Landscape of Science, Technology and Innovation in the Islamic Countries

Conference Proceedings

Abdullah Al Musa
Najwa F. Daghestani
Editors

Published by Islamic World Academy of Sciences
Amman - Jordan

بسم الله الرحمن الرحيم

Landscape of Science, Technology and Innovation in the Islamic Countries

Proceedings of the 22nd IAS Science Conference on
Landscape of Science, Technology and Innovation in the Islamic Countries

Organised in Amman - Jordan
Via Zoom;
1 December 2020

Edited by

Abdullah Al Musa
Najwa F. Daghestani

Published by

Islamic World Academy of Sciences (IAS)
Amman, Jordan.

Conference sponsored by

Arab Fund for Economic and Social Development (AFESD), Kuwait

مؤسسة الكويت للتقدم العلمي
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Inter-Islamic Network on Water Resources Development and Management (INWRDAM) Amman – Jordan

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The Higher Council for Science and Technology Amman – Jordan

First published in 2021 by
Islamic World Academy of Sciences (IAS)
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Amman 11183 – Jordan.

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Type-setting at the Secretariat of the Islamic World Academy of Sciences, Amman, Jordan.

Jordan National Library Classification Deposit Number: 2023/11/6178
Descriptors: /Technological Change//Social Change//Economic Development//Islamic Countries/

ISBN 978-9957-412-33-3 (ردمك)

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Prior to involvement in management and at intermittent periods when released from management assignments, He got involved in teaching and research. He is well published (h-index 17, i10-index 23) in the field of plant virology (Etiology & Epidemiology).

He is currently President of the National Center for Research and Development (NCRD).

Najwa F. Daghestani is currently the Programs Manager at the Islamic World Academy of Sciences (IAS). She earned her Master of Business Administration (MBA) from the German Jordanian University, Jordan, and her BSc in Computer Science from Princess Sumayya University, Jordan.

She works on organising conferences and workshops, editing proceedings, newsletter and various papers and documents and acts as a liaison with international and national organizations and institutions.

She previously worked at the Royal Scientific Society as an Applications Programmer.

ISBN 978-9957-412-33-3

PREFACE

The nascent idea of establishing the Islamic World Academy of Sciences first appeared in the plan of action developed by OIC Standing Committee for Scientific and Technological Cooperation (COMSTECH) chaired by the late General M. Zia-ul-Haque then was President of the Islamic Republic of Pakistan. In 1984 the heads of OIC member states gathered in Casablanca, had decided upon the recommendation submitted by COMSTECH, to establish the Islamic Academy of Sciences. Two years later, thirty eight distinguished scientists from different Islamic countries gathered in a conference held in Amman under the patronage of H.R.H. Prince El-Hassan bin Talal of the Hashemite Kingdom of Jordan. In that conference, Prince El-Hassan bin Talal and President of Pakistan (then was the late Zia-ul-Haque) were unanimously nominated as Patrons of the Islamic Academy of Sciences. In addition, the founding conference approved the statutes and By-Laws and elected members of the first council. The Hashemite Kingdom of Jordan offered to host the Academy headquarters in Amman and granted an annual subsidy to cover running expenses of its office. A diplomatic immunity and privilege were also granted to the Academy in recognition of its status as an international organization.

Among its many objectives, the IAS strives to fulfil its mission through many activities and initiatives such as conferences, webinars and workshops.

This conference aimed to stress that science, technology and innovation is of paramount importance in driving socioeconomic development for our nations. For this trio to be effective, a total national STI capacity trifecta should be achieved namely: a government commitment to providing STI physical and soft infrastructure, a vibrant, ethical scientific community with enabled and efficient governance, and a private sector capable and willing to invest in product development.

The efficacy of this STI ecosystem is dependent on the intricate and smooth interactions among all stakeholders in the state and a functional international outreach. An effort that should be culminated in a solid STI policy entailing an action plan to galvanize the efforts and delineate priorities.

For STI to become effective instrument for socio-economic transformation, neither science nor technology are to be considered in isolation. Both along with innovation are integral parts of a STI system empowered by STI policy that can identify strategic thrust and formulate action plan to deliver STI national agenda. In this sense science is good enough if it is translated eventually into technology and ultimately by innovation into marketable products or services. This process should be nurtured by enabling environment through policy framework, institutional setting and governance, entrepreneurial ecosystem, access to finance, human capital and research infrastructure. Of particular importance Intellectual Property Rights that constitute an important mechanism to help innovators recover their innovation cost and obtain some investment return.

A functional STI system must be inclusive and engaging all stakeholders with special emphasis on creating public-private sector partnership framework capable of promoting commercialization of the system output. Such framework may include but not limited to access to grants, venture capital, business incubators, incentive plan, legislation and collaboration.

Once STI agenda is formulated it should be adopted by the highest possible political level. Visionary leadership is required to guide drafting of foresighted action plan and to insure openness, inclusiveness and integration of STI as integral component of the overall national development plan with resource allocation and government commitment.

STI agenda must deal with the existing and futuristic needs of the society that preserves human dignity and sharpen the country competitiveness. It is to address issues related to food, water, energy and shelter. Other aspects of the agenda are as important such as education, health care, sustainable environment, wealth creation and good governance in public and private sectors. Prioritization among these targets should be identified based on the countries' capability and capacity in terms of institutions, mandate, personnel, management and funding.

Developing networks and collaboration at the local level is effective instrument allowing smooth flow of knowledge and experience among stakeholders and provides a mechanism for feedback on changing demands on skills. At the regional and international level, networking and collaboration is fundamental to tackle cross-border issues and to enhance local capability potential.

The conceptual framework of STI should target economic development in the context of sustainable development which calls for openness, social justice and environmental protection. STI role in this regard resonates with UN 2030 SDGs providing for the people needs while celebrating the richness of diverse nature of our planet.

To further emphasize STI role in sustainable development, UN launched a platform for Science, Technology and Innovation (STI Forum) to discuss issues of common interest of member states within the context of the 2030 agenda.

This publication includes the majority of the papers and presentations that were presented at the 22nd IAS Conference, which was held online via Zoom on 1 December 2020, under the Patronage of His Royal Highness Prince El-

Hassan bin Talal Founding Patron of the Islamic World Academy of Sciences (IAS).

Over 100 participants attended the conference including IAS Fellows, invited speakers, academics, decision-makers, scientists, researchers as well as presidents/representatives of academies of sciences from all over the world.

The conference addressed a number of key issues in the domain of science, technology and innovation (STI) in Islamic Countries including STI policies and indicators.

Abdullah Al Musa
Najwa F. Daghestani

ACKNOWLEDGEMENTS

The Islamic World Academy of Sciences (IAS) is grateful to His Royal Highness Prince El-Hassan Bin Talal, Founding Patron of the Islamic World Academy of Sciences (IAS) for his patronage and support of the conference.

We would also like to thank all the organisations that have sponsored the conference including: Arab Fund for Economic and Social Development (AFESD), Kuwait, The Kuwait Foundation for the Advancement of Sciences (KFAS), University of Petra, Amman, Jordan, Cairo Amman Bank, Amman, Jordan, Jordan Islamic Bank, Amman, Jordan, Inter-Islamic Network on Water Resources Development and Management (INWRDAM), Amman, Jordan and The Higher Council for Science and Technology, Amman, Jordan.

The dedicated staff of the IAS in Amman including Ms. Taghreed Saqer, all deserve our thanks and appreciation.

Abdullah Al Musa
Najwa F. Daghestani

SPONSORS OF THE IAS 2020 CONFERENCE

ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)
Amman - Jordan
www.iasworld.org

In response to the need for an international organization that can undertake such a task, the Islamic World Academy of Sciences (IAS) came into being as an independent, non-political, non-governmental and non-profit making organization of distinguished scientists and technologists dedicated to the promotion of all aspects of science and technology in the Islamic world.

The establishment of the Islamic World Academy of Sciences (IAS) was proposed, by the Organization of Islamic Cooperation; OIC Standing Committee on Scientific and Technological Co-operation (COMSTECH). Upon the invitation of Jordan, the Founding Conference of the Academy was held in Amman (Jordan) in October 1986.

The main objectives of the Academy are: to serve as a consultative organization of the Islamic *Ummah* and institutions in the field of science and technology; to initiate science and technology programs and formulate standards of scientific performance; to promote research on major problems facing Islamic countries; and to identify future technologies of relevance for possible adoption and utilization; and to formulate standards of scientific performance and attainment, and to award prizes and honors for outstanding scientific achievements in science and technology disciplines.

ARAB FUND FOR ECONOMIC AND SOCIAL DEVELOPMENT (AFESD)
Kuwait - State of Kuwait
www.arabfund.org

The Arab Fund for Economic and Social Development (the Arab Fund), based in the State of Kuwait, is an Arab regional financial institution focused on funding economic and social development by financing public and private investment projects and providing grants and expertise. The Arab Fund's activities are characterized by a number of important aspects that make it a model of cooperation and Arab economic integration, and a reflection of outstanding joint Arab action.

With all the Arab countries as its members and concentrating on economic and social development affecting the same countries, the Arab Fund carefully follows guidelines on neutrality in pursuing its activities and organizes itself under substantive rules to ensure independence from any political considerations when conducting in its operations.

مؤسسة الكويت للتقدم العلمي
Kuwait Foundation for the Advancement of Sciences

KUWAIT FOUNDATION FOR THE ADVANCEMENT OF SCIENCES (KFAS)
Kuwait - State of Kuwait
www.kfas.org

The Kuwait Foundation for the Advancement of Sciences (KFAS), a private non-profit organization, continues on its 40-year journey to harness science, technology and innovation in Kuwait, as well as to promote modernization, a better quality of life and a sustainable future for the Kuwaiti people. In line with the long-term vision of the late Amir Sheikh Jaber Al Ahmad Al Jaber Al Sabah and supported by leaders in the private sector, an Amiri Decree was issued in 1976 for the establishment of the Foundation, with a focus on advancing and integrating science, technology and innovation (STI) throughout the country.

The Foundation's efforts toward fostering STI to address national challenges first began through the pledge made by the private sector shareholding companies to fund the Foundation based on a set percentage of their annual profits — currently at one percent — as well as through the incorporation of a unique governance modality, in which the Board of Directors is chaired and appointed by the Amir of the State of Kuwait. Today, KFAS's impact is prominently embedded within the country's scientific and technological accomplishments and advancements.

UNIVERSITY OF PETRA
Amman - Jordan
www.uop.edu.jo

The University of Petra (UOP) is a hub for creating knowledge through research and for developing skills and applying knowledge to achieve creative technologies and innovation. By creating an academic culture and a social vibrant rich environment, UOP promotes quality learning, science & technology transfer (S&T), creativity and critical thinking. To fulfill its vision and mission, the university optimizes its human and material resources with responsible and accountable governance to sustain its existence.

For internationalization, UOP bridges with the scientific world for novelty, innovation, scientific research, collaboration in scholarly S&T and outreach programs and conventions.

بنك القاهرة عمان
CairoAmmanBank
Amman - Jordan
www.cab.jo

Since its establishment as a Jordanian public company in 1960, CAB has been keen on employing its strong capital and its five-decade, well-founded experience to play a distinguished leading role in promoting the national economy through providing a distinct and inclusive range of services and successful banking solutions that fulfill the various needs of its customers. CAB's pioneer services added a new dimension to the society's projects by financing the development projects as well as small, medium and micro projects that shore up the Jordanian economy.

JORDAN ISLAMIC BANK
Amman - Jordan
www.jo rdanislamicbank.com

Jordan Islamic Bank (JIB), forty years of sustainable giving and goes on.

In order to consolidate the path of pioneering by its deep-rooted approach originated from the values and principles of Islamic Sharia, which have been embodied during the past four decades, JIB continues to further promote the social role foundations for sustainable development, in addition to striving to providing a wide range of banking products and services keep up with the latest technologies that meet the aspirations of the local community in an Islamic unique manner.

INTER-ISLAMIC NETWORK ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT (INWRDAM)
Amman – Jordan
inwrdam.org.jo

INWRDAM is an inter-governmental, autonomous organization operating under the umbrella of the Standing Committee on Scientific and Technological Cooperation (COMSTECH) of the Organization of the Islamic Cooperation (OIC).

The mission of INWRDAM is to foster closer cooperation among the countries of the Muslim *Ummah* in the field of development and management of water resources. In pursuit of this mission, it seeks to generate ideas and policy directions through intensive dialogue, studies and research on a continuing basis.

The Higher Council for Science and Technology
Amman – Jordan
http://hcst.gov.jo

The Higher Council for Science and Technology was established in 1987 under Law Number (30) as a public independent institution and acts as a national umbrella for all science & technology (S&T) activities in Jordan.

The objective of the Higher Council is to build a national science and technology base to contribute to the achievement of development goals, through increasing awareness of the significance of scientific research and development, granting the necessary funding and directing scientific and research activities, within national priorities, in line with development orientations.

22nd Islamic World Academy of Sciences Conference
on

Landscape of Science, Technology and Innovation in the Islamic Countries.

CONFERENCE DECLARATION

adopted by 22nd IAS virtual Conference
1 December 2020

1. We the Fellows of the IAS and participants of the IAS 22nd virtual Conference entitled *Landscape of Science, Technology and Innovation in the Islamic Countries* at December 1st, 2020 have gathered to discuss and share STI experience in OIC Countries.

2. We express our thanks to the President of Pakistan and H.R.H Prince El-Hassan bin Talal, for their patronage of the Academy and their encouragement and sustained interest in IAS activities.

3. We call upon Islamic countries to uphold the various objectives of the Organization of Islamic Cooperation specially those related to science, technology and innovation and formulate STI policy that can deliver national STI agenda.

4. We urge our governments to increase investments in science, technology and innovation and in outreach activities to effect transfer of science and technology to speed up socioeconomic wellbeing of our countries.

5. We urge OIC countries to enhance networking and cooperation among scientists across the Islamic World and facilitate outreach activities.

6. We encourage OIC countries to implement and articulate a functional STI policy that can identify inter and intrasectional priorities and consolidate human, physical and financial resources within each country's backdrop of social, cultural, political and religious heritage.

7. We affirm that for STI agenda to achieve its objectives, the STI policy shall be inclusive and capable of enabling working ecosystem that insure participation of all stakeholders.

8. We affirm the importance of governmental commitment towards strengthening national STI capacity and capability that encompass human resources, research and development institutions, science parks and incubators, legislation, incentives, and funding.

9. Provide a STI governance framework that delineates all aspects of STI management including policy integration, STI advisory board, STI planning and coordination, research and technology commercialization, framework for cooperation, collaboration and partnerships.

10. We urge our states to monitor and review periodically their STI policies, STI agenda and action plans at national and regional levels to gain insight and share experience in best practices to set priorities, implement programs and evaluate progress.

11. We underscore the importance of private sector partnership and international collaboration and science diplomacy in performing tasks of STI agenda.

12. We acknowledge that for socio-economic development to be achieved, STI implementation action plan should take into consideration the importance of instilling science and scientific method into the education system and involving the parliaments by establishing parliamentary standing committee on STI.

13. OIC countries are urged to adapt initiative of partnership by forming STI consortium among the OIC states to rectify deficiencies and maximize the collective strength of the *Ummah* in science and technology or at least be more conscious about the need for collective cooperation and collaboration amongst scientists in our countries.

14. Government of OICs are urged to nurture and develop STI ecosystem by providing STI physical and soft infrastructure, encourage and enrich a vibrant ethical scientific community and insure participation of private sector in STI evolution.

15. We urged the OIC Countries to designate centers of excellence in disciplinary and interdisciplinary science to form networks that can initiate collective R&D and training for young scientists in priority research areas for development.

LASTLY, THE ISLAMIC WORLD ACADEMY OF SCIENCES (IAS):

Extends its appreciation and gratitude to all organizations and institutions that extended sponsorship for this conference, these are; Arab Fund for Economic and Social Development (AFESD), Kuwait Foundation for the Advancement of Science, Petra University, Cairo Amman Bank, The Inter-Islamic Network on Water Resources Development and Management (INWRDAM), Higher Council for Sciences and Technology (HCST), and the Jordan Islamic Bank.

22nd Islamic World Academy of Sciences Conference
on

Landscape of Science, Technology and Innovation in the Islamic Countries

CONFERENCE REPORT

1 December 2020

Under the patronage of His Royal Highness Prince El-Hassan Bin Talal, Founding Patron of the Islamic World Academy of Sciences (IAS), with the presence of Her Highness Princess Sumaya bint El-Hassan, President of the Royal Scientific Society, Jordan, the IAS convened its 22nd international scientific conference virtually via Zoom platform on 1st of December 2020. The theme of the conference was ***'Landscape of Science, Technology and Innovation in the Islamic Countries.'***

The IAS Conference was an open activity in which over 135 local and international participants attended the activity from 20 countries. Among the participants were Fellows of the IAS and local scientists from the various universities and institutions.

The 22nd IAS Conference was co-sponsored by:

- Arab Fund for Social and Economic Development (AFSED), Kuwait;
- Kuwait Foundation for the Advancement of Science, Kuwait;
- Petra University, Jordan;
- Cairo Amman Bank, Jordan;
- The Inter-Islamic Network on Water Resources Development and Management (INWRDAM), Jordan;
- Higher Council for Science and Technology (HCST), Jordan; and
- Jordan Islamic Bank, Jordan.

The inaugural ceremony of the conference included an address by His Royal Highness Prince El-Hassan bin Talal, Founding Patron of the IAS, the message of the President of Pakistan, IAS Patron which was read by H. E. Prof. Iqbal Choudhary, Coordinator General, COMSTECH, and the opening address of H. E. Prof. Abdel Salam Majali, Former Prime Minister of Jordan and IAS President read by H. E. Prof. Adnan Badran and welcome speech by Prof. Abdullah Al-Musa Director General, IAS.

His Royal Highness Prince El-Hassan bin Talal, Chairman of the Higher Council for Science and Technology and Founding Patron of the IAS, indicated the importance of building a partnership between science and technology in the field of scientific research, which could generate opportunities for local, national, regional and global participation. H.R.H. called for a re-focus on policies and recognition of science as a tool to push the limits of the human knowledge and to monitor and analyze responses to environmental, social and economic challenges. H.R.H. said that "in our world today as we face environmental, social, climatic and human challenges, the need for science, partnership between institutions, and building a scientific culture has become an urgent need to search for solutions through integration". H.R.H. noted the importance of science in achieving sustainable development and the well-being of societies, explaining that to achieve this, science must be assigned to human values in line with the reality of human development, and for science to have the flexibility to allow adaptation to the changing and evolving requirements of science, and the requirements of advancing development in a sustainable, economically, environmentally and socially.

The conference addressed a number of key issues in the domain of Science, Technology and Innovation in the Islamic Countries.

The first academic session of the conference included keynote presentations by: Dr. Markku Markkula, First Vice-President of the European Committee of the Regions, Finland, whose presentation was entitled *Identification and Development of STI Policies*; Prof. Adnan Badran FIAS, Former Prime Minister of Jordan, Chairman of the Board of Trustees, University of Jordan and Chancellor, University of Petra, Jordan, whose presentation was entitled *Ups and Downs of STI Indicators in Islamic Countries*; Prof. M. Qasim Jan FIAS, President, Pakistan Academy of Sciences, Pakistan, his presentation was on *Changing Climate, and Adaptation and Mitigation Measures for Sustainability of Agriculture: a Short Review;* Ms. Amani Albedah, Deputy Director General for Support Programs & Functions, KFAS, Kuwait, presented a paper entitled *Landscape of Science, Technology and Innovation in the Islamic Countries: STI Development, the Centrality of General Education;* and lastly Ms. Aicha Bammoun, Director of Programs, Islamic World Educational, Scientific and Cultural Organization (ICESCO), Rabat, Morocco presented a paper entitled *New vision of ICESCO on STI for Islamic World.*

The second working session of the conference included three presentations; Dr. Shaukat Hameed Khan, Fellow, Pakistan Academy of Sciences, Pakistan, delivered a presentation under the title *Nurturing the Thinking Mind: The OIC Dilemma in Science, Technology and Innovation*. Prof. Malek Maaza FIAS, UNESCO UNISA Africa Chair in Nanoscience & Nanotechnology, South Africa presented a paper on *SARS-COV2 Pandemic's Effects on the R&D*

Community in Africa: Challenges and Opportunities and lastly Prof. Zabta Shinwari FIAS, National Council for Tibb, Islamabad, Pakistan, presented a paper on *Islamic Countries: Open Science; Inclusive Society and Ethics*.

The declaration of the conference (approved by the IAS Council members); called upon Islamic countries to uphold the various objectives of the Organization of Islamic Cooperation specially those related to science, technology and innovation and formulate STI policy that can deliver national STI agenda.

Urged the governments to increase investments in science, technology and innovation and in outreach activities to effect transfer of science and technology to speed up socioeconomic wellbeing of our countries, and urged OIC countries to enhance networking and cooperation among scientists across the Islamic World and facilitate outreach activities.

Encouraged OIC countries to implement and articulate a functional STI policy that can identify inter and intrasectional priorities and consolidate human, physical and financial resources within each country's backdrop of social, cultural, political and religious heritage.

The declaration affirmed that the STI policy shall be inclusive and capable of enabling working ecosystem that insures participation of all stakeholders, and affirmed the importance of governmental commitment towards strengthening national STI capacity and capability that encompass human resources, research and development institutions, science parks and incubators, legislation, incentives, and funding.

The declaration also urged our states to monitor and review periodically their STI policies, STI agenda and action plans at national and regional levels to gain insight and share experience in best practices to set priorities, implement programs and evaluate progress.

The declaration acknowledged that for socio-economic development to be achieved, STI implementation action plan should take into consideration the importance of instilling science and scientific method into the education system and involving the parliaments by establishing parliamentary standing committee on STI.

And urged the OIC countries to adapt initiative of partnership by forming STI consortium among the OIC states to rectify deficiencies and maximize the collective strength of the *Ummah* in science and technology or at least be more conscious about the need for collective cooperation and collaboration amongst scientists in our countries, and urged the government of OICs to nurture and develop STI ecosystem by providing STI physical and soft infrastructure, encourage and enrich a vibrant ethical scientific community and insure participation of private sector in STI evolution and to designate centers of excellence in disciplinary and interdisciplinary science to form networks that can initiate collective R&D and training for young scientists in priority research areas for development.

Lastly, the IAS through the declaration expressed its thanks and appreciation to all the organizations and agencies which supported the conference.

As part of the follow-up action to the conference, the Academy will circulate the IAS 2020 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 presentations delivered in the conference are published on the IAS YouTube Channel (https://www.youtube.com/user/TheIASworld/videos) and on the IAS Facebook page (https://www.facebook.com/iasworld).

The IAS will also publish the complete proceedings of the conference which will be distributed internationally.

Welcome note by
Abdullah Al-Musa
Director General
Islamic World Academy of Sciences (IAS)

بسم الله الرحمن الرحيم

السلام عليكم ورحمة الله وبركاته وبعد،،،

Your Royal Highness Prince El Hassan Bin Talal, Founding Patron of the Islamic World Academy of Sciences

Your Excellency Dr Abdel Salam Majali, IAS President

Fellows of the IAS
Excellencies
Ladies and Gentlemen
Dear friends

It is my pleasure and indeed a privilege to welcome you all this morning and to great you and communicate my deep appreciation for your interest in this conference which hopefully will outline the landscape of science and technology in Islamic countries.

Science, technology and innovation is of paramount importance in driving socioeconomic development for our nations. For this trio to be effective, a total national STI capacity trifecta should be achieved namely: a government commitment to providing STI physical and soft infrastructure, a vibrant, ethical scientific community with enabled and efficient governance, and a private sector capable and willing to invest in product development.

The efficacy of this STI ecosystem is dependent on the intricate and smooth interactions among all stakeholders in the state and a functional international outreach. An effort that should be culminated in a solid STI policy entailing an action plan to galvanize the efforts and delineate priorities.

The Islamic World of Sciences (IAS) is holding its 22 conference to provide a platform for fruitful discussions and deliberations and enhance networking and exchange of STI experience in OIC Countries, especially with regard to proper governance, Partnership framework that accommodate all STI Stakeholders.

We at the IAS are grateful and honored to His Royal Highness Prince El-Hassan bin Talal for patronage of both the Academy and this conference and for his continuous interest and support of the Academy's activities.

Thanks are also extended to the President of the Islamic Republic of Pakistan, IAS Patron for his support and encouragement.

I take this opportunity to extend appreciation and gratitude to all organizations, institutions that extend or pledged sponsorship for this conference these are; Arab Fund for Economic and Social Development (AFESD), Kuwait Foundation for the Advancement of Science, Petra University, Cairo Amman Bank, The Inter-Islamic Network on Water Resources Development and Management (INWRDAM) and the Higher Council for Sciences and Technology (HCST).

Thanks are also extended to the speakers who did spare no effort to put forward their contributions in this scientific activity.

The efforts of the local organizing committee specially our President Dr Abdul Salam Majali, our Treasurer Dr Adnan Badran and the staff of the IAS are highly commended and appreciated.

At last this conference coincides with the inauguration of the IAS Headquarters building. A task that could not be done without the support from different institutions and dignitaries. On this occasion I would like to thank:

1. Arab Fund for Economic and Social Development (AFESD), Kuwait
2. Mr Awni Al Shaker, Saudi Arabia
3. Petra University, Jordan
4. Jordan Islamic Bank, Jordan
5. Sheikh Mohamed bin Hamad Al Thani, Qatar
6. Hikma Pharmaceuticals, Jordan
7. Dr Ahmed Saif Balhasa, UAE
8. Kuwait Foundation for Advancement of Sciences (KFAS)
9. Dr Adnan Mjalli, Hon. FIAS
10. Mr Mahmoud Abu Shaeerah, Jordan
11. Mr Ahmed Abu Ghazaleh, Jordan
12. Al Manaseer Group, Jordan
13. IAS Fellows, Professors ; Muhammd Ashgar, Ahmed Azad, Adnan Badran, Noor Butt, Abdallah Daar, Sehamuddin Galadari, Kemal Hanjalic, Munir Nayfeh, Munir Ozturk, Syed Qaim, Muthana Shanshal, Jackie Ying, Khalid Yusoff, Salim Yusuf.

Thank you

ADDRESS OF
HIS EXCELLENCY ABDEL SALAM MAJALI FIAS
PRESIDENT OF THE
ISLAMIC WORLD ACADEMY OF SCIENCES (IAS)

بسم الله الرحمن الرحيم
الحمدلله، والص.ة ولسلام علىرسلى الله، وبعد،،،

Your Royal Highness Prince El Hassan Bin Talal, Founding Patron of the Islamic World Academy of Sciences

Fellows of the IAS
Excellencies
Ladies and Gentlemen
Dear friends

It gives me great pleasure to welcome and thank you for attending this very important conference which deals with science and technology in OIC countries.

We are here to discuss the extent of the efforts in OIC countries in science, technology and innovation. A triangle that had been accentuated by OIC summit held in Kuala Lumpur, Malaysia in 2003 and promulgated by issuing 1441 vision.

The importance of science, technology and innovation could not be overemphasized in securing sustainable development of the *Ummah* in its three dimensions of economic, social and environment aspects. We in the Islamic world have to promote initiation and implementation processes of viable STI policy, to safeguard our resources and secure dignified livelihood for generations to come.

The linkages and interactions within STI policy framework with regard to legal, organizational and operational analysis are vital to ensure productive STI ecosystem. To be effective, STI policy should be looked upon as tools for satisfying immediate and future human needs while maintaing harmony with historical, cultural, social, political and religious heritage of the society.

Among all factors that affect success of STI policy is the political commitment to support and strengthen the nation's capacity and capability of STI components including institutions, mandates, human resource, networking, participation, education and research and development in areas with high priority and most needed in the society like water, energy, food and environment. Research and technologies thus can be identified to tackle problems and innovate solutions to existing and anticipated needs of the prioritized economic sectors.

I hope your deliberations and discussion in the conference will provide platform for exchange of experience among participants in aspects related to STI agenda in your respective countries specially with regards to proper governance of STI ecosystem, partnership among all stakeholders including the institutions, the private sector, scientists, entrepreneurs and consumers to achieve successful path from research to technology to innovation that could yield a new commercialized product.

The Islamic World Academy of Sciences, despite its limited, financial resources has spared no effort to provide platform through conferences and other activities for interaction among scientists of the Muslim World. We are so fortunate in IAS to have the support and interest of our distinguished patrons, the President of Pakistan and His Royal Highness Prince Al-Hassan bin Talal whom I would like to thank for patronising this activity.

At last I would like to commend the efforts of the organizing committee who do so much to materialize this activity.

Thank you.

والسلام عليكم و رحمة الله و بركاته

Message from Dr. Arif Alvi
President of the Islamic Republic of Pakistan

(On the occasion of 22nd International Science Conference of Islamic World Academy of Sciences, Amman, Jordan)

I wish to congratulate the Islamic World Academy of Sciences (IAS) on organizing 22nd International Science Conference in Amman and commend the Kingdom of Jordan for its patronage of this important event. I would also like to welcome the distinguished Fellows of the IAS and other participants of the conference who have gathered to deliberate on the important theme of *Science, Technology and Innovation (STI): Landscape in the Islamic Countries*. I would also like to appreciate the endeavors of COMSTECH in fostering collaborations, developing STI and Human Resource Development (HRD) in the OIC member states.

Humanity is faced with serious challenges of global dimension, such as climate change, water shortage, food security, natural disasters and energy crisis. The impact of these challenges is thought to be graver on the developing countries, including most of the OIC countries, because of their weak economies, lower level of resilience, insufficient expertise in Science and Technology, rapidly growing population, and dwindling natural resources. In this regard, importance of science, technology and innovation for the socio-economic well-being and political empowerment of the nations cannot be overemphasized.

The Islamic scholars have made outstanding contributions to knowledge and Science. We must take all the necessary steps to revive our past glory in this realm. Foremost in this regard is advancement in education and science. We have no dearth of talent and we are capable of devising credible strategies to tackle global challenges facing the Muslim World today.

In the end, I would like to express my deep appreciation to HRH Prince Al-Hasan, the Patron of IAS, Professor Abdel Salam Majali, the President of IAS and his colleagues and wish the 22nd conference of the Islamic World Academy of Sciences all the success.

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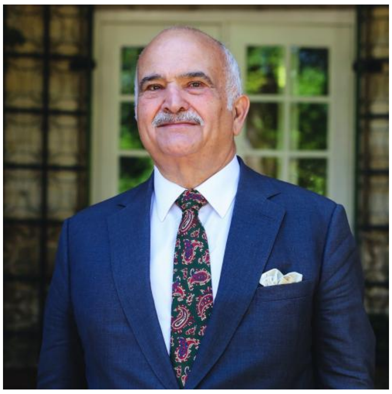
KEY POINTS OF HIS ROYAL HIGHNESS PRINCE EL HASSAN BIN TALAL FOUNDING PATRON OF THE ISLAMIC WORLD ACADEMY OF SCIENCES



- HRH started his speech by thanking the speakers, in particular, Professor Markku Markkula from Finland for participating. "His lifelong learning institute and his pedagogical approach and the direction of a centre for continuing education reminds me of the importance of generations united; international adult and continuing education is a step to take because our capital clearly is not oil or gas or natural resources alone, but it is an intra-dependent (not inter-dependent) relationship that we have to build on the bases of respect for the other and on defining of regional commons. The regional commons to me seem to be the clethra of willing young minds who have to be taken seriously in terms of what Professor Markkula refers to as accelerated pedagogic reform and more coherence between policies in the fields of education, research and innovation, i.e. a cluster of inter-disciplinary approaches. The same will apply to rationalise the funding landscape. You have a sociological landscape, you have a funding landscape and some of us have done much better than the others by buying science and technology off the shelf but I assume that what we are trying to do is to develop in the context of the EC conclusions that new ideas of innovation are born from coming together of different kinds of knowledge and through the curiosity driven research for new knowledge. The pluralism among us in Asia as with the pluralism among Europe's universities and research system should be considered as an asset for the development of diverse approaches to a fully functioning knowledge triangle." In terms of funding I am looking forward to hear the views of the professor.

- HRH mentioned the importance of Fintech and Zakat. "One is state of the art and the other is a huge engine of change that has to be driven by our cultural desire on the one side to perform a pillar of our faith by proving Zakat, 2% of our income for useful purposes, regional innovation among them, and indeed our mind set has to be considered not only an entrepreneurial term but also in terms of investment in human capital."

- Reminder to Dr Badran of the importance of the Asian countries' experiences of intra-independent (such as Vietnam and Thailand) recognitions of the identity of the others and of regional commons since 1967.

- "Without practicing what we preach, how we can move forward? and that is basically to look at knowledge in terms of knowledge clusters."

- HRH mentioned the cooperation between Kuwait "Amani Al Baida" and Jordan in terms of Diabetes and other and how this is important in touching our populace as it is today. Cluster of health aftermath of COVID.

- HRH highlighted the enormous effect of COVID-19 pandemic on mental health was enormous. How to rebuild in dignity.

- Reconstructing of human capacity to cope and to live a dignified life, brings dignity at the centre of the construct. "I believe only in one ism and that is dign-ism"

- HRH commended the cross-cutting and transboundary thinking of Mrs. Aisha Bamoun from Morocco. "How can an international blog genetic resource be extremely important both in terms of central and West Asia context and also the North Africa region". HRH highlighted her ease in corresponding in this meeting to establish and develop institutional cooperation.

- HRH highlighted the focus of Mr Shawkat Hameed khan on nurturing the thinking mind. "Building a scientific culture, this mindset that has to change is so important as we look at all these people walking around the street, not even wearing a mask and saying well this corona is really some kind of a myth". Nurturing the thinking mind.

- "The natural managing school, managing water issues, releasing that water, nutrient, food and agriculture represent a nexus that has to be taken seriously by human beings, citizens. Building citizenship through custodianship of these important elements الاستخلاف is so important if we are going to face the future."

- "The security people talk to us about nuclear threats and terrorist threats but the biggest threat is the lack of ability to build our own house with our own resources with our own intra-dependence."

- Thanking Shawkat for emphasising the drivers of innovation and their impact on research and industry. HRH asked RSS to keep in contact and reach out in this matter.

- HRH welcomed the participation of Mr. Malek Maza from Algeria, he highlighted the importance of having a representative from Africa in IAS.

- "South-south cooperation is increasingly important particularly as we dread this world in which we live where we see people been killed everywhere, 80% of the world refugees are Muslim. Are we human beings to be treated with equal dignity?"

- "Through the policy we try to develop within the multi-disciplinary field, as Nano-sciences and Nano-technology, have we had this? Do we have a landscape of scientific achievement to which we can refer? This is something that I do hope you can establish a partnership over this conversation."

- HRH referred to the concept of ethics of scientific knowledge and technology by Dr Shenwari. HRH mentioned that "the concept of the world commission on the ethics of scientific knowledge and technology is important to us, but I think that the Arab charter of ethics of science and technology is something that we should develop, I know we are still in the early days but I think that the structure of the charter as the world continues to witness sustain progress in change in all fields of science is important, especially in four sections: the ethics of production of science and technology, the ethics of transfer and localisation of science and technology, the ethics of using science and technology and the ethics of useful knowledge (the most important)."

- The 17 SDGs do not include one word: **refugee.**

- Intra-dependence, working together, responsibilities, what is matter that we recognise each other identities and contribute to complementarity.

- Concluding words: emphasis on strengthening global standards in research integrity, fulfilment of academic freedom and the human right to science. Solid based knowledge needs to be encouraged. Encourage people to produce, apply and communicate science.

Responses to comments:

- HRH mentioned in two years' time we hope to host the initiative, movement by Dr Evelin Lindner psychologist and medical doctor from Dignity University, regarding the human dignity "from humiliation to human dignity". We are all humiliated if we do not look for common good. The German's debt is not to politics but to humanity.

- "The levant region has to be taken seriously as a complementary region one to the gulf for all its resources oil and gas, and to the eastern Mediterranean with its resources oil and gas. We should not be transcended by those who want to deal directly with oil and gas fields and build pipelines, we have to ask does this infrastructure do something for the marginalised and the vulnerable?"

- "We have to move from a status-based approach to a vulnerability-based approach in dealing with our current crises. I can't talk about Yemen, Libya, etc, without talking in terms of humanity."

- We should thank COVID in terms of realising our dependence.

- "In terms of the Mediterranean region what we need yesterday(s) ago is the creation of a centre for humanities (Greek, Turkish, Latin ... etc)."

- Winning the Human Race, the feeling of urgency. What will our children inherit?

- There is a need for the concept of Generations United to face COVID, we can't be disenchanted with nature. Everyone deserves a place under the sun.

- In response to one of the attendees who mentioned that we have plenty of information but how to transfer it into knowledge. "In Ghana, they have an African barometer of knowledge supported by MIT, many of the African countries are using this knowledge base to keep on track with others achievements. We have an Arab barometer but I am afraid what we have is information rather than knowledge. Knowledge has to be irrefutable in terms of building trust with citizens."

Reamrks after Mr. Markkula's session, Identification and Development of STI Policies:

- Dr Markku provided a PowerPoint presentation regarding identification and development of science, technology and innovation policies. He highlighted the importance of having a nexus between education, innovation and research triangle in terms of policies, partnership, political will and regional innovation system.

- "Tri-dilemma in Jordan: hosting refugees, balancing the budget and attending to our nationals, in a country that has increasing in population as a result of migration over the past two decades and a half. In terms of Algorithmic weighting, I noticed that some Europeans are very diligent in assessing the human capital needs and assessing how these human capital needs can shore up their need for a younger work force. You referred to city research and industry, my question is why we can't commit ourselves (as we have the HCST) to offer the city of Amman, in order to develop a similar model in Amman city?"

- Europe is taking the best and brightest of the refugees developing a Fortress Europe and the rest of us on the gates. Europe is ensuring acquisition of human capital, which is our main capital.

- Why can't we do the algorithmic weighting for citizens before they leave their countries? There are so many security screening and assessments why not do developmental screening. Why not find out reasons for out migration? We need to study the root cause.

- HRH suggested to create a partnership between our region's research, education and innovation centres, and the EU to develop a platform of knowledge together using all useful information understanding that the main security element is the human being.

IDENTIFICATION AND DEVELOPMENT OF STI POLICIES

MARKKU MARKKULA
First Vice-President of the European Committee of the Regions
Finland

ABSTRACT

Digitalisation and globalisation have changed and will keep on changing the societies: especially service and value processes, both public and private. The importance of knowledge and science based evidence is increasing also in political decision-making.

In my keynote I will focus on recent developments in science, technology and innovation STI policies. I will analyse and describe some concepts and practices of the recent European STI policy and their interrelationships with sustainable development. I will review what that brings to not only for the European STI community but also globally. The presentation will include both top-down and bottom-up perspectives at European, national, regional and local levels.

The political focus has been, and will be, more than in the past in increasing the impact, i.e. societal influence to speed up transformation to knowledge-based society. Lessons learned in the EU research policy during the recent years in brief are:

- Need to support more the potential breakthrough innovation;
- Create more impact through mission-oriented and citizens' involvement;
- Strengthen international cooperation;
- Reinforce openness and open innovation;
- Rationalise the funding landscape; and
- Encourage participation.

The name of the EU's funding framework programme 2014-2020 for research and innovation – Horizon 2020 – reflects the ambition to deliver ideas, growth and jobs for the future. The new framework for 2021-2027 is Horizon Europe.

The societal role of universities and other higher education institutions is crucial in building the future with sustainable growth and social and economic progress. To analyze recent development I start by the European Council decision in 2009 about the role of education. The EC conclusion urged EU and the Member States to establish the following seven priorities for action:

1. Developing more coherence between policies in the field of education, research and innovation;
2. Accelerating pedagogic reform;
3. Partnership between universities and business and other relevant stakeholders;
4. Measures to develop an innovation culture in universities;
5. Creating incentives for universities to develop transferable knowledge;
6. New approaches to quality assessment;
7. Developing the EIT European Innovation and Technology Institute as a model for the future.

Among the key statements of these EC conclusions were *"New ideas and innovations are born from the coming together of different kinds of knowledge and through the curiosity-driven search for new knowledge."* And *"the pluralism among Europe's university and research systems should be considered to be an asset for the development of diverse approaches to a fully-functioning knowledge triangle."*

The following statement made by the EU Committee of the Regions already in 2012 describes well the change in the STI policy: *"The laboratories for innovation are no longer traditional university facilities, but regional innovation ecosystems operating as test-beds for rapid prototyping of many types of user-driven innovations: new products, services, processes, structures and systems, which need to be of transformative and scalable nature."*

Thus the future success of STI policy is measured increasingly in innovation actors' abilities to connect and manage their talent, partnerships, clusters and practical innovation processes – in integrating the local knowledge base into the global innovation power grid. An essential part of my keynote is describing the concepts for regional innovation ecosystems, especially place-based ecosystems.

All-permeating development activities, and especially leadership and management training should be targeted in the following critical success factors of the transformation process:

- Network-centric working culture focusing especially on the desired attitude and mindset change;
- Targeted orchestration of major transformation operations;
- Creating new collaborative value-creation methods, processes and models;
- Planning and implementing the activities to create a regional innovation ecosystem architecture; and
- Making strategic choices to start potential breakthrough mega-level initiatives focusing on joint-research topics to create new solutions.

Back in 2008, Professor C.K. Prahalad challenged the universities to create a new role for themselves by defining three critical aspects of innovation and value creation:

1. Value will increasingly be co-created with customers;
2. No single firm has the knowledge, skills, and resources it needs to co-create value with customers;
3. The emerging markets can be a source of innovation.

And one of his main conclusions should be considered especially thoroughly when creating the new role for universities: *"The competitive arena is shifting from a product-centric paradigm of value creation to a personalized experience-centric view of value creation."*

In my keynote I will describe the Aalto University in Finland as the European forerunner case in university reform. The role of Aalto University is described in the frame of Espoo Innovation Garden, thus showcasing how the fruitful university-industry-city collaboration can create the place-based innovation ecosystem.

Orchestration means systemic but at the same time flexible channeling and managing of the ecosystem level resource flows to support shared activities and collaborative processes. Orchestration is a key process for maintaining effective innovation ecosystems. Once actors are able to find each other, communicate effectively, and understand each other's questions, interests, and needs, trust and mutual respect can grow. Collaborative learning becomes possible, and the investment of time, effort and attention participants need to make in order for collaboration to be successful can begin to pay off. Support infrastructure – methodologies, technologies, tools, activities, and shared spaces (both physical and virtual meeting and co-working spaces) – are important to facilitate communication and to build shared understanding.

Conceptualizing regional innovation ecosystems is a way of understanding and strengthening the region's ability to nurture new innovation and strengthen competitiveness. Universities most often play the drivers' role in these. Companies that commercialize innovations are the main actor group, but not the only one. The various actor groups can best be described as diverse researcher networks, developer networks, user networks and producer networks, which are all needed in order to quickly produce and spread new competitive products, services and other innovations into markets.

Essential in tackling global challenges is to create new mechanisms to increase the renewal capital of our societies. Universities have to renew their own operational culture to be able to fulfill their mission to provide power to renew societies. All this can be called "the Entrepreneurial Discovery Mindset".

1. Introduction

My purpose with the help of this keynote is to inspire and instigate development and change. The opportunities exist. My presentation deviates from typical conference speeches – it is not a set of generic scientific studies, but analytical highlights of the recent 25 years of European development with conclusions and recommendations formulated for decision-makers. I have experienced through this period as a politician on national, local, and European levels in parallel with working in the academic community. Now, I try to focus on identifying the measures needed to accomplish the desired change.

Digitalization and globalization have changed and will keep changing societies: especially service and value processes, both public and private. The importance of knowledge and science-based evidence is also increasing in political decision-making.

My focus is on recent developments in science, technology, and innovation STI policies. I analyze and describe some concepts and practices of the recent European STI policy and their interrelationships with sustainable development. I review what that brings not only for the European STI community but also globally. The presentation includes top-down and bottom-up perspectives at the European, national, regional, and local levels. I encourage the STI community members to use this as a set of evidence in convincing the political decision-makers about the crucial societal importance of investments in intellectual capital.

2. Strengthening the wide knowledge base and intellectual capital

Knowledge and extensively intellectual capital have been a focus of STI policy already for long. Also, in companies, it is seen as a strong asset, and special attention is paid to knowledge management and knowledge creation. Wake-up from the industry also came to the public sector and research on increasing both the theoretical and practical understanding of creating and sharing both explicit and tacit knowledge. (Nonaka & Takeuchi 1995, Edvinsson & Sullivan 1996, Von Krogh et al. 2000).

According to many scientific studies, investing in intellectual capital is one or even the main success factor for countries. Finland, one of the Nordic welfare countries, is an excellent example of making this development. Everything is based on a long-term commitment to investing in education and R&D. As late as in the early 1980s, Finland was one of the OECD countries with the lowest R&D investments compared to GDP. National consensus and joint committing of both political and industrial decision-makers in the mid-1980s started a conscious national transformation process to the top international rankings in R&D investments, education system, competitiveness, and others. (Dahlman et al. 2006). Newsweek and USA Today wrote in 1999 their cover stories about the technology and knowledge-driven country where the future is now.

In 2013-2014 I was invited to read the manuscripts and write the foreword for a series of research studies about analyzing years 2005-2010 using indicators of national intellectual capital NIC components human, market, process and renewal capital in 11 country clusters, totaling benchmarking of 48 countries. Nordic countries became in the overall NIC rankings numbers 1, 3, 4, 8, and 9. The NIC model and results were published in 12 booklets to assist above-all policymakers navigating future direction for effective resource allocation (Lin et al. 2014).

3. National Innovation Systems

In this part of my presentation, I use my report based on the UNESCO assigned mission to Armenia (Markkula 2009). During the 1990s, Science and National Innovation Systems NIS were placed under growing economic and social pressures and, as a result, that has undergone extensive changes in all OECD countries. The hardcore of the science system consists of universities and research institutes having, in many cases, joint or at least partly integrated structures and processes. NIS is nonetheless a much larger system than only science universities, comprising of companies with their R&D operations and universities of applied sciences and many governmental organizations responsible for parts of the national STI policy.

In NIS, science needs to have an autonomous role in its internal operations, yet this is guided through the basic and competitive governmental funding – the decisions based on the international independent evaluation.

Through the global economic system changes, universities and scientific research have strengthened their roles in all political life sectors with a special focus on new partnership needs and developments in regional and global arenas. Efficiency, productivity, quality, and assessment are the requirements placed upon science and research, close to the same extent as the drivers of change in industry and public sector policies. However, the role of science has to be seen mainly as the maintainer and developer of knowledge-creation processes that work to secure the factors of long-term knowledge-based societal development.

Similarly, this means that not just the impacts of science but also the efficiency of STI processes is under much closer scrutiny than in the past. Reviewing the science policy in small and often also in less industrialized countries, the following changes can be detected. These have an important value when considering the needed science policy decisions in whatever country:

- The value of scientific research is increasingly measured throughout the value chains of innovative products and services.
- Science is integrated into industrial and public sector disciplines.
- Research and development funding on national levels increased and focused on the priorities set based on the societal decision processes and international evaluation.
- Inside science, multi-disciplinarity and interdisciplinarity are seen to have growing general importance for economic development, and in this respect regarded especially as the foundation for innovation.
- New components and concepts, such as science parks, incubators, centers of expertise, centers of excellence, technology programs, cluster programs, and different funding bodies, are created to operate within the NIS to secure both the effective and wide use of knowledge and the healthy competition.
- Incentives for creating new strategic partnerships are used to encourage knowledge sharing and collaboration.
- The role of companies in STI is increasing with the strong development of public-private partnerships.
- Post-graduate education and professional development of competencies of researchers and other key knowledge professionals are an integrated part of the STI policy.

4. Essential Elements in Knowledge-Economy

The ongoing change means a transition from an industrial to a knowledge society. As a result, education fortifies its role from an ancillary service to a leading economic and social development force. Traditionally the three main aims of education were to build disciplined individuals, competent workers, and respectful citizens. This way was perfectly suitable to the classic industrial society, which reserved responsibility, creativity, and political initiative to smoothly enlarging elites. What sort of individuals, workers, and citizens are needed in the knowledge society? Several answers can be given to this question. Still, a large consensus exists among educationalists because autonomous individuals, entrepreneurial and creative workers, responsive and socially active citizens are preferable to the versions considered more popular in the industrial society. Innovation and creativity are now valued as keys to successful economic development, the real wealth of nations of the 21st century.

There is not a unique standard Knowledge Society model. However, based on several evaluation studies, the systemic approach with the following factors seems to be fundamental elements for the knowledge-based economy:

1. Increasing human capital (intellectual capital) is the most important value base of work organizations and all communities.
2. Creativity and innovativeness are the driving forces.

3. Increasing the investments in research, development, and innovation play a crucial role in the global, EU, national, regional, and local policies.
4. Effective networking and digitalization are a way of life in creating a shared knowledge reality among individuals, organizations, and cities.
5. Knowledge management and encouraging systematic lifelong learning are bases for building concepts for learning organizations and learning cities.
6. The future of economic success is more and more built on the national innovation system and regional place-based innovation ecosystems with special emphasis on a well-targeted regional innovation policy.

I wrote these statements in 2012, integrating my Aalto University experiences with the EU policy. The new element was to have regional place-based innovation ecosystems an essential part of national innovation systems.

Strong backing for this broader perspective on STI policy also came from Professor C.K. Prahalad. In his book, he describes his research findings and ideas in the form of a *"House of Innovation"* where the resources are global R=G and solutions are tailor-made to specific needs N=1. He challenges the universities to create a new role for themselves by defining three critical aspects of innovation and value creation (Prahalad & Krishnan 2008):

1. The value will increasingly be co-created with customers.
2. No single firm has the knowledge, skills, and resources it needs to co-create value with customers.
3. The emerging markets can be a source of innovation.

And one of his main conclusions should be considered especially thoroughly when creating the new role for universities: *"The competitive arena is shifting from a product-centric paradigm of value creation to a personalized experience-centric view of value creation."*

The role of cities in the early years of the 2010s was growing not just as creating favorable conditions for education and innovation policy but also in taking an active role as initiators and contributors to embedding STI in regional innovation policies. Cities and city driven regions are becoming much stronger powerhouses than nation-states in societal development and inventing the future. A welfare society is created at a local level that is closest to the citizens' needs and lives with potential solutions to societal challenges.

To analyze deeper the changing role of cities and regions, I challenged, in my capacity as the President of the European Committee of the Regions CoR, our members the mayors or regional presidents or other key regional politicians to describe in five pages to define the critical success factors of their city or region in becoming a forerunner in co-creating regional innovation ecosystems. In addition to normal success factors, such as vision, physical and digital spaces, other resources, and the organization's personal, special focus areas to highlight in reporting were their *Policy Model, Collaboration Model, Partnering Model, and Innovative Instruments*. (CoR 2016).

Based on the stories written by CoR members, the key factors on becoming a forerunner in creating regional innovation ecosystems seemed to be:

1. Innovation communities operate as ecosystems through systemic value networking in a world without borders.
2. Innovation strategies focus on catalysing open innovation and encouraging individuals and communities towards an entrepreneurial mindset and effective use and creation of new digitalised services.
3. Innovation is often based on experimenting and implementing demonstration projects by partnerships, using the best international knowledge and creating new innovative concepts.
4. Creative processes can show what is the European Value Added and how to reach that through the bottom-up movements.

This CoR collaboration with the JRC and Commission's Directorate-General for Research and Innovation influenced on accelerating the benchmarking and benchlearning processes between regions and cities. A good example of this is the Baltic Sea macroregional cooperation in analyzing and improving the use of Smart Specialisation in regional innovation ecosystem development (Tukiainen & Hongisto 2020).

5. Instruments for Society Focused Change

5.1 Knowledge Triangle

In the EU policy, the role of universities, together with companies was and still is, to operate as drivers of co-creation and renewal. However, today's best laboratories for breakthrough innovations are no longer traditional university facilities, as such, but regional innovation ecosystems operating as test-beds for rapid prototyping of many types of user-driven innovations based on transformative and scalable systems. Innovation communities operate as ecosystems through systemic value networking in a world without borders. Innovation processes are strongly based on demand and user orientation, and customers as crucial players in innovations. Innovation strategies focus on catalyzing open innovation and encouraging individuals and communities towards an entrepreneurial mindset and effective use and creation of new digitalized services.

According to the key statements of the Swedish EU Presidency Conference *Knowledge Triangle: Shaping the Future Europe*, European higher education institutions should play a central role in knowledge triangle interaction by creating and disseminating knowledge valuable for society and businesses as well as by linking education, research, and innovation through collaboration with the wider community. The knowledge triangle concept relates to the need for improving the impact of investments in the three activities – education, research, and innovation – by systemic and continuous interaction (Swedish EU Presidency 2009).

In the conference, Jan Figel, European Commissioner for Education, Training, Culture, and Youth, highlighted the Bologna process as a step forward. The success of the process is driven largely by its innovative working method, based on open discussions and joint decision-making that involves governments, the Commission, and the main stakeholders, including universities and students. He also stresses the role of the European Institute of Innovation and Technology EIT as the most important and promising initiative that the Commission has undertaken to promote the integration of the knowledge triangle.

Janez Potocnik, European Commissioner for Science and Research, defined universities as the new 'multinationals of the knowledge industry', stressing that a well-functioning knowledge triangle is necessary to achieve the knowledge-based economy and society that will underpin sustained economic growth.

European Council decision European Council Conclusions on the role of Education & Knowledge Triangle stated: *"If the European Union is to be equipped to meet the long-term challenges of a competitive global economy, climate change and an aging population, the three components of the knowledge triangle must all function properly and interact fully with each other."* (EC 2009).

The conclusion urged the EU and the Member States to establish the following seven priorities for action:

1. Developing more coherence between policies in the field of education, research, and education;
2. Accelerating pedagogic reform;
3. The partnership between universities and business and other relevant stakeholders;
4. Measures to develop an innovation culture in universities;
5. Creating incentives for universities to develop transferable knowledge;
6. New approaches to quality assessment;
7. Developing the EIT as a model for the future;

Among the key statements of these European Commission conclusions were also *"New ideas and innovations are born from the coming together of different kinds of knowledge and through the curiosity-driven search for new knowledge."*

And *"the pluralism among Europe's university and research systems should be considered to be an asset for the development of diverse approaches to a fully-functioning knowledge triangle."*

Universities have reacted to this need for change. The network of leading universities of technology CESAER was one of the developers of this KT concept. The statement was clear: *"The universities must be determined in developing their ways of operation if they are to answer the challenges related to their societal role. They must be able to let go of the traditional methods based on sectorization and silos. Instead, they ought to create a culture of networks that crosses through the entire university".* (CESAER 2011).

CESAER showed what conceptualizing the KT means in practice. To increase synergy, each of the three basic missions (research, education, and innovation) has different key content areas, and methodological development needs to focus on them. For example, the role of research in the KT context is, especially, to produce more foresight knowledge to be used in education and innovation. To increase synergy, there is a need to define and establish three different concepts for platforms and processes to help the implementation of the KT concepts.

A. Value creation based on better use of intangible assets

- more communication and more dialogue over different borders
- modernization of the Triple Helix model
- new learning environment by learning and working together
- towards learning organizations, bringing together theory and practice

B. New processes and methods for university-industry collaboration

- supportive structures and funding for innovations
- bring together students and companies and create an interdisciplinary culture
- new ideas are generated in the boundaries of different sectors and domains
- entrepreneurial mindset
- high ambition, motivation, positivity, and risk-taking

C. Systemic change: focus especially on societal innovations

- universities form a natural network for solving grand societal challenges
- in societal innovations, there is always a structural or systemic dimension
- advanced leadership and managerial competencies are needed in orchestrating interdisciplinary, inter-sectoral, and intercultural communities
- bottom-up and user-centered thinking boosts innovations and enables the dissemination and implementation of innovations

Bringing together theory and practice is essential in implementing the Knowledge Triangle. This means that new learning environments are based on a culture characterized by learning and working together and research, development, and innovation. This motivates students to think outside the box and take the initiative and responsibility for collaborative learning.

The KT concept framework is outlined in figure 1. Concerning research, foresight in particular, stands among them, as in a high-quality university, also teaching and innovation activities are strongly future-oriented. In education, the success factors involve teaching and learning methods that encourage passionate lifelong learning. In innovation, these are typically competencies and methods for the deep understanding of innovation ecosystems and innovation as a complex process. In this, students play a crucial role. The efficient instruments and operational practices needed are illustrated in the figure as platforms and processes stressing different perspectives and approaches. Also, the orchestration plays a pivotal role. The figure portrays this as an activity that integrates the different elements and dimensions. (Markkula 2013).

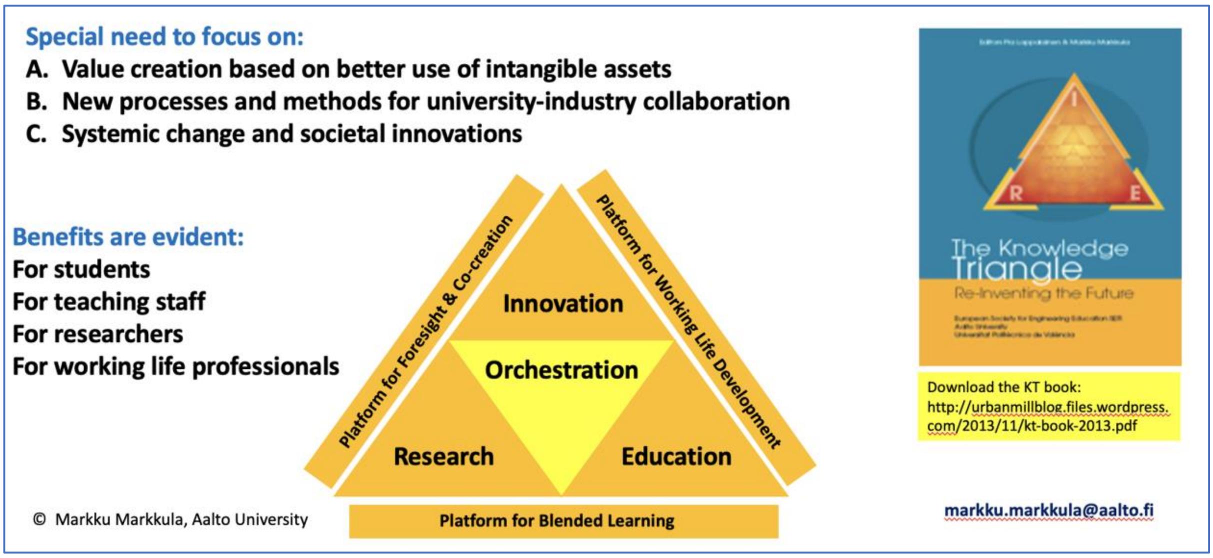


Figure 1: Platforms and Conceptualizing the Knowledge Triangle by Creating Synergy between Research, Education and Innovation

Within the Aalto University, we organized several initiatives applying the KT principles in the university-society interaction. The first Aalto Camp for Societal Innovation ACSI as a new-generation innovation process was organized in the Aalto University campus in Espoo in 2010. The constantly renewing global innovation community of ACSI offered an inspiring platform for co-creating and testing processes and methodologies needed for tackling real-life societal challenges. The concept of ACSI crystallized the methodological and pedagogical core of the Knowledge Triangle (Erkkilä & Miikki 2015).

