engaged in administering drugs via hypodermic needles' [3]. Furthermore, Barker comments that slow-release drugs, important for those in remote areas, could be assisted by nano-porous membranes [4]. In a joint project between groups in the US, India and Mexico, inexpensive, maintenance free solar panels, aimed at powering rural clinics and refrigerating medicines, are currently being developed [5].

The nature of nanotechnology's global impact will largely depend on the answers to five, key questions surrounding nanotechnology innovation: Who? What? When? Where? and Why? Developing countries will experience differing forms of engagement with nanotechnology. Will nanotechnology, as Daar suggests, be 'a profitable industry for countries in the South' or will it 'exploit the South' and threaten developing country markets in primary production areas such as cotton, rubber and minerals [7].

Will developing countries play the role of the 'manufacturing-base' for nanotechnology innovation, as suggested by Whittingham and Bateman's 2003 'cost-benefit analysis of moving nanotechnology R&D and manufacturing to Eastern European and developing countries' [8]. Already, Malaysia and South Africa have been highlighted as countries with comparative advantage in manufacturing for nanotechnology [9, 10].

With this in mind, a 2003 report by the University of Toronto Joint Centre for Bioethics claimed a number of developing countries are exhibiting a 'surprising amount of nanotechnology activity' [11]. The study noted that China, India and South Korea had established national activities in nanotechnology; Thailand, The Philippines, South Africa, Brazil and Chile had some form of government support and national funding programs were being developed; whilst Mexico and Argentina had some form of organized nanotechnology activity but no specific government funding [11]. Some see nanotechnology enabling developing countries 'to 'leapfrog' their way to leadership' [12], with the Indian government looking to use nanotechnology to 'catch up' in global economic terms [13,14].

### **3.3 Nanotechnology in Pakistan**

Conscious of the fact that nanotechnology is going to affect all countries and all societies with respect to socioeconomic aspects, early steps have been taken in Pakistan to cater for this technology. Very early initiatives were taken in the mid-nineties on the subject via seminars on 'New Materials.'

#### *3.3.1 National Commission on Nano-Science and Technology (NCNST)*

In order to carry out programme of nanotech in Pakistan, a National Commission

on Nano S&T (NCNST) was formed in October 2003 under the Ministry of Science and Technology with 17 eminent scientists as advisory members from various science organizations.

The NCNST was assigned to help assess nanotech projects for funding. A number of projects were reviewed by a committee of experienced scientists and recommended six projects out of ten for funding. Some projects relating to universities were funded by the Higher Education Commission and those relating to non-degree organizations were funded by the Ministry of Science and Technology (Table 4).

### 3.3.2 Nanotech Research in Pakistan

The specific laboratories and the areas of their research and the senior scientists involved in that research is listed below:

1. **Nanotechnology Research at PIEAS: Mesoporous Alumina**  
*Dr Mazhar Mehmood, PIEAS, Nilore, Islamabad.*
2. **Nanochemistry of Iron Oxide by Mossbauer Spectroscopy**  
*Prof. M. Mazhar, Quaid-e-Azam University, Islamabad.*
3. **Nanoscience at Department of Physics CIIT, Islamabad: Quantum Dot and Thin Films**  
*Dr Arshad Saleem Bhatti, CIIT, Islamabad.*
4. **Nanocomposites: Copper-Carbon Composites using Multi-Wall Carbon Tubes (MWCT)**  
*Prof. Fazal A. Khalid, M. Bashir, GIK University.*
5. **(a) Synthesis of Biocompatible Gold Particles, (b) Development of Nanobiotechnological Research at NIBGE: Functionalization Nanoparticles**  
*Dr Irshad Hussain, NIBGE, Faisalabad.*
6. **Influence of Rate of Deposition on the Dewetting: Characterization of Nano-clusters**  
*Shaista Babar and A. S. Bhatti, University of Illinois at Urbana Champaign.*
7. **Nanotechnology Products of Various Oxides: Rare Earth Nano oxides**  
*Prof. Ikram-ul-Haq, University of Peshawar.*
8. **Nano Research at Microelectronics Research Centre : Non-volatile Memory Devices, Magnetic Tunnel Junction Device**  
*Prof. Shahzad Naseem, Punjab University, Lahore.*
9. **Nano-magnetism: Study of Fe-based Nano-materials.**  
*Prof. Syed Khurshid Hassnain, Physics Department, Q. A. U., Islamabad.*
10. **Nano-devices: LED's etc.**  
*Dr. Arshad Mahmood, PINSTECH, P.O.Nilore, Islamabad.*

**Table 4. Funding of Nanotechnology Research Projects**

| No.  | Project                         | Institution | Rs million | Funded by |
|------|---------------------------------|-------------|------------|-----------|
| i.   | Synthesis and Characterization  | PIEAS       | 60         | HEC       |
| ii.  | Nano-magnetism                  | QAU         | 137        | HEC       |
| iii. | Micro/Nano electronic devices   | CIIT        | 189        | HEC       |
| iv.  | Nano-Composites                 | GIK         | 195        | HEC       |
| v.   | Nano-biotechnology              | NIBGE       | 155        | MoST      |
| vi.  | Nano-devices, L.E.D. etc        | PINSTECH    | 196        | MoST      |
|      | <b>Total (US\$ 15 million):</b> |             | <b>932</b> |           |

### 3.3.3 Some Publications in Nanotechnology from Pakistani Scientists (2005-2007)

#### (a) Publications: Year 2005

1. Synthesis and Structural Characterization of New Heterobimetallic Coordination Complex of Barium and Cobalt for Use as Precursor for Chemical Vapour Deposition, Asif Ali Tahir, K.C. Molloy, M. Mazhar, Gabriel K., M. Hamid and S. Dastgir, *Inorg. Chem.*, 44, 9207-9212, 2005.
2. C.J. Kiely, M. Watanabe, A. Burrows, P. Clasen, M.P. Harmer, B. Rodríguez-González, L. Liz-Marzán, I. Hussain, J. Fink and M. Brust. "What are the Limitations in the Characterization of Self-Assembled Metamaterials using Advanced Microscopy Techniques"? *Microscopy and Microanalysis*, 2005, 11 (suppl2), 204
3. Haifei Zhang, Irshad Hussain, Mathias Brust, Micheal F. Butler, Steven P. Rannard and Andrew I. Cooper. "Aligned two and three-dimensional structures by directional freezing of polymers and nanoparticles". *Nature Materials*, 2005, 4, 787
4. Christina Roth, Adam J. Papworth, Irshad Hussain, Richard J. Nichols and David J. Schiffrin. "A new Pt-Ru model system to study the bifunctional mechanism of electrocatalysis". *Journal of Electro-analytical Chemistry*, 2005, 581, 79
5. Irshad Hussain, Susan Graham, Zhenxin Wang, Bien Tan, Steven P. Rannard, David C. Sherrington, Andrew I. Cooper and Mathias Brust. "Size-controlled synthesis of near-monodisperse gold nanoparticles in the 1-4 nm range using polymeric stabilizers". *Journal of the American Chemical Society*, 2005, 127, 16398



(b) Publications: Year 2006

6. Synthesis of Isostructural Cage Complexes of Copper with Cobalt and Nickel for Deposition of Mixed Ceramic Oxide Materials, M. Hamid, Asif A. Tahir and M. Mazhar, *Inorg. Chem.*, 45. 10457-10466, 2006.
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### 3.4 Nanotechnology in Malaysia

Malaysia has established nanotechnology laboratories like the Advanced Materials Research Centre at SIRIM, Combinatorial Technology and Catalysis Research Centre (COMBICAT) at the University of Malaya.

More than 300 graduate students in Malaysia are actively pursuing research in nanotechnology while 150 local scientists are already directly involved in various area of nanotechnology research [16].

### **3.5 Nanotechnology in Iran**

Iran is paying lot of attention to science and technology in general. Iran ranked 37<sup>th</sup> in the field of research by submitting 6,700 scientific papers to the publications of the Institute for Scientific Information in 2006.

In particular, Iran has paid serious attention to nanotechnology and the office of the President of Iran is catering for the development of nanotechnology and coordinating the R&D of nanotechnology of various ministries such as Health, Energy, Agriculture etc.

Iran is thus working on getting the benefits from the use of nanotechnology and has already focused on the projects like ‘Cleaning the Diesel Oil’ plant for purification of water in cooperation with UNIDO and the Centre for Electronic Devices.

### **3.6 Nanotechnology in Turkey**

Some of the universities are already making products of high technology which form part of nanotechnology. The tip of the Atomic Force Microscope (AFM), the precision instrument extensively used in transistors and semi-conductor industry is also used in projects of nanotechnology.

The tip is a sensitive device and is a consumption item when AFM is used and at Bilkent University in Turkey such AFM tips are fabricated locally and even exported to foreign countries.

Some theoretical work on nanotechnology is also being done at KOC University in Istanbul.

### **3.7 Nanotechnology in Saudi Arabia**

Saudi Arabia will launch several new centres to boost nanotechnology research in the region.

The Saudi Arabian national research and development organisation and the international research organisation, IBM Research, announced an agreement on 26 February 2008, to establish the Nanotechnology Centre of Excellence at the King Abdulaziz City for Science and Technology (KACST) in the capital, Riyadh. The centre will collaborate with IBM Research to identify and develop promising opportunities in nanotechnology. It will provide research materials for solar energy and nanomembranes for the desalination of seawater. Researchers will also investigate new methods for recycling plastic materials.

Moreover, the King Abdullah Institute for Nanotechnology will open by mid-2008 at the King Saud University in Riyadh, according to an Arab News website. Theodor Hänsch of the Max Planck Institute in Munich, Germany — winner of the 2005 Nobel Prize in physics — will teach as a visiting professor at the institute, as part of the university’s Nobel laureates programme.

Two other nanotechnology institutes are also planned, for King Abdul Aziz University in Jeddah and the King Fahd University for Petroleum and Minerals in Riyadh, at a cost of US\$3.2 million each.

### **3.8 Nanotechnology in China**

The markets in China for nanotechnology products and systems was worth US\$ 5.4 billion in 2005 and will increase to US\$31.4 billion by 2010 and US\$144.9 billion by 2015. The main segments are nanomaterials, nanoelectronics, nanobio and nano-life-sciences which account already for 70 percent of the turnover.

Over the past three years, the number of companies in the field of nanotechnology in China has grown and reached over 800. This growth rate is very rapid and it has yet to show signs of slowing down. The sales to-date have been largely domestic, but with the increasing global interest in nanotechnology and with the advantage of modern communication, we can predict that this could be a very profitable investment in the near future.

The development shows that five nations are leading the competition today. China, as one of these five nations, has its unique advantage of high flexibility, low labour costs, no barriers for new technologies, young and vibrant society, large amount of foreign venture capital, underestimated currency (today about 25 percent undervalue compared with the US Dollar), low taxes, government support and a home market with more than 1.3 billion people for applications

China is among the few countries that have begun to explore nanotechnology since 1990s by firstly starting a large and a highly competent research team, with scientists trained in US, Europe and Japan, some being leaders in their fields worldwide.

Today, China has a research and development network of three national centres and over 20 university institutes in nanotechnology. It is rich in several important mineral and biological resources which are important for developing nanomaterials; is very competent even leading in the fields of nanomaterial research and application, tunnel microscopes, single atom operation etc; has a huge domestic market which is ideal for the growth of enterprises.

At present, some thirty institutions are engaged in basic nanotech research. These include CAS Physical Institute, CAS Chemical Institute, CAS Solid Physics Institute, Tsinghua University (Beijing), Beijing University, Hangzhou University, Nanjing University and several universities in Shanghai. In addition, Shanghai, Beijing, and Shenzhen have each created their own Nanotech Centres, uniting local R&D structures. In terms of basic nanotech R&D, China has reached the most advanced levels in the world, rivalling even the capacities of the United States.

### **3.9 Nanotechnology in Taiwan**

Taiwan authorities are planning to spend NT\$21.5 billion (US\$663.27 million) over six years on a national projects to develop the nanotechnology and relevant

industries, according to the Vice President Annette Lu [15].

Addressing the 2004 Taiwan Chemical Technology Forum at the Taipei International Convention Center, Lu said the goal of the project is to create an output value of NT\$300 billion in the nanotechnology industry by 2008, with more than 800 companies in the business, while by 2012, the output will expand to NT\$1 trillion, with over 1,500 companies in the sector. The project is expected to help local industries to upgrade or transform and to further sharpen Taiwan's national competitiveness.

Taiwan is now in a good shape in terms of technological development compared with other countries in the world, as indicated in the 2004 global competitiveness report of the Switzerland-based World Economic Forum, which puts Taiwan in first place in Asia and second in the world in terms of national competitiveness in technological manufacture and research.

In 2005, Taiwan invested US\$700 million on a nano-park project with 94% of the funds coming from 16 private companies, which estimated that they would create a market of US\$ 19.3 billion mostly for the benefit of their electronics industry.

#### **4 ACKNOWLEDGEMENT**

We are very grateful to the office of the Chairman PSF for their help in the completion of the paper.

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<sup>1</sup> As presented by the authors.

# Nanotechnology for Sustainable Development of Oil Refining and Petrochemistry

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## ABSTRACT

The sustainable development of world humanity, including the Islamic World, assumes the optimal problem solution in satisfying the demand in energy, fuel, industrial crude materials. Though there is a wide investigation of using alternative energy sources (atomic, sun and wind energies, etc.), alternative kinds of fuel (bioethanol, biobutanol, biodiesel.) for the next 40-50 years will be produced mostly of natural hydrocarbon raw material.

In this respect wide and detailed investigations and developments are necessary, which are directed at minimizing the costs of hydrocarbon raw material producing, using the oil of poor quality, including bitumen, asphalt, bituminous sands, as well as coal, natural and associated gas in producing the fuel and materials for petrochemistry.

For effective solution of these problems we cannot use only traditional chemical processes and it is necessary to create new technologies, catalysts, equipment, based on nanotechnology.

Extending and analysing our own researches and those, which are described in scientific works we can see, the main trends of nanotechnology development in oil refining and petrochemistry are:

- Using the positive side effect of relative catalytic productivity of active component of heterogeneous catalysts;
- Using the size effect of the catalysts, prepared “in situ” intimately in reaction environment ;
- Using the size effect in micro and meso poromeric systems, especially of molecular sieves on the basis of alumino- and metasilicates;
- Using the nano-effects in poly phase chemical processes;
- Using the size effect in different processes of parting the hydrocarbon and chemical compounds.

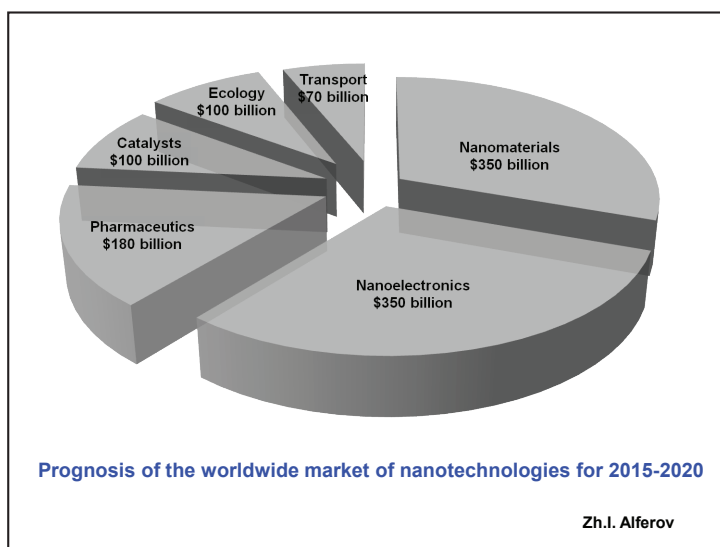
Here, we have presented the results on each of the over mentioned trend and described their future influence on the technical level of oil refining and

petrochemistry and respectively on the sustainability of development of this important human activity area.

**By definition of Nobel Prize winner Zhores Alferov**

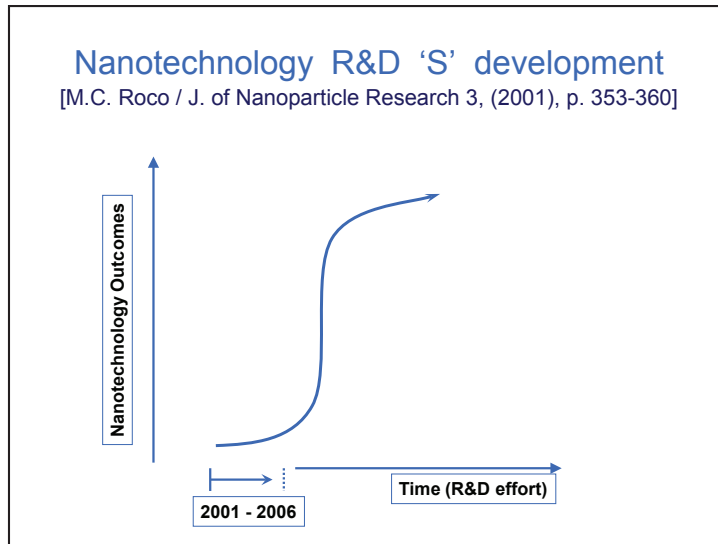
**"Nanotechnology is a very promising and powerful means of synthesizing materials, manufacturing articles and devices with appreciably improved or even essentially new properties or functional abilities".**

**Figure 1. Nanotechnology: The Definition of Nobel Prize Winner Zhores Alferov.**

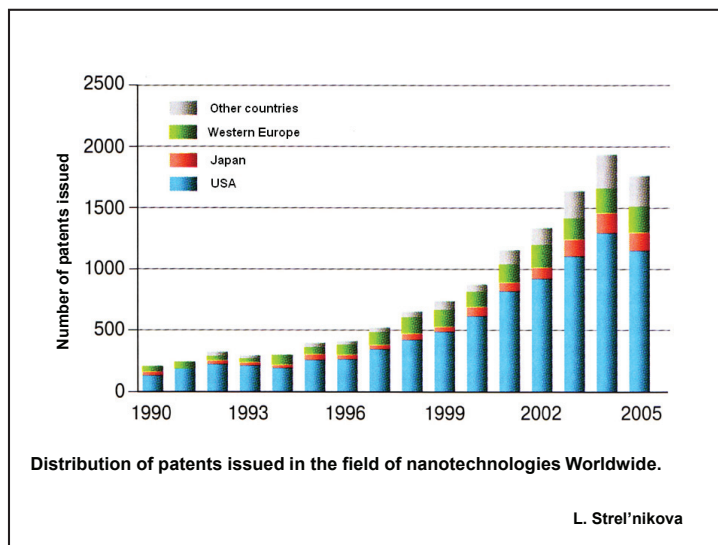


**Figure 2. Prognosis of the Worldwide Market of Nanotechnologies for 2015-2020.**

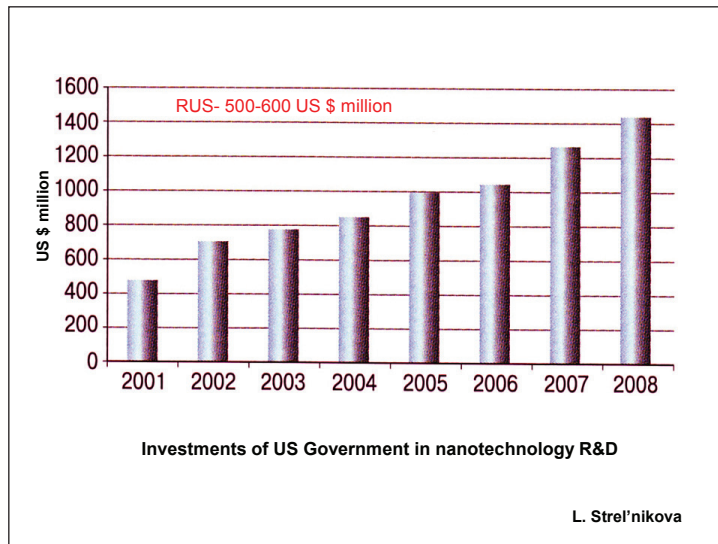




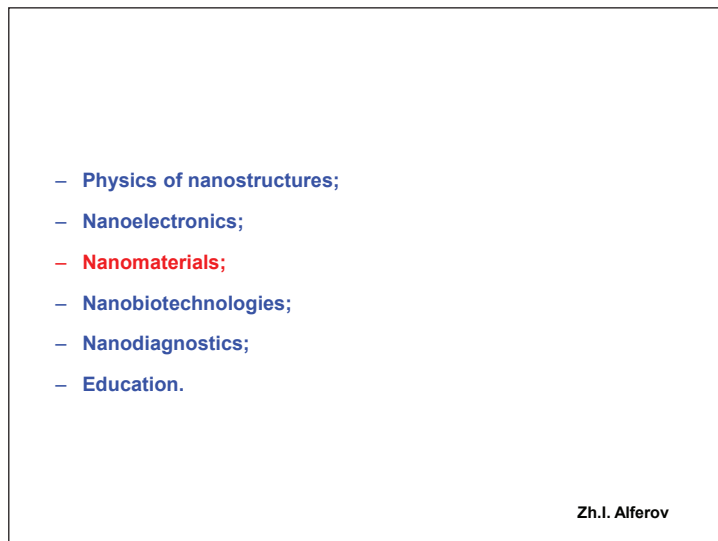
**Figure 3. Nanotechnology R&D 'S' Development.**



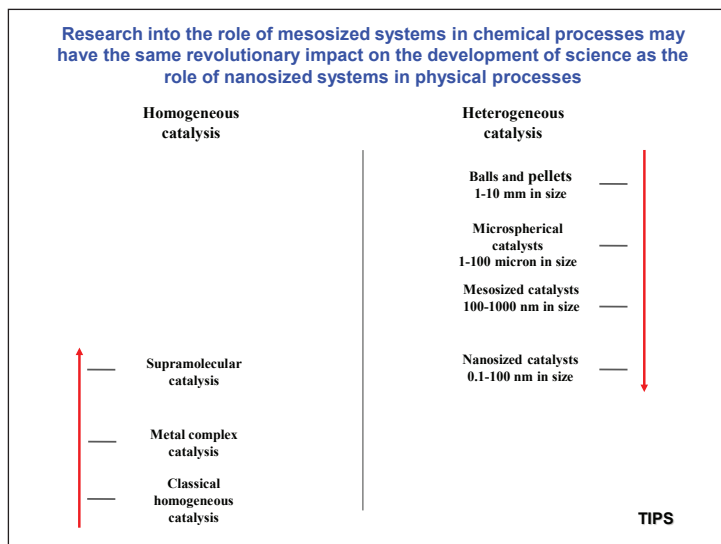
**Figure 4. Distribution of Patents Issued in the Field of Nanotechnology Worldwide.**



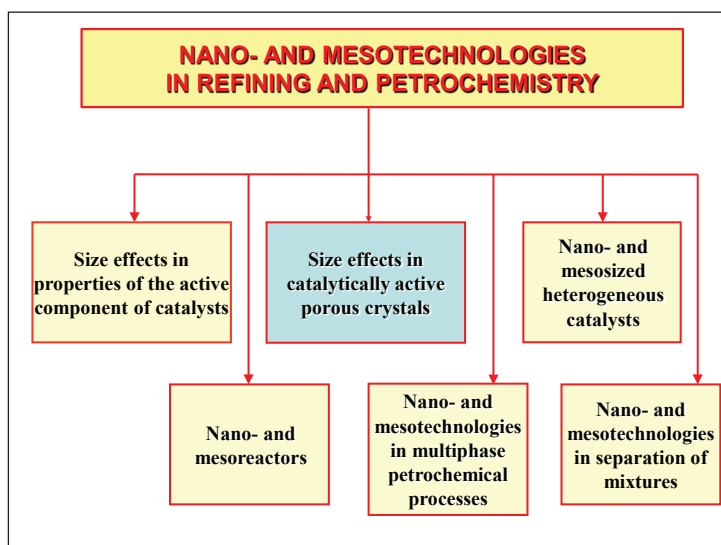
**Figure 5. Investments of US Government in Nanotechnology R&D.**



**Figure 6. Trends of Studies in Nanotechnology.**



**Figure 7. Research into the Role of Mesosized Systems in Chemical Processes.**



**Figure 8. Nano-and Mesotechnologies in Refining and Petrochemistry.**

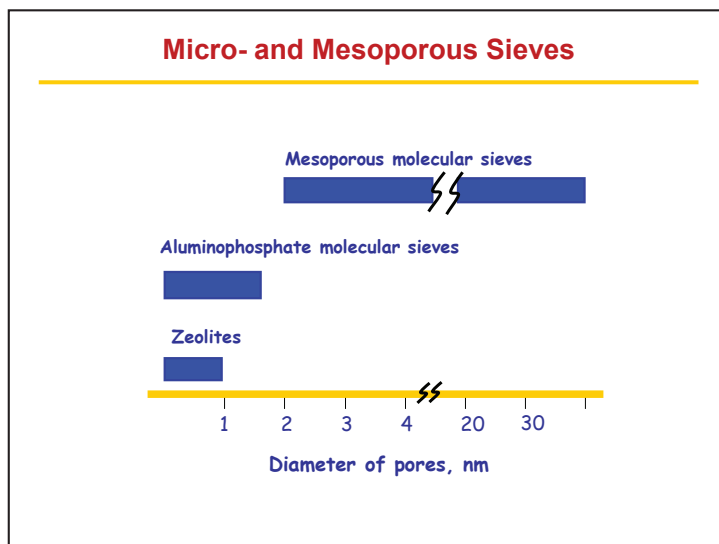


Figure 9. Micro- and Mesoporous Sieves.

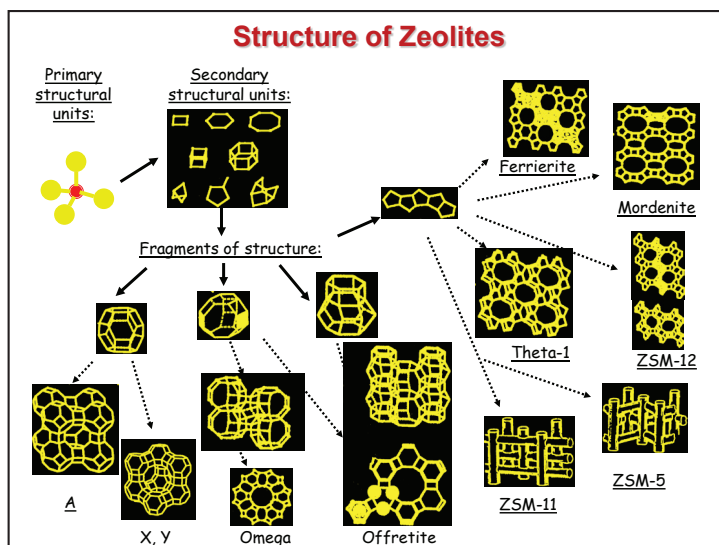
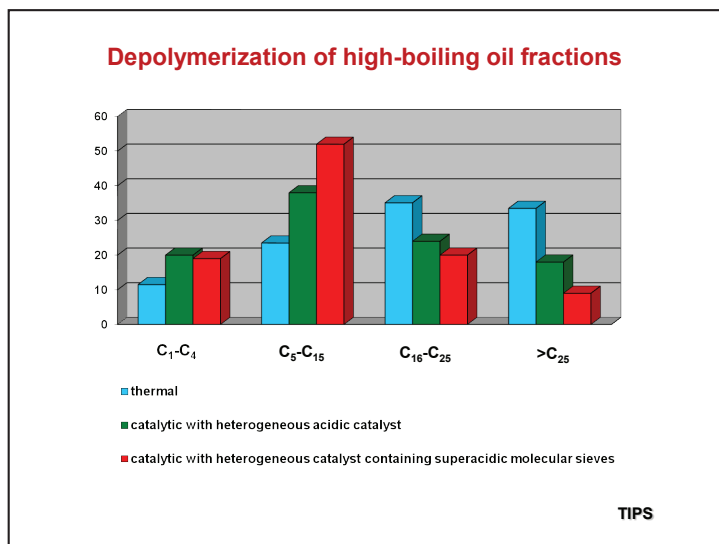
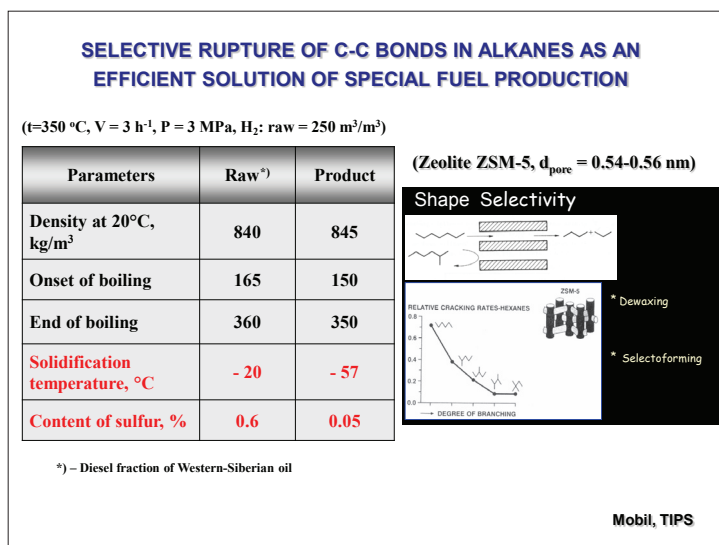


Figure 10. Structure of Zeolites.



**Figure 11. Depolymerisation of High-Boiling Oil Fractions.**



**Figure 12. Selective Rupture of C-C Bonds in Alkanes as an Efficient Solution of Special Fuel Production.**

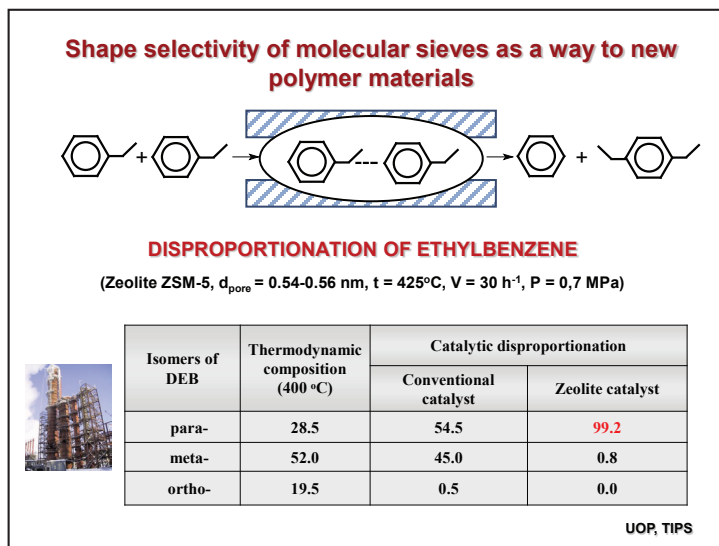


Figure 13. Shape Selectivity of Molecular Sieves to Produce New Polymer Materials.

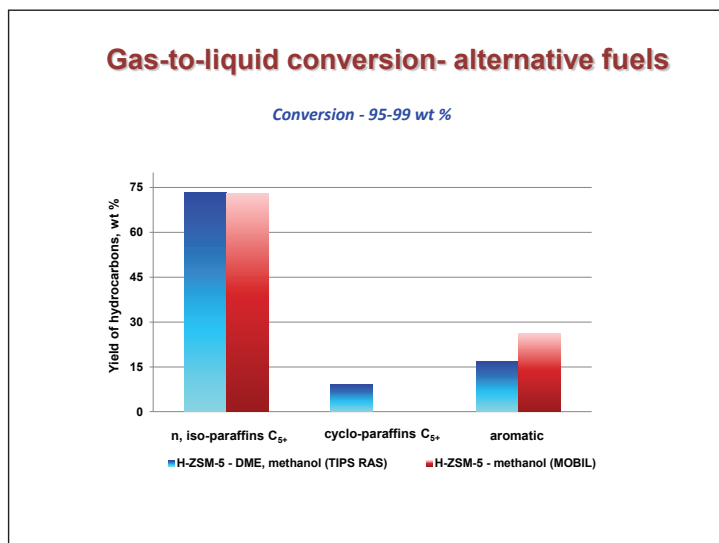


Figure 14. Gas-to-Liquid Conversion-alternative Fuels.

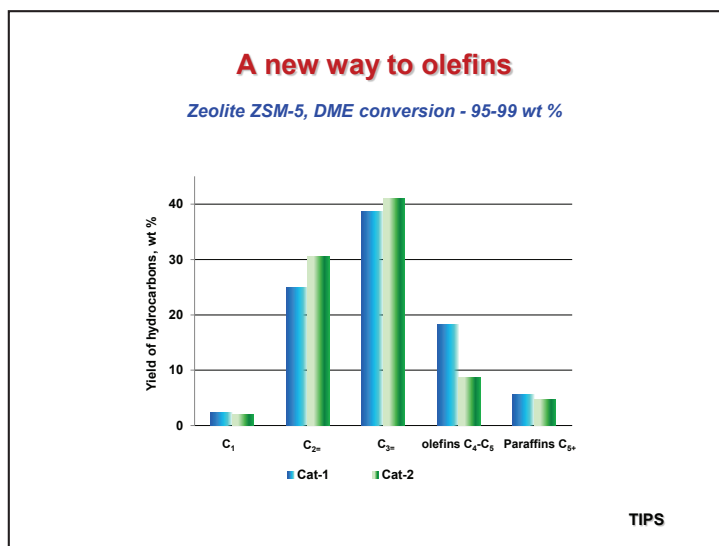


Figure 15. A New Way to Olefins.

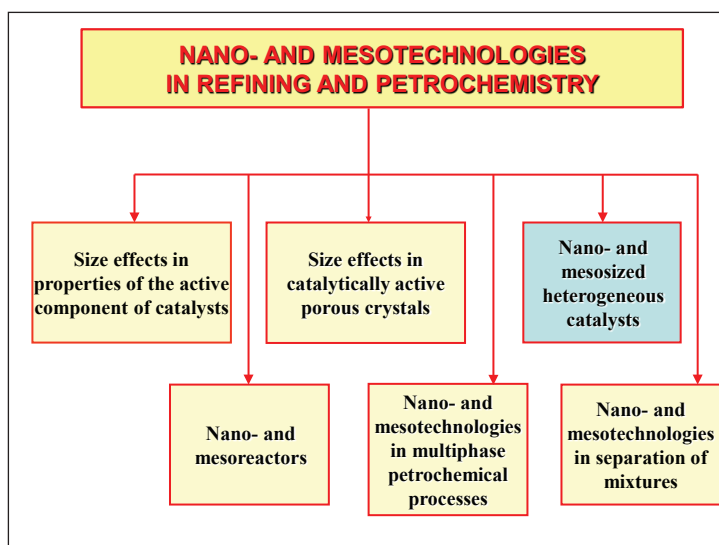
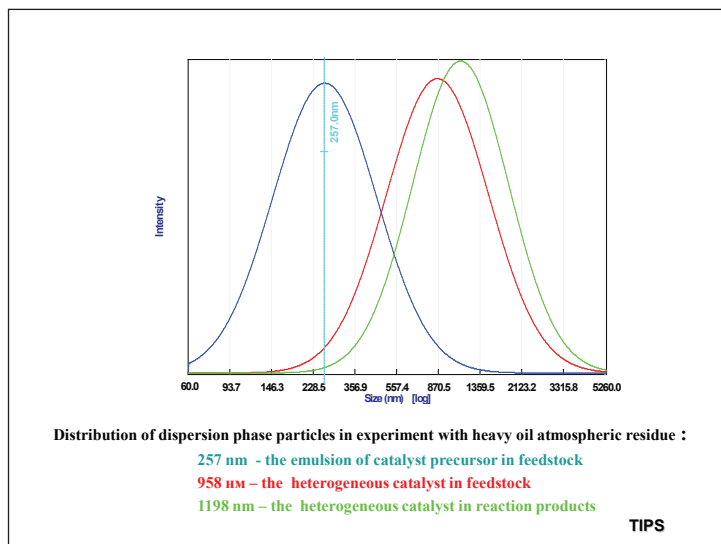


Figure 16. Nano-and Mesotechnologies in Refining and Petrochemistry.

| Recoverable deposits of fossil fuels and annual growth of biomass. billion tons of oil equivalent |                 |                   |                  |                  |
|---|-----------------|-------------------|------------------|------------------|
| Item  | Deposits in NIS | Deposits in world | World production | Potential, years |
| Oils of low and medium viscosity  | 8 +10           | 160-180           | 4                | 40-45            |
| High-viscosity (heavy) oils   | 7- 8            | 810               | 0.4- 0.5         | 150-160          |
| Coal  | ~200            | 720               | 2                | 120-150          |
| Natural gas   | ~40             | 100-105           | 2.1              | 50-55            |
| Gas in gas hydrates:  |                 |                   |                  |                  |
| - On land   | ?               | 22000             | —                | ?                |
| - In sea  | ?               | 5000000           | —                | ?                |
| Formation of plant biomass per year   | ~15 +20         | 80                |                  | ∞                |

Annual growth of plant biomass in Earth is 170 - 200 billion tons of the dry substance. When recalculated to the oil equivalent, this corresponds to nearly 70-80 billion tons

**Figure 17. Recoverable Deposits of Fossil Fuels and Annual Growth of Biomass, Billion Tons of Oil Equivalent.**



**Figure 18. Distribution of Dispersion Phase Particles in Experiment with Heavy Oil Atmospheric Residue.**



| Depolymerization of heavy residues of various oils  |                                       |  |   |                                      |   |
|---|---------------------------------------|--|---|--------------------------------------|---|
| Conditions: hydrogen; pressure - 6.5-7.0 MPa; V = 1.5-2.0 h <sup>-1</sup> ; T = 450°C, recycle 20-40% |                                       |  |   |                                      |   |
| Parameters  | Vacuum residue of Western Siberia oil | Vacuum residue of Buzachin oil from Kazakhstan | Atmospheric residue of heavy Iran oil (SOROUSH) | Vacuum residue of Canadian heavy oil | Natural bitumen from Canada (without recycle) |
| Taken, wt %:  |                                       |  |   |                                      |   |
| Vacuum residue  | 98.1                                  | 97.6   | 97.5  | 97.5                                 | 97.5  |
| Hydrogen  | 1.9                                   | 2.4  | 2.5   | 2.5                                  | 2.5   |
| Total:  | 100                                   | 100  | 100   | 100                                  | 100   |
| Obtained, wt % :  |                                       |  |   |                                      |   |
| Hydrocarbon gas   | 3.4                                   | 6.5  | 7.0   | 7.8                                  | 9.2   |
| Synthetic oil   | 86.1                                  | 81.5   | 84.6  | 82.9                                 | 63.1  |
| Unconverted residue   | 10.5                                  | 12.0   | 8.4   | 9.3                                  | 27.7  |
| Total:  | 100                                   | 100  | 100   | 100                                  | 100   |

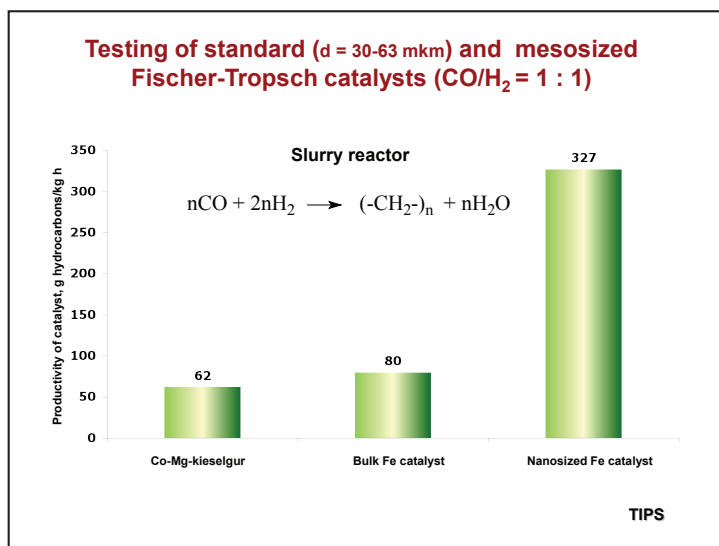
TIPS

Figure 19. Depolymerisation of Heavy Residues of Various Oils.

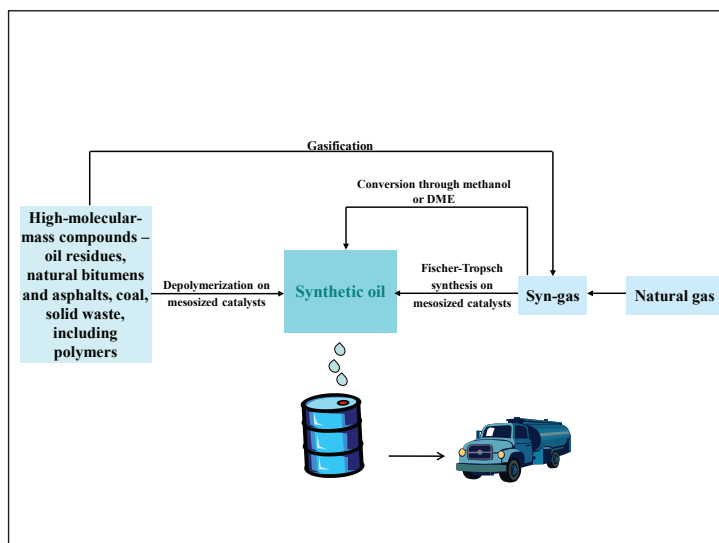
| Relative activity of catalysts during depolymerization of coals of Kansk-Achinsk basin  |                             |                                   |
|---|-----------------------------|-----------------------------------|
| ( T = 425°C, P <sub>H<sub>2</sub></sub> = 10 MPa, t = 2 h. Additive – elemental sulfur) |                             |                                   |
| Catalyst  | Relative catalytic activity |                                   |
|   | based on coal conversion    | based on yield of liquid products |
| Cobalt-molybdenum on Al <sub>2</sub> O <sub>3</sub>                                     | 1.0                         | 1.0                               |
| Cobalt-molybdenum on coal   | 1.7                         | 0.9                               |
| Natural molybdenite, MoS <sub>2</sub>   | 7.0                         | 1.7                               |
| Aqueous solution of ammonium paramolybdate supported on coal                            | 25.4                        | 16.6                              |
| Mesosized particles of Mo-containing catalyst   | 259                         | 168                               |

Federal State Unitary Enterprise, Institute of Fossil Fuels

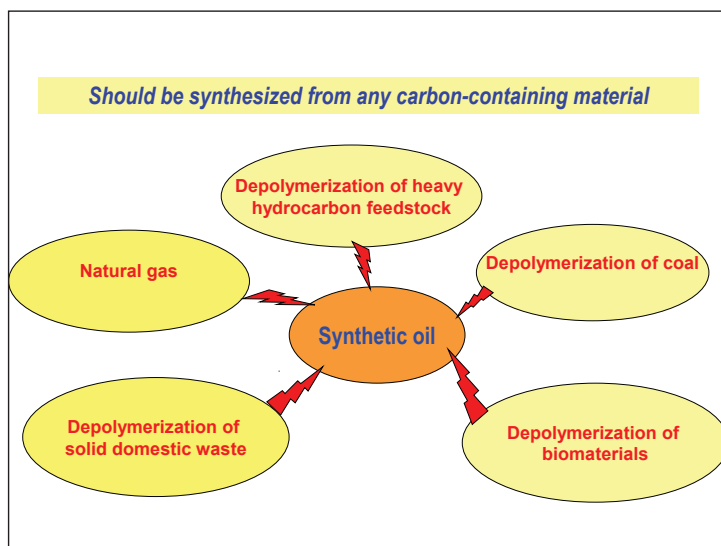
Figure 20. Relative Activity of Catalysts During Depolymerisation of Coals of Kansk-Achinsk Basin.