For several years a few ACSI cases focused on city activities. One outcome has been the ideas and potential options for Espoo urban development. A garden proved to be a good metaphor for different people and things in an innovation ecosystem. It is a scalable solution for the modernization of the Triple Helix model. Everyone and everything grows and develops based on the growth conditions. Gardeners are needed to facilitate the processes and working models. They have to be systematically educated and prepared for their tasks. Value creation in the Espoo Innovation Garden is based on transforming opportunities into values through sharing and collaboration.

Reviewing the benefits, especially societal impact, the use of KT integrated to the innovation camp concept, annually repeated ACSI camps run by the core group of around 30 innovation experts, showed that the university could strongly influence the development of the surrounding urban area into a globally competitive innovation hub that offers an excellent breeding ground for high-end research and business, attracts best international experts to the university and research institutes, creates new businesses, and draws new international companies to the area.

The ACSI experiences have been used in different parts of the world and by different expert and learner groups. The CoR, together with the European Joint Research Centre JRC, applied the concept in city-focused urban development and prepared a guide to assist using the concept (Rissola et al. 2017).

5.2 From Triple Helix to Quadruple Helix and Living Labs

The Triple Helix concept – originally developed mainly in the 1990s, especially by Henry Etzkowitz and his colleagues – has also achieved a lot of scientific recognition (Etzkowitz & Leydessdorf 1997), Leydessdorf & Meyer 2003). Many EU member states and regions in Europe have a long tradition in using the Triple Helix, a concept comprising three actor groups: industry, cities and other public-sector organizations, and universities (and other research-oriented institutions). Initially, the industry operates in the Triple Helix as the locus of product development and production, government as the source of contractual relations that guarantee stable interactions and exchange, and the university as a source of new knowledge and technology. However, the roles and responsibilities of these institutional spheres are changing. Etzkowitz has written a good summary book about the usefulness of the Triple Helix model (Etzkowitz 2008).

Professor Martin Curley, Director of Intel Labs Europe and Chair of the EU Open Innovation Strategy and Policy Group, challenged the readers of the EU Open Innovation 2012 yearbook with his message: *"Open Innovation 2.0 could be defined as the fusion of Henry Chesbrough's open innovation concept and Henry Etzkowitz's triple helix innovation concept. Triple Helix is about achieving structural innovation improvements through proactive collaborations between industry, academia, and government. The impact of this collaborative innovation goes well beyond the scope of what any organization could achieve on their own."* (Curley 2012).

The Triple Helix model is no longer enough in the context of Smart Specialisation. The Quadruple Helix allows for various innovations other than the ones strongly based on technology or science, in the spirit of the broad concept of innovation at the foundation of RIS3. This requires significant flexibility, the adaptation of processes, the acquisition of new skills, and potential re-distribution of power among organizations (JRC S3 Platform 2012).

The importance of responsiveness and innovativeness has grown hugely over the past few years in all types of business activity and work – including policymaking. In the global and digital age, pioneers and potential trendsetters are more and more often those who succeed because they open the way and set the ground rules for action. It is unnecessary to be a leader in every sphere; what matters is the state of mind. It is usually enough to build with sufficient confidence in knowledge and practices developed elsewhere. Digitization provides an enormous opportunity.

Digitization drives change, and convergence towards digital services is speeding up. New business ecosystems and value creation arenas are often driven by new consumer behaviors resulting from user-centric designs and openness. They challenge top-down construction approaches inherited from the old, analog world. (Markkula 2014).

The Living Labs concept was brought onto the EU's official agenda during Finland's Presidency of the European Union in 2006. The first phase of the European Network of Living Labs consists of 20 Living Labs in 15 Member States. It is a cross-regional, cross-national, and pre-market network, which creates multi-stakeholder cooperation models for public-private-people-partnerships. (Finnish EU Presidency 2006).

The challenge in developing LL-approach is to combine scientific basic and applied research intertwined with the application-oriented piloting with people. This requires experimentation based on hypothesis-driven or open-ended research designs, which differ much from the traditional linear innovation process approach.

For example, the Living Lab concept is widely used in the City of Espoo to increase the co-creation mentality and improve the processes with partnerships in city services. (Sutinen et al. 2016).

5.3 Smart Specialisation – a Key instrument for Economic Transformation

The EU Smart Specialisation policy aims to tackle the challenge of turning the outcomes of thousands of small development projects involving the same topics in different parts of Europe into well-documented concepts, methodologies, and tools.

Smart Specialisation is a regional policy framework for innovation-driven growth. What distinguishes the EU Smart Specialisation policy from traditional industrial and innovation policies? The answer, in brief, is that the difference is the process highlighting the "green": an interactive and innovative process in which market forces and the private sector together with universities discover and produce information about new activities and the government assesses the outcomes and empowers those players most capable of realizing the potential. Smart Specialisation Strategies are much more bottom-up than traditional industrial policies. (Markkula & Kune 2015 b).

Regional RIS3 strategies can be defined as follows (JRC S3 Platform 2012):

- They focus policy support and investments on key national/regional priorities, challenges, and needs for knowledge-based development, including ICT-related measures.
- They build on each country's/region's strengths, competitive advantages, and potential for excellence.
- They support technological as well as practice-based innovation and aim to stimulate private-sector investment.
- They get stakeholders fully involved and encourage innovation and experimentation.
- They are evidence-based and include sound monitoring and evaluation systems.

For the region, RIS3 is not just an important document. Having an approved RIS3 has been an ex-ante conditionality, i.e., obligatory for getting the EU Cohesion funds in the use of a region. For each region, RIS3 should be a continuous process, not just an important document. In the Helsinki Region, we drew the following conclusions from EU-level definitions as the foundation of our work (Markkula & Kune 2015 b):

- RIS3 is an economic transformation agenda. RIS3 is a dynamic and evolutionary process (not a structure) deeply grounded in an entrepreneurial discovery process (not a one-off action) where governments are rather facilitators than in a position to command and control. RIS3 is for innovation leaders and those lagging behind.
- The Smart Specialisation approach is not just about a more focused and limited approach to cluster funding. RIS3 is a structural reform to upgrade the entire business environment and innovation ecosystem in the region.
- Smart Specialisation is opening up important opportunities for joining forces, matching roadmaps, and building more world-class clusters.

Both official documents from the European Commission and the Helsinki Region's experience stress the importance of societal capital for the renewal of regions. The European Union's Smart Specialisation policy aims to address this challenge. In modernizing the Triple Helix and instituting ecosystem thinking, pioneering regions can better address societal challenges and apply excellence in science and industrial leadership in dealing with important issues. The direct involvement of stakeholders from industry, universities, and the public sector, and the engagement of citizens in co-creative work processes, is a prerequisite for the success of smart regions, and it is the key to translating the regional potential into a better quality of life. Through their active roles in the creative translation of potential into practice, universities are essential for infusing the region with knowledge. (Markkula & Kune 2015 a).

The EU Smart Specialisation concepts, methods, and experiences have, in recent years, been widely used in other parts of the world. The European Training Foundation and the European Commission, and the CoR have assisted using RIS3 as an example in Tunis and other EU neighboring countries.

5.4 Place-based Regional Innovation Ecosystems

The European Union Joint Research Centre JRC is the research expert organization with close to 3000 researchers focusing its work, especially on supporting the EU wide political decision-making. It has published many studies and methodological guides in its Smart Specialisation Platform: www.s3platform.jrc.ec.europa.eu. Its first study on existing or new place-based innovation ecosystems analyzed the Espoo Innovation Garden with the following main findings. (Rissola et al. 2017).

Developing the innovation ecosystem in Espoo builds on a strong knowledge base. Decades of government and private investments in research and development intensive activities resulted in a high concentration of Human Scientific and Technological Capital and important research infrastructures.

The entrepreneurial spirit and participation of all actors (including students and citizens) are seen as crucial by leading organizations in the local context. It has been actively supported and facilitated by the university and the regional and city governments. Co-creation with citizens/users is increasingly being cultivated through open innovation methodologies and open innovation spaces. Shared activities and large-scale endeavors bring together all parties involved in an entrepreneurial discovery process of experimenting, taking responsible risks, and learning collaboratively.

The broader Finnish institutional environment, experiencing a process towards deregulation, has conferred enough flexibility to innovation stakeholders to define and implement their own research and innovation agendas. Innovation brokers have, at the same time, been mandated to develop public-private partnership networks.

In the development of the Espoo innovation ecosystem, there are (at least) three 'innovation process entrepreneurs'. The first and central actor is Aalto University and the university's leadership. The second one is the local government (Helsinki-Uusimaa Regional Council and Espoo City). The third one, rather as a funding facilitator, is the national innovation funding agency Tekes. Aalto University is a unique institution within a very distinctive innovation system. It was born out of the merger of three existing universities with a mandate to become the country's national 'innovation university'. As an endowment University, Aalto University has been able to build a new organizational model, activating at the same time a constellation of entrepreneurial initiatives and spaces. This has positioned Aalto University at the heart of the Espoo Innovation Garden as one of its key orchestrators.

Given the distinctive nature of the Espoo ecosystem and of the context in which it was born, it will not be straightforward for other regions or cities to engage in wholesale institutional learning from this case. Nonetheless, some key initiatives deployed in the Espoo Innovation Garden and the way Aalto University was facilitated to play its orchestrating role can inspire national and regional governments and university administrations to develop their own policies.

Conceptualizing regional innovation ecosystems is a way of understanding and strengthening the region's ability to nurture innovation and strengthen competitiveness. Universities most often play the drivers' role in these. Companies that commercialize innovations are the main actor group, but not the only one. The various actor groups can best be described as diverse researcher networks, developer networks, user networks, and producer networks, which are all needed to quickly produce and spread new competitive products, services, and other innovations into markets.

6. EU Horizon 2020 and Its Further Development

The societal role of universities and other higher education institutions is crucial in building the future with sustainable growth and social and economic progress. To analyze recent development, I start with the European Council decision in 2009 about the role of education. (EC 2009). The EC conclusion urged the EU and the Member States to establish the following seven priorities for action:

1. Developing more coherence between policies in the field of education, research, and innovation.
2. Accelerating pedagogic reform.
3. The partnership between universities and business and other relevant stakeholders.
4. Measures to develop an innovation culture in universities.
5. Creating incentives for universities to develop transferable knowledge.
6. New approaches to quality assessment.
7. Developing the EIT European Innovation and Technology Institute as a model for the future.

Among these EC conclusions, key statements were *"New ideas and innovations are born from the coming together of different kinds of knowledge and through the curiosity-driven search for new knowledge." And "the pluralism among Europe's university and research systems should be considered to be an asset for the development of diverse approaches to a fully-functioning knowledge triangle."*

The name of the EU's new funding program 2014-2020 for research and innovation Horizon 2020 reflects its ambition to deliver ideas, growth and jobs for the future. The CoR has stressed that the key issues throughout Europe address ways of speeding up implementing the most relevant flagship activities and ways of learning to exploit existing research knowledge by sharing best practices and other sources of relevant knowledge. The CoR is challenging both the European Commission and the regions themselves to get the most out of Horizon 2020. Local and regional authorities face the challenge of developing cross-territorial and pan-European cooperation. In particular, they need to be able to develop joint platforms, such as innovation forums and test beds for cooperation, by integrating real and virtual worlds to foster open innovation and regional innovation ecosystems. Active European cooperation would result in economies of scale and the creation of wider markets for local businesses and other local developments. Smart Specialisation — as the key guiding principle both of Horizon 2020 and the EU cohesion policy — is opening up new avenues to all this. (Markkula & Kune 2013).

The EU's research framework program Horizon 2020 was built on three pillars: Societal challenges, Industrial leadership, and Scientific excellence. The impact targets were defined, in brief, as political statements:

- Smart Growth by developing an economy based on knowledge and innovation.
- Sustainable Growth by the more efficient, greener, and more competitive economy.
- Inclusive Growth by fostering a high-employment economy delivering social and territorial cohesion.

European Institute of Innovation and Technology has grown to become the important European actor implementing new developments of the European STI collaboration policy, practically throughout Europe. Figure 2 shows the connections with Knowledge Triangle.

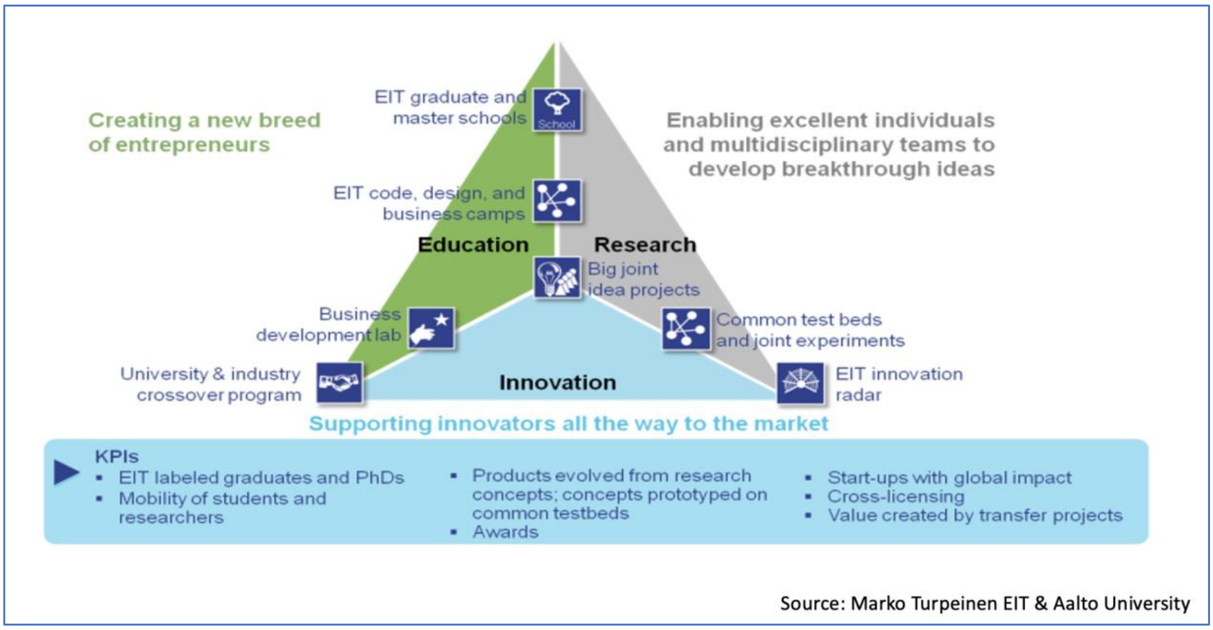


Figure 2: Creating New KT Concepts inside the University: Example EIT ICT Labs

The political focus has been and will be, more than in the past, in increasing measures for the impact. This means especially increasing societal influence to speed up the conscious transformation to a knowledge-based society. Lessons learned in the EU research policy during recent years in brief are, see figure 3:

- Need to support more potential breakthrough innovation.
- Create more impact through mission-oriented and citizens' involvement.
- Strengthen international cooperation.
- Reinforce openness and open innovation.
- Rationalize the funding landscape.
- Encourage participation.

A huge number of parallel activities to achieve the targets have been implemented. Special emphasis has been devoted to developing and applying new instruments, especially Regional Innovation Strategies based on Smart Specialisation RIS3, European Innovation Partnerships EIPs, and Key Enabling Technologies KETs.

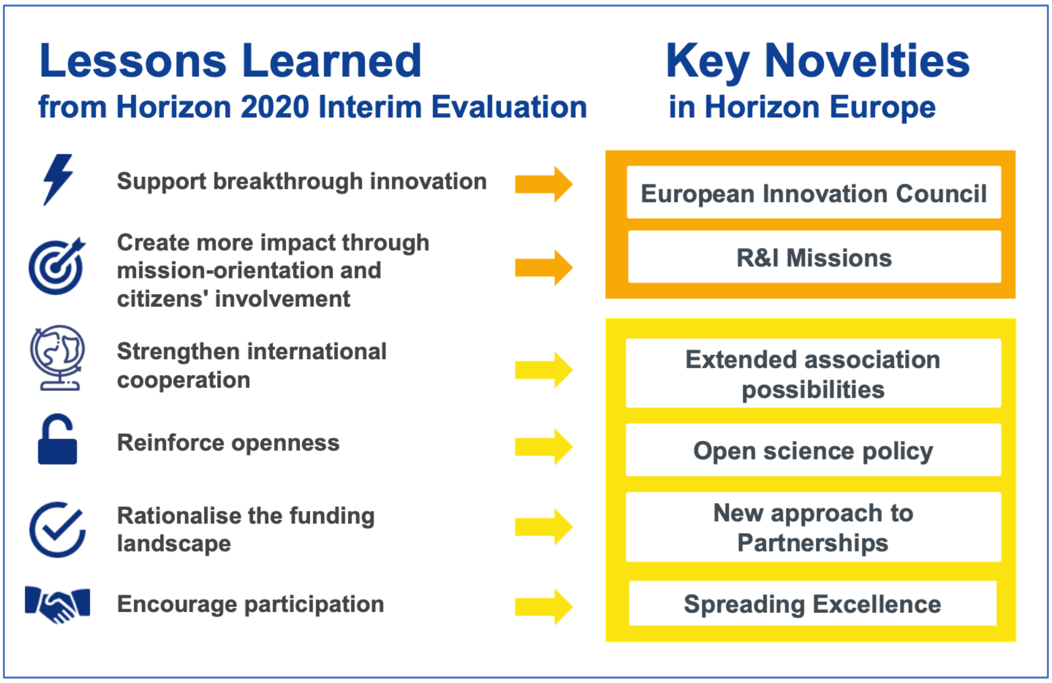


Figure 3: Moving from Horizon 2020 (2014-2020) to Horizon Europe (2021-2027), Source European Commission

The importance of the increasing impact of research activities has been the basic principle in stressing STI policy's societal perspective. KT experiences speed-up the need to move from proprietary ownership of research knowledge to open innovation and sharing of knowledge and from personal to partnerships, from following to initiating, from risk-aversion to experimentation. These are building blocks of the culture of innovation which Europe is looking for and which the Horizon 2020 program hopes to achieve. They mark shifts in deep understanding necessary to increase value creation in society. Horizon Europe is the new Framework Program to continue the European research and innovation collaboration during the years 2021-2027. Its basic element summarized in figure 4.

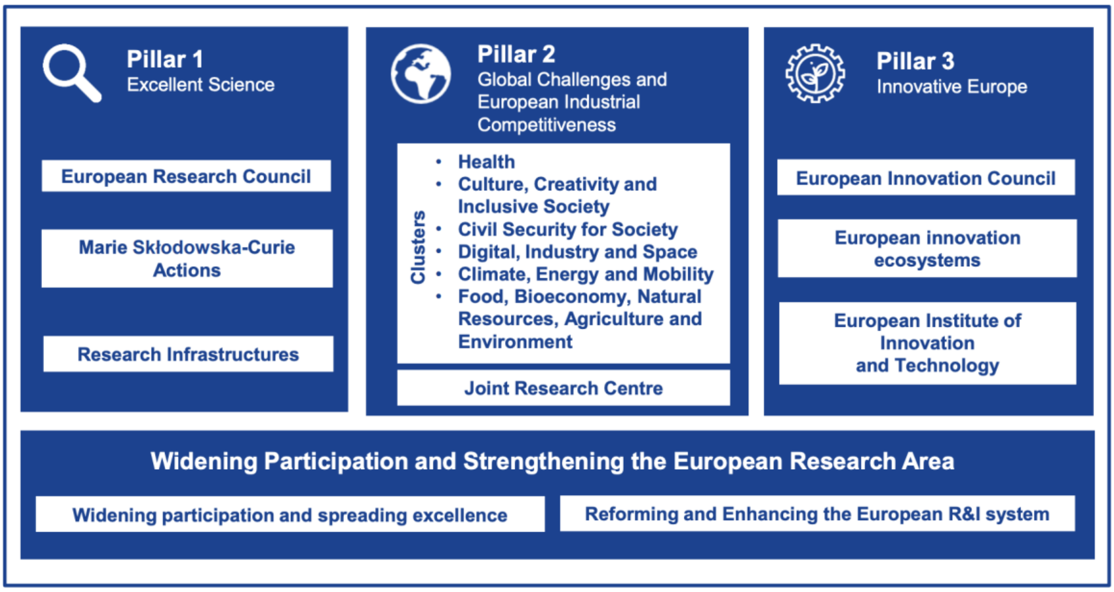


Figure 4: Basic Pillars of Horizon Europe, source European Commission

European Commissioner for Science, Research & Innovation Carlos Moedas defines Horizon 2020 as a unique program in the world in terms of its scale, duration, and scope. The interim evaluation has been an extensive activity, based on a wide range of evidence. It shows that Horizon 2020's actions have clear European added value (over 80% of projects would not have gone ahead without its support) and are managed in a highly cost-efficient manner. According to Moedas, the interim evaluation provides a rich and comprehensive evidence base for understanding the impacts of the projects, improving the program, and preparing its successor – while at the same time demonstrating the importance of research and innovation as an investment in the future we want for Europe (Moedas 2017).

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Markku Markkula CV

Mr. Markku Markkula is the Vice-President of the European Committee of the Regions (CoR), representing regions and cities in the European Union decision-making. In 2015-2017 he was the President of the CoR. Carrying these responsibilities, he has had many influential roles in the EU policy, including the CoR Rapporteur on important opinions such as innovation, digitalization, research policy, industrial renaissance, start-ups, single market, and better governance.

He is the President of the Helsinki Region (Chair of the Board of the Helsinki-Uusimaa Regional Council) since March 2018 and the Chair of the Board of the second-largest city in Finland Espoo since June 2017. The city of Espoo is the Most Sustainable City in Europe and the Most Intelligent Community in the World 2018. Within the UN family, Espoo has been nominated to be the forerunner city implementing the UN Agenda 2030, the 17 Sustainable Development Goals already by 2025.

Mr. Markkula is a former member of the Finnish Parliament (1995-2003). As an MP, his international role included the Presidency of EPTA Council, European Parliamentary Technology Assessment Network.

The professional experience of Mr. Markkula is extensive, focusing especially on knowledge creation, lifelong learning, and societal innovations. His career includes the EU Policy Advisor to the Aalto University Presidents (2010-2018) and the Aalto University Transformation Team Member (2008-_-2009). Within the Helsinki University of Technology, he has served as the Director of the Lifelong Learning Institute Dipoli (1992-1995, 2003-2008) and the Director of the Centre for Continuing Education (1985-1991).

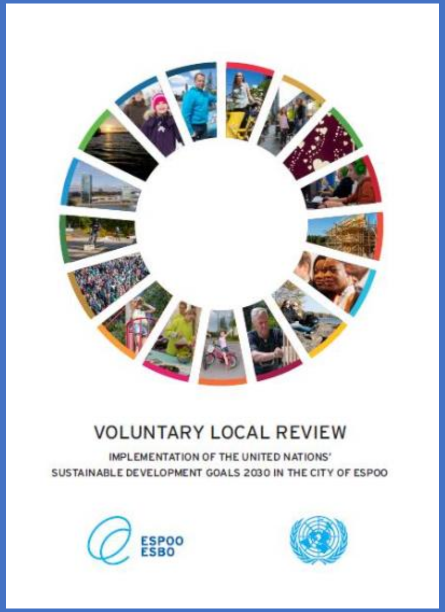
He has served the global engineering community as the part-time Secretary-General of the International Association for Continuing Engineering Education IACEE 1989-2001. He has also served as the Chair of the Board of the Association of Academic Engineers and Architects in Finland TEK 1992-2004 and held several high-quality roles in companies and organizations in Finland and internationally. As a tribute to his achievements, he was in 2008 elected to the International Adult and Continuing Education Hall of Fame.

European Committee
of the Regions

• Vice-President of the EU Committee of the Regions (Former Pres.)
• President of Helsinki-Uusimaa Region
• Chair of the Espoo City Board

Markku Markkula:

IDENTICATION AND DEVELOPMENT OF STI POLICIES



Implementing SDGs
Voluntary Local Review
See: espoo.fi/vlr

Essential Elements in Knowledge Economy

There is not a unique standard Knowledge Society model. However, based on several evaluation studies the systemic approach with following factors seem to be fundamental elements for the knowledge-based economy:

1. Increasing **human capital** (intellectual capital) is the most important value base of work organizations and all communities,
2. **Creativity and innovativeness** are the driving forces,
3. Increasing the **investments in research, development and innovation** play a crucial role in the global, EU, national, regional and local policies
4. **Effective networking and digitalisation** are a way of life in creating a shared knowledge reality among both individuals, organizations and cities,
5. Knowledge management and **encouraging systematic lifelong learning** are bases for building concepts for learning organizations and learning cities,
6. The future of economic success is more and more built on the national innovation system and **regional place-based innovation ecosystems** with special emphasis on a well-targeted regional innovation policy,

HORIZON 2020 Renewing EU Research Policy

Horizon 2020

Societal Challenges | Industrial Leadership | Scientific Excellence

Key Instruments

Smart Spesialisation | European Innovation Partnerships | Future Internet and other KET

IMPACT	IMPACT	IMPACT
Smart Growth developing an economy based on knowledge and innovation	**Sustainable Growth** more efficient, greener and more competitive economy	**Inclusive Growth** fostering a high-employment economy delivering social and territorial cohesion

Lessons Learned
from Horizon 2020 Interim Evaluation

- Support breakthrough innovation
- Create more impact through mission-orientation and citizens' involvement
- Strengthen international cooperation
- Reinforce openness
- Rationalise the funding landscape
- Encourage participation

Key Novelties
in Horizon Europe

- European Innovation Council
- R&I Missions
- Extended association possibilities
- Open science policy
- New approach to Partnerships
- Spreading Excellence

European Commission

Horizon Europe: Basic Pillars

Pillar 1
Excellent Science

- European Research Council
- Marie Skłodowska-Curie Actions
- Research Infrastructures

Pillar 2
Global Challenges and European Industrial Competitiveness

Clusters
- Health
- Culture, Creativity and Inclusive Society
- Civil Security for Society
- Digital, Industry and Space
- Climate, Energy and Mobility
- Food, Bioeconomy, Natural Resources, Agriculture and Environment

Joint Research Centre

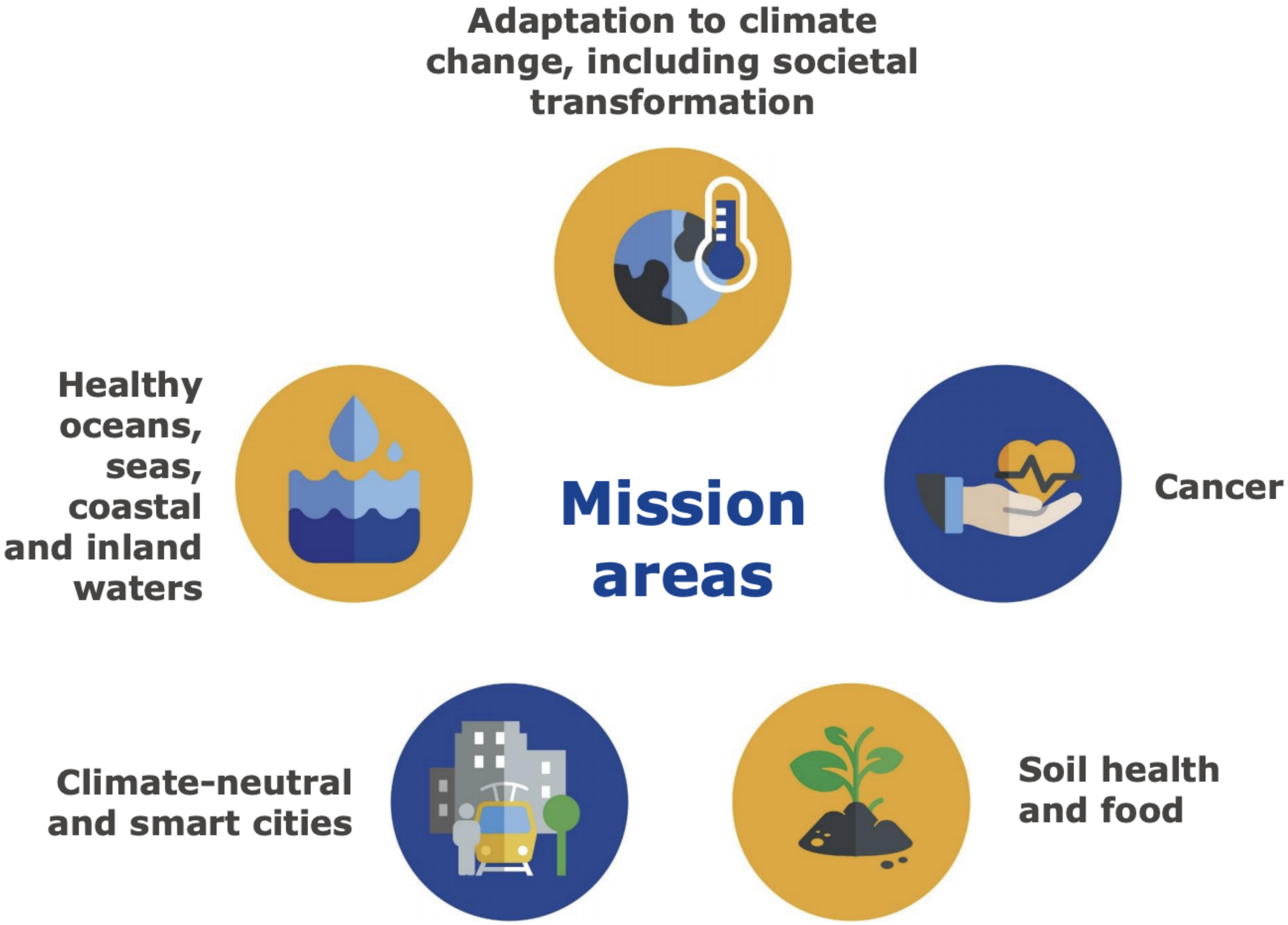
Pillar 3
Innovative Europe

- European Innovation Council
- European innovation ecosystems
- European Institute of Innovation and Technology

Widening Participation and Strengthening the European Research Area

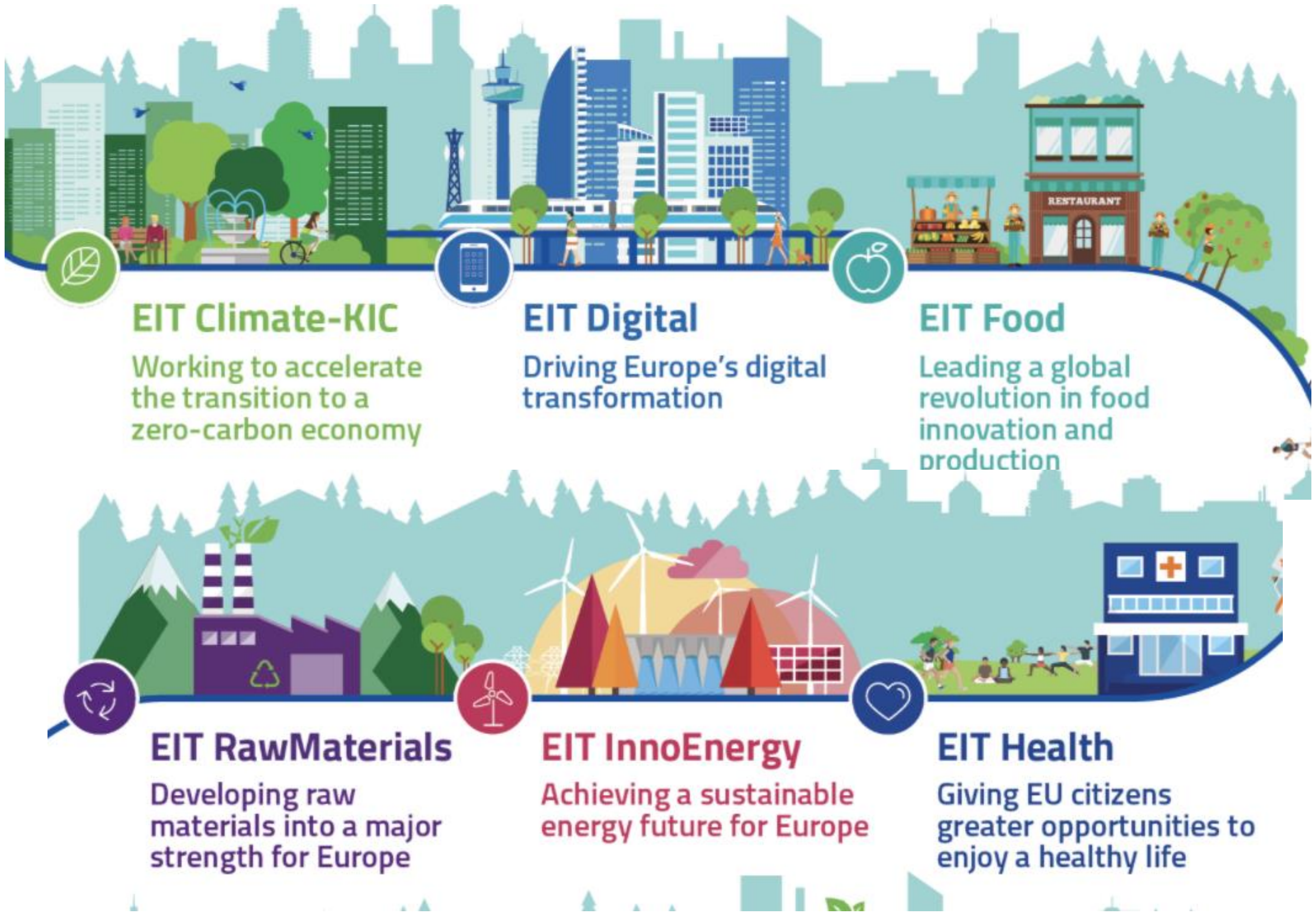
- Widening participation and spreading excellence
- Reforming and Enhancing the European R&I system

Five Missions in Research



European Commission

EIT – European Institute of Innovation and Technology



European Council in 2009:

The Crucial Role of Education & Knowledge Triangle

“If the European Union is to be equipped to meet the long-term challenges of a competitive global economy, climate change and an aging population, the three components of the knowledge triangle must all function properly and interact fully with each other.”

The conclusion urged EU and the Member States to establish the following seven priorities for action:

1. **Developing more coherence between policies in the field of education, research and education;**
2. **Accelerating pedagogic reform;**
3. **Partnership between universities and business and other relevant stakeholders;**
4. **Measures to develop an innovation culture in universities;**
5. **Creating incentives for universities to develop transferable knowledge;**
6. **New approaches to quality assessment;**
7. **Developing the EIT as a model for the future;**

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How to Implement KT in Universities?

- Among the key statements of these EC conclusions were *"New ideas and innovations are born from **the coming together of different kinds of knowledge and through the curiosity-driven search for new knowledge**."* And *"the pluralism among Europe's university and research systems should be considered to be an asset for the development of diverse approaches to a fully-functioning knowledge triangle."*
- The following statement made by the EU Committee of the Regions already in 2012 describes well the change in the STI policy: *"**The laboratories for innovation are no longer traditional university facilities, but regional innovation ecosystems** operating as test-beds for rapid prototyping of many types of user-driven innovations: new products, services, processes, structures and systems, which need to be of transformative and scalable nature."*
- **What Does the Conceptualizing the Triangle Mean in Practice?** To increase synergy, each of the three basic missions (research, education and innovation) has different key content areas and methodological development needs to focus on. For example, the role of research in the KT context is, especially, to produce more foresight knowledge to be used in education and in innovation. To increase synergy, there is a need to define and establish three different concepts for platforms and processes to help the implementation of the KT concepts.

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Implementing the Knowledge Triangle:

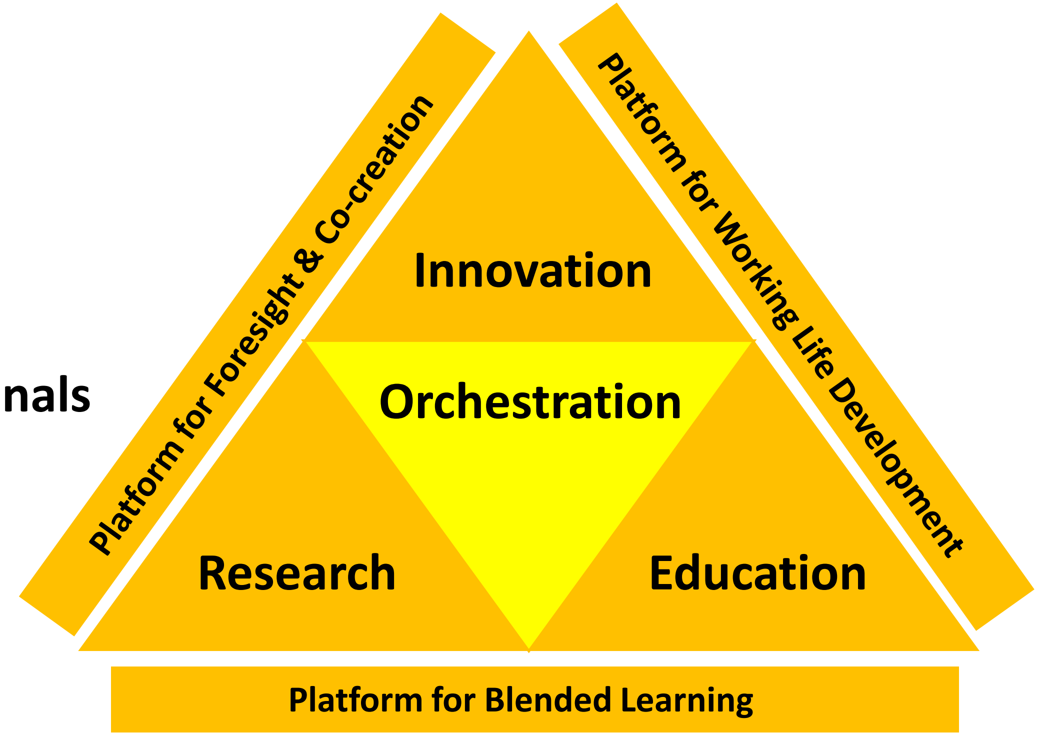
Conceptualize Platforms and Processes to Create Synergy between Research, Education and Innovation

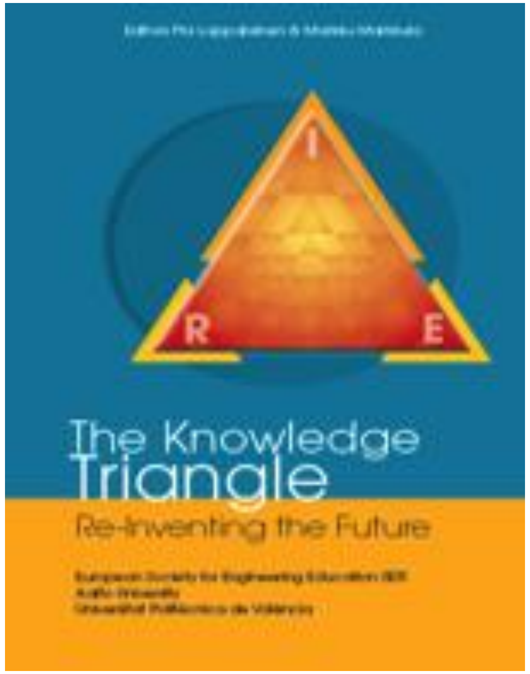
Special need to focus on:

A. Value creation based on better use of intangible assets
B. New processes and methods for university-industry collaboration
C. Systemic change and societal innovations

Benefits are evident:

For students
For teaching staff
For researchers
For working life professionals





Download the KT book:
http://urbanmillblog.files.wordpress.com/2013/11/kt-book-2013.pdf

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Lessons Learnt on Knowledge Triangle: Special Focus on

A. Value creation based on better use of intangible assets

- more communication and more dialogue over different borders
- modernisation of the Triple Helix model
- new learning environment by learning and working together
- towards learning organizations, bringing together theory and practice

B. New processes and methods for university-industry collaboration

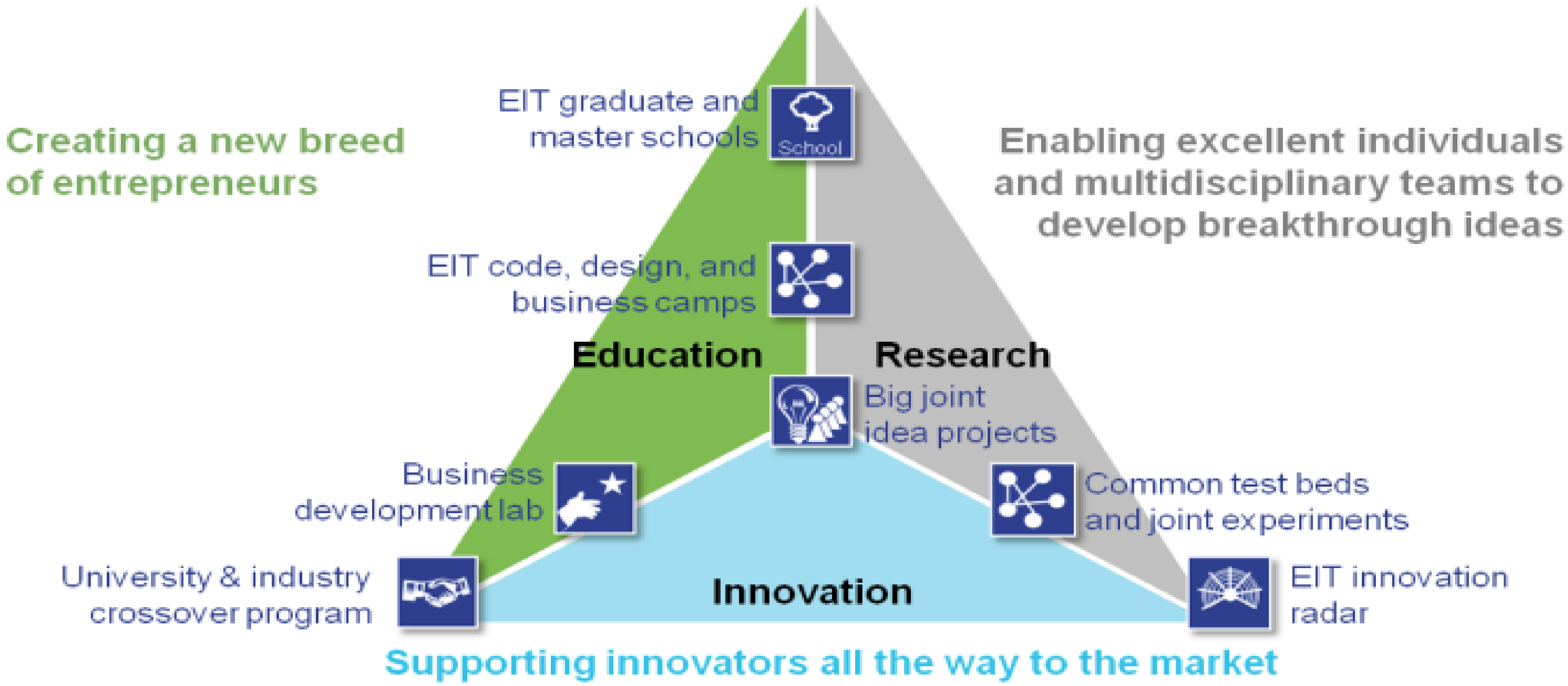
- supportive structures and funding for innovations
- bring together students and companies and create an interdisciplinary culture
- new ideas are generated in the boundaries of different sectors and domains
- entrepreneurial mindset
- high ambition, motivation, positivity and risk-taking

C. Systemic change: focus especially on societal innovations

- universities form a natural network for solving grand societal challenges
- in societal innovations there is always a structural or systemic dimension
- advanced leadership and managerial competences are needed in orchestrating interdisciplinary, inter-sectoral and intercultural communities
- bottom-up and user-centred thinking boosts innovations and enables the dissemination and implementation of innovations

Source: Markku Markkula, Brussels, CESAER & EU DG EAC, 8 March 2012

Creating New KT Concepts inside the University: Example EIT ICT Labs



KPIs

- EIT labeled graduates and PhDs
- Mobility of students and researchers

- Products evolved from research concepts; concepts prototyped on common testbeds
- Awards

- Start-ups with global impact
- Cross-licensing
- Value created by transfer projects

Source: Marko Turpeinen EIT & Aalto University

European Innovation Partnerships

The Independent Expert Group (chaired by Esko Aho) made 8 recommendations (2014) to improve the European Innovation Partnerships (EIPs) as a critical tool to enable radical improvements to help enable future European economic growth and welfare:

1. Adopt improved criteria for launching new EIPs
2. **Provide an architecture for systemic change**
3. Deploy a professional Design Team to guide the work of the EIPs
4. **Adopt an ecosystem approach to delivery**
5. Build a level playing field proactively
6. Adopt clear indicators for success
7. Secure committed high-level leadership and adopt an effective governance model
8. **Improve the stakeholder model**

SYSTEMIC CHANGE is about a fundamental change that is achieved by engaging across aspects of a system. Systemic change is rarely, if ever, the result of a single innovative action. Rather it is generally the result of many innovation actions coordinated across a broad range of dimensions, which combined create change at scale. Understanding the mix and range of innovations necessary requires an architecture, or a structure, that guides intent. Commonly the range of innovations might include technological, social, and process innovations.

Report of the expert group for the review of European Innovation Partnerships, 2014

Every EU Region Has a Smart Specialisation Strategy

CHALLENGE 1: **The "prioritization" challenge**: how to select (and justify) priority intervention domains for S3?

CHALLENGE 2: **The "integrated policy" challenge**: what are the adequate policies for S3?

CHALLENGE 3: **The "smart policy-making" challenge**: what tools for evidence-based policy (measuring, assessing and learning in S3)?

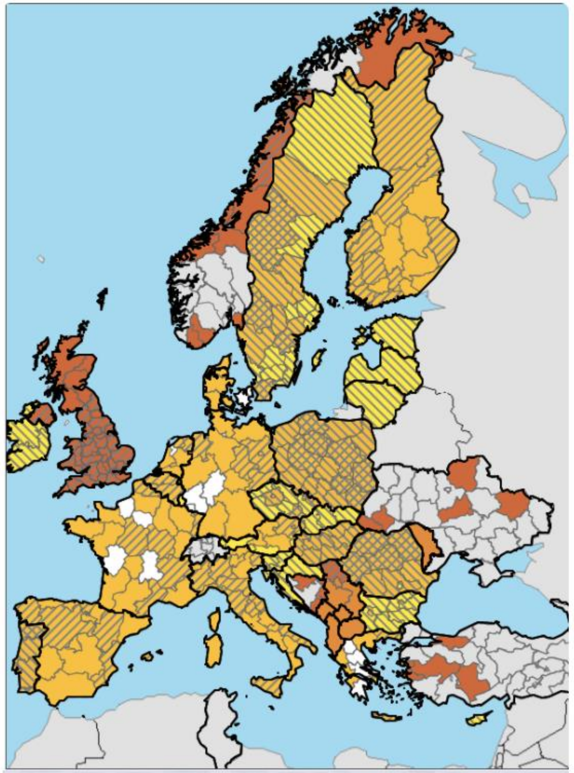
CHALLENGE 4: **The "multi-level governance" challenge**: how to align policies from national, regional, EU levels?

CHALLENGE 5: **The "cross-border collaboration" challenge**: what is the appropriate territory to conduct a S3 and how to conduct polices that conform to it?

CHALLENGE 6: **The "stakeholder engagement" challenge**: how to promote participation, engagement and commitment of the variety of stakeholders?

Markku Markkula CoR Innovation Union keynote on 27 Nov 2013, based on "The role of clusters in smart specialisation strategies", DG Research and Innovation

Join the SMART SPECIALISATION PLATFORM



- **EU Countries registered in S3P: 19**
- **EU Regions registered in S3P: 178**
- Non-EU Countries registered in S3P: 7
- Non-EU Regions registered in S3P: 31
- S3P Peer-reviewed Countries: 16
- S3P Peer-reviewed Regions: 75

EU Smart Specialisation → The Societal Role of Universities Is Changing

In addition to research and education Universities are having more societal options and responsibilities ahead, with the need to modernize the Triple Helix model:

1. Universities can and should focus more on societal challenges and as a result, broadening the innovation base, especially in:

a) Increasing a general motivation towards innovation;
b) Stressing the importance of the real-life & real-case approach;
c) Moving towards Open Innovation 2.0.

2. Universities are natural platforms for entrepreneurial discovery, especially in:

a) Increasing entrepreneurial understanding and activities through science-society dialogue;
b) Creating platforms and other pre-conditions for start-ups;
c) Universities can be key actors in creating the new culture for strategic alliances through multi- financing and orchestration.

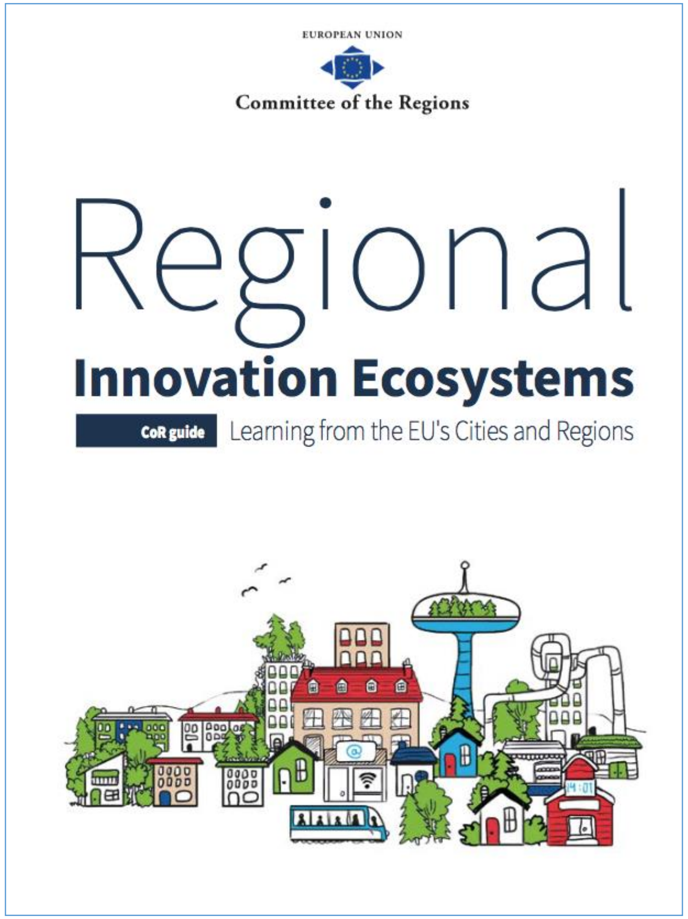
3. Universities have a crucial role in creating regional innovation ecosystems to be based on the co-creation culture and the network of innovation hubs, especially in:

a) Creating living labs and innovation test-beds for knowledge co-creation;
b) Encouraging bottom-up activities by creating new arenas as innovation hotspots;
c) Moving towards experiments, demonstrations and rapid prototyping.

4. Universities are the knowledge base in defining and implementing regional research and innovation strategies based on smart specialisation RIS3, especially in:

a) Increasing smart city & smart region initiatives;
b) Prioritizing the regional activities and strengthening the base for focused activities;
c) Building critical mass based on European-wide strategic partnerships.

CoR Cases: From Bench-marking to Bench-learning



Stories written by CoR members. How to become a forerunner in creating regional innovation ecosystems. Key findings are:

1. Innovation communities operate **as ecosystems through systemic value networking** in a world without borders.
2. Innovation strategies focus on **catalysing open innovation** and encouraging individuals and communities towards an **entrepreneurial mindset** and effective use and creation of new digitalised services.
3. Innovation is often based on **experimenting and implementing demonstration projects** by partnerships, using the best international knowledge and creating new innovative concepts.
4. **Creative processes** can show what is **the European Value Added** and how to reach that through the bottom-up movements.

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CoR: Critical Success Factors for Pioneering Cities and Regions

Vision

The Region's reason to become a pioneer;
Open Innovation 2.0: user-oriented innovation where the public sector, industry, academia and citizens work together to drive structural changes;
Realizing RIS3: implementing the Region's smart specialisation strategies;
Attractiveness: how to make the Region attractive to investors, business and citizens;
Economic, social and ecological sustainability: Europe's Urban Agenda, especially urban planning with focus on the sustainable use of land, climate adaptation, and air quality;
Circular Economy: the re-use, repair, refurbishment and recycling of existing materials and products.

Policy Model

How policies are developed and implemented to support pioneering activities.

Resources

Use and development of both tangible and intangible resources which allow the region or city to provide an attractive and prosperous environment for business and citizens: talent, knowledge, social capital.

Actors

Active participants engaged in activities to create better quality of life, making effective use of strong networks and social capital.

Physical and Digital Spaces

the use of physical and digital environments that support and enhance collaboration, co-learning and the creation of effective solutions to urban issues.

Innovative Instruments

Investment in new initiatives and technologies, active participation in the Digital Single Market, using Public Procurement to address sustainable development including economic, social and environmental objectives and to do more with less.

Collaboration Model

Organizing collaboration in Quadruple-helix: Business, government, academia and citizens working together within the city and the region to improve quality of life.

Partnering Model

How the region and the city work together with others on national, European and global levels in order to disseminate knowledge about relevant practice and scale solutions that work.

Outcomes & Results

Intended and achieved results

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The European Green Deal
CLIMATE PACT AND CLIMATE LAW
INVESTING IN SMARTER, MORE SUSTAINABLE TRANSPORT
STRIVING FOR GREENER INDUSTRY
ELIMINATING POLLUTION
ENSURING A JUST TRANSITION FOR ALL
FINANCING GREEN PROJECTS
MAKING HOMES ENERGY EFFICIENT
LEADING THE GREEN CHANGE GLOBALLY
FROM FARM TO FORK
PROTECTING NATURE
PROMOTING CLEAN ENERGY

EU / Capital of Innovation: Criteria 2017-2020

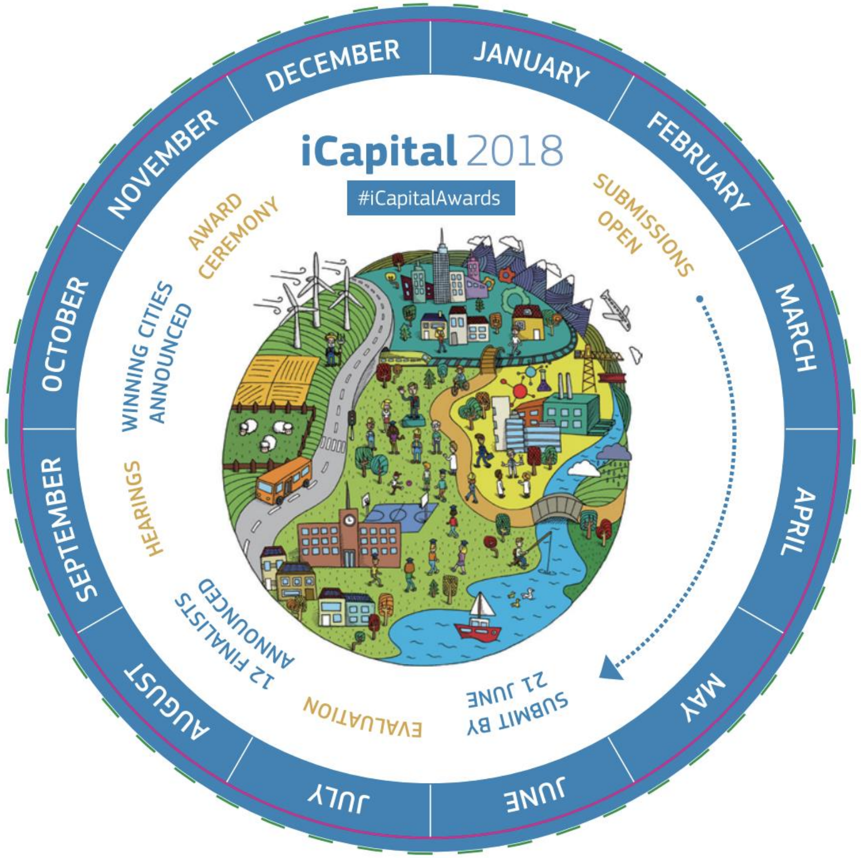
The award has been awarded to the entry that best addresses the following cumulative criteria:

1. Experimenting – innovative concepts, processes, tools, and governance models proving the city's commitment to act as a test-bed for innovative practices, and ensuring mainstreaming of these practices into the urban development process;

2. Engaging – increasing opportunities for a broader range of citizens and ensuring uptake of their ideas;

3. Expanding – outlining the city's potential to attract new talent, resources, funding, investments, and to become a role model for other cities;

4. Empowering – concrete and measurable impact directly connected to the implementation of innovative practices.



Sustainable Place-Based Innovation Ecosystem = a complex function, i.e. f(Mentality of the Place x Governance Systems x RDI Systems x Business Systems x Social Systems x Urban Systems)

FINLAND – THE GLOBAL INNOVATION ACCELERATOR

1st in Europe 2020 Competitiveness Index

The most innovative and highly educated country in the world
(The World Economic Forum, Global Competitiveness Report 2014–2015)

The most digital startups per capita in the world

The world's greenest country
(2016 Environmental Performance Index)

The best primary education system in the world

All the Elements in This Finnish Model Are Fiercely Influenced by ICT:

The Finnish Road to Success

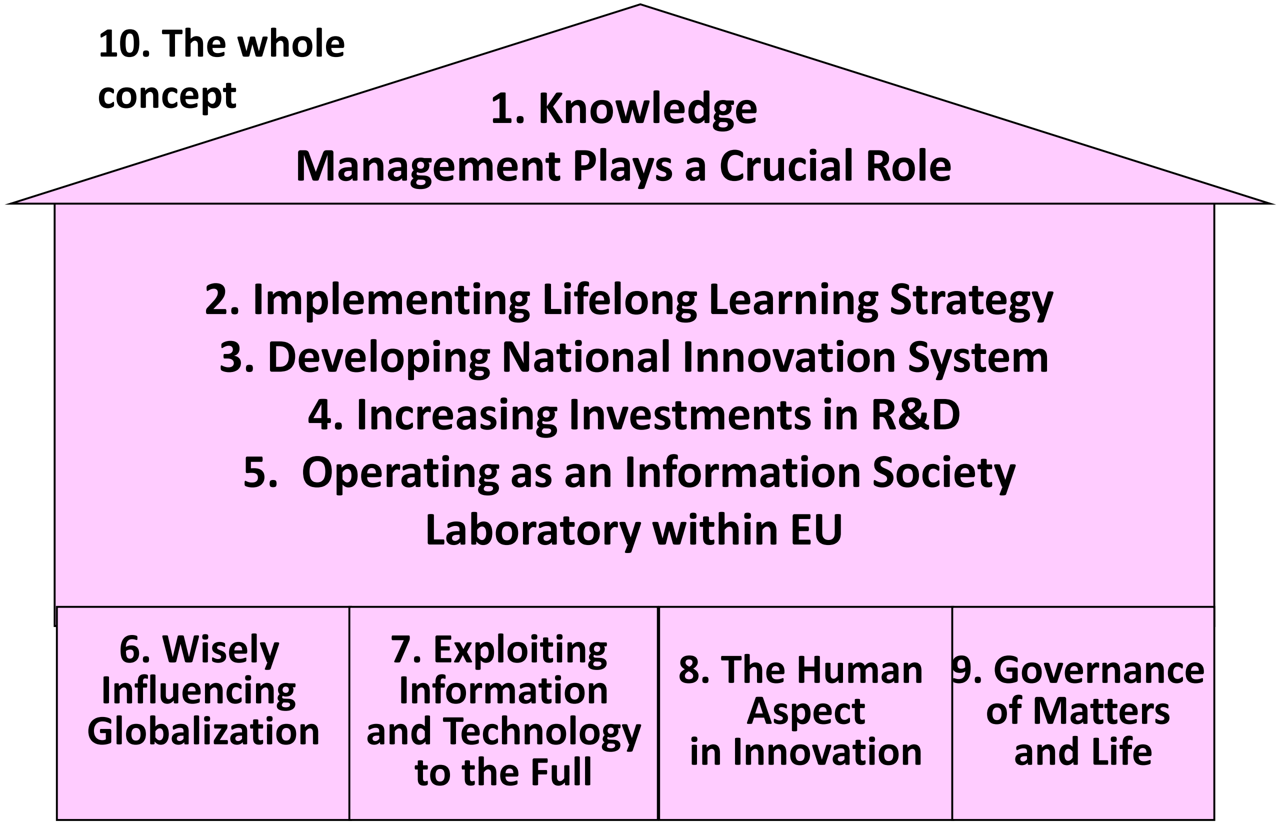


Figure: A SYSTEMATIC REVIEW OF THE FINNISH ROAD TO SUCCESS. The list on the right defines in brief the unique success factors of each element in this Finnish model.

The key drivers of change throughout the model:

1. Development and use of personal and organizational knowledge management toolbox.
2. e-Learning is implemented with special focus on the needs of changes in learning and working culture.
3. Linking innovations and productivity and stressing the importance of commercialization.
4. R&D and development of work processes are linked together.
5. The role of a forerunner means the effectiveness in developing concepts based on parallel processes. It means being an effective user of knowledge created globally.
6. Profitable "business" is more and more based on value network management, where different actors operate on mutual dependencies based on shared interests and trust.
7. Knowledge building and knowledge creation are based on what the others have already in use.
8. Not only technological innovations, but also social, cultural and administrative innovations.
9. Motivation and tools for personal and organizational competence development and better quality of life.
10. Managing this knowledge ecosystem through effective systems thinking.

World Bank Study 2014:
Case Finland / The Characteristics

- Strong social cohesion and homogeneity of the population
- Strong rule of law and good governance, very low corruption, and generally good trust in public institutions
- Small size and geographic and cultural remoteness
- Recovery from wars and dependence on a very large economy (the Russian Federation) as a primary export market
- A pervasive public sector, including a welfare state with universal health care and education as well as a broad research, development, and innovation (RDI) policy, supported by relatively heavy taxation and driven by social cohesion and trust in government institutions
- Broad organization of labor and historically very strong role of labor unions in politics
- Strong orientation to seeking a broad consensus on (political) decisions, driven by social cohesion
- Significant role of the ICT sector, particularly from the 1990s onward
- Strong orientation toward globalization, especially after joining the European Union in 1995.

World Bank Study 2014:
The Big Lessons Case Finland

When looking at the Finnish economic transition in the long run, and particularly the latest knowledge economy developments, several overarching messages can be drawn. The following are the most important for policy planning and governance:

- Finland has invested substantial time and funds in building its education system, which is the base of its knowledge economy. This is particularly relevant for developing countries.
- Determined policies and strategies for building a knowledge economy are important. Particular to Finland has been its systematic use of consensus mechanisms across all stakeholders in preparing and implementing these policies.
- Looking ahead (forward planning, impact assessment) and adjusting policies, governance, and instruments accordingly—even if sometimes during a crisis— are integral to societal evolution and economic growth. In this regard, policies and governance models should be flexible and enable cross-fertilization and horizontal collaboration.
- Finnish knowledge economy strategies have smartly aligned with and leveraged large corporations. Among the sectors, ICT has played an important role in Finnish development.
- The government has played an active role in the knowledge economy—as a coordinator and facilitator—while giving significant independence to the implementing agencies and regional or provincial organizations to allow for the efficient delivery of these strategies.

European Commission

A Successful Place-Based Innovation Ecosystem

Espoo Innovation Garden & Aalto University

- Concentration of highly skilled human capital and high quality focused research
- Vision, political commitment and collaborative culture of Helsinki Regional Council and Espoo City
- Emergence of a strong orchestrating actor: Aalto University, with its local culture of innovation
- Focus on the potential and capability of people
- Policy support from national government
- Successful involvement of start-up culture: SLUSH.ORG

JRC has made this "Place-Based Innovation Ecosystems" study focusing on the EIG experience. This is the 1st of this kind as a model for the others.

http://s3platform.jrc.ec.europa.eu/

Joint Research Centre

JRC publication EUR 28545

Key Questions on Place-Based Innovation Ecosystems

Targets cannot be reached by traditional urban planning. There are several knowledge and competence specific questions with respect to the place-based innovation ecosystems:

- How to increase human capital, especially among the highly skilled professionals, and what concepts to use in applying the principles of lifelong learning in the ecosystem reality?
- How to develop the shared vision, political commitment and collaborative culture of the city and what frame does the region provide to this?
- What are the main drivers with their unique features within the university community, especially all-permeating culture of innovation and entrepreneurship?
- What is the relevance of urban planning and urban development in creating the potential for entrepreneurial mindset to be even felt when visiting in the area?
- How to increase collaboration in using the potential for profitable financial risk-taking and how to utilize also the EU regional development and investment financing sources and European research cooperation?
- How to involve more young people and entrepreneurs and make their roles more visible?
- How to orchestrate different activities and different people in achieving the innovation ecosystem targets?

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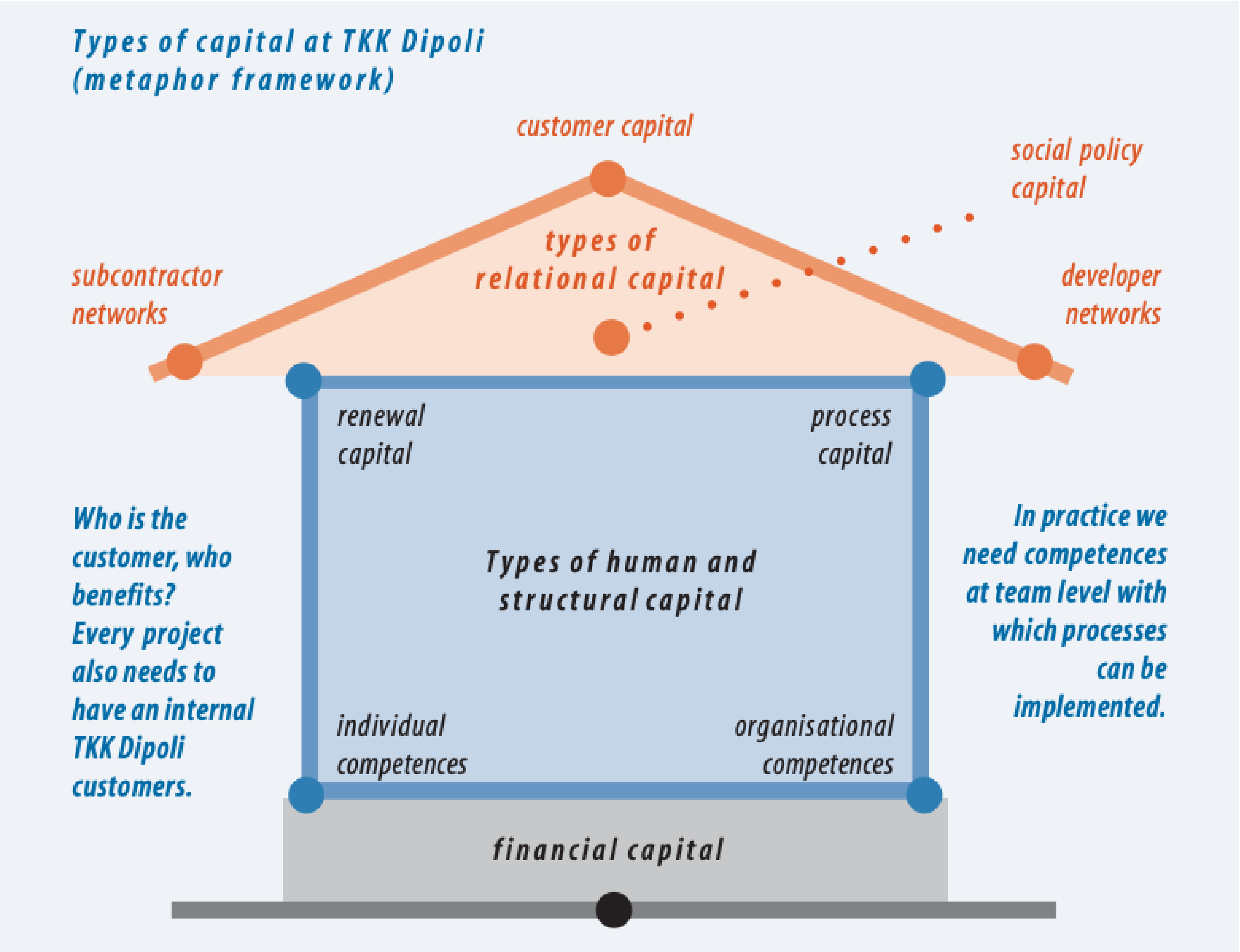
The Types of Capital in a Work Community – Metaphor of a House

All organisations contain intangible resources that belong to these three main groups:

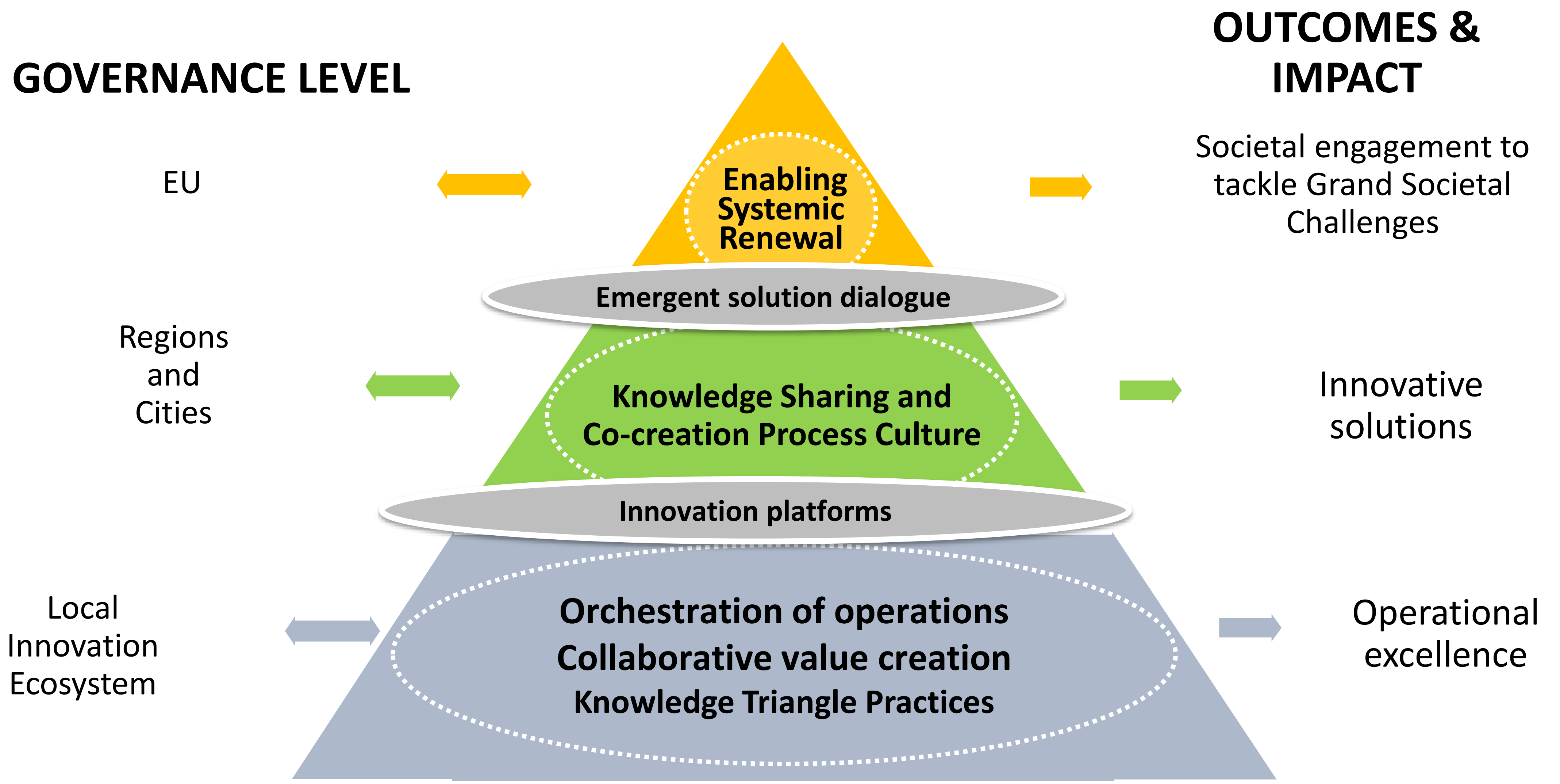
■ Competence, personal qualities, attitude and training, pertaining to the employees and managers of an organisation, are all part of human capital. Human capital belongs to single individuals, so an organisation cannot wholly control or manage it.

■ Structural capital comprises that which belongs to the organisation, such as values and culture, work atmosphere, documented knowledge and immaterial rights. They often remain in the organisation, even if individual employees leave.

■ Relational capital is made up of various intangibles pertaining to interest groups outside of the organisation, such as relations with subcontractors, clients and partners, image and brands.



Source: Markku Markkula, TKK Dipoli.



Based on the article M. Markkula, Knowledge Triangle book 2013

Summary
based on the
CoR 2015-2017 key
messages and proposals:

Developing Attractive Innovation Environments

Digitalisation drives change, and convergence towards digital services is speeding up:

- The best laboratories for breakthrough innovations today are no longer traditional university facilities, but **regional innovation ecosystems operating as testbeds** for rapid prototyping of many types of user-driven innovations, based on transformative and scalable systems.
- Innovation communities operate **as ecosystems through systemic value networking** in a world without borders.
- Innovation processes are strongly based on demand and user orientation and **customers as crucial players in innovations.**
- Innovation strategies focus on **catalysing open innovation** and encouraging individuals and communities towards an **entrepreneurial mindset** and effective use and creation of new digitalised services.
- Innovation is often based on **experimenting and implementing demonstration projects** by partnerships, using the best international knowledge and creating new innovative concepts.

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UPS AND DOWNS OF STI INDICATORS IN ISLAMIC COUNTRIES

ADNAN BADRAN FIAS
Former Prime Minister of Jordan
Chairman of the Board of Trustees/
University of Jordan
The Chancellor/ University of Petra
Amman, Jordan

ABSTRACT

Investing in research and related higher education is a priority for building a knowledge-based economy based on human capital. Knowledge is gained from basic research to stimulate innovations, and the introduction of new technologies in industry and agriculture and develop new goods and services to overcome unemployment and poverty. Problem-oriented research by universities and research centers would lead to the creation of startups that are closely related to development of wealth, and increased domestic production, and income per capita.

Indicators show that UAE and Malaysia lead the Islamic countries in the Global Competitiveness Index (2019). In addition, indicators show that investment in research is mostly made by governments in the Arab region compared to OECD countries where investment in scientific research is made mostly by the private sector. United States continues to lead the world in investing in science and scientific research by investing 2.8% of GDP - $ 465 billion a year in fields of scientific research and technological development, and 50% of Nobel laureates in science and medicine are United States scientists.

Malaysia leads the Islamic countries of investment in research (1.44% of GDP), followed by UAE, Turkey, Jordan, Egypt and Tunisia, while UAE ranks first in the number of researchers (FTEs per million people), followed by Malaysia, Tunisia, Turkey, Morocco, Egypt, Jordan, Kuwait, Pakistan, Oman, and Indonesia. (2016-2017).

As for the number of scientific papers reviewed by counterparts, China leads the world, followed by Unites States, India, Germany and the United Kingdom, while in the Islamic world, Iran ranks first, followed by Turkey, Malaysia, Egypt, Saudi Arabia, Pakistan, Indonesia and Tunisia (2017). Turkey tops the density of

indexed publications (Scopus in the Middle East), followed by Iran, Egypt, Saudi Arabia, Tunisia, Morocco, United Arab Emirates and Jordan.

As an indicator of technology in terms of percentage of total exports, Malaysia leads the export of high technology in the Islamic region, followed by United Arab Emirates, Indonesia, Tunisia and Kuwait. In patents, China, United States, and Japan top the world in filed patents (2018), while, Iran, Turkey and Indonesia lead the Islamic world in filed patents followed by Malaysia, Saudi Arabia and Egypt. As for patent applications for every $ 100 billion of GDP, South Korea leads the world, followed by China, Japan, and German y as pioneers of global science (2018).

Introduction:

The Arab region is facing a widespread collapse, and the Arab hope now is to preserve what the Arab countries achieved in United Nations Development Goals (MDGs) by the end of 2015, and it is hoped that Arab countries will achieve the United Nations Sustainable Development Goals (SDGs) by 2030. Unfortunately, due to internal wars Arab societies are disintegrated in religious and ethnic strife, and some Arab countries were classified internationally failed states for failing to achieve security, stability and prosperity for their people.

The question is how to get out of this mess. The answer is to go to the basics of renaissance and enlightenment, "education", and start international reforms to get out of the darkness to enlightenment, starting from early childhood, through primary, secondary, and higher education.

I. GDP per capita of Islamic Countries as compared to the World [1]:

A comparison with per capita GDP of Islamic countries to other countries in the world (2018) clearly shows that Luxembourg leads the world of $116,639 per capita, followed by Switzerland $82,796 and Norway $81,697, then Ireland $78,806, Iceland $73,191 and Qatar $68,793 Singapore $64,581, United States of America $62,794, Germany $47,603, the United Arab Emirates $43,005, Japan $39,290, Kuwait $33,994 Bahrain $24,050 Saudi Arabia $23,339, Malaysia $11,373, Turkey $9,370, Iran 5,627, Jordan $4,241 Indonesia $3,893, Egypt 2,549, Bangladesh 1,698, Pakistan $1,482 and finally Yemen $944 per capita as shown in Figure 1.

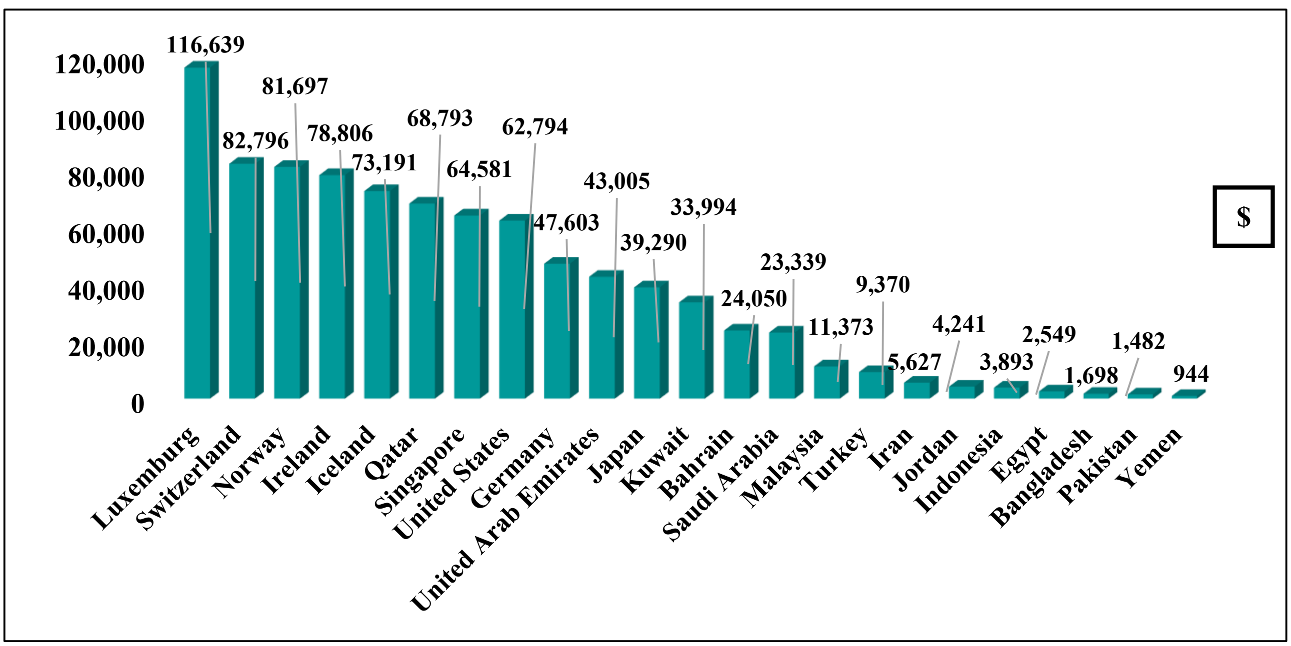


Figure (1): Comparing the per capita gross domestic product of Islamic countries with other countries in the world. [2] **World Bank 2018.**

II. Global Competitiveness of Islamic Countries as compared to the World:

The natural ranking of global competitiveness (2019) clearly shows that Singapore leads the world index of 84.8, followed by the United States index of 83.7 and the Netherlands index of 82.4, then Switzerland of 82.3, Sweden of 81.2, the United Kingdom and Germany of 81.2, Finland of 80.2, Canada of 79.6, United Arab Emirates of 75, Malaysia of 74.6, Qatar of 72.9, Saudi Arabia of 70, Bahrain of 65.4, Kuwait of 65.1, Indonesia of 64.6, Oman of 63.6, Turkey of 62.1, Jordan of 60.9, Morocco of 60, Tunisia of 56.4, Algeria of 56.3, Lebanon of 56.3, Egypt of 56.5, of Iran 53, Bangladesh 52.1, Pakistan of 51.3, and Yemen of 35.5. As shown in figure 2 there is no doubt that the quality of education plays a major factor in the growth of research, technology and innovation leading to competiveness. [2]

Looking at the Islamic region, the UAE tops the index of 75.0, of the Islamic countries followed by Malaysia of 74.6, Qatar index of 72.9 and then Saudi Arabia index of 70.0 as shown in figure 2.

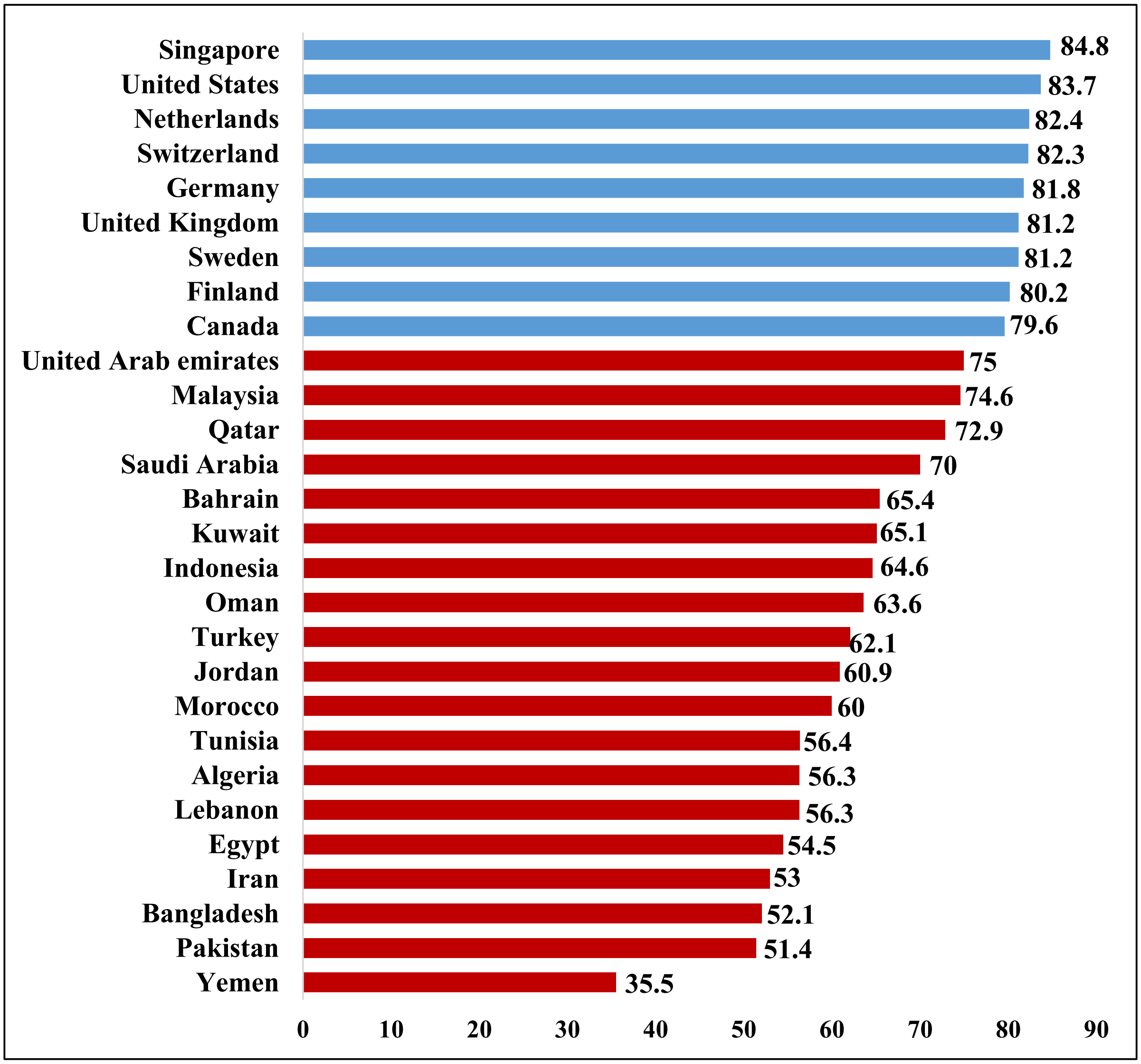


Figure (2): Global Competitiveness Index 2019 in the ranking of countries of the world-The Global Competitiveness Report 2019 (weforum.com)

III. Who is Who Conducting Scientific Research [3]:

Universities constitute the leaders of research and development all over the world, where its share was 56% of the amount of global scientific research. Table 1 shows that basic research is mostly carried out by academia in universities with 29% and scientific research centers with 9%, while applied research constituting 25% is conducted in universities, and 8% in scientific research centers. Basic research that is neglected by others who are looking for rapid return of research for marketing is carried out by academia. The scientific research institutes and centers carry out 19% of global research, 9% of which is basic, and 8% is applied as shown in (Table 1).

	Basic Research	Applied research	Development	Consulting & other	Total
Academia/University	29%	25%	1%	1%	56%
Research Institute	9%	8%	1%	1%	19%
Government	1%	3%	0%	0%	4%
Domestic Corp.	0%	2%	2%	2%	6%
Multinational Corp.	1%	7%	3%	1%	12%
Other Organizations	1%	2%	0%	0%	3%
Total	41%	47%	7%	5%	100%

Table (1): who is who of conducting scientific research internationally- (Battelle/R&D Magazine 2014)

Government research on the world stage represents 4% of all scientific research, of which only 1% is for basic research, and 3% for applied research.

Local companies do not spend on basic research. In general, companies direct their funding toward applied research and development as a short-term goal, and are not concerned with basic long-term research. This task is left to academia in universities, and research centers and institutes.

But when we look at the expenditure on research and development (R&D) in the Arab region, we find that research is mostly done through funding from governments sector (70%) as compared to the countries of the Organization for Economic Cooperation and Development (OECD), (Figure 3) where the private sector undertakes 70% of (R&D). Therefore, we find that the outputs of (R&D) in developed countries are directed towards industrialization and marketing, especially with regard to patents, while Arab countries lack the participation of the private sector in (R&D), and government research outputs also lack incentives for marketing. Government funding for (R&D) is subject to a reduction and instability as a result of any emergency deficit in the government treasury [4].

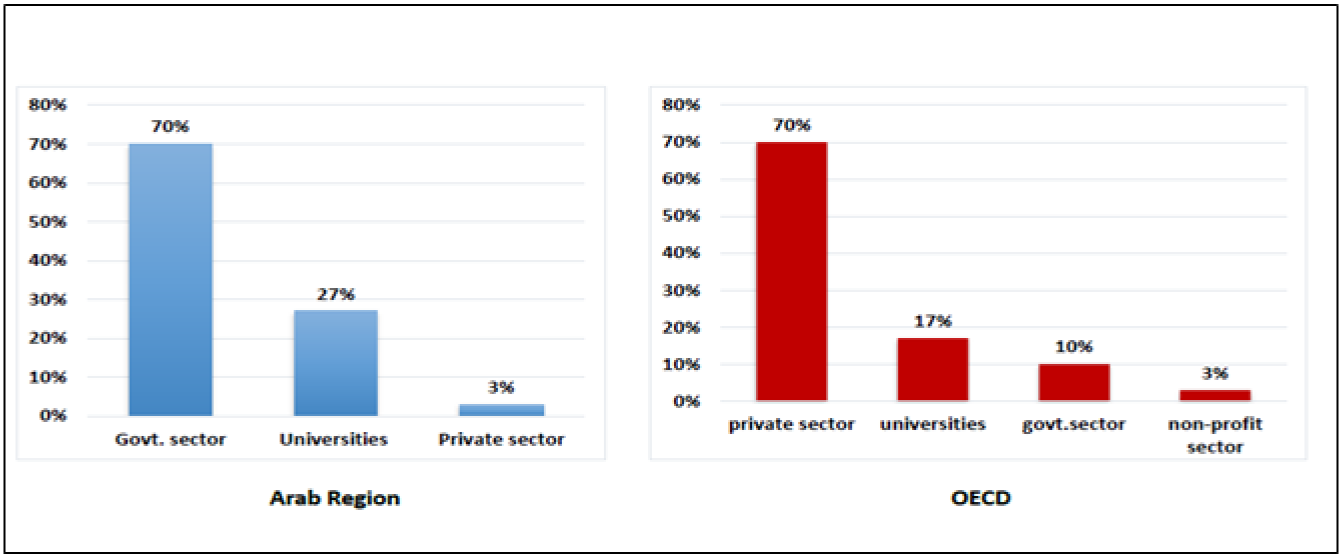


Figure (3): Distribution of investment in scientific research between the government as a public sector and companies as a private sector in the Arab region compared to the industrialized countries. (Badran 2018)

IV. Global Expenditure on Research and Development (R&D):

Major industry and companies are setting up their own R&D laboratories to conduct research on their own. They hire scientists to do target-oriented R&D to acquire new materials or to create marketing technology, especially in the field of internet, computing, software technology, electronics, pharmaceuticals, and automotive industries.

Global spending on R&D by industry is shifting towards a knowledge economy such as computing, software, internet, artificial intelligence healthcare and education, where quality education for building human capital is vital for driving sustainable research and innovation.

Share of Total Global R&D Spending	
United States	25.25%
China	21.68%
Japan	8.52%
Germany	5.32%
South Korea	4.03%
India	3.80%
Russia	2.80%
Middle East	2.51%
Africa	0.92%

Table (2): Indicators of spending on research and development- Battelle/R&D Magazine 2018

Total investment in R&D expenditure has maintained a great momentum worldwide ass shown in (Table 2). United States remains the largest research and development investor in the world, having spent $ 465 billion on scientific research (2014).

Thus, America forms the pinnacle of competitive research intensity, as 2.8% of its GDP is spent on scientific research annually. It ranks first in investment in scientific research, followed by China which rank second, and Japan which rank third in the world (2018) [5].

V. Expenditure on Research and Development (R&D) in the Islamic Countries as compared to the World:

Indicators indicate that the Islamic world has failed to achieve 1% of GDP spending on research and development as expected at the United Nations Conference in Vienna in 1979. Malaysia ranks first with a rate of 1.44%, Turkey and United Arab Emirates with a rate of 0.96% of its gross domestic product on R&D as shown in Figure 4, then, Jordan 0.72%, Egypt 0.61%, followed by Tunisia 0.6%, Algeria 0.53%, Indonesia 0.24, Pakistan 0.24%, Oman 0.22%, Kuwait 0.08%, and Iraq 0.04%; while looking at other countries of the world, Japan ranks first in the world in spending on R&D 3.2% as a percentage of its GDP in 2017, followed by Germany 3.04%, United States of America 2.8%, Finland 2.76%, France 2.19% Iceland 2.18%, China 2.13%, United Kingdom 1.67%, (Figure 4). Spending on R&D is crucial to maintaining market leadership and ensuring national security. Countries that increase their investments in scientific research are developing a better and healthier world for humanity. Of course, it is stimulated by free trade and competition on the global market. However, any short-term imposition of a national tax or customs to detail trade by politicians is a short-term view that will lead to a humanitarian catastrophe and disrupt the lives of people on this planet. Therefore, in order to improve the quality of life on our planet, protectionism must be reduced to drive progress and scientific research to reach better diversified expensive goods and new technology that allows people to have a better life with sustainable environment [6].

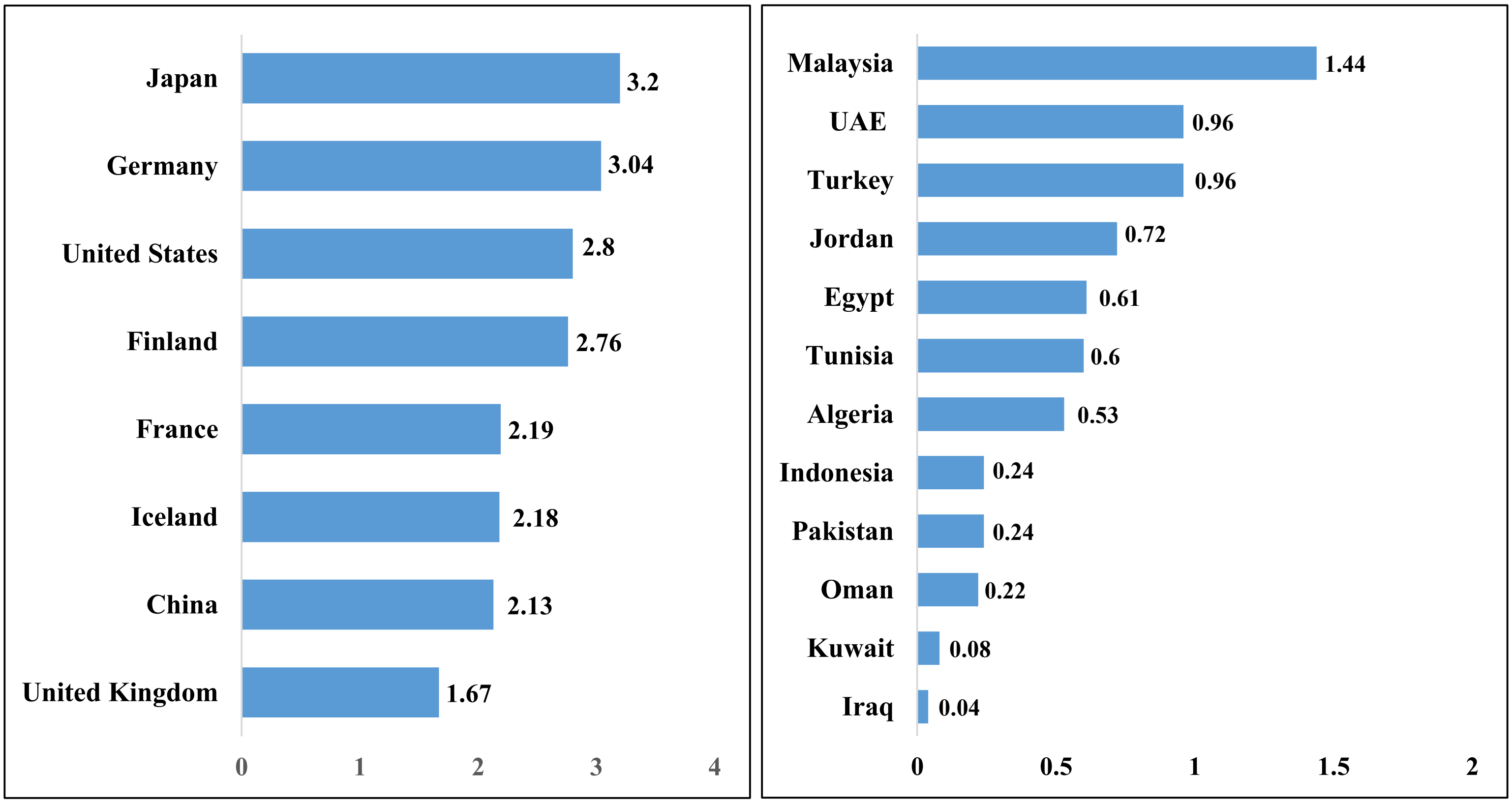


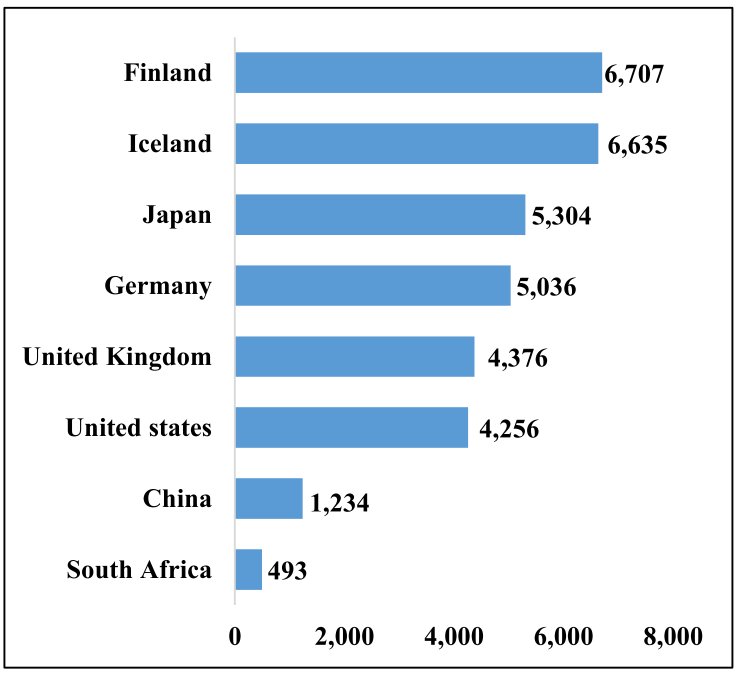
Figure (4): R&D expenditures in Islamic countries as compared to other countries in the world (as a percentage of GDP) 2016-2017. (Knoema.com)

VI. Researchers of R&D per Million People in Islamic Countries as compared to the World:

Professional researchers participate in creating knowledge, new technologies and innovations which will lead to new products and processes.

Figure 5 shows that Finland leads in the number of researchers of 6,707 (FTEs) per million people (2017), followed by Iceland 6,635, Japan 5,304, Germany 5,036, United Kingdom 4,376, USA 4,256, China 1,234, and South Africa 493 researchers.

When we analyze number of researchers in the Islamic countries (FTEs) per million people (2017), we find that United Arab Emirates is leading of 2,406 researchers, followed by Malaysia 2,357, Tunisia 1,964, Turkey 1,385, Morocco 1,068, Egypt 669, Jordan 601, Kuwait 491, Pakistan 354, Oman 243, and Indonesia 215 researchers [7].



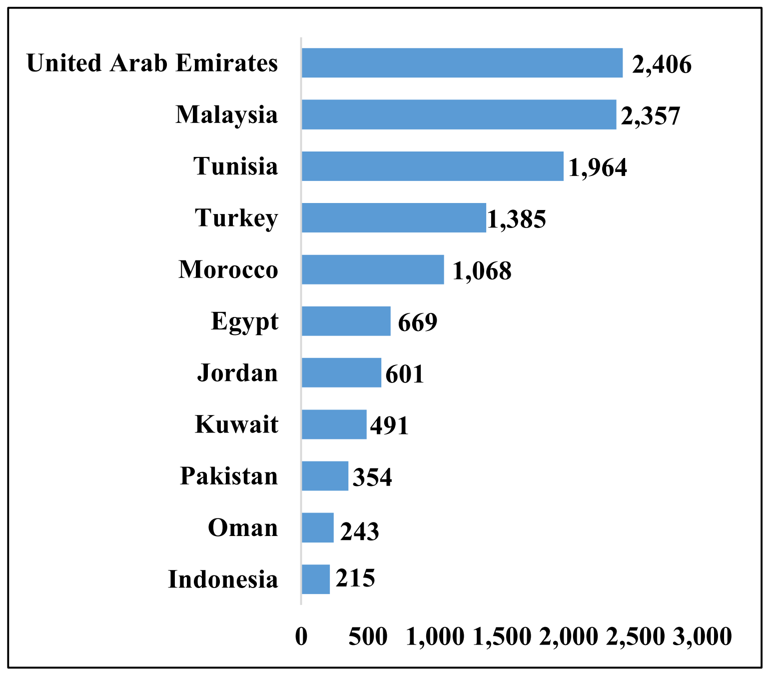


Figure (5): Number of researchers (FTEs) per million people in Islamic countries compared to the world, 2016-2017. (indexmundi.com)

VII. Published Scientific and Technical Journal Articles:

Another indicator of STI is the number of research papers published in peer-reviewed journals, particularly in the fields of physics, biology, chemistry, mathematics, medicine, engineering and technology, earth and space sciences. Scientific articles are good indicators for research outcome.

In absolute numbers China leads the world in publishing number of articles of 426,165 peer-reviewed scientific papers (2017), followed by U.S.A of 408,985, India 110,319, Germany 103,121, the United Kingdom 97,526, Japan 96,536, France 69,430, Australia 51,068, Southern Africa 11,881, Singapore 11,253, Finland 10,545, and Iceland 651 research articles as shown in Figure 6.

In the Islamic world, Iran leads in the number of published articles of 40,974, followed by Turkey 33,902, Malaysia 20,331, Egypt 10,807, Saudi Arabia 9,231, Pakistan 9,180, Tunisia 5,265, Indonesia 7,728, Algeria 4,447, Morocco 4,062, Bangladesh 2,546, United Arab Emirates 2,180, Jordan 1,651, Lebanon 1,397, Qatar 1,310, Iraq 1,227, Oman 795, Kuwait 738, Libya 438, Sudan 368, Syria 273, Bahrain 210, and Yemen 111 research papers [8] (Figure 6).

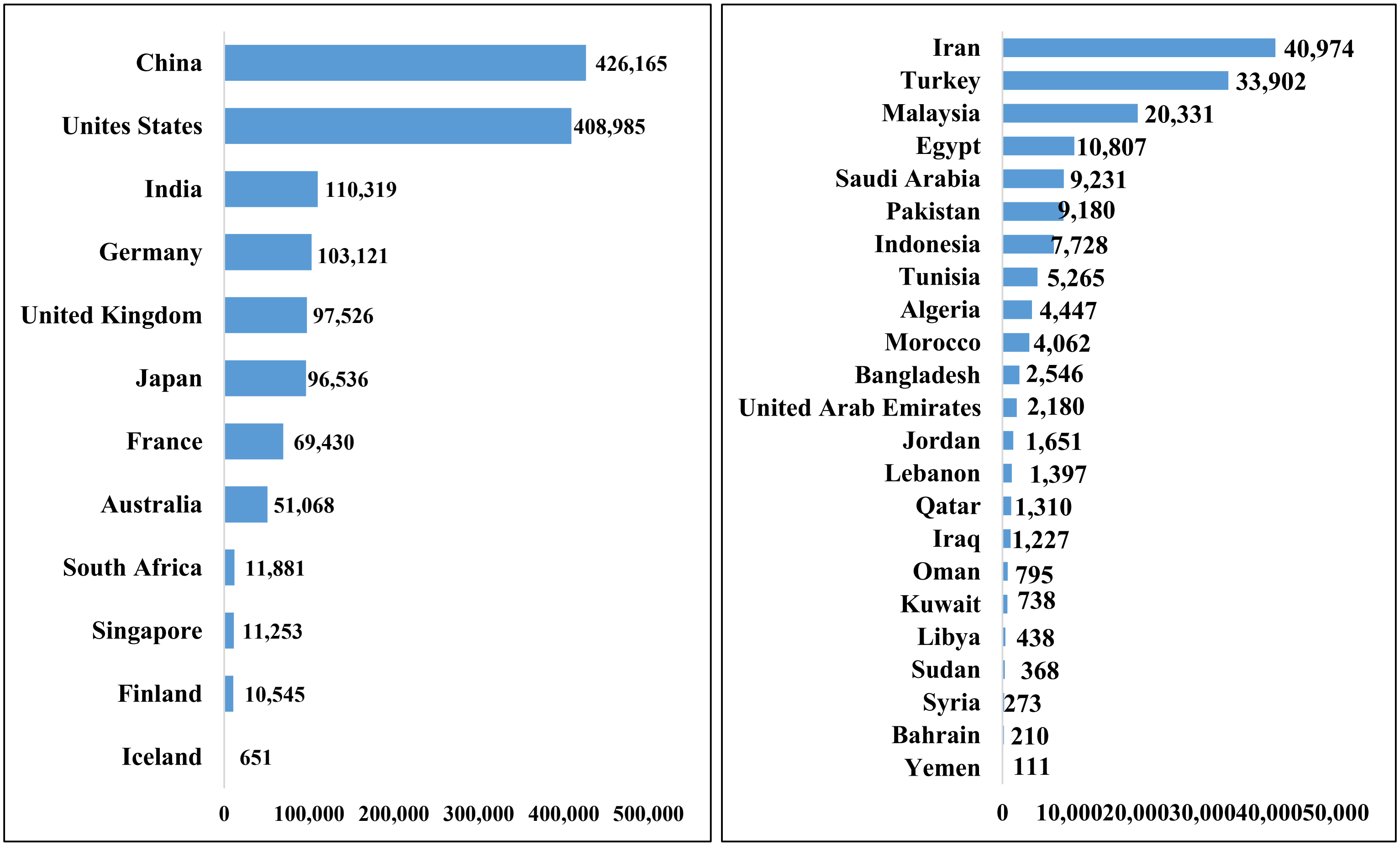


Figure (6): The absolute number of published research papers of Islamic countries as compared to the world, 2016-2017. (Knoema.com)

VIII. Density of Indexed Publications and Quotations of the Islamic World:

Indexed publications accumulated for the years 1996-2016 is led by Turkey of 453,566 articles, followed by Iran 377,098, Egypt 152,954, Saudi Arabia 127,612, Tunisia 64,445, Algeria 48,608, Morocco 44,578, United Arab Emirates 34,927, Jordan 30,556, Lebanon 30,927, Kuwait 19,366, Qatar 16,313, Iraq 14,098, Oman 13,733, and others [9] as shown in Figure 7.

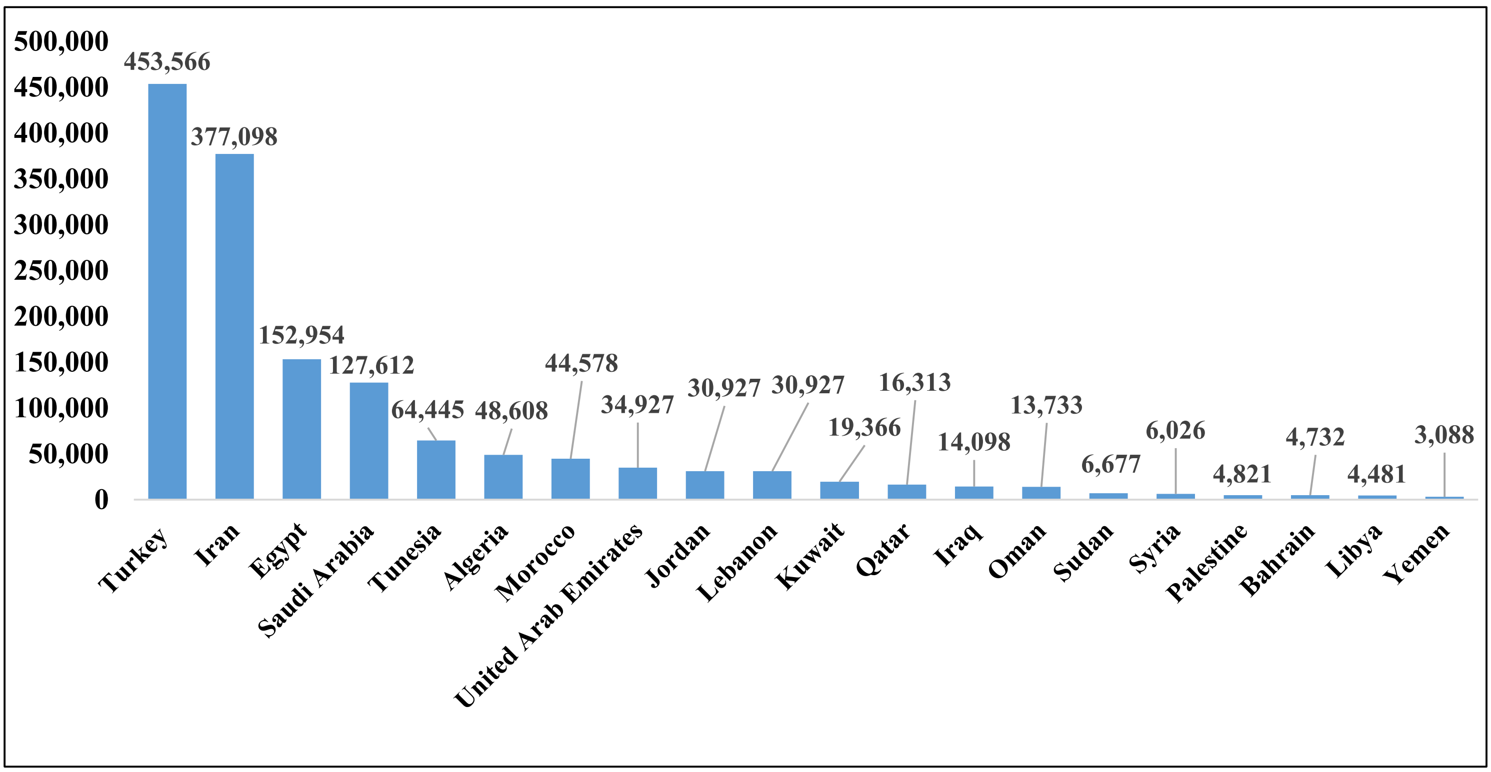


Figure (7): The accumulated research density of Islamic countries in the Middle East during the years (1996-2016). (SJR 2016)

The H-index for the Islamic countries [10] Turkey is ranked first 795.13, followed by Pakistan 390.93, Malaysia 296.76, Indonesia 272.38, Tunisia 210.06 Iran 109.88, Bangladesh 105.74, United Arab Emirates 78.28 and others as shown in Figure 8.

The H-index of the world, with United Kingdom leading of 3566.75, after United States, followed by France 3462.96, Germany 3308.42, Canada 1543.08, Australia 1435.19, Russia 1315.05 and others [10] as shown in Figure 8. United States has been reported in separate states of a total of 10,677.72 for all states.

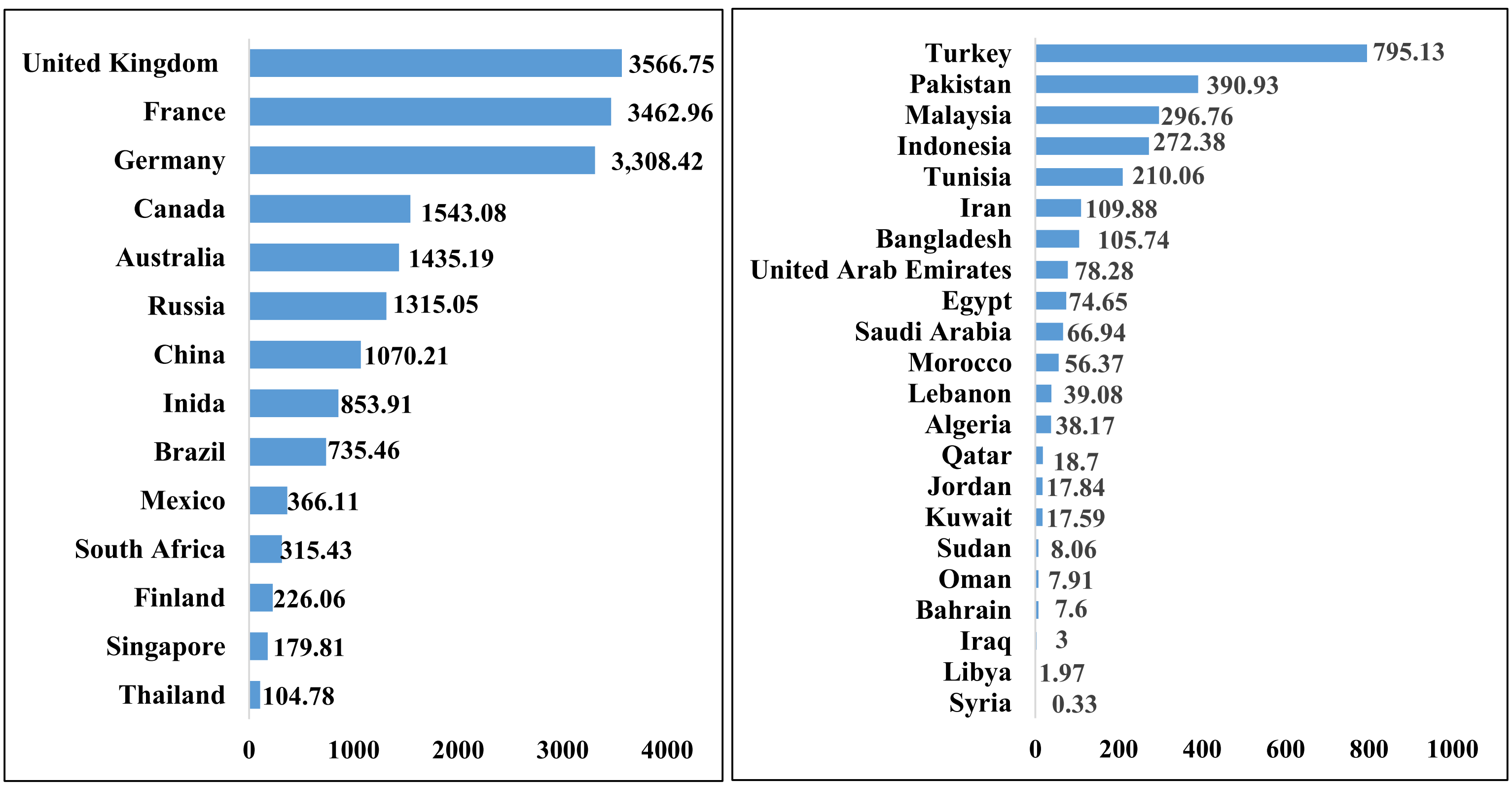


Figure (8): H-index for Islamic countries as compared to the world. (Hirsch-Impact, 2019) https://ideas.repec.org/top/top.country.hindex.html

IX. Who Leads What in World Productivity:

- United States ranks first in agriculture and food production, commercial and military space, nano-advanced materials, healthcare and life sciences, information and communications, tools and electronics.
- United States ranks second in energy technology, environment and sustainability, and third in automobiles.
- Germany ranks first in cars, power generation and efficiency, and environmental sustainability. It ranks second in advanced nanomaterials, and ranks third in airspace, health care and life sciences, tools and electronics and ranks fourth in information and communications.
- Japan ranks second in automobiles, information and communications, tools and electronics, while it ranks third in nanostructured materials, environment and sustainability, it ranks fourth in healthcare and life sciences, energy technology, and ranks fifth in commercial space.
- China ranks second in agriculture and food production, and third in military aviation, energy technology, information and communications, ranks fourth in commercial aviation, automobiles, nano-advanced materials, electronics and ranks 5th in health care and life sciences.
- UK ranks second in healthcare and life sciences, and ranks 5th in military aviation, nano-advanced materials, environment and sustainability, tools and electronics.

X. High-Tech Exports in Islamic Countries as compared to other Countries in the World:

Malaysia leads the Islamic world in hi-technology exports ratio with 52.77% of its manufactured exports, followed by the United Arab Emirates 13.63%, Indonesia 8.02%, Tunisia 7.39%, Kuwait 4.12%, Morocco 3.84%, Lebanon 2.35%, Turkey 2.33%, Pakistan 2.2%, Jordan 1.81% and others as shown in Figure 9.

Singapore leads the world of the ratio of high-tech exports which account for 51.72% of its manufactured exports, followed by France 25.92%, Iceland 23.47%, United Kingdom 22.59%, United States 18.9%, Japan 17.27%, Australia 16.71%, and others [11] as well shown in Figure 9.