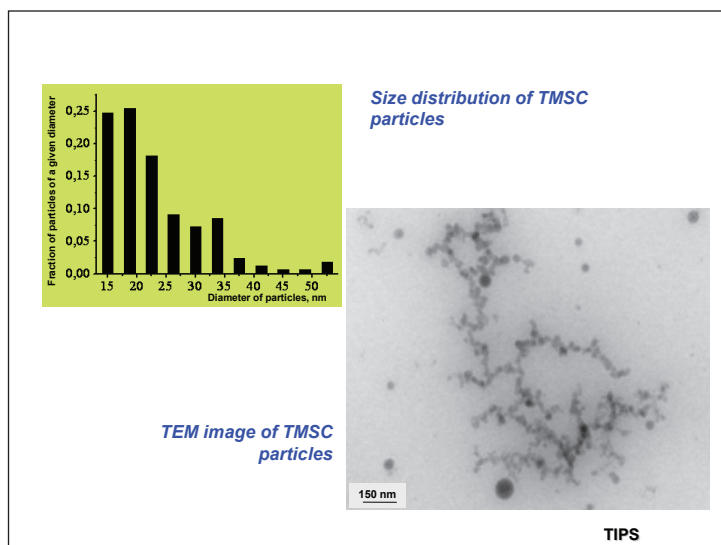
**Figure 21. Testing of Standard ( $d = 30\text{-}63\text{ mkm}$ ) and Mesosized Fischer-Tropsch Catalysts ( $\text{CO}/\text{H}_2 = 1 : 1$ ).**



**Figure 22. Gasification.**



**Figure 23. Synthetic Oil.**



**Figure 24. Transmission Electron Microscopy.**

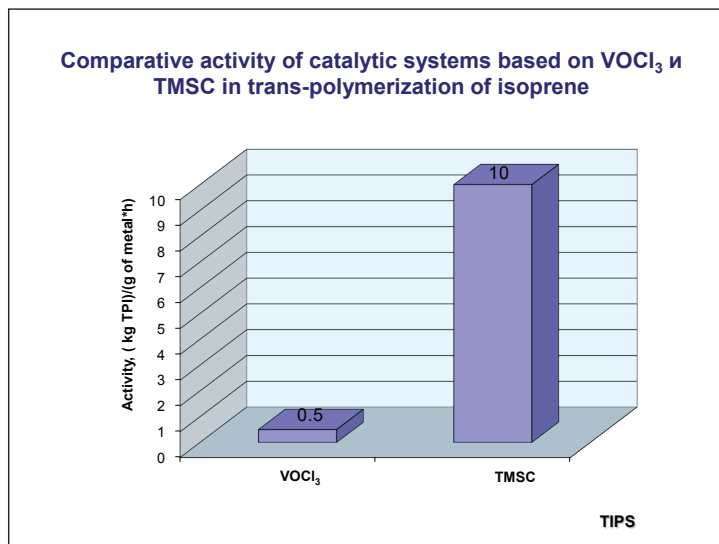


Figure 25. Comparative activity of Catalytic Systems.

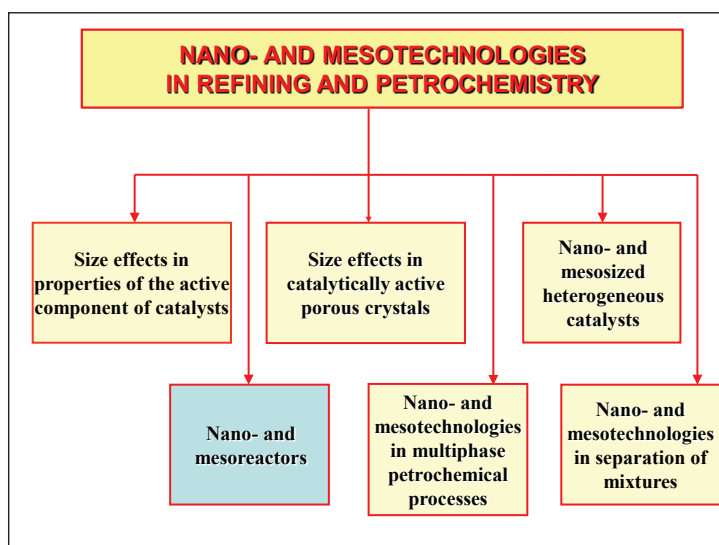


Figure 26. Nano- and Mesotechnologies in Refining and Petrochemistry.

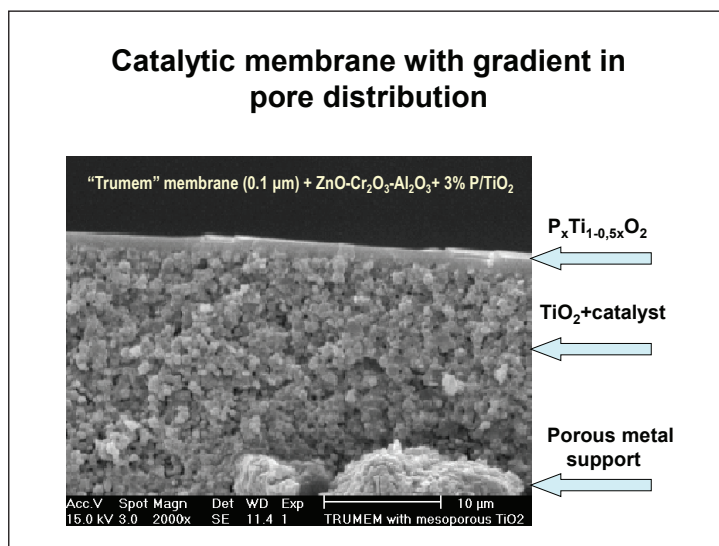


Figure 27. Catalytic Membrane with Gradient in Pore Distribution.

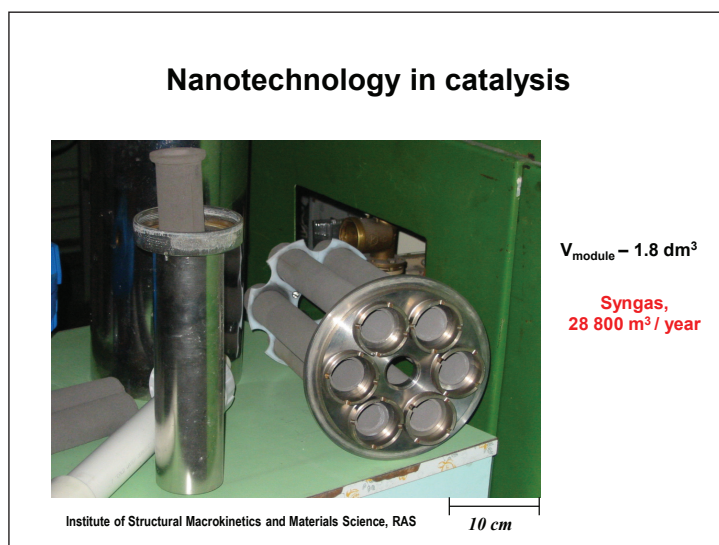
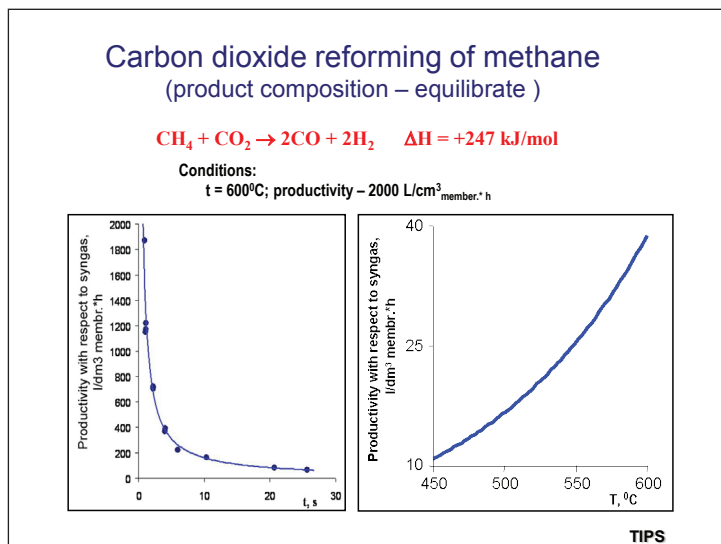


Figure 28. Nanotechnology in Catalysis.



**Figure 29. Carbon Dioxide Reforming of Methane.**

**Alkylation of iso-Butane with Butylenes**  
(PILOT UNIT; CATALYST LOADING, 1 L)

| System              | Mass velocity of raw supply, h <sup>-1</sup> | Time of continuous catalyst operation, h | Component composition of alkylate, wt % |     |     |      |     | Octane number of alkylate ROM, points |
|---------------------|--|--|---|-----|-----|------|-----|---------------------------------------|
|                     |  |  | ΣC5                                     | ΣC6 | ΣC7 | ΣC8  | ΣC9 |                                       |
| Liquid-phase system | 0.15   | 5  | 6.8                                     | 5.5 | 5.0 | 75.2 | 7.5 | 96                                    |
| "Structured" system | 0.15   | 40                                       | 1.9                                     | 2.4 | 3.9 | 87.9 | 3.9 | 98                                    |

**TIPS**

**Figure 30. Alkylation of Iso-Butane with Butylenes.**

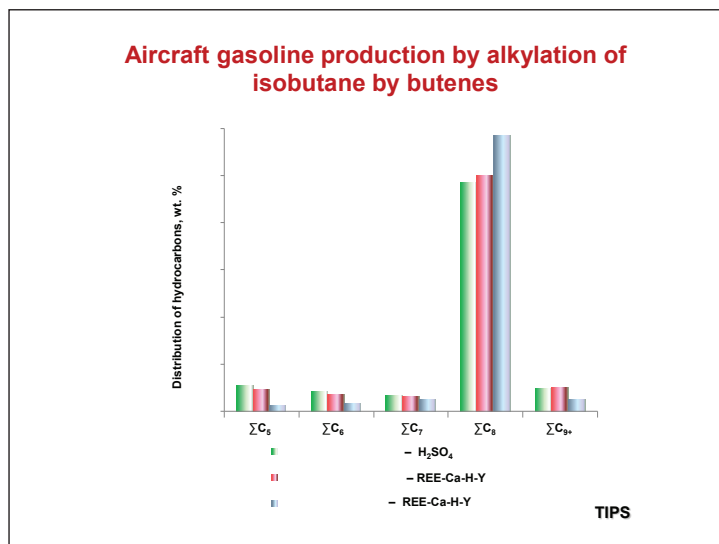


Figure 31. Aircraft Gasoline Production by Alkylation of Isobutane by Butenes.

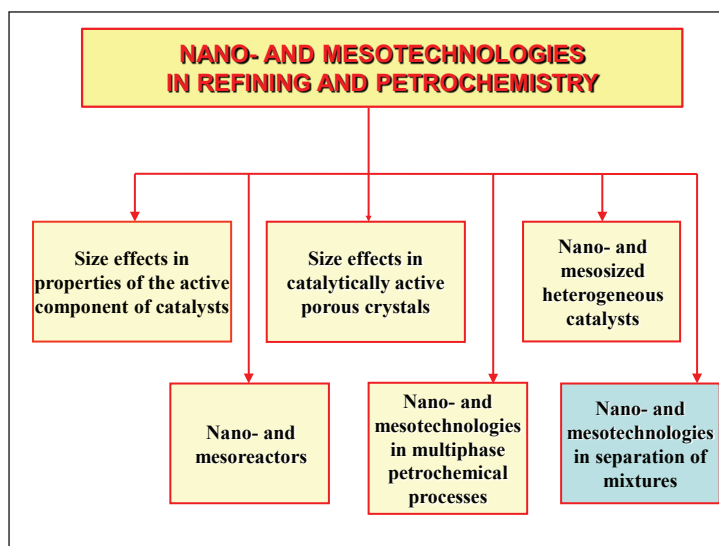


Figure 32. Nano- and Mesotechnologies in Refining and Petrochemistry.

### Pervaporation: removal of alcohol from mash (span) with the use of membrane instead of rectification unit

Conditions: nanoporous hydrophobic polymer glass, pervaporation membrane

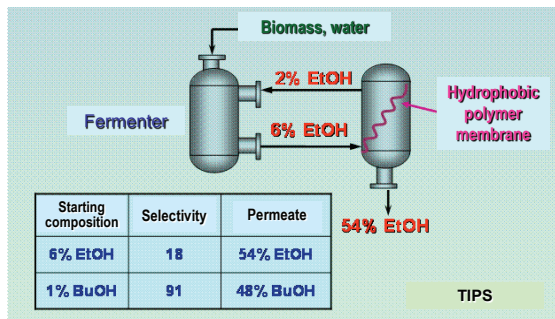


Figure 33. Pervaporation: Removal of Alcohol from Mash (span) Through the Use of Membrane and not a Rectification Unit.

### Block diagram of the catalytic reactor containing the heat-resistant porous membrane

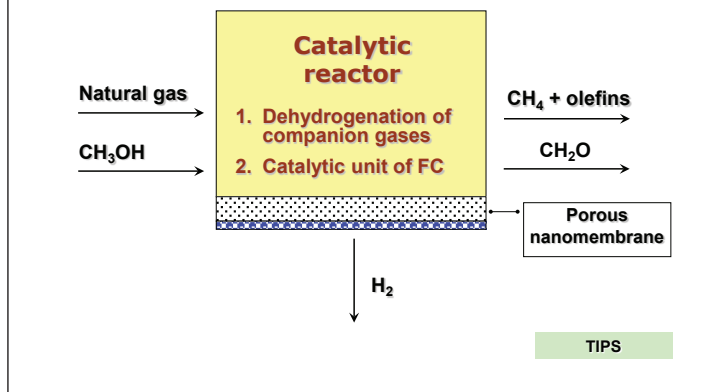


Figure 34. Block Diagram of the Catalytic Reactor containing the Heat-Resistant Porous Membrane.



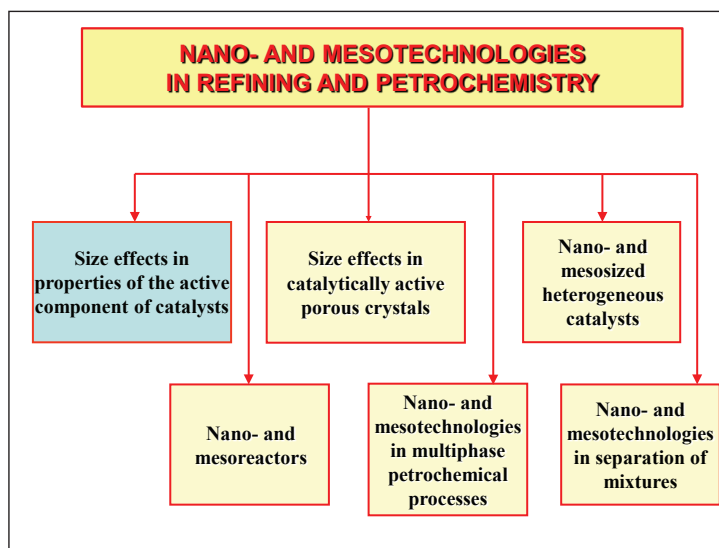


Figure 35. Nano-and Mesotechnologies in Refining and Petrochemistry.

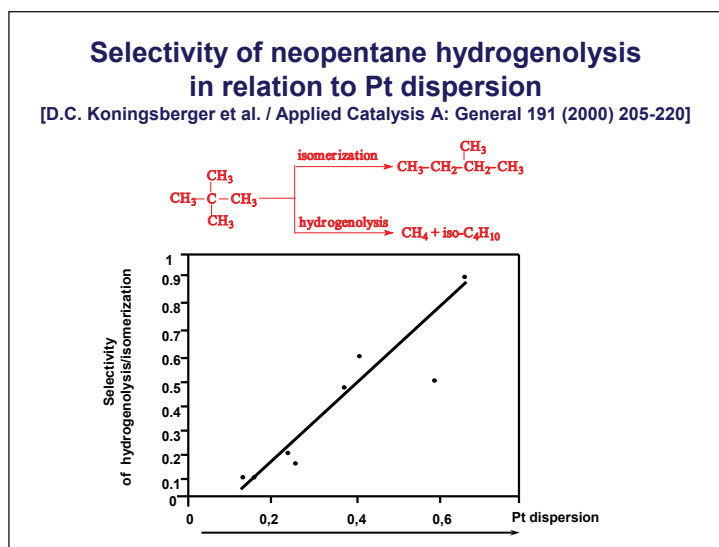


Figure 36. Selectivity of Neopentane Hydrogenolysis in Relation to Pt Dispersion.

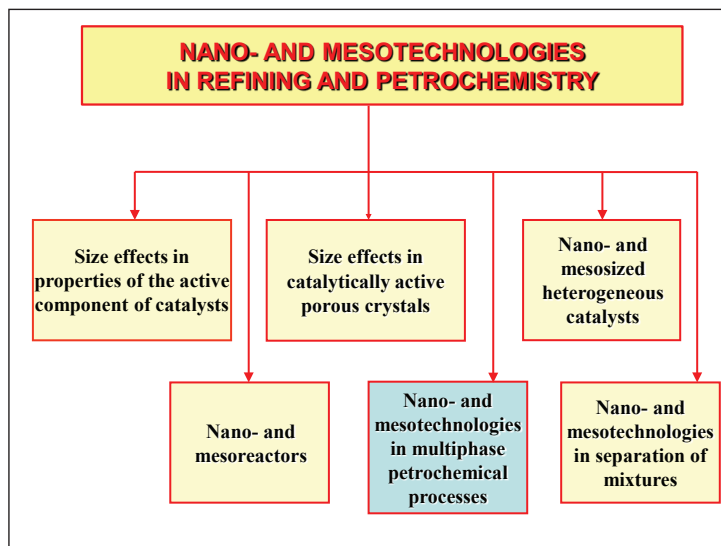


Figure 37. Nano- and Mesotechnologies in Refining and Petrochemistry.

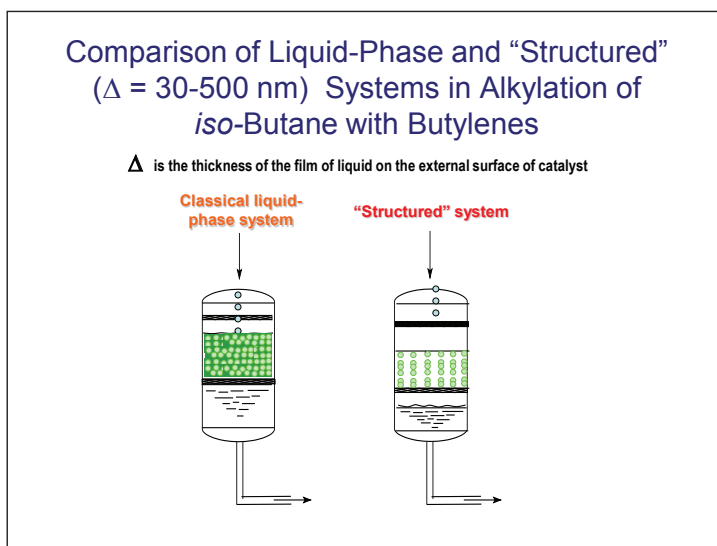


Figure 38. Comparison of Liquid-Phase and "Structured" ( $D = 30\text{-}500\text{ nm}$ ) Systems in Alkylation of *iso*-Butane with Butylenes.

**"Sustainable development implies  
meeting the needs of the present without  
compromising the ability of future  
generations to meet their own needs"**

Commission on Environment and Development

**Figure 39. Conclusion.**



# Nano-Tec in Iran: Programmes and Achievements

REZA SAJJADI

*Secretary of High Council for Promotion of Nanotec  
Iran*



**Figure 1. Topics.**



Figure 2. Background.

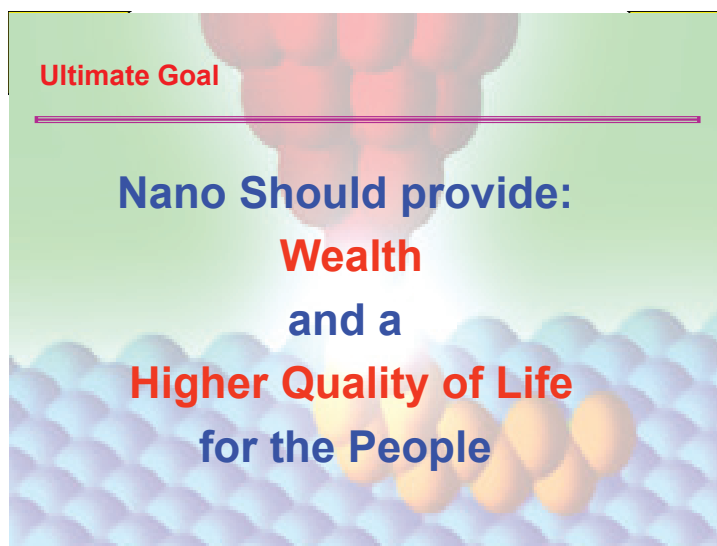


Figure 3. Ultimate Goal.



Figure 4. Policies.

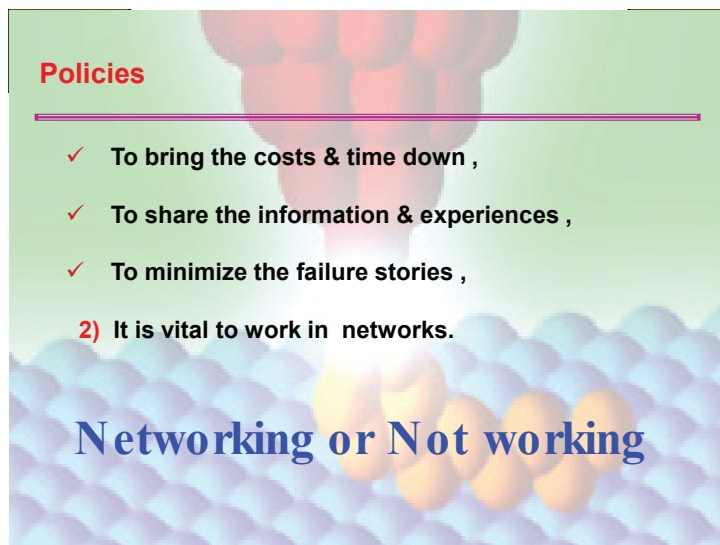


Figure 5. Policies.

## The Role of High Council

---

We should not be the engine of the Nanotech Ship. We should be the navigator :

3) **Little force and logistics , too much effect.**

- ☐ We design the strategy and the program
- ☐ We define every organisation's duty,
- ☐ We support them,
- ☐ We control them to ensure they are on the right track.

Figure 6. The Role of High Council.

## Priorities are :

---

- ☐ **Energy (oil, gas & petrochemicals)**
- ☐ **Health (DDS & Diagnostic Kits)**
- ☐ **Water Desalination & Purification**
- ☐ **Solar Cells**
- ☐ **Agricultural Products Packaging**

Figure 7. Priorities.



### **High Council for promotion of Nano**

- 1<sup>st</sup> deputy for the President of Iran
- Head of MPO
- Minister of Economy
- Minister of Health
- Minister of Industries & Mines
- Minister of Science , Research & Technology
- Minister of Oil
- Minister of Energy
- 5 Scientists & top managers
- Representative from Parliament
- Chairman of TCO ( General Secretary)

Figure 8. High Council for Promotion of Nano.

### **Nanotechnology's 10-Year Strategy**

□ Included 53 Executive Programs in 4 areas:

□ Human Resource Development

□ Infrastructure (Labs , Standards, IP , Incubators ,VC's, Tech Market, etc.)

□ Public Awareness

□ Production and Marketing

Figure 9. Nanotechnology's 10- Year Strategy.

## Human Resource Development

- 12 universities engaged in M.Sc. programs
- 5 universities running Ph.D. programs
- No. of Post Graduate Projects:
  - Ph.D. Projects: 320
  - M.S. Projects: 1900
  - World Ranking (ISI Publ). : 25
- 23 International Patents Registered

Figure 10. Human Resource Development.

## Rate of Progress in ISI Papers

| Rank | paper | year |
|------|-------|------|
| 55   | 6     | 2000 |
| 49   | 14    | 2001 |
| 47   | 27    | 2002 |
| 44   | 33    | 2003 |
| 43   | 53    | 2004 |
| 36   | 125   | 2005 |
| 32   | 250   | 2006 |
| 25   | 447   | 2007 |

Figure 11. Rate of Progress in ISI Papers.

| Paper Citations<br>(2005) |               |
|---------------------------|---------------|
|                           | Ref. to Paper |
| International Mean        | 2             |
| S.Koria                   | 2.7           |
| Iran                      | 2.2           |
| India                     | 1.8           |
| Turky                     | 1.53          |
| Russia                    | 1.24          |

Figure 12. Paper Citations (2005).

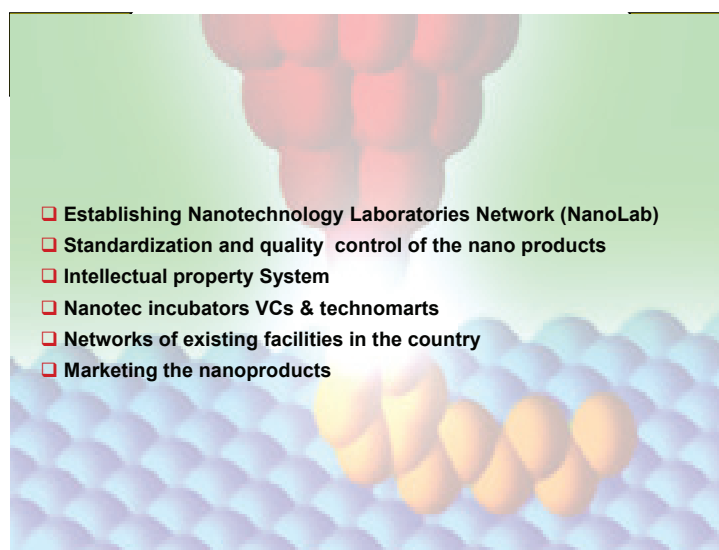


Figure 13. Strategy for Nanotechnology.



Figure 14. Nanotechnology Lab I.

**Some of the equipments of NanoLab**

| Equipment              | Number       | Equipment      | Number |
|------------------------|--------------|----------------|--------|
| XRD                    | 20           | TEM, STEM      | 14     |
| Raman                  | 3            | AFM, SPM       | 4      |
| HPLC                   | Large number | XPS ESCA, UPS  | 4      |
| FT-IR                  | 15           | AES            | 3      |
| GC-Mass                | Large number | SEM            | 20     |
| Automated DNA Analyzer | 1            | NMR (>300 MHz) | 6      |
| Confocal Microscope    | 1            | SIMS           | 2      |

Figure 15. Nanotechnology Lab II.

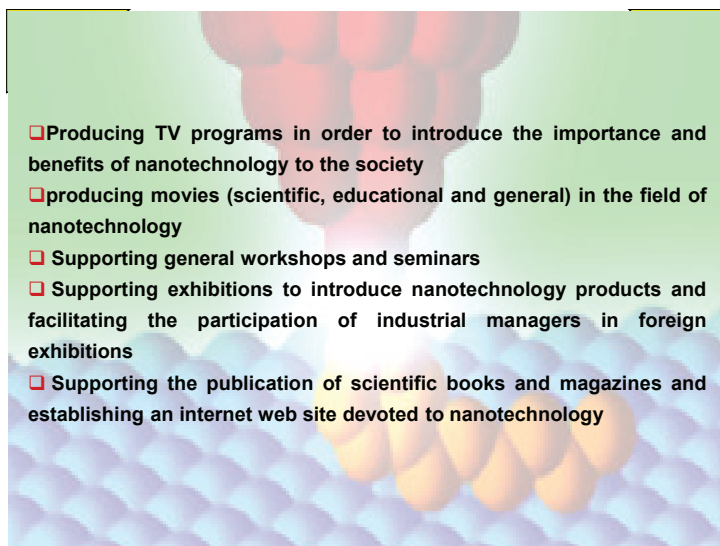


Figure 16. Nanotechnology Culture.

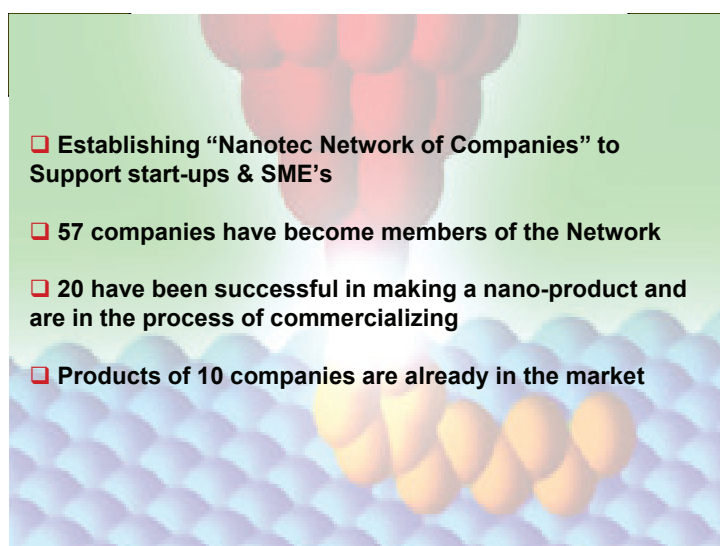


Figure 17. Nanotechnology Network.

**Parsroos Co : IMOD**

The Medicine for the treatment of aids.  
It strengthens the immunity of the body.

It is already in the  
Iranian Market




Figure 18. Nanotechnology Medicines I.

**Parsroos**

**Angi Pars**

The Medicine for the treatment of  
Diabetic Foot Ulcers

It is already in the  
Iranian Market



Figure 19. Nanotechnology Medicines II.

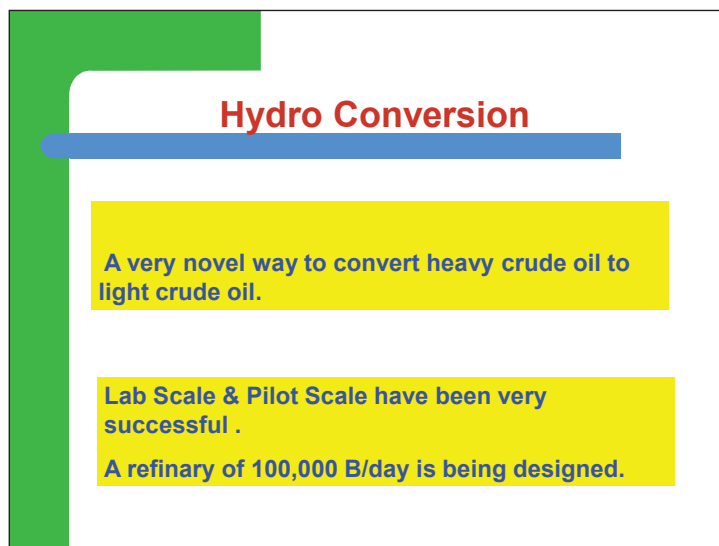


Figure 20. Nanotechnology Energy.

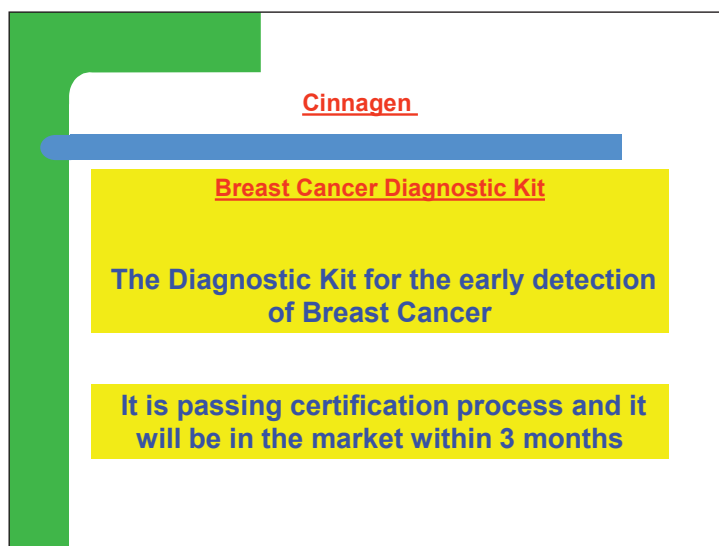
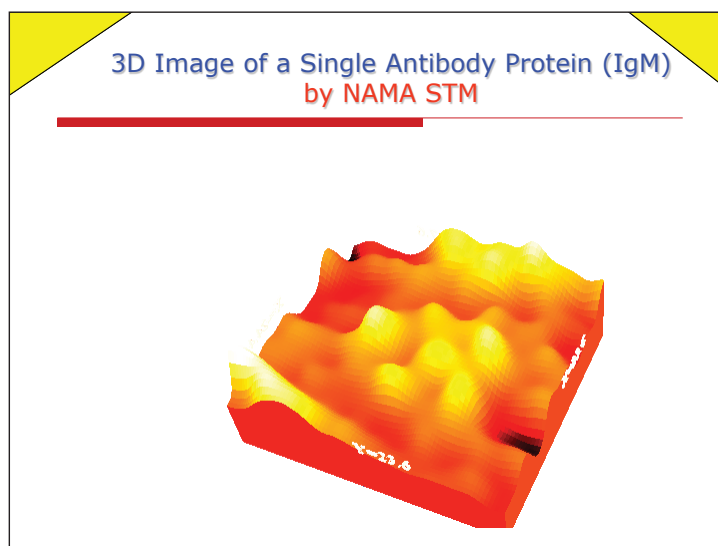
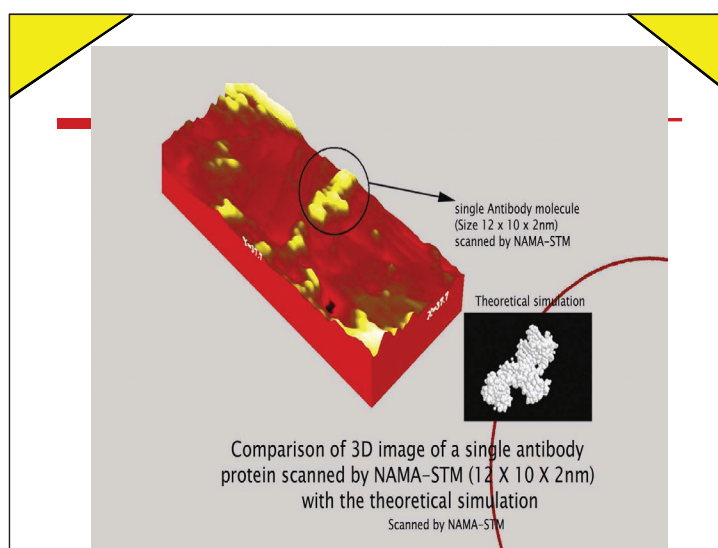


Figure 21. Cancer Detection.



**Figure 22. 3D Image of a Single Antibody Protein (IgM).**



**Figure 23. Theory vs. Practice.**



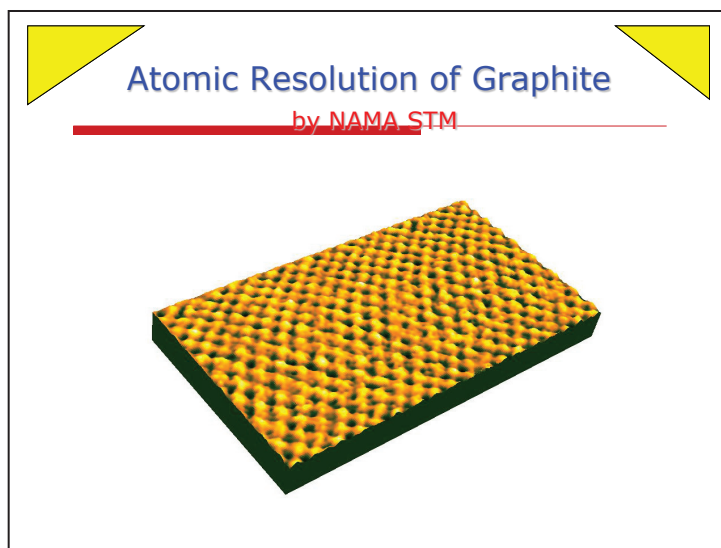


Figure 24. Atomic Resolution of Graphite.



Figure 25. Nano Carbon Tube Production 8kg/ day.

**Nano Additive for Petrol**

**An additive to decrease the consumption of petrol in the engine for at least 6%**

**It is in the market now.**

**Figure 26. Nano Additive for Petrol.**

**KAVEH FLOAT GLASS Co**

[www.kavehglass.com](http://www.kavehglass.com)

**Products:**

Nano Coating Glasses such as Low-E, Solar Control



The screenshot shows the Kaveh Float Glass Co. website. The header features the company logo and navigation links. The main content area includes a large image of a hand holding a globe with the word 'GLASS' overlaid. Below this, there is a section titled 'The Quality You Can Fully Out...' and a 'NEW MESSAGE - NEW RELATION' section at the bottom right.

**Figure 27. KAVEH FLOAT GLASS Co.**

## PARS NANO NASB Co

[www.nanocid.com](http://www.nanocid.com)

### Products:

Nano Silver in colloidal and powder forms For hygiene & AntiBacterial usages.



Figure 28. PARS NANO NASB Co.

### Nano Modified Varistors

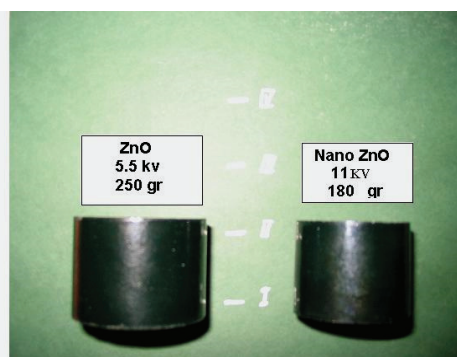


Figure 29. Nano Modified Varistors.



Figure 30. Nano Fiber Co.



Figure 31. Why Cooperate?



Figure 32. International Collaboration.

**PART FIVE**  
**SUSTAINABLE DEVELOPMENT**



# **Climate Change and its Implications for the Muslim World**

ISHFAQ AHMAD FIAS

*President, Pakistan Academy of Sciences*

*Advisor (S&T), Planning Commission*

*Pakistan*

## **1 ABSTRACT**

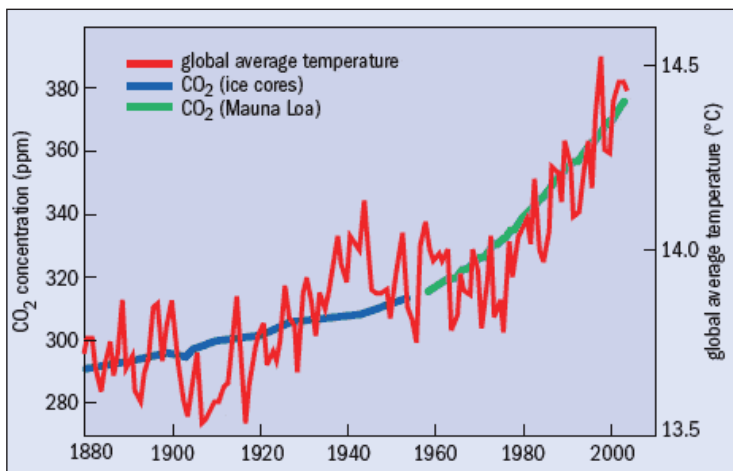
Climate Change (CC) is a serious threat to our planet. Our earth is facing a crisis due to an accelerated CC felt over the last two decades of the last century and the few years of this century. Anthropogenic activities such as burning of fossil fuels, lead to an accelerated pace of the global warming which is a direct manifestation of the CC. Impacts of CC are not uniform all over the world. Temperature increases are high in some areas and moderate to low in some other areas. The polar region in the Northern Hemisphere is observing unprecedented melting rate putting risk to coastal areas due to sea level rise. There are observational evidences that glaciers outside the polar region are also melting fast, raising concerns about availability of fresh water in valley regions. Sea surface temperature has also increased leading to an increased frequency of occurrence cyclones/hurricanes and sea storms all over the world. As the pace of CC is accelerating, scientists think that the climate system may reach a tipping point from where a return to the present conditions would be impossible. CO<sub>2</sub> continues to be pumped into the atmosphere as the Kyoto protocol was not adhered to, as per expectations. Economists are concerned that if we do not act now, the cost of CC would become more prohibitive.

Public opinion, worldwide, has been sensitized on this issue and even in the Muslim world; there is a growing concern over the issue of CC. There is a need to study the impacts of CC in the least studied regions of Muslim world spanning from the east coasts of Indonesia to the west coasts of Africa. Some countries in the Muslim world have already started national programs to study the impacts of CC. We in Pakistan have established a Global Change Impact Studies Centre (GCISC) since 2003, which is working in close collaboration with other national and international organizations. The centre has been mandated by the Government of Pakistan to study the impacts of CC on Indus valley region as we traverse through the 21<sup>st</sup> Century. In this paper, global concerns on the issue of CC are presented highlighting some of the scientific facts behind the phenomenon and the role the Islamic world can play in facing the threats of the CC along with the rest of the world. Finally, some CC projections for the geographical regions covering Muslim countries are presented.



## 2 INTRODUCTION

There is an unequivocal evidence for the accelerated pace of CC and global warming as a result of anthropogenic interventions [1]. The Industrial revolution provided the technology to use fossil fuel for energy production and transportation. This increased use of fossil fuel induced more and more man-made greenhouse gases (GHGs: CO<sub>2</sub>, Methane and Nitrous Oxide) into the atmosphere which are the main culprits of global warming. Figure 1 shows atmospheric CO<sub>2</sub> concentration pattern, having a remarkable similarity with global temperature increase pattern [2]. The influence of human activities on these foot-prints is being deepened and pronounced as more and more GHGs are pumped into the atmosphere. Although, there has been a natural variability of the climate but the influence of anthropogenic activities on global warming is more pronounced when it coincides with the positive phase of the natural variability. We have observed unprecedented high temperatures and it is evident now that warming is leading to more warming. Figure 2 shows an increasing trend of global average surface temperature since 1850 [3]. It is clear that increase in global temperature is accelerating, indicating that the global warming has a spiral effect. According to NOAA sources, the increase in global temperature is approximately 0.7° C since 1900[4].

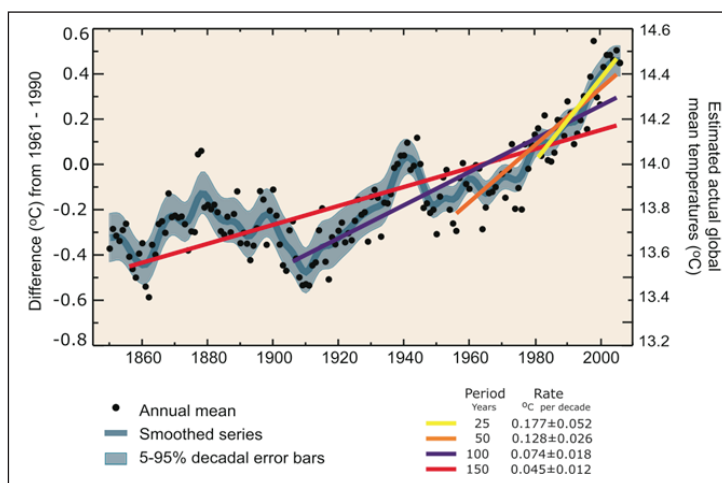


**Figure 1. Atmospheric CO<sub>2</sub> concentration and Global average temperature trends (Information on past CO<sub>2</sub> levels has been gathered from gas trapped in ice cores, and since 1958 there has been continuous monitoring of CO<sub>2</sub> levels at the Mauna Loa observatory in Hawaii. Source: <http://physicsworld.com>).**

Manifestations of CC not only come from the world wide observations of increase in temperatures of land and air but the faster rate of melting of polar ice and inland glaciers, rising sea level, increased frequency and intensity of extreme events such as hurricanes, erratic weather conditions etc. Some physical reasons of

the accelerated global warming come from the following facts: warming is melting the glaciers and ice sheets into water which has less reflectivity and absorbs more heat; oceans absorb carbon dioxide and act as sinks but as they get saturated, more and more CO<sub>2</sub> remains in the atmosphere. Further, at higher temperatures, oceans may start to release absorbed gases and cause enhanced greenhouse effect; warming leads to more evaporation from lakes and oceans leading to more clouds and water vapours in the atmosphere, which acts as a greenhouse gas. Furthermore, as land gets warmer, it emits more CO<sub>2</sub> in the atmosphere due to enhanced decay process and melting of permafrost is releasing trapped GHGs in to the atmosphere.