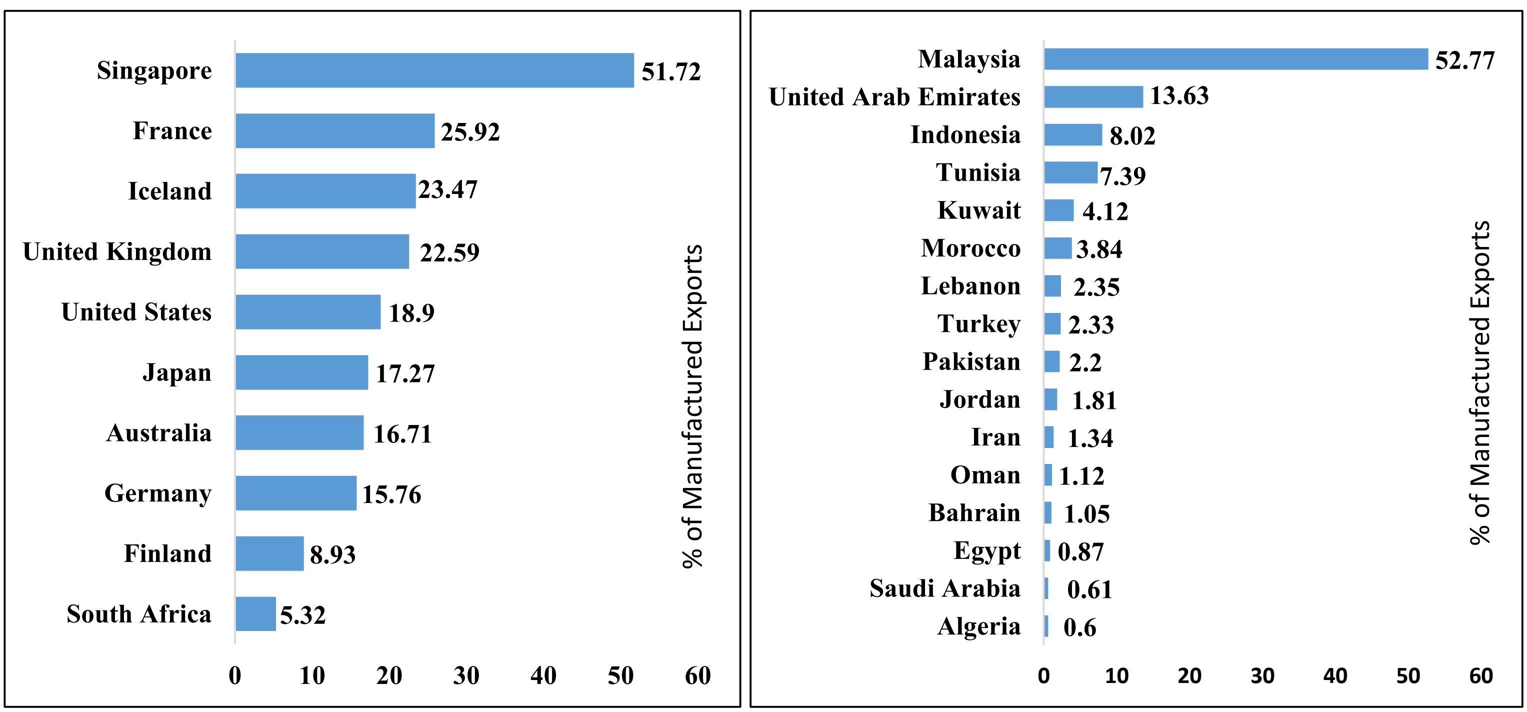


Figure (9): The ratio of high technology in total exports of Islamic countries as compared to the world, (2017-2018). (theglobaleconomy.com)

XI. Patents in Islamic Countries as compared to the World:

Patents are considered good indicators of technology transfer and innovation. It is provided through worldwide patent applications of a national patent office of executive rights of the invention by the owner for a limited time, generally 20 years.

The Arab world is weak in its invention and patent registration. This is an indication of weak technology transfer of the application of knowledge and research findings to innovations. There is a gap or divorce between academia and industry in the Arab region, where both do not talk to each other. Figure 10 shows patents submitted by **residents** in Islamic countries [12] as compared to the world (2018).

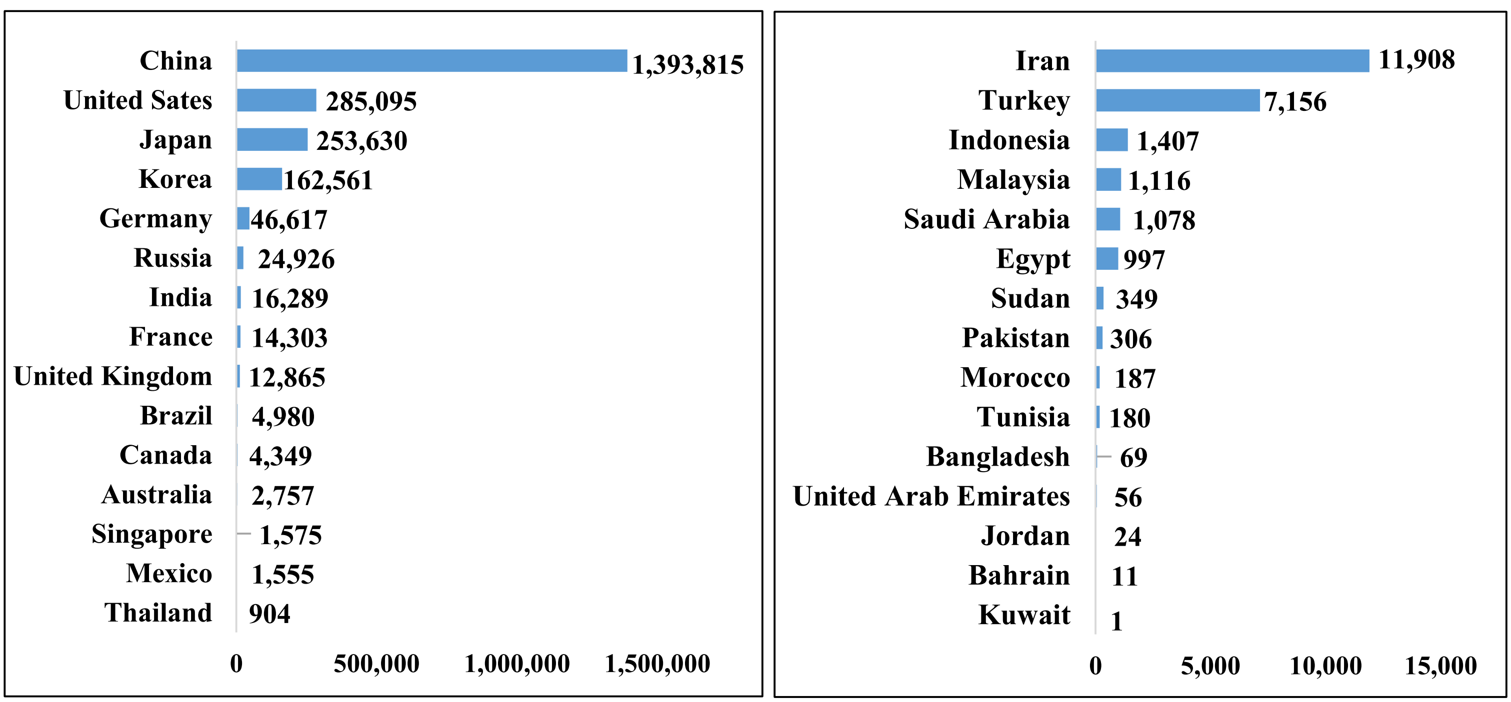


Figure 10: Patents of residents in Islamic countries as compared to the world 2018 (Indexmundi.com)

As shown in Figure 10, Iran ranks first of 11,908 filed patents, followed by Turkey 7,156, Indonesia 1,407, Malaysia 1,116, Saudi Arabia 1,078, Egypt 997, Sudan 349, Pakistan 306, Morocco 187, Tunisia 180, Bangladesh 69, UAE 56, Jordan 24, Bahrain 11, Kuwait 1.

Comparing the Islamic world with other countries in the world, Figure 10 shows that China tops the number of applications of **filed residents** in the world with 1,393,815 patents, followed by United States 285,095, Japan 253,630, Korea 162,561, Germany 46,617, Russia 24,926, India 16,289, France 14,303, United Kingdom 12,865, Brazil 4,980, Canada 4,349, and others [13] as shown in the same figure.

While for **non-resident applications** submitted in Islamic countries, Figure 11 shows for non-residents patents, Indonesia comes first with 8,347 patents, followed by Malaysia 6,179, Morocco 2,350, Saudi Arabia 2,321, United Arab Emirates 1,727, Egypt 1,258, Iran 915, Pakistan 586, Turkey 310, Bangladesh 299 and others. United States tops the world with 312,046 patents, followed by China 148,187, Japan 59,937, Korea 47,431, India 33,766, Canada 31,812, Australia 27,200, Germany 21,281, Brazil 19,877, Mexico 14,869, Russia 13,031, and Singapore 10,270, and others [13], as shown in figure 11.

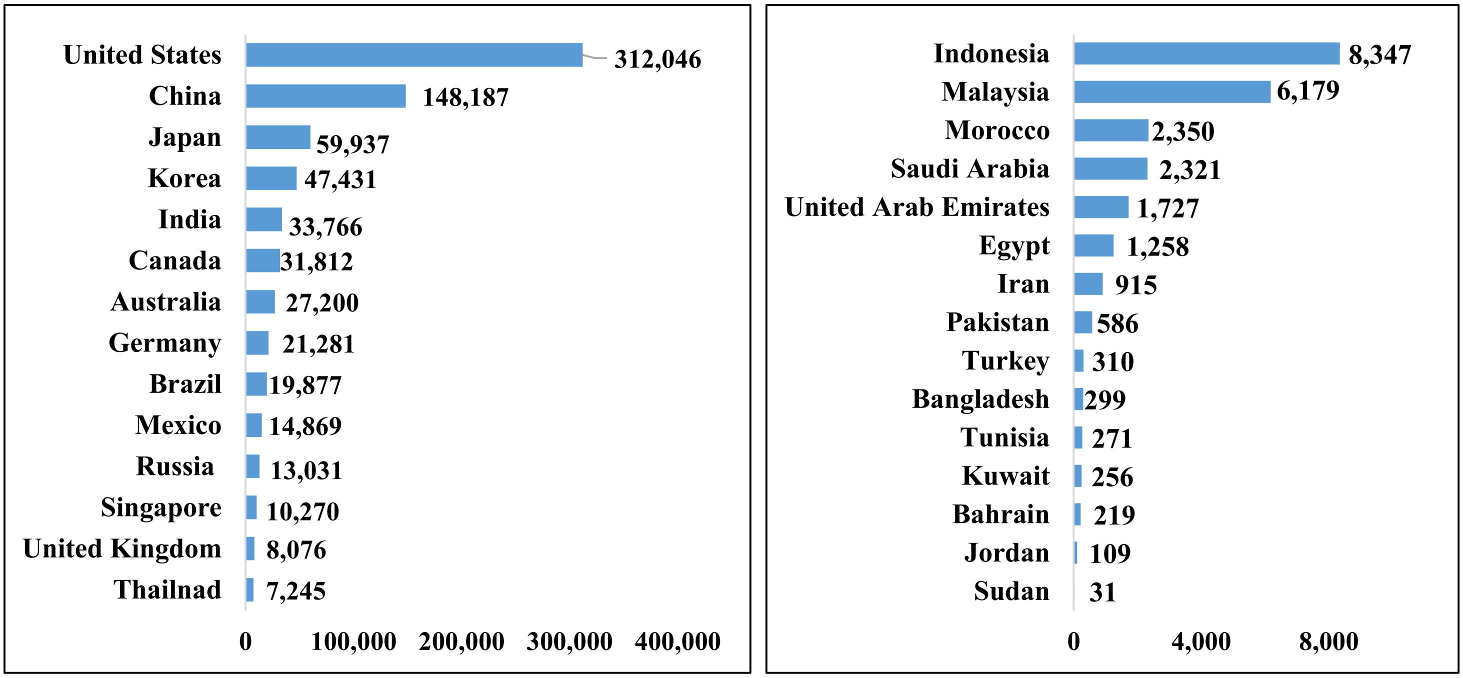


Figure (11): Patents for non-residents in Arab countries compared to the world 2017 (Knoema.com)

XII. The Widening Gap of Wealth between Rich and Poor:

Davos Economic Forum (2020), stated that Oxfam stressed that "the gap between the rich and the poor cannot be resolved without deliberate policies to combat inequality. Governments should ensure that companies and the rich pay their fair share of taxes. Traditionally, Oxfam stressed that "egregious inequalities are at the heart of social divisions and conflicts around the world. They are not inevitable (but) as a result of policies that reduce the participation of the richest in solidarity efforts through tax, had weakened public service financing." The report indicates that:

- 2153 people own wealth more than 4.6 billion people.

- The wealth of 1%, the richest in the world, represents more than twice the total wealth owned by 6.9 billion people least wealthy or 92% of the world's population.
- 42% of women in the world cannot get paid work compared only for 6% of men.

The organization considers that between the work of household cleaning, cooking, collecting firewood and fetching water in southern countries "the monetary value of unpaid care work performed by women from the age of 15 years represents no less than $10,800 billion annually, which is three times greater than the value of The digital sector globally.

In France, seven of the billionaires have more money than the poorest, who make up thirty percent of the population, while the 10 percent wealthiest among the French own half of the country's wealth, according to the organization [14].

Conclusion:

There is a growing gap in R&D, inventions and innovations between the Islamic world and the developed world, and there is growing gap between rich and poor in most countries of the world. Islamic countries need to increase investment in R&D in the field of science to reach a goal of one percent of their GDP by 2023. They need to build knowledge and transfer technology to develop self-reliance and create wealth to increase per capita income, and overcome poverty and unemployment, especially among the youth.

The Islamic world needs to develop the inquisitive minds of men and women through quality education to develop critical thinking, problem solving, logic, and empowering graduates to become creative thinkers, and leaders in the field of research. Islamic scientists need to communicate with industry to gain their trust and provide technological solutions in a competitive market. They also need to bridge with other scientists abroad and learn how to coexist with other cultures and other civilizations.

Capital investments in research and development alone cannot perform the task without a stimulating environment to unleash the minds of men and women to leap forward to new horizons of technologies and innovations.

To unleash the minds, we must provide a creative environment of freedom of expression and thought. Justice and equal opportunities for all, good governance and full participation of all segments of society to maximize the potential of everyone.

Governments cannot do everything, and the private sector should take its share of the initiative in carrying out this task, while governments should become regulators, with the issuing of appropriate incentive legislations, which promote the private sector to grow and employ the masses of unemployed to overcome poverty.

Arab countries have failed to use the income generated from their vast natural resources, especially oil, to build the human capital through quality education and investments in R&D for self-reliance in building technological goods and services. Instead, they have become good large consumes of others' technologies. It also failed to produce the entrepreneurs of innovation to transform the Arab society in knowledge economy from productive one for a better future.

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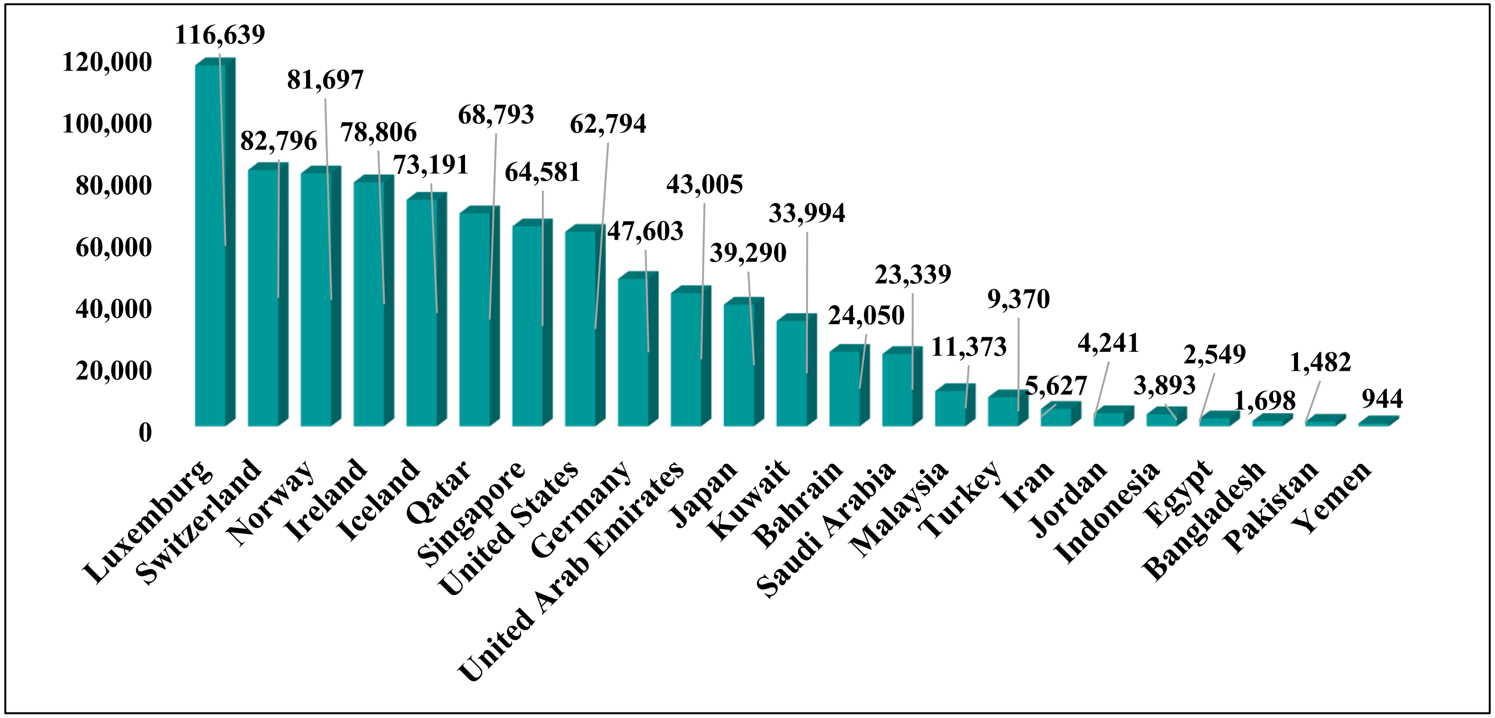
Ups and Downs of STI Indicators in Islamic Countries

Adnan Badran
University of Petra

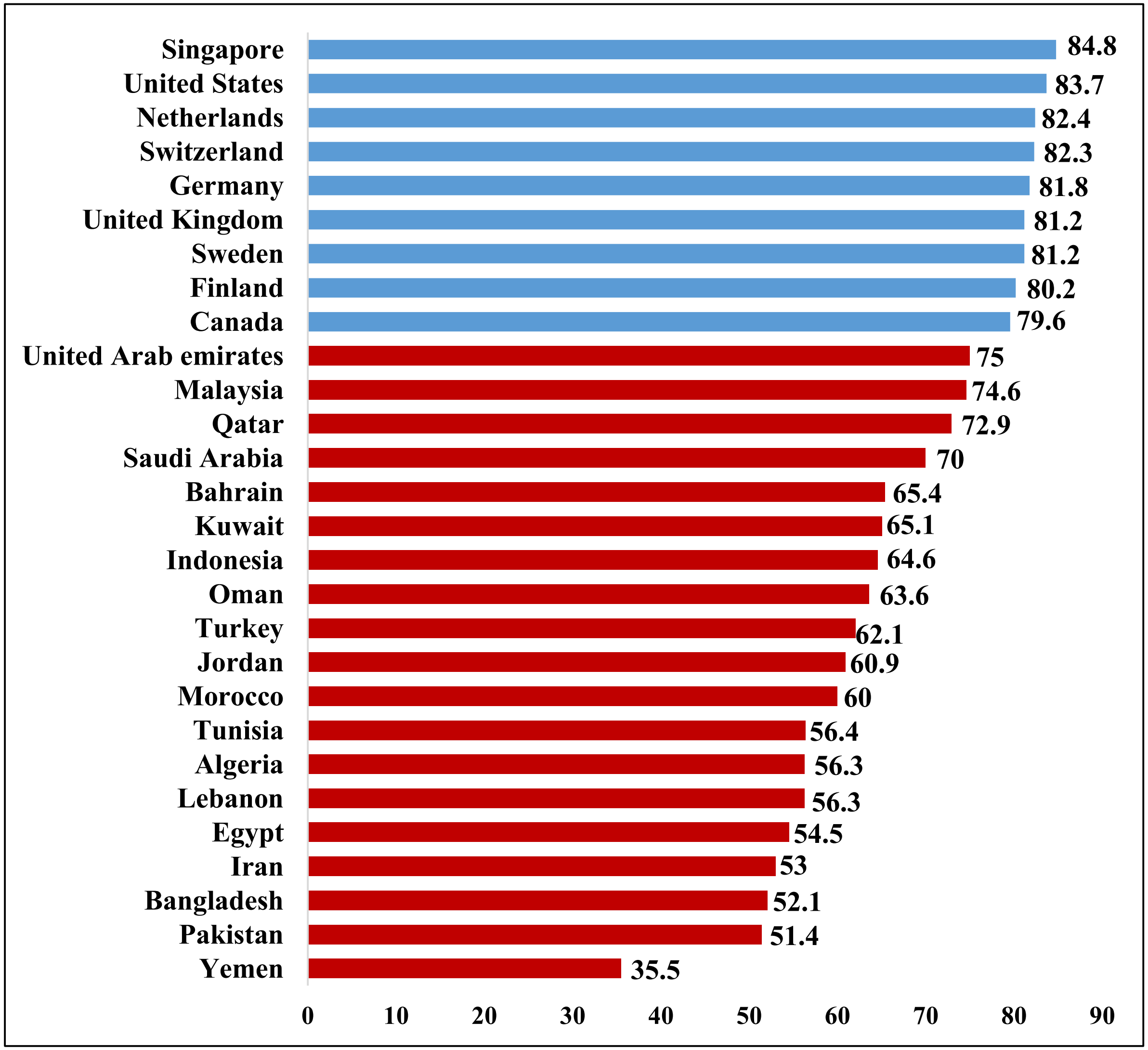
Paper presented at the 22nd Conference
of the
Islamic World Academy of Sciences (IAS)
on
Landscape of Science, Technology and Innovation in the Islamic Countries
15-16 April 2020
Amman-Jordan

I. GDP per capita of Islamic Countries as compared to the World (2018):



Comparing the per capita gross domestic product of Islamic countries with other countries in the world 2018. International Monetary Fund World Economic Outlook-2018, WORLD BANK.

II. Global Competitiveness of Islamic Countries as compared to the World (2019):



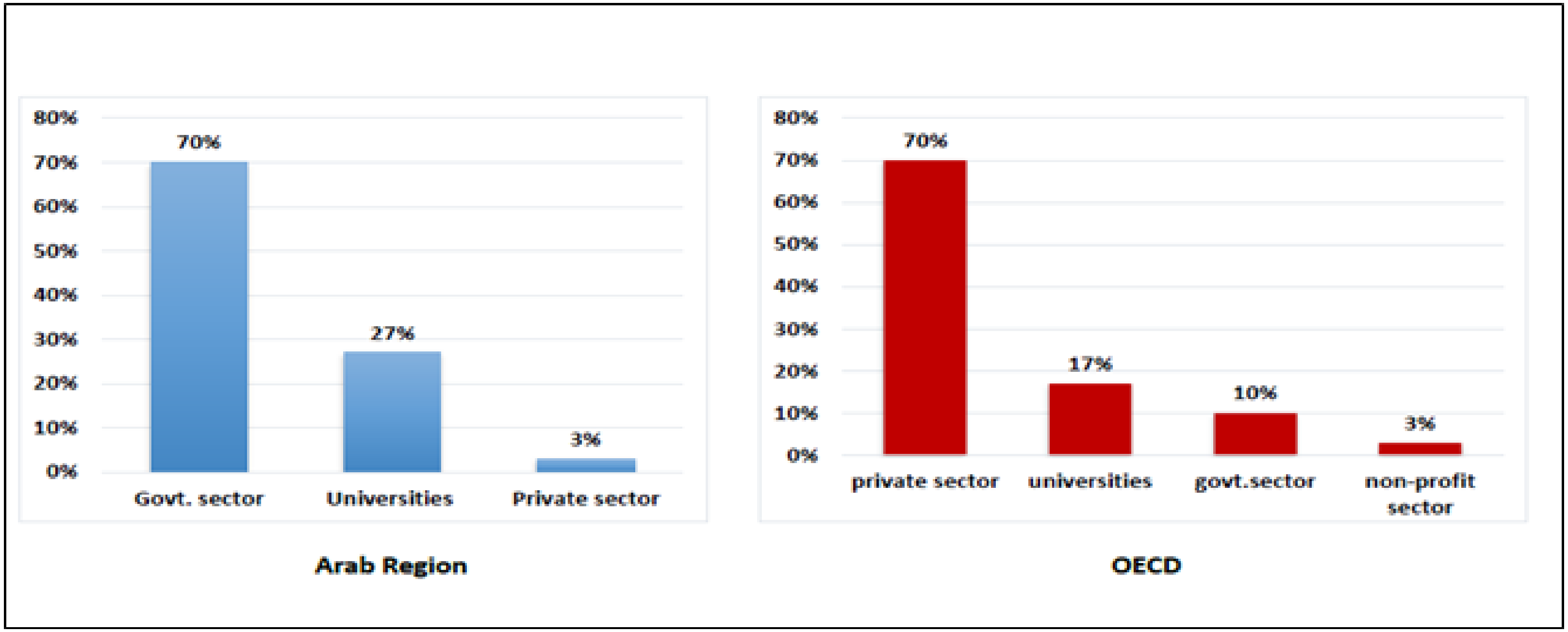
Global Competitiveness Index 2019 in the ranking of countries of the world-The Global Competitiveness Report 2019 (weforum.com)

III. Who is Who Conducting Scientific Research (2014):

	Basic Research	Applied research	Development	Consulting & other	Total
Academia/University	29%	25%	1%	1%	56%
Research Institute	9%	8%	1%	1%	19%
Government	1%	3%	0%	0%	4%
Domestic Corp.	0%	2%	2%	2%	6%
Multinational Corp.	1%	7%	3%	1%	12%
Other Organizations	1%	2%	0%	0%	3%
Total	41%	47%	7%	5%	100%

who is who conducting scientific research internationally-(Battelle/R&D Magazine 2014)

III. Who is Who Funding Scientific Research (2018): (continue)



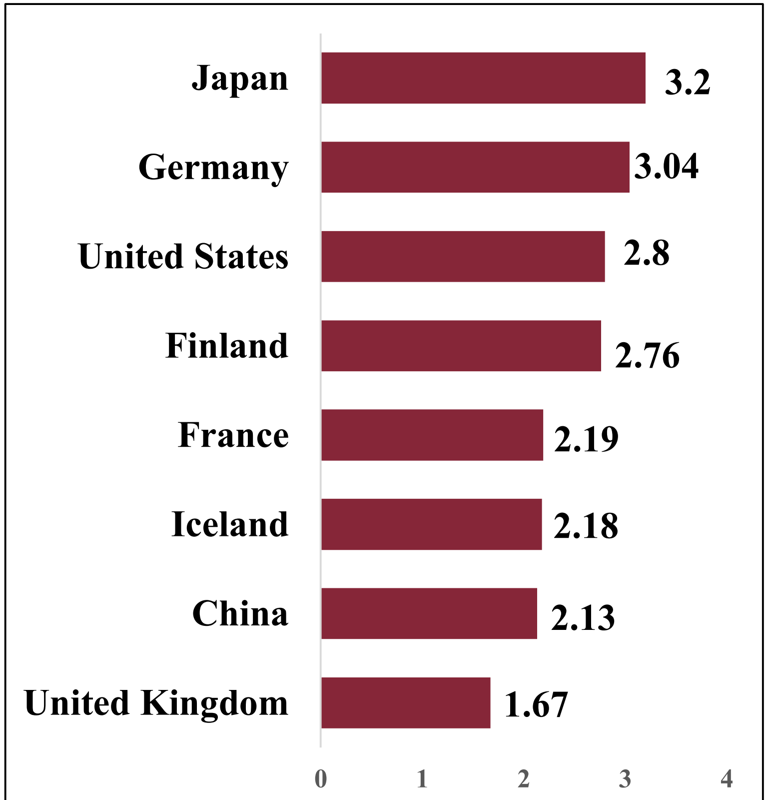
Distribution of investment in scientific research between the government as a public sector and companies as a private sector in the Arab region compared to the industrialized countries. (Badran A 2018)

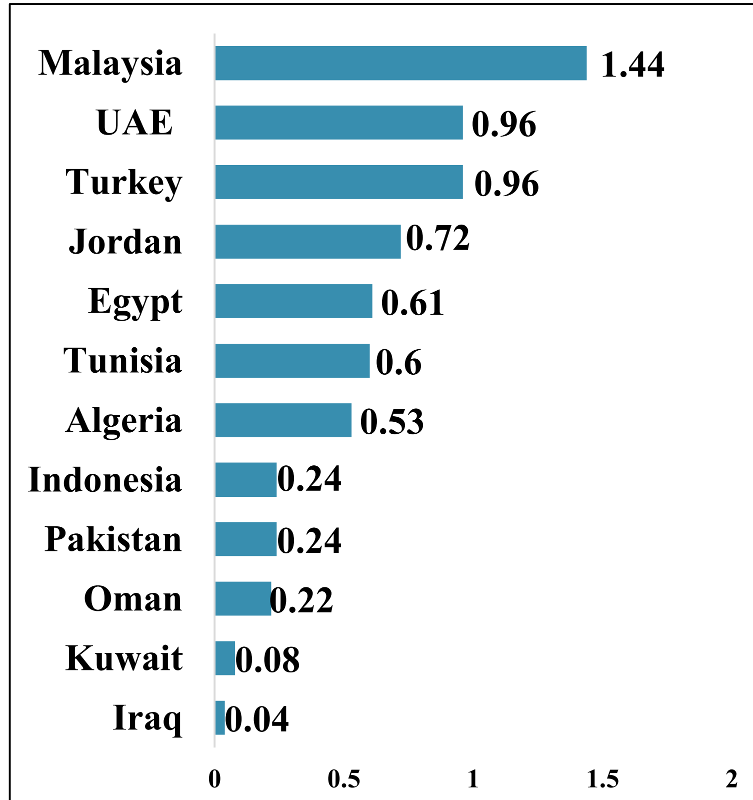
IV. Global Expenditure on Research and Development (R&D) 2018 :

Share of Total Global R&D Spending	
United States	25.25%
China	21.68%
Japan	8.52%
Germany	5.32%
South Korea	4.03%
India	3.80%
Russia	2.80%
Middle East	2.51%
Africa	0.92%

Indicators of spending on research and development. Battelle/R&D Magazine 2018

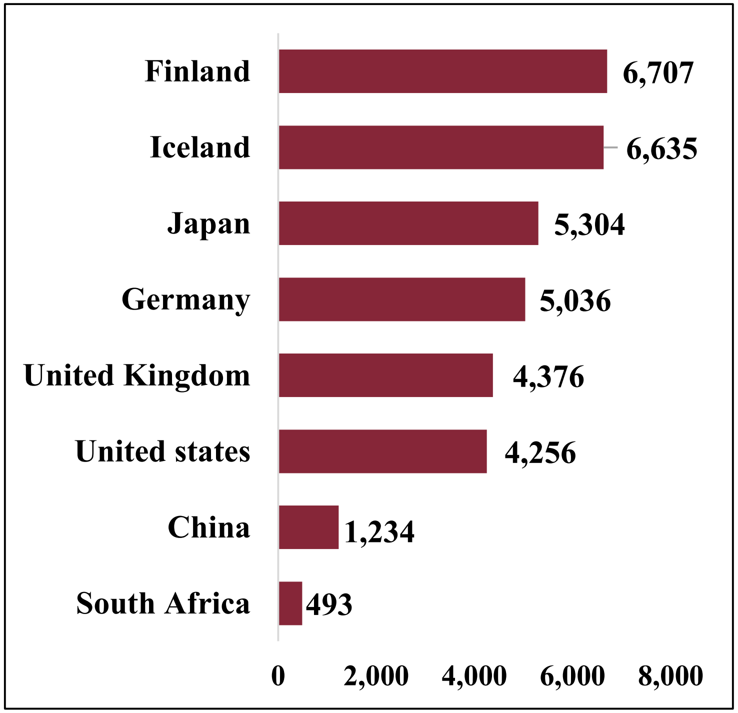
V. Expenditure on Research and Development (R&D) in the Islamic Countries as compared to the World (2016-2017):

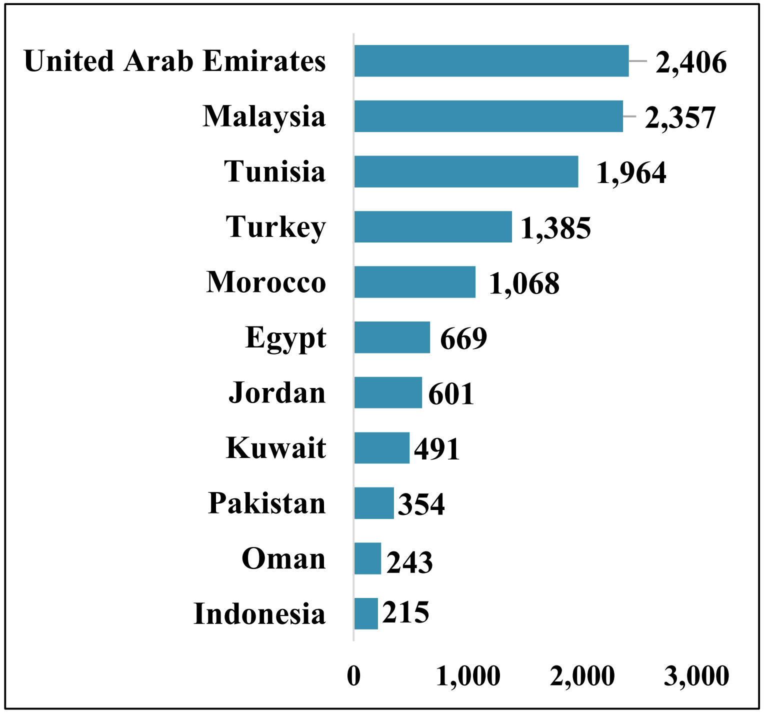




R&D expenditures in Islamic countries as compared to other countries in the world (as a percentage of GDP) 2016-2017. (Knoema.com)

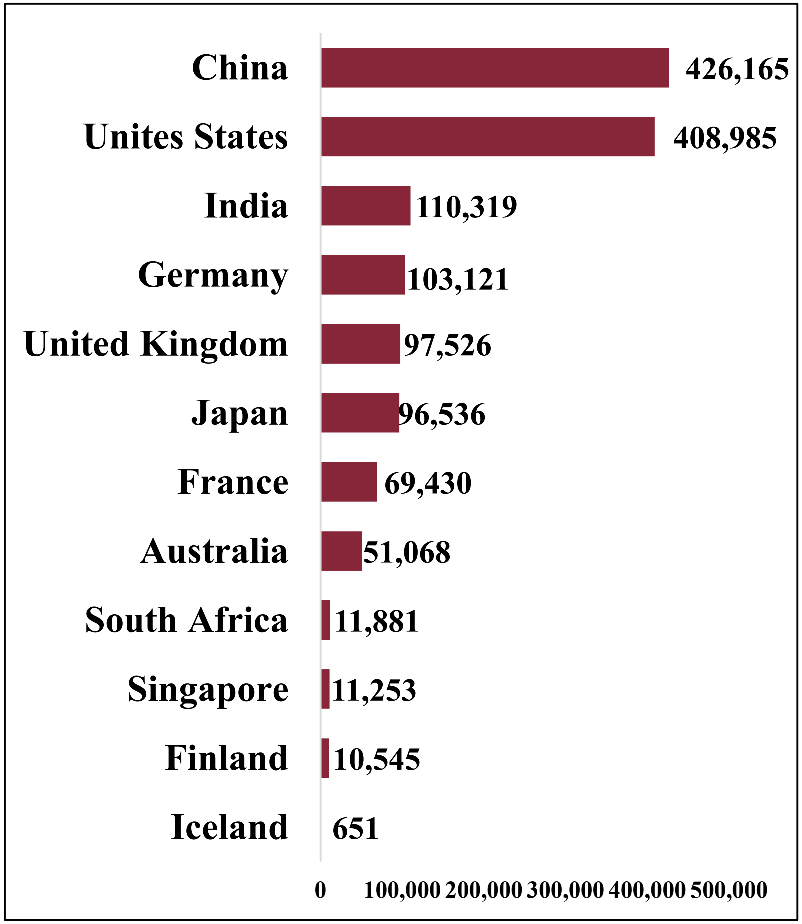
VI. Researchers of R&D per Million People in Islamic Countries as compared to the World (2016-2017):

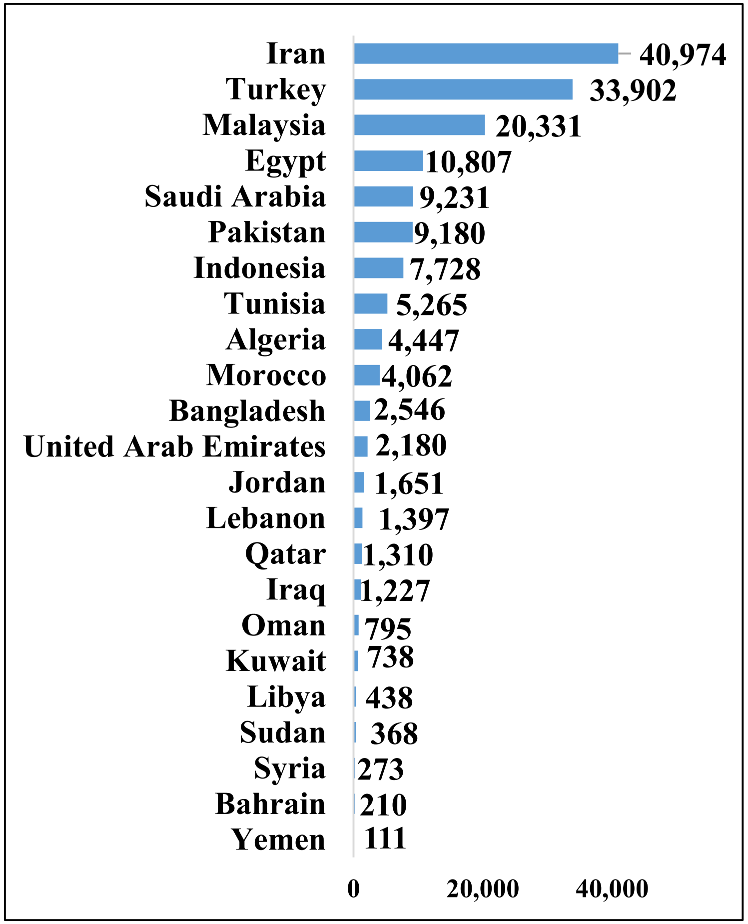




Number of researchers (FTEs) per million people in Islamic countries compared to the world, 2016-2017. (indexmundi.com)

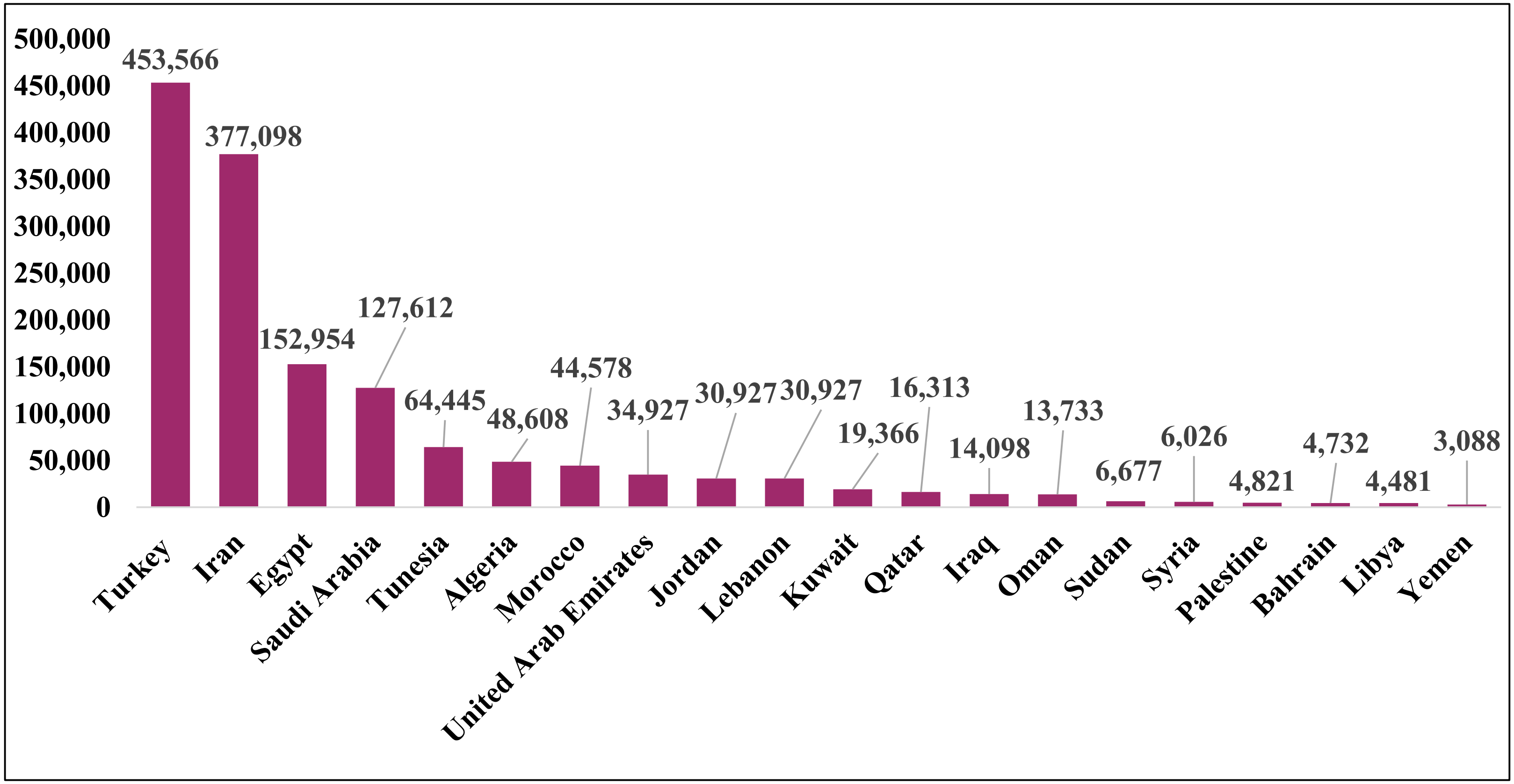
VII. Published Scientific and Technical Journal Articles (2016-2017):





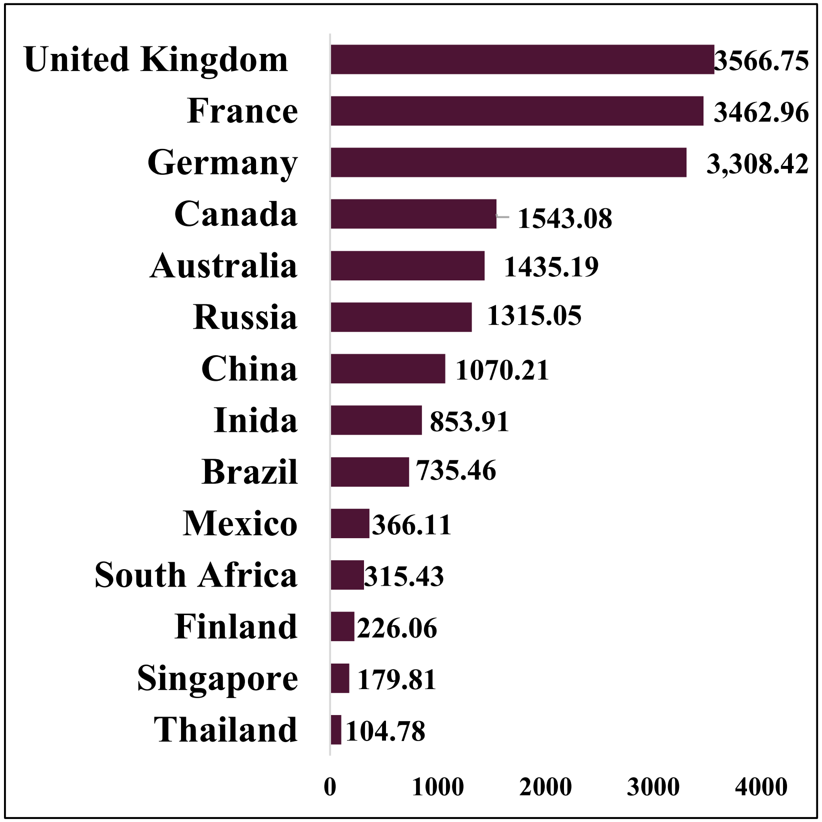
The number of published research papers of Islamic countries as compared to the world, 2016-2017. (Knoema.com)

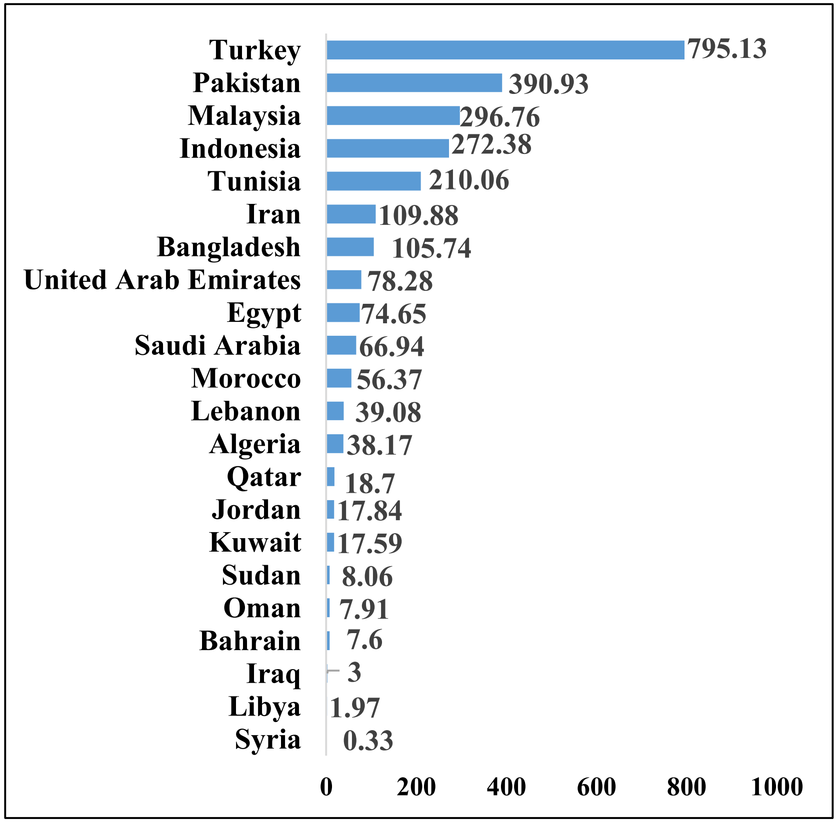
VIII. Density of Indexed Publications and Quotations of the Islamic World (1996-2016):



The accumulated research density of Islamic countries in the Middle East (1996-2016). (SJR 2016)

IX. Impact (H-index) of Publications and Quotations of the Islamic Countries (2019): (continue)





H-index for Islamic countries as compared to the world. (Hirsch- Impact, 2019)
https://ideas.repec.org/top/top.country.hindex.html

X. Who Leads What in World Productivity:

- United States ranks first in agriculture and food production, commercial and military space, nano-advanced materials, healthcare and life sciences, information and communications, tools and electronics.
- United States ranks second in energy technology, environment and sustainability, and third in automobiles.

X. Who Leads What in World Productivity: (continue)

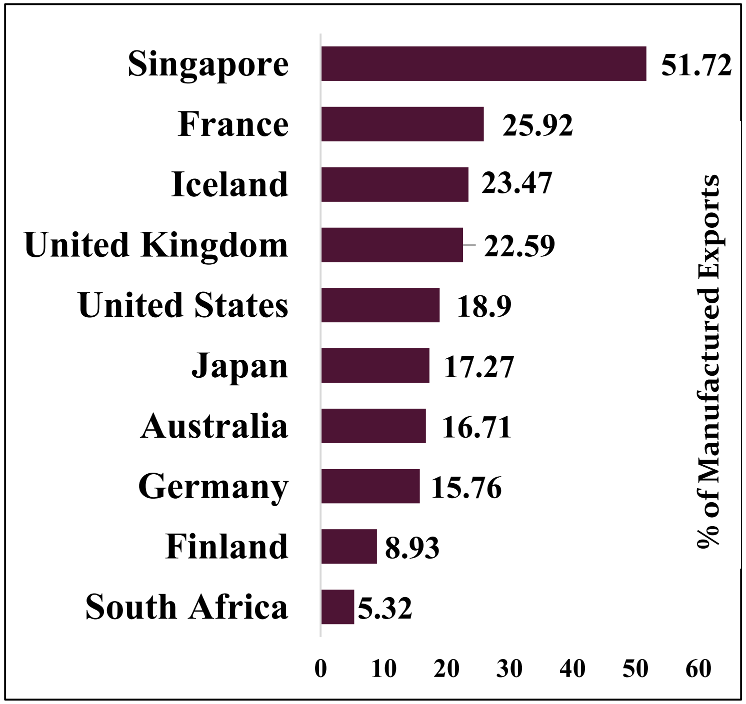
- Germany ranks first in cars, power generation and efficiency, and environmental sustainability. It ranks second in advanced nanomaterials, and ranks third in airspace, health care and life sciences, tools and electronics and ranks fourth in information and communications.

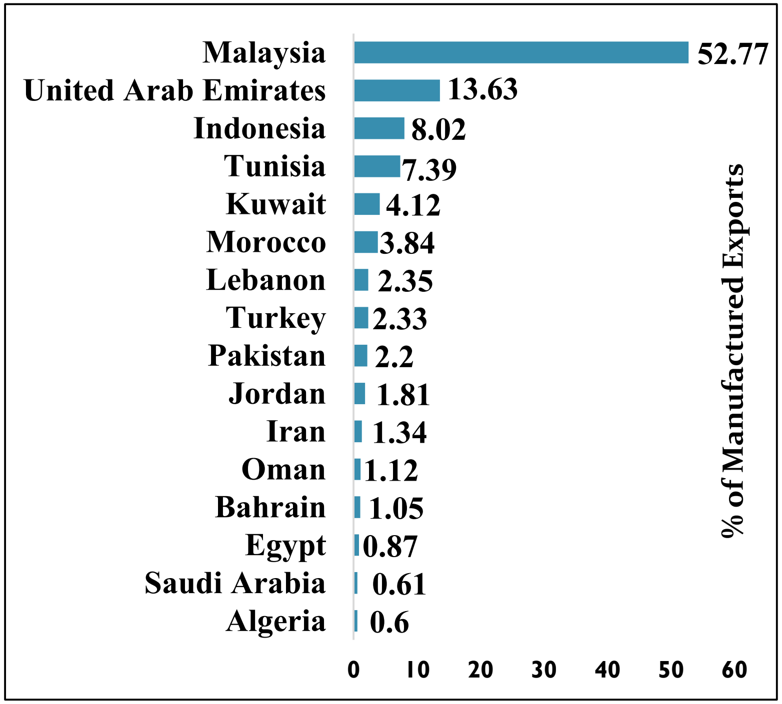
- Japan ranks second in automobiles, information and communications, tools and electronics, while it ranks third in nanostructured materials, environment and sustainability, it ranks fourth in healthcare and life sciences, energy technology, and ranks fifth in commercial space.

X. Who Leads What in World Productivity: (continue)

- China ranks second in agriculture and food production, and third in military aviation, energy technology, information and communications, ranks fourth in commercial aviation, automobiles, nano-advanced materials, electronics and ranks 5th in health care and life sciences.
- UK ranks second in healthcare and life sciences, and ranks 5th in military aviation, nano-advanced materials, environment and sustainability, tools and electronics.

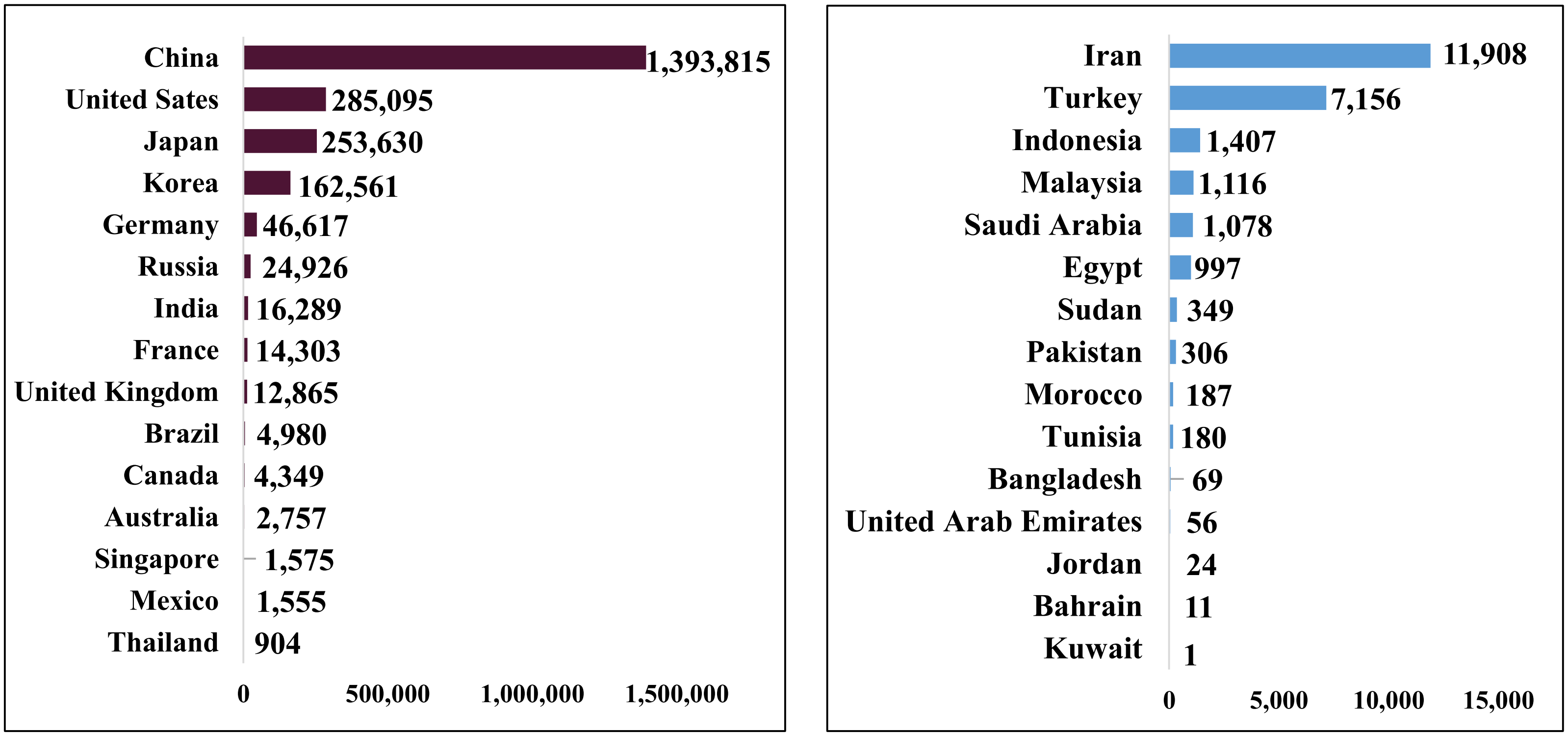
XI. High-Tech Exports in Islamic Countries as compared to other Countries in the World (2017):





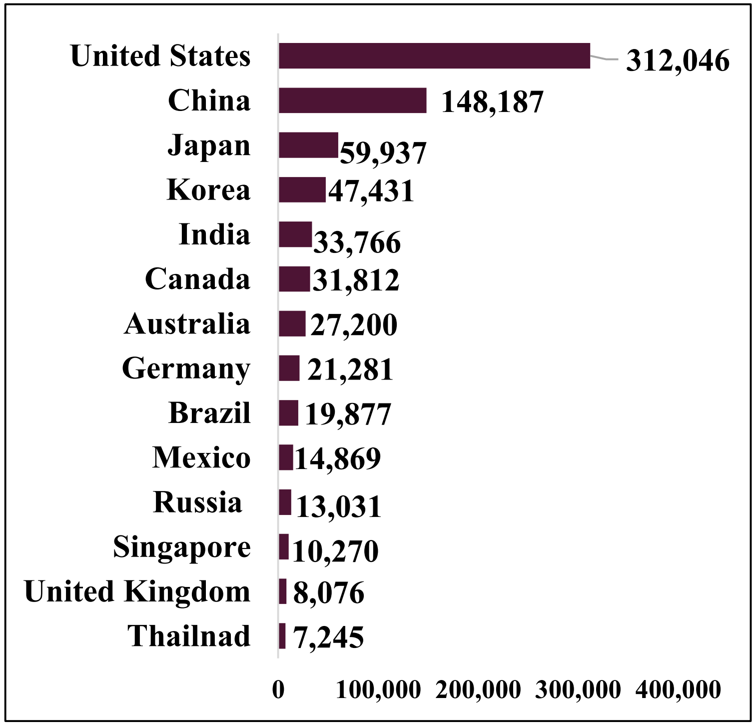
The ratio of high technology in total exports of Islamic countries as compared to the world, (2017-2018). (theglobaleconomy.com)

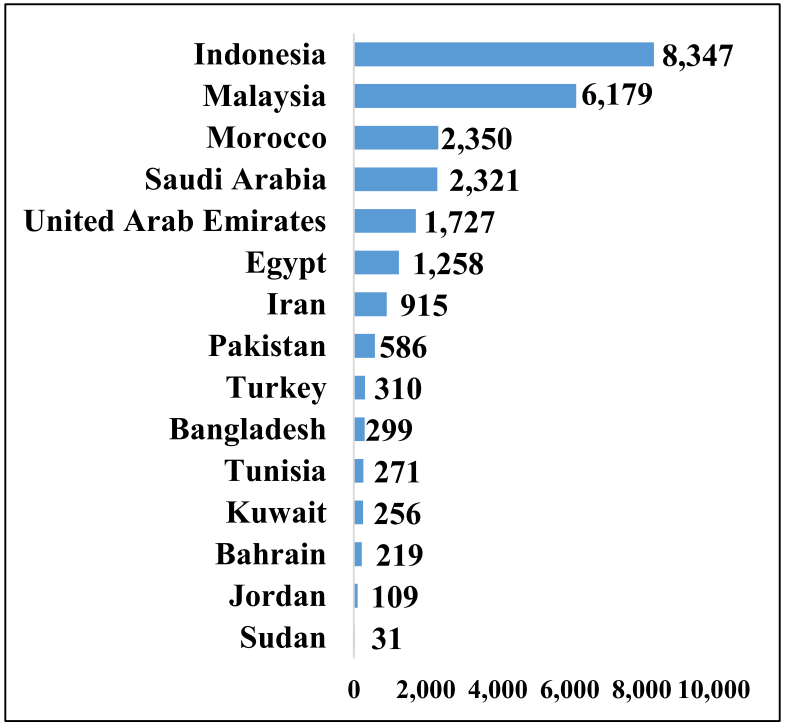
XII. Patents of Residents in Islamic Countries as compared to the World (2018):



Patents of residents in Islamic countries as compared to the world 2018 (Indexmundi.com)

XIV. Patents of Non-Residents in Islamic Countries as compared to the World (2017):





Patents for non-residents in Arab countries compared to the world 2017 (Knoema.com)

XIII. The Widening Gap of Wealth between Rich and Poor:

Davos Economic Forum (2020), stated that Oxfam stressed:

- The gap between the rich and the poor cannot be resolved without deliberate policies to combat inequality. Governments should ensure that companies and the rich pay their fair share of taxes.
- Egregious inequalities are at the heart of social divisions and conflicts around the world.