In the past 150 years, atmospheric CO<sub>2</sub> concentration has increased from the pre-industrial value of about 280 ppm to more than 380 ppm and is increasing at a rate of 2-3 ppm per year. It is feared that if the trends continue, we may reach a tipping point with irreversible damage to the natural eco-system and where the adaptation costs would become more prohibitive. A recent study by NASA has warned that CO<sub>2</sub> exceeding 450 ppm, is almost surely dangerous, and the ceiling may be even lower [5].



**Figure 2.** Ever increasing global warming rates since 1850 (Annual global mean temperatures (black dots) with linear fits to the data. The left hand axis shows temperature anomalies relative to the 1961 to 1990 average and the right hand axis shows estimated actual temperatures, both in °C. Linear trends are shown for the last 25 (yellow), 50 (orange), 100 (magenta) and 150 years (red). The smooth blue curve shows decadal variations, with the decadal 90% error range shown as a pale blue band about that line. The total temperature increase from the period 1850 to 1899 to the period 2001 to 2005 is  $0.76^{\circ}\text{C} \pm 0.19^{\circ}\text{C}$ , Source IPCC, 2007).

Muslim countries are not the major culprits to the GHG emissions. As shown in Table 1, the United States being the biggest polluter, followed by European Union, Russia and China. Among the Islamic world Iran, Indonesia, Saudi Arabia,

Turkey and Pakistan (in order) being the only significant emitters contribute only 2.2% (collectively) in the Global emissions as of 2002 ([http://pdf.wri.org/navigating\\_numbers\\_chapter6.pdf](http://pdf.wri.org/navigating_numbers_chapter6.pdf)). However, if we look at the emissions on per capita basis, which is an indicator of the quality of life style, we see that the Muslim countries like Qatar, Malaysia, UAE, Kuwait and Brunei come among top 10 countries of the world [6].

There is a need to reduce GHG without compromising the development process, because poverty is not only the cause of political instability, it also is a root cause of environmental degradation and instability. Although there is not much potential for GHG emission reductions among the Muslim countries, yet we should play our role in contributing towards the global mitigation efforts and to save planet Earth. We as climatologists are not against the use of fossil fuel as the economies of certain countries depend upon fossil fuel, but there is a need to prolong the use of natural resources and leave a due share of natural resources for future generations. Simultaneously, we should invest more for the development of alternate energy resources which are more eco-friendly and carbon free. Nuclear as well as Hydro can be considered as alternate energy resources along with solar, wind and geothermal etc.

Public opinion on the issue of CC has been sensitized by various initiatives taken e.g. by the former US Vice President Al Gore, who authored a book [7] and an Oscar award winning documentary “An Inconvenient Truth” on this issue [8]. In recognition of such efforts, Nobel Peace Prize-2007 has been awarded jointly to Al Gore and the Intergovernmental Panel on Climate Change (IPCC) [9].

**Table 1. Cumulative CO2 Emissions, 1850–2002**

| Country            | % of World | Rank | Country                         | % of World | Rank |
|--------------------|------------|------|---------------------------------|------------|------|
| United States      | 29.3       | 1    | South Africa                    | 1.2        | 14   |
| EU-25              | 26.5       | 2    | Australia                       | 1.1        | 15   |
| Russia             | 8.1        | 3    | Mexico                          | 1          | 16   |
| China              | 7.6        | 4    | Spain                           | 0.9        | 20   |
| Germany            | 7.3        | 5    | Brazil                          | 0.8        | 22   |
| UK                 | 6.3        | 6    | South Korea                     | 0.8        | 23   |
| Japan              | 4.1        | 7    | Iran                            | 0.6        | 24   |
| France             | 2.9        | 8    | Indonesia                       | 0.5        | 27   |
| India              | 2.2        | 9    | Saudi Arabia                    | 0.5        | 28   |
| Ukraine            | 2.2        | 10   | Argentina                       | 0.5        | 29   |
| Canada             | 2.1        | 11   | Turkey                          | 0.4        | 31   |
| Poland             | 2.1        | 12   | Pakistan                        | 0.2        | 48   |
| Italy              | 1.6        | 13   | <b>Developed 76 % of World</b>  |            |      |
| Source: WRI, CAIT. |            |      | <b>Developing 24 % of World</b> |            |      |

### 3 IMPACT OF CLIMATE CHANGE

The meteorological impact of CC can be divided into distinct categories; 1) Due to slow climate processes such as sea-level rise, salinization of agricultural land, desertification and growing water scarcity; 2) Rapid climate events such as flooding, storms and glacial lake outburst floods; and 3) Social processes such as government policy, population growth and community-level resilience to natural disaster.

Among the slow processes, sea level rise and coastal flooding alone may have very pronounced impacts. It has a potential to displace as much as 200 million people by 2050 from their native lands and force them to be called climate refugees/evacuees or climate migrants [10]. Global average sea level, after accounting for coastal land uplift and subsidence, is projected to rise between 17 - 29 cm by 2050 (depending on the model and scenario used). The area of coastal wetlands is projected to decrease as a result of sea level rise. Emphasis has been put on the fact that current carrying capacity of large parts of the world, i.e. the ability of different ecosystems to provide food, water and shelter for human populations, will be compromised by CC.

According to IPCC (2007), by 2099, the world is expected to be on average between 1.8°C and 4°C hotter than it is now. Large areas are expected to become drier—the proportion of land in constant drought is expected to increase from 2 % to 10 % by 2050. Meanwhile, the proportion of land suffering extreme drought is predicted to increase from 1 % at present to 30 % by the end of the 21<sup>st</sup> century. Rainfall patterns will change as the hydrological cycle becomes more intense. In some places, this means that rain will be more likely to wash away top-soil and cause flooding. Changed rainfall patterns and a more intense hydrological cycle mean that extreme weather events such as droughts, storms and floods are expected to become increasingly frequent and severe. Although the IPCC projections are based on the results of global models, which tend to obscure smaller-scale regional effects, the AR4 raised fears that storm activity in the eastern Mediterranean would decline this century if global warming continues on present trends. In turn, that would have reduced rainfall by between 15 and 25 % over a large part of the so-called Fertile Crescent. This is land encompassing parts of Turkey, Syria, Jordan, northern Iraq, and north-eastern Iran and the strategically important headwaters of the Tigris and Euphrates rivers. About 170,000 square kilometres of viable rain-fed agricultural land would be lost; a longer dry season would limit grazing on rangelands; and changes in the timing of maximum rainfall would force farmers in northern Iran to change cropping strategies and even crop types.

Less rain would have particularly serious impacts for sub-Saharan African agriculture which is largely rain-fed. Crop yields from rain-fed agriculture could fall by up to 50 % by 2020. Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change (Figure 3). Millions more are vulnerable in Africa,

particularly around the Nile Delta and along the west coast of Africa. Changed patterns of rainfall would have particularly serious impacts for food security in sub-Saharan Africa (Hoerling, 2006). Nigeria has been reported to be turning into desert every year, making desertification the country's leading problem. As the desert advances, farmers and herdsman are forced to move, either squeezing into the shrinking area of habitable lands or forced into the already overcrowded cities. It is also believed that the current crisis in Darfur has its origins in the extended drought that brought pastoralists into competition with farmers.

Glacier melt in the Himalayas is projected to increase flooding, and rock avalanches from destabilized slopes, and to affect water resources within the next two to three decades, followed by decreased river flows. Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease. It is projected that crop yields could decrease up to 30% in Central and South Asia by the mid-21st century (Figure 4). Taken together and considering the influence of rapid population growth and urbanization, the risk of hunger is projected to remain very high in several countries. Endemic morbidity and mortality due to diarrhoea primarily associated with floods and droughts are expected to rise in due to projected changes in the hydrological cycle associated with global warming. Meanwhile, melting glaciers will increase the risk of flooding during the wet season and reduce dry-season water supplies to one-sixth of the world's population particularly in the Indian sub-continent. Melting glaciers will increase the risk of glacial lake outburst floods in the mountainous regions of the continent. The crops yield in central and south Asia could fall by 30 % by the middle of the 21<sup>st</sup> century. Some fish stocks will migrate towards the poles and colder waters, and may deplete as surface water run-off and higher sea temperatures lead to more frequent hazardous algal blooms and coral bleaching.

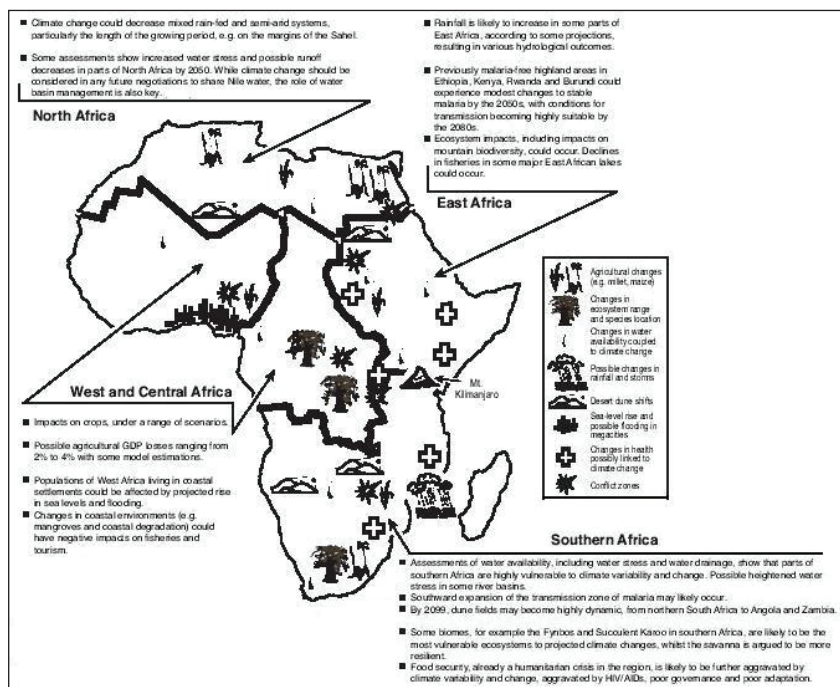
Small island states around the world are particularly vulnerable to sea level rise because in many cases (the Bahamas, Kiribati, the Maldives and the Marshall Islands) much of their land is less than three or four metres above present sea level (11).

On a national level sea level rise could have serious implications for food security and economic growth. This is a particular concern in countries that have a large part of their industrial capacity under the "one metre" zone. Bangladesh's Gangetic plain and the Nile Delta in Egypt, which are breadbaskets for both countries, are two such examples. Egypt's Nile Delta is one of the most densely populated areas of the world and is extremely vulnerable to sea level rise. A rise of just 1 metre would displace at least 6 million people and flood 4,500 km<sup>2</sup> of farmland.

CC is predicted to worsen a variety of health problems leading to more widespread malnutrition and diarrhoeal diseases, and altered distribution of some vectors of disease transmission such as the malarial mosquito.

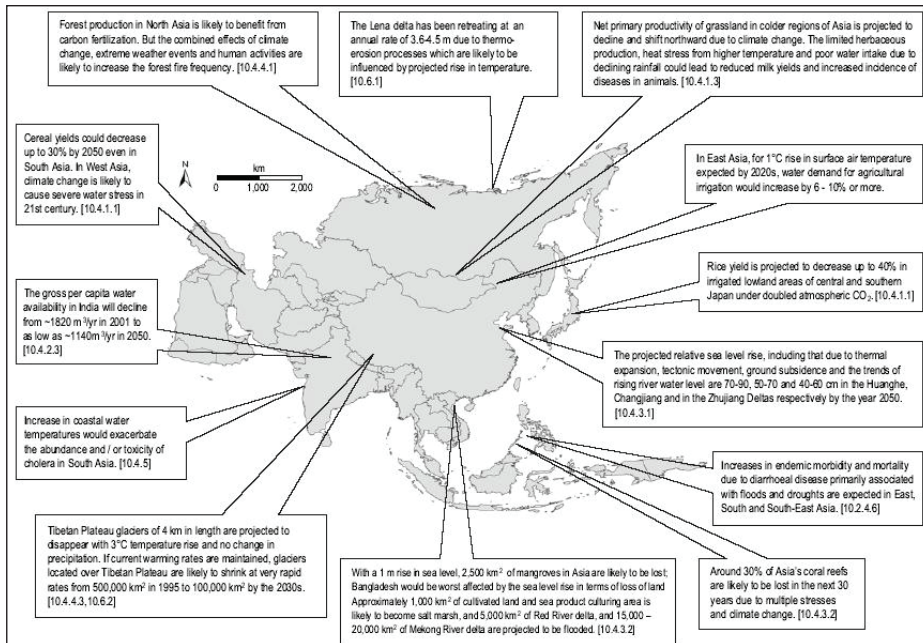
According to the Stern report [12] on the economic impacts of CC, about 1 to 4 billion people would suffer water shortages and 150 to 550 additional million people would be at risk of hunger. Millions of people would be temporarily

displaced by extreme weather events. South and East Asia are particularly vulnerable to large-scale forced migration. This is because sea level rise will have a disproportionate effect on their large populations living in low-lying areas of the Asia's big cities (including Jakarta, Mumbai and Karachi) which are located on the coasts.

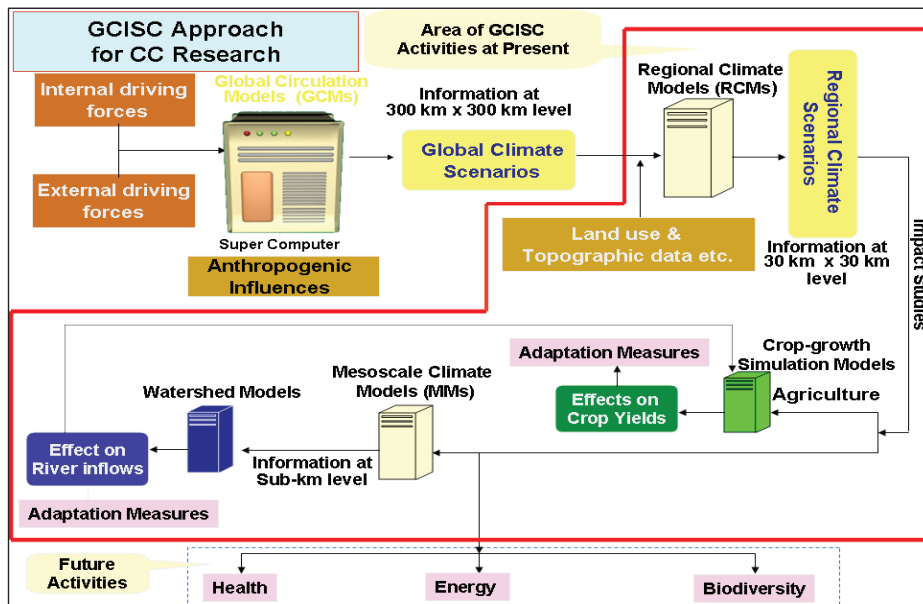


**Figure 3. Climate Change Impact on Africa.**  
(Source: IPCC, 2007).





**Figure 4. Climate Change Impact on Asia.**  
(Source: IPCC, 2007).



**Figure 5. Methodological approach adopted by GCISC.**

## 4 ADAPTATION TO CLIMATE CHANGE

Different regions, countries and communities have very different adaptive capacities to CC [13]. For example, the pastoralist groups in the Sahel are socially, culturally and technically equipped to deal with a different range of natural hazards than, say, mountain dwellers in the Himalayan region. National and individual wealth is one clear determinant of vulnerability – enabling better disaster risk reduction, disaster education and speedier responses. On a national scale, Bangladesh has very different adaptive capacities and disaster resilience to the United States. In April 1991, Tropical Cyclone Gorky hit the Chittagong district of south-eastern Bangladesh. Winds of up to 260 kilometres per hour and a six-metre high storm surge battered much of the country killing at least 138,000 people and leaving as many as 10 million people homeless. The following year in August 1992, a stronger storm, the category five Hurricane Andrew, hit Florida and Louisiana with winds of 280 kilometres per hour and a 5.2-metre storm surge. While it left US\$ 43 billion in damages in its wake, it caused only 65 deaths. The 2004 Asian Tsunami, for example, killed more than 200,000 people and displaced twice as many. The 1998 monsoon floods in Bangladesh brought some of the worst flooding in living memory, inundating two-thirds of the country for two months, devastating its infrastructure and agricultural base and leading to fears about the country's long-term future in a world of higher ocean levels and more intense cyclones. The floods left an estimated 21 million people homeless.

UNFCCC has supported the development of National Adaptation Programmes of Action (NAPA) which are supposed to help LDCs identify and rank their priorities for adaptation to CC (UNFPA, 2006). These countries include Bangladesh, Bhutan, Burundi, Cambodia, Comoros, Djibouti, Haiti, Kiribati, Madagascar, Malawi, Mauritania, Niger, Samoa and Senegal.

Development and adaptation policies in potential source countries need to focus on reducing people's vulnerability to CC, moving people away from marginal areas and supporting livelihoods that are more resilient. In particular, more efficient use of existing resources would offset some of the predicted impacts of CC. In Pakistan, for example, irrigated agriculture uses 85 % of the country's fresh water supply but leakage and evaporation means that it is only 50 to 65 % efficient.

According to UN sources, the global population is currently growing at a rate of 1.1 % per year and is predicted to reach 9.075 billion by 2050 (from its 2005 level of 6.54 billion). Meanwhile, there is an accelerating move to urban areas. Already 49 % of the world's population live in cities, and the growth rate of the urban population is nearly double (2%) that of total population growth [14]. These trends are especially pronounced in low and middle-income countries. Between 2005 and 2010, Burundi, for example, is expected to have a population growth rate of 3.7 % and an urban growth rate of 6.8 %. Meanwhile, the Sahelian region of northern Nigeria, perhaps the area of the country most susceptible to CC, is already characterized by high population growth (about 3.1%) and rapid



urbanization (about 7%). If the current trends continue, the adaptation potential of most vulnerable countries would further reduce.

## **5 CLIMATE CHANGE RESEARCH IN PAKISTAN**

In order to pursue a systemic research on the assessment of CC and its impacts on food and water security of Pakistan, Global Change Impact Studies Centre (GCISC) was created in 2003 in Islamabad. Since the creation of the centre, the CC issue has been sensitized among policy makers, government ministries and departments and the general public. Pakistan Academy of Sciences (PAS) has also started work in the area of CC. The Prime Minister has constituted a high level ministerial committee on CC to review and access the progress made by GCISC and provide policy guidelines for research and activities of the Centre. The methodological approach adopted by GCISC is given in Figure 5.

The research conducted by GCISC is published in peer reviewed journals [15] and also as technical reports and policy documents for the government. Some adaptation options for Pakistan as recommended by GCISC are given below:

- Alteration in planting dates of crops to evade harmful effects of high/low temperatures.;
- Development of new crop varieties, heat tolerant, short duration and drought resistant;
- Rain water harvesting ;
- Efficient use of available amounts of water through high efficiency irrigation methods, e.g. Drip, Sprinkler irrigation;
- Development of new water reservoirs, and increasing the capacity of existing reservoirs; and
- Crop insurance.

## **6 CONCLUSION**

CC is a real issue and needs scholarly attention from the entire Globe including the Muslim world, to face its challenges. We should improve our understanding of the CC phenomena and bring this issue to the lime-light among our policy makers, government organizations, NGOs and the public.

CC has become more of an ethical issue than a purely scientific issue, because those who emit more are not those who suffer more. The poor has to pay more the price of CC in terms of more suffering from the negative impacts of CC.

Although Muslim countries have little mitigation potential, they need to adapt to CC to minimize the negative impact. We should enhance our capability to adapt to the changing climate.

We should formulate a Muslim strategy to face the issue of CC. Coordinated efforts need to be done to enhance our adaptation capacity and we should meet more frequently to review our progress. The forum of Islamic World Academy of Sciences (IAS) may be used for this purpose.

## **7 ACKNOWLEDGEMENT**

The support provided by Dr Shoaib Raza of PIEAS and Mr Nisar Ahmad of COMSATS in preparation of this paper is acknowledged.

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# **Environmental Aspects of Sustainable Development in Central Asia**

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Step-by-step switch to sustainable development while maintaining the quality of the natural environment indefinitely and rationally using nature, is one of the strategic objectives of the world society. In a number of countries of arid zone, where some severe ecological processes have occurred, the local population suffers from poverty, hunger and disease. For prevention, the complications in the system 'Human–Nature, it is necessary for decision makers of all scales to follow the modern concepts in sustainable development.

One of the most catastrophic environmental occurrences has been the desert invasion which undermined the economy and social sphere of the countries of Sudan-Sahel zone in 1968-1974 in Africa. More than 30% of the territory of arid lands became desert.

Central Asian countries, such as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan which are geographically located at the meeting point of Europe and Asia between 35-55 degrees of latitude north and 48-87 degrees of longitude east of the equator cover about 4 million square km. Their total population is around 57 million and the density of population is 15 people per square km. Central Asia represents a united region which is interrelated naturally and historically. As it is situated in the buffer zone between the countries of Eastern Europe and Western Asia, historically, it was closely exposed to their political, economic and cultural influence. The Silk Route had passed through this region playing the role of the main link.

Central Asia covers the huge Turanium inland cavity, where Aral Sea, Caspian Sea and Lake Balkhash are located in its lowest parts. Here climatic and landscape zones alternate with each other, they are different in genesis and natural structure. The territory of Central Asia is mainly covered by deserts and semi-deserts; it is connected with its inland secluded geographical location.

Central Asia has rich mineral raw material resources, especially oil and natural gas and their output and export increases year by year.

The nature in Central Asia is a unique biological diversity. Here one can find more than 7000 sorts of higher plants, 900 sorts of vertebrates and more than 200 thousand sorts of invertebrates.

Agricultural lands account for more than 300 million hectares where ploughed field constitute more than 40 million hectares including 10 million hectares of irrigated area. Hayfields and pastures take 220 million hectares.

Central Asia is an ancient center of irrigated farming, where for many centuries people cultivated fine-stapled sorts of cotton, cereals, vegetables, melons and grapes. That is why in arid conditions of the region the sweet water has primary importance and it is the main factor of sustainable development. Although the increasing lack of fresh water resources connected with permanently rising demand and wasting arouses serious anxiety. Water pollution is another side of this problem. The water reservoirs are systematically polluted by dumping manifold drainage effluent and sewage. The existing water usage technology has hang-the-expense approach and result has been the loss of large volumes of water in hydro-engineering system and irrigated fields; the water saving technologies are applied very slowly in the irrigated farming, industry and municipal economy. The unit discharge of water for irrigating is still 15000 cubic meters per hectare and the coefficient of efficiency is 0.55-0.60. The annual volume of manifold drainage effluent is up to 20 cubic kilometers, and it is dumped to the rivers and grazing lands.

Rapid population upsurge, expansion of irrigated areas and industrial development require additional water resources that are not found in this region. Considering the fact that more than 90% of agricultural output in Central Asia is produced due to the irrigated farming, it becomes obvious that the lack of water resources puts the food safety of the region under threat. So the only way out of the situation lies in stopping the expansion of irrigated areas, decreasing today's rates of water usage, turning as soon as possible to new water saving technology and increasing the crop capacity of every irrigated hectare. Otherwise it will be necessary to return to the issue on transferring part of the water courses of Siberian rivers to Central Asia in order to top up the local water resources, and renew the research and design works which were interrupted in 1986.

In trying to find solutions to the problems of sustainable development, the main part is taken by environmental safety. Basically there is no natural landscape in Central Asia that is not touched by mankind. So all the sorts of landscapes of the region with no exception are influenced by anthropogenic factors to a variable degree – irrigation, mowing, pasture, poaching, building industrial plants, roads and pipe lines, transmission and communication facilities, mining operations, settlement and urban services.

Large-scale development of irrigated farming started in 60s-70s and that required a lot of water from Amu-Darya and Syr-Darya which resulted in an ecocatastrophe situation in the basin of Aral Sea. The water-level in the Aral Sea (with the area of 68,000 square km) went down by 22 m. and its area of water decreased to one-quarter of its original size, the water volume decreased from 1064 to 115 cubic km and salinity reached 72 grams per liter. More than 40 million hectares of the dried bottom of the sea is today a giant source of dusty and saline aerosols. The natural cycles of the ecosystem has changed and the

economy and public health has been strongly undermined.

If the process of desertification in the Aral zone continues in the current rate, no doubt, in 20-25 years the dried sea bottom will become an epicenter forming storms of salt dust with negative consequences.

Over thousands years of using the natural resources, mankind was aiming at benefiting as much as possible, with no sense of the consequences. This phenomenon must be changed if we think of the future generations. It is necessary to keep the balance of using natural resources and providing normal functioning of all elements of natural environment in general. At the same time the priority must be given to keeping the renewable functions of the components of the ecosystem strictly limiting the rates and volumes of using the natural resources. However it may be difficult for modern economy, it is necessary not only to weaken the advance but sometimes to act in a manner of retreat.

From this point of view the common sense suggests that averting the misallocation further, undoubtedly will be conducive to the anticipatory development of resource-saving technology and will lead to balancing the natural system.

In Central Asia, as a rule, administrative and territorial boundaries do not coincide with natural-environmental coverage. That is why the key role in the formation of the united Central-Asian geo-economic space must be taken by the trans-boundary territories. Mutual adaptation of territorial-economic structures of contiguous contacting areas based on the regional system of production infrastructure, having in sight creation of different forms of free economic zones, doubtlessly will contribute the sustainable socioeconomic development of Central-Asian countries.

In 1993, the International Foundation for Saving Aral (MFSA) was founded. It has played a positive role in joint resolution of a number of important environmental and socioeconomic problems. However later, its activity has been weakened and its judgments have become declaratory in character.

As the water and land resources have special importance for the economy of the region the intensity and efficiency of using them are becoming key activities not only for sustainability but also for socioeconomic safety in general. But for all that, we have to thoroughly elaborate the water usage standards before starting the Program of Sustainable Development. At the same time in order to put correctly the water intake standards for irrigation and washing the saline soil it is necessary to elaborate the land register of the whole region and estimation standards of the lands territorial distance from water-mains. This allows to define the difference between their dislocation with appropriate coefficients.

Central Asia has reached particular success in macroeconomic stabilization and creation of conditions for economic growth. It has managed to stop the production fall, to decrease the rate of inflation, to increase the investments and keep the budget deficits at low level. A tendency of ecological stabilization has been outlined despite the fact that the anthropogenic load on the environment has not decreased.



To reach the aims of environmental policy of Central Asian countries, it is necessary to develop the economic tool of nature management and to identify appropriate tools that are efficient for both economy and ecology.

In order to develop the collaboration within the Central Asian region to address the environmental trans-boundary problems such as: Aral Sea dry out and desertification of Aral Region; biosphere degradation; protection and usage of trans-boundary waterways; waste processing, utilization and consumption, it is necessary to speed up the implementation of the Regional Program of Activities for Environmental Protection.

It should be noted that recently understanding the concept of environmental balanced development and the necessity of combining efforts in intergovernmental integration field significantly has risen. However even now the countries of Central Asian region are lacking in political will in terms of trying to find the sense and desire for reaching an efficient regional integration, and the necessity of mutually beneficial distribution of natural, financial and labor resources for achievement of final goals of the sustainable development. In this area it is necessary to develop new conceptual and methodological approaches. To start the coordinated activities in integration we should define sharply the principles of indicators and criteria at national and then at regional levels, that would allow us to control the process of ecologically balanced sustainable development and the improvement of the common good.

# Islam and Conservation of Nature

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## 1 ABSTRACT

There is no doubt that the contemporary age is witnessing an “Environmental Catastrophe.” While we are confronted with global threats as a result of this catastrophe, about US\$1000 billion are spent every year to support military activities. Ten days’ expenditure on armaments can abolish hunger on this planet.

At the very moment, we are spending billions of US Dollars, millions of children go to sleep hungry, their bodies stunted, their minds distorted by malnutrition and lack of medical care.

Citizens of the earth are consuming too much natural resources, discharging high amounts of waste and hazardous materials, abusing soils, forests, rivers and seas, killing wild animals, and injuring our planet in many ways.

## 2 PREVAILING HUMAN VALUES

Our human values are the root for all these direct causes of threat to the globe. The anthropocentricity of modern civilization has now reached neurotic proportions.

Certainly, values prevailing among people are decisive in shaping the basic attitudes in our lives, greatly affecting how we appreciate situations and take decisions that have threatened the lives of human beings. We should understand that life is not only maintained within the environment, but by the environment and in interaction with it.

It appears that human behaviour, and what governs that behaviour in terms of values, ethics and virtues, would definitely control the relation between man and the environment.

Therefore, any behavioural deviation from the sound innate path would constitute a relation that is quite detrimental to the nature or the environment and its components, making life more difficult.

\* Prof. Batanouny passed away in 2011.

### 3 WHAT IS ISLAM?

‘Islam’ is an Arabic word and connotes submission, surrender, and obedience. As a religion, Islam stands for complete submission and obedience to Allah and only to Him- and that is why it is called ‘ISLAM’

Islam, the last heavenly religion, and the Islamic Law embody numerous injunctions, which are directly related to the care of the environment and the conservation of nature. The essence of Islamic beliefs represents core values for the environmental ethics.

### 4 ISLAM AND THE CREATURES

We, human beings, live in an orderly universe. There is law and order among all the units that comprise this universe. From the little whirling electron to the mighty nebulae, and from the small organelles of any cell to the heart and the brain are governed by the laws prescribed for them in accordance with an unalterable law of Allah. This means that everything in the universe obeys God by submission to His laws. They behave ‘Muslim.’ Even a man who refuses to believe in Allah has perforce to be a ‘Muslim’ as far as his bodily existence is concerned.

All creatures, except man, are obedient to the ‘environmental laws.’ Islam highlights this fact; for all creatures behave in a constant code ordained by the Almighty. Man is the only creature that has the choice of spoiling or enhancing his relation with nature.

There is an emphasis on Justice in Islam. Environmental abuse and/or its destruction are a form of injustice.

### 5 ISLAMIC PRINCIPLES AND VALUES

The scientists of the so-called ‘Deep Ecology’ hold that each living organism has a value within its ecosystem; and that it has the right to existence in its place. It is the same concept of Islam.

Man has been endowed with countless powers and faculties. The success of his life depends upon the proper use of these powers for the fulfilment of his needs and requirements.

A fundamental principle of Islam is that:

*Man has the right to make use of all what have been harnessed to him in a way that does not jeopardise the interests of other people or cause harm to their strivings towards the fulfilment of their rights and duties.*

It is a pity that we, Earth’s inhabitants, are unable, or at least uninterested, to find mechanisms to control and manage our activities that are detrimental to the environment and the natural resources, or to avoid conflict between the various

countries, religions, ethnical and social groups and political systems.

The pillars of Islam and its ethics are based on the concept of equity and benevolence, which governs all human relations. Islam focuses on the so-called 'environmental equity', by which we mean the soundness and development of the environment coupled with economic and social justice. It therefore denotes well-being for all people on Earth.

Muslims believe in the universality of peace. This entails that Muslims be concerned with the affairs of the world, i.e. calling for protection of the environment, conserving nature, combating desertification, and controlling world environmental threats, e.g. Climate change, should be one of their tasks on Earth.

## 6 FAITH '*DIN*' & CODE OF CONDUCT '*SHARI'AH*' IN ISLAM

Islam has two main components: The faith and the conduct. *Faith* in Allah with all His attributes: faith in the Day of Judgment, faith in the Prophets and the Holy Books and to live a life of obedience and submission to Allah. This is the '*Din*.' It is clear that it is common to the teachings of all the Prophets.

*Shari'ah* (the juristic rules or the Law of Islam) is the detailed code of conduct or the canons comprising ways and modes of worship, standards of morals and life, laws that allow and prescribe that judge between right and wrong. *Ibn Qayem Aljawziah*, a prominent Islamic scholar, says:

'Shari'ah is built and founded on justice, satisfying the interests of people in terms of living and towards fulfilment in preparation for the Day of Reckoning. All over, Shari'ah is justice, mercy, interests and wisdom. Each matter that diverts from justice to injustice, from mercy to cruelty, from interest to damage, from wisdom to imprudence should be considered as outside the realm of Shari'ah, even if it does so by virtue of interpretation.'

The major sources of the Islamic Shari'ah are the Qur'an, which is a divine revelation and the Hadith, which is collection of the instructions issued or the memoirs of the Prophet's conduct and behaviour.

Shari'ah gives priority to the well-being of humans and their good life. It gives them freedom, a freedom to which responsibility is attached. It is not justifiable to destroy common resources for the interests of specific group of individuals; neither is it acceptable to spoil an arable land nor to cause deterioration of the ecosystems such as rivers, seas and forests.

Man is not a mere 'economic animal,' but each individual has the right of life, to live a serene and tranquil life. This right gets priority over economic freedom, which is usually stained by selfishness and domination.

The needs or interests that compel man to exploit the environmental components can be divided in the Shari'ah as follows:

1. Basic needs: without which life is impossible;
2. Normal needs we require in seeking rest, ameliorating pain and disturbances and in enhancing our life quality; and

3. Complementary needs, which are sought by man in order to satisfy his desire or to immerse in pleasures.

By applying the Islamic codes in dealing with these needs, we would certainly behave in a merciful manner toward the environment; that is, without destroying its components. Islam urges for avoidance of depletion of the natural resources: evading exploitation of such resources in a way that exceeds their capacity to regenerate and rejuvenate, or forestalling activities that have adverse impacts on the environment or the natural resources.

## **7 RIGHTS AND COMMITMENTS (OBLIGATIONS) IN THE SHARI'AH**

Islamic legislation gives man the right to benefit from the environment and its resources. But, prior to that, comes the obligation. In this respect, man's regency on Earth is a responsibility; for man is a regent designated to develop and promote what he has been mandated to a regent for.

The Islamic Law (Shari'ah) embodies numerous injunctions, which are directly related to the care of the environment and conservation of its components. The essence of Islamic beliefs represents core values for the environmental ethics.

The Islamic way of life, as given by the law of Islam (Shari'ah), is controlled by set of rights and commitments. The Law of Islam imposes four kinds of rights upon every man; these are the corner stone of Islam:

1. The Creator's rights, including faith, monotheism, and worshipping;
2. One's own rights, for each person has rights towards himself/herself. This is established by the fundamental Islamic principle "There are rights upon you to your-self." Islam forbids resorting or accepting self-persecution; and in the meantime selfishness and hedonism are forbidden;
3. The rights of others and the society; Man is forbidden from encroaching upon the rights of others; and
4. The rights of all creatures and those powers and resources, which Allah has placed in his service and have empowered him to use for his needs.

## **8 THE RIGHTS OF ALL CREATURES UPON MAN**

A well-recognized Islamic value is that man should not waste the resources on fruitless ventures nor should he unnecessarily hurt them or harm them. When he uses them for his service he should cause them the least possible harm, and should employ the best and the least injurious methods of using them.

Islam calls for the conservation of resources and their development on the basis of a balanced equilibrium in all relations with people and nature pointing out to basic Islamic principle of "Neither hurt nor be harmed."

Below are some injunctions of Islam relevant to the rights of creatures:

1. It is forbidden to kill animals merely for fun or sport and deprive them from their lives without necessity;
2. Killing an animal by causing continuous pain and injury is considered abominable in Islam;
3. Islam allows the killing of dangerous and venomous animals and of beasts of prey only because Islam values man's life more than theirs. But here too, it does not allow their killing by resort to prolonged painful methods;
4. Catching birds and imprisoning them in cages without any special purpose is considered abominable;
5. Islam does not approve the useless cutting of trees and bushes;
6. Islam does not allow the waste of lifeless things; and
7. Polluting the natural resources is forbidden.

## **9 SHARI'AH RULES: CODES OF ISLAMIC LAW AND DEVELOPMENT**

The Shari'ah or the juristic rules conform to keeping the life of human beings and the other creatures in balance. These general juristic rules, inferred from Qur'an and Sunnah (conduct of the Prophet, PBUH), which can be applied to the conservation of the environment and the natural resources.

These include:

1. 'Prevention of damage takes preference over the achievement of interests or fulfilment of needs;'
2. Prevention of damage should get priority over fetching of interests;
3. 'All false excuses leading to damage should be repudiated;'
4. 'If two evils conflict, choose the lesser evil to prevent bigger evil;'
5. 'Resort to alternatives, when the originals become undesirable, the least of evils and the lightest of damages should be selected;'
6. 'No damage can be put right by a similar (equivalent) or a greater damage;'
7. Incurring a special damage to avert a public damage;
8. 'The severest of damages should be removed by the slightest one.'

## **10 THE HOLY *QUR'AN* AND THE HUMAN LIFE**

The Holy *Qur'an*, the sacred book of Islam, deals with a vast variety of subjects, which affect man's life. It deals not only with the ways of devotion, with the forms of worship of *Allah*, with the means which make men attain communion with Allah, but also, and in richer details with the problems of the world around us.

Questions of relations between man and his social and political life, institutions of marriage, divorce and inheritance, the division of wealth and the relation between labour and capital, the administration of justice, peace and war, national finance, debt and contracts, laws for the poor, rules for the service of

humanity, the orphan and the widow and hundreds of other questions, the proper understanding of which enables man to lead a happy life.

### **10.1 Role of Man on the Earth from the Islamic point of view**

Man has been granted inheritance on earth to manage and utilize the Earth for his benefit, and for his interests. From the Islamic point of view, man has to keep, maintain and preserve the earth honestly. He is only a mere manager of the earth and not a proprietor, beneficiary and not a disposer or ordainer.

Man should have the role of a custodian and guardian of the earth. He is the vice-regent or *khalifa* on the earth.

### **10.2 Islam and Sustainable Development**

Sustainability is now the guiding motto, entering the vocabulary all over the world. One can state that within this issue, we have rhetorical surplus and an ethical deficit.

Shari'ah confirms the rights of future generations, conserving them and forbidding any damage to them by way of causing environmental deterioration, natural resources depletion, or indifferent pollution.

By turning to sustainable development and taking into consideration the future generation, we are adopting an ethical shift. This is not a mere technological or financial investment, but a value shift in terms of taking natural resources as valuable in themselves as well as functional for sustainability of life. Their values are not just their potential to be inputs for the grinding machine of the economic growth.

Religions and ethics incorporated within their injunctions must guide us to reshape and transform the political structures and mechanisms attempting to chart our future.

Inhabitation of Earth as one end for creating man cannot be achieved except with sustainable development. This could be exemplified by this statement:

‘On Doomsday, if anyone has palm shoot in his hand, he should plant it.’

## **11 ISLAM AND CONSERVATION OF BIODIVERSITY: NOAH’S ARC**

### **11.1 Noah Principle**

Every species in nature has a right to continue to live on the earth. In the Qur'an, as in the other heavenly books, the first Divine lesson for humanity pertaining to conservation of biodiversity was the order Allah gave to Noah, Peace be upon him, to take into his boat two pairs of every species. This was a precaution against possible extinction that might happen due to the flood. It was a lesson for

conservation of creatures. That is why scientists nowadays refer to conservation of biodiversity as 'Noah principle.'

### **11.2 Codes of Islamic Law and the role of Man in the Islamic Society:**

Being a member of the big human family, a Muslim is entitled to enjoy the common benefits as he is enjoined to share the common responsibilities. He is responsible for the common welfare and prosperity of his society. A Muslim is enjoined to play an active part in the establishment of sound social morals by way of inviting to the good and combating the evil in any form with all lawful means at his disposal. All these rules and injunctions related to the social life of Muslims plant values among the individuals of the Muslim society, which are reflected upon the ethics prevailing in the society.

Respect of life, modesty, solidarity, altruism, equity, tolerance and democracy are fundamental values in Islam.

## **12 WAR AND CONSERVATION:**

Although it is legitimate to wage war to ward off assaults against Islam, yet Islam prohibits causing damage to the property of the opponents. Perhaps the instructions of the First Caliph, Abu Bakr As-Siddiq, to the fighters would illustrate the environmental ethics of Islam. Abu Bakr said to the fighters, 'Don't kill a woman, a child, nor an elderly; Don't cut a palm tree, a fruitful tree, nor put them on fire; Don't destroy what is established, nor wound an animal.'

## **13 CONCLUSION**

In reality, environmental concerns represent a point of convergence for many countries. It is therefore important to support this convergence and cooperation. Whereas other interests result in severe conflicts among nations, the environmental ones would lead to a convergence of opinions rather than the other way round.





# **Energy Sustainability as the Basis for Overall Sustainable Development**

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## **1 ABSTRACT**

In this contribution, I argue that the sustainability of the multi-source and multi-use energy has to be the basis for an overall sustainable development of society. Different sources of energy are considered, to which science and technology has to contribute constantly and consistently for the success of this scenario and the salvation of the Earth and those of the Earth-dwellers who have to learn to live within its capacity.

## **2 SUSTAINABLE DEVELOPMENT (SD)**

It is widely accepted that sustainable development (SD) implies a development that meets the needs of the present without compromising the ability of the future generations. The equation of SD has three parameters: the environment, the economy and social politics. Its most practical solution has to correspond to the optimization of these parameters. The optimal environment is the one that maintains its equilibrium established over a period of thousands of years in terms of its multidimensional structure and dynamics. This includes the temperature bracket to which nature's diversity of life: its fauna and flora got tuned up over time. The complex interaction of the atmosphere with the oceans results in the winds of the Earth and ocean currents. This process controls the temperature distribution on Earth from being the coldest on the poles and to the hottest at the equator. If the Earth were alone without its interacting diversity, perhaps, it would have followed its destiny like many other planets in the cosmos. However, this is not the case. At present as a part of the biodiversity, more than six billion human beings live on it. They use its resources both renewable and non-renewable to live, and here comes in the role of the parameter of economy. One has used and one still uses these resources as if they were unlimited and will remain so in the future. However, now, one knows that that the Earth is rather small in size, even quite

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fragile and limited in its resources. And, here comes in the parameter of social and political responsibility that should help us to determine the way forwards.

## **2.1 Where are we at present?**

At present, we already use over 30 % more of the resources than the earth can provide. The way things are going, if nothing is done, the situation would certainly get worse and very soon we shall need many Earths to meet our needs. The glasshouse effect produced by gases like carbon dioxide and methane, due to the inefficient and even careless use of resources, is already disturbing the winds and the ocean currents and this is beginning to have major consequences in terms of devastating hurricanes, floods and merciless droughts. On a finer scale, the butterflies are moving up or away to find the survival-window of temperature, the fish are migrating for the same reason, the other fauna and flora seem to have started to show the same tendency, the populations of low lying areas near the seas and oceans have started to feel besieged by the climate trap through their wavy vagaries, and one sees the consequences of the debilitating drought in different regions of the globe.

Now, let us ask: what is the most important agent that can help us to optimize the three parameters of the above equation and where science and technology can make a decisive contribution to win nature back and keep it in a state of reasonable equilibrium where we come back to live within the Earth's capacity instead of the 30% overcharge it is under at present? We argue that this agent is the energy in its different forms, its multi-source production and its varied use. Energy is the basis and the driving force of life in the most general sense of the word and without energy there cannot be any life. Thus, that the sustainability of energy has to be the basis on which to optimize these parameters in order to ensure an overall sustainable development of the society that stays within the One-Earth capacity of the Earth.

Two sources of energy, one renewable and the other non-renewable are available on Earth. Let us start with the non-renewable source:

1. The 'fossil fuel' of gas, petrol, and coal created through the patient endeavour of its geology and the sun that provided it over time with the necessary organic raw material;
2. The 'fossil star-dust metallic fuel' such as uranium and thorium, which is the cosmic heritage of the earth and the source of highly concentrated fission energy. The heat freed principally from the radioactive decay of the thorium and uranium radioactive chains within the Earth, is the source of the geothermal energy.

## **2.2 Non-Renewable vs. Renewable Sources**

The sun energy which is a source of different types of renewable energy, has been pouring on the earth for billions of years. Due to this energy the waters of the seas

and oceans evaporate and then fall on the ground as rain and on the mountains as snow that partly freezes into glaciers. All this provides us with fresh water and is the source of hydraulic energy. It also creates winds for the wind energy. One can use its radiation directly via suitable methods to produce both heat and electricity for daily use. The existence of flora depends on the sun for its energy needs through the very efficient process of photo-synthesis.

Let us see how science and technology can help us to use such energy resources in an optimal manner:

## **1. Fossil fuels**

### *a. Petrol and gas*

Here one has to improve the fuel consumption efficiency of all the systems that use these fuels. For example, one can produce car engines without much effort that will not use more than 3 litres per 100 km, which is at least a factor two less than the present value. This should immediately reduce significantly the daily fuel consumption of around 85 million barrels. Technical improvements, new and better motor engines should lead to even further gains. An improvement in the industrial apparatus and a better isolation of the habitat with better isolating materials, can lead to an important fuel economy. In short, one has to analyze thoroughly all the systems that use these fuels and come up with the appropriate technical solutions in order to minimize their consumption. This will also reduce the degradation of the environment. However, it is very important to note that petrol and gas should not be used this way at all, if possible, because this is a unique raw material for the petrochemical industry for a large variety of products. In this case, one has to find alternative sources of energy to replace them.

### *b. Coal*

The earth has huge resources of coal. A serious research effort has to be made to find ways to produce cleaner energy from coal such as its liquefaction using specially designed systems such as nuclear reactors and designing special filters to sequester carbon that normally results into harmful glasshouse gas of carbon dioxide. If the coal is used in a clean way, it can provide macro energy for hundreds of years.

## **2. Fossil fissile metallic fuel**

This is the most interesting fuel, because it produces at least a million times more energy per unit mass than the chemical fuels of petrol, gas and coal. At present, the nuclear energy is contributing around 7% of the total energy used in

the world. A very active international collaborative research work is being done to develop different types of new generation thermal reactors and epithermal and fast breeding reactors that should come into operation in the next 20 to 30 years. This palette of reactors will be really a macro source of energy for centuries to come. While this development work is going on, one is also studying actively the related and the serious problem of nuclear waste, its treatment and the eventual disposal of the final minimum residual waste in a well-controlled manner.

### **3. Direct solar energy**

The sun's energy on the earth amounts to a power of about 1 KW per square meter. This energy can be converted directly into electric current via the photo-voltaic process or via the photo-synthesis as the plants do. In this domain, material scientists are playing a leading role to find materials both inorganic and organic as thin films or other suitable forms that will be robust, cheap and will lead to higher conversion efficiency than a few per cent available at present with the silicon based systems.

Solar energy can also be directly converted into heat. Here one is looking for materials that can be used to produce efficient but relatively cheap and standard domestic systems for producing hot water and for heating the habitat in cold weather.

However, solar energy is available only during the day, when the sun is there. One can partly overcome this natural limitation by storing this energy in appropriate batteries. In this context, a lot of research work is being done in different countries on new types of batteries with new materials such as lithium that will have a much higher storing capacity.

One can also collect the solar energy over a large area using a forest of properly designed and computer-controlled mirrors and focus it on a water container to produce vapour to run a turbine coupled to a generator. As an example, a station that produces around 9 MW is already in operation in Spain, and Portugal has recently installed a photovoltaic station of about 9 MW. However, these installations are still quite expensive and not cost effective. One hopes that the future technical improvements due to new materials would bring down the cost significantly and open up their wider use.

### **4. Wind energy**

Wind energy has been used for a long time employing simple and elementary domestic windmills, but due to the recent realization that wind can be a very important source of energy, the windmill industry has come up strongly. More and more countries have started to install windmill parks along the wind corridors on the ground and in the windy off shore regions of the sea. The most powerful machines available at present can produce up to 5 MW power with an input cost of little more than \$1000 per KW; this power is sufficient for 2000 households.

The future technological progress should increase their power and bring down the per KW investment cost. The windmill installation capacity in the world is going up a hefty 25 % per year and there are signs that this rate should increase in the future. However, as the wind blows only on the average for about 30 % of the time, this limits the availability of these machines to about 30 %, too, but connecting the different regions of a country or the neighbouring countries, where the winds have different rhythms, one can get over a good part of this limitation. Furthermore, one can reduce the effects of the 'off wind period' through a suitable storage of energy, when these machines are in operation.

## **5. Hydraulic power**

This is an important component of the renewable energy converted into electric current through the storage in barrages of rain water and the water from the melting of mountain ice and glaciers. Developed countries exploit this energy almost to the maximum available limit. In developing countries, where this energy is available, a major part is still unexploited. As an example, the Chinese Three Gorges Dam on the Yangtze Rivers, when fully operational, will produce 22,500 MW electric energy which is more than the present total generation capacity in Pakistan- a country with more than a 50,000 MW hydraulic capacity.

## **6. Sea-tide and sea-wave power**

This renewable energy is partly due to the sun radiation and partly due to the moon and the earth mutual gravity infatuation. A lot of thinking and technical work is going in this domain, because the sea tides and sea waves can be a macro source of electric energy. This work consists of producing corrosion resistant materials and looking into the best ways of setting up these stations. As an example, a multi-MW tide-based station has been in operation in France for more than 40 years.

It is important to note the renewable energy in its different forms and whose source is the sun, is sustainable and environment friendly, that is, it does not emit any greenhouse gases.

## **7. Biomass**

Biomass refers to the living and the recently dead biological materials: trees, plants, crops, grass... that can be used in different ways to produce energy. Like petrol and gas it produces the greenhouse carbon dioxide gas. However, here one has the obligation to replace the same quantity of biological material via new plantings that will absorb the equivalent amount of carbon from the atmosphere through the photosynthesis process and, therefore, as a rule, it should be carbon neutral for the environment. The biomass energy is renewable, because its source is the sun, too.

A lot of research work is being done to find the best way to produce biomass and evaluate its contribution to the energy matrix and, as an example, at present the USA has a capacity of generating of around 2000 MW of power from this source.

## **8. Geothermal energy**

As mentioned above, this energy results principally from the radioactive decay of the uranium and thorium chains. This source can produce a significant amount of energy in a nearly sustainable manner. Iceland is a unique example in the world, where the country lives on and via this energy in the form of hot water for domestic use, for habitat heating and for the production of electric current. This electric power is also used to produce hydrogen to run cars and buses and even boats and very soon ships. Furthermore, in the near future, Iceland will be the first and the only country in the world with hydrogen-based economy.

There are ambitious projects in a number of countries such as Australia, where favourable geothermal structures exist, to produce tens of MW's or more of power from this source.

## **3 CONCLUSION**

This contribution argues that the sustainability of energy coupled to its multi-source production and use has to be the basis for an overall sustainable development of the society. To reach and maintain this sustainability, one will need a strong and continuous scientific and technical input to:

- a) Develop transport systems with new and improved materials that will run with the highest possible efficiency allowed by the laws of physics;
- b) Find better construction and insulation materials for the habitat and general construction;
- c) Avoid wasting of resources via a rational and efficient recycling of the products;
- d) Find energy-efficient ways to face the looming enormous crisis of lack of fresh water and one which will allow us to produce it at a reasonable cost and on a massive scale for domestic, agricultural and industrial use;
- e) Develop new varieties of plants and crops that will need minimal quantities of fresh water or even accept water with certain amount of salinity for their healthy growth in the water stressed, dry and desert regions;
- f) Maintain the biodiversity of the earth by protecting its habitat in a sustainable way;
- g) Achieve effective and healthy family planning to avoid overcrowding the

earth and its eventual incapacity to take care of world population;

All these steps should help to ensure that the use of the earth's resources remains within the one-earth capacity and the environment remains healthy without the deadly looming greenhouse effect. To reach this holy grail, well-thought out politics and policies have to be set in motion, and the society has to be educated and made aware of the challenges it faces and it confronts them with a shared responsibility otherwise, as the cynics would say: what will be, will be, and the future is not for us to see!





**PART SIX**  
**SCIENCE, POLITY AND THE MEDIA**



# Scientific Networking for Sustainable Development

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## 1 ABSTRACT

The driving force behind economic prosperity, social wellbeing, and environmental stability is science and technology. Science and technology (S&T) has revolutionized the world in the two centuries. The concept of sustainable development on the other hand has been documented in a number of earlier publications. The major purpose of sustainable development is to use resources that meet human needs while preserving the environment, and can be met without compromising the needs of future generations. The Brundtland Commission defined sustainable development as development that ‘meets the needs of the present without compromising the ability of future generations to meet their own needs.’

The inability of one nation, to manage and address economic, social and environmental concerns, is a liability for other nations. It is therefore crucial that at the global level one appreciates that we are all sharing one common pool of resources and the world is viewed as a global village. The term network refers to any interconnected group or system. More specifically, a network is any method of sharing information, resources and knowledge between two or more systems such as human or mechanical. It can also mean an interconnected system of things or people. The world has become a global village and the progress of nations has become interdependent. These considerations obviously point to the need for networking among countries, institutions, scientists, and academicians. To cope with these multifaceted challenges the need is to identify, develop, maintain channelize and network existing intellectual, scholastic, scientific, technological and human resources.

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The currently available revolutionary technologies have greatly facilitated the potential for networking, and the number of opportunities available in the present era is indeed a real asset for OIC member states. This should be done by both actual networking among Muslim countries as well as the developed countries.

This paper will also cite a number of examples of networking which will help in achieving sustainable development through this approach.

## 2 INTRODUCTION

The attribute of sustenance in all aspects of development has assumed greater significance globally, especially since the first Earth Summit in Rio de Janeiro. Enormous endeavours have been made to transform the notion of sustainable development from merely a concept to reality. It is, the so called, improvement in standards of living over the period of human history and its correlation to the exhausting natural endowments of mother earth that has given new meanings and values to 'conservation' and 'sustainability'.

The present scenario of global development gives us a deplorable picture, especially when the knowledge, information and economic divides are widening, and the social friction and environmental degradation are taking their toll. To analyse the repercussions of these present day trends, and to develop plans and policies to change such trends, one needs to introduce a set of explicit goals for long range sustainability. In developing such goals, we must include both the environmental and social aspects of the sustainable development concept. Sustainability in terms of environment implies changing human activities so they no longer threaten the naturally endowed resources, upon which depend economic development, human health and social well-being. Social sustainability calls for doing away with absolute poverty and discrimination on both moral and practical grounds. Bringing and maintaining social sustainability is indispensable since poverty is both a cause and an effect of environmental degradation (World Bank 1996). Besides, a society plagued with social tension is prone to being sloppy on the environmental front.

The responsibility of global development does not merely rest with the developed world, the developing countries, being more in number and size; need to make an effort that is sizable. Muslim countries being a significant bloc within the developing world must realize their role as responsible nations, which by virtue of faith are entrusted with a greater responsibility towards human development and knowledge generation.

Sustainable development is not a onetime activity; it requires visionary thinking, dynamic leadership, optimization of resources in consumption and generation, as well as patience and tolerance towards social, cultural and religious divides. Moreover, it needs absolute commandment, cohesion, commitment and coordination. The real question is how this is to be achieved when sustainable development has a global perspective in terms of scale and scope of activities

required for it. It must be understood that such an enormous task cannot be fulfilled by a standalone individual, group, community, nation or a regional bloc. In addition, we need to clearly understand what tools we have at present to gear ourselves up to meet the issues of present and meet the challenges of the future; what gels and fortifies us as one global nation and may be the motivating and confidence giving factor to initiate such massive efforts.

The answers to these questions may be deciphered from the history of the human struggle since time immortal. Time and time again the human civilization has been challenged by natural and human-made catastrophes. It has been human intellect, the total mass of knowledge gathered and used as well as the ability to respond collectively, that has been the saviour, and had induced life back into even greater and continuous struggles.

Sustainable development is yet another challenge posed by time to the human civilization that calls for making use of our intellectual capital, available and potential knowledge-resource, and for networking and interconnecting ourselves to overcome this challenge. The dividend of human intellectual capital has been science, which has seen off spinning of technologies as per human needs at different times. It is therefore imperative that scientific networking be undertaken to achieve the goals of sustainable development.

### **3 SCIENCE AND TECHNOLOGY AS THE ‘RESCUE AGENT’**

With science and technology bringing revolution in all spheres of life, changing the way we socialize, communicate, work, commute, produce, consume and entertain ourselves, it is going to work as a major change-agent in both developing and developed nations. As we are all aware, change, competition, and complexity will be the feature of the modern era in a world increasingly dominated by science and technology. Science and technology is progressing faster than before, and nobody will be able to master and handle it alone. Therefore, we must share information, knowledge and expertise, funds and facilities. The normal ethics of science and technology must guide our every endeavour for the benefit of humankind. In the 21<sup>st</sup> century; industries will be more technology-intensive and human society increasingly knowledge-intensive. Therefore, S&T collectively, will assume an increasingly crucial role and it can prove to be the ‘Rescue Agent’ for developing countries, in particular. Through S&T, developing countries can shield themselves, with the global problems emerging so rapidly, and can avert the challenges at the national level, whether social, economic or environmental. S&T bears great potential in addressing the issues and challenges confronting developing countries and can contribute immensely towards preventing these countries from the projected economic and social havoc.

S&T is the key to sustainable growth and development and there is no denying the revolutionary powers it possesses. These powers are now evident in the form of technologies such as information and communication technologies, biotechnology, nanotechnology and so many other technologies of modern times.

The future trade and commerce and economic growth would largely depend on the applicability and utilization of these technologies. Information technology is a means to cheap and accessible information and education for all. Research done in the field of biotechnology up-till now empowers the scientist to address horrifying forecasts for food insecurity, health and malnutrition. The use of depleting natural resources for energy production can be optimized with the alternative of renewable-energy technologies, such as photovoltaic, thermal, wind and geothermal technologies.

The need of the hour is to identify the areas that need planning. First of all, taking a look at the present status of science and technology in the developing countries, we find that the developing nations are good in some fields of science and technology and lack expertise in others, mostly working in isolation. Secondly, the infrastructure required for proliferation of science is far below international standards; thirdly, developing nations need capacity building in the key-areas of science to make proper use of technology. Most of the developing countries have agriculture-based economies, and the economies thrive on the status of yearly yield. With the usage of science and application of technology, the crop cannot only be salvaged from external threats, but also the yield can be raised. Usage of agro-sciences can help the economies to achieve higher levels of sustenance. After achieving the higher level of sustenance, the economies transform and can broaden the base for growth and progress, through other industries.

The number of scientists per thousand people in the developing countries range mostly from 0.1 to 1, whereas the industrialized nations have figures in the range of more than 2 to 3 persons per thousand. In addition, developing countries have failed in retaining the critical mass due to the phenomenon of brain drain and thus well trained scientists move to developed countries, for better returns.

Although the challenges and issues are common to the developing world but, due to disparities in their economic and technological state of development, the key-issues regarding science and technology need to be identified at national and regional levels for proper strategizing.

In short, S&T still remains one of the major rescue agents for human civilization. Focusing narrowly, the disparities amongst developing countries in terms of science and technology can be overcome through scientific networking and interconnecting the intellectual and knowledge-resources.

#### **4 GLOBAL NETWORKING AND KNOWLEDGE-SHARING**

This is a period characterized by knowledge-based competition, whereby the most valuable commodities are innovation and information. Countries as well as regions are competing to attract or develop successful knowledge-based business or industries, recognizing the importance of research and innovation in economic and social development. However, these are at different stages of their transition to knowledge-based economies, partly due to differing levels of

economic development and capabilities for producing and using information and communications technologies (ICTs). Countries have different visions of how to develop knowledge-based economies as well as varying governmental styles and traditions and differences in the social institutions, cultural values and capabilities that underpin the political and economic systems. Thus, they tend to emphasize different aspects of this transformation. Developing countries that fail to transform effectively to knowledge-based economies will fall further behind the more advanced countries, widening the disparities between developed and developing countries and among themselves. It is therefore necessary to stress the correlation of the national need of innovation with the development of S&T at a global level in the form of research oriented networks, where the multidisciplinary international cooperation focuses specifically on resolving identified problems. The developing countries mostly forming the emerging economies of today have realized that they can no longer rely only on their own resources, human or infrastructure, but will have to collaborate and network, form strategic alliances to develop and exploit new innovations and technologies.

New forms of communication technologies have made it possible to form global networks that connect scientists, engineers, and health professionals in all countries and occupations. These networks have and can allow people to access and assess the scientific and technical knowledge that they need to solve local problems and enhance the quality of their lives, as well as to communicate and share their own knowledge, insights, and needs to others. International exchange of scientists and students to promote a productive, international scientific community and enhance global cooperation is vital. The talents of visiting scientists and students greatly enrich the local S&T enterprise.

Scientists should use these initial connections as a tool for spreading their knowledge, skills, and values throughout their own nations. Transfer of technology through knowledge centres can provide the much needed interface between the domestic need of innovation and the solutions that may be adapted from the global knowledge stock, in this regard.

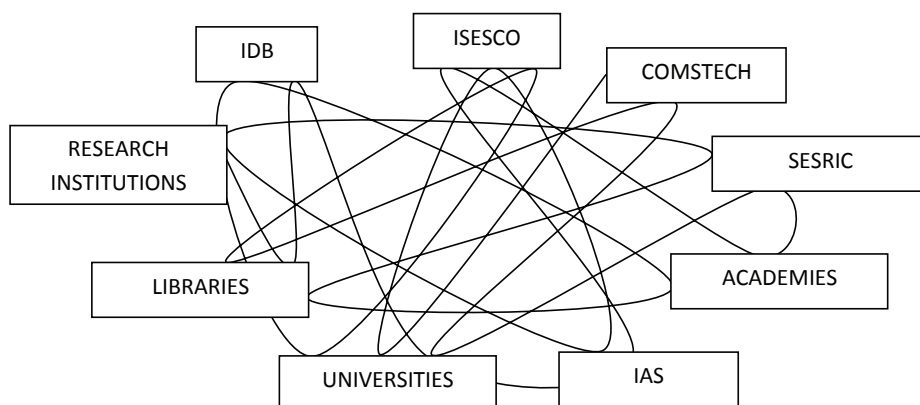
We need to build a knowledge-based society that should focus on solving problems to meet the challenges/demands as expressed by the economy and the society. Science knows no boundaries and research is expected today to deal with issues that are increasingly global in magnitude. The number of technologies used in the production of a given product or service is increasing and firms need expertise in a greater range of technologies than before. This combined with the accelerating pace of scientific and technological change means that firms increasingly resort to R&D collaboration and out-sourcing to acquire the technologies they need. Development of leading-edge science and technology is now undertaken in many more locations and, together with the increasing globalization of markets, this means that firms must be prepared to seek technologies relevant to their businesses from wherever in the world it is to be found. Innovation is thus the result of numerous interactions by a community of actors and institutions. Moreover, the global information network and its



underlying technology can and certainly will rapidly evolve to provide new possibilities that we cannot foresee at present.

## 5 SCIENTIFIC NETWORKING

As it has already been established that it is science and technology that can help us realize the objectives of sustainable development and achieve the various concepts and goals such as 'Agenda 21' and 'Millennium Development Goals.' It is therefore necessary that we interconnect the academic, scientific and technological resources all across the globe, with particular focus to OIC member states. Rather, the goal should be to create synergies irrespective of developmental advancement at all levels and across all disciplines. Scientific networking would particularly imply building institutional arrangements to facilitate scientific exchange, transfer of technology, and cooperative research and development, as well as any initiative that would add value and quality to the above stated processes and objectives. This concept is depicted in the following figure.



**Figure 1. Scientific Networking at the OIC Level.**

It is economically competitive, socially and culturally acceptable, and administratively convenient to form such networks amongst groups, partners or nations who are at nearly the same level of development, geographically in the same vicinity or share similar value systems. It is therefore suggested that the bloc of Muslim countries can form a closely knitted network and system, which is effective as well as efficient.

Realizing the importance of networking, OIC Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTech) has established ten inter-Islamic networks in different fields of science and technology in different OIC member states. With the objective to exchange ideas, conduct collaborative researches, human capacity building, internships to carry out research and

development, to help create a world class infrastructure, to evolve an extensive pool skilled manpower, attract investors, promote linkages and facilitate dissemination of knowledge. A list of these networks with their host country is given below:

**Inter-Islamic Networks on:**

1. Renewable Energy, **Niger;**
2. Space Science and Technology, **Pakistan;**
3. Water Resources Development and Management, **Jordan;**
4. Oceanography, **Turkey;**
5. Genetic Engineering and Biotechnology, **Egypt;**
6. Tropical Medicine, **Malaysia;**
7. Information Technology, **Pakistan;**
8. Biosaline Agriculture, **Dubai;**
9. Environment, **Sudan; and**
10. Veterinary Science, **Sudan.**

COMSTECH passed a resolution during its 13<sup>th</sup> General Assembly meeting to establish three networks in Islamic Republic of Iran on Nanotechnology, Virtual Universities and Science and Technology parks.

It is with the emergence of modern-day Information and Communications Technologies (ICTs) that virtual networking has expedited and amplified, accessing and sharing of scientific knowledge and contributed significantly to research and development. ICTs have added the dimension of global research to the contemporary scientific initiatives. Virtual and knowledge networking is thus imperative and strategic as far as scientific networking is concerned.

## **6 KNOWLEDGE NETWORKING**

Knowledge-based networking thrives on the principle that that the individuals, groups and communities posses the knowledge and expertise that needs to be synergized with the existing information for making decisions and strategic planning. There always are informational and knowledge gaps between various segments of societies besides the prevalent phenomenon amongst different states and regions, commonly categorized as developed and developing. Such networks are meant to fill the gap between the various segments of societies and between development agencies and rural communities. This may be done by initiating interaction and dialogue, new alliances, inter-personal networks, and cross-sectoral links between organizations so that ‘useful knowledge’ is shared and channelled to develop “best management practices” and provide practical decision support.

Knowledge based networking implies that knowledge is acquired not just by creation but also by transfer of knowledge existing elsewhere. Knowledge

Networking potentially facilitates and expedites introduction of breakthrough technologies which are otherwise promoted through the gradual process of transferring know-how and technologies among users and information carriers. The dissemination of run-time information and knowledge is becoming highly cost effective with every day improvement in communication-technologies. Networking for knowledge-sharing intensifies the global thirst for information, builds up awareness among the change agents or those who can exert external pressure, and encourages informed and active participation of communities and individuals. Further, it creates a mechanism which enables articulation and sharing of local knowledge with potential for further enrichment of this information as it passes through the network users. Benefits include more efficient and targeted development intervention, less duplication of activities, low communication costs and global access to information and human resources.

## **7 BUILDING KNOWLEDGE-NETWORKS FOR ACHIEVING GLOBAL AGENDA**

Information is imperative to the social and economic activities that contribute towards the developmental processes. The capacity to gain relevant information on time also holds importance as environmental issues are rapidly transforming into economic issues in a world of increasing awareness and decreasing tolerance to the environment. Often access to conventional and non-conventional information regarding the sustainable development is limited. This is due to the lack of information management which, if organized properly, can give appropriate and timely support. Building knowledge networks in such cases enables millions of people to have better understanding of decision-making processes in their countries, cities, villages and help local communities to improve their standard of living and the environment around them.

Knowledge networking creates the potential to achieve unprecedented gains in economic and human development and in return giving the power to cope with the problems of poverty, inequality, and environmental degradation. Such forms of networks transform people from mere information recipients to information providers and decision-makers. Over a period, effectively contributing knowledge based networks will strengthen the link between information access, democracy, human rights, environmental protection and sustainable development by providing useful information for problem-solving, for enhancing community participation, for better organization of developmental interventions and for improving the relationships between the various stakeholders in development. Such networks also break the margins which limit the availability of information and bring together governmental and non-governmental organizations, researchers, business and industrial establishments in a network for information exchange.

Knowledge-networking has great potential to grow as an alternative institutional model for development promotion; therefore, it should not be confined within

the closed boundaries of information flows. Knowledge Networks build upon institutional memory of past successes and failures to guide towards a more targeted and pragmatic approach to current and emerging challenges concerning sustainable development. Alternative mechanisms to carry out these tasks would take a lot more time, resources and efforts.

## **8 CONCLUSION**

There is a great need for mechanisms that can find and modify what one person, group, firm, or nation knows into something that another person, group, firm, or nation needs and can use. We now have remarkable new tools and opportunities for collaboration and partnership, and for need-based interactive efforts, rather than the unidirectional technical assistance of earlier programs. Meeting the potential of science and technology to contribute to human welfare will require high standards of quality. This includes objective assessments of scientific knowledge and its uncertainties, pursuit of best practices, and development of a fuller understanding of the implications of technological directions. Cooperating with others and in turn learning from them in order to serve the wider world, is the key to survival in this century. Thus, it is only by working globally that we can begin to eradicate the damage already done and can ensure a safe, clean and healthy environment for the generations to come. In many cases, effective decisions often must be reached and implemented by countries in cooperative ways. The natural and social sciences, engineering, and health communities can, together with many other societal sectors, make important contributions in building international understanding and cooperation, as well as in alleviating the root causes of conflicts.

OIC member states have to become more self-reliant and perhaps more dependent on one another to reap the collective benefits of R&D and technology. Different approaches and experiences can be usefully shared among the emerging economies and developed countries. Use of scientific knowledge and best-available technologies will be essential elements of transition to sustainability. These can contribute to new energy sources, more efficient methods of food production, better quality products, improved human health, and options for institutional changes, and environment-friendly technologies. Linking knowledge with action for sustainable development is the strategy of success in the 21<sup>st</sup> century. This realization has to sink deep in the minds of policy makers, researchers and academicians in OIC member states.



## Science, Polity and the Media

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Tehran, Iran*

In recent decades, we have made rapid and immense progress in terms of science and technology. Science has delivered great benefits to human society, contributing in countless tangible ways to improve human life. Science shrinks the space between continents, cultures and civilizations, and technology has pushed diverse peoples closer. However, it is clear that science and technology by itself is not enough and innovation alone cannot provide the solutions and there are strong ethical and cultural dimensions related to many of the world's challenges.

The ever-increasing impact that science has come to play in society has paved the way in recent years for a more fluent dialogue between the scientific community and the general public. For many scientists today, communicating science and technology to the public is growing into a recognized activity to increase public awareness. But despite the progress achieved in the direction of dialogue and participation, it is also true that there are still many obstacles to be addressed in consolidating a culture of science communication in the world.

Most scientists consider communication with the public as very important, but also believe that they are most committed to communicating when the research area is of critical impact on society (e.g. Health, Nutrition) or controversial (e.g. Nuclear Energy). Finding out more about the public and developing ways of talking with and to it more effectively are becoming increasingly necessary. It is no longer possible to ignore the public. If science is not successful in reaching to the general audiences, it is unlikely that it will find the support and resources it needs to continue to develop. There is also a skills gap whereby scientists often find it difficult to find the right language with which to communicate to the wider audiences.

In this area, media plays a vital role as a communication bridge between scientists and the public. The rationale for communication with society through the media is that public accountability is commonly cited as the reason why scientists feel a need for wider communication actions, which aim to inform society of research results they indirectly support. Also, providing information to correct or avoid misconceptions of science is another key impetus, particularly given their fear that scientific information is sensationalized if not provided by trustworthy sources.

Scientists and media inhabit different worlds. Surveys highlight that scientists are concerned about the way that science is reported by the media and that they believe that there are still significant barriers and constraints, which need to be addressed because they seriously limit the effective communication of science and research to the general public via the media. Despite the current status quo, scientists are not necessarily sceptical of the media, which they see as an important mechanism to shape and inform public opinion. Scientists witness an increased and improved relationship with the media in some scientific disciplines. However, there is a strong desire for a better relationship with the media, which ensures balance on scientific issues and a more considered and holistic approach overall.

Scientists understand that the media has the power to influence the public, but also believe that the media has a responsibility to educate the public rather than respond to popular interest areas. Thus, according to scientists, the way to improve the coverage of science and the public perception of science is for the media to be provided with and to commit to disseminating the 'right' scientific message. This view shows lack of realism on the part of scientists that the media is able to perform a purely didactic role, and is not driven by the need to attract viewers, readers and listeners by being responsive to their interests.

It is an unfortunate fact that only a few scientists have an active relationship with the media, although most are involved in some way in communicating to a wider audience on a sporadic or very occasional basis. There appears to be a significant willingness to create dialogue and partnership with the media to achieve better coverage of science as the key to improve the public perception of scientific culture and its benefits. Despite these good intentions, the fact that so few senior scientists are involved in explaining topics that are vital to everyday life is worrying, because this community is dependent on outside support to allow it to continue to make the significant advances that are enjoyed by society. Many scientists recognise that there is a fundamental difference of approach in media reporting and scientific reporting and they suggest that this leads to frustrations on both sides. A key issue is that the media is thought not to understand the basis of the scientific method or its culture, including the timescales required to achieve results and the fact that these are then only valid until proven otherwise.

Despite this concern, it can be considered that if the focus of media interest relates to the ability of scientists to play a greater role in the interpretation of everyday occurrences rather than purely resting on the release of research results, this issue does not have to be a barrier. There is a clear mismatch between what the media wants to communicate (news items) and what scientists believe needs to be communicated. It seems that for many scientists explaining about science in general and the scientific method are more important than the short term dissemination of the results of their work. Although research results that are ground-breaking and new are likely to be of interest to the media, there is great potential for scientists to be the interpreters of the day-to-day events which affect

people's everyday lives, but this role does not seem to have been fully harnessed by either side.

For scientists to feel comfortable with the science-media dialogue, there is a need for trust between the scientist and the media contact. However, scientists believe that this trust is best achieved through face-to-face contact, which means that establishing the required trust remains somewhat out of reach. This suggests that to improve communication between scientists and the media there is a need to find a more immediate and feasible mechanism to allow trust to be established.





# **The Intellectual and the State: A Snapshot**

EHSAN MASOOD

*Nature Magazine*

*United Kingdom*

## **The Machinery of Power**

- Executive
  - Departments for science/innovation/skills
  - Departments for environment/business
  - Department for Education/universities/schools
- Judiciary
- Legislature
- Local government

**Figure 1. The Machinery of Power.**

## Who Influences Government?

### Insiders

Civil Servants  
Ministers  
MPs  
The law  
OIC  
United Nations

### Outsiders

Trade Unions  
Professional bodies  
[Science academies]  
NGOs/Charities  
Organized religion  
Media

Figure 2. Who Influences Government?

## The Intellectual in Power

“The idea that better educated people can help understand and solve problems better than less-educated people”

**Tevi Troy**

*Intellectuals and the American Presidency (2005)*

“Someone who in a democratic society tries to gain the consent of potential customers, win approval, marshal consumer or voter opinion”

**Antonio Gramsci**

*The Prison Notebooks (1971)*

Figure 3. The Intellectual in Power.

## The Intellectual in Power

"One of the most bizarre features of any advanced industrial society is that cardinal choices have to be made by a handful of men: in secret"

**C. P. Snow**  
*Science and Government*  
(1961)

"To provide authority with their labour, while gaining great profit for themselves"

**Edward Said**  
*Representations of the Intellectual*  
(1994)

Figure 4. The Intellectual in Power.

## Supply and Demand

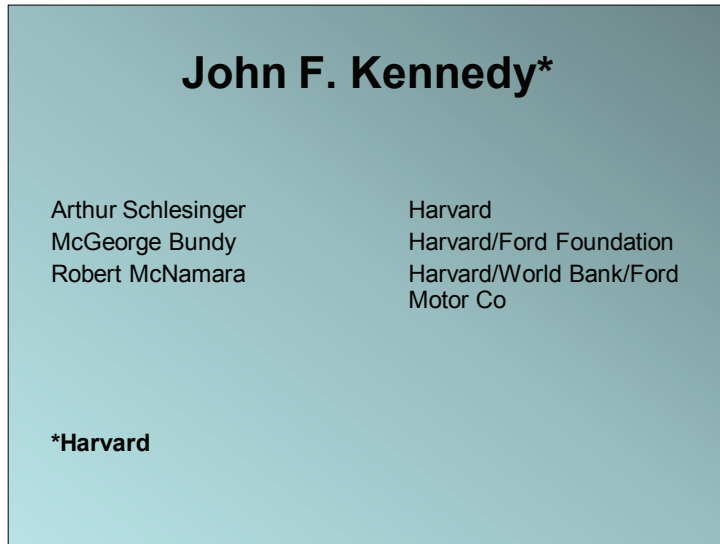
### Supply

- New knowledge you want to communicate
- Knowledge for lobbying and influence
- Opposition to government policy using scientific evidence

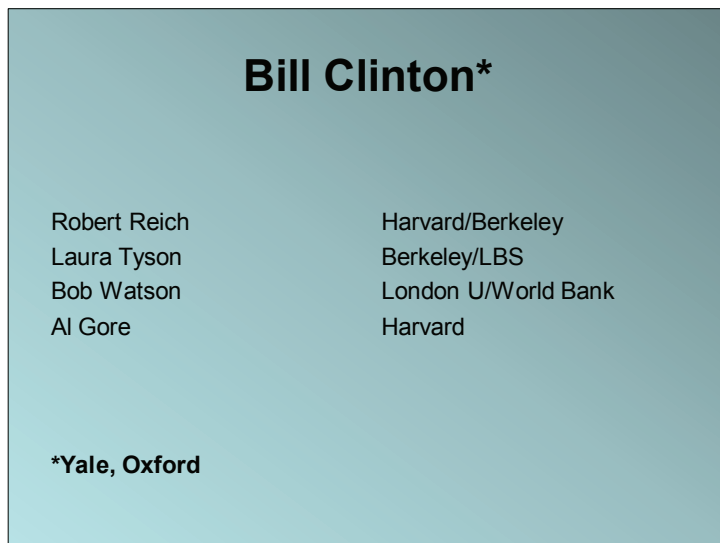
### Demand

- Briefings to parliaments
- Briefings to ministers/officials
- Government advisory committees
- The 'independent' scientific review

Figure 5. Supply and Demand.



**Figure 6. John F. Kennedy.**



**Figure 7. Bill Clinton.**

## **Why do they want you?**

- To fix a problem
- So they can look clever
- To look clever
- To get votes from clever people

**Figure 8. Why do they want you?**

## **Success**

- Understand which areas of policy need your input
- Excellent communicator – easy to understand
- Access and trust of the boss
- Wide network of experts in different fields
- Power and respect as an independent thinker

**Figure 9. Success.**

## **Pitfalls**

Lose your independence; lose the respect of  
your peers

Ahmad Ibn Hanbal Effect

**Figure 10. Pitfalls.**

# **Influence of New Technologies on Social Sciences**

NADIR DEVLET

*Fellow of TAS*

*Kazan, Tatarstan*

## **1 INTRODUCTION**

In historical research, sometimes because of political conditions, analyzing a case or bringing a fact is problematic or impossible. Therefore, and because of other reasons, there is tendency to call social and behavioral sciences unscientific.

Nowadays to escape from such accusation, new possibilities have opened. At the end of the 20<sup>th</sup> and the beginning of the 21<sup>st</sup> centuries, new technologies on telecommunications gave us the possibility to collect data and cross our borders much more easily. Still, there are many problems connected with these new phenomena.

## **2 ACCESS TO INFORMATION**

Only with the invention of mechanical printing (printing house) did human knowledge start to be distributed among people. In some societies, this facility started to be used only after three centuries. Before that, the access to human knowledge was the privilege of restricted groups such as rulers, army personnel or clergy. When Johannes Gutenberg (1400-1468) printed his Bible (or more correctly its translation) in Mainz, the mass production of book printing was started (1454). Almost in the same year, the Ottoman Sultan Mehmet II (1432-1481) was conquering the Byzantine capital, Constantinople, today's Istanbul. The first printing house for Turks in the Ottoman Empire was created by Ibrahim Müteferrika (1674-1745) only in 1727.<sup>1</sup> In other words, the distribution of scientific knowledge among Ottoman Muslims started only after centuries compared to Europe.

## **3 BOOKS AND LIBRARIES**

For many centuries, the only accesses for information were books and we still benefit from them. Especially for social scientists, libraries and archives are the

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1 M. Serpil Altuntek, "İlk Türk Matbaasının Kuruluşu ve İbrahim Müteferikka", *H.Ü. Edebiyat Fakültesi Dergisi*, X. No. 1 (July 1993), pp. 191-204.



main sources for research. Philosophy and history are the oldest branches of science and many new branches are derived from them. With the development of science and technologies not only in natural but also in social sciences many disciplines became independent branches. For example, jurisprudence is mainly divided between civil and criminal law. But law which coordinates human relations has many sub branches such as labor, employment, business, public, immigration, asylum, international, constitutional laws etc. Nowadays every law branch has its experts, specialized lawyers, attorneys and scientific researchers, namely professors. All of them had to use code books, court decisions and interpretations. Even with new technologies in social and natural sciences, books are still a very important resource.

#### **4 NEW TECHNOLOGIES**

Especially at the end of 20<sup>th</sup> and beginning of 21<sup>st</sup> centuries new developments in printing and communication, technologies gave us new possibilities in research. Therefore, we can use our precious time much more efficiently. Some of these facilities could be compiled as follows:

#### **5 TYPEWRITER**

The older generation, who were born before forties or even fifties could remember that they were taking their notes and preparing their manuscripts by hand (writing). Manuscripts, which were sent to printing houses, created difficulties to typographers, when the handwriting was not so well readable. We come across with such difficulties when we try to read old private letters. When in 1930s the mechanical typewriters came to the market, such problems started to vanish. At the end of the sixties, with the introduction of electrical typewriters, we were able to prepare our scripts much more efficiently. Still, it was not fully satisfying.

#### **6 PHOTOCOPY-MICROFILM**

Other technological inventions or developments were the improvements of photographic devices. The mid 1960s photocopier or xerography gave us the possibility of making facsimile or exact copies. However, in the beginning using such a technology was very expensive. A page could be printed for \$10, but following developments within two decades, the prices dropped to \$0.25 per page or even less. In the mid 1970s, the color photocopiers gave us the possibility of having copies from colored documents. Nowadays, we use digital systems instead of analog.

Another development was invention of microform. In 1930s and 1940s, the books and printed documents started to be photographed by special cameras.

Microfilms (reels), microfiches (flat sheets) and micro cards gave us the possibility of a healthier way to distribute or preserve our books and documents. Today, the Library of Congress possesses 500,000 reels of microfilms. This library started its collection by copying 3 million pages of books from the British Library between the years of 1927-1935.<sup>2</sup>

## **7 COMPUTER-INTERNET**

In our modern era especially with the development of personal computers (PC) researchers and scientists were confronted with a challenging development. Computers, with integrated circuits (or microprocessors) and computer programs enabled access to a new era. Manual and mechanical typewrites were out, digital computers were in. Printing houses started to reject our handwritten or typewritten manuscripts. Instead, we were asked to prepare our articles or books in digital format, copied on discs.

For many people, especially to the elderly this was really a challenging task. Every step using a personnel computer needed to be learned from nil. We had to learn a new technology, terminology, the differences between hardware and software, operating system like Linux, Windows, and some new push buttons on our keyboards, and their functions. Now a rodent is sitting on our desks, 'the mouse.' At the same time the transition from analog to digital systems enabled us not just to write but also to print our own articles at home.

In the 1990s, many users were able to link computers together using telecommunication technology. Therefore, we could communicate with our colleagues all over the world by using our computers. This facility was called as e-Mail. Through Internet and we send e-Mails, search through World Wide Web. With the development of wireless technologies, we can speak and send data through mobile phones. Almost every year we come across new technologies or developments in this field. For example, memory sticks and USB (universal serial bus) flash drives gave us the possibility of carrying data from one place to another much easier. They have huge memory capacities. You can restore 32 GB (gigabyte) in it. Before that, we were using diskettes, CDs (compact discs), DVDs (digital videodisc) or double-sided DVDs. Now almost bi-monthly we come across with a new invention on this field.

## **8 NEW TECHNOLOGIES AND THEIR POSITIVE CONTRIBUTION**

Personnel computers enabled us not just easier communication, but accelerated our research work. We can make research through the internet in different libraries around the world. Computer technology has decreased research time. Access to information is now much easier, much cheaper and quicker.

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2 [http://en.wikipedia.org/wiki/Library\\_of\\_Congress](http://en.wikipedia.org/wiki/Library_of_Congress)

When we prepare a book or an article footnotes are put automatically, we can edit our work much more easily, and we do not need to count lines or pages. Searching for a special name does not take time. To prepare an index is not a problem anymore. You may recall in the old times we were preparing cards in alphabetic order and putting page numbers on them by hand one by one. We can add pictures, maps, charts, statistical tables in no time. Correcting writing mistakes became much easier, if you have necessary programs the mistakes are underlined in red, so you recognize them automatically. Some programs even make suggestions when your sentences are inappropriate.

There is no need to search dictionaries, encyclopedias or maps for hours. There are many free sources for such information. Even articles on special scientific fields are accessible, but many of them are not free. You still have to become a member or register to a private site like 'Pro Quest,' if you wish to benefit from them. Many universities grant free accesses to these articles for scholars and students.

In your hardware, you are able to store information of many megabits. You can access these documents any time you like. Today downloading songs or films became a national sport. Through websites, you have access to all kinds of information. From weather condition in a certain city to the political situation in Africa, there is lot of information, buying, making bank transactions, applying for a job, learning your exam marks or surfing through internet is common in every developed country. E-state (or e-government) enables us to get information from different state departments or institutions. Universities give information about their education programs, scientific staff and their academic activities. University libraries or other libraries give us information about their holdings. Through inter-loan system, we can borrow books or ask for copies. In short, internet is occupying all spheres of our life. However, on the other hand whoever does not have these facilities or is unable to use them loses time and money. Now a new age of computer users and non-users has started. This gap could be compared with literates and illiterates of the past. In that respect, a new generation took the dominance and the older generation became their students. Knowledge and experience of the old generation is not a determining fact today.

## **9 NEW TECHNOLOGIES AND NEW PROBLEMS IN SOCIAL SCIENCES**

All of the above are positive developments, which have contributed to the development of social sciences. Still the old research methods, namely working in libraries and archives, on archeological sites, deciphering old documents, observing and investigation are still important methods and have not lost their value. The new technological possibilities just facilitate our research and help us gain time. However, we come across many difficulties and restrictions when we use internet sources.

## **10 LANGUAGE AND ALPHABETS**

The development of the World Wide Web search engines (disambiguation) that began to function in the beginning of this century have given scholars and researches many alternatives. However, the majority of these search engines are in English. Sources like Alta Vista, Yahoo, Google, hakia.com, Answers.com, or online encyclopedias are mainly in English. Among the exceptions, Wikipedia has articles in 250 different languages. 2.5 million articles are in English; in the second place is German. In Russian 300,000, in Turkish 112,348, in Arabic 66,000 and in Tatar 3,000 articles could be found in this free encyclopedia. These articles have been created by free contributions and therefore we cannot categorize them as scientific works. However, it still is the main information source for many people. For academicians, there are also special academic databases and search engines such as Google Scholar, ProQuest, EBSCO or BASE but reliable sites ask for payment.