The report indicates that:

- 2153 people own wealth more than 4.6 billion people.
- The wealth of 1%, the richest in the world, represents more than twice the total wealth owned by 6.9 billion people least wealthy or 92% of the world's population.
- 42% of women in the world cannot get paid work compared for 6% of men only.

The Widening Gap of Wealth between Rich and Poor: (continue)

- The monetary value of unpaid care work performed by women from the age of 15 years represents no less than $10,800 billion annually.
- In France, seven of the billionaires have more money than the poorest, who make up thirty percent of the population

Conclusion:

- There is a growing gap in R&D, inventions and innovations between the Islamic world and the developed world, and there is growing gap between rich and poor in most countries of the world.
- Islamic countries need to increase investment in R&D in the field of science to reach a goal of one percent of their GDP by 2023.
- They need to build knowledge and transfer technology to develop self-reliance and create wealth to increase per capita income, and overcome poverty and unemployment, especially among the youth.
- To unleash the minds, we must provide a creative environment of freedom of expression and thought to maximize the potential of everyone.

Conclusion: (continue)

- Governments cannot do everything, and the private sector should take its share of the initiative in carrying out this task.
- While governments should become regulators, with the issuing of appropriate incentive legislations.
- Arab countries have failed to use the income generated from their vast natural resources, especially oil, to build the human capital through quality education and investments in R&D for self-reliance .
- It also failed to produce the entrepreneurs and innovators to transform the Arab society in knowledge economy to productive one for a better future.

my motto :

ICID

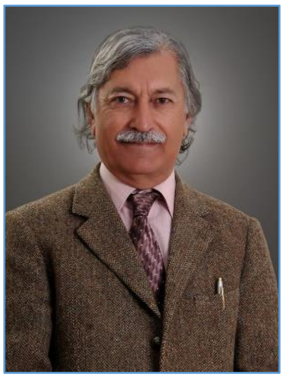
Initiate, Create
Innovate, Disseminate

For Listening

CHANGING CLIMATE, AND ADAPTATION AND MITIGATION MEASURES FOR SUSTAINABILITY OF AGRICULTURE: A SHORT REVIEW

M. QASIM JAN[1] FIAS AND MUHAMMAD ZAFFAR HASHMI[2]
[1]*NCE Geology, University of Peshawar, Peshawar, Pakistan (mqjan@yahoo.com)*
[2]*Department of Chemistry, COMSATS University, Islamabad, Pakistan (zaffar.hashmi@comsats.edu.pk)*

ABSTRACT



Global warming and climate change are enormous threats to sustainable development and humanity. Climate change is conceived to be characterized by hot climate, extreme and unpredictable weather conditions, changes in precipitation pattern, melting of glaciers and thawing of permafrost, rise in sea level, and overall environmental degradation. These would have a serious impact on agriculture, food security of ever increasing population, human society and natural habitat. Agriculture and climate change are characterized by a complex cause-effect relationship. Agricultural sector emits great quantities of greenhouse gases that affect climate which, in turn, affects agriculture itself. Increase in temperature, changes in the precipitation regime, and land degradation have repercussions not only on the quality, volume and stability of zoo technical production and agricultural, but also on the natural environment in which agriculture is practiced. Here we summarize the climate change effects on sustainable agriculture and mitigation measures, including some of the traditional practices. It is suggested that rescuing traditional management systems combined with the use of agro-ecologically based management strategies, water-efficient irrigation, and input of biotechnology may represent the only viable and robust path to ensure sustainability, resilience, and increase productivity in peasant-based agriculture practices under predicted climate scenarios.

Keywords: Global warming, climate change, threats, sustainable agriculture, food security

1. INTRODUCTION

The Earth has been passing through a very difficult time over the past half century because of the degradation of its habitat and rising of temperature. Extensive exploitation of natural resources, and land use for agriculture, building and infrastructure have led to biodiversity crisis. According to the Plumptre et al. (2021), only about 3% of the Erath's surface remains ecologically intact with undisturbed habitat, low human footprint and no species loss below functional densities. Recorded temperatures on land and oceans, recession of glaciers, reduction of polar icecaps and thawing of permafrost, and rise in sea level provide ample evidence for global warming. There is an ongoing debate regarding the nature of the global warming, with some experts relating it to natural causes and others to increase in greenhouse gases in the atmosphere due to burning of the fossil fuels. Figure 1 shows the pattern of temperature and CO_2 over the past millennium, with rather dramatic rise in both during the last 100 years. Figure 2 lends further support to the latter observation, and provides information on lower tropospheric temperature anomaly data during the past 40 years, together with the impact of El Nina and El Nino events.

The Earth's atmosphere has five layers and among them troposphere is most important to understand the climate change. In this thick layer the oxygen we need to live is stored, clouds are formed, and planes fly. This is also where air movement that creates climate patterns takes place. Radiation from the sun is the fuel that drives this movement. Solar radiation usually takes one of two pathways when it enters Earth's atmosphere: gases, water vapor, and the Earth's surface can absorb it or reflect it back into space. Molecules that trap energy in the atmosphere include water vapor, ozone and greenhouse gases (GHGs: carbon dioxide, ozone, methane, chlorofluorocarbons, nitrous oxide). Although the GHGs represent only a small fraction of atmospheric gases – 0.03 percent – they are extremely effective at trapping energy, and keeping our planet warm and habitable (Figure 3).

Whatever the causes of global warming, the associated climate change is feared to have adverse impact on well-being of the society and human activity, notably agriculture and food security. Needless to say that agriculture has been the main kit of human survival since time immemorial. Traditional challenges to agriculture sustainability and food security have concerned the availability of soil, water, and increasing population. Despite the global spread of agriculture and progress in science and technology, sustainable agriculture and food security are seriously challenged by the triple menace of global warming-related climate change, water deficiency, and population growth.

The impacts of climate change on the global hydrological cycle are expected to vary the patterns of demand and supply of water for agriculture - the dominant user of freshwater. The extent and productivity of both irrigated and rainfed agriculture can be expected to change. As a result, the livelihoods of communities and the food security of a rapidly increasing urban population are at risk from water-related impacts linked primarily to climate variability. Adaptation measures that build upon improved land and water management practices will be fundamental in boosting overall resilience to climate change. And this is not just to maintain food security: the continued integrity of land and water systems is essential for all socio-economic uses of water.

In this review our objectives are to summarize the information regarding global warming, climate change, and their impact on Earth, life, and human activities. We have tried to elaborate the impact of climate change particularly on agriculture (and hence food security), and describe mitigation measures for sustainability in various geographic, geomorphological and climatological regions.

2. EVIDENCE, CONSEQUENCES AND MITIGATION OF CLIMATE CHANGE

Increase in temperature on continents (weather stations data and near surface troposphere 50 years satellite temperature data), over ocean's surface and in heat content of the oceans, recession in glaciers, reduction in polar icecaps and thawing of permafrost, and rise in sea-level are striking evidences of global warming (Gbetibouo 2009, Pachauri &Reisinger 2007, Stoll-Kleemann et al. 2001). Recorded data suggest that global temperature has risen by 0.8-1.0°C over the past 130 years, an alarming rate indeed (Figure 4). Human activities empirically known to influence climate and ecosystem include burning of fossil fuels in industry, automobiles, power plants, and buildings, waste disposal, deforestation, forest fires, urbanization, agriculture, and wastage of water (Arbuckle et al. 2013, Gemenne et al. 2014). The consumption of fossil fuels results in the production and accumulation of GHGs, such as CO_2, CH_4, N_2O, and fluorinated gases, which take various lengths of time for removal from the atmosphere. Although geological record provides evidence for major climate changes due to natural causes, many scientists argue that GHGs are the main cause of the present day global warming. Figure 4 shows a good correlation between global warming, atmospheric carbon dioxide and sea level rise.

Various aspects of the GHG and their sources are summarized in Figure 5, along with the proportion of major GHGs (Figure 5A), with CO_2 emission from fossil fuel being the highest (65%), followed by methane (16%), CO_2 from forest and other land uses (11%), nitrous oxide (6%), and fluorinated gases (2%). Global emissions by economic sectors are given in Figure 5B. The large quantity of GHGs accompanying the generation of electricity and heat production indicates the demand of growing population, but the agriculture sector is also a major contributor. CO_2, the principal GHG, takes flabbergasting one hundred years for its removal, and has increased significantly in the atmosphere over the past century to 400 ppm (ca. 40 billion tons) (Moran-Taylor &Taylor 2021).

The consequences of the climate change can be disastrous, long lasting, and even irreversible. Changes in patterns of rainfall and snow, increased likelihood of drought and severe storms, decline in ice cover, melting of glaciers, increase in floods (including GLOFs), landslides, rise in sea level, higher humidity, disease outbreak, changes in animal and plant behavior, faunal extinction, collapse of fisheries, bleaching of coral reefs and dying of the African iconic baobab trees are the feared scenarios (Anita et al. 2010, Deschênes & Greenstone 2007, Jan et al. 2017, Tong &Ebi 2019). Climate change would impact infrastructure, steady supply of energy, patterns of livelihood, and standard of living, leading to a vicious socioeconomic burden (Change 2001, Karl et al. 2009, McNutt 2013). At the present rate of global warming, around 75% of world's population will be exposed to deadly climate conditions by 2100. Water borne and water related diseases, such as malaria, dengue, diarrhea, dysentery and typhoid, are likely to become epidemic. Global warming is projected to cause approximately 20,000 heat-related deaths among the elderly in 2030. There would be severe impact on agriculture sector, food security, food supply chain, and fresh water, which will initiate human migration and social conflicts.

The competition for water resources with respect to the requirements of agriculture, environmental protection and socio-economic development has gradually reduced the amount available for crop production to about 64% of the total amount of water used on the plain (China 1997). Furthermore, under climate change scenarios and demands of rising population, water resource availability for agriculture is projected to decline, and shortages will continue to challenge agricultural sustainability, ecosystem services, and environmental health.

Climate change brings storms and floods (Wasko et al. 2021) that can disrupt canals and water supplies (Andimuthu et al. 2019). Desertification is a change in soil properties, vegetation or climate, which results in a persistent loss of ecosystem services that are fundamental to sustaining life. Desertification affects large dryland areas around the world and is a major cause of stress in the affected human societies. Hot weather, and possible desertification in some parts of the globe (D'Odorico et al. 2013), would require shift to heat tolerant food plants, and growing population would need more food (Long et al. 2015).

The Paris Agreement 2016 was adopted as an implementation plan to combat climate change. This policy demands global commitment to keep the temperature increase below 2°C, preferably not more than 1.5°C by the end of this century (Blau 2017). More than 180 countries have pledged to limit carbon emissions as part of Intended Nationally Defined Contributions (INDC) to keep temperature from rising. Use of renewable, environment friendly energy sources are to be given priority while traditional energy sources dependent on fossil fuel are to be replaced. These INDCs are not legally binding on any country, and no end timeline is set forth for the task. The Paris agreement also gives an added emphasis on the financing and budgeting of the losses; damages caused by climate change and for the infrastructure change that is required for curbing emissions (Dimitrov 2016). It looks difficult to achieve these targets; therefore, there is an urgent need for international commitment in devising a more effective long-term plan to restrict the temperature rise to the recommended limits by the end of this century.

Remedial steps on global scale and changes in lifestyle are touted as major ways of effectively fighting climate change (Jan et al. 2017). The remedial steps include use of clean energy, removal of CO_2 from atmosphere, increase in forest cover, replacement of coal by gas in power generation, and geo engineering. Changes in lifestyle, which would help reduce environmental degradation, include expanded use of renewable energy in buildings, energy efficient housing, reducing waste, avoiding unnecessary use of vehicles, eating less meat, and spatial planning and infrastructure to accommodate green and environment friendly infrastructures.

Agriculture is both a victim of and a contributor to climate change. On the one hand, agricultural activities contribute approximately 30 per cent of total greenhouse gas emissions, mainly due to the use of chemical fertilizers, pesticides and animal wastes. Avoiding pesticides use, efficient irrigation (Zou et al. 2012), reduction in meat-eating (and hence fewer animals for meat), and extensive plantation (including heat-tolerant plants) and forest cover (Bita &Gerats 2013) would help to reduce contribution to climate change from the agriculture sector.

3. Climate change and agriculture sustainability

The previous century raised global concerns regarding new and serious problems related to climate changes, e.g., rising of temperature, heat waves, droughts, storms, increase in precipitation, increase in flood risk, depletion of ozone layer, thickening of CO_2 blanket and rising of the sea level (Publishing et al. 2012). These changes, commonly considered to be induced by anthropogenic activities, have created new challenges for human beings to maintain sustainability despite the depletion of natural resources. It is now commonly agreed upon that climate changes will adversely affect agricultural yields and pose threat to food security (Adams et al. 1998, Ahmed et al. 2018, Moretti et al. 2010, Waggoner

1983). However, the agriculture implications of climate change would vary for different crops and different regions (Adams et al. 1998). Warming may be helpful for irrigation activities in the present day snow covered areas, but it would severely impact the tropical and neighboring regions which house the bulk of the global population.

The climate changes may be beneficial for some areas by the action of some components of climate change (e.g. cool countries with rising temperatures or "carbon fertilization effects" (Stokes & Howden 2010). Other countries could suffer significantly adverse effects (e.g. water stress, increasing in the variability of yield, reduced crop yields, etc.). However, the vulnerability increases in various countries by the combined effect of these changes (Adger 2006) Füssel 2007). There is an interesting relationship between the climate change and agriculture: the agriculture sector produces a significant amount of gas directly emitted to the environment that effects the climate and, on the other side, agriculture and livestock are impacted by the climate change through changes in temperature, precipitation and climate variability (such as erratic rainfall, floods and droughts). Agriculture is vital for human survival and is probably the most vulnerable human enterprise to changing climate with complex and interconnected impacts.

Water resources in particular will be the most affected natural ecosystem due to global warming-related climate change and increasing agriculture, and domestic and industrial needs of ever-growing population. Continued global warming will cause melting of the polar ice caps and mountain glaciers, leading to water scarcity, sea level rise and increase in water-related disasters such as flash floods and cyclones. Global warming would be particularly disastrous for agriculture activities in the southeastern half of Asia that depends heavily on river waters drawn from the snows and glaciers of the 'Third Pole', i.e., Tibet, Himalaya, Karakoram, Pamir and Hindu Kush, (Azam et al. 2018, Hewitt 2005). This region (Figure 6), with the largest irrigation systems and alluvial flood plains, provides nourishment, hydroelectricity, and transport facility to over 2.5 billion human population.

Water resources are depleting on the planet due to overuse and climate drying. For example, in recent decades discharges in the Haihe, Yellow, and Huaihe Rivers have declined by 15%, 41%, and 15%, respectively (NDRC National Development and Reform Commission et al. 2007, (Li &Wang 2009). Domestically and ecologically water requirement has increased, resulting in further withdrawals of ground water and a continuous decline in its levels. There is likelihood that with passage of time apportionment of water to the agricultural sector may also be curtailed. In Beijing metropolitan area and Hebei province the amount of pumped ground water represents 70% of the total water resource supplies (Chen et al. 2003, Zhang 2009). It is suggested that serious associated environmental problems are occurring, such as seawater intrusion, large-scale groundwater funneling, land surface subsidence and groundwater pollution (Wu et al. 2010).

Melting of polar ice caps and glaciers, and heavy rains would also lead to GLOFs (glacial lake outburst floods), flash floods, rapid erosion of soil cover, sediment-filling of water reservoirs, disruption of waterways and irrigation systems, and coastal areas inundation (Chen et al. 2013, Hagen et al. 2003). The rise in sea level (hence greater surface area) and rising temperatures would likely result in greater evaporation and higher global humidity. However, its overall impact on green gas house effect and quantity of rainfall are not clear.

Climate change would cause changes in agro-ecological conditions which, in turn, would impact crop yield, nutrition value and livestock productivity (Hristov et al. 2018, Zhou et al. 2019). Crop cultivation and harvesting, support pests, weeds and plant pathogens, with excessive precipitation and accumulation of GHGs affecting the biogeochemical cycle of the soil. Growth of crop plants is driven by interaction among CO_2, temperature, light and precipitation. Overall seasonal precipitation determines the yield over large areas, but stress and dry spells threaten productivity, even a few hours at critical growth stages. Increase in temperature will consequentially affect growth, nutritional value and required yield of the crop plants (Dixon 2012, Moriondo et al. 2011, Wei et al. 2014). The rise in warming condition may also affect the bee population, and pollination stage of the plants, leading to hindrance in development of fruit, fiber and grain and, in return, negatively influencing the crop yield. The impact is feared to be complicated, as can be seen in Figures 7 and 8. Growth of green and leafy vegetables would be severely hindered by rise in temperature. Negative effects of high night temperature on grain development are confidently and abundantly reported. Livestock is also affected directly by the lack of pasture and forage availability, and compromised quality as the agriculture production is affected. Livestock and poultry exposed to higher night time temperature are likely to have reduced milk, meat and egg production due to increased physiological stress (Das et al. 2020, Dimes et al. 2008).

The quality of soil and water are two key factors that have significant impact on agriculture production, which gets affected directly or indirectly by climate change. Soil erosion is caused by floods which affect the cultivability of the land while soil nature is affected by carbon content. Changing climate will not only impact the quantity, but also the quality, of water that is available and accessible for irrigation use (Jansson &Hofmockel 2020, le Roux et al. 2013, Reitsma et al. 2015).

Another way through which agriculture is affected by climate change includes weeds, insects and disease re-emergence. Major losses to crop production globally are caused by weeds (estimated at 34%), insects (18%) and diseases (16%) (Howden et al. 2007, Schmidhuber &Tubiello 2007, Tubiello et al. 2008). Increase in temperature helps induce higher incidences of plant and livestock pathogens, and geographical distribution/relocation of insects and diseases. It is important to note that the weed species can adapt to higher temperatures and CO_2 levels than the crop plants, providing them a competitive advantage. This re-emergence will cause increased use of pesticides and insecticides for the protection of agriculture and livestock health, which can lead to pesticide resistance and entrance of these chemicals into food chain, creating long-term implication for food safety and consumption (Schmidhuber &Tubiello 2007).

Sector wise impacts of climate change is given in the Table 1. In the agriculture sector the pontial impacts of climate change are shortening of maturity period, crop failure and expanding crop diseases. Climate change impact on the livestock are: change in livestock feed availability and qaulity, effects on animal health, growth and reproduction, etc. The impact of climate change on envirnment are reduced productive capacity from degradation of forests, range and water resources.

Rapid population growth, increasing urbanization and natural habitat degradation have rendered the thickly populated South Asia a highly vulnerable region to climate change, thereby posing a serious threat to agriculture and food security (Hulme et al. 1994, Iglesias et al. 1996, Sivakumar & Stefanski 2010). Some of the major challenges of climate change for agriculture in this region include increasing temperatures, availability of irrigation water, increased variability of monsoon, severe water-stressed conditions in arid and semi-arid areas, and extreme events, such as floods, droughts, heat waves, cold waves, and cyclones (An 2014, Mirza 2011).

Temperature increase will negatively impact crops which are grown close to their temperature tolerance threshold (wheat, rice and maize, vegetables) in tropical and temperate regions of South Asia although individual locations may benefit (Anbumozhi et al. 2012, Knox et al. 2012). It is important to note that the climate impact on agriculture and risk of food security are greater in low altitude areas. Indirect impact on agriculture is likely to emerge from changing soil moisture content, erosion of soil, disruption of existing irrigation systems, frequent occurrence of pests and crop pathogens. In summary, the biosphere and agriculture are feared to undergo multiple and interconnected harsh impacts of global warming and climate change disruption, as shown in Figure 9.

4. ADAPTATION AND MITIGATION OPTIONS FOR SUSTAINABLE AGRICULTURE

The global climate change has compelled scientists to think about the severe threat to agriculture sector and its related problems of food security both globally and locally. It is evident that extreme climate change can severely impact small farmers, but the available data are just about the gross estimate at understanding the heterogeneity of lower scale agriculture, ignoring the myriad of strategies used by traditional farmers to deal with climatic variability (Table 1). Many small farmers cope with, and even prepare for, climate change, by utilizing a series of agroecological practices to minimize the crop failure. Observations of agricultural performance after extreme climatic events in the last two decades have revealed that resiliency to climate disasters is closely linked to the high level of on-farm biodiversity, a typical feature of traditional farming systems. It is necessary to accelerate the research for climate change adaptation and mitigation in a multi-dimensional approach (Altieri &Nicholls 2017, Berger &Troost 2014). The adaptation initiatives need to focus on development of new cultivars, innovations in plant protection, advances in biological engineering, enhancing productivity of horticultural crops, broadening the genetic diversity, and development of resource conservation technologies (Alemu & Mengistu 2019, Aryal et al. 2020a, Loboguerrero et al. 2019, Shahid et al. 2018).

The threat of climate change to food security is an issue of global dimension and needs international collaboration. A comprehensive plan of adaptation measures is needed to be vigorously pursued for sustainable agriculture development to ensures the security of food for the growing population, as suggested by Jan et al. (2018):

A) Crops related measures, including alteration in sowing dates, use of new crop varieties, development of short duration, drought and heat-tolerant varieties, changes in cropping pattern, e.g. replacing high water requiring crops with low water requiring ones, inclusion of legumes in all-cereal cropping pattern, advance seasonal weather forecast, short duration weather forecasts and warning system during emergency.

B) Water related measures, involving changes in irrigation system and adapting water smart technologies like drip, sprinkler and sub-surface irrigation, rainwater harvesting, solar pumping and integrating irrigation with water sensitive growth stages of crops.

C) *Soil related measures,* entailing soil mulching to suppress evaporation and lower soil temperature, laser land leveling and improving soil drainage to prevent soil degradation.

The long-term response to climate change may include investing in creating new or improving existing infrastructure, e.g., water storages (through aquifers or dams), water harvesting structures, and canal lining. The impacts of extreme events can be avoided, for example, through restricting development in floodplains and areas of increasing aridity. Adoption of clean energy and increase in forest cover are some of the viable options for climate change mitigation.

Global agricultural products demand continues to grow while production resources are diminishing due to increasing climatic variability. Therefore, ensuring agricultural sustainability necessitates a transformation of the production system to become input efficient, more productive, and ~~to~~ lower in the environmental footprint. Climate-smart agriculture (CSA) provides effective solution to mitigate climate change. CSA can enhance mitigation to and adaptation of climate change and overall food security (Lipper &Zilberman 2018). Key climate change management strategies are improved legume varieties, conservation agriculture and drought tolerant maize (Agrimonti et al. 2020, Aryal et al. 2020b), as already mentioned above section. Their complementary efforts in adaptation to climate change are sternly important for farm productivity and income.

Moreover, application of biotechnology can help in minimizing the impact of climate change in at least some cases. For example, it helped develop varieties with reduced intake of water ~~for example~~ to survive in drought; and also the cold and salt tolerant varieties of Faba bean (Ahmed et al. 2008, Bartels & Sunkar 2005, Winicov 1998). Using modern technology, e.g., CRISPR/Cas9 to design varieties that can have better yield with less input, or pest resistant varieties to reduce use of pesticides and fertilizers, are effective to lower the impact of climate change (Tian et al. 2018, Zhang et al. 2018). For example, scientist used CRISPR/Cas9-mediated base-editing to engineer herbicide-resistant watermelon.

5. Adaptation and mitigation options for Raised fields

The archive record on agriculture system provides examples of sustainability and resiliency, and is considered an important source of past data (Altieri &Nicholls 2017). Examples of such agriculture systems include the remnants of more than 170 000 ha of 'ridged-fields' in Colombia, Surinam, Ecuador, Venezuela, Peru, and Bolivia, as discovered by researchers (Denevan 1995). Most of these systems consisted of highland basins and raised field of seasonally flooded lands in savannas. The farmers from many parts of the world have been using these raised bed cultivation systems since time immemorial. The origin and use have traditionally been associated with water management issues, either by providing opportunities to reduce the adverse impact of excess water on crop production, to actively harvest excess water, or to irrigate crops in times of rainfall scarcity. "Chinampas" and 'waruwarus' are the example of wetlands forming subjected to temporal flooding, used in the valley of Mexico and Peru + Bolivia, respectively (Wilken 1990). The Chinampas is constructed with mud scraped from surrounding swamps or shallow lakes which looks like an "island" of raised platforms with width of 2.5-10 m and length up to 100 m.

The Aztecs platforms range in height from 0.5 to 0.7 m above the water level and their sides are reinforced with posts interwoven with branches and trees planted along the edges (Altieri &Koohafkan 2004). The chinampa beds from the past till now are built from alternating layers of aquatic weeds, bottom muck, and earth packed inside rectangular cane frames firmly rooted to the lake floor. Because of the narrowness of the beds size, the water of the surrounding canals is filtered and eventually reaches the root level. The fertility of soil is maintained by the regular application of swamp muck, manure and aquatic plant. The chinampas are like a network of islands separated by canals of 1-3 m width (Gliessman et al. 1981). Waru-Warus were the platforms of soils surrounded by ditches filled with water and had the capability to produce bumper crops in the face of droughts, floods, and the killing frosts common at altitude of 4,000 m. Around the Titicaca Lake, the remnants of over 80,000 ha of them can still be found.

The combination of canals and raised beds has developed an important moderation in temperature effects that not only avoids the devastating effects of frosts but also extends the growing season (Council 1989). During the floods, the furrows drain away excess runoff while in droughts condition moisture from the canals slowly ascends to the roots by capillary action. The extreme low temperature effect can be reduced by Waru-warus. The canals water absorbs the sun radiations at daytime and radiates it back by night, thereby helping the crops against frost. The temperature of the raised beds is slightly higher than the surrounding area (Erickson &Candler 1989). These sophisticated environmental effects on the Waru-Warus lead to higher productivity compared to chemically fertilized normal pampa soils. In the Huatta district a sustained potato yield of 8–14 t ha^{-1} $year^{-1}$ was produced by reconstruction of raised field. These figures contrast favorably with the average Puno potato yields of 1^{-4} t ha^{-1} $year^{-1}$ (Erickson & Candler 1989).

6. ADAPTATION AND MITIGATION OPTIONS FOR DRYLAND AGRICULTURE

Farmers have over generations developed management in arid and semiarid regions that can enhance the soil's capacity for the storage of water used for plant, mitigate vulnerability to drought as well as help halting soil erosion and degradation (Barrow 2014). A technique, in which the ridges are included at a regular interval across the furrows between crops which are planted on raised beds, is utilized in those areas which are facing water limitation problem, for example in Nigeria. This technique of cultivation is also referred as 'tied ridges' that help to prevent runoff, to hold rainfall and promote water infiltration. The local farmers of Tigray (Ethiopia) used to make contour furrows of 2-4 m of width intervals for teff cultivation. Locally called "terwah", the purpose of these is to trap water in the ridges so that after a storm the chequered fields contain elongated pools of retained water for later crop use instead of being lost as runoff (Boers &Ben-Asher 1982). The same pattern basins are also found apparently at the Kofyar of the Jobs Plateau of Nigeria. In the flat semi-arid regions of West Africa, plants are with large planting holes or pits. Traditions of hand-dug pits for land rehabilitation have been successfully revived in Burkina Faso (where pits are known as zay) as well as in Niger (tassa) (Reij et al. 2013). The pits not only work as reservoirs of water, but also act like a micro-catchment for rainfall from the area between them. The utilization of manure in these pits increase the growing conditions and attracts the soil-improving termites there. There is a direct relationship between the size and depth of the pits with slope of the beds, as steeper slopes are generally associated with large and deeper pits. The most prominent of these pits are found in southwest Tanzania, which have apparently been in use for several centuries and currently extend over some 18,000 ha (Stigter et al. 2005).

7. PERFORMANCE OF BIODIVERSE AGROECOSYSTEMS UNDER EXTREME CLIMATIC EVENTS

A survey conducted in Central American hillsides after Hurricane Mitch showed that farmers using diversification practices, such as cover crops, intercropping and agroforestry, suffered less damage than their conventional monoculture neighbors. In this survey, led by the Campesino a Campesino movement, 100 former technicians were mobilized to carry out paired observations of specific agroecological indicators on 1,804 neighboring sustainable and conventional farms. The study, performed in Nicaragua, Honduras and Guatemala, covered 360 communities and 24 departments. It was concluded that sustainable plots had 20-40 % more topsoil, less erosion and greater soil moisture, and experienced lower economic losses than their conventional neighbors (Holt-Giménez 2002). Similarly, it was found that coffee system of Sotonusco, Chiapas, having high level of vegetational complexity and plant diversity, suffered less damage from Hurricane Stan than more simplified coffee system (Philpott et al. 2008).

A survey of farms in the provinces of Holguin and Las Tunas, 40 days after Hurricane Ike hit Cuba in 2008, noted that diversified farms exhibited losses of 50% compared to 90 or 100% in neighboring monoculture ones. Faster productive recovery (80-90%, 40 days after the hurricane) was shown by agroecologically managed farms than monoculture farms (Rosset et al. 2011). These studies suggest and emphasize the significance of plant diversity and complexity in farming systems to mitigate vulnerability against extreme climatic conditions. The study has reinforced that biodiversity is integral to the maintenance of ecosystem functioning. Moreover, the study points out that the utility of crop diversification strategies could be used by traditional farmers as an important resilience strategy for agroecosystems (Lin et al. 2008). Silvopastoral, agroforestry and poly-cultural systems are the examples of diversified farming systems which showed how complex agroecosystems are able to adapt and resist the effects of climate change. After the Hurricane Mitch, a survey was conducted in Central American hillsides (Holt-Giménez 2002). He observed that farmers in these areas utilizing diversification practices, such as intercropping, cover crops and agroforestry, suffered less damage than their conventional monoculture neighbors.

Wilken (1990) concluded that the integrity of agroecosystems relies on synergies of plant diversity and the function of the microbial community supported by soil that is rich in organic matter. It has been demonstrated by researchers that the addition of organic matter increases the ground biological diversity, which in turn provides a hospitable condition to plant roots, allowing the development of strong, healthy and resilient crops. SOM not only improves the soil's water retention but also strengthens infiltration-diminishing runoff which is important to fight against drought (Díaz-Zorita et al. 1999). It also has the characteristics of surface soil aggregation, which tightly holds the soil particles during rain or windstorm (Magdoff &Weil 2004, Weil &Magdoff 2004). Many peasants commonly manage polycultures and/or agroforestry systems in dealing with climatic change. For the design of climate change resilient agricultural systems, it is important to understand the agroecological features of traditional agroecosystems(Altieri & Koohafkan 2008).

8. Mitigation of GHGs as byproduct of Agriculture activity

We describe earlier the connectivity between agriculture and generation of GHGs (24%, Figure 5). According to another estimate, globally, agriculture accounts directly for 13.5% of GHG emissions and indirectly another 17% due to deforestation & land-use change. A major cause of rising methane concentration is particularly the increasing emission from agricultural activities involving rice, cattle, and other domestic animals (Khalil & Rasmussen 1994). Livestock farming has become the biggest anthropogenic source of global methane since 1983, and contributed 113.1 Tg methane in 1994 (Stern & Kaufmann 1996, 1998). Therefore, agriculture is part of the problem and (in combination with forestry) part of the solution to climate change. Environment friendly, smart agricultural activities would 1) help in reduction of GHGs, 2) lower demands on shrinking water resources, and 3) ensure sustainable supply of food.

Traditional systems at farm level and their insertion to diverse landscapes helps in reduction of GHGs, which in turn contributes to reduction in global warming (Tscharntke et al. 2005) (Figure 10). Traditional farms and their diversification do not rely on agrochemical inputs, like fertilizers and pesticides. Traditional practices use less energy, fertilizers and pesticides (Niggli et al. 2009), and keep N_2O emission low because of low N_2 inputs.

Tropical small farmers use diversified agroforestry systems (DAS) and they produce food crops combined with growing trees for the purpose of timbers, firewood and other trees' products. The traditional systems have high diversification in small lands and protect soil from erosion, provide nutrients, and decrease dependency on synthetic fertilizers (Montagnini &Nair 2004). Evidences support that DAS reduces soil erosion and have low GHG emission (Mutuo et al. 2005). Carbon standing stock above the ground is high in the agroforestry as compare to the lands without trees, and in comparison with field crops, DAS have high potency to sequester carbon. This is because of the fact that trees in pastures and croplands can sequester carbon above and below the ground (Domke et al. 2020). In comparison with annual crops, perennial crops (like coffee and cacao) with agroforestry can sink high carbon contents.

Agroforestry potential for controlling GHG emission is not limited to sequestering carbon.-Studies reveal that agroforestry is able to control and reduce CO_2 and N_2O emission and also elevate strength of methane sinks (Mutuo et al. 2005). Study in Peruvian Amazon shows that agroforestry reduces N_2O emission less than a third compared to annual crop system with high fertilizers inputs and half to the crops of low fertilizers input levels. Data collected from different countries suggested that CH_4 emission can partially be offset by agroforestry as compare to high systems that intensify the emission of CH_4 (Montagnini & Nair 2004). Different traditional agricultural methods, like intercrop usage, use of green manures, tress incorporations, and organic manures, can enhance the sequestration of soil carbon (Stigter et al. 2005). Such agricultural practices can greatly increase the soil organic matter and, in turn, improve the soil structure. Intergovernmental Panel on Climate Change (IPCC) have pointed out the increased carbon level as mitigating option. Reduction estimates of CO_2 through carbon sequestering is 3.5-4.8 Gt (which is around 55-80% of total GHGs) and 2 to 3% reduction of NO_2 (Niggli et al. 2009).

Dense human population in the Brazilian Amazon region have produced oxisols for 2500 years, leaving behind the 'Terra Preta' rich soil. Incomplete burning residue (left behind by the Amerendian population) is rich in black carbon which, in combination to oxisol, gives 'Terra Pretta'. Black carbon is microbially and chemically stable due to its highly aeromatic structure and can persist for centuries in the environment. High fertility of Terra Preta soil is due to high level of nutrients-holding capacity, soil organic matter (SOM) and high phosphorous, nitrogen, potassium, and calcium levels, moisture holding capacity and higher PH value than the surroundings. This dark soil serves as the source of CO_2 sink. Amazon dark earth stocks CO_2 147–506 Mg C ha^{-1} m^{-1} and the Belterra area 72–149 Mg C ha^{-1} m^{-1}. In Amazon dark earth there is high carbon ranging from 1.5 to 4.6, especially in a topsoil (0–30 cm depth). The top soil is agronomically important for agriculture activities (Sombroek et al. 2003).

9. CONCLUSION

Agriculture and food security would be drastically affected under unrestrained climate change. Since the current global warming is generally considered to be related to the release of GHGs during the burning of the fossil fuels, international commitment for appropriate measures, vis a vis reduction of GHGs in the atmosphere, are emergently required before the situation goes out of control. Adaptation measures, such as conservation of water, use of organic fertilizer, cultivation of drought and salt resistant crop varieties, integrated pest control, hydroponics and, of course, reducing GHG in the atmosphere would be needed to protect agriculture from the negative impacts of climate change. Additionally, it is highly imperative that actions are taken in the areas of consumption and production trends, research, and mass education regarding adaptation and changing of life style, which will help to better understand climate stresses, economic losses and alternative methods and approaches. The policies, investments and implementation strategies should emphasize on an integrated, evidence-based and climate smart approach and efficient irrigation methods to addressing food security at all levels, from international to National to local, and across private, public and civil society sectors to achieve the scale and rate of change required.

Acknowledgement: Zabta K. Shinwari read an earlier draft of the paper and offered suggestions and comments for improvement. We would also like to thank K. Muazim for useful suggestions.

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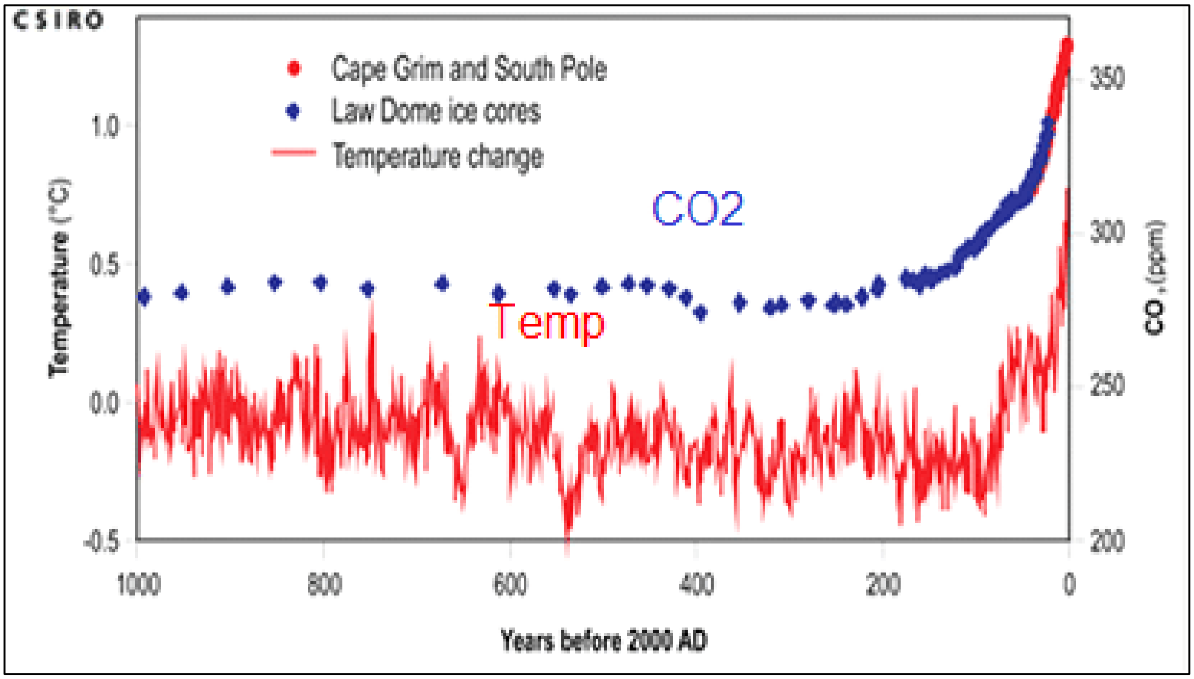


Figure 1. Carbon dioxide and temperature trends during the last 1,000 years (source SCSIRO). Note the sharp rise in the two during the last 100 years.

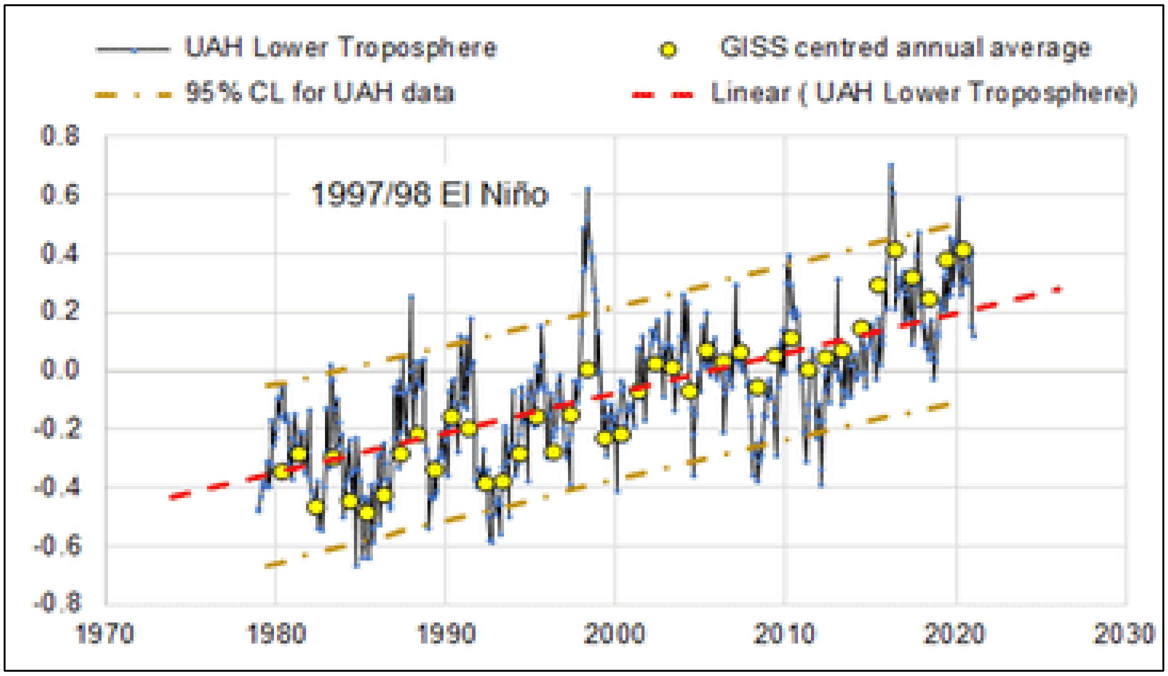


Figure 2. Comparison of UAH lower tropospheric temperature anomaly data with GISS terrestrial data. Both data sets are referred to the mean for 1991-2020. The GISS mean data follow the trend of the UAH monthly data. It has been suggested that tropospheric temperatures respond slightly differently to El Nino and El Nina events than do terrestrial temperatures. If correct, this could account for the UAH peaks in February 1998 and 2016, that coincide with stronger than normal El Nino events.

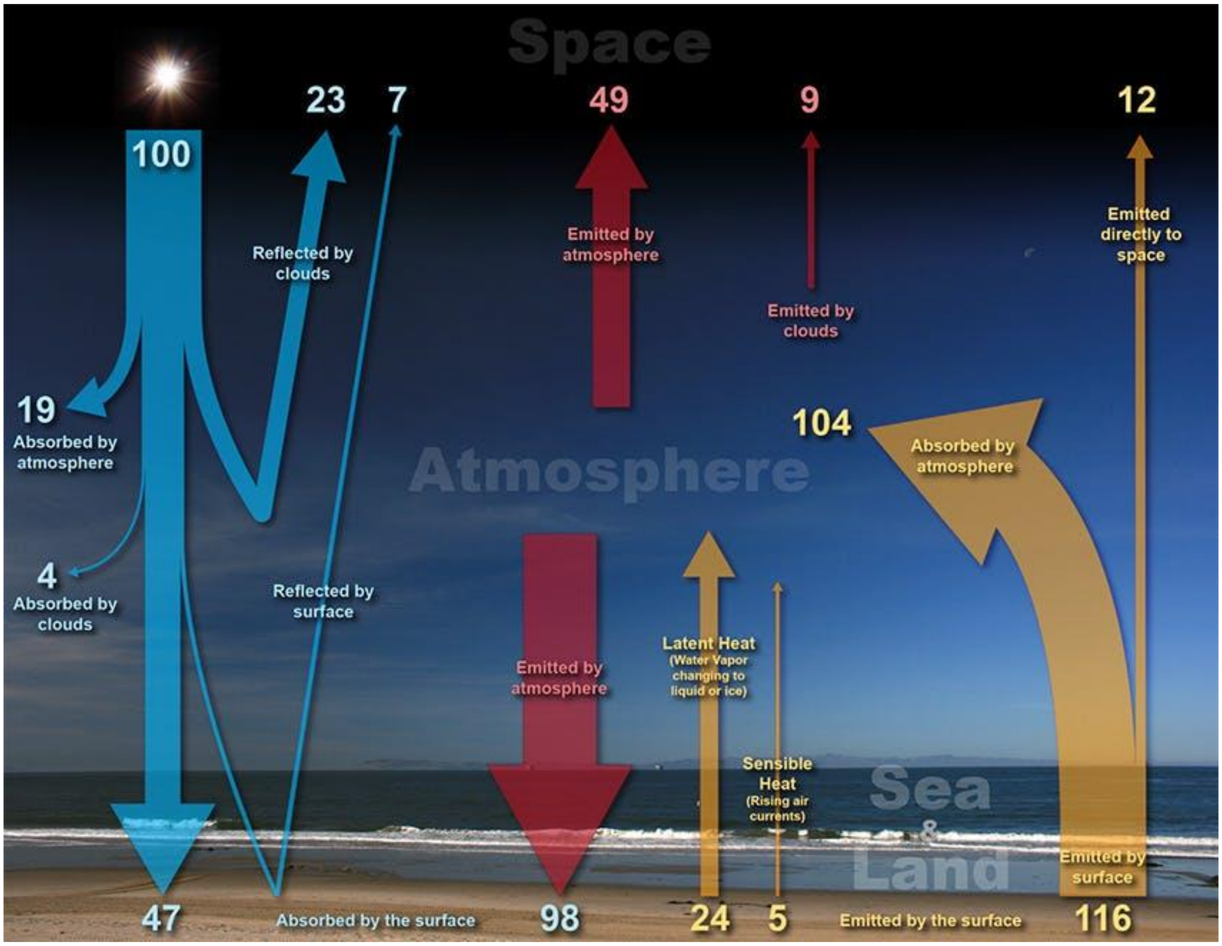


Figure 3. The diagram shows how the incoming energy from the sun is balanced with outgoing energy from the Earth. Total energy of the Sun is taken as "100", and all other figures are relative to that. (<u>NOAA from Lyon 2020).</u>

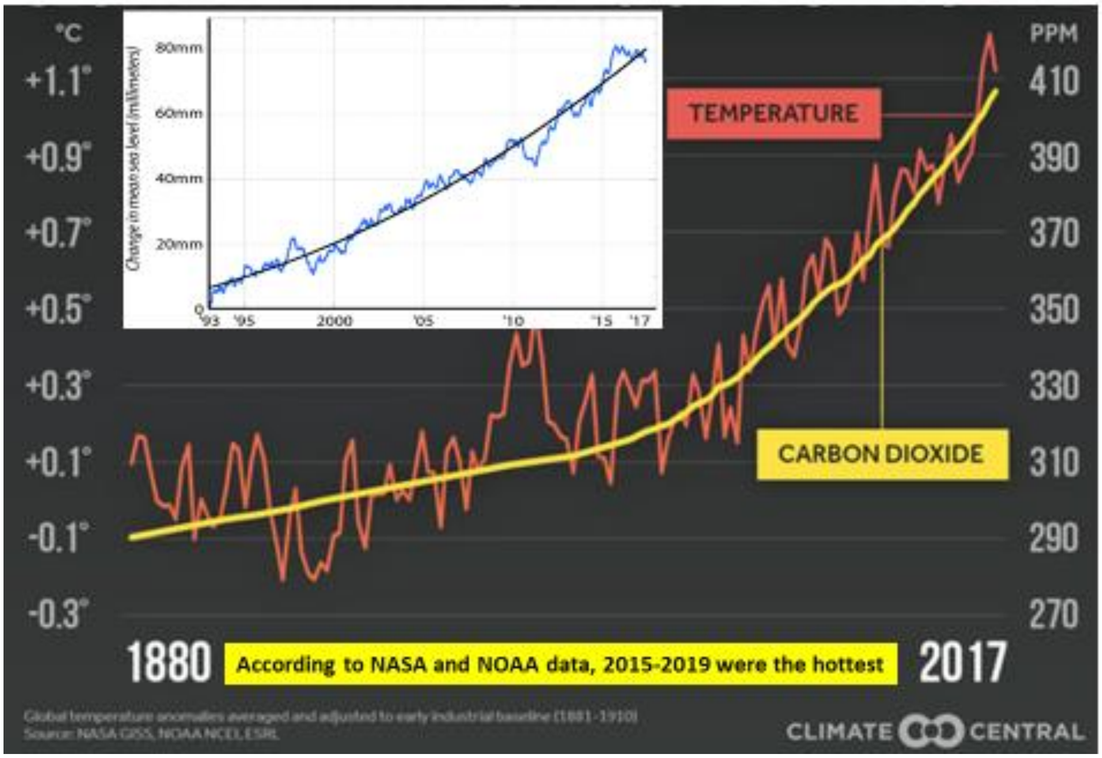


Figure 4. Composite figure showing, relation between global temperature (ºC) since 1880 and atmospheric CO_2 (ppm). Inset shows relation between the temperature rise since 1993 and rise in sea level (adapted from Satellite Data 1993-2017, University of Colorado, Boulder, NASA and NOAA).

GHG	Emission Source	Approx. Atmos. Life [1]	%	GWP
CO_2	Fossil fuels, Deforestation	Variable	65	1
N_2O	Fertilizers, Fossil fuels	114 yrs	-	310
CH_4	Landfills, Agriculture, Livestock, Natural gas	12 yrs	25	21
CFC	Refrigerators, Spray cans	45 yrs	10	-

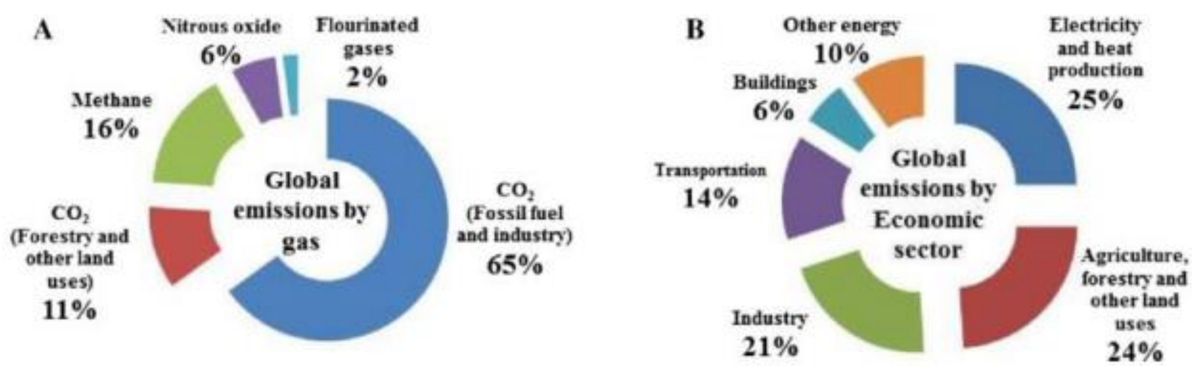
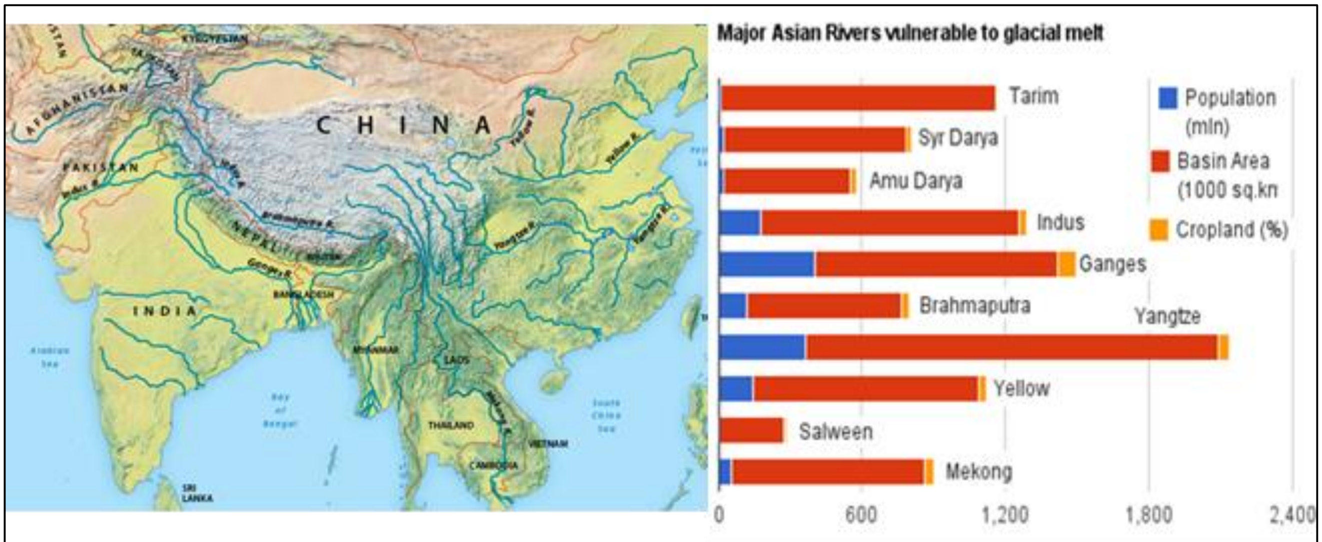


Figure 5. Top: Global Warming Potential: All <u>GHGS</u> have what is called a Global Warming Potential (GWP). This value is used to compare the abilities of different GHGs to trap heat in the atmosphere. GWPs are based on the heat-absorbing ability of each gas relative to that of carbon dioxide (CO2), as well as the decay rate of each gas (the amount removed from the atmosphere over a given number of years). GWPs can also be used to define the impact greenhouse gases will have on global warming over different time periods or time horizons. http://www.global-greenhouse-warming.com/global-warming-potential.html

Bottom: Major greenhouse gases (A) and their sector-wise distribution (B). Note the large quantity of carbon dioxide among the GHGs in A, and the large contribution of agriculture to GHGs in B.
(IPCC 2014: USEPA2014) 1. IPCC 2016).



Flow of water in m3/sec: Amu 2525, Brahmaputra 19880, Ganges 16648, Indus 6600, Mekong 16000, Salween 4876, Yangtze 30166, Yellow R 2571

Figure 6. Glacier melting, river vulnerability and threat to food security in south-eastern part of Asia. Most of the rivers can be seen to originate in the snow-covered 'Third Pole' of Pamir, Hindu Kush, Karakoram, Himalaya and Tibet. Melting of glaciers due to rise in temperature would seriously affect the food security of more than two billion people in the region.

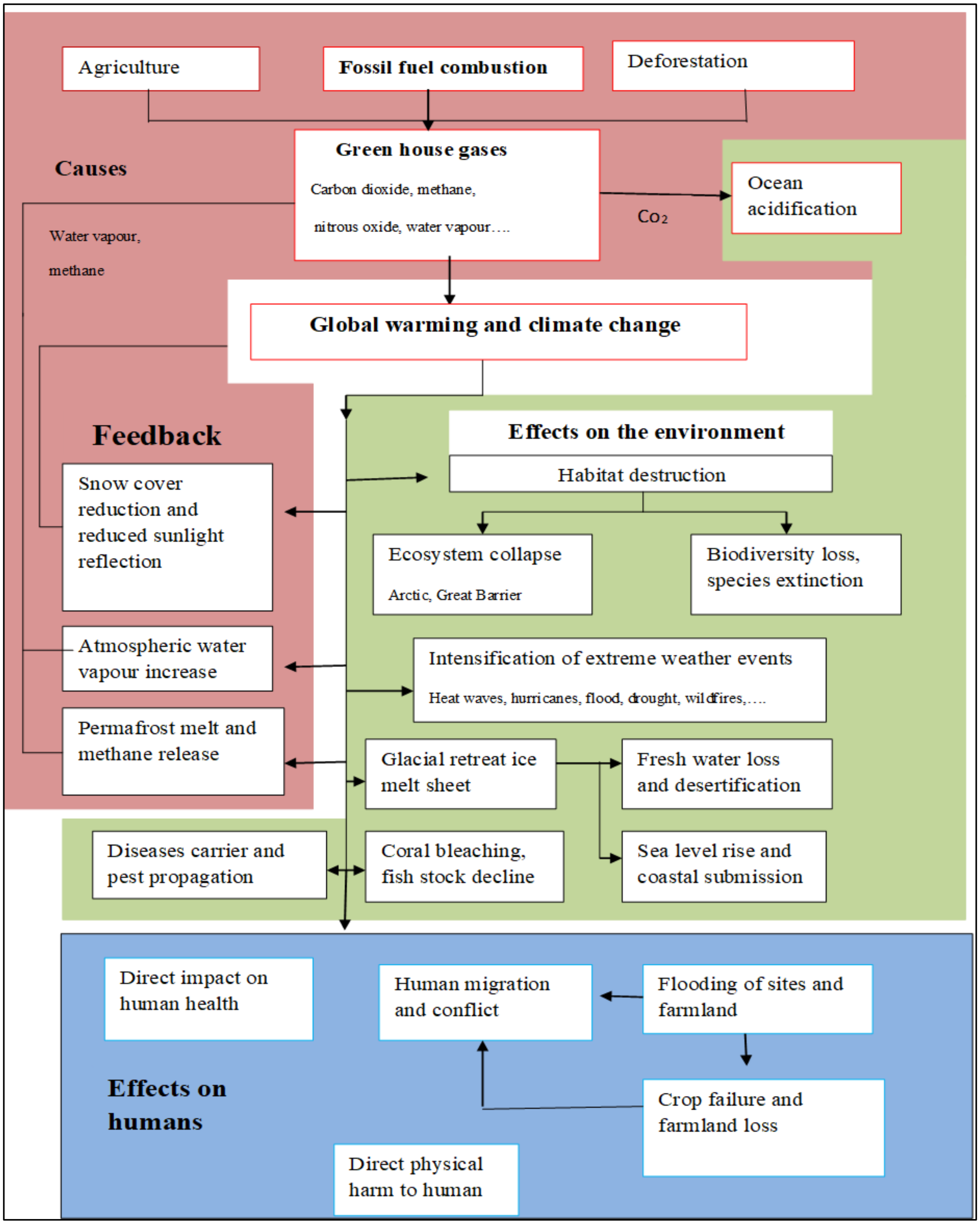


Figure 7. Climate change, global warming, feedback; causes and effects on environment and human health. Modified after http://en.wikipedia/wiki/Effects_of_climate-change

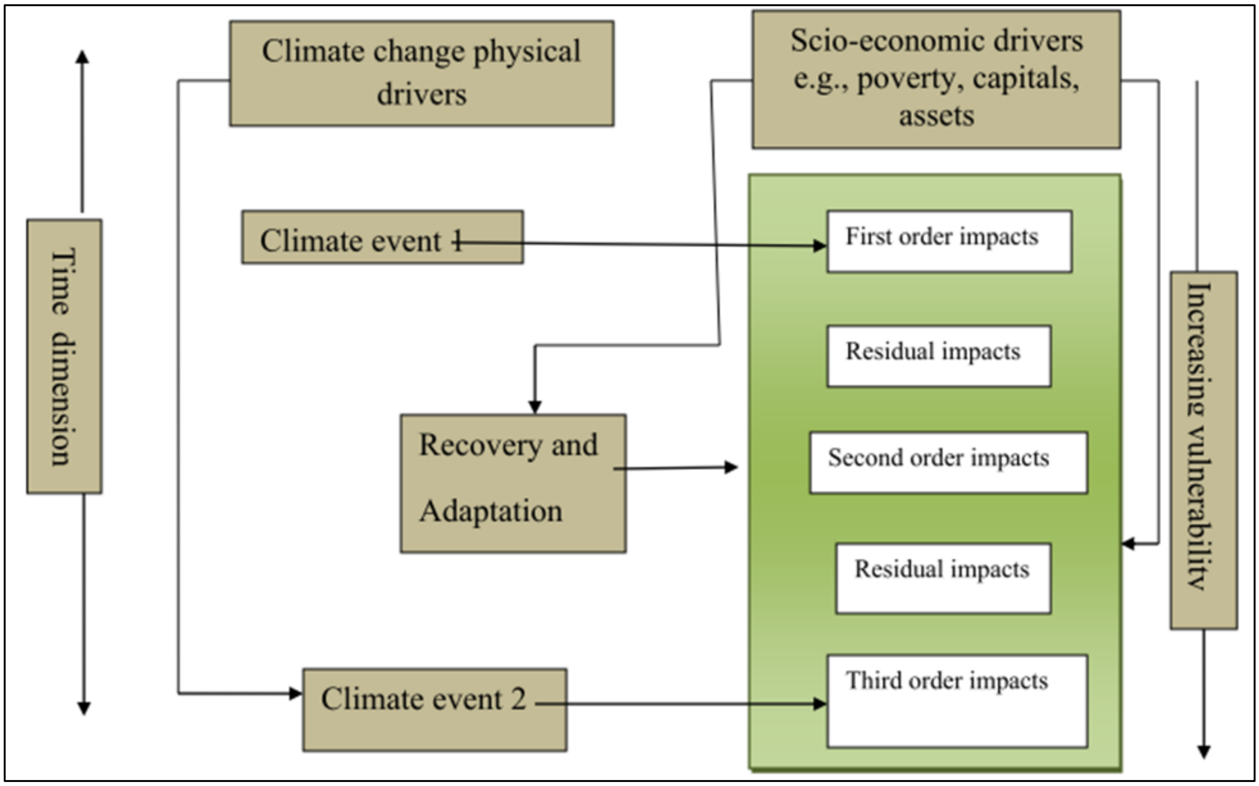


Figure 8. Climate change physical and socio-economic drivers and increasing vulnerability (modified after (Huq et al. 2015).