In fact, English became worldwide scientific language of modern times, historically like Latin or Arabic. Certainly most developed countries have their own research engines in their own languages, but they are not as developed as the English search engines. On the other hand, the World Wide Web also allows us to search for someone in his/her own language. However, to undertake global research, you first need to know English.

Countries which use other than Latin-alphabet on their keyboards have difficulties especially when sending e-Mails. If there is no appropriate conversion or support programs installed, recipient sees on his/her screen strange symbols instead of proper letters. Turkey uses Latin script, but has additional six letters, which do not exist in English. When using these Turkish letters, recipient usually sees these letters as strange symbols, when the recipient does not have the appropriate encoding system on his/her computer. Therefore, many people tend to write even their Turkish e-Mails only by using the English version of Latin script, which looks rather odd.

## **11 TECHNICAL SUPPORT AND RESTRICTIONS**

For internet access, you must be equipped with a server, IP number, necessary devices (computer, a phone line, and modem). Infrastructure should be provided usually by the state and protection of rights should be guaranteed by law. New technologies also create some new problems. Strangers can send spam, junk mail, viruses, etc. Some viruses can destroy your hardware and you may lose all your files. Most dangerous are the hackers who can infiltrate your personnel data and bank accounts.

Sometimes the official authorities can restrict your access to certain web sites. The reason could be security or something else. Such official moves could be interpreted as restriction of rights however; in many countries, such actions are common. Another reason to fear is state surveillance of personal correspondence

or research. All these can be interpreted as human rights abuses however we must remember that nobody is stronger than state apparatus.

## **12 PLAGIARISM**

Plagiarism is one of the oldest diseases of humanity. Human nature leads people to laziness; we like to reach our goals in an easy way. Scientists are also human and we expect them to be correct and disciplined. In social sciences, determining plagiarism is not easy, but possible. One of the worst examples of plagiarism could be seen in PhD dissertations. There were or are still cases in Turkey in which some parts of or even complete works prepared by a foreign (or local) scholar have been translated (or copied) into Turkish and represented as their own dissertations to the jury.

Students can find prepared papers on the internet and present these as their own term papers to their instructors. Therefore, instructors have much more challenging duty when controlling and marking papers.

Students and some researchers use copy paste method without mentioning the source. Such plagiarism is easy to recognize and could be deciphered, however, clever ones among them use the information in footnotes as their own findings. In short, internet resources have given us a huge access to information leading to some people with limited knowledge and talent preparing a semi scientific work. For example, without visiting a country, travel books can be produced and only the professionals can detect it.

Now the question is how we can protect our original works from such plagiarizes? If our original researches are printed or made public, there is almost no possibility of that happening any more. Certainly, we are happy when someone uses our finding and analysis, as long as they are properly quoted.

## **13 CONCLUSION**

In the modern world, new technologies such as internet are giving us a quicker and larger pool of resources. Through the internet, we can create our ‘home offices’ and can work much more efficiently. We can correspond with our colleagues without considering time zones, and we have access to most library holdings. We can even find scientific articles and get copies thereof. We can scan our documents, pictures and send them. In addition, manuscripts ready for publication can be sent to our publisher with little effort. As in many fields of life computers and internet has given us the possibility to be perfect in our scientific works. Sitting hours and hours before the screen could create elbow, spine or eye disorders. However, the possibilities of these technologies are so precious that we cannot get rid of them.

However, at the same time these possibilities involve dangers such as loosing personnel contacts, not giving the necessary attention to the sources which are

not on the internet, being influenced by certain information, data and analysis, ignoring healthy judgment ...

In short, we should make use the new technologies in order to broaden our horizon, but still we should be very careful when we deal with them.



# **The Muslim World as a Centre of Geopolitical Gravity: A Personal View**

Y. N. KHALIULLIN  
*International Academy of Eurasia  
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On the threshold of the third millennium, the political map of the world sees a new order of political and economic forces, which will certainly influence the development of world events, in the globalization age of the whole geopolitical space.

The world leading political scientists agree that the USA, China, India, Russia, Japan and the other huge geopolitical centres, European Union and Islamic world, will become the main players in the world arena of the 21<sup>st</sup> century. In fact, they represent the leading world civilizations: Christianity (the USA, EU and Russia), Islam (57 Muslim countries of the Organization of Islam Cooperation), Confucianism (China), Hinduism (India), and Buddhism (China, Japan and India).

Let us describe the world of the future and the role of Islam in it. Unfortunately, we have to stress that due to a number of historical reasons, Muslim countries did not take an active part in the development of the new structures in the current system of international relations. It was only at the turn of the century that they became part of these processes. Therefore, it is natural that nobody initiates any political discussion on the creation of a geopolitical centre encompassing Muslim countries, like the European Union. It took almost half of the last century for the Europeans to join forces.

The European Union today is a huge geopolitical centre of Eurasia. It includes 27 countries, the total population amounting to 500 million people, and its GDP is about US\$10 trillion, which is comparable to the American economy and far exceeds the GDP of China. The European Union countries are members of NATO, where the US military forces are the main contributor. Moreover, the American geopolitical scientists insist on the fact that the 'Old Europe' is not capable of fulfilling its geostrategic tasks in the world. European politicians, however, hope that in 10-15 years, the European Union will obtain the status of a new superpower, which will compete with the USA in the world markets and in international relations.

To go back to my previous point, the comparative analysis of the Muslim world on the basis of 2-3 parameters, human resources and economic potential in particular, does not give a clear picture. As for the distribution of human resources,



the main wealth of any country, the contemporary international system has no analogies in the world history. That is, out of 200 countries in the international community, the population of 110 countries is less than 10 million people. In fact, half of the countries - members of UNO, are mini-states, which are not capable of providing security for their own political, economic, humanitarian rights and cultural heritage.

At the same time, the Asian giants like China (1.3 billion people) and India (1 billion people) stand close to the European Union. Both countries are in the list of ten industrially-developed powers, and they own nuclear weapons. In the middle of this century, India will become the most densely populated country in the world (over 1.5 billion people). Both countries might soon become new economic superpowers.

We can see the same picture in the Islamic world. According to different estimations, 1 to 1.5 billion people in the world practice Islam in 130 countries. The population of 22 out of 57 Muslim countries is less than 5 million people, the population of 12 countries is about 10 million people. There are less than 10 countries with population of 20 to 30 million, while only two populous Muslim countries exist, Nigeria (120 million people) and Egypt (70 million people).

It is common knowledge that a considerable part of Muslim population live on the Asian super continent — about 1 billion people, half of them (500 million) being the population of three countries — Pakistan, Bangladesh and India. The population of the most populous Muslim state, Indonesia, is 215 million people, which is equivalent to the population of Arab countries. This factor is of a serious political importance.

First, Eurasia is the axis of the whole geopolitical plane of the contemporary world. 75% of the whole population of the planet are concentrated here, 60% of the world GNP is produced here, 70% of the world fossil fuels deposits are here as well. This means that the 'golden billion' of the developed countries depends on 'energy feedstock' from the countries of the Middle East and Asia-Pacific region.

Second, Asia is slowly approaching the forefront of the world politics. It attracts the attention of the world community - statesmen and scientists. Mass media of many countries describe the Asian economic miracle as the revival of Asian civilization. Political scientists propose a thesis on the 21<sup>st</sup> century being the Asia-Pacific century. They suppose that it is here that the competition between superpowers for new markets will take place. According to the expectations of the World Bank, by 2025 the leading economic world superpowers will rank in the following order: 1) China; 2) the USA; 3) Japan; 4) India; 5) Indonesia.

Another important parameter - economic development potential. Unfortunately, according to many economic indicators, living standards in almost all Muslim countries are far behind the so called 'golden billion' of the developed countries. The total volume of GDP of 57 Muslim countries is about 3 trillion dollars, which is lower than the GDP of the USA, the EU, and makes one half of China GDP.

Muslim countries are integrated in the modern system of international relations.

All the Muslim states are members of UNO or other international organizations. They are integrated into the world economy as well. For example, about 90% of foreign trade of Saudi Arabia and a number of oil producing Arab countries goes to the developed countries of the West, over half of export and import of Turkey goes to the EU countries. This means that the international policy of the Muslim states cannot develop without taking into account the trends of the world politics.

The huge Islamic world which is often called 'the heirs of caliphate empire' gained more importance after the clerical revolution in Iran and the collapse of the communist ideology. Muslims today exceed 1 billion people, this means that every sixth person on Earth is a Muslim, thus Islam religion can be compared to Christianity only. No other religion developed so rapidly in the last decades. Today Islam has the dominating positions in a considerable part of the Asian continent.

The last years saw vigorous expansion of Islam in European countries. In France, 10% of population are Muslims, that is, 6 million people. The Turkish community of Germany has increased 500 times, and now has 3 million people. If this trend continues, in 25 years half of the population of Germany will be Turk. Several thousand mosques and hundreds of Muslim organizations work in the countries of Europe.

There is a certain difference between Islam and other Eastern religions. Confucianism and the culture of China, Hinduism and the culture of India are horizontal civilizations, and so is the Christian one.

Unfortunately, the Islamic world enters the third millennium being broken into pieces because of political, economic, territorial, ethnic and other contradictions coming from the outside. International organizations of Muslim countries – the OIC and the League of Arab states do not play an important role in solving international problems, including the development of Muslim countries themselves. The last few years however, have seen a new search for geopolitical leaders who could take charge of the Muslim world in the situation where only one superpower has global claims.

Lately moreover, we have heard many opinions about the clash of the two world civilizations - the Muslim and the Christian ones. Is this a really possible danger, and how can we prevent it? This concept has been developed in the countries of the West, mainly, the USA. The main idea is that the global politics and international relations acquire a new, intercivilizational nature in the new post-confrontation era. The adherence to this concept imposes the idea of 'the clash of civilizations' to the world leaders. They say that this clash might take different forms in the 21<sup>st</sup> century, for example, 'boundary clash' - on the line between civilizations and 'axis clash' - between the great superpowers of different civilizations, something like World War III.

In case of this 'intercivilizational' alignment of forces, two civilizations come to the forefront, the Muslim and the Christian ones.

Throughout the history of mankind, interpenetration and interaction of different civilizations proves the contrary thesis: great religions can coexist peacefully

on small and huge territories. That is why, we should speak about cooperation between civilizations, not clash. Fortunately, the leaders of some countries do understand this, this can be proven by 'intercivilizational dialog' between the heads of the governments of Turkey and Spain in Madrid at the beginning of 2008. Earlier, one of the leaders of Iran (President Khatami) expressed this kind of sentiment from the podium of the UN.

The events of the late 20<sup>th</sup> and early 21<sup>st</sup> centuries prove the idea of mankind entering a new civilization. It will differ from the contemporary one no less than the post-industrial civilization differed from the previous millennium.

Unfortunately, there is no homogeneity in the world entering this civilization. Different regions have different levels of development. The USA and Japan represent the civilization of information, while over a hundred of other countries are far behind it. It is for this reason that the picture of the next millennium will look like a mosaic of civilizations, different in their political, economic, cultural and spiritual development.

On the threshold of the third millennium, mankind still has to look into the future in the conditions of new global threats and problems, which require cardinal philosophic and political rethinking of realities in order to save the world of the new civilization.

The Muslim world does not have leading world scientists in the field of humanities or natural sciences. Until the end of the 20<sup>th</sup> century, Abdus Salam was the only Muslim scientist - Noble prize winner (1979). It is very gratifying that the last years have seen four more Muslim scientists awarded with this prize in chemistry, medicine, economics and literature.

In conclusion, I would like to advance a proposal to the Islamic World Academy of Sciences.

Due to the growth of tension in the last years in different regions of our planet, including the places most important for the Muslim countries interests, I would like to propose the creation of a working committee for the scientists of the Southern and Northern hemispheres with the purpose of studying the most urgent international problems in order to relieve tension in the relations between the countries of the South and the North. This can be something like the Pugwash Movement which played an important and positive role in supporting peace between the East and the West in the Cold War years.

# Science and the Media: Bridging the Gap

NADIA EL-AWADY  
*Chair, Arab Science Journalists Association  
Egypt*

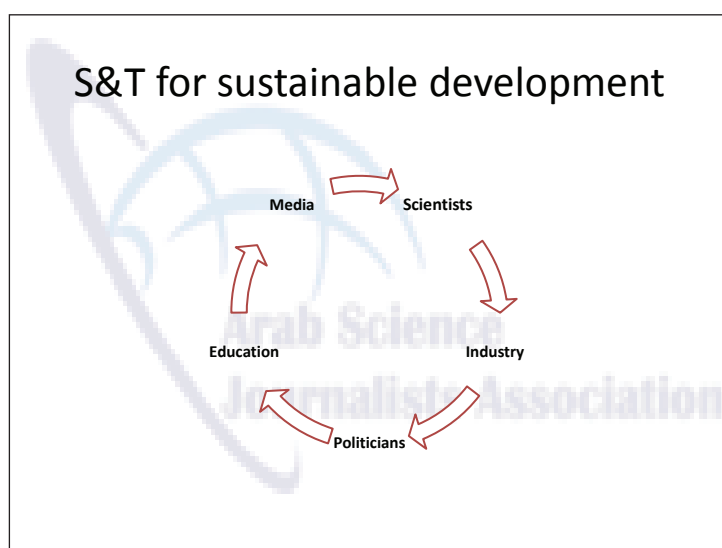


Figure 1. S&T for Sustainable Development.

## What is science journalism?

....the branch of journalism that deals with news stories, feature articles, documentaries or current affairs programs on science, technology, health, medicine and the environment for print, electronic or online mass media. The key is the medium. Unlike other science writers who write books, technical papers or even science fiction, the science journalist works in the mass media format and is mostly concerned with scientific breakthroughs, trends, ethics, institutions, people, policy, history, impact, etc

(Diran Onifade, WFSJ Mentors Discussion Board, 2006)

**Figure 2. What is science journalism?**

## What is the role of the media?

- Monitor
- Observe
- Inform
- Report
- Create awareness
- Enable informed public debate

**Figure 3. What is the role of the media?**

### This can result in:

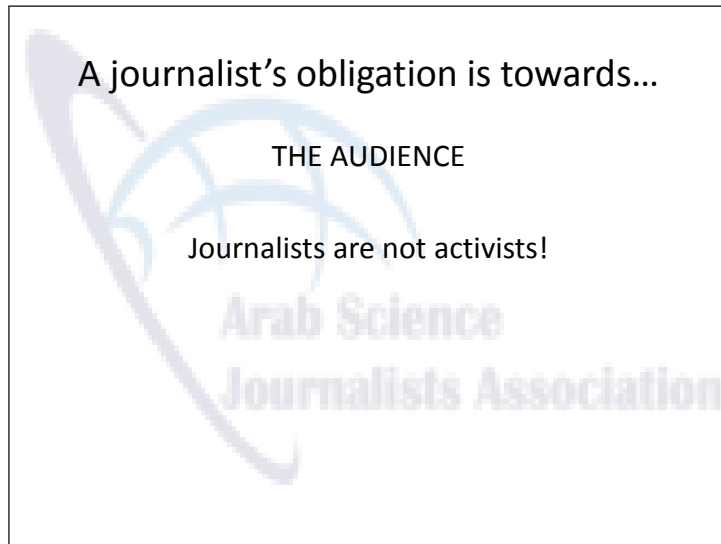
- Linking scientists, industry, policy makers and the general public
- Scientists voice their concerns and ambitions
- General public voice their concerns and ambitions about science, technology, health, and environment issues
- Scientists gain recognition for their work
- Pinpointing areas in need of further research or research funding

**Figure 4. Result.**

### Who should play these roles?

- The scientist? Does he/she have a vested interest?
- The journalist? Is he/she qualified enough to cover science?
- A specialized science journalist with special training to cover complex scientific issues?

**Figure 5. Stakeholders?**



**Figure 6. A Journalist's obligation towards the audience.**



**Figure 7. Are we doing our job?**

# **The SjCOOP Project: Impacting Media to Impact Science through Journalism Training**

JEAN-MARC FLEURY  
*Executive Director*  
*World Federation of Science Journalists*  
*Bell Globemedia Chair in Science Journalism*  
*Université Laval (Québec)*



**Figure 1. The journalists participating in the World Federation of Science Journalists' SjCOOP project met in Education City, Doha (Qatar), 4 – 9 February 2008.**

## **1 ABSTRACT**

This paper describes the work being done by the World Federation of Science Journalists and the training programmes it implements in the Middle East and Africa. It also discusses some examples of the work journalists carry out and how it impacts science and society.



## **2 THE WORLD FEDERATION OF SCIENCE JOURNALISTS**

The World Federation of Science Journalists (WFSJ) is a non-profit organization representing associations of science and technology journalists from Africa, the Americas, the Asia-Pacific, Europe and the Middle East. It is, in short, an association of associations. The WFSJ promotes the role of science journalists as key players in civil society and democracy. The Federation's goals are to improve the quality of science reporting, promote standards and support science and technology journalists worldwide.

There are 37 national, regional or international associations of science journalists members of the World Federation of Science Journalists including the Arab Science Journalists' Association (ASJA), which was created in Damascus, in December 2006.

The WFSJ answers to an international Board of seven members, of which Ms Nadia el-Awady, who heads the science and health section of the website IslamOnline, is the Treasurer.

A major activity of the Federation is the periodic convening of the World Conference of Science Journalists (WCSJ). The fifth Conference brought more than 600 participants in April 2007 in Melbourne (Australia). The next conference will be held 29<sup>th</sup> June – 2<sup>nd</sup> July 2009, in London (United Kingdom).

Another activity of the Federation is the organization of international competitions for science journalists. During the first half of 2008, it has sent 15 journalists to spend one to three weeks aboard the Canadian Arctic research icebreaker Amundsen. One of these journalists was Raghida Haddad, Executive Editor of Al-Bia Wal-Tanmia (Environment & Development), the leading environment magazine in the Middle East and North Africa.

### **3 SJCOOP PROJECT: HOW TO ESTABLISH AND SUSTAIN SCIENCE JOURNALISM?**

SjCOOP is the flagship project of the World Federation of Science Journalists. It is aimed at professional journalists in Africa and the Middle East. All of the participants in the programme are journalists who already have a full time job with a newspaper, radio station or television station, or who freelance for different media. They commit themselves for two years of training. It is training at a distance, but we all meet once a year.

#### **3.1 Mentoring in science journalism**

The key feature of SjCOOP is the use of mentoring. As an example, experienced science journalists Raghida Haddad, shares her experience and knowledge

(mentors) with journalists in Egypt, Morocco and Algeria who want to improve their skills at reporting science (the mentees).

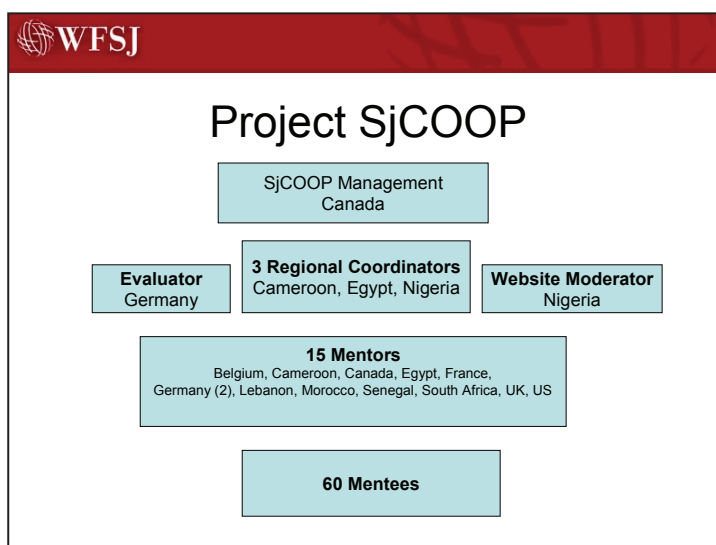
The WFSJ has 15 mentors from several different countries: Cameroon, Canada, Egypt, France, Germany, Lebanon, Morocco, Senegal, South Africa, the United Kingdom and the United States. It purposefully selects a mix of mentors from the mentee's region and from outside their region.

Jean-Marc Fleury is the Director of SjCOOP, based in Canada, at the headquarters of the World Federation. In the office, two colleagues help him: a project manager and a part-time information technology specialist.

The 60 mentees make three groups: Arab-speaking, English-speaking and French-speaking, or as people in Québec say: arabophone, anglophone and francophone. Each group is led by a coordinator from the region. Ms Nadia el-Awady is the coordinator of the Arab group. The coordinators' main task is to make sure mentors do their job, the foundation of the project.

Mentoring is done at a distance; a Lebanese mentor can mentor a journalist in Morocco, a Canadian mentor can mentor a mentee in Congo while a Nigerian journalist relates to a German mentor.

As any of you who experienced education at a distance will observe, it usually does not work. To make distance mentoring work we need a whole series of supportive activities. First, we insist on everyone working through a dedicated website and we have someone who keeps the website interesting. And, to keep all of us on track, we have continuous monitoring and evaluation from Dr Jan Lublinski, based in Bonn, Germany.



**Structure of the SJCOOP Project.**

### 3.2 Impacting science and policy

Let us now look at some of the journalists who have had an impact on science and policy.

Jordan newspaper **Al Ghad**'s managing editor Mr. Mohamed Souidan says of mentee Ms. Hanan Al-Kiswany: 'Hanan's skills improved a lot compared to two years ago, especially in scientific issues. Her colleagues are asking her advice on scientific subjects. ... We may dedicate a page for science and health in the future.'

Hanan Al-Kiswany wrote a story about AIDS orphans, in December 2007. Because it was a new and touching subject, the story was published on the first page. It was highly appreciated by her chief editor; it was re-published in international outlets such as BBC, Monte Carlo, and [www.alarabiya.net](http://www.alarabiya.net). The Ministry of Health established a special unit to combat AIDS, as a result.

Hanan also wrote a story about smoking in the Health Ministry's premises that led to the Health Minister (Deputy Minister – Editors) refraining from smoking in public and posting of Non-Smoking signs in offices of the Health Ministry (Jordan). Recently, Hanan was asked to train 15 journalists in science reporting.

In Baghdad, Abdalzahra Haider Nigm, with newspaper **Asharq Al-Awsat**, has now been promoted to Deputy Director of the Baghdad office of the London-based leading Arabic international newspaper.

In November 2007, Haider published an article on the prevalence of mental disorders in Iraq. His article led to coverage by the TV channel Al Hurra. It was shocking for the public but led the Ministry of Health to acknowledge the struggle of the mentally ill and of their families.

Ghosn Zeinab, Editor at **As-Safir** newspaper (Cairo office), became Managing Editor of **Al-Insani**, the magazine of the International Committee of the Red Cross in Egypt. Zeinab is not afraid of controversy and is a confirmed science journalist.

Fatiha Nour Chara, who is a journalist with Algeria's main radio, now does two new radio-programmes every week. One of the programs, 'Innovation,' has become a platform for innovators. Fatiha reports about new technology and new patents. She defines and explains technological terms. For this programme, which is broadcast on the main national Channel 'Première Chaîne' (duration: between 1 hour and 1h30), she invites experts, inventors, engineers and representatives from the industry and patent office (Institut des brevets) to discuss and explain new developments. She has just won a \$60K scholarship that includes three months with a science news agency in Montréal (Canada) and three months of travel anywhere in the world to do reporting.

The African contingent of science journalists taking part in SjCOOP include Théodore Kouadio, who is journalist with **Fraternité-Matin**, Côte d'Ivoire's main newspaper, responsible for the science and technology pages on the website of his daily newspaper ([www.fratmat.info](http://www.fratmat.info)), the main daily newspaper in Abidjan.

He also now contributes a lot more to the printed version of the newspaper. He can now spend 50% of his time on science stories.

Recently, he wrote about the recognition of the special needs of people displaced by war. It is a big issue in his country. His article demonstrated that it is never too late to accept psychological treatment. He followed and researched this story for three months. His editor first did not want to print the story, as it was attacking the government too directly – **Fraternité-Matin** is normally aligned on the government. He then discussed it with his mentor (Patrice Goldberg, Belgium TV) and they came up with a different, more narrative introduction that was less direct, but the article still made the main point.

Moreover, the story of Kimani Chege, who was appointed Editor of **Tech News Africa**, Kenya, is worth telling. Kimani used to specialise in agriculture, biotechnology and environment. He has now branched into new areas of science. In his new job, he has also taken on editing, design, layout and management. 'It is double work,' he says but 'it is worth it.'

He has also successfully freelanced, publishing two stories in the prestigious scientific journal **Nature**. The South African newspaper **Mail and Guardian** has asked him to do a regular blog for the paper's website. He is now a MIT Knight Fellow and will spend a year improving his science journalism skills in Boston.

In February 2007, Alexander Augustine, at **Nigeria' News Agency**, was promoted to supervise two other reporters. Augustine has been the author of the most read article on the website [www.SciDev.Net](http://www.SciDev.Net).

He is a model for African science journalists, challenging shaky claims with one simple question: 'In which peer-reviewed journal have you published your results?' He has been violently attacked by pseudo-inventors and pseudo-discoverers, some holding prestigious degrees. He has the courage to question bad science and bad scientists and is having quite an impact on science in his country, prodding the scientific community itself to higher standards.

### 3.3 Influencing policies and government decisions

With two years of achievements, the SjCOOP project has started documenting the impact of the stories written by its participating science journalists. Here are a few examples of their impact:

- Installation of filtering system on a cement plant (Jordan);
- Allocation of funds to fix lake Nyos (Cameroon);
- Setting up technical committee on lake Nyos (Nigeria);
- Speeding up of water treatment in Baghdad (Iraq);
- Attacking societal taboos concerning children born with deformities (Côte d'Ivoire); and
- Firing of corrupted AIDS drugs distribution official (Uganda).

### **3.4 How SjCOOP works**

Since SjCOOP is mainly mentoring at a distance, the organisers make systematic use of the internet. All participants have access to a dedicated website where they can find information on the project, the work of their colleagues and participate in discussions.

A key feature of the dedicated SjCOOP website is a series of private sub-sites for the exclusive use of the mentored journalists (mentees). This is where they can upload their articles or electronic files for their mentor to see, review and comment.

Another result of the SjCOOP project is the creation of the first ever online course in science journalism, now available in Arabic, English and French at [www.wfsj.org/course/](http://www.wfsj.org/course/)

The SjCOOP approach has two major advantages: ‘in situ’ development of the skills of the journalists and a low ‘rate of losses of trainees.’

Because the journalists benefit from two years of training while on the job, their progress also simultaneously modifies their environment. Their bosses and their colleagues can see the journalists’ skills and self-confidence increase over the two years. Their colleagues start seeking them for advice; their editors give them more space, more responsibilities and even promotions.

At the same time, while the journalists and their immediate professional environment evolve, their relationship with scientists and policymakers also evolves. Scientists begin to notice their new competence at covering science. Scientists become eager to contact the new journalists who can understand them! At the same time, policymakers and decision-makers begin to feel the impact of their well documented articles and programs.

One of the project’s coordinators, who has extensive experience in the training of science journalists in Africa, has done a preliminary analysis of the rate of success of SjCOOP in graduating journalists in science journalism.

He estimates that with ‘Off site’ training (academic, workshops), some 70 to 90% of the graduates do not continue as science journalists, while with ‘in situ’ training (SjCOOP), only 30 to 40% are lost to science journalism. He insists that ‘losses’ is not entirely appropriate since it is the SjCOOP managers who take the initiative of eliminating the journalists who do not participate actively. This relatively low rate of loss is confirmed with the Arab group. In September 2006, the group started with five mentors and 20 mentees from nine countries, while there were four mentors and 12 mentees still participating in July 2008.

### **3.5 Evaluation criteria**

SjCOOP has a built-in monitoring and evaluation process. Some of the progress markers for the mentees are reached when the journalists:

- become resources for other reporters;

- do more science reporting;
- report on new areas in science journalism;
- start to work for new news outlets (freelancing for international media);
- win journalism awards (11 have won awards and scholarships);
- create new science beats (four have been asked to manage science sections or programs); and
- impact policy and decisions (10 documented instances).

One mentee became a mentor and one is now teaching science journalism in a university (Madagascar).

The mentors also benefit from their mentoring. One mentor now teaches science journalism in a Cairo university. One mentor won a 3-week stay aboard the Arctic research icebreaker Amundsen (Raghida Haddad, Lebanon) and another mentor has started a science magazine (Otula Owuor, in Nairobi, Kenya).

### **3.6 Building associations of science journalists**

The SjCOOP project also supports the creation of associations of science journalists. In Africa, nine new associations have arisen from the project, including one in the Sudan. These new associations are then twinned with well established associations -- Cameroon with France, Kenya with Canada, Germany with Nigeria, Uganda with the United Kingdom -- but the most productive twinning has been between the new Arab Science Journalists' Association (ASJA) and the US National Association of Science Writers (NASW).

## **4 CONCLUSION**

The success of the SjCOOP project has been such that other regions of the world are looking at initiating similar schemes to reinforce science journalism. Australia is in discussion with Indonesia to launch an East Asian SjCOOP and Latin America also wants a similar project.

Amongst other results is the establishment of promising relationships between associations of science journalists and local academies of science. The African science academies have now invited African science journalists to speak at their next meeting, in November 2009, in Accra (Ghana).



**PART SEVEN**  
**HISTORY OF ISLAMIC SCIENCE, TECHNOLOGY AND**  
**INNOVATION (ISSTI III)**





# **Islamic Science, Technology and Innovation (ISSTI) for the Future**

Lee Yee Cheong

*Chairman, Governing Board, International Science, Technology and Innovation  
Centre for South-South Cooperation under the Auspices of UNESCO  
Kuala Lumpur, Malaysia*

## **Ladies and Gentlemen**

I would like to thank the Islamic World Academy of Sciences (IAS) and the Tatarstan Academy of Sciences for inviting me here and more importantly for agreeing to organize ISSTI III. I would also like to thank the Kazan State University for agreeing to host ISSTI III in its beautiful campus.

To set the scene, I would like to provide some background to ISSTI.

I have always been fascinated by history especially the rise and fall of empires. I fully subscribe to the premise ‘To know where we are going, we must know where we come from.’ As an engineer masquerading as a scientist due to my role in the formation of the Academy of Sciences Malaysia (ASM) and my interaction with the international scientific community through IAP, IAC and ICSU, I promoted the idea of the Islamic Science, Engineering and Technology Conference to ASM in the late 1990s, with negative result. There was a mindset that we should to look forward to advanced S&T in the West rather than wasting time in looking backwards.

In 2005, I was the then President of the World Federation of Engineering Organisations (WFEO), whose head office is in the NGO building in UNESCO Paris. I got to know UNESCO leadership better, particularly the Deputy Director General, Dr M. Barbosa, a noted aero-space engineer from Brazil.

I wrote to him to organize a ‘History of Science, Engineering and Technology Conference (HISSET).’ My approach was well timed, as UNESCO was then conducting a major cross-cultural initiative. UNESCO justified this initiative by stating that ‘until the discovery of the new world in the fifteenth century, the world witnessed the rise of successive civilizations each of which gave rise to the other, starting with the beginnings of science and civilization in Mesopotamia, Egypt and China, Greek, Hellenistic, Roman, Byzantine, Arab-Islamic, and West European. None of these could claim to be isolated from its predecessors. In fact, the history of science and civilization in the western world should be considered as one continuous history.’

UNESCO mounted an impressive exhibition called ‘Golden Age of the Arabic

Sciences' in Paris, October 2005-March 2006. The Exhibition was aimed to carry a message of goodwill to non-Muslim societies, and to remind them that Islamic science is part of their own heritage. It was the Islamic S.E.T. that sparked the European Renaissance. I suggested to UNESCO that it was equally important to spread the message to Muslims as well, as the contributions of Muslim scientists were not understood or appreciated in the Islamic world itself. In view of their apparent aversion to S.E.T seen to be Western, there is a pressing need to acquaint the youth in Islamic countries of their rich S.E.T heritage.

In 2005, the IAS held its 14<sup>th</sup> Conference in Kuala Lumpur. I lobbied IAS President, Professor Abdel Salam Majali and Director General Moneef Zou'bi to support HISET. The support received from IAS was unequivocal. To my great delight, Moneef is a great authority on the History of Islamic Science, Engineering and Technology and has been a fellow conspirator from the very beginning. Other supporters were Mohamed Hassan of TWAS, Nobel Laureate Professor Ahmed Zewail and then IAP Co-Chair, Professor Yves Quéré, IAC Co-Chair, and then USNAS President, Professor Bruce Alberts and Director of the Institute of Advanced Studies, Professor Zakri Abdul Hamid.

Responding to my proposal, UNESCO held a Symposium on the 'History of Islamic Science, Engineering and Technology (HISET)' as the closing event of the Exhibition in March 2006. Yves Quere spoke at the opening ceremony. Both Moneef and Zakri were present to hold my hands. Through the efforts of Dr El-Tayeb Mustafa, UNESCO Director on Science Policy and Sustainable Development, sponsorship was obtained from the Islamic Call Society. A great array of eminent historians of Islamic Science and Technology contributed to the success of HISET 2006 now renamed ISSTI 1. Professor George Saliba was present, so was Professor Djebbar of University of Lille, who later on went on to write a book on Islamic scientific experiments for school children. I feel very proud to have been the matchmaking in bringing the two of them together during ISSTI 1!

From the deliberations of ISSTI 1, I consider the outcomes to be as follows:

- To incorporate the rich Islamic S.E.T heritage and the present day Islamic S.E.T. role models into the textbooks and curricula both in the developed world and the developing world, particularly Islamic countries;
- To incorporate historic Islamic S.E.T experiments in the InterAcademy Panel inquiry based hands-on primary science education programme, led by the 'la Main a la pate' of the French Academy of Sciences;
- To have a travelling exhibition from the Paris Exhibition to Islamic countries;
- To rescue study and research centers in History of Islam S.E.T in Western universities from closure to repatriation to universities in Islamic countries;
- To organize subsequent Islamic S.E.T conferences.

The most important outcome of ISSTI 1 was the strong support of the then Minister of Science, Technology and Innovation Malaysia, the Hon. Dato Sri Dr

Jamaludin Jarjis on behalf of the government of Malaysia. In his keynote address at the opening of ISSTI 1, he committed Malaysia and his Ministry to collaborate with UNESCO in the follow-up of the ongoing UNESCO Initiative.

The baton was passed to Malaysia, which organised the 'Excellence in Islamic Science, Technology and Innovation' Exhibition in Kuala Lumpur, January-February 2007, with exhibits from the collection of Professor Sezgin of the Goethe Institute of the University of Frankfurt. Professor Sezgin was the honoured guest of the Exhibition and received an honorary professorship from the University of Technology with the understanding that it replicate his exhibits and writings. The Exhibition was visited by 300,000 people, mostly students. Most did not realize until then the splendour of Islamic S&T.

ISSTI II was jointly organised in Kuala Lumpur by the Ministry of Science, Technology and Innovation (MOSTI) Malaysia and UNESCO with a number of other international organizations like IAS, TWAS and again the Islamic Call Society in August 2007. ISSTI II extended the spectrum from eminent historians of Islamic S&T through present day Islamic S&T icons, to future S&T role players. Also, an important innovation of ISSTI II was the International Workshop for Young Muslim S.T.I practitioners.

The outstanding plenary and session keynote speakers and session speakers included Nobel Laureate Professor Ahmed Zewail, Professor Jeffrey Sachs, Professor Yves Quéré, Dr Walter Erdelen, Dr El-Tayeb Mustafa, Professor Mohamed Hassan, Professor George Saliba, Professor Gul Russell, Dr Djebbar, Dr Moneef Zou'bi, Tan Sri Omar Abdul Rahman, Dr Razley Nordin, Dr S.T.K Naim etc. The key role player was the Honourable Dato Sri Dr Jamaludin Jarjis, Minister of Science, Technology and Innovation Malaysia. The video and written presentations and other details of the symposium are available on the Internet [www.issti.gov.my](http://www.issti.gov.my)

Moneef Zou'bi offered during the OIC COMSTECH STI Policy Study Centre Workshop 29-30 March 2008 in Islamabad to hold ISSTI III during the 16<sup>th</sup> of the Islamic World Academy of Sciences in Kazan, Tatarstan in August 2008.

Here we are with Professor George Saliba, Yves Quéré, Mohamed Hassan offering once again their strong support by their presence. Dr El-Tayeb Mustafa asked me to convey his apologies to you all due to unavoidable circumstances but pledges UNESCO's continuing support.

It is my earnest hope that you all would think this initiative is well worth continuing.



# **The Role of Kazan University in the Development of Domestic and World Science**

M. KH. SALAKHOV  
*Rector of Kazan State University*  
*Kazan, Tatarstan, Russia*

The history of Kazan State University goes back more than two centuries. Celebration of the 200-year anniversary of the University in 2004 has confirmed its high status and significance of our historical achievements in the sphere of science, education, and enlightenment. Today, we aspire at further development of these traditions and try our best to maintain our brand at the world level.

Contribution of KSU to the development of science and, first, of fundamental science is quite significant. Moreover, this is not by chance. The very idea of the university matched the need of the European counterparts to combine scientific creativity with dissemination of theoretical knowledge. Centuries passed before historical role of the first universities had been appreciated. Then, it became clear that applied knowledge always stems from 'pure' science. The French thinker of the 19<sup>th</sup> century Josef Renan (foreign correspondent member of Saint-Petersburg Academy of Sciences) used to say, 'pure' science is unable to produce something immediately appreciated by society. Therefore, to eliminate the given injustice, the latter should invest in the development of 'pure' science in order to receive profit in future.

The first university outside the capital centers of the country – Saint-Petersburg and Moscow, was founded in 1804 as the classical educational institution focused on maintenance of close alliance between science and education. The founding of the university contributed to the modernization of the country initiated by Peter I, whose reforms changed the very relationship between science and education through combination of a scientific 'Humboldt University' with the French model. Under the influence of Leibniz, Peter the Great introduced the given model in Russia. At that time, French universities concentrated exclusively on education, whereas science developed only in the Academy.

Therefore, initially Russia had two centers for the development of science – universities and the Saint-Petersburg Academy of Sciences. However, one should not exaggerate the case. Famous doctor and organizer of science of the 19<sup>th</sup> century Nikolai Pirogov used to say, that 'actually there was no difference between academy and university. Those who moved science forward, simultaneously educated students.'

Thanks to the efforts of brilliant cohort of scholars and teachers, Kazan University soon became a real classical university aimed at the development of fundamental science. However, the watershed between applied and fundamental sciences is conditional. Applied sciences use the results of fundamental research, whereas practical application of such assumes 'intrusion' into the content and methodology of theoretical knowledge. Moreover, theorists usually opt for finding solutions both to cognitive and social-practical problems.

During the first 100 years of its existence, KSU produced fifteen full members and over thirty honorary and associate members of the Academy of Sciences.

There were several preconditions to the development of science in the Kazan University. Since the very beginning, the government granted strong financial support to the university, enough to bring in leading scientists from abroad. Research program of N. I. Lobachevsky gave a strong impetus to the development of science at KSU. His geometry turned out to be not only a brilliant mathematical theory, but also a new philosophy of the world. The university has become the 'universe of sciences,' and the realm of interaction between different scientific methods and public opinions.

KSU boasts of a number of world-famous research schools founded by chemists Klauss and Zinin, astronomer Simonov, biologists and doctors Bekhterev and Vishnevsky, linguist Baudouin de Courtney, orientalists Kazem-Bek and Vasiliyev; in Soviet times – physicists Zavoisky, Altshuler, Kozyrev, Petrov, chemists – father and son Arbuzovs, and many other bright scientists. Alexander Arbuzov, founder of chemical school of phosphor-organists, used to emphasize the role of Kazan as the cradle of Russian chemistry. To some certain extent, this is also true about a number of other systems of knowledge – modern mathematics, physiology of animals and plants, Earth sciences, astronomy, 'Far North' studies, etc. Overall, the scientific activities of Kazan University took an active part in the formation of a scientific picture of the world of modern and contemporary history.

Our famous scientists were quite aware of an extraordinary significance of the university for the continuation of scientific traditions. Founder of the world-known Kazan chemical school, Rector of Kazan University Butlerov introduced radical changes to the university education in Russia. His ideas laid the basis for the development of a neat program of teaching in natural sciences and insured the formation of strong scientific character of education. Butlerov insisted on the significance of preparation of new generations of scientists. Thus, universities strived at the development of natural sciences, maintenance of strong scientific component in education process and popularization of scientific knowledge. Although key participants in public life of that time opted for political radicalism or imperial power, Butlerov promoted different ideas, insisting that in order to move forward, to change to the better, the society should arrive at understanding that 'science is the best source of its power,' whereas 'knowledge and development always go the same way.' Who would say that these words have lost their deep meaning nowadays?

Science is an international phenomenon. Therefore, KSU scientists have been always actively mastering the world science realm. They maintained strong contacts with largest scientific societies of that time – Astronomy and Asian societies in Paris, Asian and Royal societies in London, academies of sciences in Brussels, Berlin, Lisbon, and other cities. Tubes with chemical regents sent by Kazan scientists to their French colleagues in the 19<sup>th</sup> century are still carefully kept at College de France.

Apart from this, Kazan University and the city of Kazan had been glorified by many cultural workers, social thinkers, and politicians, to include writers Gavriil Derzhavin, Leo Tolstoi and Sergei Aksakov, Melnikov-Pechersky and Maxim Gorky, Velimir Khlebnikov, politicians Lenin and Rykov.

At the end of the 19<sup>th</sup> – beginning of the 20<sup>th</sup> century - KSU stayed in touch with prominent Turkic-Tatar enlighteners Shigabutdin Mardzhani, Husain Faiskhanov, Kauym Nasyri, Gayaz Iskhaki, Izmail-Bei Gasprinsky, Sadri Maksudi, Galimzhan Ibraghimov, and many others.

KSU-based public lectures of prominent Tatar historian Gainetdin Akhmarov, founder of Kazan ‘Oriental Club’ (Sheryk Klouby), won great popularity among the wide public. At ‘Oriental Club’ Kazanites also enjoyed lectures of such outstanding representatives of Tatar culture, as Gabdulla Tukai, Fatikh Amirkhan, Galiaskar Kamal, public and religious activists brothers Sharafs, and others. In the 20<sup>th</sup> century, KSU associates with the names of composer Salikh Saidashev and hero of antifascist resistance poet Musa Djalil.

Due to a number of cultural and historical preconditions, since the first years of its existence Kazan University managed to maintain optimal balance between general and special disciplines. Anglo-Saxon universities started to address practical commitments. In Germany, famous politician and scientist Humboldt organized a university of a new type, based on the idea of promotion of free scientific research opportunities. Russia experienced combination of these two approaches even earlier than the western countries. In the beginning of the 19<sup>th</sup> century, the state persistently involved classical universities in practical activities. At the same time, it did not prevent them from free scientific research undertakings. Overall, Kazan University maintained its strong position and status in conditions of rapidly developing network of higher education institutions, where the number of institutions had increased from seven universities by the end of the 19<sup>th</sup> century to 12 by 1917.

Emergence of more than 300 various academic communities on the eve of the 20<sup>th</sup> century was conducive to the development of interaction between the Academy of Sciences and university professorate. Nine such communities had been organized at Kazan University, to include Society of Physics and Mathematics, Society of Psychiatrists and Neuropathologists, Society of Archaeology, History and Ethnography, etc. However, in Soviet times the very tendency of close association of university and academic science had not received further development. Instead, the emphasis had been made on narrow specialization of higher education.



Old universities with their worldview based on pluralism and democracy in education contradicted new political principles. Ten of eighteen universities were closed down in pre-war decades, including Kharkov University, the age-mate of KSU. The threat of liquidation hovered over Moscow State and Leningrad State universities. In 1931, Kazan University had only two faculties, Faculty of Physics and Mathematics and Faculty of Geology and Biology. Rector of Kazan University, outstanding chemist Kamai criticized the reduction of faculties at the session of rectors of the USSR universities, saying that five new institutes formed based on KSU deprived the latter of everything, 'down to Director's chair.' With irony he added, 'Kazan University used to be rich and famous. Its riches had been taken away, but it retained its glory.'

Meanwhile, scientific and technical development of the country required the revival of the university system. However, fundamental science was still the sphere of competence of various structures of the Academy of Sciences, whereas universities focused at the development of applied science only. KSU Docent Zavoisky who had made one of the most significant discoveries in contemporary physics – the phenomenon of electronic paramagnetic resonance, had to overcome many serious obstacles at that time. Scientific career of his students, prominent representatives of university science Altshuler and Kozyrev, was also far from being ideally smooth. The same is true about famous mathematician, Lenin Prize winner Petrov, Head of the Department of Relativity and Gravitation Theory, and a number of other scientists. Conditions for the development of fundamental science were very unfavorable. The more important is the contribution of Kazan scientists and scholars from other Russian classical universities. Sometimes, success was possible only through contradiction to the system in force. Scientific community should never forget about this.

Science is a special matter. It strives at the replenishment of the existing gaps. One can hardly imagine scientific research without interaction between representatives of various scientific centers, which at different times went differently. In 1920s – the end of 1930s the development of science in Kazan and the republic was supervised by the Academic Center of the People's Commissariat for Enlightenment of the Tatar Autonomous Soviet Socialist Republic. The activity of the latter laid the basis for the development of the unified academic system in the country. Sometimes life makes sudden turns: in the very beginning of the war, elite academic scientific institutions were moved to Kazan. The city hosted the panel of the Academy of Sciences chaired by vice-presidents Shmidt and Chudakov, key academic scientific institutions, about 2000 staff members. The development of science at the university got new powerful impulse.

In the victorious 1945, scientific potential of Kazan University was widely used in the course of organization of official structure of the so called 'big academy' – Kazan branch of the Academy of Sciences of the USSR, initially headed by KSU professor Alexander Arbuzov, who always maintained contact with Kazan University. Apart from that, KSU produced many talented scholars

and outstanding organizers of science who later headed large institutions of the Academy of Sciences of the USSR – astronomer and mathematician Perevoshikov, mathematician Lavrentyev, historian Nechkina, physiologist Parin, biologist Bayev, geologist and petroleum expert Trofimuk, physicist Valiev, and others.

Every classical university has its own history of science. During the World War II, Kazan University played important role in the development of scientific potential of the country. The majority of Moscow and Leningrad institutes of the Russian Academy of Sciences were moved to Kazan. For some time, Kazan became the main research center of Russia. Although scientists worked for the defense industry, science has its own logic: applied projects required theoretical justification. Not by chance, 15 of those who worked then at KSU were elected members of the Academy of Sciences already during the war, whereas 99 scientists got membership in the post-war period.

In 1944 Evgeny Zavoisky, then Docent of Kazan University, discovers the phenomenon of electronic paramagnetic resonance (EPR) – perhaps, last fundamental property of matter discovered in the 20<sup>th</sup> century. KSU scientists are successfully developing nowadays Zavoisky's heritage.

The world is changing rapidly, and fundamental science faces new problems. Interestingly enough, the development of fundamental science stems from the basic ideas of modern science, which were first suggested more than half a century ago. If the first half of the 20<sup>th</sup> century witnessed the emergence of several branches of science, which have changed the picture of the world, such as quantum mechanics, relativity theory, and genetics, then the situation in the second half is different. Today's fast development of engineering is essentially based on the achievements of scientific-technical revolution of the end of 19<sup>th</sup> – middle of the 20<sup>th</sup> century. Theoretical science more than ever needs to find radically new approaches. Nowadays it is necessary to search and find optimal balance between innovations and traditions, academic advantages and economic relevancy.

The development of science at KSU has been always influenced by the geographical location of the university – the most eastern European one. Last year we celebrated the 200-year anniversary of the Department of Oriental Linguistics.

According to the outstanding Finnish ethnographer Matias Castren who had visited KSU in the middle of the 19<sup>th</sup> century, 'there is hardly any other university in the world where students would study Oriental literature with such zealously as they do it at Kazan University.' He has distinguished several teachers of Oriental languages – natives of Oriental countries: Khadji Mir Abu-Talib Mir Mominov, Mirza Abd-us-Satar Kazem-Bek, Mukhamed-Ali Makhmudov, and Alexander Kazem-Bek.

Oriental Faculty consisted of six departments: Arab-Persian, Turkish-Tatar, Mongol, School of Chinese-Manchuria philology, Sanskrit, and Armenian language. Because of these six departments the glorious Oriental Department of Kazan University had been formed. The given scientific center focused simultaneously on preparation of specialists in Oriental Studies and

enlightenment. Members of Oriental Department managed to accumulate huge volume of materials related to country studies and form a comprehensive collection of oriental manuscripts. The Department also published compendiums and dictionaries, translated works of oriental authors.

The Oriental Studies Department at the KSU is inextricably connected with the studies of Turkic-Tatar culture and history of multinational Volga river region. The university moreover always paid special attention to culture and history of native population. German scientist Karl Fuks, Rector of the university, wrote the book 'Kazan Tatars in Statistics and Ethnography,' which is still of interest and importance to the academic world.

Nowadays, Kazan University aims at further development of Oriental Studies. In the spring of 2000, the KSU Oriental Studies Institute was opened.

KSU hosts the regional Turkic Studies Center functioning with financial support of the Turkish International Cooperation Agency (TICA). Our students and teachers study and upgrade qualification in Egypt, Turkey, Taiwan, Korean Republic, and other countries.

Sinology is being actively developed, too. Following the visit to KSU by the Chairman of People's Republic of China Hu Jintao, who highly appreciated the achievements of Kazan University in the sphere of science and enlightenment; it was decided to open the Confucius Institute at KSU.

Our Oriental Studies strategy reaches far beyond the academic sphere. Economic cooperation and prosperity are based on moral values informed by the culture of hope and optimism. Therefore, we pay special attention to establishment of contacts with embassies and public organizations of Turkey, India, Republic of Korea, People's Republic of China, Arab and other countries.

Mongi Busnina, Director General of the Arab Organization of Education, Culture and Science (ALECSO) under the League of Arab States took part in the celebration of the 200-year anniversary of KSU. Within the framework of his visit, KSU and ALECSO signed the Agreement on Cultural and Educational Cooperation.

At present, Russia undergoes system-level modernization of higher education. A network scientific-educational center of the world level is being created. KSU actively participates in the process. We see our university as a classical educational institution of tomorrow, opened to external challenges, global market of knowledge and technologies.

While looking into future, we honor our cultural-political traditions. Since the very beginning, a geopolitical task of Kazan University was to study and master both the Russian East and foreign East, in the broadest sense of the word.

Our present goal is to increase our scientific-innovative potential in order to contribute to a stable development of multinational Republic of Tatarstan and the Volga region, to use our potential for sake of scientific study of the East, to assist the government of Russia in political relations with Oriental states, especially with Islamic world countries.

# The Rise and Decline of Science in the Muslim World

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## 1 ABSTRACT

According to George Sarton, Muslims were the leaders of science for six centuries during which – for about 350 years [1] - they were the sole bearers of the flag of science.

There is no doubt that the development of science in the Muslim world got momentum with the translation of books from Greek and other sources. But, as to the extent of Muslim scholars' contribution to the development of Greek philosophy and science, there are different opinions among Western scholars.

During the glorious Islamic civilization all sciences blossomed, but there were several factors that were behind the rise of science in the Islamic world which will be discussed.

## 2 FACTORS AFFECTING THE RISE OF SCIENCE IN ISLAM

The first two of the following factors are the real source of the others.

### 2.1 The recommendations of the Qur'an and Sunnah for the study of nature

The Qur'an has frequent references to natural phenomena and invites people to explore natural phenomena and to contemplate about them:

قُلْ اَنْظُرُوا مَاذَا فِي السَّمَاوَاتِ وَالْأَرْضِ ... (يونس/ ١٠١)

*"Say: Behold what is in the heavens and in the earth ... "(10: 101)*

قُلْ سِيرُوا فِي الْأَرْضِ فَانظُرُوا كَيْفَ بَدَأَ الْخَلْقَ ... (العنكبوت/ ٢٠)

*"Say, journey in the earth, then behold how He originated creation ... "*  
(29: 20)

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**In my view, the Qur’anic urge for the study of nature was the main cause of the rise of science in the Muslim world. George Sarton, too, believes that in order to understand the motive behind Muslim scientists’ engagement with various scientific fields, one should note the axial role of the Qur’an for them:**

*“I ask once more, how could we reach a correct understanding of Muslim science if we did not fully grasp its gravitation around the Qur’an.” [2]*

## **2.2 The urge of Sunnah to seek knowledge from any source**

We begin with a well-known *hadith* of the **Holy Prophet** where he urges Muslims to seek knowledge even in China:

اطلبوا العلم ولو بالصين

*"Seek knowledge even if it be in China." [3]*

and it is narrated from **Imam Ali**:

“العلم ضالة المؤمن فخذوه ولو من ايدي المشركين”

*«Knowledge is the lost property of a believer; thus, acquire it even it is in the polytheists’ hands.» [4]*

Thus, Muslims assimilated knowledge from whatever source they got, and within a short time they assimilated most of the sciences of their time and molded them within their Islamic outlook. For example, al-Biruni went to India and lived among Indians and learnt their sciences and their customs and gave an unbiased report of their thought and living.

It is interesting that while Islam does not permit the reliance of Muslim on non-Muslims, it does not put any boundary for learning.

## **2.3 The encouragement of scholars by the rulers**

Many of the rulers throughout the Muslim world respected scientists of various religious denominations. Furthermore, the financial needs of scholars were compensated, and in some cities, students were financially supported. Furthermore, both the rulers and the rich established various schools in which everything was thought. Furthermore, some rich people made endowments for running the schools. There were many libraries in various cities, to which people flocked from far places. Some of these libraries contained several hundred thousand books. Thus, there was a suitable environment that provided the necessary grounds for the development of science

## 2.4 The prevalence of the spirit of tolerance and academic freedom

The prevalence of the spirit of tolerance and the presence of academic freedom made collaboration and the exchange of ideas between scholars, belonging to various religions or schools of thought, possible. Thus, Muslim, Christian, Jewish and Zoroastrian scientists gathered together at the court of *Khulafa* or local rulers. This led to the flowering of various sciences and all kinds of intellectual activity.

## 2.5 The lack of prejudice and the prevalence of rationality

Proof, evidence and rational reasoning was the rule of thumb in Muslim scientists' scientific work. **Ibn Sina** said clearly that:

”من تعوّد ان يصدّق من غير دليل فقد انسلخ عن الفطرة الانسانية“

*“Whoever confirms something without any reasoning, he has deviated from the track of human nature.”[5]*

and **Beihaqi**, an eminent Muslim historian, wrote:

*“Now that I have decided to write this history book, I have committed myself to write either about what I have seen myself or I have heard it from a reliable person.”[6]*

This was rooted in the Qur’anic injunction:

وَلَا تَقْفُ مَا لَيْسَ لَكَ بِهِ عِلْمٌ ۚ إِنَّ السَّمْعَ وَالْبَصَرَ وَالْفُؤَادَ كُلُّ أُولَٰئِكَ كَانَ عَنْهُ مَسْئُولًا  
(الاسراء/ ٣٦)

*“Do not follow that of which you have no knowledge. Indeed the hearing, the eyesight, and the heart – all of those are accountable.”  
(17: 36)*

Thus, it was in this spirit that **Ibn al-Haytham** said:

”فطالب الحق ليس هو الناظر في كتب المتقدمين، المسترسل مع طبعه في حسن الظن بهم، بل طالب الحق هو المتهم لظنه فيهم، المتوقف فيما يفهمه عنهم، المتبع الحجة والبرهان لا قول القائل الذي هو انسان، المخصوص في جبلته بضروب الحال و النقصان. والواجب على الناظر في كتب العلوم، اذا كان غرضه معرفة الحقائق، ان يجعل نفسه خصماً لكل ما ينظر فيه، و يجيل فكره في منته و في جميع حواشيه و يخصمه من جميع جهاته ونواحيه، ويتهّم ايضاً نفسه عند خصما له فلا يتحامل عليه ولا يتسمح فيه. فانه اذا سلك هذه الطريقة انكشفت له الحقائق، وظهر ما عساه وقع في كلام من تقدمه من التقصير والشبه.“[7]

*“Therefore, the seeker after the truth is not one who studies the writings of the ancients and, following his natural disposition, puts his trust in them, but rather the one who suspects his faith in them and questions what he gathers from them, the one who submits to argument and demonstration, and not to the sayings of a human*

*being whose nature is fraught with all kinds of imperfection and deficiency. Thus, the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and applying his mind to the core and margins of its content, attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency.” [8]*

The prevalence of rationality and lack of prejudices was one of the most important factors in the flowering of natural sciences in the Islamic lands.

## 2.6 Freedom of immigration in Darul-Islam

An important factor in the prevalence of science in the Islamic lands was the feeling of Muslim scientists that all parts of *Darul-Islam* was their land. Thus, if they did not have an easy feeling about their birth place or they thought that they could benefit from a specific teacher or school at another place, they immigrated easily to another land which could be under another ruler. There was a general feeling that one has to get knowledge from the best sources available. Our prophet’s urge to get knowledge from anywhere, including China, and his counting the traveling for the acquisition of knowledge as an act of worship was definitely an impulsive push in this regard. In the words of **Ibn Khaldūn** in his *al-Muqaddimah*:

“فالرحلة لابد منها في طلب العلم لاكتساب الفوائد والكمال بلقاء المشايخ ومباشرة الرجال.”

*“Traveling is necessary for the acquisition of knowledge, in order to benefit and become mature through meeting great scholars and having the companionship of great men” [9]*

It was with this spirit that **Masoudi**, one of the greatest Muslim geographers, who was born in Baghdad, went to Syria, Palestine, Saudi Arabia, Zanzibar, Iran, Central Asia, India and even to the China sea, and gathered his data into 30 volumes which was reduced to the present *Morouj-Azzahab* (in 4 volumes).

An important factor that helped this along was the fact that the existence of disputes between the rulers of different lands didn’t stop migrations (contrary to what is the case today). As **Adam Metz** explains:

*“A Muslim could travel in Darul-Islam under [the protection of] his religion and its flag, and there he would see people who worship the unique God that he worships and do prayer in the same way that he does, and have the same religion, rituals and traditions. There was a practical rule that guaranteed the citizenship for every Muslim, so that throughout that extended land nobody could harm his freedom or take him as a slave. Indeed, Naser Khosro traveled throughout all these lands during the 5<sup>th</sup> century (11<sup>th</sup> century AD)*



*without encountering any of the problems that a German met during the 18<sup>th</sup> century while traveling in Germany.” [10]*

## **2.7 The unity of sciences**

For Muslim scholars, the source of all knowledge was God. They didn't differentiate between specifically religious sciences and the sciences of nature. The aim of studying the latter was the cognition of nature, as the handiwork of God. The sciences of nature are to show the unity of the Creator from the unicity of nature - which is exactly the aim of the religion. It was for this reason that they taught all sciences at the same schools, and some scholars were experts in philosophy, sciences of nature and the specifically religious sciences at the same time. They were often relating various sciences together in order to give a coherent picture of them.

## **3 DECLINE OF SCIENCE IN THE MUSLIM WORLD**

From the early 12<sup>th</sup> century, the decline of sciences in the Islamic world started. By decline we mean that the pace of scientific activity slowed down. Of course, it is not true that after the 12<sup>th</sup> century, there was no more worthy science in the Islamic lands. In fact, there were outstanding scientists and original contributions to the scientific knowledge in the second half of the 12<sup>th</sup> century and in the 13<sup>th</sup> century and even later. Such works as the great Maragha observatory and later the Samarkand observatory paved the way for Copernicus. But, by and large, the initial impetus was lost due to the reasons mentioned below. In most of the schools (*madradas*) that were founded from the 12<sup>th</sup> century on, the teaching of philosophy, mathematics and natural sciences was, more or less, abolished. These schools' curricula consisted mainly of the literature and specifically religious sciences. The teaching of rational sciences became restricted to private classes. Thus, rational sciences lost their splendour, and the number of distinguished scientists and innovative works dropped appreciably. Of course, the decline was neither simultaneous nor equal in all fields of science and all regions of the Islamic world. For example, philosophy continued to flourish in parts of *Dārul-Islam* (e.g. Iran) and, in fact, some important philosophical schools (e.g. **Mulla Sadra's** transcendental philosophy) appeared at the down of modern science.

Scholars have given various reasons for the decline of scientific activity in the Islamic lands:

1. The prevalence of fanaticism and mysticism;
2. Invasion of Mongols on Islamic lands (during the 13<sup>th</sup> century);
3. The invasion of Crusaders on Islamic lands;
4. Political disputes throughout the Islamic lands, that lead to political instability and unstable environments and lack of financial support for scientific work.



Here, I do not want to negate the destructive effect of the Mongol invasion or the Crusaders on the social and economic set up of the Muslim world. But, in my humble view, the main impetus for the decline of science in the Islamic world was the growth of anti-rational currents, specifically the development of a theological school, that opposed the teaching of philosophy and the sciences of nature and excluded these subjects from the curriculum of most of the religious schools and confined their curriculum to specifically 'Islamic sciences.' This was due to the prevalence of the belief in the existence of conflict between the specifically religious sciences and rational sciences. Of course, not all of the theological schools had this anti-rational sentiments. But, for some noticeable period, the aforementioned theological school was supported by the rulers. The prevalence of mysticism in the 11<sup>th</sup> and 12<sup>th</sup> centuries fortified the anti-rational current. Mystics considered philosophy and rational thinking as a barrier (*hijab*) for understanding world's realities. Thus, e.g., in the *Nezāmiyah* schools only specifically religious sciences were thought.

The mentality behind the neglect of rational sciences, as we said, was that they might eventually harm religious convictions. As **Imam al-Ghazzali** put it:

”وإما طبيعيات؛ فالحق فيها مشوب بالباطل والصواب فيها مشتبّه بالخطأ“

*"But in the natural sciences, the truth is mixed with the falsehood and right is being mistaken by wrong." [11]*

As for mathematics, **Imam al-Ghazzali** thought that it is harmless by itself, but since it is preliminary to rational sciences, it could also lead to perversion:

”أما الرياضيه: فتتعلق بعلم الحساب والهندسة وعلم هيئة العالم، وليس يتعلق شئ منها بالأمور الدينيه نفيًا و اثباتًا، بل هي أمور برهانية لاسيلى الي مجادحتها بعد فهمها و معرفتها، و قد تولدت منها آفتان: **أحدهما:** ان من ينظر فيها يتعجب من دقائقها ومن ظهور برهينها، فيحسن بسبب ذلك اعتقاده في الفلاسفه و يحسب ان جميع علومهم في الوضوح [وفي] وثاقه البرهان كهذا العلم. ثم يكون قد سمع من كفرهم و تعطيلهم و تهاونهم بالشرع، ما تداولته الالسنه فيكفر بالتقليد المحض ...

**الآفة الثانية:** نشأت من صديق للاسلام جاهل، ظنّ أنّ الدين ينبغي ان ينصر بانكار كل علم منسوب اليهم، فانكر جميع علومهم وادعي جهلهم فيها حتي انكر قولهم في الكسوف والخسوف، وزعم أنّ ما قالوه علي خلاف الشرع فلما قرع ذلك سمع من عرف ذلك بالبرهان القاطع، لم يشك في برهانه. ولكن اعتقد ان الاسلام مبني علي الجهل و انكار البرهان القاطع، فازداد للفلسفة حبًا و للاسلام بغضاً.“

*“As for mathematics which involves arithmetic, geometry and astronomy, no part of it is related to religious affairs, positively or negatively, but it consists of things based on arguments for which there is no way to deny after one understands them, but it brings up two kinds of damages.*

*First, whoever looks at it, he would be surprised by its precision and the explicitness of its arguments. Thus, his belief in philosophers becomes positive, and thinks that all of their sciences are clear and*

*based on argument as this science is. Then, one hears from others about their unbelief and their negligence and contempt of religion, and imitating them he loses his faith, and says: if religion was right, it would not be left hidden to these people which have so much precision in this science.*

*The second damage arises from one who is a true believer in Islam and is ignorant and thinks that to support religion one should deny all sciences attributed to them: thus, he denies all of their sciences and claims that they are ignorant about them. He even denies their sayings about solar and lunar eclipse, and thinks that whatever they say is against religion. Then, when somebody whoever knows these sciences by definitive arguments hears about this, he does not doubt about his own argument, but believes that Islam is based on ignorance and the denial of definitive arguments. Thus, his love for philosophy is fortified and his animosity toward religion increases”[12].*

and **Ibn Taimiyyah** said:

”العلم الموروث عن النبي (ص) هو الذي يستحق ان يسمي علماً، و ماسواه اماً ان يكون علماً فلا يكون نافعاً و اماً لا يكون علماً و ان يسمي به و لئن كان علماً نافعاً فلا بد ان يكون في ميراث محمد (ص).“

*“The knowledge inherited from the prophet is what is supposed to be called knowledge. The rest is either knowledge but not beneficial, or is not knowledge, even if it is called so; and if it is useful knowledge, then such knowledge must be in the heritage of Muhammad (SA)” [13].*

This kind of mentality was not confined only to the Eastern *Dar-islam*, but it even penetrated the Western part of it. Thus, e.g., we read in **Ibn Khaldūn**’s *al-Muqaddimah*:

”أنه ينبغي لنا الاعراض عن النظر فيها [أي مسائل الطبيعيات] اذ هو من ترك المسلم لما لا يعنيه. فإن مسائل الطبيعيات لا تهمنا في ديننا ولا في معاشنا فوجب علينا تركها و اما ما كان منها في الموجودات التي وراء الحس وهي الروحانيات ويسمونه العلم الالهي و علم مابعد الطبيعة فإن ذواتها مجهولة رأساً ولا يمكن التوصل اليها ولا البرهان عليها.“

*“It is appropriate to avoid thinking about them [i.e. natural sciences], because this is [an illustration] of a Muslim neglecting what is not useful for him because the problems of natural sciences are neither important for our religion nor for our living. Thus, it is necessary that we leave them out. As for the case of their arguments for the of beings that are beyond our senses, i.e. spiritualities, what is called knowledge of God and metaphysics, their essences are completely unknown and one cannot have access to them, nor can one argue for them” [14].*

#### 4 QUESTIONING THE QUESTIONS!

In the last hundred years , Western scholars have argued about why there was a decline in science in the Muslim world or about why Islamic science did not lead to modern science. Here, we summarize their reasoning.

1. Some western scholars have speculated that the reason for the non-development of sciences in the Islamic world was because in the Muslim mentality everything is attributed to God directly and there is no room for secondary causes or laws in nature.

*This claim is false, as it refers only to one school of theology in the Islamic world. This school of theology, however, was strongly supported by some Muslim rulers during the 11<sup>th</sup> and 12<sup>th</sup> centuries who supported that school of thought and suppressed others. But, all Muslim philosophers as well as other important theological schools believed in strict causality and supported the idea of secondary causes.*

2. Some Christian scholars have speculated that science developed in Europe and not anywhere else, because of the unique features of Christian theology. The leading scientists of the 16<sup>th</sup> and 17<sup>th</sup> centuries were devout Christians who considered their duty to comprehend God's handiwork. Furthermore, some of the presuppositions of science were lacking in the Muslim world.

*But, those very presuppositions of science that they claim have paved the ground for the development of modern science, were also present in the Islamic outlook and with a stronger urge. The Qur'an and Sunnah are full of recommendations for the study of nature, as signs of God. Furthermore, most of the eminent Muslim scientists admitted explicitly that the main motive for their study of nature was to comprehend God's handiwork in nature.*

3. Some other Western scholars claim that Muslim scientists lacked the intellectual capacity for innovation and were simply transmitters of knowledge to medieval Europe. The Islamic scientific work was mainly empirical and directed towards practical applications, and studies that did not lead to useful results were discouraged. Islamic science lacked the strong urge to understand the physical world. In the words of **Bertrand Russell**:

*"Mohammedan civilization in its greatest days was admirable in the arts and in many technical ways, but it showed no capacity for independent speculation in theoretical matters. Its importance, which must not be underrated, is as a transmitter" [15].*

In Russell's view, they were essentially commentators of Aristotle and Neoplatonists in logic and metaphysics, Galen in medicine and Greek and Indian sources in mathematics and astronomy [15].

*The claim that the Islamic science was mainly empirical is not true. In fact, Muslim Mathematicians did some of the most abstract things. It is enough to look at the works of **Ibn al-Haytham** on physics, **Khayyam** on algebra and **Tusi** on astronomy. Here, I give several examples:*

- *Both Khayyam and Tusi challenged Euclide's fifth postulate [16];;*
  - *Al-Razi wrote a treatise in which he criticized Gallen [17];*
  - *Ibn al-Haytham criticized Ptolemy's optics and had innovations in the theory of optics [18];*
  - *The works of Al-Kharazmi in algebra involved real innovations relative to the Greek inheritance.*
4. Some writers, Muslim and non-Muslim, claim that modern science did not develop in the Islamic lands, because Muslim scientists had a lot of prejudice for their predecessors' heritage and lacked the courage to go beyond the received view. They talk about the progressive nature of modern science and the stagnating nature of scientific thought in the Arabic-Islamic context. They claim that Muslim scientists were conservative whereas Western scientists were revolutionary. This is far from the truth. The objections of al-Razi to Galen, al-Biruni to the Aristotelian physics, the innovations of Ibn al-Haytham (Alhazen) in optics are good evidences for this. Thus, **al-Razi** wrote a monograph in which he criticized some philosophical and medical views of Galen, and in response to those who criticized him for making objections to a distinguished philosopher-scientist of the caliber of Galen, said:

”لكن صناعة الطب والفلسفة لا يحتمل التسليم للروساء، والقبول منهم ولا مساھلتهم وترك لاستقصاء عليهم، و لا الفيلسوف يحبّ ذلك من تلاميذه و المتعلمين منه.“

*“But, the fields of Medicine and philosophy do not admit submission to authorities and accepting their views, and going along with them and leaving out exploration beyond them. Similarly, a philosopher does not like this attitude from his students or those who learn from him” [19]*

Similarly, Ibn al-Haytham wrote a monograph in which he challenged some of the views of Ptolemy. The following quotation from **Ibn al-Haytham** (in his book *Doubts Concerning Ptolemy*) shows explicitly the revolutionary character of some Muslim scientists:

يعني ان الهيئة التي فرضها ليس تؤثر في حركات الكواكب، و هذا القول ليس بعذر في فرضه هينات باطللة لا يصح وجودها. لانه اذا فرض هيئة لا يصح وجودها، ثم كانت تلك الهيئة تؤدي حركات الكواكب في تخيله علي ما هي عليه يخرج ذلك من ان يكون غالطاً فيما فرضه من الهيئة، لانه لا يجوز ان تكون حركات الكواكب الموجودة علي هيئة لا يصح وجودها .

[20]

*“Ptolemy assumed an arrangement (hay’a) that cannot exist, and the fact that this arrangement produces in his imagination the motions that belong to the planets does not free him from the error he committed in his assumed arrangement, for the existing motions of the planets cannot be the result of an arrangement that is impossible to exist ...” [21].*

## 5 CONCLUSION

With this kind of mentality, had the intellectual atmosphere of the golden era continued, the Muslim world would have preceded the Western world in developing modern science.

In summary, I believe that the main impetus for the rise of science in *Darul-Islam* was due to the strong urge of the Qur’an and *Sunnah* for the study of nature. This led to the development of rational sciences in the Muslim lands. The weakening of rational sciences due to some internal factors, undermined the Qur’anic urge, and the growth of mysticism and the division of Islamic lands furthered the stagnation of rational sciences.

To establish a new up to date Islamic civilization requires a return to the strong recommendations of the Qur’an and *Sunnah* about the experimental and theoretical study of nature, accompanied by a real determination on the part of Muslim scientists and rulers to establish such a civilization.

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# **Ibn al-Haytham's Contributions to Optics, Art, and Visual Literacy**

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## **1 INTRODUCTION**

In his book, “Secret Knowledge: Rediscovering the Lost Techniques of Old Masters,” the artist David Hockney reported visual discoveries within some of the best-known European paintings that affect long-held understandings of the development of western art over the course of the past 600 years (2001, 2006). Subsequently, a collaboration combining the visual skills of one of the world’s greatest artists (Childers, 1996; Langmuir & Lynton, 2000) with the analytical skills of an optical physicist (Charles M. Falco), resulted in Hockney and Falco developing the foundations of a new methodology for extracting information from complex, optics-based images (Hockney & Falco, 2000, 2004, 2005a, 2005b, 2005c). As will be discussed in this paper, this methodology also contributes to our burgeoning understanding of visual literacy.

Visual literacy is not limited to the narrative and symbolic qualities of pictures and images (Duncum, 2001; Hockney, 1998), but it is also rooted in the scientific and cultural study of optics and the visual system (Edgerton & Steinberg, 1987; Greenstein, 1997; Grootenboer, 2007). As we will discuss, the genesis of this concept can be traced to the work of the 11<sup>th</sup> century Arab polymath, Ibn al-Haytham (Latinized Alhazen or Alhacen), whose scientific exploration of vision significantly impacted the study and practice of visual art, as well as our cognitive capacity to interpret it.

## **2 HISTORIC THEORIES OF VISION**

During the first two centuries of the Islamic Golden Age (8<sup>th</sup>–13<sup>th</sup> centuries), translation of ancient writings on the science of optics offered contemporary intellectuals with various philosophical theories of vision. Euclid, Ptolemy, Galen



and Aristotle, whose Greek texts were translated into Arabic during this period, provided disparate views on the way the organ of the eye reacts with light to aid in vision. Greek theories were largely appropriated by Islamic scholars until the first quarter of the 11<sup>th</sup> century, when a new method of inquiry was introduced by Ibn al-Haytham. With the “scientific method” he introduced to the world, al-Haytham used experimental evidence to develop a remarkably accurate theory of vision. His design and interpretation of elegant experiments became the root source for Western understandings of optics up to the 17<sup>th</sup> century (Lindberg, 1967).

Born in Basra in 965, Ibn al-Haytham primarily worked in Cairo’s al-Azhar Mosque – an epicentre in for academic inquiry – where he wrote prolifically on subjects as diverse as poetry and politics. He is primarily known however, for his writings on geometrical optics, astronomy, and mathematics. His landmark seven-volume treatise on the human visual system, *Kitāb al-Manāẓir* [Book of Optics], published sometime between 1028 [418 A.H.] and 1038 [429 A.H.], was incorporated throughout the core of post-Medieval Western culture. This seminal work initiated an unbroken chain of continuous development of the modern understanding of both optics (i.e. science), as well as understandings related to two-dimensional pictorial representations of three-dimensional space (i.e. art).

Prior to the work of Ibn al-Haytham, theories of vision could be broadly classified into one of three categories: extramission, intromission, or a combination of the two. Extramission theories require some sort of illuminating particles be emitted by the eye. Euclid and Ptolemy are well-known scholars associated with this category (Lindberg, 1981). Although there are obvious flaws with extramission theories, they do get the geometry right, with a one-to-one correspondence between points on the object and points on the eye. Intromission theories, with Aristotle as a prominent proponent, postulated that objects continuously sloughed off microscopically thin replicas of themselves that then travelled to the eye of the observer. Intromission theories avoid some obvious problems of extramission theories, such as near and far objects simultaneously being visible the moment the eye is opened. A third alternative, supported by Plato and Galen (and Aristotle, to a lesser degree), combines the two theories, proposing that light emitted by the eye engages in some way with the intervening air and aforementioned replicas, or species (Lindberg, 1967, 1981).

Like others before him, Ibn al-Haytham also recognized that there were problems with all existing theories of vision, but he was uniquely successful in finding a solution that had eluded the best minds of antiquity. He proposed a type of intromission theory of vision, and validated his conclusions by empirical understanding deduced from scientific experimentation. This methodology expanded his understanding beyond the theoretical, which resulted in the incorporation of psychology to explain vision, in combination with the behaviour of light and the physiology of the eye.

Ibn al-Haytham also linked sight and vision with the properties of light

throughout his studies. His experiments subsequently verified scientific principles commonly associated with what is known today as optical “ray tracing.” These experiments included using flat and curved mirrors to control and manipulate light, but primarily involved observing the effect of light pouring through apertures of various sizes into darkened spaces (i.e. camera obscura) (Smith, 2001a, 2001b). Perhaps most importantly, they provided him a theoretical basis for the existence of rays; a theoretical construct that he used as a means for describing and interpreting the visual system. These rays are subsequently represented by geometrical lines associated on a point-by-point basis with an object in space.

Al-Haytham did get one important aspect of vision wrong: the fact that an image projected by a lens is upside down and flipped right-to-left apparently was more than he could accept in a theory of vision, even though it is contained within his optical formalism. Leonardo da Vinci also failed to accept this when he approached the problem much later (Kemp, 1977). Ultimately, it would take another five hundred years before Kepler would follow Ibn al-Haytham’s formalism to its inevitable and logical conclusion in developing the theory of the retinal image.

Smith (2005) points out that such contrasting theories of vision in the preceding centuries before Kepler had profound epistemological implications on medieval culture. The Platonist perspectivists supporting extromission, for example, suggest that the eye has powers which extend outward as a means for engaging reality which, in a general sense, can be understood as a “visual finger reaching out to palpate things” (Smith, 2005, p. 223). Intromission theories however, are uniquely Aristotelian. They ascribe to the idea that, “Knowledge is inductive... Sensation and its representations are therefore not to be deprecated as the bearers of falsehood (Platonism) but rather to be prized as the bearers of truth” (Smith, 2001, p. cx).

Perhaps predictably, as cultural understandings of vision and cognition expanded to include these disparate theories, so too did evolving cultural considerations for concepts seemingly unrelated to the science of optics, the impact of which was not relegated to the science community alone but spread out to include the humanities at large.

### **3 INTERDISCIPLINARY DISSEMINATION AND APPROPRIATION OF *KITĀB AL-MANĀZIR***

There is little debate that Ibn al-Haytham’s seminal work, *Kitāb al-Manāzīr*, translated into Latin as *De Aspectibus* in the early to mid-13<sup>th</sup> century, is largely responsible for the widespread appropriation of its contents by Western European intellectuals (Lindberg, 1967). Smith recognizes that variations exist among the Latin version as compared with the Arabic original, not simply in its organizational structure but in the interpretation of specific terms (2001). From the beginning, however, knowledge of the core principles and experiments detailed throughout

the manuscript by its original author were not limited to Western readers alone, or to the scientific audiences specifically.

*De Aspectibus* is first referenced in Bartolomeo Anglicus' *De proprietatibus rerum*, [On the Property of Things] c1220-1230 (Smith, 2001), a monumental and early encyclopaedia covering a wide variety of subjects. The text refers to the study of optics and Ibn al-Haytham specifically several times. It was required reading at the University of Paris in 1296, available in the university library of the Sorbonne by 1306, and used widely as reference material at Oxford, Cambridge, Canterbury and Merton College by the mid-fourteenth century (Holbrook, 1998).

Specific proposals contained within *De Aspectibus* however, are most significantly referred to in the well known optics manuscripts, *Perspectiva* by Roger Bacon (c1268), *Perspectiva* by Erazmus Witelo (c1278), and *Perspectiva communis* by John Pecham (c1280) (Lindberg, 1967). Although today we think of these scholars as optical scientists, they approached their work as theologians, which, in turn, influenced their interpretation of medieval optical theories. Bacon, for example, was a Franciscan friar, who transmitted his scientific manuscripts to the Papal court in secrecy (Smith, 2005). Pecham and Witelo were priests as well, who relied on Ibn al-Haytham in constructing their own evolving optical theories, but who also took liberties with their interpretations and infused them with spiritual undertones. The work of these scholars, collectively and respectively, had enormous influence on the progression of optical understandings throughout the centuries that immediately followed.

The nature of light, vision and cognition are so directly linked with ontological aspects of the human experience in that they also appeal to considerations beyond the scientific. As the encyclopaedic and monastic traditions of scholarship propelled intellectual curiosity, and as images increasingly became the popular visual culture of the day, it should not be surprising that the science of optics entered other areas. It is remarkable, though, just how widely it permeated western European consciousness and the broader culture.

Popular literary examples published during this period illustrate just how widespread the interest and understanding of optics had become. Ibn al-Haytham, for example, is referred to several times in the epic poem *Roman de la Rose* [Romance of the Rose] by Guillaume de Lorris and Jean de Meun, one of the most widely read works in the French language for 300 years after its publication in c1275 (Ilardi, 2007). In the text, the authors describe the properties of mirrors, with the text exhibiting a surprisingly non-trivial understanding of optics. One short passage from these four pages makes its debt to Ibn al-Haytham (Alhacen; Alhazen) quite clear:

*There [in Alhacen's Observations] he will be able to discover the causes and the strengths of the mirrors that have such marvellous powers that all things that are very small – then letters, very narrow writing, and tiny grains of sand – are seen as so great and large*

*and are put so close to the observers – for everyone can distinguish among them – that one can read them and count them from so far off that anyone who seen the phenomenon and wanted to tell about it could be believed by a man who had not seen it or did not know its causes. This would not be a case of belief, since he would have the knowledge of the phenomenon* (Ilardi, 2007, p. 44).

A century later Geoffrey Chaucer refers to Ibn al-Haytham in *Canterbury Tales*, written over the period 1387–1400, and the first major piece of literature in the vernacular English language. Chaucer, too, was influenced by his understanding of the content of Ibn al-Haytham’s works on vision and optics, as is clear from the following passage:

*They spoke of Alhazen and Vitello and Aristotle, who wrote of curious mirrors and of perspective glasses, as they know who have heard their books.*

(NeCastro, 2007, p. 3)

As medieval optical theories increasingly informed scientific inquiry and, furthermore, epistemological frameworks of society and culture, interest in the visual system – particularly how it might be applied to artificial representations of space and spatial perception (i.e. painting and drawing) – were considered for use in the visual arts. Interestingly, although Ibn al-Haytham’s developments were disseminated through the works of Bacon, Pecham and Witelo, what transpired was not so much a period of scientific discovery in optics, but rather a prolific period of advancement of *visual literacy*, with the science of optics providing the *syntax* upon which new spatial understandings were constructed. As Greenstein (1997) states, “Because vision is a cognitive process involving inner sense and intellect, optics links sight with semantics, semiotics, and theories of the soul. It makes use of such fundamental Aristotelian concepts as form, substance, accident, quality, individual, universal, species, and whatness.” (p. 682).

#### 4 ART AND OPTICS

What influence perspectivist theories of vision had on the visual arts leading up to and throughout the Renaissance, however, has yet to reach a consensus among scholars. Writing on the influence of optical scientists on visual artists Klein (1961) states, “We may observe the widespread conviction that there was a close connection between their disciplines, really an identity” (p. 212). He further states, “If one can believe Rafaello Maffei, the ancient science of Alhazen and Vitellio now included artistic applications and was almost identified with the fine arts” (Klein, 1961, p. 212). Kemp (2005) remains cautious of considerations that superimpose perspectivist theories of vision directly upon the development

of linear perspective or visual transitions in the visual arts. A more favourable and synergistic point of view, however, can be found in the introduction of Smith's (2001) English translation of *De Aspectibus*, where he states:

*The representation of visual space in Renaissance art was the expression of a world-view implicit in the Perspectivist analysis of sight, a worldview based upon the 'geometrization' of visual space. If, however, Alhacen and his Perspectivist followers taught Renaissance artists to 'see' the world in such spatial terms, those artists in turn taught early modern thinkers to see the world in those same terms and thus to conceive of it as a Euclidean continuum.*

Written evidence of this "Euclidean continuum" is interpretable in the writings of such well-known Renaissance masters as Alberti, Ghiberti and da Vinci, and equally important visual evidence is evident in the actual images created throughout the period. Alberti's most notable work, *On Painting*, c1435, for example, employs a model for vision taken directly from Ibn al-Haytham. Greenstein (1997) validates a parallelism between Ibn al-Haytham and Alberti's respective models of vision by stating, "Alberti's viewer first sees under aspects [*aspecimus*]; then recognizes by intuition [*intuentes...dignoscimus*]; and finally discerns with greater discrimination [*aspicientesdistinctius...discernimus*]" (p. 682). These stages of visual succession imply that Alberti understood spatial perception as a layered and complex cognitive process; one that must account for the perceptual tendencies the viewer applies as a means for interpreting any given scene. There is support for the idea as well that the "Euclidean continuum" informed Alberti's understanding of the visual pyramid (Lindberg, 1981).

Kemp (1990) however, is conservative in his estimate of the influence optics had on transitions in visual art practice evident in painting stating, "Medieval optical science created far more problems than it solved for Renaissance artists" (p. 345). For example, that Alberti is explicit about having composed *On Painting* for artists and demonstrates indifference to debates about which direction visual rays might reach the eye of the viewer, i.e. intromission vs. extromission, is interpreted by Kemp (1997) as a break in Alberti with scientific tradition. Kemp's conclusions, however, do not wholly consider the practical implications which occur when the visual system is oriented and applied to visual art practice, and pre-date the discoveries of the Hockney-Falco Thesis by a decade.

Alberti was aware of the debate born out of the perspectivist optical tradition about visual rays; aware enough to put forth that such considerations are "useless" for artistic purposes (Kemp, 1997). Subsequently, Alberti focuses his attention instead on concepts relative to spatial disposition and composition, and how these two principles are translated and reoriented as objects on a two dimensional picture plane. In short, Alberti was the first to interrupt (in writing) the visual pyramid by placing the canvas perpendicular to the visual rays, specifically

at the vertex of the pyramid. Whether Brunelleschi's panel experiments at the Piazza del Duomo or the Piazza della Signoria, in Florence, were actually the first experimental illustration of this effect, will not be discussed here. However, the latter certainly informed the former (Arnheim, 1978; Kemp 1990). The necessary level of understanding for providing audiences with instruction of these advanced visual considerations subsequently required a new form of erudition and language, namely *perspective*.

Lorenzo Ghiberti's efforts to make a contribution to the discussion appear a decade or so after *On Painting* was first published and immediately translated into Italian. Ghiberti attempted a theoretical understanding of the arts, relying heavily on the optical theories of Pecham, Witelo and others, which in turn relied on Ibn al-Haytham. Ghiberti certainly had access to a 14<sup>th</sup> century Italian translation of Ibn al-Haytham, given that entire portions of it are incorporated in

Book 3 of his *Commentarii* (Fragenberg, 1986; Greenstein, 1997, etc.). The book was incomplete at the time of Ghiberti's death but is described by Lindberg (1981) as, "The most transparent case of the influence of medieval visual theory on a Quattro-centro artist... he [Ghiberti] presents a complete survey of the mathematical tradition in optics consisting mainly of excerpts and paraphrases drawn from the perspectivists." (p. 152). Subsequently, by the time da Vinci would consider the works of these same optical scientists, he too would be forced to reconcile for himself the relationship between vision, perception, and pictorial representation.

Kemp's (1977) research on da Vinci makes it clear that the artist established an "Increasingly sharp separation between perspective as the science of vision and perspective as a geometrical means for constructing a rational picture space," which da Vinci refers to respectively as 'perspective made by nature' and 'perspective made by art'; or *prospettiva naturale* and *prospettiva accidentale*. (p. 147). It is also clear that Alberti and Ghiberti's shortcomings in affirming or denying the function of the visual pyramid are too laconic in the mind of da Vinci, who subsequently embarks on an intense period of experimentation, applying a methodology and conducting experiments remarkably similar to those of Ibn al-Haytham (Smith, 2001).

Given the progression of events outlined throughout the preceding sections it seems unusual that an artist like Alberti was so familiar with the perspectivist tradition, and yet so little is known about how he arrived at the principles of linear perspective. Nevertheless, a clear language of visual literacy has been established, beginning most significantly with the work of Ibn al-Haytham and culminating with Alberti's visual pyramid for artistic production during the Renaissance.