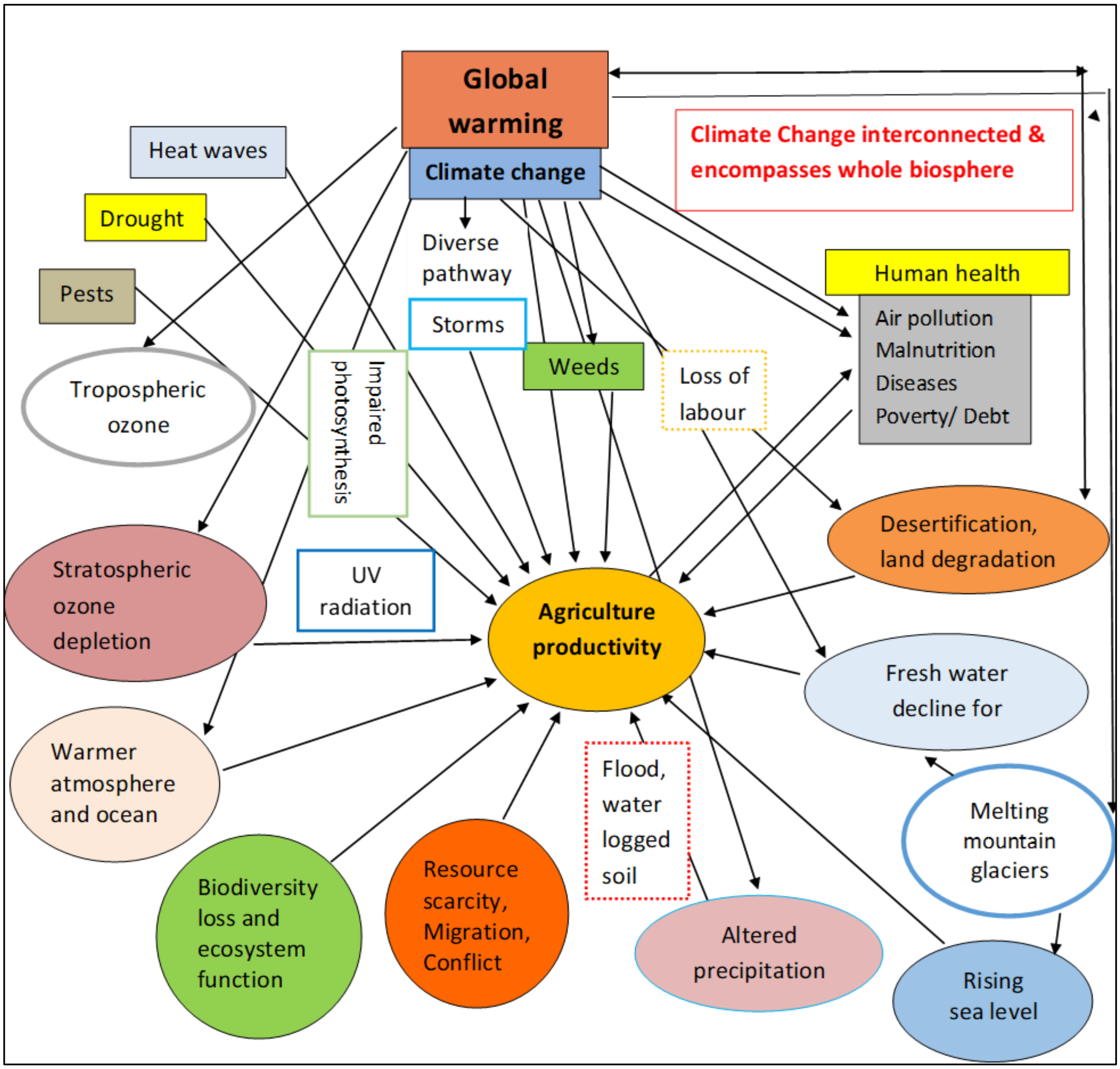


Figure 9. Interconnectivity in biosphere of the multiple impacts of global warming and climate change disruption on agriculture (modified after Climatechange-foodsecurity.org).

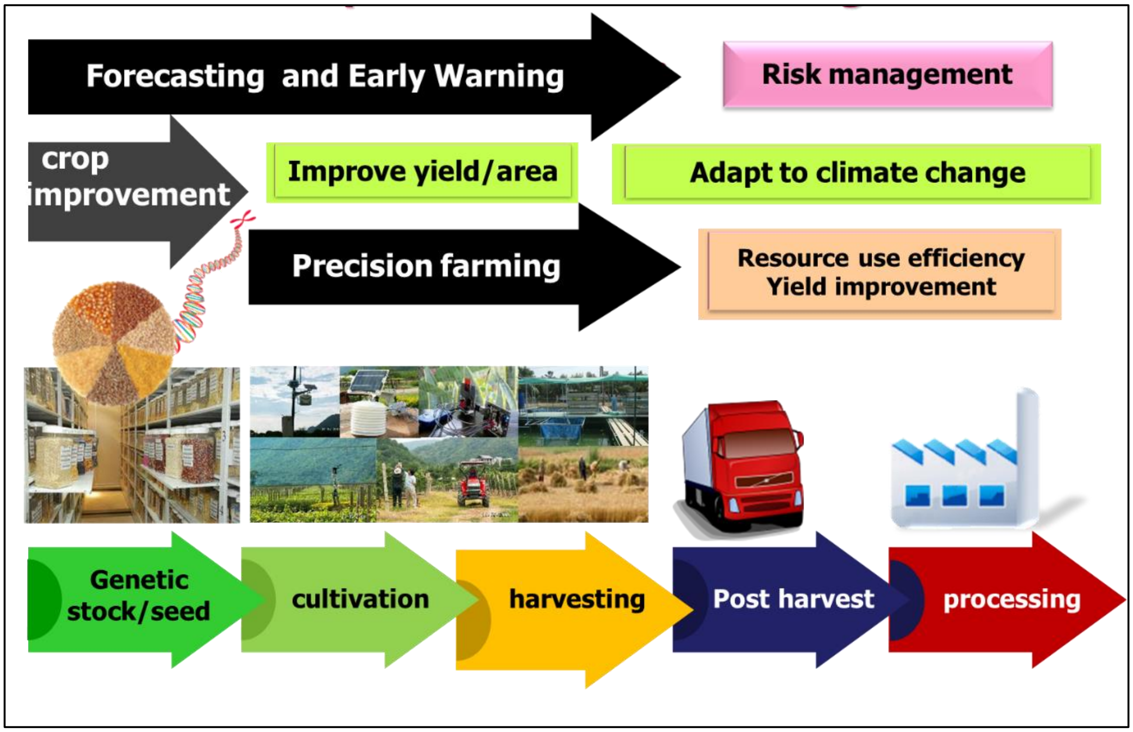


Figure 10. Technologies development for agriculture adaptation (crop and yield improvement) to cimate change (adapted from Tanticharoen, 2018, Food and National security and agriculture, AASSA Russia FNSA).

Table 1: Sector wise impacts of climate change

Sector	Potential impacts
Agriculture	Shortening of maturity period, crop failure and expanding crop diseases
Livestock	• Change in livestock feed availability and quality • Effect on animal health, growth and reproduction • Impact on forage crops quality and quantity • Change in distribution of diseases, decomposition rate, income and price • Contracting pastoral zones in many parts of the country
Forests	• Expansion of tropical dry forests, desertification • loss of indigenous species/expansion of toxic weeds
Water resources	• Decrease in river run-off and energy production • Flood and drought impacts
Health	• Expansion of malaria to highland areas • Threat from expanding endemic diseases and newly emerging varieties of human, plant and livestock diseases
Wildlife	• Shift in physiological response of individual organisms • Shift in species distribution and Shift in biomass over decades/centuries • Shift in genetic make-up of populations • Loss of key wetland stopover and breeding sites for threatening birds species • Out migration, of endemic and threatened species
Environment	Reduced productive capacity from degradation of forests, range and water recourses

LANDSCAPE OF SCIENCE, TECHNOLOGY AND INNOVATION IN THE ISLAMIC COUNTRIES
STI DEVELOPMENT, THE CENTRALITY OF GENERAL EDUCATION

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Deputy Director General for Support Programs & Functions,
The Kuwait Foundation for the Advancement of Sciences (KFAS)
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ABSTRACT

Economic growth and sustainability rests on a keen understanding of the structural, legislative and political economy of any particular region. Most policy-makers borrow indicators for STI development from context that are at odds with their regional context, such are overall R&D expenditure, specialized peer reviewed publications, the maturity of integration between academia and industry, etc. While these indicators may track the development of STI's in a mature industrial context, they may provide a misleading reading of other developing economies. This paper focuses on the centrality of general education setup, competencies, and outcomes as the baseline for STI evolution in a developing economy. It sheds light on the value of critical thinking, problem-solving and creative thinking for the evolution of STI, in opposition to the tradition focus on content driven curricula. Conclusions will be made about the types of indicators that might be used to track the transformation of general education as a precursor to STI.

NEW VISION OF ICESCO ON STI FOR ISLAMIC WORLD

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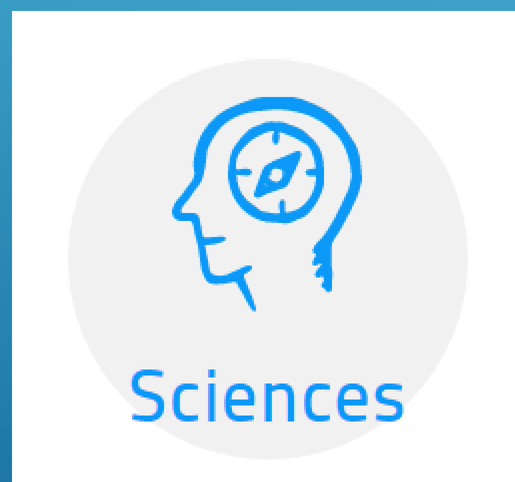
"New vision on STI for the Islamic World".

22nd conference of the Islamic World Academy of Sciences on "Landscape of Science, Technology and Innovation in the Islamic Countries"

1 December 2020

Dr. Aicha Bammoun
Director of Program
Science and Technology Sector
The Islamic World Educational, Scientific and Cultural Organization -ICESCO

Sector of Activities



"NEW VISION ON STI FOR THE ISLAMIC WORLD".

Vision

Making change through innovation and developing technology

Strategic choices:

- Create opportunities for drawing benefits from artificial intelligence and digital technologies in community development;
- Steer innovation towards adaptation to climate change and the sustainable management of natural resources;
- Create and develop innovative programs and institutions to advance joint Islamic environmental action.

Action priorities

1

Strengthening science, technology and innovation systems and policies.

2

Development of partnerships to achieve socio-economic development.

3

Achieving gender equality in science, technology, engineering and mathematics (STEM) and digital occupations

4

Capacity-building of young people in modern and cutting-edge technologies

5

Grasping problems and finding solutions through knowledge sharing and technology transfer

6

Well-being: water, food, environment and health

Making Change through innovation and developing technologies

Materialize, innovative methods, modern tools, cutting-edge and future technologies harnessed in all areas, and needs of horizontal, vertical and external interactive approaches.

Need for a greater cooperation in science and technology between developed, emerging and developing Islamic countries

Multidimensional approach requires the development of supportive, fact-based policies and systems that involve all relevant stakeholders at all levels

Develop and adopt new tools and methods, and to gain experience in harnessing emerging and future technologies to address issues that affect society

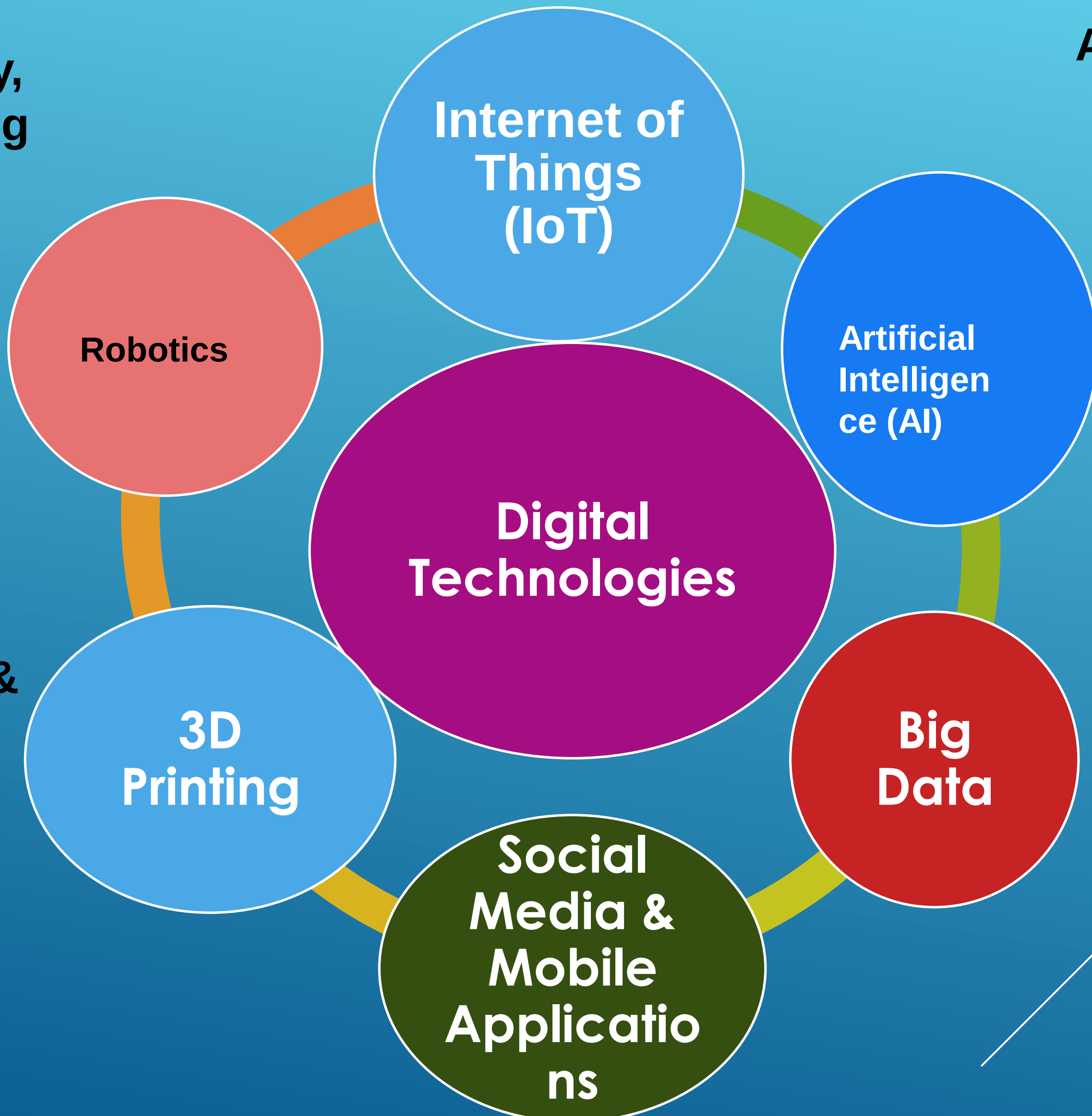
Tools and instruments to strengthen STI Policies

The World Islamic Observatory for STI shall serve as the International repository in Islamic world for Science, Technology, and Innovation (STI) data and statistics and a source of policy analysis in support of evidence based policy-making in Member States

ICESCO's Open Innovation Platform (IWOIP): Going from strategy to a stakeholder service-oriented IT platform

Digital Technologies in the 4th Industrial Revolution Era & Their Useful Applications

Medicine, Biotechnology, Nanotechnology, Energy, Environment, Food/ water safety & Quality, Agriculture, Energy, Drug Design & Production, Gene editing & Synthetic Biology, Personalized Medicine, Defense Security,…



All are Integrated Technologies.. Cross cutting

Artificial intelligence and digital technologies at the service of community development

- Promote artificial intelligence in the Islamic world
- Harness artificial intelligence and smart technologies in tackling social and economic issues.
- Improve research and development capabilities;
- Transfer knowledge of artificial intelligence and make it available to everyone;
- Identify the ethical, legal, and social aspects of artificial intelligence activities and innovations at the local, national, and regional levels

Gender Equality & STI in Sustainable Development agenda:

STI driver for sustainable development

www.un.org

1) **Gender Equality are part of the Sustainable Development Goals (SDGs)** and contribute actively to the achievements of all other SDGs

Girls and Women have demonstrated their **talent in finding solutions for** a better **live and for sustainable development**

BUT, They are untapped to become the next generations of STEM professionals. Women represent ONLY 35% of student in STEM in HE and 3% (globally) in ICT (!!)….

THANK YOU

FOR YOUR ATTENTION

NURTURING THE THINKING MIND: THE OIC DILEMMA IN SCIENCE, TECHNOLOGY AND INNOVATION

SHAUKAT HAMEED KHAN
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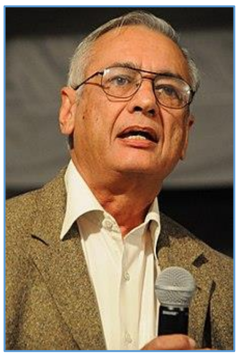
Islamabad, Pakistan

ABSTRACT



Encouraging advances have been registered in Islamic countries in the areas of higher education, science, technology, and innovation (STI). This is reflected in the tripling of scientific publications and researchers, and major investments by several countries in education and scientific infrastructure. However, a true scientific culture is conspicuous by its absence in Islamic countries, whereas this is as an essential pre-requisite for any sustainable impact on society, and most OIC countries generally lag behind other fast developing nations.

The author attempts to go beyond a simple numbers game and examines the profile of the Islamic countries related to research and innovation. Leading Centers in various disciplines in the countries are identified. Disruptions caused by the current ‘expectation’ crisis in universities and the fast-changing nature of work and the workplace are discussed. It is emphasized that the ‘knowledge worker’ in this century is not necessarily a PhD. University education in Member States must move beyond simple expansion in enrolment and faculty numbers or publications, and the focus must shift towards contemporary knowledge generation, excellent teaching, and expanded international linkages. Finally, the drivers of innovation and their impact on research and industrial is examined.

Nurturing the Thinking Mind: The OIC Dilemma in Science , Technology and Innovation

Dr. Shaukat Hameed Khan[1]

Abstract: Encouraging advances have recently been registered in Islamic countries in the areas of higher education, science, technology, and innovation (STI). This is reflected in the tripling of scientific publications and researchers, with major investments by several countries in education and scientific infrastructure in recent years. However, a true scientific culture is conspicuous by its absence in Islamic countries, whereas this is as an essential pre-requisite for any sustainable impact on society, with the result that most OIC countries generally lag other fast developing nations.

It needs to be emphasized at the outset that science and technology *alone* is not a magic wand. Lessons from numerous growth accounting studies highlight the fact that it is not possible for a country trying to pay 'catch-up' to replicate exactly those who have gone before unless there is a *strong congruence* between its *technological* and *social* capabilities. Late-comers must dance to their own music. This however needs some good orchestration! This article attempts to go beyond a simple numbers game and examines the profile of the OIC countries in research and innovation. Leading centres in various countries are identified. Disruptions caused by the current 'expectation' crisis in universities and the fast-changing nature of work and the workplace are discussed. It is emphasized that the 'knowledge worker' in this century is not necessarily a PhD. The role of the state as the agent of change for technology mediation and innovation is discussed.

1. *Introduction*: Science is nurtured by governments as much as the social norms of a country, which must be willing to embrace the pursuit of knowledge and its accompanying disruptions.

In many countries, universities have expended time and resources in modernising management systems and processes, which has tended to become market oriented, while neglecting academic *processes* and education. University education in OIC Member States must move beyond simple expansion in enrolment and faculty numbers or publications, and shift the focus towards contemporary knowledge generation, excellent teaching, and expanded international linkages.

Economic growth in the 21st C depends upon a new breed of worker, from the scientist to the ordinary employee. This is the result of the changing nature of work and the workplace, coupled with rapid technological and organizational changes, leading to innovation and productivity. Finally, the knowledge worker is not necessarily a PhD, and is the skilled worker – possessing different and, higher skills.

2. *The STI Landscape in OIC Countries.* It is difficult to avoid playing the numbers game, even though this enhances confusion because of differing metrics. This would apply to scientific research publications and their impact, and the quality of teaching and university rankings. International university rankings can vary considerably whether THE., QS, or Shanghai Rankings systems. This is all part of the current expectation crisis in the modern university.

Several parameters are examined to better understand the STI landscape and identify some leading institutions in Muslim countries. These are:

a. Number of published research articles, while taking care to avoid multiple counts and repetition (such as counting the same publication under different disciplines).
b. Quality and significance of the publication based on impact, journal where it was published, and citations received.
c. University rankings, or awards bestowed on the researcher or the institute, and patents obtained.

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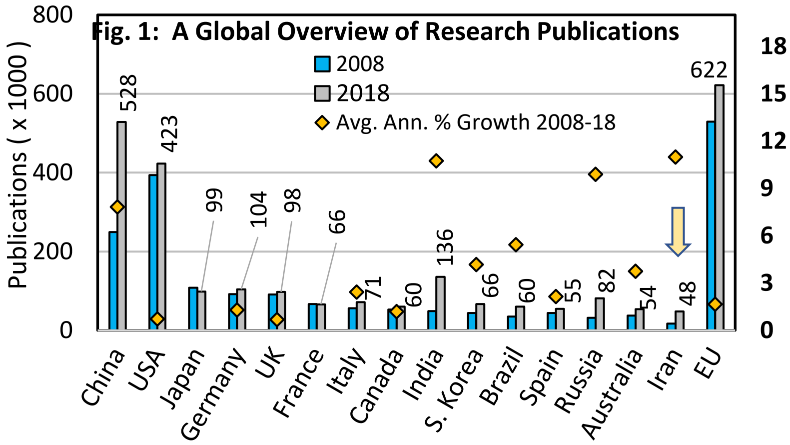
[1] *Former*: CG, COMSTECH; Rector (GIKI); Chief Scientist (PAEC) where he founded the laser programme which has evolved into a national Center (NILOP) combining R&D, teaching and production (the latter exceeding US$ 170 m). At CERN, he helped design the detector position monitoring system for the CMS Tracker, where 40 Pakistani laser systems are now operational. Fellow, Pakistan Academy of Sciences, and recipient of the President's Medal for Technology. Author of the national foresight document 'Vision 2030' at the Planning Commission (2007).

Finally, innovation capabilities are discussed based upon technological readiness of a country, share of high-technology products in its exports, patents, etc. The role of the agent of change and its role for promoting innovation is identified.

3. *The Numbers Game:* Detailed analysis of the science profile of selected OIC countries was undertaken by COMSTECH [2] for the period 2014-16. It covers life sciences, chemistry, material sciences and nanotechnology, physics, mathematics, and engineering. In addition to the databases used by COMSTECH, (Web of Science, Nature Science Index, UNESCO UIS Statistics), the author has further included data from the NSF USA, the World Bank, and Global Innovation Index.

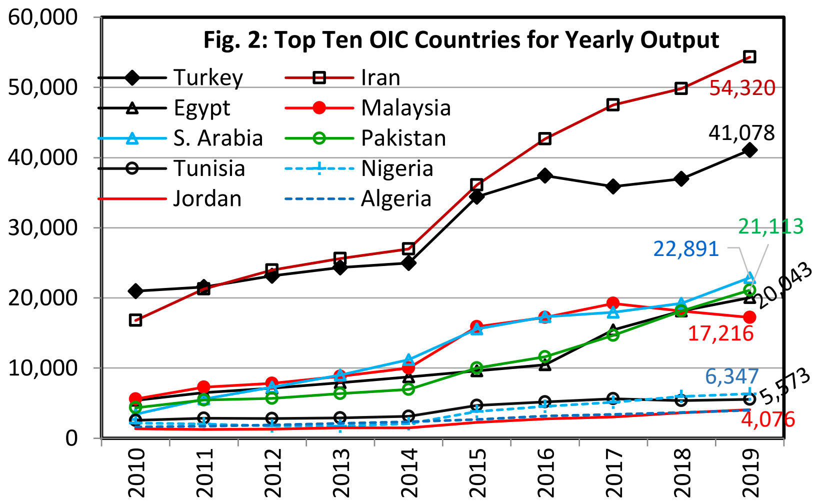
The reference point for the OIC countries would be the global research ecosystem[3]. Globally, the number of scientific publications increased from 1.76 m in 2008 to 2.56 m in 2018 (~ 4 % a year) in the top 15 countries *(**Fig. 1**)*. Percentage share of publications from China, USA and EU was 21%, 17% and 24% respectively in 2018. *Iran is the only OIC state in this list of the top 15 globally, growing the fastest (~11%)*



Japan shows a decline of 0.91 % between 2008-18. China emerges as the leader in sheer numbers, while impact was highest for the USA (NSF 2020). *In 1980, only 5 countries did 90% of all science — the United States, the United Kingdom, France, Germany, and Japan, now[4] there are 20 countries within the top producing group.* Interestingly, the *highest growth rate* was observed for India.

However, there is rising concern worldwide about the role of on-line Journals, which publish on payment, resulting in poorly reviewed articles coupled with cross-country authorships, and fake citations. India alone is home to 42% of such fake journals [5].

From 2009-2019, *the total publications[6] from all OIC states grew from ~ 67,300 to ~ 222,000, (3.3 times),* while OIC global shares increased from 3.8 % to 8.7 %). ***Fig 2*** shows the time trends for top 10 OIC countries.



*Malaysia saw a decline after 2017 (returning to figures of 2015)***.** Pakistan and Egypt grew the fastest. Share of OIC in *top elite journals*, however, was only 0.1% while OIC share of global patents was 1.8%.

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[2] *'Nurturing the Thinking Mind';* Ten Year Plan presented by COMSTECH at the OIC Summit on S&T, Sep. 2017. Also: COMSTECH Series of Reports on Publications Profiles of OIC States; (*Ed:* S. Khurshid Hasanain, 2017-18)

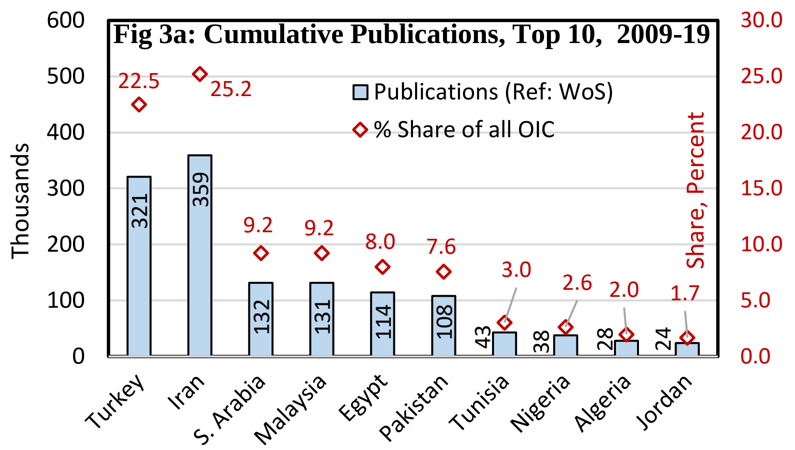
[3] *Report on the S&E Indicators, 2018*, NSF, 2020. See also: *Nature Briefing, 27 Dec. 2018*

[4] *Caroline Wagner,2020 (science and technology policy analyst at Ohio State University)*

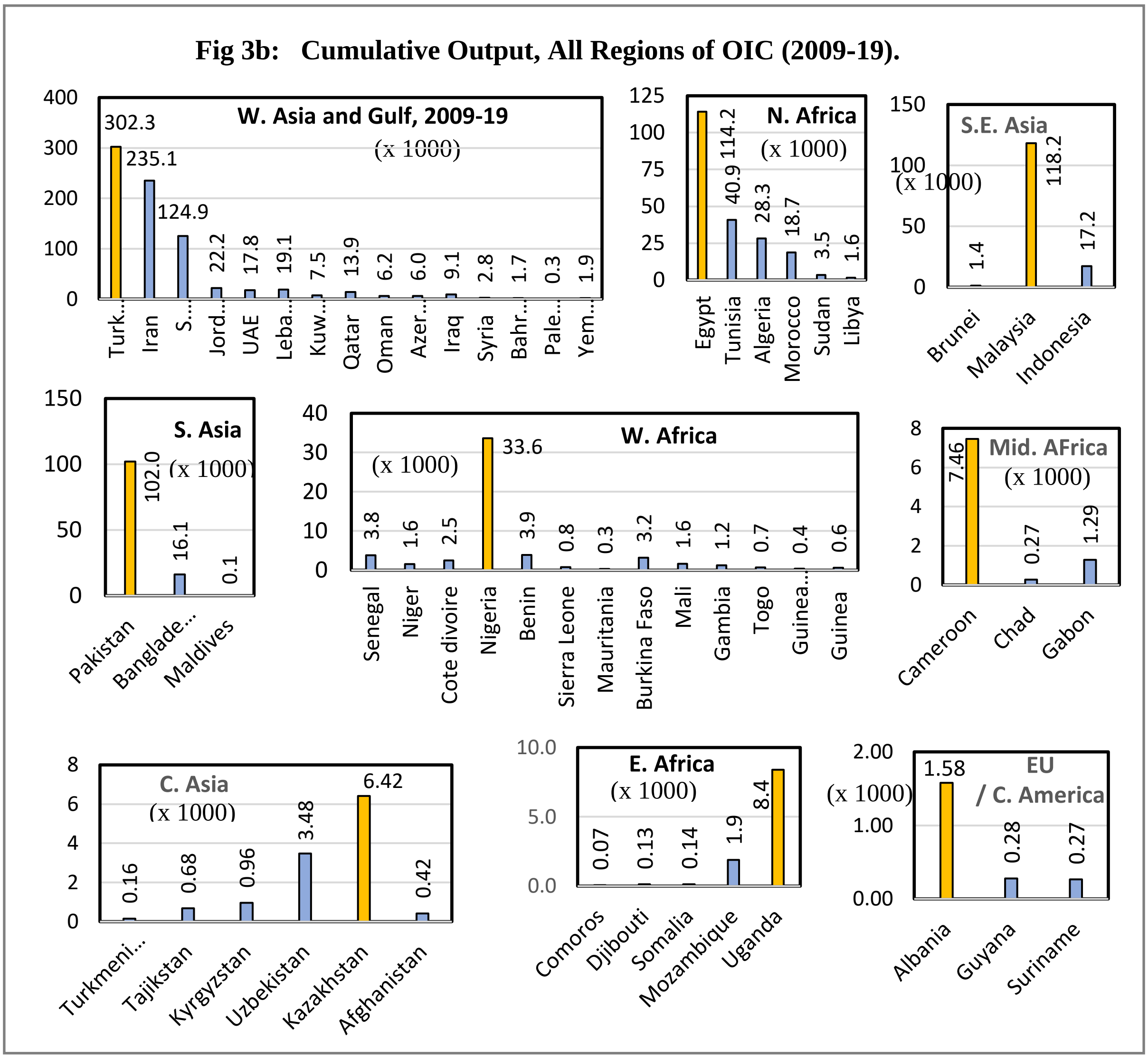
[5] *Fake Journals_ Make in India Gone Wrong;* R. Prasad, The Hindu, Oct. 2015

[6] *ISI Web of Science (WoS)*; Science Citation Index Expanded – 1975 to present.

Figures 3a, 3b show the cumulative number of research papers during 2009-19 by the top 10 OIC countries (1,298,641 or 91%), with a total of 1,425, 298 from all 57 OIC states. Iran and turkey dominate in this period, producing nearly 48% of the total. Data from S. Arabia is interesting and needs greater study because of suggestions that this is the result of extensive international collaboration, which includes visiting scientists from other countries.



A regional comparison within OIC is shown in ***Fig. 3.b,*** with the leading country highlighted.



The next section attempts to deal with the matter of quality and identification of leading centres of education and research.

4. ***Quality Matters:*** There is considerable concern globally about the quality of journals where much research is published. An alternative quality index has recently been initiated by the prestigious journal, Nature. This index is obtained by *counting and weighing* the number of publications from a country or institute, that appear in a limited set of the 82 *most elite* journals of science (selected by a panel of leading active scientists, independently of Nature Research), and reflects 'researchers' perceptions of journal quality, rather than using a quantitative measure such as impact factor (IF), which varied[7] from <1 to over 32 in 2020 for different journals.

The journals included in the first release of the Nature Index account for close to 30% of total citations even though they represent less than 1% of the journals covering natural sciences in the Web of Science / Thomson Reuters. The list of the Journals may be seen on the Nature Index website. The Nature Index recognizes and evaluates within the following four different categories: (i) Physical Sciences; (ii) Natural Sciences; (iii) Chemistry and (iv) Earth and Environmental Sciences.

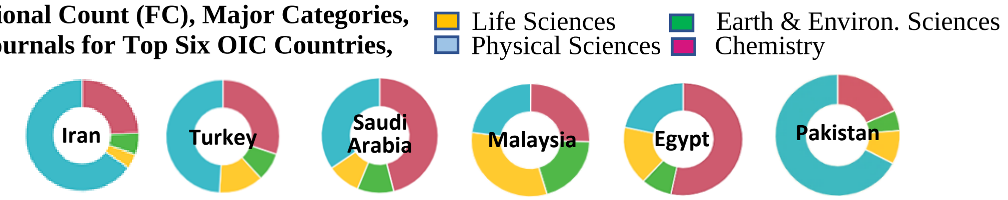
This section examines the publication profile[8] for selected fields for the period 2013-16, based on the analysis carried out at COMSTECH in 2017. Islamabad, which has prepared extremely detailed profile for several countries. This has been partly reported in the COMSTECH document prepared for the Extraordinary OIC Summit on ST held in Astana, Kazakhstan in September 2017.

The numbers data in **Figs. 2,3** in the previous section is examined further. The method adopted combines seven criteria for assessing performance and quality. These are: ***a:*** Number of publications in specific fields, 2009 - 2019; ***b:*** Nature Index; **c:** Total Citations of the selected publications 2013-2016. ***d:*** QS Ranking of universities by subject. ***e:*** Research Facilities ***f*** **:** The Institution's own contribution in research work. ***g:*** Awards to researchers and institutions together with patents filed or granted.

The selected fields[9] among the *basic sciences* are Life Sciences, Chemistry; Physics and Mathematics; Biomedical Sciences; Earth & Environmental Sciences; and Agriculture. The *Engineering sciences* are also examined; these include:(i) Chemical/Petroleum Engg., / Mining /Minerals. (ii). Electrical / Electronics / Computer Sciences / IT. (iii). Mechanical & Aeronautical Engg. *and* iv). Civil and Structural Engineering.

The Nature Index consists of 3 parts: (i) Article Count (AC); (ii) Fractional Count (FC); and (iii) Weighed fractional Count (WFC). The WFC indicator allows filtering of factors such as national / multinational collaboration, multiplicity of authors and affiliated institutions, as well as weighing the articles in the selected and by balancing the relatively higher number of publications (AC) in these selected journals. For the top six OIC countries, the Nature Index (Oct. 2019 - Sept. 2020) gives interesting[9, 10] results (Table 1). The broad breakdown of research specialisation is shown in **Fig 4**.

Fig 4: Fractional Count (FC), Major Categories, in 68 Elite Journals for Top Six OIC Countries, 2019



#	Country	Iran	Turkey	S. Arabia	Malaysia	Egypt	Pakistan
	Table 1: Publications & FC according to NATURE Index Data. (1st October 2019 to 30 September 2020)						
1	**From ISI Web of Science**	54,320	41,078	22,891	17,216	20,043	21,113
	With Nature Index applied to ISI Web of Science, the numbers change drastically						
2	**AC (Article Count)**	290	372	439	134	188	198
3	**FC (Fractional Count)**	121.01	72.38	140.81	10.96	14.05	23.19

[7] Annual Reviews: Rankings in Journal Citation Reports (Clarivate Analytics) 2020

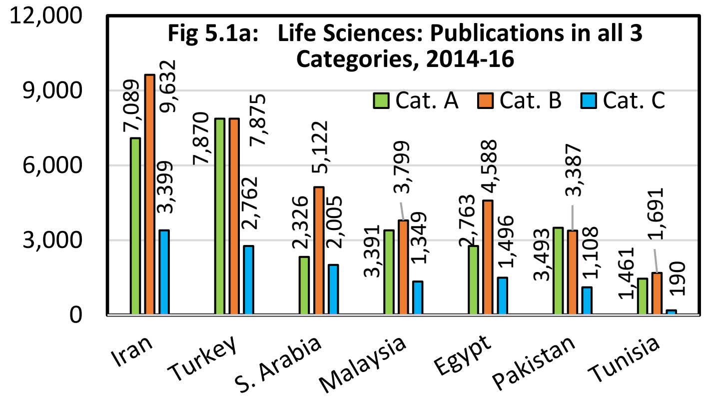
[8] *Ten Year Plan of Action*; COMSTECH's Working Document for the OIS Astana Summit, Sep. 2017.

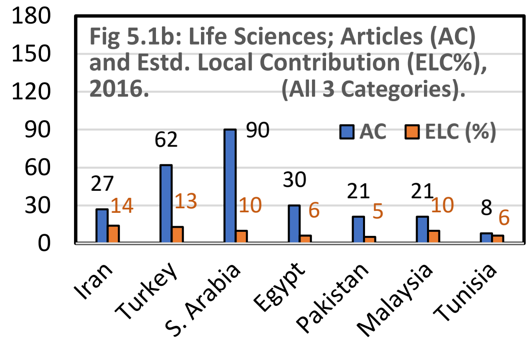
[9] *Comparative Analysis of 7 Leading OIC Countries (2014-16)*. Ed: Dr S. Khurshid Hasanain, April 2018.

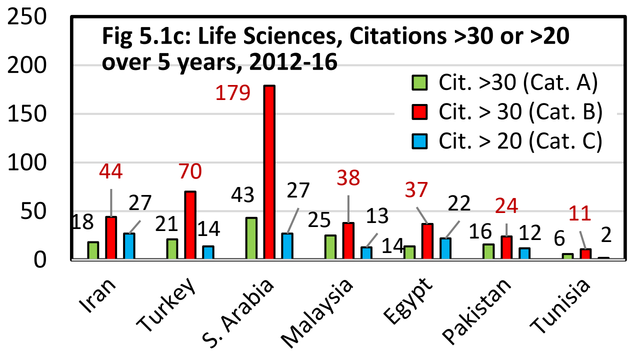
[10] *Nature Index:* Data from Sept. 2019 - Aug. 2020.

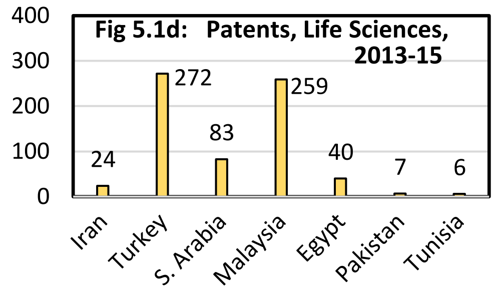
5. ***Top Seven Countries by Field:*** Total publications, papers with high citations (≥ 20 to 40), patents, and leading institutions for seven selected countries are examined next. The Web of Science lists publications in over 10,000 journals while Nature Index now covers 82 elite journals in 2019 (which partly explains lower figures in article count, falling from thousands to ≤ a hundred in some fields. It must be remembered that a true citation profile emerges after about 3 years.

5.1 Life Sciences: **Figures 5.1a - 5.1c** provide a glimpse of the research profile and its quality in the life sciences for 2014-16. The three categories considered were: Agricultural and Life Sciences (Cat. A); Biology and Biological Sciences (Cat. B); and Pharmacological Sciences (Cat. C).



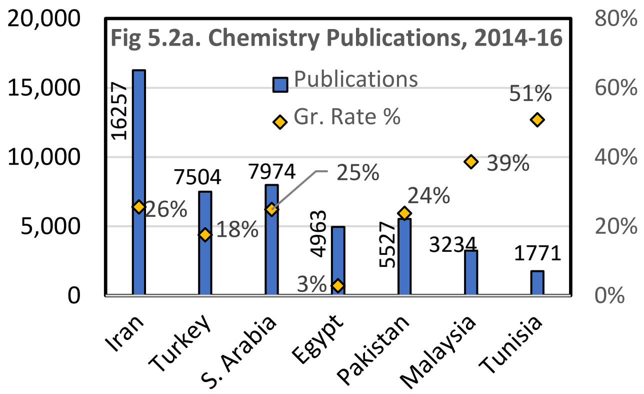


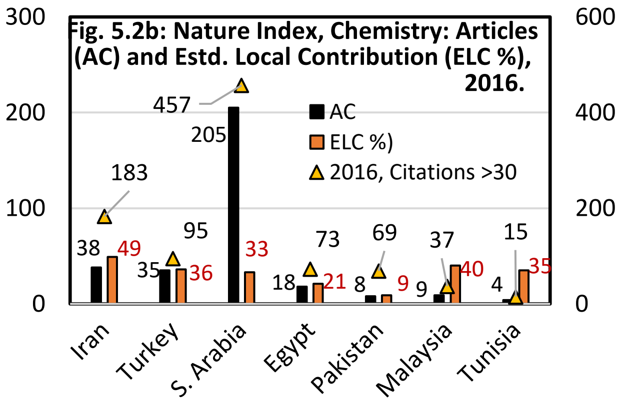




Cat B (Biology and Biological Sciences) appears more popular for all the selected countries, and Saudi Arabia has the highest number of articles[11] with citations ≥30. The article number (AC) in the Nature Index, Fig 5.1(b), helps to eliminate multiple counting by converting it to Fractional Count (FC) to allow for estimation of authors of institution(s) or country, and the estimated[12] local contribution (ELC) varies from 6% to14%. Another indicator, patents, is a useful indicator for innovation or technology transfer. These are dominated by Turkey and Malaysia.

***5.2 Chemistry*.** For the period 2014-16, Iran again leads in article number, followed by S. Arabia and Turkey, (the former leading in total citations). According to Nature Index,[13] KAUST, (King Abdullah University of Science and Technology, Saudi Arabia) appears at 84 in the top 100 global institutions in chemistry in 2019. It has strong international collaboration (>98% share in publications).





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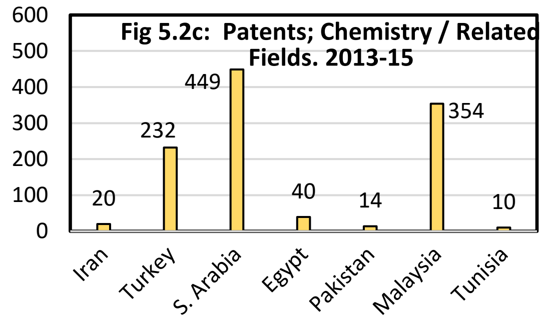
[11] ISI Web of Science (WoS); Science Citation Index Expanded – 1975 to present

[12] Estimated Local Contribution (ELC) according to Nature Index. 2018. ELC) = (FC/AC) x 100

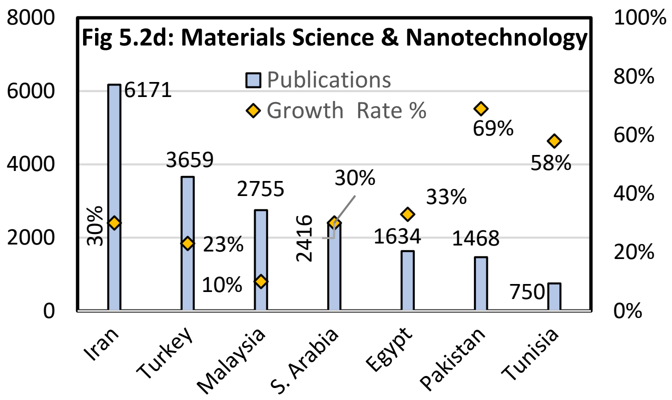
[13] https://www.natureindex.com/annual-tables/2019/institution/all/chemistry. (Top 82 Journals).

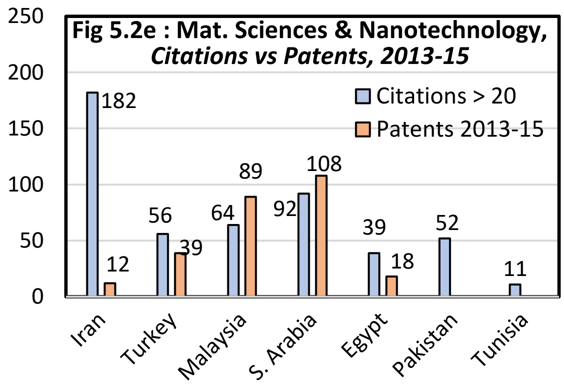
New materials and pharmacology are a major driving force in this broad area of chemistry. The Egyptian origin scientist, Ahmed Zewail, is the only Muslim Nobel Laureate in Chemistry (1999), but his work has been carried out primarily in the USA. *The environment matters.*



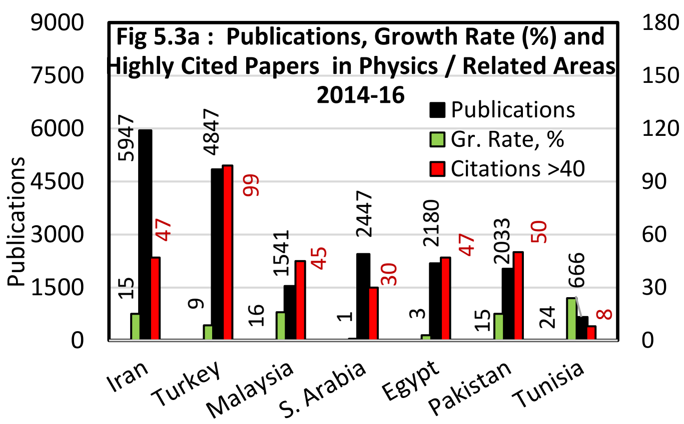
In chemistry, the average citation/article over the three-year period 2014-16 for the seven countries[14] was S. Arabia *8.98*; Malaysia *4.68*; *Iran* 4.19, *Turkey* 4.14; Egypt *4.09*; Tunisia 3.62, and Pakistan *3.0*. S. Arabia led in patent filings, followed by Malaysia and Turkey.

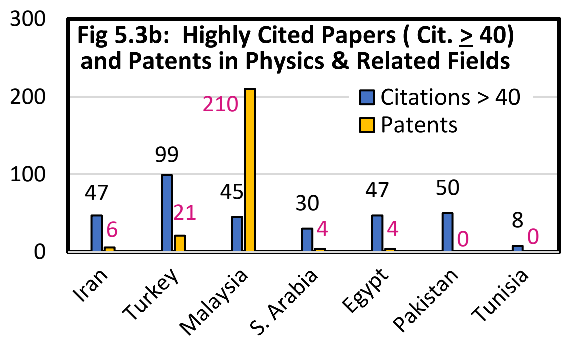
Material sciences, and nanotechnology have a natural overlap with chemistry, physics, and computer-generated / designed molecules.





***5.3 Physics and Mathematics*:** Physics is facing diminishing interest and expectations in academia, and many departments around the world lapsed at the beginning of the century except those which were strong in astronomy and particle physics, whereas biology/ biotechnology /pharmacology and IT are experiencing a boom. Fortunately, several physics departments have reopened on the strengths of the combination of mathematics with astronomy and space, particle physics, nanotechnology, and materials, among others. The only Muslim Nobel Laureate in Physics was Abdus Salam from Pakistan, who spent his active academic life outside his home country. *The environment matters.*





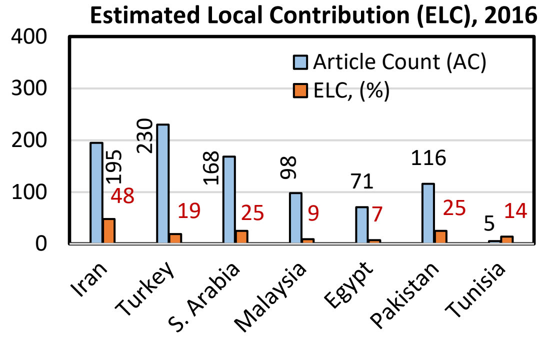
For the seven selected countries, the average citation per paper during 2014-16 for physics was highest for Pakistan (6.38) followed by Iran (3.38), Turkey (6.10), Malaysia (5.70), S. Arabia (5.26), Egypt (4.86), and Tunisia (2.80). The most highly cited papers (Fig. 5.3c, citation >40) emerged from Turkey, followed by Pakistan, Egypt, Iran, Malaysia, S. Arabia, and Tunisia. **It may be noted that Nature Science Index does not evaluate the work done in mathematics or engineering.**

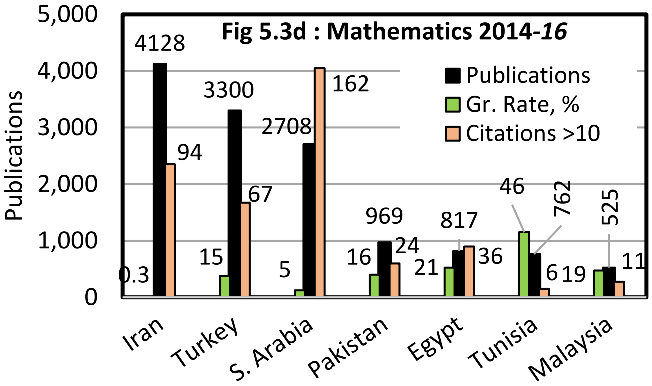
[14] *'Comparative Analysis of 7 Leading OIC Countries, 2014-16'.* Ed: S. K. Hasanain, COMSTECH Report; 2018

Patents in physics-related fields were highest in Malaysia, which shows a well-developed linkage with emerging industries. Patents are elaborated further in Section 6.2.

Many publications in mathematics are related to other fields, categories, and sub-categories. All data bases such as Web of Science. Nature Index acknowledge this and COMSTECH attempted to overcome this issue through its locally developed algorithms. Fluid flow, thermodynamics, economic statistics, numerical analysis, and several engineering related categories publish many mathematics related articles.

Fig 5.3c: Nature Index. Physics. AC & Estimated Local Contribution (ELC), 2016

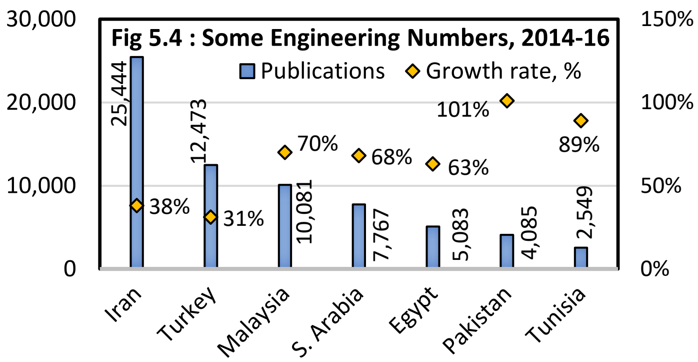




The case of materials sciences and nanotechnology, **(Figs. 5.2d and 5.2e)** illustrates this overlap with physics, since the journals where such articles are published include many sub-categories such as materials, physics, engineering, computer designed molecules, and semiconductors, among many others.

> While one attempts to make sense of the numbers given earlier, it is necessary to emphasize the rising concern about metrics such as Impact factor (IF) and the H-index which are often hidden in the activity of international collaboration which receives high percentage marks in global university ranking systems, as it is supposed to represent global ‘reputation’ and ‘attractiveness’ of the institution.

Some numbers related to engineering, agriculture and environment, and earth sciences are shown in Figures 5.4 – 5.6. The average IF ranged between 1.1 and 2.09 for the selected countries in agricultural and environmental sciences during this period.



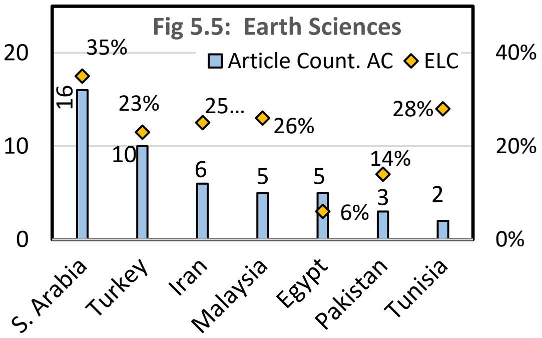
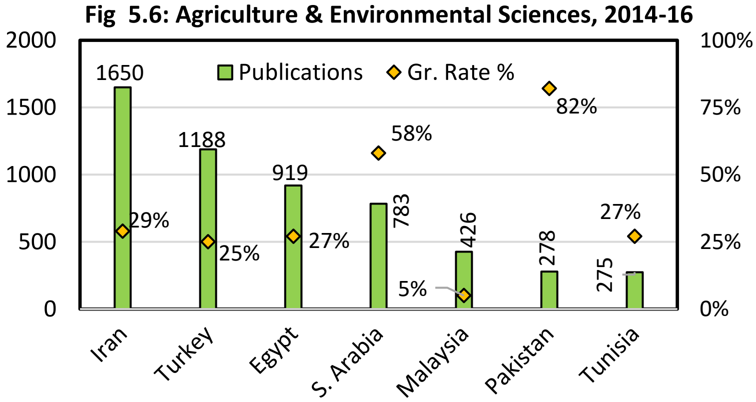
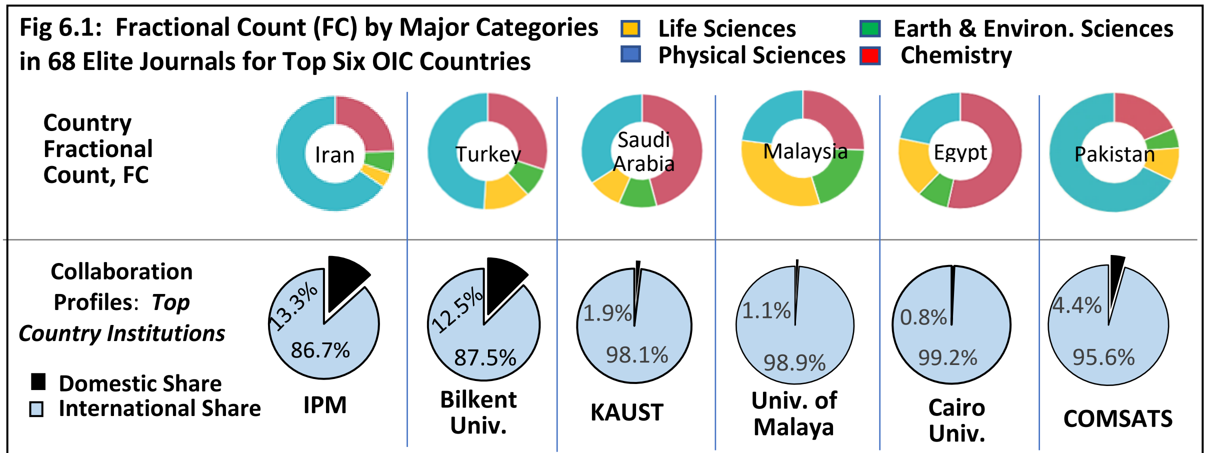


Fig 5.6: Agriculture & Environmental Sciences, 2014-16



6. *International Collaboration.* A useful 'global' index in the Nature Index country data lists the share of domestic vs international share in publications, the top ten collaborating countries, and the top ten institutions of that country. **Fig. 6.1** shows the counts and share of publications[15] for the period October 2019 - September 2020.

Fig 6.1: Fractional Count (FC) by Major Categories in 68 Elite Journals for Top Six OIC Countries



Source: **Nature Country Index, October 2019 – September 2020 .**

The collaboration profiles show *small* domestic (internal) collaboration and *high* 'international linkages' for all six countries except for Turkey and Iran.

This makes partial sense as it is natural to build partnership with the best institutions in the world. Moreover, the Gulf countries and Saudi Arabia are expending considerable resources in inviting foreign scientists to their institutions for short periods, besides sending large numbers for studies in the EU and North America. The drawback is that this diminishes a truly local science culture while encouraging papers for well compensated, short-term, visiting scientists.

Data for UAE's leading university (Khalifa University of Science and technology) depicts zero local contribution, it is all "international' contribution to research publications!

***6.1 Some Leading Universities / Institutions*:** The university ranking metrics vary from one ranking organization to another, and the author will not attempt to rank them. However, the following names appear in nearly all rankings related to the natural sciences:

- ***a.*** **Iran:** *Institute for Research. in Fundamental. Sciences* (IPM); *Sharif University of Technology; Iran University of S&T;*
- **b. Turkey:** *Hacettepe Uniersity*.; *Middle East Technical. University* (METU); *Bogazici University*; *Bilkent University*; *Istanbul Technical University.*
- **c. Saudi Arabia:** *King Abdul Aziz University* (KAU); *King Abdullah University of S&T* (KAUST); *King Fahad UPM (KFUPM). King Saud University* (KSU).
- **d. Malaysia:** *Universiti of Malaya* (UM); *Universiti Sains Malaya* (USM); *Universiti Technologi Malaysia* (UTM); *Univ. Kebangsaan Malaysia* UKM);
- **e. Pakistan:** *Quaid-e-Azam Univ.*, (QAU); *COMSATS Univ.*; *Karachi University* (KU); *National University of S&T* (NUST); *Punjab University*; *University of Agriculture, Faisalabad* (UAF), *PIEAS.*
- **f. Egypt:** *Cairo University*; *Ain Shams University*.
- **g. Indonesia:** *Bandung Inst. of Technologi; Indonesian Inst. of Sciences* (LIPI)**;** *Bogor Agric. Univ*. (IPB);
- **h. Jordan:** *Jordan University of S&T***.**

In engineering and technology, the top institutes are shown in Table 2**.**

[15] Nature Country Index, Oct. 2019 – Sept. 2020. (*Note*: Other ranking agencies have differing University ranks)

Table 2: **Top 5 Institutions[16] in Engineering and Related Fields**				
#	***Chem./ Petrol., Mining & Minerals***	***Electrical/Electronics, CS, & IT***	***Mech. & Aeronautical.***	***Civil & Structural***
1	Univ. Sains Malaysia (USM)	Univ. Teknologi Malaysia	Univ. Malaysia (UM)	Univ Malaysia (UM)
2	Univ. Malaya (UM) Malaysia	Univ. Sains Malaysia (USM)	Univ. Sains Malaysia (USM)	Univ. Tech. Malaysia (UTM)
3	Univ. Technologi Malaysia	METU, Turkey	Univ. Tech. Malaysia	METU, Turkey
4	Univ. Kebangsaan, Malaysia	Univ. Kebangsaan, Malaysia	KFUPM, S. Arabia	Univ. Sains Malaysia (USM)
5	KAUST, S. Arabia	King Fahd UPM (S. Arabia)	Univ.Kebang-saan, Malaysia	Istanbul Tech. Univ. Turkey

6.2 ***The Numbers Game Revisited.*** Ultimately, publications numbers alone are not sufficient. This question was first addressed by Hirsch[17] **(**2005) who proposed the h-index as a stronger metric to characterize the scientific output of a researcher. It was meant to overcome the 'publications number' syndrome and hopefully, bring in the cumulative impact and relevance of a researcher. This was followed in 2015 by the Leiden Manifesto[18] for research metrics, which proposed ten guides for evaluation of a person's research. Can these metrics and indices flourish when the evaluation is only led by data and surveys, making judgement difficult among the proliferating array of indices and weightage given to different sub-categories.

The entire system is now operated by organizations[19] *who are more dependent on data and surveys* and may not possess the requisite tools, thus endangering the entire system. Different organisations give differing University rankings, especially for the middle and lower-income countries. As an example, the Shanghai University Academic Rankings of world Universities, ranked[20] the 'Mechanical Engineering' department of Quaid e Azam University (QAU) Islamabad between 76-100 in 2017, improving annually until it was rated 51-75 in 2020. This placed it just below Tokyo University but higher than Oxford University. *The tragedy is that QAU does not have any engineering departments discipline on its campus*!

Nature Index acknowledges that even in their elite 82 journals multiple counting was not overcome since the paper could be published in other journals.

The confusion is further confounded because of the 'citations community' which is guilty of inducting an army of co-authors to raise each other's citation numbers, even when their fields of expertise are quite different. A further aggravation is caused by fake[21] on-line journals, led by India, which is alleged to host 42% of all such entities.

A higher Impact Factor (IF) of a journal implies higher citation numbers and is claimed[22] to provide *a "quantitative and qualitative tool for ranking, evaluating and categorizing the journals for academic excellence. This factor is used for evaluating the prestige of journals. The evaluation is carried out by considering the factors like Scientific Quality, Regularity and stability, Editorial quality, Technical*

[16] *Profile of Leading OIC Institutions*, COMSTECH, 2017.

[17] Hirsch, J.E.; *An Index to Quantify an Individual's scientific Research Output;* PNAS, Nov 15, 2005, 102 (46), *pp* 16569-16572. A scientist has index *h* if *h* of his or her *N* papers have at least *h* citations each.

[18] Diane Hicks et al*; The Leiden Manifesto for Research Metrics*, 22 April 2015. Proposed 10 guides to Research Evaluation.

[19] ISI, Scopus, and university rankings systems have different weightage and marking systems.

[20] Hoodbhoy, P.; *The Academic Rankings Racket QAU*: Dawn, 12 Dec. 2020.

[21] Prasad. R. *Fake Journals_ Make in India Gone Wrong*, The Hindu, Oct. 2015 (see also ref 5 earlier)

[22] 2020 Edition, Journal Citation Reports (Source: 2019 Clarivate)

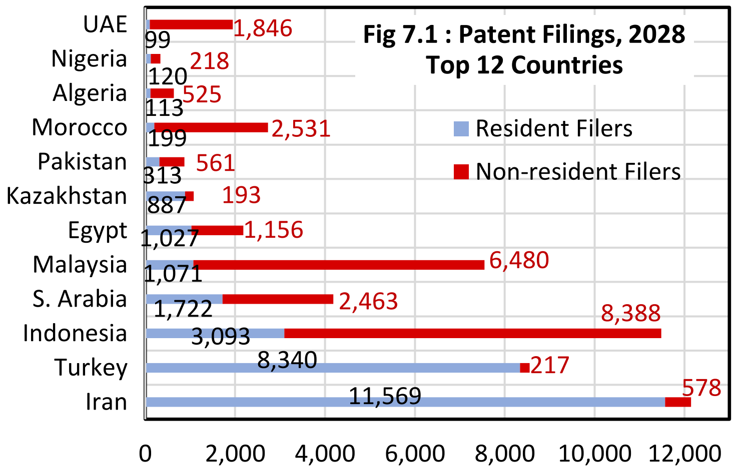
Quality, Internationalization, Standards and Print and website score. It is claimed that it is based on how often articles published in that journal in the preceding two years are cited by articles in that year".

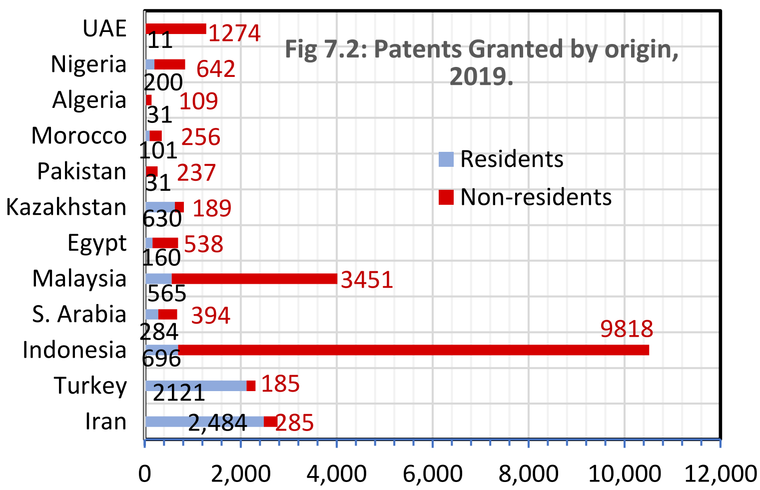
While this may be true for a particular field, it is improper to compare journal IF across different fields. As an example, the IF (impact factor) for journals in 2020 is highest for the group of health, medicine, and biology (ranging from 11 to 26), physics and astronomy (33), while mathematics[23] is generally lower (1.5 to 9). *Pure sciences are in neglect everywhere*. There are Nobel prizes for technology !

7. Technology, Innovation, and Patents. The system of invention, technology transfer, design and innovation are strongly interrelated. While global patent and trademark applications doubled in the last decade, there has been a gradual shift towards middle income countries and particularly East Asia, led by China and South Korea.

How does one measure innovation? Some relevant indicators include patents, export of high-tech products, technological readiness, and skill levels at the secondary / higher secondary levels. *Patents are an important proxy for innovation and technology transfer, and FDI.*

A total of 3,326,300 patents[24] were filed globally in 2018. The share of all OIC countries **(Fig 7.1**) was only 52,817, (1.59 %). Iran, Turkey, and Indonesia were the top 3 OIC *filers.* Pakistan (27.8%), Uzbekistan (17.5%) and Morocco (14.1%) witnessed the largest year on year growth; however, all countries show the preponderance of non-residents in filings.





The largest patent applications were in China (1,540,000 or 46.3 %), which is similar in magnitude to the combined total of the next 10 offices. China was followed by the USA (597,141 or 17.90 %), Japan (313,567 or 9.43 %) and South Korea (209,992 or 6.31 %). China witnessed an increase (2017 to 2018) of 11.6% while the others saw their shares fall by 1.6%, 1.5% and 2.5% respectively.

Fig. 7.2 shows the number of patents *granted*. Approval and grant of a patent application can take 15 to 30 months depending upon the filing country. Although Indonesia and Malaysia lead in share of non-residents, Iran and Turkey saw their *residents* leading by far in the numbers approved, in addition to being the two biggest patent filers.

Resident filings reflect the presence or otherwise of local talent, expertise, and innovation, plus an environment for protection of intellectual property rights, (while the non-resident filers together generally reflect FDI (foreign direct investment). IP data includes industrial design, trademarks, utility models, plant varieties, and geographical indicators.

[23] Scimagojr.com (2019)
[24] WIPO IP Facts and Figures, 2019 (wipo_pub_943_2019). These refer to applications filed in calendar year 2018.

In the category of new plant varieties, only seven OIC countries filed a total of 440 patents in 2019, of which 231 were filed by residents, (**Fig 7.3**). Turkey had the largest share (145 by residents and 82 by non-residents. OIC Member States are also generally uncaring of plant "breeders rights" and "geographical varieties" which need to be protected. Turkey and Iran alone have worked on this and had 398 and 385 claims in force in 2019. By comparison, a total of 21,430 patents for plant variety were filed globally in 2019 (a growth of 7.8% over 2018).

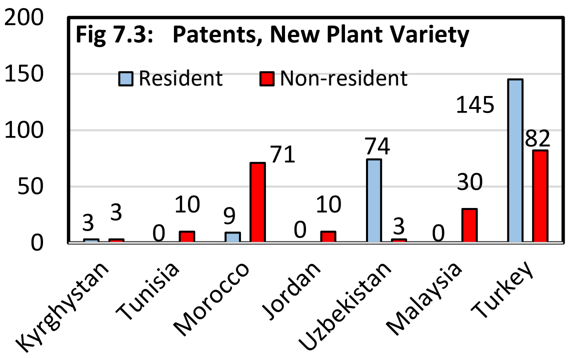


Fig 7.3: Patents, New Plant Variety

Table 3 shows the categories / specialisation in which most patents were filed in some leading OIC countries. The difference in numbers between the top OIC countries and Korea and Germany highlights the crucial lag *within* OIC, and of OIC with EU and East Asia in technology generation, absorption and innovation, and technological readiness. This is further reflected in the technology content of exports from OIC countries **(Fig 7.4)**.

Table 3: Indications for Specialization in Patents, (2019 or 2016*)

Country	EM. Apparatus, Energy	Digital Comms.	Computer Technology	Controls	Semi-conductors	Optics	Medical Technology	Biotechnology.	Pharmaceuticals	Macromolecular Chem & Polymers
Egypt*	8	1	4	-	1	1	10	6	6	0
Jordan (2019)	1	1	-	-	-		1	6	38	-
Indonesia*	-	-	3	-	-	-	-		2	-
Turkey*	11	1	10	-	-	-	-	-	-	3
S. Arabia*	-	-	-	-	-	-	-	-	-	7
Malaysia*	110	133	121	-	65	38	105	-	131	
Kazakhstan*	3	-	1	-	-	-	2	-	1	1
Morocco (2019)	19	13	6	8	5	2	14	30	98	5
The numbers for South Korea and Germany (2019) are shown below for comparison										
S. Korea (2019)	10,099	5,556	8,141	2,339	7.578	4,328	4,502	2,183	2,549	2,171
Germany (2019)	1,404	227	394	358	584	440	604	72	15	43

The leading technologies which received the most international patents in 2019, were in the categories of computer technology (21,449), digital communications (19,090), electrical machinery, apparatus, energy (17,223), medical technology (16,954), and measurement (11,471).

7.1. Hitech Exports. High technology products such as aerospace, computers, pharmaceuticals, scientific equipment and electrical machinery, have high R&D intensity. The value of hitech merchandise[25] in exports is small with the exception of Malaysia and Indonesia. *Malaysia outperforms within the OIC with such exports worth US$ 90.396 billion in in 2018 or 52.8% of its total exports.* Pakistan has a robust nuclear technology base (power plants and weapons)

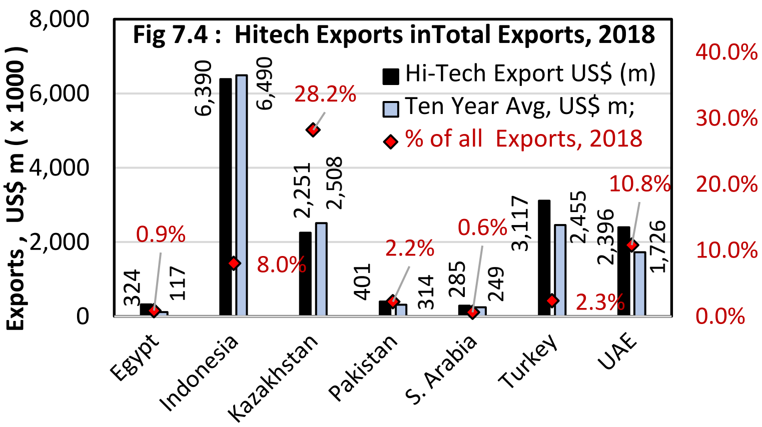


Fig 7.4 : Hitech Exports inTotal Exports, 2018

[25] The Global Economy, 2019

but the share of technology in its exports is small for its size, although it has exported lasers to Malaysia, Bangladesh and CERN (Geneva). In fact the Pakistani paradigm serves to emphasise the impact of security and strategic factors, which have also played a large role in Iran. Sanctions is probably the best incentive sometimes to generate an indigenous technology base !

Fig. 7.5: Training Simulator for Pakistani Nuclear Power Plants, (locally designed and built)

Computing, digital communications, AI (artificial intelligence), robotics, chip design, and pharmaceuticals / medical devices, clean energy are driving the current scintific and industrial revolution. Handling big data with security is a major current and future issue. Most OIC countries may have improved their communications infrastructure, but have generally failed to make an international impact with their own products. However when scientists from these states go and work in the developed countries, they perform well as the environmnent is more conducive with a fairly high degree of irreverence. Some 25 scientists[26] are among the few (thousand) scientists with an *h-index* >100 (i.e 100 papers cited at least 100 times), who migrated to leading institutions in the West, where they found the conducive research environment.

With electrification of economies underway in the last 3 decades in OIC states, opportunities exist for manufacture of turbines, contro rooms and heat exhangers for power plants. Joint consortius can be set up for say one country focussing on standardised turbines or control rooms (e.g. Turkey, Egypt, Malaysia, and Pakistan). Pakistan already makes many critical modules for nuclear power plants, including control rooms (**Fig 7.5** above). *Its nuclear programme is actually the child of sanctions imposed upon the country after India tested its 2nd device in 1974; the country went on to develop its complete fuel cycle. within 8 years.*

8. The Agents of Change: In order to identify public policies for promoting better generation, management and acquisition of technology, it is necessary first to understand the emerging morphology of the global economy. Its distinctive features are the transnational/vertical division of labour and diffusion of work, technology, and ownership, which requires matching transnational skills. From the 1970s to the 1990s, it was shown that manufacturing could be done anywhere. Now, designing, too, can be undertaken anywhere and this shift appears to be irrevocable. Other intrinsic factors remain the development of institutional excellence and fast-moving human resources, coupled with strategic alliances for complementary resources. The key drivers of growth are, and will remain, people, innovation, and capital. These, however, require a strong congruence between social and technological capabilities.

The national and regional innovation system is built upon productivity and competitiveness of the firm[27]. These need to be backed up by innovation support from universities, technical colleges, vocational training organizations and R&D institutes as well as business associations and financial institutions.

Finally, there is need for technology transfer agencies such as KISTEP (Korean Instt. of S&T Evaluation and Planning).

Almost all developed economies are now identified as ‘knowledge economies’ to some extent or the other and they are taking further steps to consolidate this position by becoming even more knowledge intensive and competitive Even when their productivity growth has slowed down, the *rate of increase in the skill bias in technology has not*. In some newly industrialized Asian countries, such activities have already enabled small and medium enterprises (SMEs) to evolve into major global players and

[26] *Highly Cited Researchers (h_100) according to their Google Scholar Citations*, Cybermetrics, CSIS Spain, 2020

[27] Khan, S.H.; *Productivity Growth and Entrepreneurship in Pakistan; The Role of Public Policies in Promoting Technology Management;* LSE Conference, 30-31 March, 2016.

conglomerates, which now offer complete end-to-end services in the supply chain, whether as manufacturers of piece parts and systems or providers of services, design, and research. Developing countries, too, have witnessed a sharp reduction in the relative demand for unskilled labor since the end of the 1970s.

The OIC countries have generally been left behind and will continue to lag unless the state plays its role as 'agent of change'. The culture and irreverence required to generate a vibrant technology base is missing because of the absence of the modern knowledge worker, who is not necessarily a PhD or even a graduate, but one possessessing *different and higher* skills. Playing 'catch-up' will however require a strong congruence between technology, innovation, and social capabilities. Here are some steps that can be taken by the state.

8.1 The Skilled Worker: The state must ensure higher enrolments in formal technical education for people in the 15-20 age group in order to break out of the "low skills, low productivity, low expectations" trap. In 2019, there were a total of 601 million youth enrolled globally[28] in secondary education, of which 62.5 million were engaged in vocational education. Considering their populations, most OIC countries fare poorly **(Fig 8.1)**. Indonesia, Turkey, Egypt and Uzbekistan have the highest gross numbers, but only Malaysia and Turkey have a strong industrial and manufacturing base.

Unfortunately, few technology clusters are available in IAS member states; the latter must pick the winners in the universities and in the market and bring them together, with incentives for taxes, coupled with provision of excellent physical and electronic infrastructure.

8.2 Change Management: Work is constantly being reshaped by technological progress. The priorities must be training and skills development which alone will allow a wider canvas for adaptation of new technologies and the new work force. This will improve internal and external efficiencies. Next it needs to focus on internal technology transfers from the best to the not so good enterprises as well as match making with local and foreign concerns.

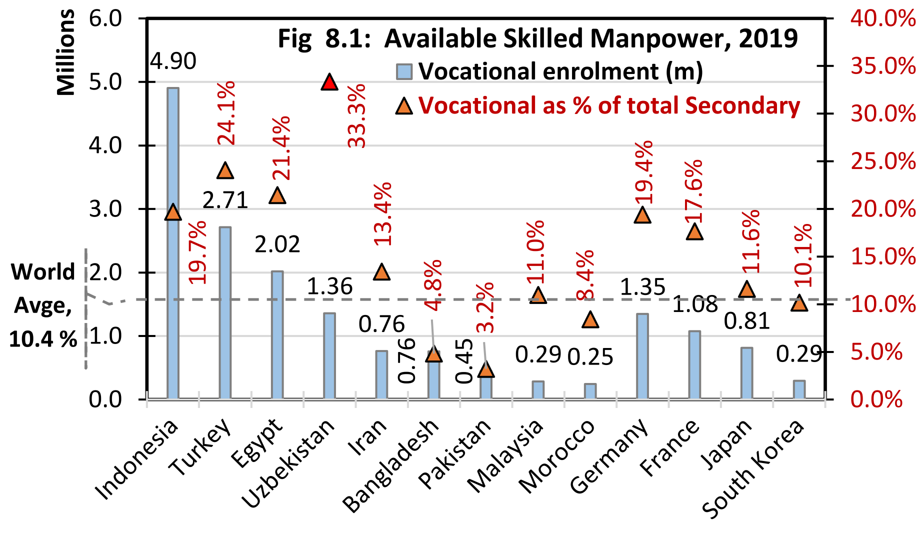


Fig 8.1: Available Skilled Manpower, 2019

The disruptive role of the high technology enterprise requires better linkages between universities and business. Becoming an entrepreneur involves changing the external environment, from a state *without* the venture and the new state, *with* the venture. This will cause a discontinuity in the competitive structure of the local industry and may sometimes lead to an altogether new industry. This evolution is generally not linear and certain stages may be bypassed in a rapidly changing situation.

The role of the state as the 'change agent' is important. It needs to pick the winners and support those activities that have strong spillovers and forward / backward linkages. This requires regular foresight exercises so as to generate intensive 'changing technology' intelligence.

Every country now wants to become a knowledge economy. Competition must be viewed not just as a threat but as a source of inspiration.

[28] *World Development Indicators;* 12 June 2020.

- Some examples are POSCO in South Korea where public ownership together with high protection walls initially led to its emergence as the most efficient firm in the global steel industry by the 1990s.
- In China the auto industry has emerged as a world class first tier supplier through emphasis on domestic content / and deletion.
- Malaysia has a compulsory programme of re-training of the work force in the private and public sectors.
- MITI (Ministry of International Trade and Industry) in Japan is of course a classic example of integrating R&D and education policies with import tariffs. In the late sixties and seventies, MITI would encourage and fund Japanese universities to replace imported productsthrough new designs and systems. *This is how Sony was born.*

8.3 The Technology Cluster. An important tool is the nurturing of technology clusters by bringing together in close proximity, adequately skilled manpower with universities, the latter being the repository and generator of scientific research. While many of the low hanging fruits of innovation have already been picked, the nature of innovation is also changing because of the emergence of the new normal caused by the 'death of distance' whereby physical proximity is no longer essential for many functions and decisions. The corporate sector would perform its R&D at dedicated research centers in the 20^{th} C, but is now moving towards an innovation ecosystem, with universities providing actual research and innovation, and final development done by the corporations, who also provide funding. Both sides share in patents. The best-known examples of clusters are Silicon Valley (in which sits Stanford university) and Shenzhen/Hong Kong. In 2018, Silicon Valley and the San Francisco Bay area together[29] made up 53.8% of California's patent registrations and 14.8% of total U.S. patent registrations. Based on typically 4-5 years analysis, WIPO has published a list of top 100 global technology clusters[30] spanning the period 2014-2018. ***Only Tehran, Istanbul and Ankara appear in the list with ranks of 43, 51, and 88 respectively***.

Table 4: Ranking of Top Innovation Clusters, 2020

#	Name /Location of Cluster	Patents Filed	Research Publications
1	Tokyo Yokohama, (Japan)	113,244	143,822
2	Shenzhen-Hong-Guangzhou, (China)	72,259	118,600
3	Seoul, (South Korea)	40,817	140,806
4	Beijing, (China)	25,080	241,637
5	San Jose-San Francisco, CA. USA	39,748	89,974
6	Osaka-Kobe-Kyoto (Japan)	29,464	67,514
7	Boston-Cambridge, Mass. (USA)	15,448	128,964
8	New York City, (USA)	12,302	137,263
9	Shanghai, China	13,347	122.367
10	Paris, (France)	13,561	93,003
43	Tehran, (Iran)	149	62,530
51	Istanbul, (Turkey)	2,677	31,709
88	Ankara, (Turkey)	430	27,758

Such clusters have led to major increase in patents awarded to universities, in addition to building a relationship between the industrial sectors through student internships.

Nearly 90% of the world's electronics originate from Shenzhen/HK. It is now shifting its activities from being the 'world's factory' to becoming a hub of high-tech innovation such as robotics, and AI (Artificial Intelligence) in collaboration with universities in UK, EU and USA.

9. *Collaboration within the OIC.* Collaboration within the OIC needs to increase considerably. We still do not know one another well enough, but there are some very innovative centres which need to build a more extensive and intensive exchange of students and scholars. This will help the weaker countries to move up the ST&I ladder a little faster. Many of these activities have been approved in the Astana Summit of 2017.

For example, we have a glorious tradition in astronomy, but no reasonably sized telescope exists in member states. The first mid-size (4m dia.) telescope is just starting in eastern Turkey. Jordan is home to the SESAME accelerator and is open to all. The National Laser Institute in Islamabad has over 500

[29] *Disruptive Innovations VII*; Citi GPS, February 2020.
[30] *The Top 100 Science and Technology Clusters;* Bergquist K. and Fink C., WIPO 2020. Also:

personnel and has built petawatt lasers apart from research in atomic and molecular spectroscopy, and exporting systems to S.E. Asia and the EU. Some of its products are shown.

Fig 9.1 Laser Land Leveller. ~ saves 30 % of water

Fig 9.2. ***Installation of the Tracker, containing 40 laser systems to monitor detector positions being installed in CMS at CERN, Geneva, 2007***

There are over two dozen oceanographic research vessels in the OIC, and nearly 10 million sq. km of coastal areas are still waiting to be mapped for marine life, environmental pollution, and geological resources. The Antarctica is also waiting; after Pakistan first went there some 20 years ago, Malaysia and Turkey have sent their expeditions in 2010 and 2015, 2017 respectively. Joint expeditions will be more effective and fruitful.

COVID-19 has exposed the absence of drug development in our member countries. At a more basic level, there is acute shortage of nurses, technicians and teachers in many African member states, and special training institutes can be set up there.

10. ***Some Conclusions:*** Some interesting changes are taking place in the OIC countries, in terms of improved education infrastructure, greater number of universities. There is greater understanding of their inadequacies and much greater desire for joining the global race for talent. *However, much remains to be done, especially in creating the environment which nurtures the thinking mind.*

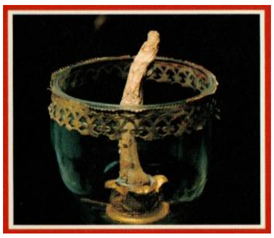
Let us also remember that there are no Nobel Prizes for technology, only in basic sciences.

Basic sciences have quite often been neglected at the altar of patents and economic gains, even though these have unintended disruptive consequences for society at large. Research is unpredictable. *The basic necessity is therefore the promotion of multidisciplinary research while giving equal importance to basic and applied sciences.*

Finally, there is a tendency sometimes to hail the earlier glorious period of Islamic science while ignoring the example of great Muslim scientists and philosophers, such as Al Razi and Ibn Rushd among others, who insisted that there is little value without critical thinking, reason, and evidence. There should be no fears about the disruptive nature of knowledge and science, as this has been part of our heritage and traditions for centuries.

Let us also remember Galileo's famous words "*E pur si muove"* (and yet it moves) uttered as he left the Vatican inquisition in 1632 which forced him to renounce his claim that the earth moves round the sun and not the other way round. Placed under house arrest for life, his book was placed in the infamous list of 'forbidden books'. He also raised his middle finger as he left. This was dug up 95 years after his death and placed in the Florence Science Museum. Was he pointing at the stars or was it a rude gesture?

Fig 9: Galileo's Finger



Science is supposedly 'free', (the '*Republic of Science*', Polany, 1962). Technology, however, is driven by secrecy and profits, production of industrial goods & services, and finally by military systems (software & hardware).

SARS-COV2 PANDEMIC'S EFFECTS ON THE R&D COMMUNITY IN AFRICA: CHALLENGES & OPPRORTUNITIES

MALEK MAAZA

UNESCO UNISA Africa Chair in Nanoscience-Nanotechnology

and

Nanosciences African Network (NANOAFNET),

iThemba LABS-National Research Foundation

South Africa

SARS-COV2 PANDEMIC's EFFECTS ON THE R&D COMMUNITY IN AFRICA: CHALLENGES & OPPRORTUNITIES

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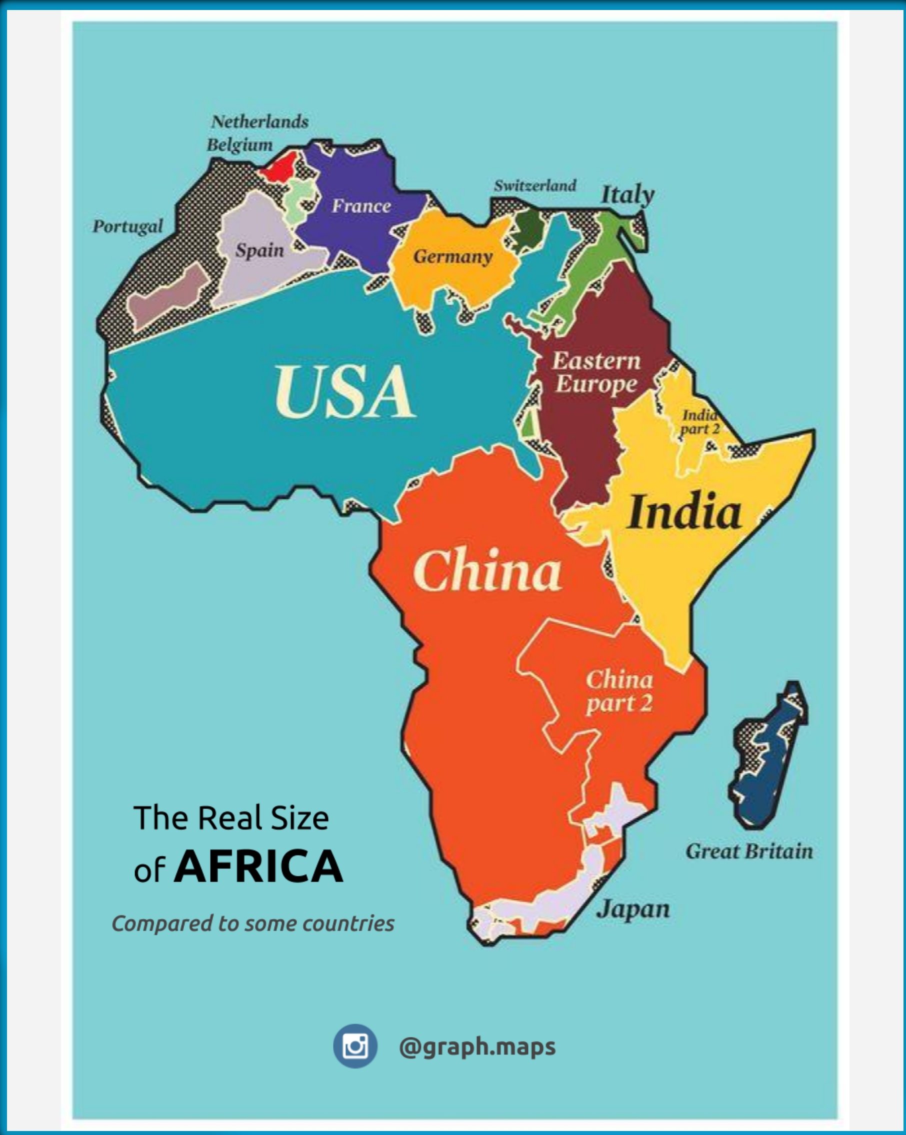
•METRICS:

- Population:
- ≈1billion,

- Age ratio
- 60%<25 years old
- 24%World (2030),

- Economy trend:
- >9 fast growing economies ,



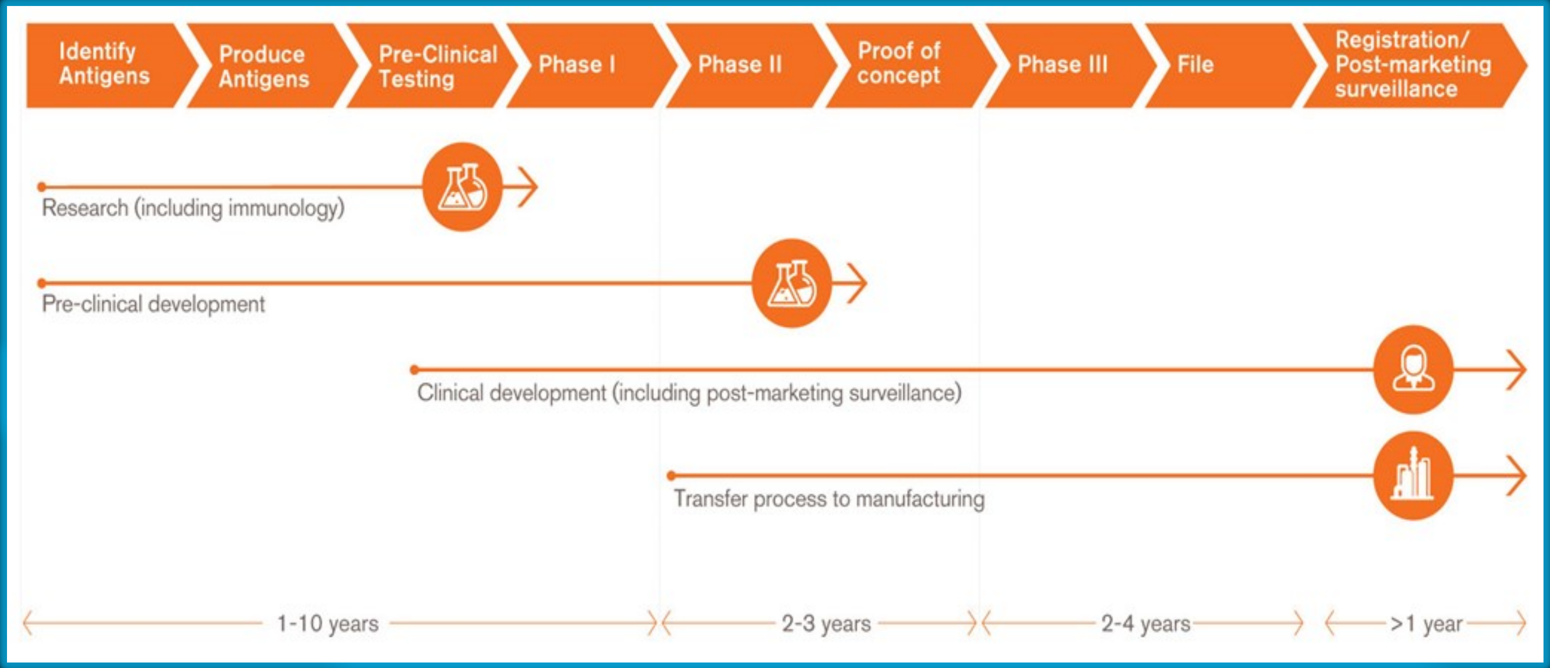
OUTLINE:

- Challenges facing the Africa R&D community
- Opportunities towards a proactive Africa R&D community
- Conclusions & Foresight: Towards
  - Multilateralism,
  - Multidisciplinarity
  - Sustainable Science Diplomacy (North-South & South-South)

United Nations Educational, Scientific and Cultural Organization

UNESCO-UNISA Africa Chair in Nanosciences/Nanotechnology (South Africa)

BC-AC: ADAPTATION & MIND-SHIFT



- Even with an accelerated process, **herd immunity will take time**

The fastest a vaccine has ever been made is 5years (Pre-clinical trials…

- **1918:** H1N1 infuenza, , 50-100 Million fatalities,
- **1957:** H2N2 infuenza, 1.1Million fatalities
- **1968:** H3N2 influenza re-emergence,
- **1977:** H1N1Influenza
- **2009:** H1N1 pandemic,284,000 fatalities

IAS 01-12-2020, Amman-Jordan

CHALLENGES & OPPORTUNITIES

- 1-Mobility restriction
- 2-Grid accessibility
- 3-Low internet penetration
- 4-High Gender-Equity gap
- 5-Large youth influx
- 6-Low %GDP national investment in R&D
- 7-Lack of robust R&D national infrastructure
- 8-Inexistance of Advisory STI at the policy sphere
- 9-Non existence of STI National Foundations

CHALLENGES n°1: MOBILITY RESTRICTION

- **North Africa:**

  France: 40%
  Italy: 2%
  Spain:2.5%
  USA:2.6-9.6%

- **West/Central Africa:**

  USA: 7.4-11%
  UK: 5.9-12%
  Germany:2.5-7.2%
  China:2.6-8.1%

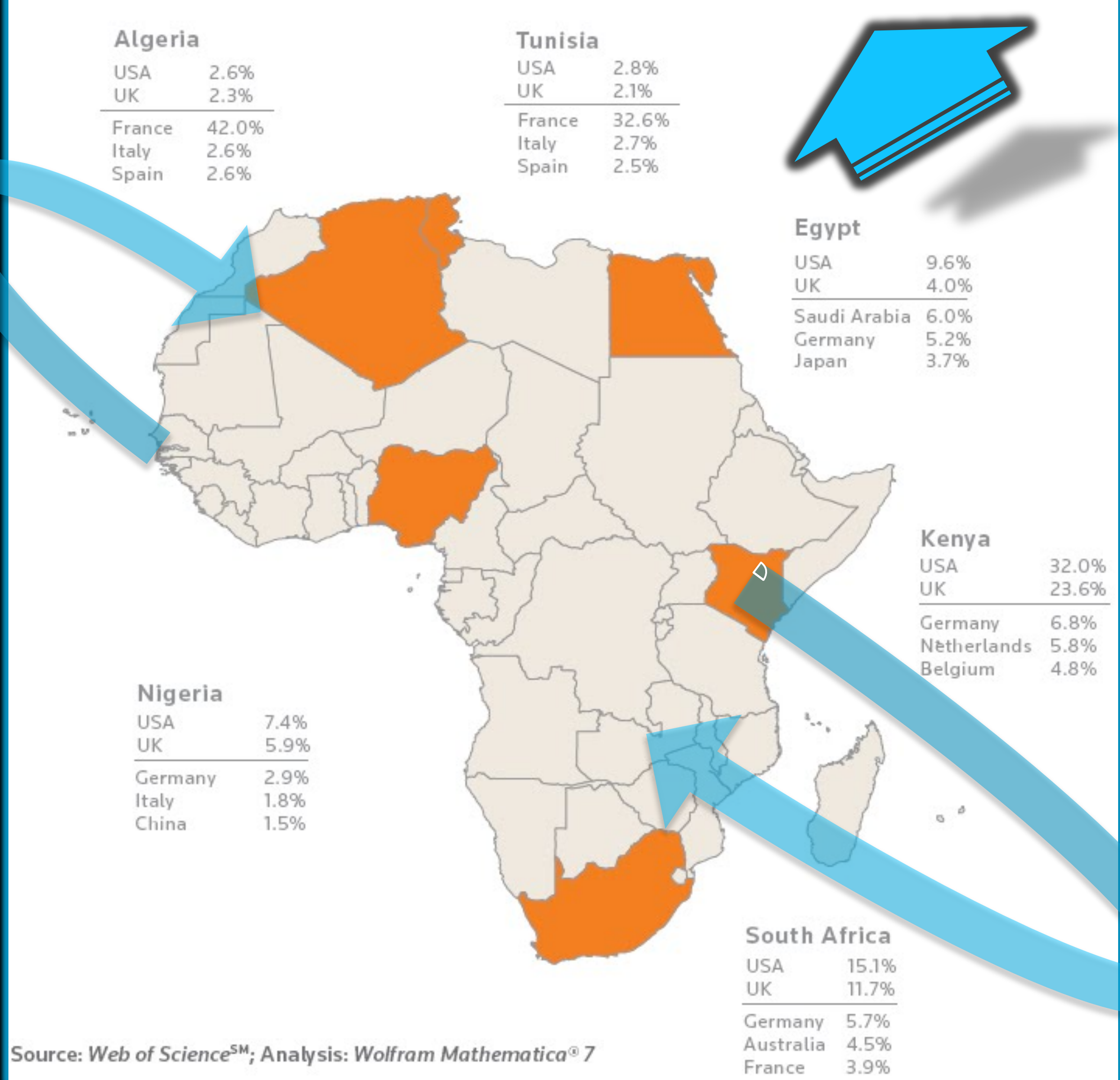
- **East Africa:**

  USA: 2.7-32%
  UK: 5.9-23%
  Germany:6.8%
  Netherlands:5:8%

- **Southern Africa:**

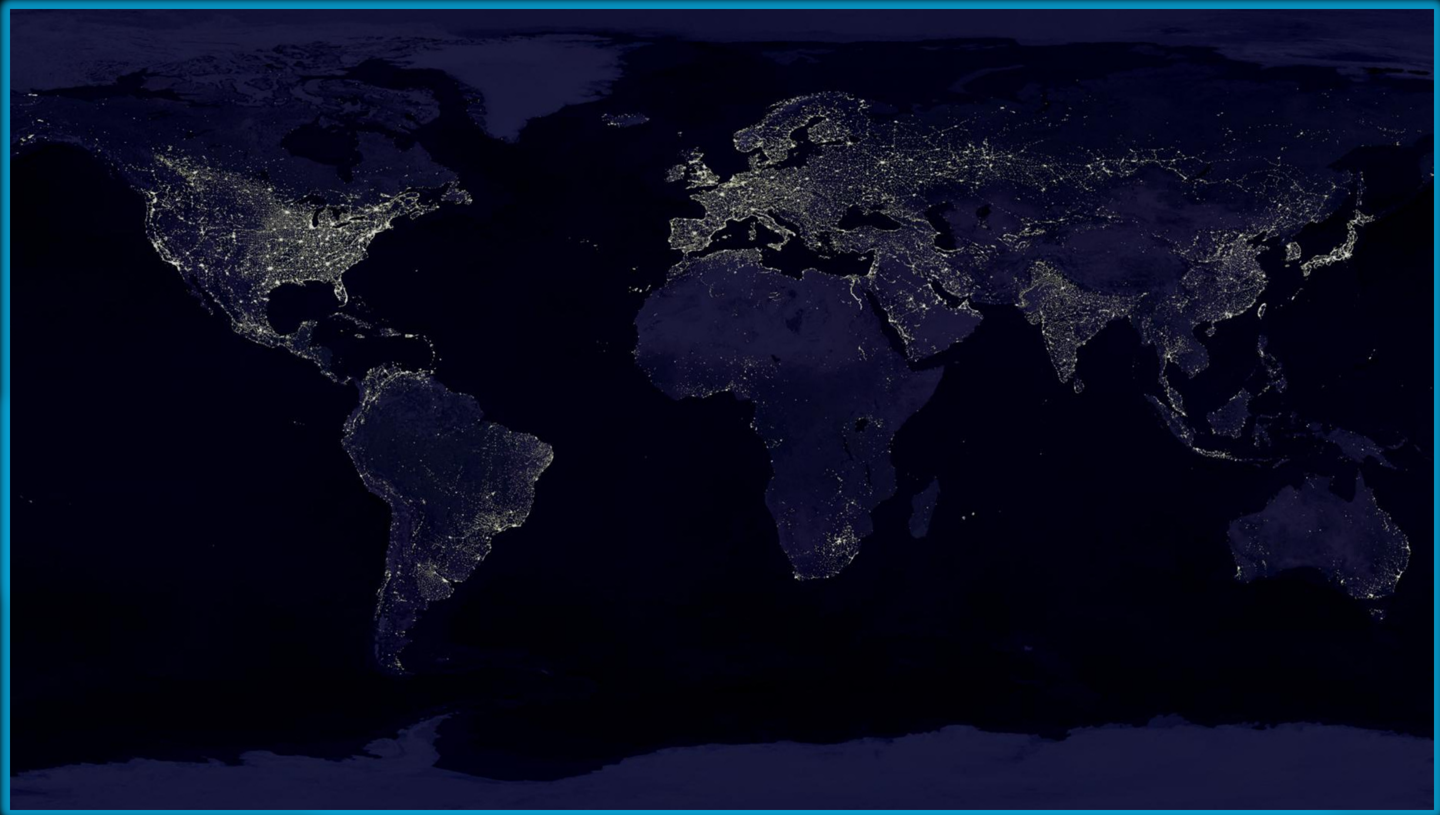
  USA: 15.1%
  UK: 11.7%
  Germany:5.2%
  Australia:4.5%

FIGURE 5: TOP COLLABORATING COUNTRIES FOR SIX KEY AFRICAN COUNTRIES



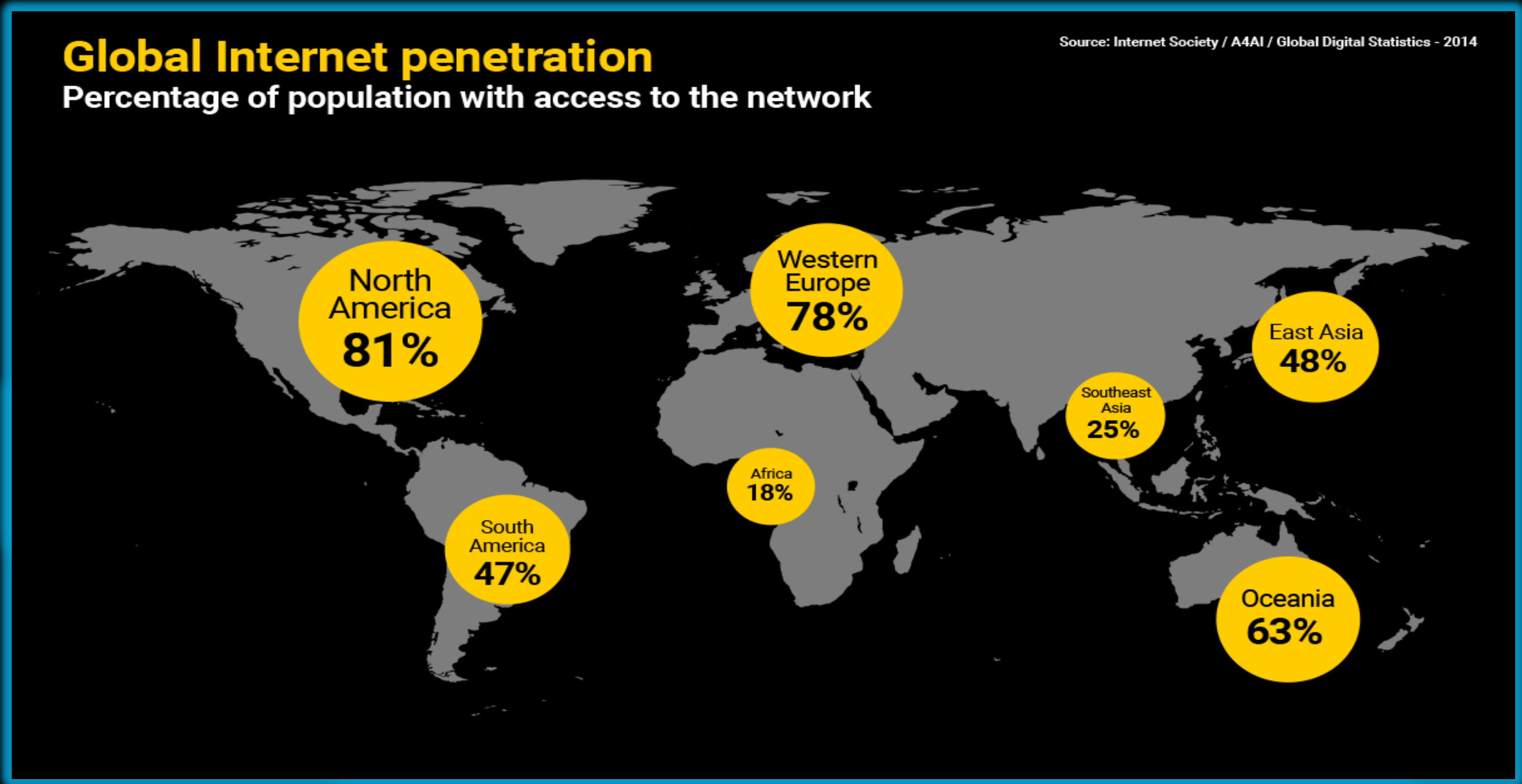
Source: *Web of Science*SM; Analysis: *Wolfram Mathematica*® 7

CHALLENGESn°2: GRID ACCESSIBILITY



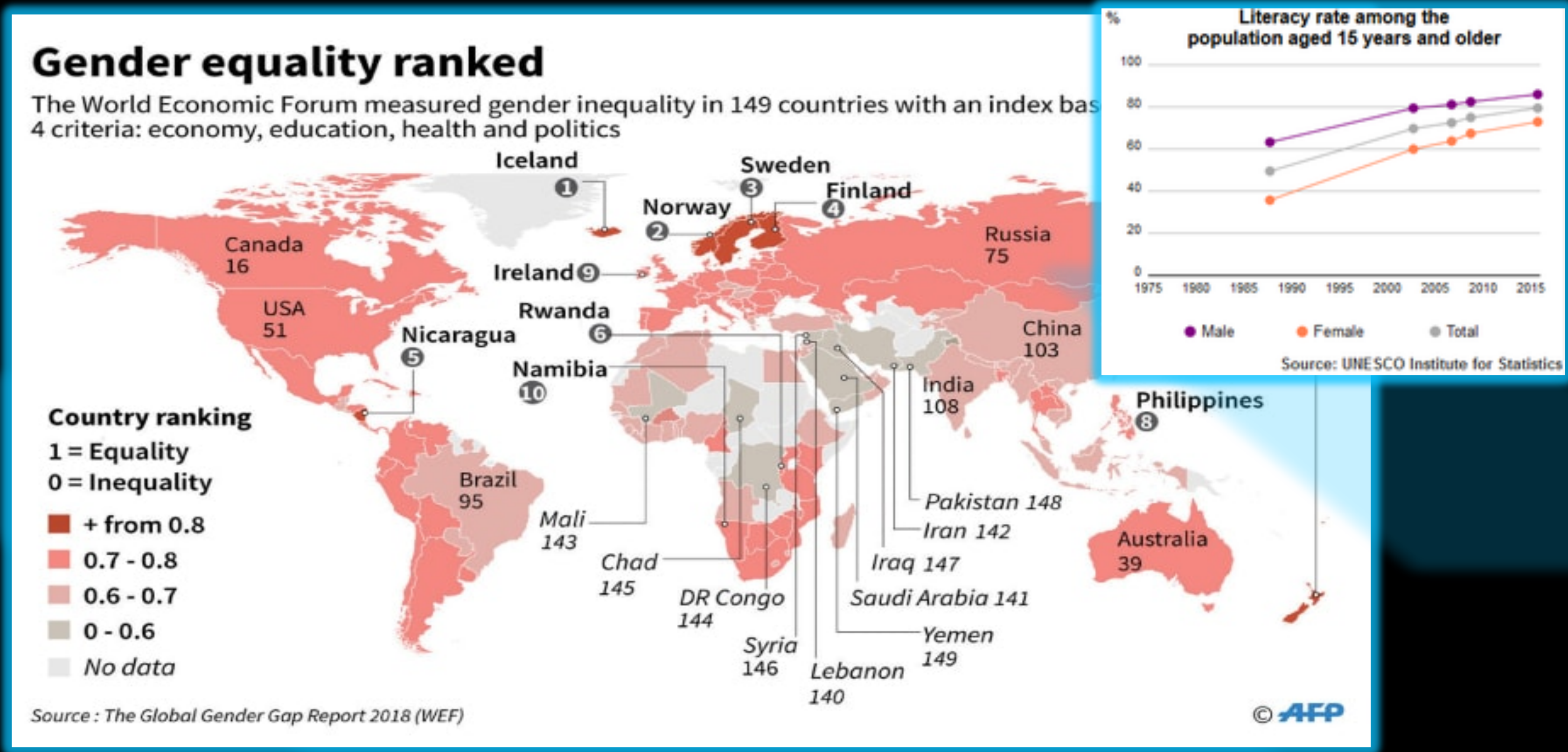
- **70% of the African Population does not rely onthe national grid** (Excluding Nort Africa, Kenya, Southern Africa & West Africa coast)
- > 61% Urban
- Several HEIs make use of own onsite generators

CHALLENGEn°3:LOW INTERNET PENETRATIO



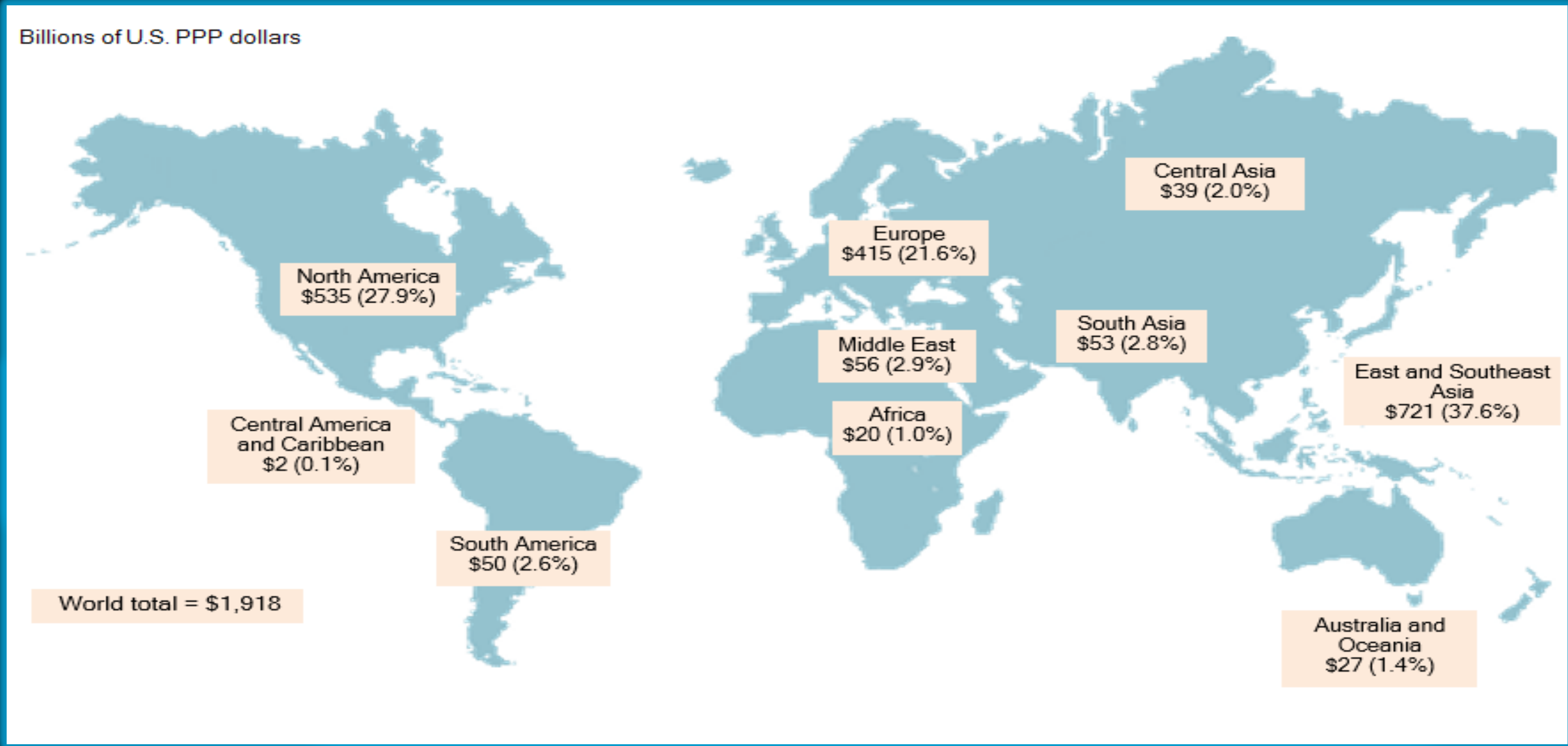
- Total population:911.9 Million/ **Lowest in Africa:18%**
- Mobile subscribers: 314 million • **Mobile penetration:34.4%**
- Average fixed broadband household panetration : 2.5 %
- Average **Broadband** penetration:**3.3%**
- **167 million of 1 billion people** living in **Africa now have internet acces**

CHALLENGEn°4: GENDER-EQUITY GAP



- **Education: Literacy rate increase but slightly**
- Family: Early Marriage: 21% Married before the 18th birthday
- Household: More Unpaid work: 3 X spent on unpaid Care work
- Workforce: Less opportunity: 26 % GAP in the Workforce
- **Towards full equity: Rwanda (6), Namibia(10)**

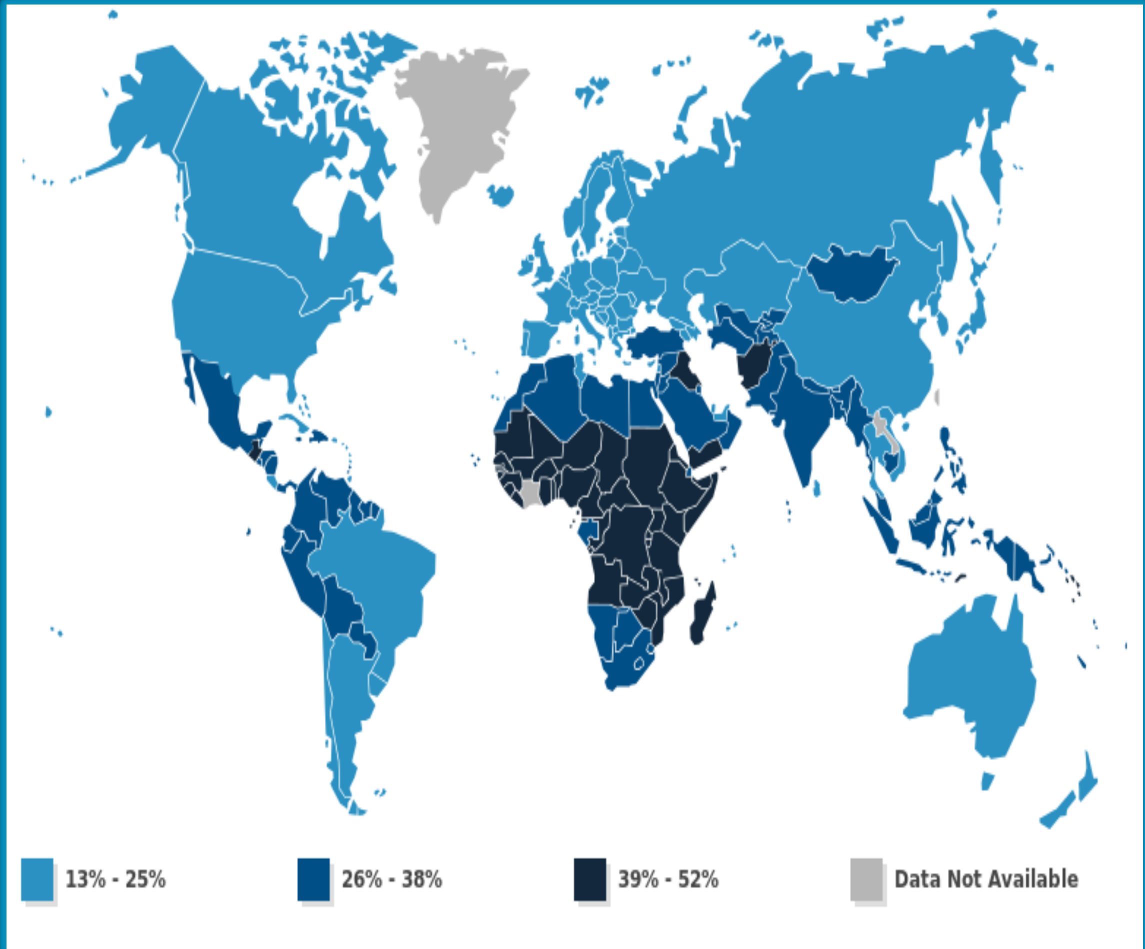
CHALLENGEn°5: LOW R&D GDP EXPEND.