## 5 CONCLUSION

Consideration of the lineage of medieval optical theories leading up to and throughout the Renaissance is necessary for understanding the methodology Hockney and Falco developed, centuries later, for analyzing well known European paintings, as well as the larger impact of the perspectivist tradition as it relates to realist image production. This methodology is one based on a framework of visual understanding, i.e. visual literacy; one that dates back to the perspectivist tradition and explicitly recognizes the optical principles evident within artificial and natural representations of space.

Smith eloquently and accurately illustrates the complex relationship that exists between visual literacy and reading by interpreting Ibn al-Haytham:

*In likening spatial perception to reading, Alhacen underscores that the ease with which we read 'space,' like the ease with which we read words, masks the arduousness of acquiring that reading-skill in the first place. Reading space, in short, is far more intellectual than it is tactile (Smith, 2005, pg. 2005).*

That the mind of a painter is as intrinsically involved in the creative process, as is his hand in creating paintings, makes original works of art highly complex subjects to analyze. Hockney and Falco however, demonstrated that optical evidence exists within the visual compositions of certain paintings. This evidence is therefore subject to visual (qualitative) as well as optical (quantitative) interpretation.

Such 'optical evidence' might consist of visual elements observed within a painting that do not reflect the perspectivist world-view of the age in which the image was created. Unlike an image projected onto film or canvas, for example, the human eye constantly adjusts its aim and focus as the mind constructs the scene it is viewing. As a consequence, humans do not simultaneously see part of a scene in focus and part of it out of focus. Although modern humans have seen the effect of scenes depicted out of focus countless times in the form of photographs, in movies, and on television, it is not an effect that is part of natural human vision. Hence, a simple example of the indirect use of optics is if an artist has painted a distant portion of a scene as if it were out of focus, replicating the depth-of-field of an image projected by a lens. This is precisely the effect Hockney and Falco identified from their observations of Lorenzo Lotto's Portrait of a Married Couple, c1524-5 (Hockney & Falco, 2005).

While optically assisted techniques for artistic production are known to have become common by the 19th century, including tracing projected images (Paschall, 2001), earlier use of optics has been difficult to identify and analyze hindered, we believe, by the lack of sufficiently close interaction between art historians with artists and scientists. Sullivan's (2004; 2005; 2006) research of

art practice as a verifiable form of research affirms this belief, and suggests that Hockney and Falco's approach for observation and deduction, essentially born out of their practice of art and optics respectively, might account for why their theories were rejected, at least initially, by some art historians (2005).

Additionally, lack of detailed understanding of optics and the history of optics continues to affect interpretation of historic realist images. For example, despite documentary evidence showing that concave lenses and mirrors of high enough quality were available in the first quarter of the 15<sup>th</sup> century (Ilardi, 2007), such evidence has done little to achieve wide acceptance by historians that a concave mirror can, in fact, project useful images for artists (Campbell, Syson, Falomir, & Fletcher, 2008).

Despite these challenges, recently study of Hockney and Falco's collaborative process highlights the specific manner in which their respective practice of art and optics enabled them to identify optical evidence within a number of Renaissance paintings, and ultimately demonstrate that artists as early as Jan van Eyck (c1425) used optical projections as aids for producing portions of their paintings (Allen, 2007).

Hockney and Falco's methodology of visually interpreting optics-based images stipulates that visually evident compositional details qualify certain paintings as "photo representations" composed both by the hand and mind of the artists, but resulting from optical geometry as well. Hockney and Falco's methodology and findings have implications for the histories of science and art, as well as science and art education. This unique approach for analyzing works of art is within the long, interdisciplinary, progression towards a new visual language; one historically informed by the science of medieval optics, but put into action by visual artists during the Renaissance.

## **6 ACKNOWLEDGEMENTS**

We gratefully acknowledge David Hockney for his invaluable insights on painting through his investigation of over 1000 years of European art. These insights provided the foundation for ongoing work subsequently being pursued with David Graves, resulting in locating documents related to the early use of optics by artists, the origin of which we have traced to the writings of Ibn al-Haytham.



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32. Steinberg, Leo (1987), "How shall this be?" Reflections on Filippo Lippi's "Annunciation" in London, part I, *Artibus et Historiae*, 8 (16), 25-44.
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## Images for “Painted Optics”

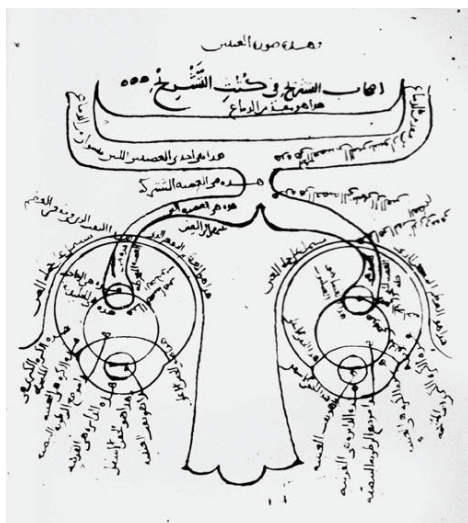


Figure 1. Ibn al-Haytham's description of the human visual system. From a 1083 [475 A.H.] copy of his *Kitāb al-Manāẓir* in the Süleymaniye Library, Istanbul.

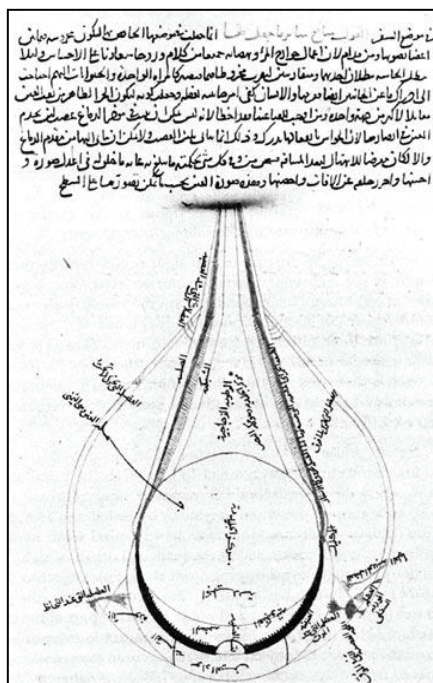


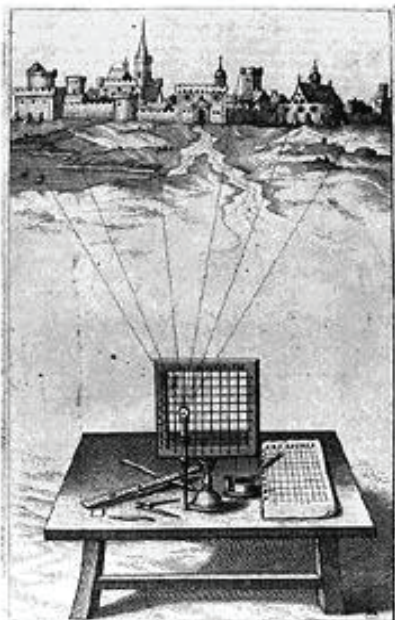
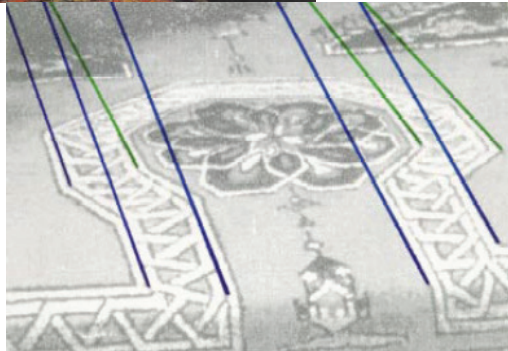
Figure 2. The anatomy of the eye according to Ibn al-Haytham, from *Kitab al-Manzir*, Museum Victoria.



Figure 3. Jan van Eyck, *The Arnolfini Marriage*, 1434 (detail showing approximately 25% of the 81.8×59.7 cm painting). By tracing the rays of perspective on two dimensional images, specific information can be elicited about the manner in which images are produced.



**Figure 4. Husband and Wife, Lorenzo Lotto, c.1523-4. 96cm x 116cm. Hockney and Falco observe that the octagonal pattern in the center of the tablecloth appears to go out of focus – one piece of the optical evidence that Lotto used optics when composing this portion of the painting.**



**Figure 5. Illustration of Alberti's picture plane, interrupting the visual rays of the perspectivist pyramid.**



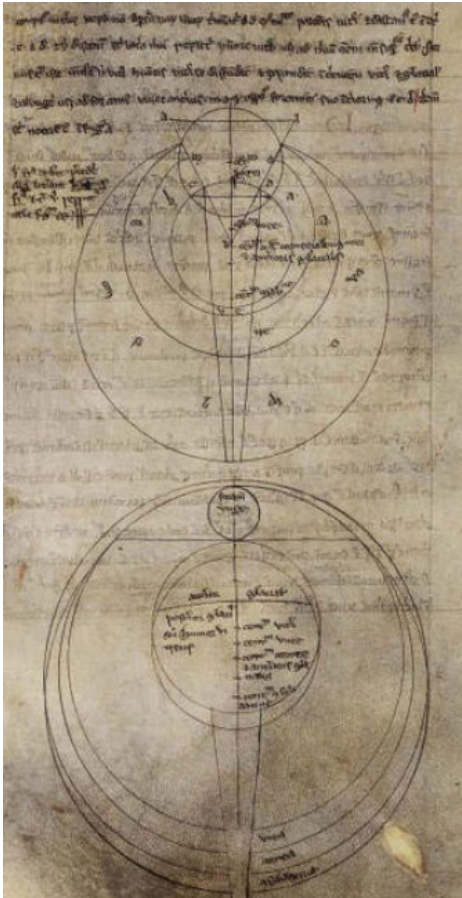


Figure 6. Roger Bacon's diagrams relating to the scientific study of optics, from *Perspectiva*, British Library, ms. Royal 7 F. VIII, f. 54v.

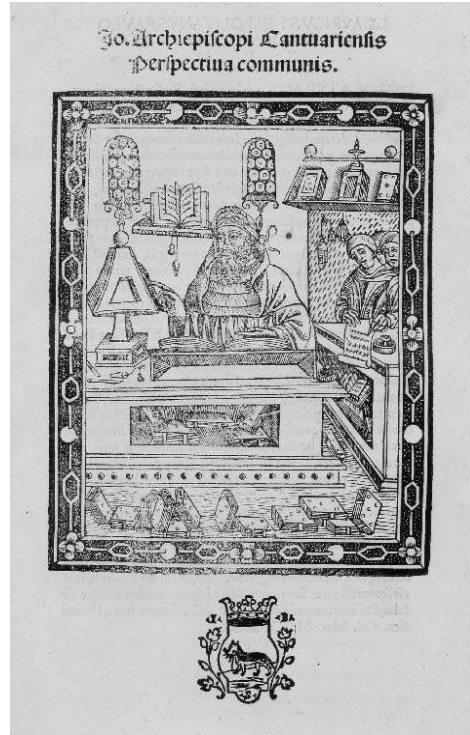


Figure 7. Woodcut cover image of a 16<sup>th</sup> century translation of *Perspectiva Communis*, by John Pecham. Edited by Luca Gaurico, c1510.



# Science as a Component of the Overall Intellectual Activity in the Early Muslim World

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## 1 ABSTRACT

It has frequently been noted that the impetus for sciences comes from a multitude of sources, some of these social and cultural. In an earlier paper at the 2001 Rabat IAS Conference, an effort was made to study the convergence and divergence between Islamic Thought and Scientific Thought over the centuries. In this paper, an attempt is made to examine and develop the relationships that doubtless exist between the various aspects of human culture, namely intellectual activity, scientific activity and socio-religious activity. All these are in fact components of the broad spectrum of knowledge, but we, in emphasizing one aspect, tend to ignore the others. Accordingly, the broad patterns of (a) scientific history and (b) intellectual history of the early Muslim period from 1 H. to about 900 H. are depicted in the present paper quantitatively in graphs, which show a series of peaks separated by deep minima.

The detailed comparison between these graphs is undertaken for the first 600 years. It shows certain remarkable features, one of which is that, as already indicated in earlier papers, intellectual activity precedes scientific activity by about a century. What is more, it now appears almost certain that the half dozen narrow peaks of scientific activity originate in the incubating process initiated by certain outstanding intellectuals, at or near the observed minima of this intellectual activity.

The case of the impact of Abu Hamid Al Ghazzali in the 5<sup>th</sup> century Hijri is discussed in some detail. Further careful multidisciplinary studies of the 3<sup>rd</sup> and 6<sup>th</sup>-8<sup>th</sup> centuries Hijri are needed to understand the intricate patterns of rise and decline of this activity. Some of the factors to be especially looked for are indicated.

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## 2 INTRODUCTION

Civilization can be said to have begun in a big way with the innovation of the alphabet, which goes back 6,000 years ago, when the Semitic alphabet developed, of which the current forms are found in Arabic and Hebrew. The history of the period 6,000 B.C. onwards has been pieced together from inscription, scrolls and similar writings preserved in the various civilizations of the world, and especially in the religious literature. 'Culture,' 'Religion' and 'Science' are three aspects of the intellectual doings of various civilized societies, all through recorded history, but the relationship between the three has varied from time to time and from society to society. A great deal has been written in this field, but perhaps we can begin with straight forward definition of these three, as given in the Oxford Advanced Learners' Dictionary<sup>1(a)</sup>, Sixth Edition (2000) and the Concise Oxford Dictionary<sup>1(b)</sup>. These are as follows:

- ✓ **Science** is defined as: knowledge about structure and behaviour of the natural and physical world, based on facts that one can (observe and) prove; (also defined as organized knowledge);
- ✓ **Culture** is defined as: the customs and beliefs, or, way of life and social organization of a particular group or country;
- ✓ **Religion** is defined as: the belief in the existence of a god or gods and the activities that are connected with the worship of these.

Other definitions of science have been given in the part, including that contained in the German word *Wissenschaften*<sup>2</sup>, which covers not only natural sciences, as defined above, but also philosophy and philology.

A quick look at these three definitions brings out two features almost immediately, namely,

- (i) Science (as defined above) is most readily amenable to definition and description, and
- (ii) The notion of culture is a very extensive one, incorporating, in fact, both science and religion, whereas,
- (iii) Religion is perhaps the least amenable to precise or complete definition, partly because it deals with the inner beliefs of human beings, which often have roots going back into antiquity.

At all events, it is clear that science and religion are both, in some measure, involved in what we call cultural or perhaps intellectual activity.

Accordingly, in extension of the above ideas, we may first present here a comparative quantitative survey of scientific and intellectual activities in the Muslim world over the first millennium (1 H. to 1,000 H.).

### 3 A COMPARATIVE SURVEY OF SCIENTIFIC & INTELLECTUAL ACTIVITY FROM 1 TO 1,000 H

We first begin with the scientific activity, which is well documented. In the first place, these achievements are the result of the work of almost a dozen outstanding scientists of the early Muslim period, whose works were so well-known and widely read that the Latinized versions of 9 of their names are still current, viz:

**Table 1. Latinized versions of Names of Ten Renowned Muslim Scientists**

|                   |                  |                |          |           |             |
|-------------------|------------------|----------------|----------|-----------|-------------|
| Name of Scientist | Jabir Ibn Hayyan | Al Khwarizmi   | Al Kindi | Al Razi   | Al Zahrawi  |
| Latinized Version | Geber            | Algorizm       | Kindus   | Rhazes    | Abulcasis   |
| Name of Scientist | Ibn Sina         | Ibn al Haytham | Ibn Zuhr | Ibn Rushd | Ibn Khaldun |
| Latinized Version | Avicenna         | Al Hazen       | Avenzoar | Averroes  |             |

For further refined analysis, we can use the names of 106 Muslim scientists of world-renown listed in C.C. Gillispie's Dictionary of Scientific Biography<sup>[3]</sup>, Vols. 1-16, published in 1976. From the listing of the 106 Muslim scientists of world renown listed therein, it is possible to work out their nos. per half-century and every 30 years. These are plotted in Figure 1(a) and 1(b). The presence of a series of 5 maxima and minima in scientific activity is thus clearly brought out, extending over the period 100 H to 900 H. The highest of these occurred around 370 H, while the last at 800 H corresponds to the tail end of scientific activity of the millennium. To discover the various factors underlying these peaks, we undertake a corresponding survey of intellectual activity of that era.

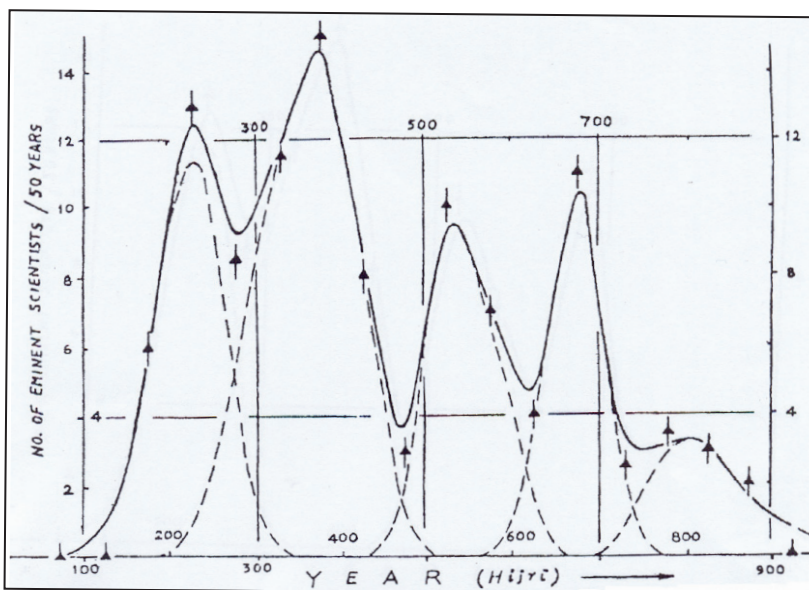


Figure 1(a). Plot of scientific activity, showing the number of scientists of note every 50 years in the Muslim world (100 H – 1,000 H.).  
**Resolution into Peaks:** The broken-line curves show this resolution into 5 symmetrical peaks of (approximately Gaussian error-function) shape

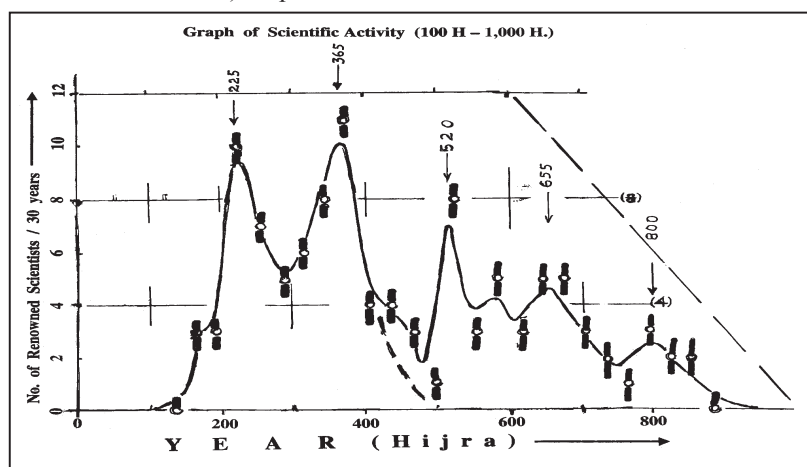
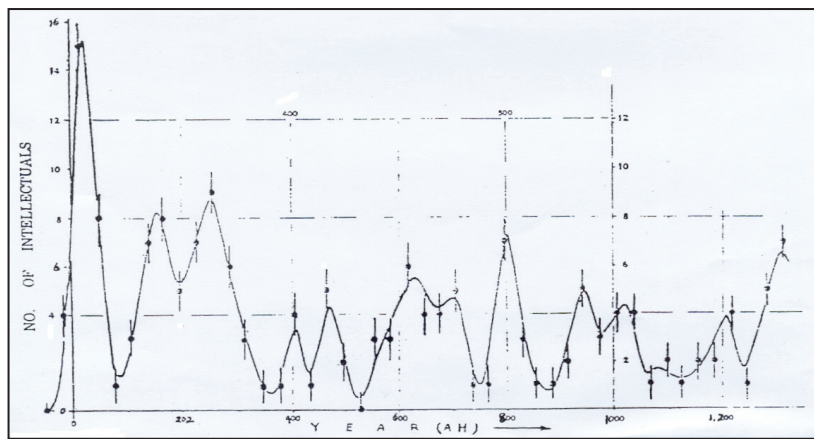


Figure 1(b). Plot of scientific activity, showing the number of scientists of note every 30 years in the Muslim world (100 H – 1,000 H.).

#### 4 A QUANTITATIVE SURVEY OF INTELLECTUAL ACTIVITY

This survey of intellectual activity is based on a 12-page compilation entitled a 'Backward Glance (Ik Nazre-Wapasin)' published<sup>[4]</sup> in a 14<sup>th</sup> Century Hijri issue of Siyyarah Digest. The data were worked out from this compilation (ignoring the few names of mere conquerors and rulers entered therein) by enumerating the intellectuals in succession of 30-year periods, taking the 2<sup>nd</sup> 30 year period as 1-30 H. The numbers so obtained are shown plotted against the middle of the relevant periods from – 10 H to 1300 H in Figure 2.



**Figure 2. Showing numbers of major intellectuals in successive 30-year periods from – 10 to 1,300 H.**

The smooth graph drawn in the figure, to pass evenly between these plotted solid circles, exhibits a series of clear maxima and minima, one every century, the first ten being rather prominent.

While making a broad comparison with scientific activity peaks, it becomes extremely interesting to note that the first 5 or 6 peaks of scientific activity (Figure 1) show a general correspondence with the peaks of intellectual activity, but with an average 'lag' of about 150 years. We may follow this lead further in detail by looking at the outstanding personalities whose period of impact was at or within a couple of decades of the minima of intellectual activity. This comparison is made in Table 2.

**Table 2. List of groups of candidates for ‘Men of the Century’ (at the activity-minima) arranged in century-wise serial order**

| Ordinal No. of Minimum   | 2                              | 3   | 4  | 5   | 6   | 7   |
|--|--------------------------------|---|--|---|---|---|
| Year (A.H.)  | 85                             | 195   | 345 ± 15   | 430   | 530 ± 10  | 665   |
| I  | Umar Ibne Abdul Aziz<br>91-100 | Shafa’i<br>181-190                                | Abu Nasr Siraj Sufi<br>351-360                               | Al Jawaini<br>451-460   | Ibne Rushd<br>491-500                                     | Jalaluddin Rumi<br>651-660                  |
| II   | Ja’far Sadiq<br>121-130        | Al Ma’mun<br>201-210                              | Darqutni<br>361-370  | Nizamul Mulk<br>461-470   |   | Nizamuddin Tusi<br>Sa’di Shirazi<br>671-680 |
| III  | Abu Hani-fah<br>121-130        | Ahmad Ibne Hanbal and Imam Bukhari<br>221-230-240 | Ibne Sina<br>401-410   | ----  | Salahuddin<br>571-580                                     | Ibne Taymiah<br>701-710                     |
| <div> <div>←</div> <div>←</div> <div>Arabic<br/>Dominant Language of Islam<br/>For nearly 5 Centuries</div> </div> |                                |   |  |   | <div> <div>→</div> <div>←</div> <div>Persian</div> </div> |   |
| Ordinal No. of Minimum   | 8                              | 9   | 10   | 11  | 12  | 13  |
| Year (A.H.)  | 755 ± 5                        | 880 ± 5   | 990 ± 10   | 1.120   | 1.235   | (1.350)                                     |
| I  | Hafiz Shirazi<br>771-780       | Jalaluddin Suyuti<br>891-900                      | Sh. Mubarak Nagori<br>981-900                                | Aurangzeb<br>1091-1100  | Shah Abdul Aziz<br>1220-1230                              | ----  |
| II   | Ibne Khal-dun<br>781-790       | Abdul Qud-dus Gangohi<br>921-930                  | Kh. Baqi Billah<br>991-1000                                  | Shah Waliullah<br>1151-1160   | Shah Ismail Shaheed<br>1220-1230                          | -----                                       |
| III  | ----                           | ----  | Sh. Ahmed Sarhindi<br>1011-1020<br>Sh. Mian Mir<br>1020-1030 | Abdul Wahab<br>1181-1190  | Mohd. Ali Pasha<br>1241-1250                              |   |
| <div> <div>→</div> <div>Persian<br/>Dominant Language for<br/>3½ centuries</div> </div>                            |                                |   |  | <div> <div>←</div> <div>Urdu<br/>Dominant Language for 3 ½<br/>centuries or so</div> </div> |   |   |

While the maxima are quite dramatic, exhibiting  $10 \pm 5$  personages active at or near the peaks, the minima are perhaps even more interesting, because these

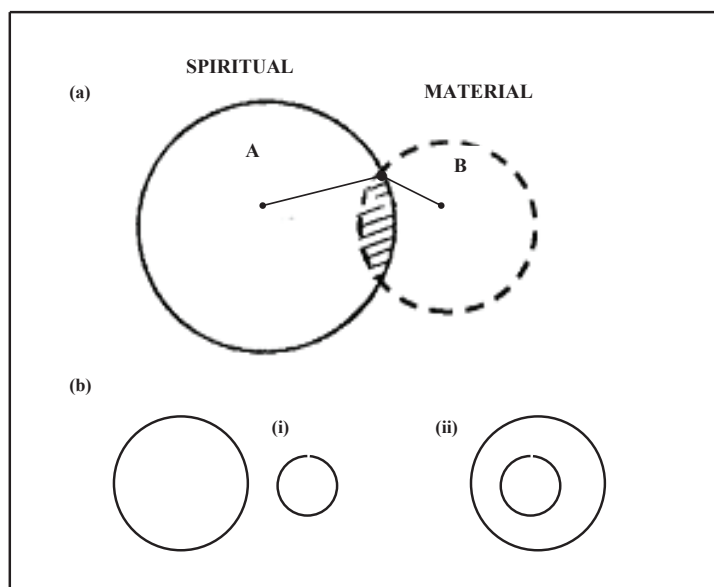
almost surely contain evidence of those persons and factors that were responsible for, or were at the base of, the resurgence that led to the *subsequent peak*. Accordingly those persons are listed in Table 2.

When we come to look for the common factor between scientific and intellectual activity in the Islamic millennium, we are forced to look towards *Tafakhur*, *Tadabbur* and *Zikr* of Allah. So let us examine these in some depth.

## 5 RELATION BETWEEN THE PHYSICAL AND SPIRITUAL SPHERES

### 5.1 The *Zikr* of Allah and *Fikr* or *Tadabbur*

In this context, one of the authors had proposed that the relation between these two spheres of human experience (spiritual and material) is best represented<sup>[5]</sup> in the most general form (see Figure 3(a)) by two intersecting circles (or spheres), of which the two extreme conditions (Figure 3(b)) would be (i) no overlap, or (ii) one sphere totally within the other. Some persons appear to insist on one or the other of these extreme situations, but the scientific and rational approach should be to take the most general form\* and try to determine the extent of the overlap, in various sectors.



**Figure 3. Possible relation between systems 'A' & 'B.'**

\* In fact, while many eminent physicists including some Nobel laureates feel that the two spheres should be kept separate, yet there are others who believe (V. Weiskoff) 'there is Bohr complementarity between science and religion' and that 'religion and science are aimed at much the same problem and must in time converge (C.M. Townes).'

Of course, everything in the universe is there for man to make use of: ‘See ye not how Allah hath made subservient (serviceable) unto you whatsoever is in the skies and whatsoever is in the earth and showered on you His blessings, both manifest and hidden’ (Al Qur’an 31: 20). The proviso is that man should use these in accordance with the guiding rules given by Allah and his Prophet Muhammad (SAW). It is stated in Surah Al-Shura:

*‘Whoso desireth the harvest of the Hereafter, We give him increase in its harvest. And whoso desireth the harvest of the world, We give him thereof, and he hath no portion in the Hereafter’, (42: 20).*

And again, in Surah Al-Baqarah, we are told:

*‘(And of them is he) who saith: ‘Our Lord! Give unto us in the world that which is good and in the Hereafter that which is good, and guard us from the doom of Fire. For them, there is in store a goodly portion out of that which they have earned, Allah is swift at reckoning’ (2: 201-2).*

**So, it follows that it is incumbent on a Muslim to study and use the things of this world (primarily) as a means to the ‘harvest of the Hereafter’ and not merely as an end in itself.**

A certain person asked Aishah (Radhiallaho anha):

‘Tell me something noteworthy concerning the Prophet (Sallallaho alaihe wasallam).’

She answered: ‘There was nothing which was not unusual about him. Everything he did was noteworthy. One night, he came and lay down with me. After sometime, he got up saying, ‘Now let me pray to my Lord, the Sustainer.’ With this, he stood up in Salaat, humbling himself before his Creator with such sincerity that tears rolled down his cheeks to his beard and on to his breast. He then bowed for Ruku‘and Sajdah, and his tears flowed down as fast as before and, after raising his head from his Sajdah, he continued weeping in this manner till Bilal (Radhiallaho anho) announced the approach of fajr. I pleaded with him:

“O, Prophet of Allah! You are sinless, as Allah has in His munificence forgiven your each and every sin (even if committed) in the past and which may happen in the rest of your life (Al Quran, 48: 2) and still you grieve so much”. He replied: ‘Why, then, should I not be a grateful slave of Allah?’ Then he added, ‘Why should I not be praying like this, when Allah has today revealed to me these verses.

إِنَّ فِي خَلْقِ السَّمَوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لَآيَاتٍ لِأُولِي  
الْأَلْبَابِ ۚ الَّذِينَ يَذْكُرُونَ اللَّهَ قِيَامًا وَقُعُودًا وَعَلَىٰ جُنُوبِهِمْ - - -  
(ال عمران - ١٩٠-١٩١)

*'Lo! in the creation of the Heavens and the Earth, and in the difference of night and day, are tokens (of His Sovereignty) for men of understanding, such as remember Allah, standing, sitting and reclining – and consider (ponder over) the creation of the heavens and the earth (and they say) Our Lord, thou credest not this in vain; glory be to Thee: preserve us from the doom of fire. (Aal-i-Imran 190-191). (See Fazail-i-Zikr, Hadith 17, by M. Mohammad Zakariyyah).*

The clear import of this ayat is to underline the great importance of pondering over the creation and structure of the universe, including the solar system, the earth and the moon i.e. working out the science underlying these.

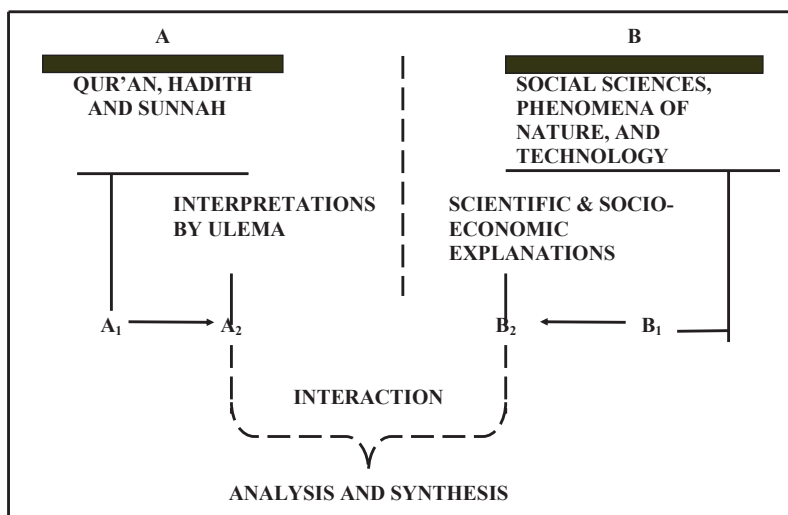
This clearly implies a state of harmony between our spiritual aspirations and the study and use of nature, as also (by implication) between the two major sources of knowledge viz. science/reason and revelation. It is a fact that these two sources are sometimes difficult to reconcile or harmonize, as appears from the varying relationship between the 'Sciences' and 'Islam,' wherein we apparently find considerable diversity of views over the centuries.

## **5.2 Science vs. Religion**

By definition, there are certain domains that are considered specific to religion and certain others which are specific to science. However, there are numerous regions where there is considerable overlapping between the two. It is in these regions of overlapping that serious difficulties can and often do arise. Fortunately, in the case of Islam, the results or directions obtained from religion and science are generally concordant or, at least, in basic agreement. However, quite often, problems and issues do arise, in which the presently held views in the sciences and those in Islam are in conflict with each other, whether apparent or real. The overall situation may be depicted schematically (Figure 4) as follows, where the 'Natural or Observed phenomena' ( $B_1$ ) and 'Qur'an' and 'Sunnah' ( $A_1$ ) are boxed in, because both of these are more or less definite and invariant:

In a paper<sup>[6]</sup> presented at the joint meeting of Islamic World Academy of Sciences and the Aal al-Bait Foundation (for Islamic Thought), an attempt was made to outline a basis for the possible integration of modern scientific studies with Islamic Thought. In this, the relationship between the two systems was provisionally depicted as reproduced below in Figure 4 at (A) and (B).





**Figure 4. A framework for future study of interactions between Islamic Thought and the Sciences.**

*Note: The significant interactions in Figure 4 would occur between  $A_2$  and  $B_2$ , i.e. between interpretations of Ulema and the scientific or socio-economic explanations.*

The significant interactions occur between  $A_2$  and  $B_2$  i.e. between interpretations of *Ulama* and the scientific explanations. In general, three main alternative situations can arise viz:

- (a) Conclusions  $A_2$  = Conclusions  $B_2$
- (b) Conclusions  $A_2 \simeq$  Conclusions  $B_2$
- (c) Conclusions  $A_2 \neq$  Conclusions  $B_2$

Examples of situations of type (a) have been used sometimes to show the concordance of Islam with modern science and, sometimes, even to present the Qur'an as a book of science. Among the earliest, in the South Asian region, was the movement of Sir Syed Ahmad Khan, who went so far in rationalism as to almost reject the super-natural and, so earned for himself the epithet of 'Naturi.' We have another example of this in the book "دوقرآن" by Ghulam Jilani Barq. The situations like (b) do not cause too much concern, but those in the category (c) do raise serious problems because they demand revision of some of the *processes* or *premises* in one or both halves of Figure 4. This is an important problem in the Islamic world today. Before studying examples of these, it is desirable to have before us some broad consideration of the bounds or limits laid down by Allah, so that we can specify more clearly the framework within which to operate.

## 6 THE BOUNDS OR LIMITS LAID DOWN BY ALLAH

### 6.1 Hudud Allah

Two facts are significant in the various Qur'anic verses mentioning Hudud Allah, The bounds:

- (i) The bounds or limits are plural and not just singular.
- (ii) We are warned not to transgress these bounds and, in fact, reminded not even to *approach* or come near these.

These two ideas are inter-connected and indicate the presence of an *upper* and a *lower* bound for each type of action or human activity. Once the rigour of the law is, so to speak, softened by laying down not just a single narrow path, but an upper and a lower limit, it becomes quite fair and just to require that a Muslim should not even approach these limits, but should try to remain well inside the clear and safe middle region. Hence the significance of the interesting and revealing attribute of *Ummate-e-Wusta* (the middle Ummah) given in the Qur'an for those who follow it.

We may take the analogy of a person driving a car in a fast lane on a highway at an average speed of 120 km per hour. As a matter of fact, his speed will *not always* be 120 km/hour. It will frequently come down very close to the minimum (which may be around 90 km/hour) and also sometimes rise to the maximum (which may possibly be 190 km/hour). For example, when he is overtaking another car, the speed of his car will be maximum. While the ideal in our mind may well be a steady speed of 120 km per hour, the driver remains within the bounds of the law with the above changes of speed, even though he is often constrained by the conditions of the traffic to drive at varying speeds.

In much the same way, a Muslim in his life is bound by laws which set an upper and a lower limit (Hudud Allah) to his freedom of action in each sector of activity. Thus, he can become a so-called well-integrated personality while remaining well within the dictates of Islam, which indeed provide guidance and a light for all those who have a desire to do the right thing and avoid the wrong. This attitude or desire, of course, is the basic requirement of Islam and is necessary if one wants to obtain guidance from the Qur'an.

### 6.2 A Detailed Look at Tables 1 & 2

We can now attempt a somewhat closer study of the names of the scientists and intellectuals listed in Tables 1 & 2, respectively. Bearing in mind the broad picture emerging from the above study of the clear rise and fall of intellectual activity among early Muslims, over the centuries, one can make a first attempt at discerning the likely causes of the various maxima to be seen in the scientific activity. The first lead of interest is the fact that Jabir Ibn Hayyan<sup>[8]</sup>, almost the first Muslim scientist of world renown, is reputed to have studied under Imam Jafar Sadiq (impact ~ 125 H, see Table 2).

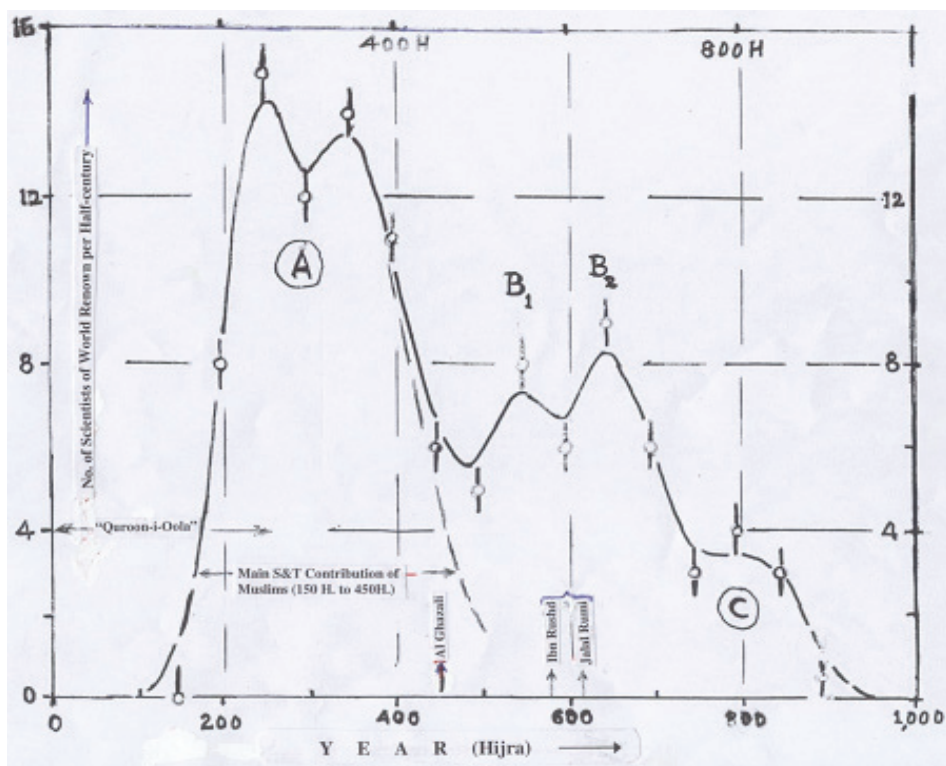
We may then surmise that the first major surge of scientific activity, had its origin in the intellectual activity initiated by the 3 Men of the 1<sup>st</sup> century Hijra, viz. Jafar Sadiq, Umar ibn Abul Aziz and Abu Hanifa (See Table 2). So we can reasonably assume that the first apparent minimum was the incubation for the subsequent scientific activity, which peaked around  $230 \pm 25$  H. This activity was slow to rise, presumably because of the initial period of collection and translation of the relevant knowledge into Arabic. Thus, it is easy to understand that the peak occurred about 100 years after this start.

We may now take a look at the possible situation for the second peak of scientific activity (around  $370 \pm 20$  H.).

## 7 A LOOK AT THE PERIOD 300-550 H

First we examine the 2<sup>nd</sup> minimum of intellectual activity (around 200 H), at which one finds (Table 2) notables like Imam Shafa'i and (Caliph) Al Mamoon. Comparing that with the second peak of scientific activity (around  $370 \pm 20$  H.), we can postulate a lag of  $150 \pm 30$  years in this case; so, overall, we may justifiably consider the 'periods' near or at the intellectual activity minima as 'incubators' for the scientific activity that flowered something like  $125 \pm 20$  years later. This corresponds to a lag of 2 to 3 generations, which is understandable when we look at what happens today in universities (and Industry). We may now take a preliminary look at the situation after 400 H.

**Al Ghazzali:** On the face of it, the scientific activity took a sharp plunge after 400 H. (see thick broken line in Figure 1(b), based on data every 30 years from 150 H. onwards) and was headed for zero in 500 H.; but for the advent of a remarkable savant like Abu Hamid Al Ghazzali <sup>[9]</sup> around 450 H. He profoundly changed the intellectual atmosphere, with notable contributions like *Ihya'ul Uloom al-Din* and *Al Munqidh min al-Dalal*. In the latter work, he has also debated on the interconnection between religious belief and scientific laws of motion of celestial bodies. He says<sup>[10]</sup>, 'Another difficulty is created by a bigoted follower of religion who thinks that in order to save religion, it is essential to deny all science. As a matter of fact, there is nothing in religion which is against the sciences, nor is there anything in the sciences which is against religion.' Again, he says, 'in this respect, natural science resembles medical science, which deals with the human body and its vital and subsidiary organs, and with the changes of the temperament. Hence, as it is not necessary to deny the validity of medical science, in order to believe in religion, in the same way, it is not necessary to deny the validity of natural science either.' He can be readily considered as the main causative factor leading to the scientific activity peak at 520 H. (Figure 3), about 90 years after his impact.



**Figure 5.** Graph showing the variations of early Muslim Scientific Activities from 100H to 900 H. The two peaks at B ( $B_1$  &  $B_2$ ) are analyzed as being due to the impetus provided by (a) Al Ghazzali and (b) Ibn Rushd and Jalaluddin Rumi (Taken from paper presented at International Conference on Rumi held in April 2008 at University of Sargodha).

**Jalaluddin Rumi:** This second pair of peaks ( $B_1$  &  $B_2$ ) is of special interest for us, because it indicates a resurgence of S&T activity, following the steep decline (broken line) after the effects of the initial impulse during the ‘Quroon-e-Oola’ (1 H – 250 H) (the first few centuries) had faded away. A close study of the intellectuals of the period 400 to 700 H brings out clearly the presence of three outstanding personalities, namely (a) Al Ghazzali, (b) Ibn Rushd (in Spain) and Maulana Rumi (in Turkey). Their points of impact may be taken approximately as 450 H, 580 H and 610 H. Thus, we can reasonably attribute the two S&T peaks at (a) 530 H and (b) 650 H, respectively, to the influence of (a) Al Ghazzali (450 H) and (b) Maulana Rumi and Ibn Rushd (580–610 H). What is remarkable is that the resultant S&T peaks occur 60-80 years after the impact of the above-mentioned intellectuals. This would correspond to the next generation of intellectuals/scientists.

To explore this further, we need to study and analyze in detail, the works of the 9 scientists who occur under the second peak  $B_2$ , as also the 8 scientists

who occur under the peak  $B_1$ , and would correspond respectively to the S&T activity immediately following the periods of Maulana Rumi and of Al Ghazzali, respectively. In the meantime, we may note here that the second peak ( $B_2$ ) contains two very well known scientists, Al-Tusi and Ibn-al-Nafis who are renowned, respectively, for the latent discovery of the helio-centric theory of the planetary system (through ‘the Tusi couple’), and for the circulation of the blood in the human body (later rediscovered by Harvey in England).

Of course the first peak  $B_1$  contains two equally renowned scientists, Ibn Zuhr (Avenzoar in Latin) and Ibn Rushd (Averroes in Latin), whose shining forth is a more or less direct consequence of the earlier impact of Al Ghazzali and his scholarly efforts. We present now a few interesting extracts from Rumi, relating to scientific phenomena.

## 9 SOME SCIENTIFIC ANTICIPATIONS IN THE MATHNAWI OF MAULANA RUMI

As a further example of the above – mentioned interactions during the 7<sup>th</sup> century Hijri (see Figure 5) we may describe here the case of the theories of gravitation, of evolution and of relativity, descriptions of the basic ideas of which have been noted by the late M. Raziuddin Siddiqui in a paper<sup>[11]</sup> that was published a decade ago in the Pakistan Council of Science and Technology’s journal ‘Science and Technology in the Islamic World.’

### 9.1 Gravitation

Before speaking further on these points, let us first reproduce the lines written and the words used by Maulana Rumi on these topics. About gravitation, there are first of all, the following lines in the Mathnawi:

*‘The Questioner asked how the Earth remained in the midst of the heavenly sphere, suspended like a lantern in the space; neither coming down nor going up. The philosopher told him that, due to the attraction from all directions, it remained suspended in the space. It is just like a piece of iron inside a magnetic dome, which remains suspended in the Middle.’ (Mathnawi, Dafter I, p.266).*

When it is remembered that the gravitational force between two particles obeys the inverse square law, just as the magnetic force between two magnetic poles also obeys the same kind of inverse square law, the simile used by Maulana Rumi is quite remarkable, and would require some explanation as to how it came about.

There are another four lines in the third Dafter which are equally remarkable:

*Allah in His Wisdom, while laying down the Commandments, made*

*us attracted towards each other. From the early Commandments all particles of the universe attract each other like twins. Every particle in the universe is attracted towards its twin, just as the iron filing is attracted toward the Magnet. (Mathnawi, Daftar 3 p.418).*

It may be particularly noted that the words used in the last but one line, viz :

*Every particle in the universe is attracted towards its twin, like the magnet and the iron filing, have a remarkable similarity to the words used by Newton for his Theory of Gravitation; 'Every particle in the universe attracts every other particle.'*

Considering that there is an interval of about four hundred years between the times of Maulana Rumi and Newton, the question naturally arises: how can this similarity be explained?

## **9.2 Evolution**

Let us take the concept of evolution now. This is given in Daftar 4, pp.334 and 345, of the Mathwani under the Headings:

*Description of the ways and stages of creation of man from the Beginning of Creation. The original lines in the Mathnawi say:*

*The creature appeared first in the form of inorganic matter, and then grew into a plant; it remained in this form for years and years, and did not remember anything of its earlier inorganic state. When it evolved from the plant state to an animal state, it had no recollection of its earlier plant state. Later the Creator, whom you know, developed him from animal to human state, thus it went on from one state to another state, until it reached its present state of a knowing, intellectual and wise creature. ' (Mathnawi, Daftar 4 p.345).*

So, we see here a vivid illustration of the close interaction between the scientific activities and the cultural activities.

## **10 CONCLUSION**

From the foregoing discussion, it would be fairly clear that, just as the phenomenal rise of scientific activity in the 2<sup>nd</sup> century Hijri was a (direct or subsidiary) consequence of the overwhelming Islamic impulse of the 1<sup>st</sup> century Hijra, so are the major peaks B<sub>1</sub> (at 520 H.) and B<sub>2</sub> (at 655 H.) a more or less direct consequence of the catalytic intellectual work of (a) Al Ghazzali (around 470 H.)

and (b) Ibn Rushd and Jalaluddin Rumi in the period of 590 H. to 620 H. It is also noteworthy that the time-lag between these peaks of scientific output and the catalyzing activity is of the order of 50 years.

It is also desirable to undertake further such multi-disciplinary studies, covering the 3<sup>rd</sup> as well as the 5<sup>th</sup> - 8<sup>th</sup> centuries Hijri, so as to better understand the intricate patterns of the rise and decline of these intellectual and scientific activities. These should include the condition of educational institutions, intellectual mutual interaction and state-patronage, among others.

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# Science-Driven Entrepreneurship in the Islamic World

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## 1 ABSTRACT

In view of the challenges facing the Islamic world today particularly with regard to progress in knowledge and development related fields and the need to stimulate and modernize scientific infrastructures and improve their output while clinging to Islamic fundamental values, and in accordance with Islam's call for the middle course and moderation, ISESCO placed the question of scientific reform at the center of its attention in its scientific programs and activities. By doing so, the organization expressed the belief that a modern scientific network throughout the Islamic countries capable of fulfilling the aspirations and hopes of the Islamic *Ummah* for an elevated status among nations cannot come true without linking the past to the present while keeping an eye on future.

## 2 ISLAM AND SCIENCE: SOME QUESTIONS

Our holy prophet Muhammad (PBUH) displayed remarkable social, political and economic ingenuity in securing the earliest conversions to Islam, moving with his co-religionists from Mecca to Medina to establish a basic state, and then defeating his pagan opposition. Over the following few centuries; the development of Islamic norms, standards, rules, laws, practices, organizations, belief systems, and reward mechanisms, which entailed a highly creative synthesis based on the appropriation, and also the refinement and modification, of pre-Islamic laws and trends.

Not surprisingly, at the time, Islam was still spreading to far corners of the world, through the establishment of mercantile midpoints operating under Islamic law. Merchants was one of the several groups that carried Islam to many parts of East Africa, India, China, and, later, Indonesia. Such trading posts attracted diverse professionals. In addition to privileged access to their services, persons converted to Islam to enjoy the benefit of acceptance into lucrative Muslim

trading networks, preferential treatment in Islamic courts, eligibility for high administrative positions, and sometimes also lower taxation.

During these golden eras, the Islamic world had always possessed distinguished scholars, scientists, inventors, philosophers and political leaders since its glorious advent. They contributed to many diverse disciplines and became the fountainhead of knowledge and learning.

The greatest challenge that we face today arises from this reality that the celebrated scholars of the Islamic world have rarely put their knowledge into action. It means that they have not converted their knowledge into technology and they also did not commercialize the technology. The commercialization of technology paves the grounds for entrepreneurship which ultimately results in employment and productive wealth, the area that most of the Islamic countries are facing deficiency in, today.

If the Islamic scholars had fulfilled this critical mission, the following critical impacts would have been attainable:

First, they, and also the world of Islam, could have become a source of indisputable income; and second, as a result, the world of Islam would not be dependent on other great sovereignties.

I have proceeded to investigate the how's and why's of this leeway for fault finding and trouble shooting and in addition to focus on the implications of entrepreneurship and technology. I would like to bring to your kind attention that my indication on the renovation of knowledge throughout the Islamic world will spin around four essential questions.

Question One:

***What elucidates the unappeasable zeal for knowledge and learning within a certain stages of Islamic civilization like amid the 8<sup>th</sup> and 14<sup>th</sup> centuries?***

There is no doubt at all that one of the most significant incentives behind such achievements was the Qur'anic call to recognize the universe, the human being's physical environment and even the workings of the human body, all provided the inspiration to search for knowledge and to master the sciences. Islamic texts especially the Qur'an also encouraged entrepreneurship and fruitful economic activities, such as the following: "When the prayers end, disperse and go in quest of Allah's bounty" (62:10).

Besides, these and other Muslim men of scholarship in the early centuries were open-minded, accommodative and all-encompassing in their thoughts and orientation which was why they had no suspicions about embracing ideas on science from the Greeks, the Indians and the Chinese. In their conversion of remarkable works from non-Muslim sources into Arabic, they collaborated with Christians, Jews and people of other religious affiliations.

In that first phase of the knowledge escalation within the Muslim world, the emphasis was upon translations from earlier civilizational sources. In the second phase, in which pioneering discoveries were made by well-known Muslim

scholars, the vital feature was the sponsorship of some leaders who had an intense pledge to knowledge and wisdom that resulted in an entire array of scholars who were able to carry out their study and writing.

Moreover, Qur'anic insight, open-mindedness and the support of enlightened rulers then were amid the key reasons for the success of knowledge and sciences in the Muslim world for approximately six centuries.

Hence, Islamic culture and creed have always insisted on understanding and deliberation and as the result, the intellectual and critical thinking is considered as an essential approach of thinking regarding noble ideas and concepts.

In the same orientation, school building is another factor that boosted intellectual movements and empowered cultural development. Within that era, a good number of scholars (ulama) considered school building a deed that should be launched and developed for the sake of Almighty Allah.

Question Two:

***What clarifies the decrease in concern in scientific scholarship and study between the 14<sup>th</sup> century and the end of the western colonial era?***

The downfall in science and technology development in the Muslim world from the fourteenth century onwards was due to a number of factors like:

1. The majority of Islamic scholars, scientists, inventors, philosophers and political leaders did not have access to first requisites of their researches and studies; hence, they had to put a big share of their energy to surmount the obstacles.
2. Governments, except in some eras, did not pay considerable attention to research and study and these critical fields have been dwarfed by other fields and have been overshadowed by prompt social and economic needs and problems.
3. The scientific society in the Islamic world suffered from the lack of powerful scientific networks or intelligent scientific management and powerful, creative R&D centers; scholars and scientists were not aware of their colleagues' activities. This shortcoming resulted in scholars repeating researches of other scholars; besides, they were unable to follow up other researches in order to complete them.
4. Because of aforementioned shortcomings, we are facing brain drain from undeveloped and less developed countries to developed countries. It makes the problem more drastic and will scientifically impoverish Islamic world.
5. The assault upon several of the original doctrines of scientific thinking -observation, trial, inductive reasoning and substantiation- by a part of the *ulama* which started in the ninth century is one more reason. These religious elites considered that coherent thinking and the continuous challenge to

institute cause and effect ideas amongst Muslim scientists and philosophers would destabilize faith and revelation.

6. What had a devastating impact upon scientific examination were the Mongol invasions of the twelfth and thirteenth centuries. Annihilation of Baghdad in 1258 was the most traumatic event in a series of assaults which saw the sacking of other centres of knowledge such as Samarkand and Bokhara. It was not just the physical effects of the wreckage which crippled Islamic scholarship; the psychological consequences were even more damaging. Scientific ingenuity shrank and shrivelled. The drive for intellectual innovation lost its impetus.

Question Three:

***What are some of the current barriers in the reconstruction of knowledge in the Islamic world?***

Today, the academic and scientific domination of west continues to have a negative impact upon the growth of science in the Muslim world. Of course, many countries in the non-Muslim world are also victims of this hegemony. This hegemonic power is attempting to curb and control the emergence and dissemination of independent science in Muslim and non-Muslim societies, especially if it is a society which insists upon asserting its political and economic liberty.

But, that is not the only, or even the most severe impediment to the restoration of scientific knowledge in the Muslim world. Muslim elites in a number of countries have given inadequate notice to scientific research or to foster a scientific spirit in their societies. Indeed, the allocation for research and development (R&D) even in wealthy Muslim countries is low compared to the amount set aside for this purpose in developed countries.

On the other hand, there are oil rich Muslim states that have become so complacent that they do not bother to raise the level of skills and competence of their people. Consequently, these societies remain underdeveloped from a scientific and technological perspective in spite of a veneer of wealth and sophistication. Once again, it is the failure of the ruling class to value the importance of a creating one's own scientific base in order to boost one's economic development which is the cause of the problem.

Question Four:

***How can we surmount some of these challenges?***

To overcome these obstacles, Muslims should adopt a number of approaches. Leading Muslim reformers of the nineteenth century, Jamal al-Din Asad-Abadi (Afghani) (1839-97), had exposed this question that if Islam promotes hard work, risk taking and innovation; why were the strongest countries of his time

predominantly non-Muslim? They are strong because they are not really non-Muslim, he answered. As for Muslims, they are weak because they are not really Muslim. What they preach and practice, Asad-Abadi held, is Islam only in name.

Although Islamic texts especially the Qur'an really encourage entrepreneurship and fruitful economic activities, unfortunately, ever since some of the Islamic countries slipped into a state of underdevelopment, lack of creativity, excessive risk aversion, and lack of sympathy to innovation have been among the factors viewed as causes of its economic shortcomings and alas this state of underdevelopment has made this assumption that Islam does not agree entrepreneurship and economic development. Whereas, over the ages, Islam influenced the promotion of entrepreneurship and productivity of entrepreneurs through its effects on the capacities to pool resources, expand commercially, engage in long-lasting ventures, and preserve successful businesses.

### 3 CONCLUSION

We need a comprehensive effort to create an enabling environment to harness the collective potential of the Muslim *Ummah*. We must also recognize that commitment to cooperate among ourselves enjoined by our common faith which encourages us to seek an attractive environment for investment and profitability in order to achieve sustainable development.

The rejuvenation of science and knowledge in the Muslim world would depend, to a certain degree, on Muslims and non-Muslims working together to check global scientific hegemony. But whether science flourishes or withers in the Muslim world will be determined in the ultimate analysis by Muslim governments themselves. More specifically, will they emphasize science in their national agendas, raise the awareness of their scholars about the significance of science and strengthen a rational, scientific outlook within the people as a whole? Or will they -- the majority of them ---continue to flow without direction?

ISESCO has painstakingly strived to fulfill the educational, scientific and cultural needs of Islamic countries. In this regard, joint cooperation, workshops and conferences have been conducted by ISESCO to help member states to achieve quality scientific development and intellectual setup by means of interactions and exchange of ideas through an integrated institutional setup.



**PART EIGHT**  
**APPENDIXES**





## APPENDIX A

### 2008 CONFERENCE COMMITTEES

#### Advisory Science Committee

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Prof. Ahmed **Marrakchi** FIAS  
Prof. Mehmet **Ergin** FIAS  
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Prof. Akhmet **Mazgarov** FIAS  
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#### IAS Organising Committee

Dr Moneef R **Zou'bi** DG-IAS  
Ms Lina Jalal **Dadan**, IAS  
Ms Taghreed **Saqer**, IAS

#### Local Committee

H E Mintimer Sharipovich **Shaymiev** (Chairman)  
H E Ravil Fatykhovich **Muratov**  
Prof. Akhmet Mazgarovich **Mazgarov** FIAS  
Mr Timur Yriyevich **Akulov**  
Prof. Mikhail Chokkaevich **Zalikhhanov** FIAS  
Prof. Robert Iskanderovich **Nigmatullin** FIAS  
Prof. Salambek Naibovich **Khadzhiev** FIAS



## APPENDIX B

### CHAIRPERSONS OF THE 2008 CONFERENCE SESSIONS

|             |                                     |            |
|-------------|-------------------------------------|------------|
| Session 1:  | Prof. Abdel Salam Majali FIAS       | Jordan.    |
| Session 2:  | Prof: Munir Ozturk FIAS             | Turkey.    |
| Session 3:  | Prof. Naci Bor FIAS                 | Sudan.     |
| Session 4:  | Prof. Zohra Benlakhdar FIAS         | Tunisia.   |
| Session 5:  | Prof. Mohammed B. E. Fayez FIAS     | Egypt.     |
| Session 6:  | Prof. Zakri Abdul Hamid FIAS        | Malaysia.  |
| Session 7:  | Prof. Akhmet Mazgarov FIAS          | Tatarstan. |
| Session 8:  | Academician Dato Eng Lee Yee Cheong | Malaysia.  |
| Session 9:  | Prof. Noor M. Butt FIAS             | Pakistan.  |
| Session 10: | Prof. Anwar Nasim FIAS              | Pakistan.  |
| Session 11: | Prof. Ugur Dilmen FIAS              | Turkey.    |



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42. Dr Radik Raufovich Gayzatullin, Minister of Finance of the Republic of Tatarstan, Kazan, Tatarstan, Russian Federation.
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48. Prof. Lonel Haiduc, President of the Romanian Academy of Sciences, Bucharest, Romania.
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115. Dr Ramil Mirgasimovich Valeev, Head of the Department of Higher Secondary and Professional Education and Science of the Republic of Tatarstan, Russian Federation.
116. Mr Razil Ismagilovich Valeev, Chairman, Committee of State Council of the Republic Tatarstan on Culture, Science, Education and National Problems; Kazan, Tatarstan, Russian Federation.
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## APPENDIX D

### PATRONS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

His Excellency the President of the Islamic Republic of Pakistan.  
His Royal Highness Prince El Hassan Bin Talal of the Hashemite Kingdom of  
Jordan, Founding Patron.

### HONORARY FELLOWS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

Prof. **Richard R. Ernst**, 1991 Nobel Laureate (Chemistry), Switzerland.  
Mr **Fouad Alghanim**, President, Alghanim Group, Kuwait.  
Prof. Ekmeleddin **Ihsanoglu**, OIC Secretary General, Turkey.  
Sheikh **Saleh Kamel**, Chairman, Dallah Elbaraka Group, Saudi Arabia.  
Datuk Patinggi Tan Sri Haji Dr **Abdul Taib Mahmud**, Chief Minister, State of  
Sarawak, Malaysia.  
Dr **Adnan M. Mjalli**, Chairman of the Board, President and CEO, TransTech  
Pharma, Inc., USA.  
His Excellency Dato' Seri Dr **Mahathir Mohamad**, Former Prime Minister of  
Malaysia.  
Prof. **Ferid Murad**, 1998 Nobel Laureate (Medicine), USA.  
His Excellency **Nursultan Abishevich Nazarbayev**, President of the Republic  
of Kazakhstan.  
H E Mr **Mintimer Shaimiev**, President of the Republic of Tatarstan/ Russian  
Federation.  
His Excellency Sheikh **Hamad Bin Jassim Bin Jabr Al Thani**, Prime Minister  
of Qatar, Qatar.  
Sheikh **Hamad Al-Zamil**, Chairman, Al-Zamil Group, Saudi Arabia.  
Prof. **Ahmed Zewail**, 1999 Nobel Laureate (Chemistry), Egypt/USA.



## FELLOWS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

|     |  |                      |
|-----|--|----------------------|
| 1.  | Prof. Mohammad <b>Abdollahi</b>              | Iran                 |
| 2.  | Prof. Zakri <b>Abdul Hamid</b>               | Malaysia             |
| 3.  | Prof. Omar <b>Abdul Rahman</b>               | Malaysia             |
| 4.  | Prof. Naim <b>Afgan</b>                      | Bosnia-Herzegovina   |
| 5.  | Prof. Ishfaq <b>Ahmad</b>                    | Pakistan             |
| 6.  | Prof. Askar <b>Akayev</b>                    | Kyrgyzstan           |
| 7.  | Prof. Sajjad <b>Alam</b>                     | Bangladesh/USA       |
| 8.  | Prof. M Shamsheer <b>Ali</b>                 | Bangladesh           |
| 9.  | Prof. Qurashi Mohammed <b>Ali</b>            | Sudan                |
| 10. | Prof. Huda Saleh Mehdi <b>Ammash</b>         | Iraq                 |
| 11. | Prof. Wiranto <b>Arismunandar</b>            | Indonesia            |
| 12. | Prof. Muhammad <b>Asghar</b>                 | France               |
| 13. | Prof. Attia A <b>Ashour</b>                  | Egypt                |
| 14. | Prof. Allaberen <b>Ashyralyev</b>            | Turkmenistan         |
| 15. | Prof. Saleh A <b>Al-Athel</b>                | Saudi Arabia         |
| 16. | Prof. Ahmad Abdullah <b>Azad</b>             | Bangladesh/Australia |
| 17. | Prof. Agadjan <b>Babaev</b>                  | Turkmenistan         |
| 18. | Prof. Adnan <b>Badran</b>                    | Jordan               |
| 19. | Prof. Ibrahim Gamil <b>Badran</b>            | Egypt                |
| 20. | Prof. Farouk <b>El-Baz</b>                   | USA                  |
| 21. | Prof. Kazem <b>Behbehani</b>                 | Kuwait               |
| 22. | Prof. Azret Yusupovich <b>Bekkiev</b>        | Balkar/Russia        |
| 23. | Prof. Naci <b>Bor</b>                        | Turkey               |
| 24. | Prof. Rafik <b>Boukhris</b>                  | Tunisia              |
| 25. | Prof. David (Mohamed Daud) A. <b>Bradley</b> | UK                   |
| 26. | Prof. Noor Mohammad <b>Butt</b>              | Pakistan             |
| 27. | Prof. Muhammad Iqbal <b>Choudhary</b>        | Pakistan             |
| 28. | Prof. Abdallah <b>Daar</b>                   | Oman/ Canada         |
| 29. | Prof. Ali Al <b>Daffa'</b>                   | Saudi Arabia         |
| 30. | Prof. Mamadou <b>Daffe</b>                   | Mali/France          |
| 31. | Prof. Fakhruddin <b>Daghestani</b>           | Jordan               |
| 32. | Prof. Ramazan <b>Demir</b>                   | Turkey               |
| 33. | Prof. Oussaynou Fall <b>Dia</b>              | Senegal              |
| 34. | Prof. Ugur <b>Dilmen</b>                     | Turkey               |
| 35. | Prof. Mustafa <b>Doruk</b>                   | Turkey               |

|     |   |                       |
|-----|---|-----------------------|
| 36. | Prof. Mehmet <b>Ergin</b>               | Turkey                |
| 37. | Prof. Nesreen <b>Ghaddar</b>            | Lebanon               |
| 38. | Prof. Mehdi <b>Golshani</b>             | Iran                  |
| 39. | Prof. Kadyr G <b>Gulamov</b>            | Uzbekistan            |
| 40. | Prof. Ameenah <b>Gurib-Fakim</b>        | Mauritius             |
| 41. | Prof. Hashim M <b>El-Hadi</b>           | Sudan                 |
| 42. | Prof. Mohammad <b>Hamdan</b>            | Jordan                |
| 43. | Prof. Adnan <b>Hamoui</b>               | Syria                 |
| 44. | Prof. Kemal <b>Hanjalic</b>             | Bosnia-Herzegovina    |
| 45. | Prof. Mohamed H A <b>Hassan</b>         | Sudan                 |
| 46. | Prof. Tasawar <b>Hayat</b>              | Pakistan              |
| 47. | Prof. Ali Ali <b>Hebeish</b>            | Egypt                 |
| 48. | Prof. Bambang <b>Hidayat</b>            | Indonesia             |
| 49. | Prof. Rabia <b>Hussain</b>              | Pakistan              |
| 50. | Prof. Abdul Latif <b>Ibrahim</b>        | Malaysia              |
| 51. | Prof. Aini <b>Ideris</b>                | Malaysia              |
| 52. | Prof. Mohammad Shamim <b>Jairajpuri</b> | India                 |
| 53. | Prof. Mohammad Qasim <b>Jan</b>         | Pakistan              |
| 54. | Prof. Hamza <b>El-Kettani</b>           | Morocco               |
| 55. | Prof. Salambek <b>Khadjiev</b>          | Chechnya              |
| 56. | Prof. Idriss <b>Khalil</b>              | Morocco               |
| 57. | Prof. Abdul Qadeer <b>Khan</b>          | Pakistan              |
| 58. | Prof. Hameed Ahmed <b>Khan</b>          | Pakistan              |
| 59. | Prof. M. Ajmal <b>Khan</b>              | Pakistan              |
| 60. | Prof. Mostefa <b>Khiati</b>             | Algeria               |
| 61. | Prof. Abdelhafid <b>Lahlaidi</b>        | Morocco               |
| 62. | Prof. Zohra Ben <b>Lakhdar</b>          | Tunisia               |
| 63. | Prof. Malek <b>Maaza</b>                | Algeria               |
| 64. | Prof. Abdel Salam <b>Majali</b>         | Jordan                |
| 65. | Prof. Ahmed <b>Marrakchi</b>            | Tunisia               |
| 66. | Prof. Akhmet <b>Mazgarov</b>            | Tatarstan/Russia      |
| 67. | Prof. Syed Qasim <b>Mehdi</b>           | Pakistan              |
| 68. | Prof. Amdoulla <b>Mehrabov</b>          | Azerbaijan            |
| 69. | Prof. Sami <b>Al- Mudhaffar</b>         | Iraq                  |
| 70. | Prof. Zaghoul <b>El-Naggar</b>          | Egypt                 |
| 71. | Prof. Ibrahim Saleh <b>Al- Naimi</b>    | Qatar                 |
| 72. | Prof. Anwar <b>Nasim</b>                | Pakistan              |
| 73. | Prof. Munir <b>Nayfeh</b>               | Jordan/ United States |
| 74. | Prof. Robert <b>Nigmatulin</b>          | Tatarstan/ Russia     |
| 75. | Prof. Gulsen <b>Oner</b>                | Turkey                |
| 76. | Prof. Ramdane <b>Ouahes</b>             | Algeria               |
| 77. | Prof. Korkut <b>Ozal</b>                | Turkey                |
| 78. | Prof. Mehmet Nimet <b>Ozdas</b>         | Turkey                |
| 79. | Prof. Sinasi <b>Ozsoylu</b>             | Turkey                |

|      |                                      |                   |
|------|--------------------------------------|-------------------|
| 80.  | Prof. Munir <b>Ozturk</b>            | Turkey            |
| 81.  | Prof. Iqbal <b>Parker</b>            | South Africa      |
| 82.  | Prof. Syed Muhammad <b>Qaim</b>      | Germany           |
| 83.  | Prof. Subhi <b>Qasem</b>             | Jordan            |
| 84.  | Prof. Atta-ur- <b>Rahman</b>         | Pakistan          |
| 85.  | Prof. Najih Khalil <b>El-Rawi</b>    | Iraq              |
| 86.  | Prof. Makhmud <b>Salakhitdinov</b>   | Uzbekistan        |
| 87.  | Prof. Hussein Samir <b>Salama</b>    | Egypt             |
| 88.  | Prof. Eldar Yunisoglu <b>Salayev</b> | Azerbaijan        |
| 89.  | Prof. Jawad A. <b>Salehi</b>         | Iran              |
| 90.  | Prof. Mohammad <b>Salimullah</b>     | Bangladesh        |
| 91.  | Prof. Boudjema <b>Samraoui</b>       | Algeria           |
| 92.  | Prof. Lorenzo <b>Savioli</b>         | Italy             |
| 93.  | Prof. Misbah-Ud-Din <b>Shami</b>     | Pakistan          |
| 94.  | Prof. Ali <b>Al-Shamlan</b>          | Kuwait            |
| 95.  | Prof. Ahmad <b>Shamsul-Islam</b>     | Bangladesh        |
| 96.  | Prof. Muthana <b>Shanshal</b>        | Iraq              |
| 97.  | Prof. Ahmedou M <b>Sow</b>           | Senegal           |
| 98.  | Prof. Mahmoud <b>Tebyani</b>         | Iran              |
| 99.  | Prof. Ahmet Hikmet <b>Ucisik</b>     | Turkey            |
| 100. | Prof. Gulnar <b>Vagapova</b>         | Tatarstan/ Russia |
| 101. | Prof. Ibrahima <b>Wone</b>           | Senegal           |
| 102. | Prof. Bekhzad <b>Yuldashev</b>       | Uzbekistan        |
| 103. | Prof. Khalid <b>Yusoff</b>           | Malaysia          |
| 104. | Prof. Khatijah Mohd <b>Yusoff</b>    | Malaysia          |
| 105. | Prof. Mikhael <b>Zalikhanov</b>      | Balkar/Russia     |

## APPENDIX E

### LAUREATES OF THE IAS-COMSTECH IBRAHIM MEMORIAL AWARD

|                                       |      |               |
|---------------------------------------|------|---------------|
| Prof. Ugur <b>Dilmen</b>              | 1996 | Turkey.       |
| Prof. Mohammad <b>Abdollahi</b>       | 2005 | Iran.         |
| Prof. Mohammed Manna <b>Al-Qattan</b> | 2007 | Saudi Arabia. |
| Dr Faris <b>Gavrankapetanovic</b>     | 2009 | Bosnia.       |
| Dr Saima <b>Riazuddin</b>             | 2011 | Pakistan.     |
| Prof. Liaquat <b>Ali</b>              | 2013 | Bangladesh.   |



## APPENDIX F

### IAS COUNCIL (2009-2013)

|                      |                             |             |
|----------------------|-----------------------------|-------------|
| President:           | <b>Abdul Salam Majali</b>   | Jordan.     |
| Vice-President:      | <b>Farouk El Baz</b>        | Egypt.      |
| Vice-President:      | <b>Mehmet Ergin</b>         | Turkey.     |
| Vice-President:      | <b>Misbahuddin Shami</b>    | Pakistan.   |
| Treasurer:           | <b>Adnan Badran</b>         | Jordan.     |
| Secretary General:   | <b>Mohamed H A Hassan</b>   | Sudan.      |
| Member:              | <b>Amdulla Mehrabov</b>     | Azerbaijan. |
| Member:              | <b>Anwar Nasim</b>          | Pakistan.   |
| Member:              | <b>Syed Muhammad Qaim</b>   | Germany.    |
| Member:              | <b>Najih Khalil El-Rawi</b> | Iraq.       |
| Member:              | <b>Khatijah Mohd Yusoff</b> | Malaysia.   |
| Member (Ex-officio): | <b>Moneef R. Zou'bi</b>     | IAS/Jordan. |

### IAS EXECUTIVE STAFF

**Dr Moneef R. Zou'bi**

*Director General.*

**Lina Jalal Dadan**  
**Taghreed Saqer**  
**Hamzah Daghestani**  
**Habes Majali**  
**Saleh As'ad.**  
**Hamdi Bader**

*Programme Officer.*  
*Executive Secretary.*  
*Finance Officer.*  
*Public Relations Officer.*  
*Office Manager.*  
*Driver.*



## APPENDIX G

### DECEASED IAS FELLOWS

|                                     |             |                 |
|-------------------------------------|-------------|-----------------|
| Prof. Mohammad <b>Ibrahim</b>       | (1911-1988) | Bangladesh.     |
| Prof. Djibril <b>Fall</b>           | (1930-1992) | Senegal.        |
| Prof. Salimuzzaman <b>Siddiqui</b>  | (1897-1994) | Pakistan.       |
| Prof. Abdus Salam <b>Mia</b>        | (1925-1995) | Bangladesh/USA. |
| Prof. Suleiman Gabir <b>Hamad</b>   | (1937-1996) | Sudan.          |
| Prof. Mohammad R <b>Siddiqi</b>     | (1908-1998) | Pakistan.       |
| Prof. Abdullah M <b>Sharafuddin</b> | (1930-1998) | Bangladesh.     |
| Prof. Achmad <b>Baiquni</b>         | (1923-1998) | Indonesia.      |
| Prof. Mumtaz Ali <b>Kazi</b>        | (1928-1999) | Pakistan.       |
| Prof. Faramaz G <b>Maksudov</b>     | (1930-2000) | Azerbaijan      |
| Prof. Ali <b>Kettani</b>            | (1941-2001) | Morocco         |
| Prof. Mohamed Kamel <b>Mahmoud</b>  | (1926-2003) | Egypt.          |
| Prof. Samaun <b>Samadikun</b>       | (1931-2006) | Indonesia.      |
| Prof. Iftikhar Ahmad <b>Malik</b>   | (1936-2008) | Pakistan.       |
| Prof. J (Younis) Ario <b>Katili</b> | (1929-2008) | Indonesia.      |
| Prof. Ibrahima Mar <b>Diop</b>      | (1921-2008) | Senegal.        |
| Prof. Syed Zahir <b>Haider</b>      | (1927-2008) | Bangladesh.     |
| Prof. Muhammad Ilyas <b>Burney</b>  | (1922-2008) | Pakistan.       |
| Prof. Badri <b>Muhammad</b>         | (1943-2009) | Malaysia.       |
| Prof. Pulat <b>Khabibullaev</b>     | (1936-2010) | Uzbekistan.     |
| Prof. Mohammed A <b>Waqar</b>       | (1941-2010) | Pakistan.       |
| Prof. Souleymane <b>Niang</b>       | (1929-2010) | Senegal.        |
| Prof. Ahmad Nawawi <b>Ayoub</b>     | (1937-2010) | Malaysia.       |
| Prof. Kamal H. <b>Batanouny</b>     | (1936-2011) | Egypt.          |
| Prof. Mohamed B E <b>Fayez</b>      | (1927-2011) | Egypt.          |
| Prof. Mazhar M <b>Qurashi</b>       | (1925-2011) | Pakistan.       |
| Prof. Mahmoud <b>Hafez</b>          | (1912-2012) | Egypt.          |
| Prof. Jamal <b>Nazrul-Islam</b>     | (1939-2013) | Bangladesh.     |
| Prof. <b>Riazuddin</b>              | (1930-2013) | Pakistan.       |
| Prof. Naeem Ahmad <b>Khan</b>       | (1928-2013) | Pakistan.       |





## APPENDIX H

### PUBLICATIONS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

#### CONFERENCE PROCEEDINGS

- *The Islamic Academy of Sciences*. Proceedings of the Founding Conference (1986). Published by the Islamic Academy of Sciences, **Editor: A. Kettani (Morocco)**.
- *Food Security in the Muslim World*. Proceedings of the first international conference, Amman (Jordan) (1987). Published by the Islamic World Academy of Sciences, **Editor: S. Qasem (Jordan)**.
- *Science and Technology Policy for Self-Reliance in the Muslim World*. Proceedings of the second international conference, Islamabad (Pakistan) (1988). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), H. El-Mulki (Jordan), and M. Al-Halaiqa (Jordan)**.
- *New Technologies and Development of the Muslim World*. Proceedings of the third international conference, (Kuwait) (1989). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), and S. Qasem (Jordan)**.
- *Technology Transfer for Development in the Muslim World*. Proceedings of the fourth international conference, Antalya (Turkey) (1990). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and M. Ergin (Turkey)**.
- *Science and Technology Manpower Development in the Islamic World*. Proceedings of the fifth international conference, Amman (Jordan) (1991). Published by the Islamic World Academy of Sciences, **Editors: F. Daghestani (Jordan), A. Altamemi (Jordan), and H. El-Mulki (Jordan)**.
- *Environment and Development in the Islamic World*. Proceedings of the sixth international conference, Kuala Lumpur (Malaysia) (1992). Published by the Islamic World Academy of Sciences, **Editors: S. Al-Athel (Saudi Arabia), and F. Daghestani (Jordan)**.
- *Health, Nutrition and Development in the Islamic World*. Proceedings of the seventh international conference, Dakar (Senegal) (1993). Published by the Islamic World Academy of Sciences, **Editors: N. Bor (Turkey), A. Kettani**

**(Morocco), and Moneef R. Zou'bi (Jordan).**

- *Water in the Islamic World: An Imminent Crisis*. Proceedings of the eighth international conference, Khartoum (Sudan) (1994). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), H. Dogan Altinbilek (Turkey), and Moneef R. Zou'bi (Jordan).**
- *Science and Technology Education for Development in the Islamic World*. Proceedings of the ninth international conference, Tehran (Iran) (1999). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-7).**
- *Information Technology for Development in the Islamic World*. Proceeding of the tenth international conference, Tunis (Tunisia) (2000). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), M. Doruk (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-03-5).**
- *Biotechnology and Genetic Engineering for Development in the Islamic World*. Proceedings of the eleventh international conference, Rabat (Morocco) (2001). Published by the Islamic World Academy of Sciences, **Editors: A. S. Majali (Jordan), M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-07-8).**
- *Materials Science and Technology and Culture of Science*. Proceedings of the twelfth international conference, Islamabad (Pakistan), (2002). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-06-x).**
- *Energy for Sustainable Development and Science for the Future of the Islamic World and Humanity*. Proceedings of the thirteenth international conference, Kuching, Sarawak (Malaysia), (2003). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-08-6).**
- *Science Technology and Innovation for Socioeconomic Development of OIC-Member Countries Towards Vision 1441*. Proceeding of the fourteenth international conference, Kuala Lumpur (Malaysia), (2005). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 9957-412-11-6).**
- *Higher Education Excellence for Development in the Islamic World*. Proceeding of the fifteenth international conference, Ankara (Turkey), (2006). Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-18-0).**
- *Science and Technology and Innovation for Sustainable Development in the Islamic World: Policies and Politics Rapprochement*, Proceeding of the sixteenth international conference, Kazan (Tatarstan), (2008) – Published by

the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-19-7).**

- *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination*, Proceeding of the seventeenth international conference, Shah Alam, *Selangor (Malaysia)*; 2009 - Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-22-7). In press.**
- *The Islamic World and the West: Rebuilding Bridges through Science and Technology*, Doha (Qatar), 2011 - Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-22-7). In press.**
- *Achieving Socioeconomic Development in the Islamic World through Science, Technology and Innovation*, Dhaka (Bangladesh), 2013 – Published by the Islamic World Academy of Sciences, **Editors: M. Ergin (Turkey), and Moneef R. Zou'bi (Jordan). In press.**

## BOOKS

- *Islamic Thought and Modern Science*. Published by the Islamic World Academy of Sciences (1997) - **Author: Mumtaz A. Kazi.**
- *Qur'anic Concepts and Scientific Theories*. Published by the Islamic World Academy of Sciences (1999) – **Author: Mumtaz A. Kazi.**
- *Personalities Noble* **Editor: Hakim Mohammed Said**, Second Revised Edition. Published by the Islamic World Academy of Sciences (2000), **Editor: Moneef R. Zou'bi** (Arabic-English). **(ISBN: 9957-412-01-6).**
- *Declarations of the Islamic World Academy of Sciences*. Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef. R. Zou'bi (ISBN: 9957-412-09-4).**
- *Islamic World Academy of Sciences Outreach*. Published by the Islamic World Academy of Sciences (2005), **Editor: Moneef R. Zou'bi (ISBN: 9957-412-10-8).**
- *Intellectual Property Rights: An Introduction for Scientists and Technologists*. Published by the Islamic World Academy of Sciences (2006), **Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-18-0).**
- *Reverse Engineering: The Permissible but not Well-Recognized* -Published by the Islamic World Academy of Sciences (2010), **Author: Mohamed B. E. Fayez (ISBN: 978-9957-412-20-3).**
- *Découvertes en pays d'Islam* – Arabic Edition Published by the Islamic World

Academy of Sciences (2013), **Author: Ahmed Djebbar (ISBN: 978-9957-412-23-4).**

#### PERIODICALS

- *Medical Journal of the Islamic World Academy of Sciences* (ISSN 1016-3360) – quarterly. Chief Editor: **Prof. Naci Bor FIAS**, Mithatpasa Cad. No. 66/5, Ankara, Turkey.
- *Newsletter of the Islamic World Academy of Sciences* – quarterly. Chief Editor: **Moneef R. Zou’bi**.
- *Islamic Thought and Scientific Creativity* (in Arabic) - quarterly Journal of the Organisation of the Islamic Conference (OIC) Standing Committee on Scientific and Technological Co-operation (COMSTECH). Arabicised version published by IAS with the support of the Royal Academy for Islamic Civilisation Research (Al-Albait Foundation) (publication ceased in 1996).

#### OTHER PUBLICATIONS

- *An Overview* of the IAS, Chief Editor: **M. R. Zou’bi**.
- IAS Postcards.

## APPENDIX I

### IAS SUPPORTERS

**The Hashemite Kingdom of Jordan**

**The Islamic Republic of Pakistan**

**The State of Kuwait**

**The Republic of Turkey**

**Malaysia**

**The Republic of Senegal**

**The Republic of Sudan**

**The Islamic Republic of Iran**

**The State of Qatar**

**The Republic of Tunisia**

**The Kingdom of Morocco**

**The State of Sarawak/Malaysia**

**The Republic of Indonesia**

**The Republic of Tatarstan/ Russian Federation**

**The State of Selangor/Malaysia**

**The Sultanate of Oman**

**The Republic of Kazakhstan**

**The People's Republic of Bangladesh**

**The State of Perlis/ Malaysia**

The OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH), Pakistan.

The Islamic Development Bank (IDB), Saudi Arabia.

The OPEC Fund for International Development, Vienna, Austria.

Arab Potash Company, Jordan.

United Nations Educational Scientific and Cultural Organisation (UNESCO), France.

Islamic Educational Scientific and Cultural Organisation (ISESCO), Morocco.

The World Bank, USA.

The United Nations Environment Programme (UNEP), Kenya.

Kuwait Foundation for the Advancement of Sciences (KFAS).

Turkish Scientific and Technical Research Council (TUBITAK).

The Royal Scientific Society (RSS), Jordan.

Pakistan Ministry of Science and Technology.

Ministry of Science, Technology and the Environment, Malaysia.

University Cheikh Anta Diop, Dakar, Senegal.

Ministry of Higher Education and Scientific Research, Sudan.

National Centre for Research, Sudan.  
 Ministry of Culture and Higher Education, Iran.  
 Iranian Research Organisation for Science and Technology (IROST).  
 The Academy of Sciences, Tehran, Iran.  
 The Academy of Medical Sciences, Tehran, Iran.  
 Saudi Arabian Oil Company, Saudi Arabia (ARAMCO).  
 Ihlas Holding, Turkey.  
 Arab Bank, Jordan.  
 Jordan Kuwait Bank, Jordan.  
 Rafia Industrial Company, Jordan.  
 Secretariat of State for Scientific Research and Technology, Tunisia.  
 Academy of the Kingdom of Morocco.  
 Petra Private University, Jordan.  
 Higher Council of Science and Technology (HCST), Jordan.  
 Pakistan Academy of Sciences.  
 Majlis Islam Sarawak, Malaysia.  
 Tabung Baitulmal Sarawak, Malaysia.  
 Sasakawa Peace Foundation, Japan.  
 Perdana Leadership Foundation, Putrajaya, Malaysia.  
 Royal Jordanian Airlines, Jordan.  
 Arab Jordan Investment Bank, Jordan.  
 National Centre for Human Resources Development, Jordan.  
 Al Bukhary Foundation, Malaysia.  
 Bilkent University, Turkey.  
 US National Academy of Sciences, USA.  
 International Islamic Charity Organisation, Kuwait.  
 Islamic Organisation of Medical Sciences, Kuwait.  
 Arab Gulf Programme for Development (AGFUND), Saudi Arabia.  
 Fouad Alghanim & Sons Group of Companies, Kuwait.  
 Saudi Basic Industries Corporation (SABIC), Riyadh, Saudi Arabia.  
 Tatarstan Academy of Sciences, Tatarstan, Russian Federation.  
 World Islamic Call Society, Tripoli, Libya.  
 Jordan Phosphate Mines Company, Amman, Jordan.  
 International Islamic Academy of Science and Biotechnology (IAB), Malaysia.  
 University of Industry of Selangor (UNISEL), Malaysia.  
 Ministry of Foreign Affairs of Qatar: The Permanent Committee for Organizing Conference, Qatar.  
 Doha International Centre for Interfaith Dialogue (DICID), Qatar.  
 R.B. Suleimenov Institute of Oriental Studies, Kazakhstan.  
 Prime Ministry of Bangladesh, Bangladesh.  
 Foreign Ministry of Bangladesh, Bangladesh.  
 University Grants Commission of Bangladesh, Bangladesh.  
 Bangladesh Academy of Sciences, Bangladesh.  
 Sheikh Mohammed bin Hamad Al Thani, Qatar.  
 Eng. Awni Shaker Al Aseer, Saudi Arabia.  
 Eng. Amjad Abu Aisheh, Jordan.

## APPENDIX J

| <b>IAS Waqf</b>   | <b>IAS Endowment Fund</b>  |
|---|--|
| <p>Islamic World Academy of Sciences<br/>Jordan Islamic Bank<br/>Shemeisani Branch<br/>Account No.: 809/\$91<br/>Telephone : +962 6 5677107<br/>Facsimile: +962 6 5691700<br/>PO Box 925997<br/>Amman 11110<br/>Jordan.</p> | <p>Islamic World Academy of Sciences<br/>Arab Bank<br/>Fifth Circle Branch<br/><b>Account No : 0134-32907-711</b><br/>Telephone : +962 6 5526870<br/>Facsimile: +962 6 5526874<br/>PO Box 141107<br/>Amman<br/>Jordan.</p> |

### ***IAS on the Internet***

<http://www.iasworld.org>

### ***Medical Journal of the IAS on the Internet***

<http://www.medicaljournal-ias.org>