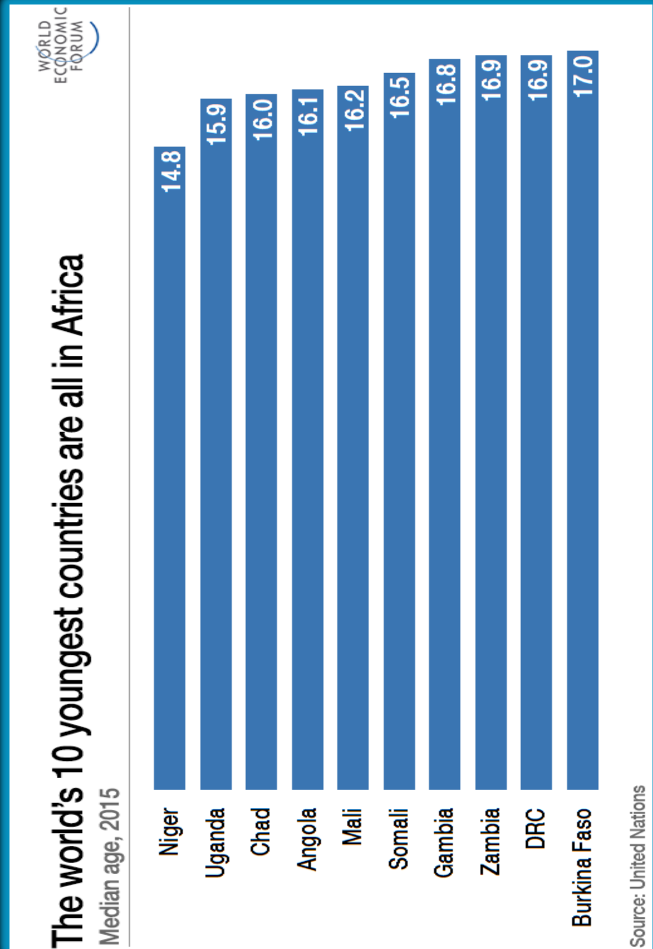


- **In average: Less than 1% except Tunisia**
- Angola: 0.08%, •Ethiopia 0.21%,
- Ghana:0.38%, •Uganda:0.32%
- Senegal:0.45%, •Tanzania:0.42%
- Kenya:0.78%,•South Africa:0.97%

- **Globally: Africa 1%**

CHALLENGESn°6: LARGE YOUTH INFLUX





- **In average: Less than 1% except Tunisia**
- UN Youth definition: 15-24 years,
- Currently 60% of entire continent is <25
- Youth population in 2015, numbering 226 Million (19%)Worlwide population (24% 2030)

- **Globally: 24%(2030)**

IAS 01-12-2020, Amman-Jordan

CHALLENGES & OPPORTUNITIES

- 1-Enhanced North-South & South-South/Continental Synergies
- 2- i-GDP investment, higher internet penetration & BB
- 3-High Gender-Equity & GDP increase
- 4-Multidisciplinarity & cross discipline fertilization
- 5-Potential increase %GDP national investement in R&D
- 6-Science based Advisory & policy sphere
- 7-Towards STI National Foundations

OPPORTUNITYn°1: NORTH-SOUTH SYNERGY
TRIESTE SYST-

- TRIESTE System:
  - Abdus Salam ICTP,
  - TWAS,
  - OWSD,
  - ELETTRA,
  - ICGEB,
  - IAP

OPPORTUNITYn°2: NORTH-SOUTH SYNERGY TRIESTE SYSTEM

- **ICTP** is active in all 54 African countries, where it has held over **200** scientific meetings. >50% of its postgraduate students are from Africa, and 6730 African scientists were trained through ICTP activities in Trieste;

- **TWAS** awarded 590 PhD fellowships and 120 postdoctoral fellowships to young African scientists;

- **86% of OWSD's** PhD fellowships went to African women;

- **IAP** supported the creation of 15 new national science academies;

- **ICGEB** Active in 27 African nations, ICGEB awarded 120 PhD and postdoctoral fellowships and 30 grants, held 35 meetings and hosted 5000 paticipants and 100 nationals .

OPPORTUNITYn°3: NORTH-SOUTH SYNERG
UPPSALA SYSTEM

Sida
SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY

Stockholm University

UPPSALA UNIVERSITET

- **ISP:Swedish International Development Cooperation Agency(SIDA)**
- **1973 Uppsala Univ./Stockholm Univ.(60-80MSK/year)**
- South HEIs:Latin/Central America, Africa/Far East low income countries)
- **Prog.-1** ISP Physical Sciences Program:IPPS (1961)
- **Prog.-2** ISP-Chemical Sciences Program:IPICS (1970)
- **Prog.-3** ISP-Mathematical Sciences Program: IPMS (2002)

OPPORTUNITYn°4: NORTH-SOUTH SYNERG PEER PROGRAM

The National Academies of SCIENCES ENGINEERING MEDICINE

PARTNERSHIPS FOR ENHANCED ENGAGEMENT IN RESEARCH (PEER)
DEVELOPMENT, SECURITY, AND COOPERATION
Policy and Global Affairs

USAID FROM THE AMERICAN PEOPLE

PEER is implemented by
The National Academies of SCIENCES · ENGINEERING · MEDICINE

Partnerships for Enhanced Engagement in Research (PEER)

- **PEER:PARTNERSHIP FOR ENHANCED ENGAGEMENT IN RESEARCH(PEER)**
- **NASEM/USGs/USAID**
- **Started 2011**
- 80-100K$/Year-project.
- Single-Multiple countries
- Development Related projects

OPPORTUNITYn°5: NORTH-SOUTH SYNERGY
FLAIR PROGRAM

The African Academy of Sciences
Driving Scientific and Technological Development in Africa

The African Academy of Sciences
THE ROYAL SOCIETY
GCRF
Global Challenges Research Fund

- **Trilateral: UK Rsoc/AAS/GCRF (Global Challenges Research Fund)**
- **150.000£each grantee/year (2-3 years)**
- 20-30 each year,
- SubSahara
- 2021: 3rd call

OPPORTUNITYn°6: NORTH-SOUTH SYNERGY

AESA PROGRAM

The Alliance for Accelerating Excellence in Science in Africa (AESA)

Putting science at the core of Africa's future

The African Academy of Sciences · NEPAD TRANSFORMING AFRICA · UKaid from the British people · wellcome trust · BILL & MELINDA GATES foundation

- **Multi-lateral: UK DFID/AU-NEPAD/AAS/WELCOME TRUST+BMGF**
- **2015 Nairobi**(Shifting the centre of gravity for African science to Africa

40.000 each grantee/year (2-3 years)

- Building R&D Infrastructure
- Developing Excellence (DELTAS)
- Innovation & Entrepreneurship
- Rising Research Leaders/Post-Docs (AESA RISE.)

The African Academy of Sciences
Driving Scientific and Technological Development in Africa

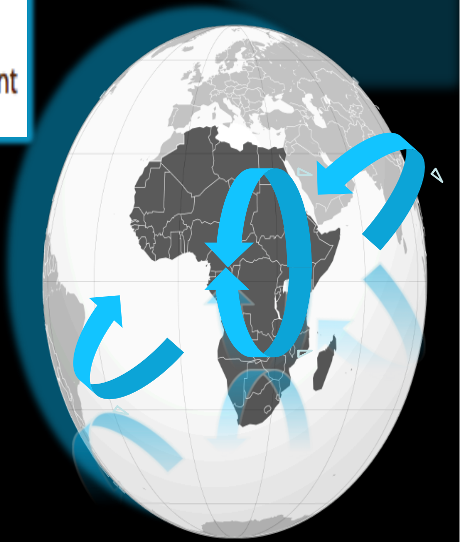
The African Academy of Sciences · THE ROYAL SOCIETY · GCRF Global Challenges Research Fund

OPPORTUNITn°7: NORTH-SOUTH SYNERGY
AGNES PROGRAM

- **Partnership:A.von HUMBOLDT/TWAS/MERIAN INST/RUFORUM.**
- **2011 Yaounde**(Shifting centre of gravity for African science to Africa
- **Prog-1:**AGNES-PAWS Intra-Africa Mobility Grant
- **Prog-2:**AGNES Intra-Africa Mobility Grant
- **Prog-3:**AGNES-PAWS Junior Research
- **Prog-4:**AGNES Junior Research Grant

OPPORTUNITYn°8: SOUTH-SOUTH SYNERGY CONTINENTAL DYNAMIC

- LAMNETWORK-1993
- ALC-1999:
- AMRS-1999
- NANOAFNET-2005
- ANSOLE-2011
- ANDi-2012
- U2ACN2-2013



OPPORTUNITYn°9: i-GDP INVESTMENT

iGDP 2017 Comparative Table[23]

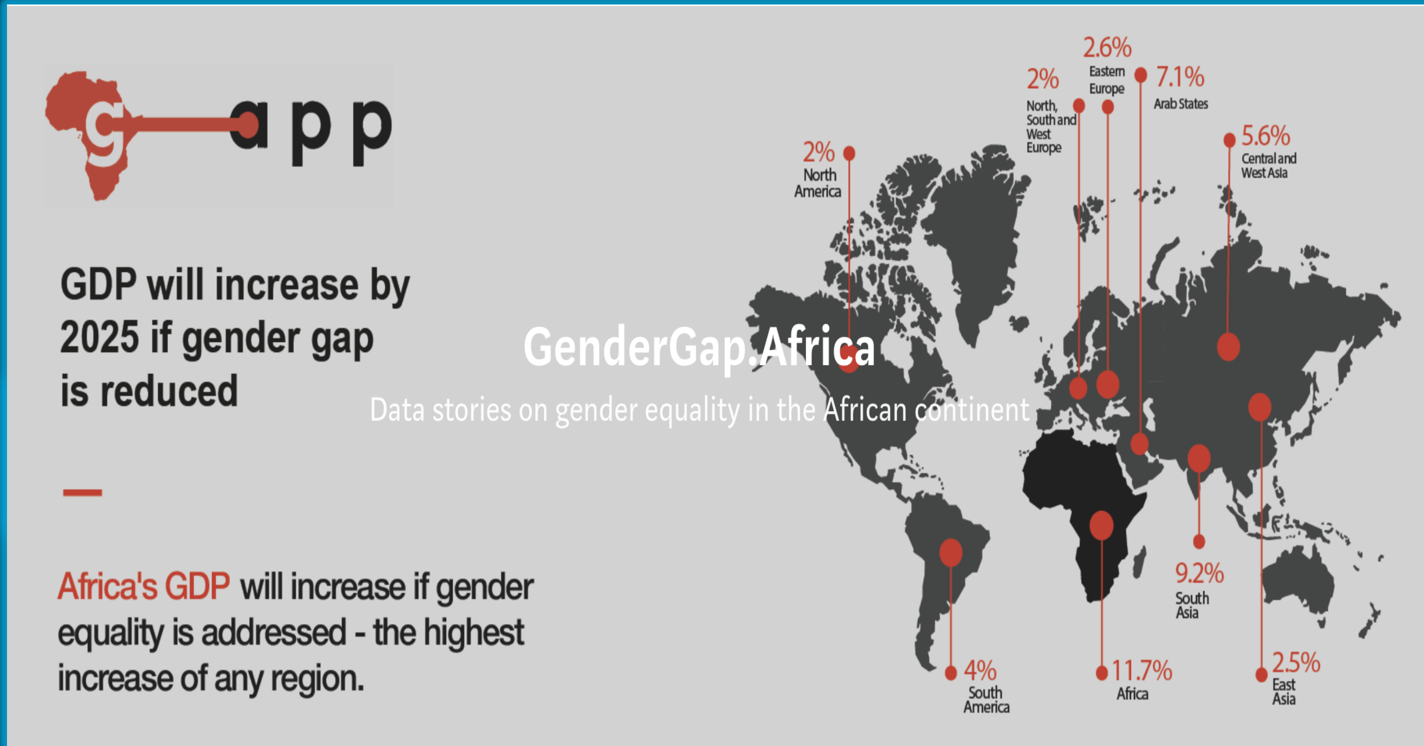
Country	iGDP 2017
Sweden	6.3%
South Korea	4.6%
Mauritius	2.9%
South Africa	1.4%
Morocco	2.3%
Ghana	1.1%
Côte d'Ivoire	1.3%
Kenya	2.9%
Egypt	1.6%
Nigeria	1.5%
Ethiopia	0.6%
Senegal	3.3%

Source: Table based on compilation of data from the report «Africa is becoming digitalized» - McKinsey, 2017.

- Africa is becoming **"digitalized"**
- Several African nations embarked in i-GDP investment:
  -Senegal:3.3%, -Mauritius:2.9%, -Morocco:2.3%, Kenya: 2.9%
- Higher **Broadband** penetration:**3.3% to increase**
- **HEIs towards ODL**

IAS 01-12-2020, Amman-Jordan

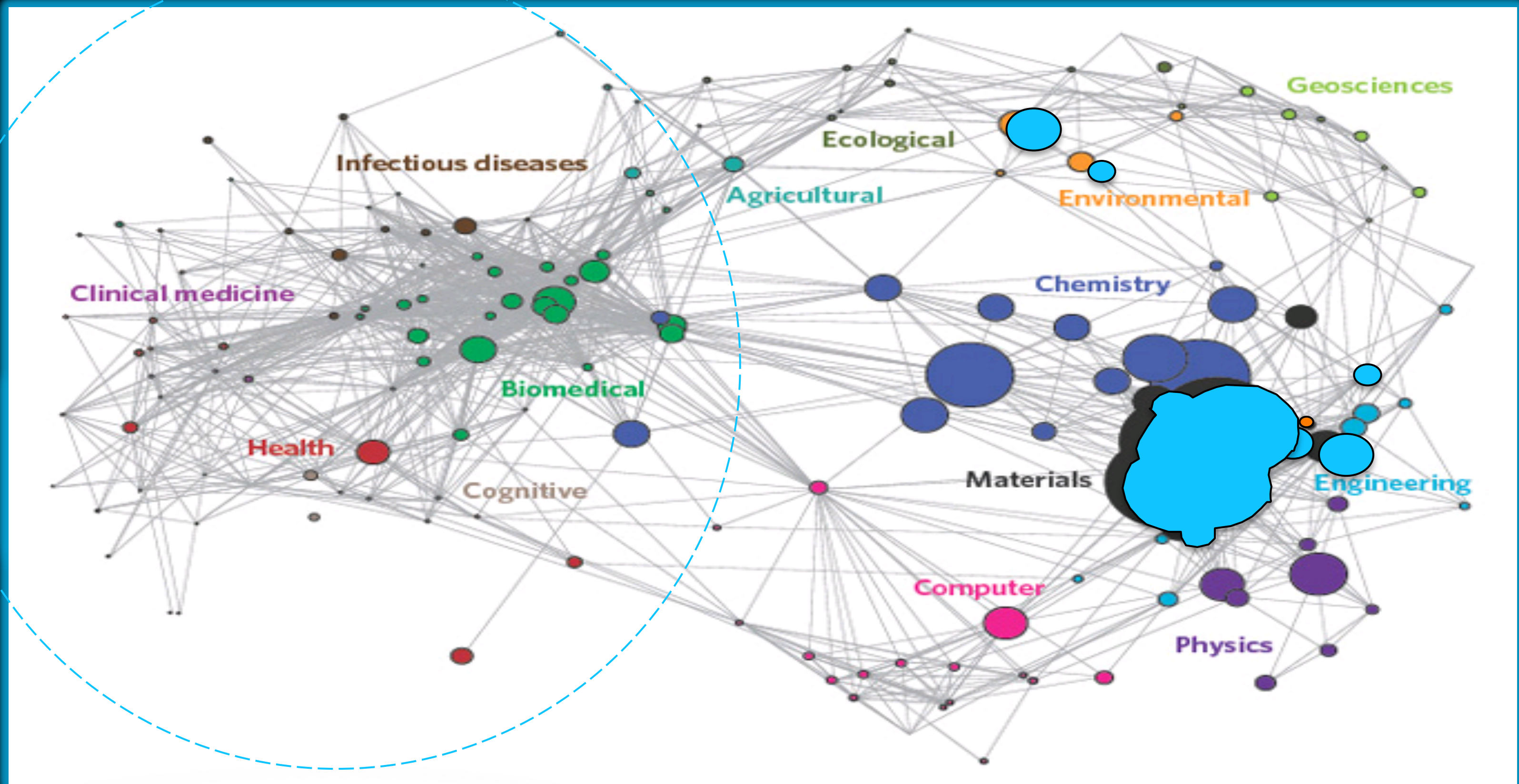
OPPORTUNITYn°10: CLOSING GENDER GAP TOWARDS HIGHER GDP



- if gender equity implemented, GDP increase by
- **11.7% in Africa (Highest increase)**
- 9.2% in South Asia
- 4% in Latin America
- 5.6% in Central & West Europe, •7.1% in Arab states,
- 2.6%in Eastern Europe, • 2% EuropeNorth America

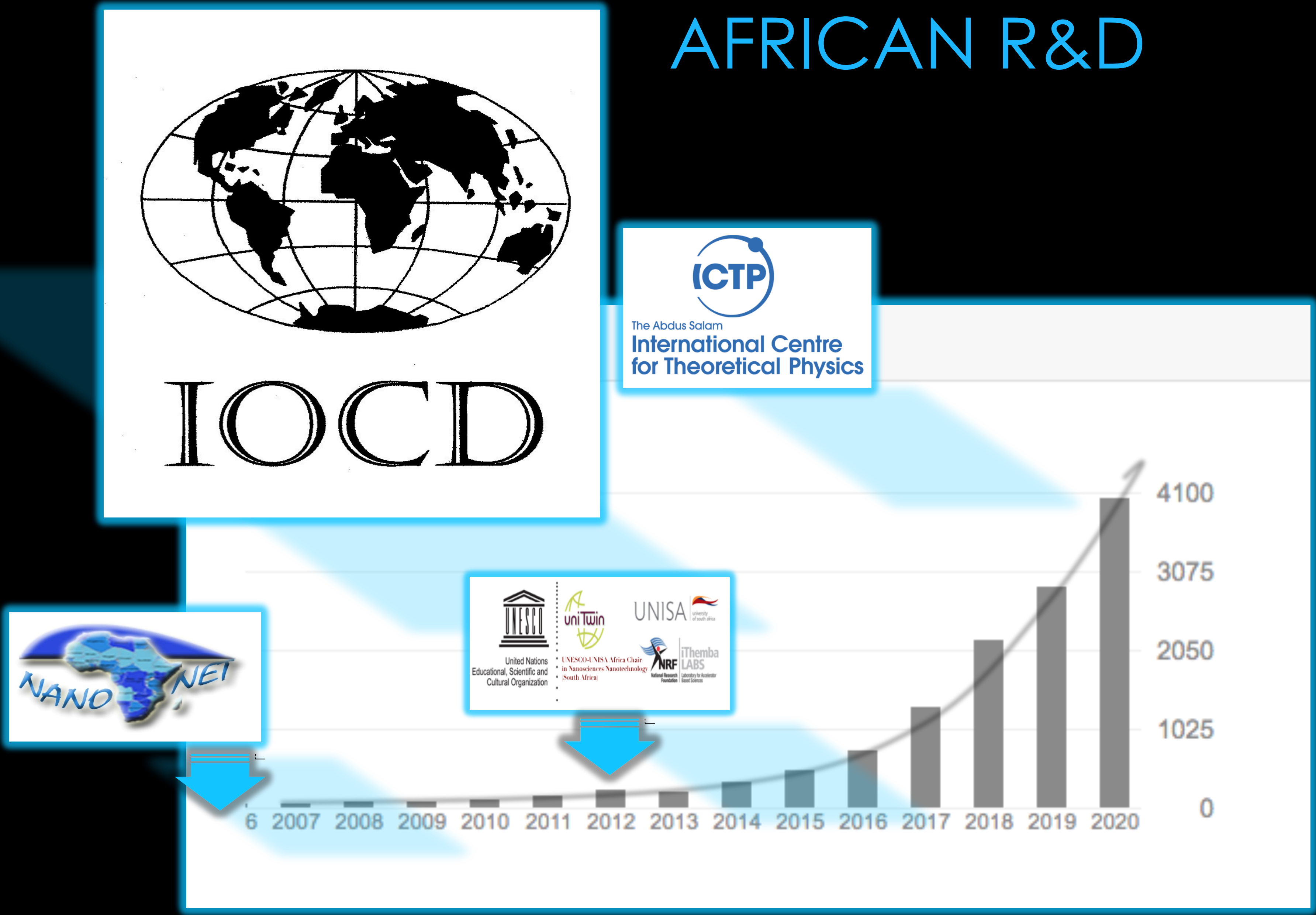
IAS 01-12-2020, Amman-Jordan

OPPORTUNITYn°11: MULTI-DISCIPLINARITY



- **Towards Multi-Disciplinarity**
- Towards **Continental AU programs** with **Social impact** ,
- Towards**R&D translations**, unlikely100% Blue Sky type R&D.
- **Effective limited Resources sharing/usage**
- **Towards Multi-skilled emerging workforce**

OPPORTUNITYn°11: HIGHER VISIBILITY OF AFRICAN R&D



IAS 01-12-2020, Amman-Jordan

•**GREEN NANOCHEMISTRY:** **Valorization of Indigenous Knowledge:**

OPPORTUNITYn°12: MULTI-SKILLED YOUNG WORKFORCE

IAS 01-12-2020, Amman-Jordan

OPPORTUNITYn°12: MULTI-SKILLED YOUNG GENDER BALANCED-WORKFORCE

GENDER BALANCE: SDG-5

Research Article Vol. 37, No. 11 / November 2020 / *Journal of the Optical Society of America A* 1

Journal of the Optical Society of America A

OPTICS, IMAGE SCIENCE, AND VISION

5 GENDER EQUALITY

VO_2-based active tunable emittance thermochromic flexible coatings

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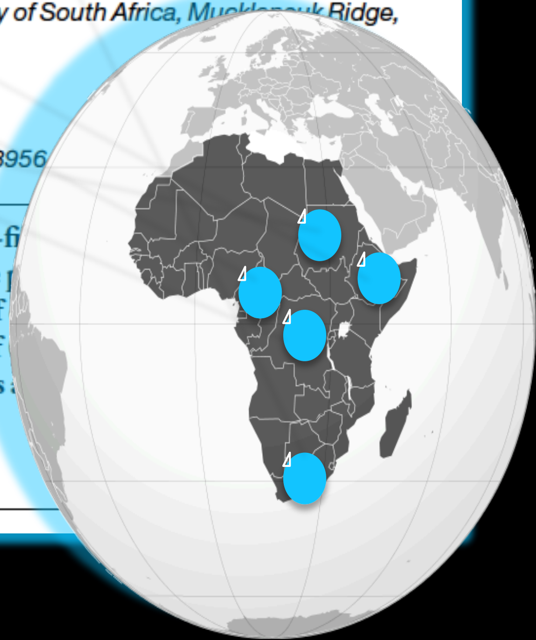
Received 22 April 2020; revised 30 May 2020; accepted 9 June 2020; posted 10 June 2020 (Doc. ID 3956

This contribution reports, for what we believe is the first time, on the VO_2-based thin-fi
substrates exhibiting a tunable positive emittance-switching $\Delta\varepsilon = (\varepsilon_H\text{-}\varepsilon_L) > 0$. More
a- Si:H/SiO_2/VO_2 onto flexible Al sheets presents minimum and maximum values of
0.57 at 40°C and 83°C, respectively, and hence allows an emittance-switching $\Delta\varepsilon$ of
$\Delta\varepsilon/\varepsilon_A$ of ~217%. Such variations fit with the potential applications of such coatings
small satellites and spacecraft.

https://doi.org/10.1364/JOSAA.395647



NANOAFNET: SDG-17 Addressing joint Social challenge

17 PARTNERSHIPS FOR THE GOALS

Contents lists available at ScienceDirect

Applied Surface Science

journal homepage: www.elsevier.com/locate/apsusc

Structural and optical properties of nano-structured tungsten-doped ZnO thin films grown by pulsed laser deposition

B.D. Ngom[a,b,c,*], T. Mpahane[c], N. Manyala[d], O. Nemraoui[c], U. Buttner[e], J.B. Kana[f], A.Y. Fasasi[g], M. Maaza[a,c], A.C. Beye[a,b]

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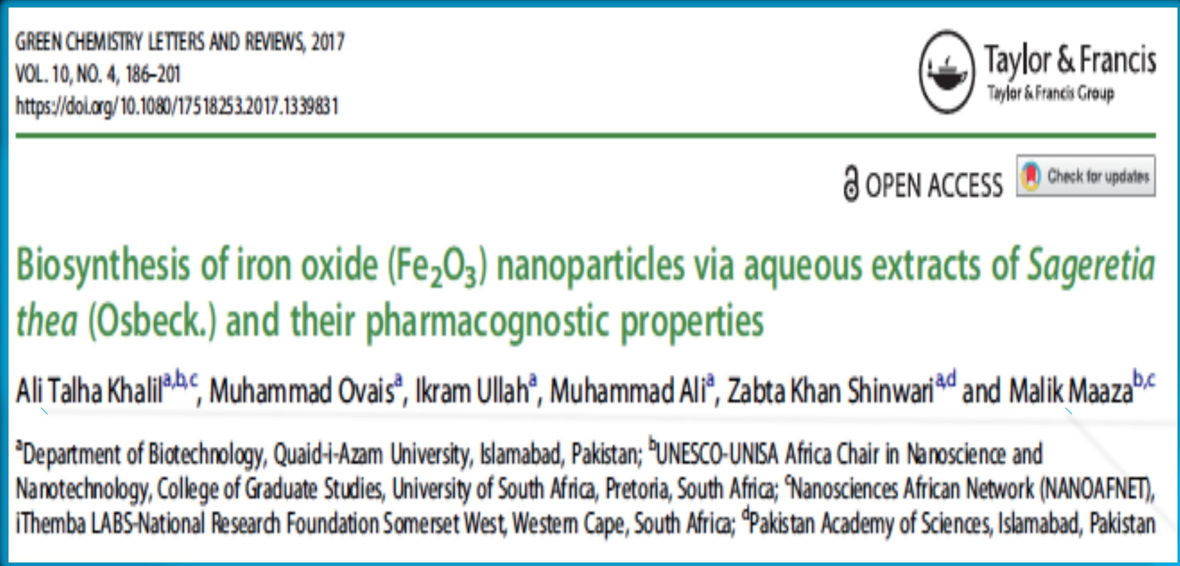
NANOAFNET: SDG-17 Addressing joint Social challenge



GREEN CHEMISTRY LETTERS AND REVIEWS, 2017
VOL. 10, NO. 4, 186–201
https://doi.org/10.1080/17518253.2017.1339831

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS | Check for updates

Biosynthesis of iron oxide (Fe_2O_3) nanoparticles via aqueous extracts of *Sageretia thea* (Osbeck.) and their pharmacognostic properties

Ali Talha Khalil[a,b,c], Muhammad Ovais[a], Ikram Ullah[a], Muhammad Ali[a], Zabta Khan Shinwari[a,d] and Malik Maaza[b,c]

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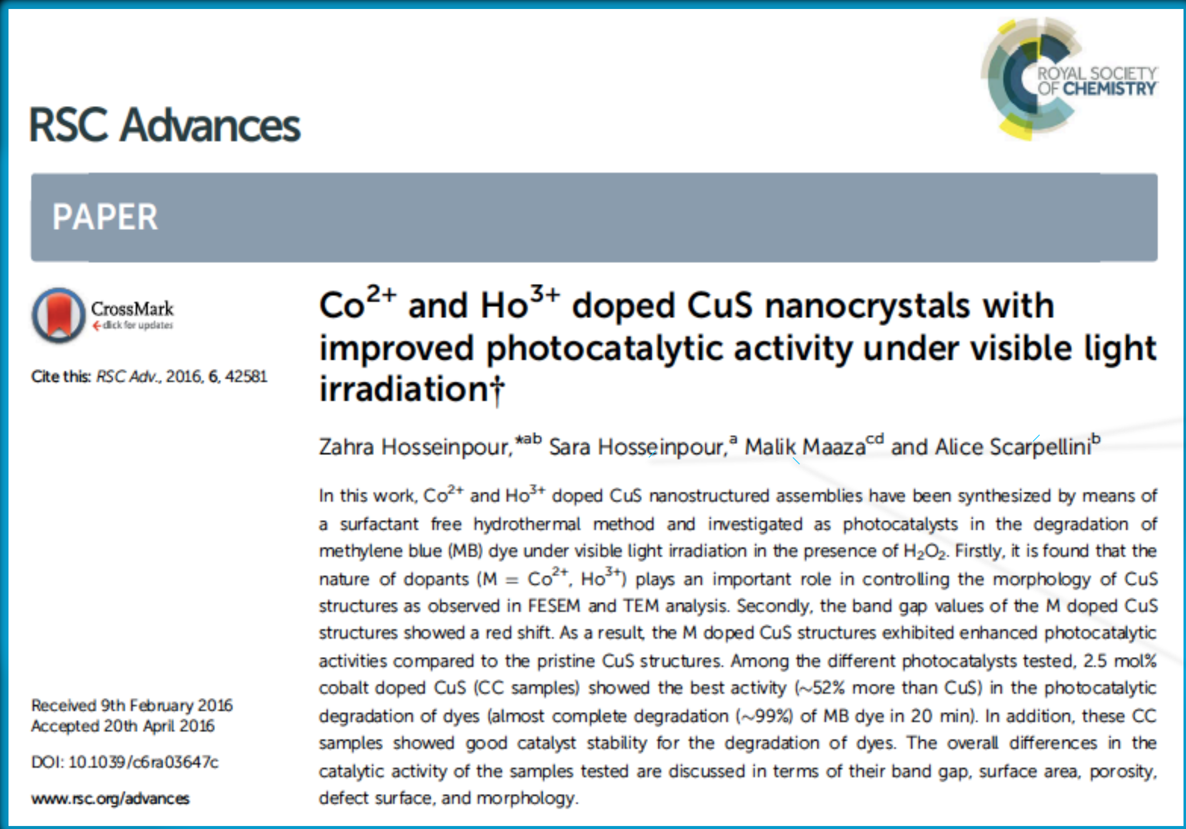
NANOAFNET: SDG-17 Addressing joint Social challenge

17 PARTNERSHIPS FOR THE GOALS



RSC Advances

ROYAL SOCIETY OF CHEMISTRY

PAPER

CrossMark

Cite this: *RSC Adv.*, 2016, 6, 42581

Co^{2+} and Ho^{3+} doped CuS nanocrystals with improved photocatalytic activity under visible light irradiation†

Zahra Hosseinpour,[*ab] Sara Hosseinpour,[a] Malik Maaza[cd] and Alice Scarpellini[b]

In this work, Co^{2+} and Ho^{3+} doped CuS nanostructured assemblies have been synthesized by means of a surfactant free hydrothermal method and investigated as photocatalysts in the degradation of methylene blue (MB) dye under visible light irradiation in the presence of H_2O_2. Firstly, it is found that the nature of dopants (M = Co^{2+}, Ho^{3+}) plays an important role in controlling the morphology of CuS structures as observed in FESEM and TEM analysis. Secondly, the band gap values of the M doped CuS structures showed a red shift. As a result, the M doped CuS structures exhibited enhanced photocatalytic activities compared to the pristine CuS structures. Among the different photocatalysts tested, 2.5 mol% cobalt doped CuS (CC samples) showed the best activity (~52% more than CuS) in the photocatalytic degradation of dyes (almost complete degradation (~99%) of MB dye in 20 min). In addition, these CC samples showed good catalyst stability for the degradation of dyes. The overall differences in the catalytic activity of the samples tested are discussed in terms of their band gap, surface area, porosity, defect surface, and morphology.

Received 9th February 2016
Accepted 20th April 2016

DOI: 10.1039/c6ra03647c

www.rsc.org/advances

NANOAFNET: SDG-4: Addressing joint Social challenge

4 QUALITY EDUCATION

NANOAFNET: SDG-4: Addressing joint Social challenge

4 QUALITY EDUCATION

THANK YOU, NDIALIVUHA ASANTE SANA,CHUKRAN MERCI,DANKE

NANO NET

UNESCO
United Nations Educational, Scientific and Cultural Organization

uniTwin
UNESCO-UNISA Africa Chair in Nanosciences/Nanotechnology (South Africa)

UNISA university of south africa

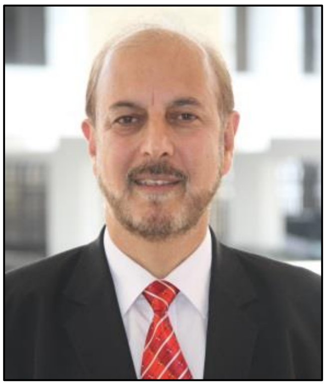
NRF National Research Foundation

iThemba LABS Laboratory for Accelerator Based Sciences

ISLAMIC COUNTRIES: OPEN SCIENCE; INCLUSIVE SOCIETY AND ETHICS

ZABTA K. SHINWARI
Vice Chair of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST)-UNESCO
President, National Council for Tibb
Islamabad, Pakistan

ABSTRACT



Though we have Phenomenal Growth per capita in 300 years, yet every second 4 people die because of starvation or related diseases. One percent of the world population has 50% of world wealth. Majority of the under developed world, lag behind its major competitors in the region. Policy makers have to develop strategies for these countries to gain competitive advantage through innovation. However, most commercialization efforts have failed mainly due to the lack of connectivity between the Policy makers, industry and academia. The formidable challenges are being faced due to ever widening gap between research needed and research conducted. This can be achieved by Social inclusion which reflects, on the one hand, an individual's experience of and possibilities for self-actualization, and on the other hand, societal capacities to eliminate causes of exclusion and ensure equal opportunities for all.

Sustainable competitive advantage allows the maintenance and improvement of a nation's competitive position in the global market. It is an advantage that enables business to survive against its competition over a long period of time. Sustainable competitive advantage is achieved by continuously developing existing and creating new resources and capabilities in response to rapidly changing market conditions. Among these resources and capabilities, in the new economy, knowledge represents the most important value-creating asset.

Connectivity between industry and academia in the developing countries are typified by the following issues: (1) commercialization of R&D has not been traditionally a high priority of universities; (2) the policy of promotions and appointments based on impact factor etc forced the academia to publish or perish; (3) during the last decade these efforts have been restructured in leading universities; and (4) increased emphasis has been put on connecting R&D capabilities to the commercial strengths and responsibilities of the university.

One of the major issue while talking about development is the ethical aspect of modern science. UNESCO set up World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) in 1998. The Commission is mandated to formulate ethical principles that could provide decision-makers with criteria that extend beyond purely economic considerations. COMEST works in several areas: environmental ethics, with reference inter alia to climate change, biodiversity, water and disaster prevention; the ethics of nanotechnologies along with related new and emerging issues in converging technologies; ethical issues relating to the technologies of the information society; science ethics; and gender issues in ethics of science and technology. Since its inception in 1998, the functioning of COMEST has been guided by its Statutes adopted by the UNESCO Executive Board at its 154th session.

In the long run, it is intended to build a partnership among the three pillars (Policy makers, industry and academia) so that the alliance works more effectively towards achieving the ultimate objective of self-reliance through knowledge economy based on ethical principles.

Inclusiveness will require focus on regions, areas and social groups afflicted by low access to education. The revamped strategy for education should recognize these challenges and propose several initiatives around the following six focus areas to address them:

1. Expansion – augmenting capacity of the existing institutions,
2. Equity- creating targeted schemes for backward areas and minority communities,
3. Excellence - through research and innovation, and faculty development
4. Governance - enhancing institutional autonomy and transparency,
5. Funding – increasing public and private funding linking them to outcomes, and
6. Implementation and monitoring – improving coordination among the concerned agencies.

It is important that close linkages between science and technology institutions in the province be established with world-class institutions in technologically advanced countries through exchange of personnel and promotion of joint research programs. Think Tanks should be set up in various sectors such as agriculture, engineering, biotechnology, information technology, pharmaceuticals, basic sciences, renewable energy, biodiversity, Disaster Risk Management, Urban Planning & Development, Global Warming & Land use Planning, Natural Resource Management, Social Awareness & Conflicts Resolution, etc. For international collaboration freedom, equality, solidarity, tolerance, respect to nature and shared responsibility are essential.

Islamic Countries: Open Science; Inclusive Society and Ethics

Zabta K. Shinwari
PAS, QAU, NCT-Islamabad-Pakistan

Disinformation and Epidemics: Biowarfare in 2020

- State-sponsored online disinformation campaigns “a fifth phase of biowarfare with a “cyber-bio” framing”.
- **Rise of measles cases following disinformation campaigns** connected to the US 2016 presidential elections,
- Rise of disinformation in the **current novel coronavirus disease 2019 pandemic**,
- Undermining of **sociopolitical systems, the delegitimization of public health and scientific bodies**.
- Norms related to use of biological weapons and cyber campaigns. By doing so, we anticipate the advent of a combined cyber and biological warfare.
- (WHO) Director-General declared: “We're not just fighting an epidemic; we're fighting an infodemic”.
- Conditions for development of new era of biowarfare is emergent. These conditions are: (1) the weaponization of online **fake news campaigns**, with wide reach; (2) the potential impact of these campaigns to have **significant negative impact on public health**; (3) the **exacerbating effect of social media misinformation** and disinformation during an epidemic; and (4) the delegitimization of science and **mistrust of officials**.
- the third decade of the 21st century, **the threat of use of a biological agent, without the deployment of a biological agent *per se*.**

Health Security 19(1) : 2020 DOI: 10.1089/hs.2020.0038

Pseudoscience and COVID-19 — we've had enough already

- Cow urine, bleach and cocaine have all been recommended as COVID-19 cures — all guff. The pandemic has been cast as a leaked bioweapon, a byproduct of 5G wireless technology and a political hoax — all poppycock. And countless wellness gurus and alternative-medicine practitioners have pushed unproven potions, pills and practices as ways to 'boost' the immune system.
- WHO has called it, the "infodemic" — Regulators have taken aggressive steps to hold marketers of unproven therapies to account. All scientists — not just a few of us — must stand up for quality information.

Here are two places to start.

- First, we must stop tolerating and legitimizing health pseudoscience, especially at universities and health-care institutions. Many bogus COVID-19 therapies have been embraced by integrative health centres at leading universities and hospitals.
- Second, more researchers should become active participants in the public fight against misinformation. We need physicists, microbiologists, immunologists, gastroenterologists and all scientists from relevant disciplines to provide simple and shareable content explaining why this hijacking of real research is inaccurate and scientifically dishonest. Good science and public trust are perhaps the most valuable tools in the fight against misinformation.

27 APRIL 2020 https://www.nature.com/articles/d41586-020-0126

3.Ownership

Recognize that the science we do is not entirely our property. Whether the taxpayer helps fund our scientific education or not, most of our training and research is paid for by the public – in grants from the research councils or charities. The public has a major stake in the ownership of what we do.

What to Expect in the Publishing World in 2020

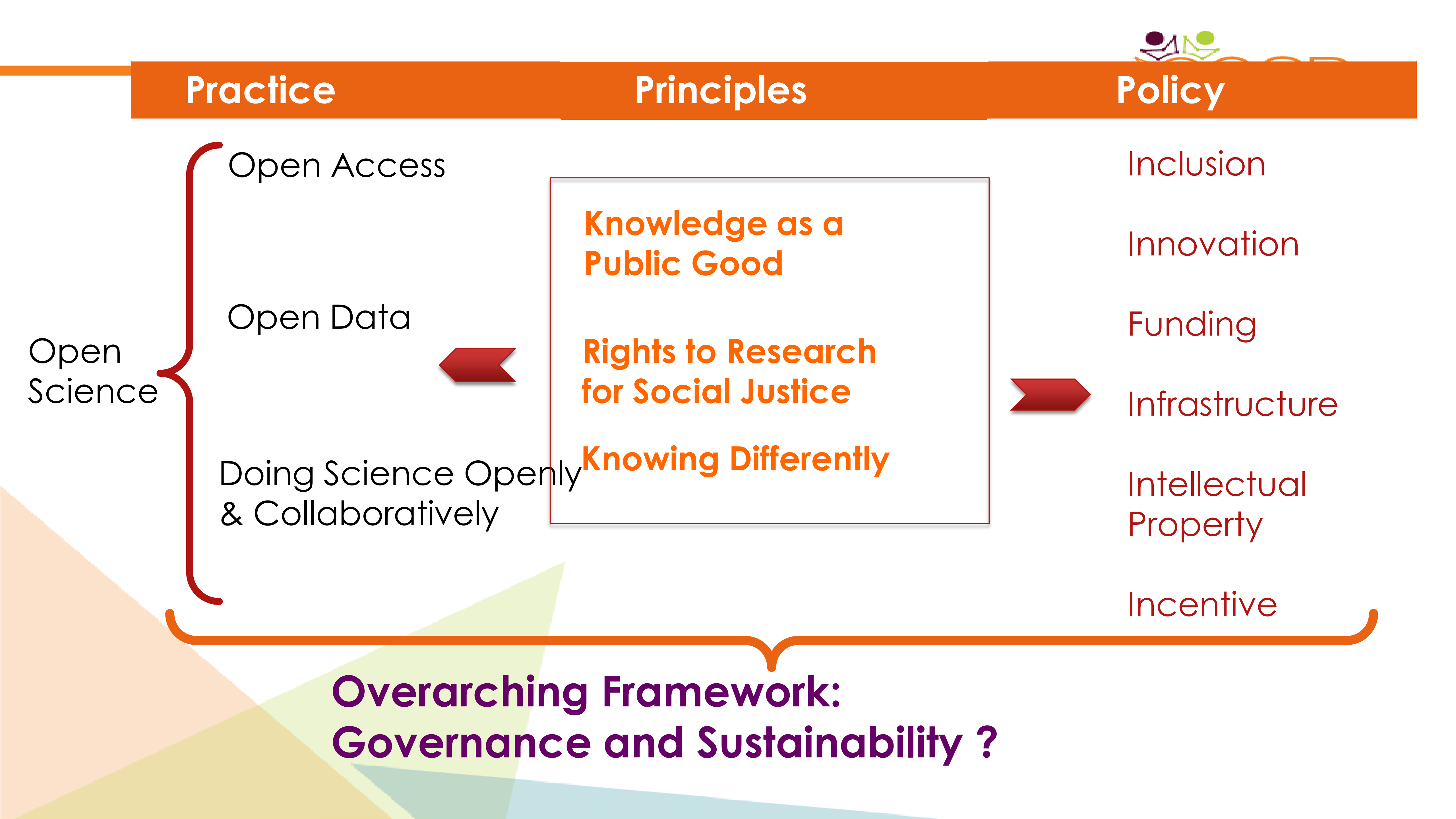
- Publishers' efforts to reduce "leakage," funder-driven open-access schemes, the growth of academic publishing in China, and more.
- US government was planning on passing an executive order that would mandate all papers from federally funded research be open access immediately upon publication—abolishing the 12-month paywall allowed under current rules.
- In response, more than 135 scientific societies and academic publishers penned an open letter to President Donald Trump's Administration strongly opposing such a policy, warning that the proposed changes would "jeopardize the intellectual property of American organizations engaged in the creation of high-quality peer-reviewed journals and research articles and would potentially delay the publication of new research results."
- In 2019 a group of European funding agencies calling themselves cOAlition S launched a plan to mandate strict rules to make research published by grantees immediately and freely available to the public. The initiative, which was dubbed Plan S and is set to launch in 2021, has been both praised and criticized by members of the academic community.
- Over the last few years, there has been a growth in so-called "transformative" agreements, in which publishers and academic libraries at universities and research institutions agree to a contract that contains elements geared towards increasing open access. Many of the large commercial publishers, such as Elsevier and Wiley, have several such agreements in place.

Dec 31, 2019 https://www.the-scientist.com/

What to Expect in the Publishing World in 2020

- **Efforts to reduce "leakage"**
- sites such as Sci-Hub, which provides illegal access to paywalled scientific papers, and Research Gate, an academic networking platform where authors can share their published work, have provided alternative options for academics to assess content in scholarly journals. This phenomenon, which is known as "leakage," has caused the value of subscription content to decline
- Get Full Text Research (GetFTR), a new online tool designed to help users find scientific articles. GetFTR was announced this December by a group of major publishers, including Wiley, Springer Nature, Elsevier, and the American Chemical Society (ACS).
- ACS and Elsevier previously won lawsuits against Sci-Hub; "**Major Publishers File Second Lawsuit Against ResearchGate**"
- **Chinese** government announced that over the next five years, it would provide more than 200 million yuan ($29 million US) per year in funding for efforts aimed at improving the standards and reputation of more than 200 mostly English-language journals put out by Chinese publishers—and to attract international submissions.
- Chinese journals have had low rates of international submissions, partly due to concerns about the low quality of their papers, which contained rampant plagiarism as well as cases of fraudulent research. In recent years, China has launched several initiatives to clamp down on misconduct and improve the reputation of its journals.

Dec 31, 2019 https://www.the-scientist.com/


Practice
Principles
Policy
Open Science
Open Access
Open Data
Doing Science Openly & Collaboratively
Knowledge as a Public Good
Rights to Research for Social Justice
Knowing Differently
Inclusion
Innovation
Funding
Infrastructure
Intellectual Property
Incentive
Overarching Framework:
Governance and Sustainability ?

The Hong Kong Principles to strengthen research integrity.

- Five principles:
  - responsible research practices;
  - transparent reporting;
  - open science (open research);
  - valuing a diversity of types of research; and
  - recognizing all contributions to research and scholarly activity.

Moher, et.al. (2019, September 17). The Hong Kong Principles for Assessing Researchers: Fostering Research Integrity. https://doi.org/10.31219/osf.io/m9

THE RESEARCH COMMUNITY SAFEGAURDS SCIENTIFIC INTEGRITY

WHISTLEBLOWERS
Draw attention to questionable research

Researchers
Reproduce, expand on, and openly debate research results

WHAT'S **YOUR** ROLE ?

WHISTLEBLOWERS
Draw attention to questionable research

FUNDING AGENCIES
Ensure funding of quality research through rigorous grant review

GOVERNMENT REGULATORY AGENCIES
Protect humans, animals and tax dollars in research and handle research misconduct allegations

JOURNALS & PEER REVIEWERS
Scrutinize submissions to disseminate accurate research

Learn more about responsible research with our educational materials: ori.hhs.gov/resources

Meanings of Openness

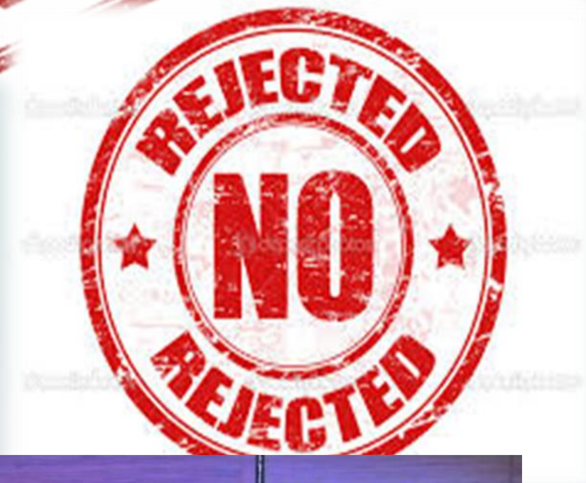
- Free of cost barriers
- Free of permission barriers
- Free to share and re-use
- **Rights to Research, meaning the rights to participate in knowledge production and meaning making**
  - **Inclusive Participation (beyond expertise)**
  - **Equitable Collaboration**
  - **Promote Cognitive justice**

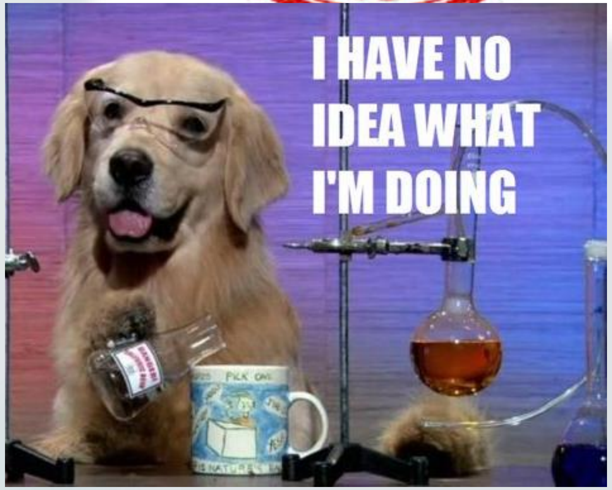
Open access Journals

- The number of open-access journals has risen steadily, in part because of funders' views that papers based on publicly funded research should be free for anyone to read.
- By 2011, 11% of the world's articles were being published in fully open-access journals.
- A paper that costs US$5,000 for an author to publish in *Cell Reports*, for example, might cost just $1,350 to publish in *PLoS ONE* — whereas *PeerJ* offers to publish an unlimited number of papers per author for a one-time fee of $299.
- Science-publishing industry generated $9.4 billion in revenue in 2011 and published around 1.8 million English-language articles — an average revenue per article of roughly $5,000 (profit margins at 20–30%) .

THE VALUE OF REJECTION

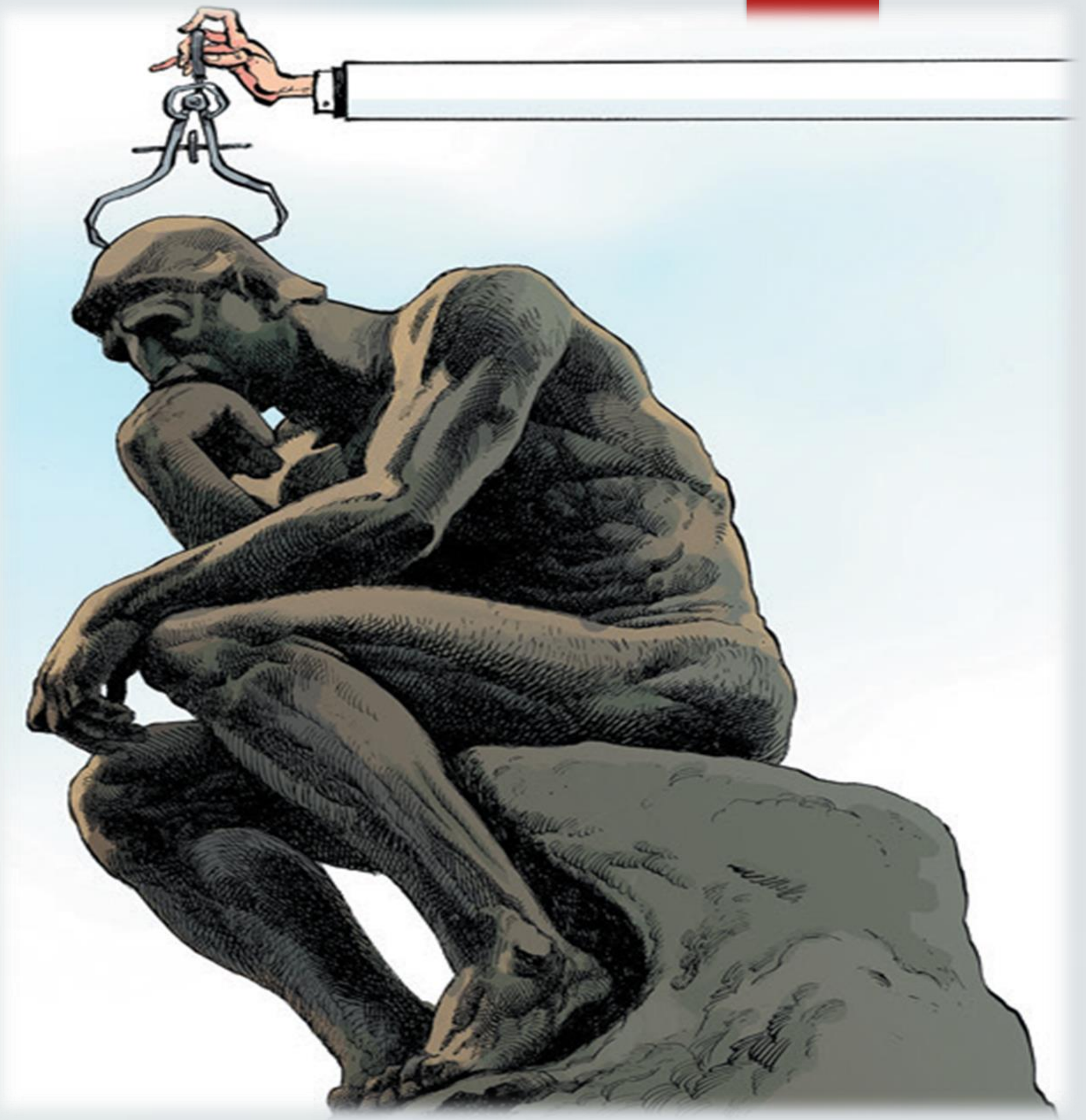
- *PLoS ONE* (which charges authors $1,350) publishes 70% of submitted articles, whereas *Physical Review Letters* (a hybrid journal that has an optional open-access charge of $2,700) publishes fewer than 35%; *Nature* published just 8% in 2011.
- Corruption: Directly related to the global internet, access is an avalanche of so-called "*degree mills*"—thousands of them, located in all regions. There is a Wikipedia page that lists house pets that have earned degrees.
- Crime in academia has overtaken even the legendary bribery of our police departments or the easy corruption of income tax authorities. But dealing with academic heist, now organized and systematized, won't be easy.





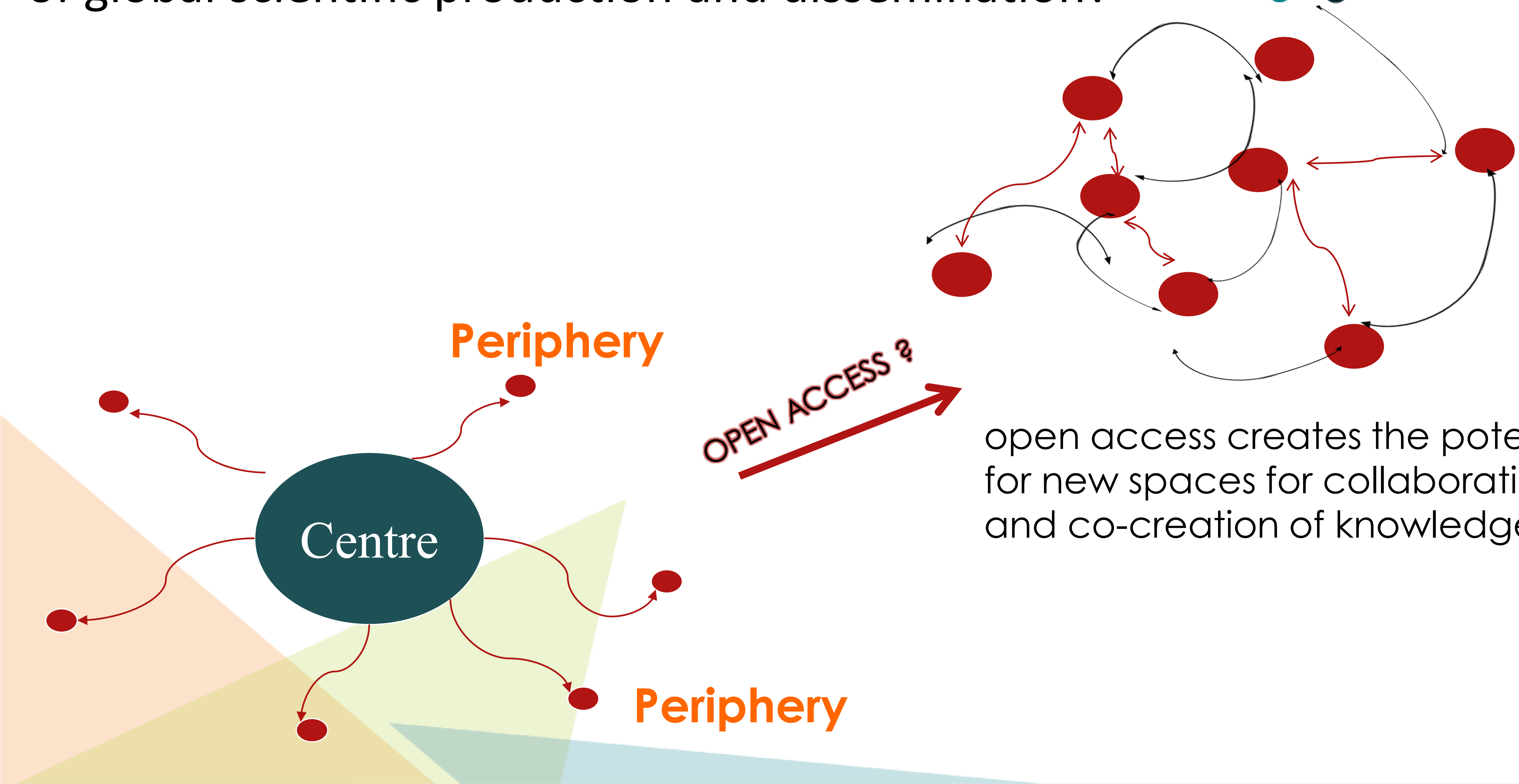
Performance measurements:

- Quantitative evaluation should support qualitative, expert assessment;
- Protect excellence in locally relevant research;
- Keep data collection and analytical processes open, transparent and simple;
- Scrutinize indicators regularly and update them.
- Account for variation by field in publication and citation practices;



N AT U R E 5 2 0 : (429) April 2015

Could Open Access change the current power structure of global scientific production and dissemination?



open access creates the potential for new spaces for collaboration and co-creation of knowledge

“The right to science envisages the scientific and technological endeavor as a process that every person is entitled to participate in—a collective and collaborative process that can help to unite a frequently fragmented world.”

Lea Shaver, The Right to Science and Culture. 2010 WISC. L. REV. 121 (2010)

Open Access

Open Access is the free, immediate, online availability of research articles combined with the rights to use these articles fully in the digital environment.

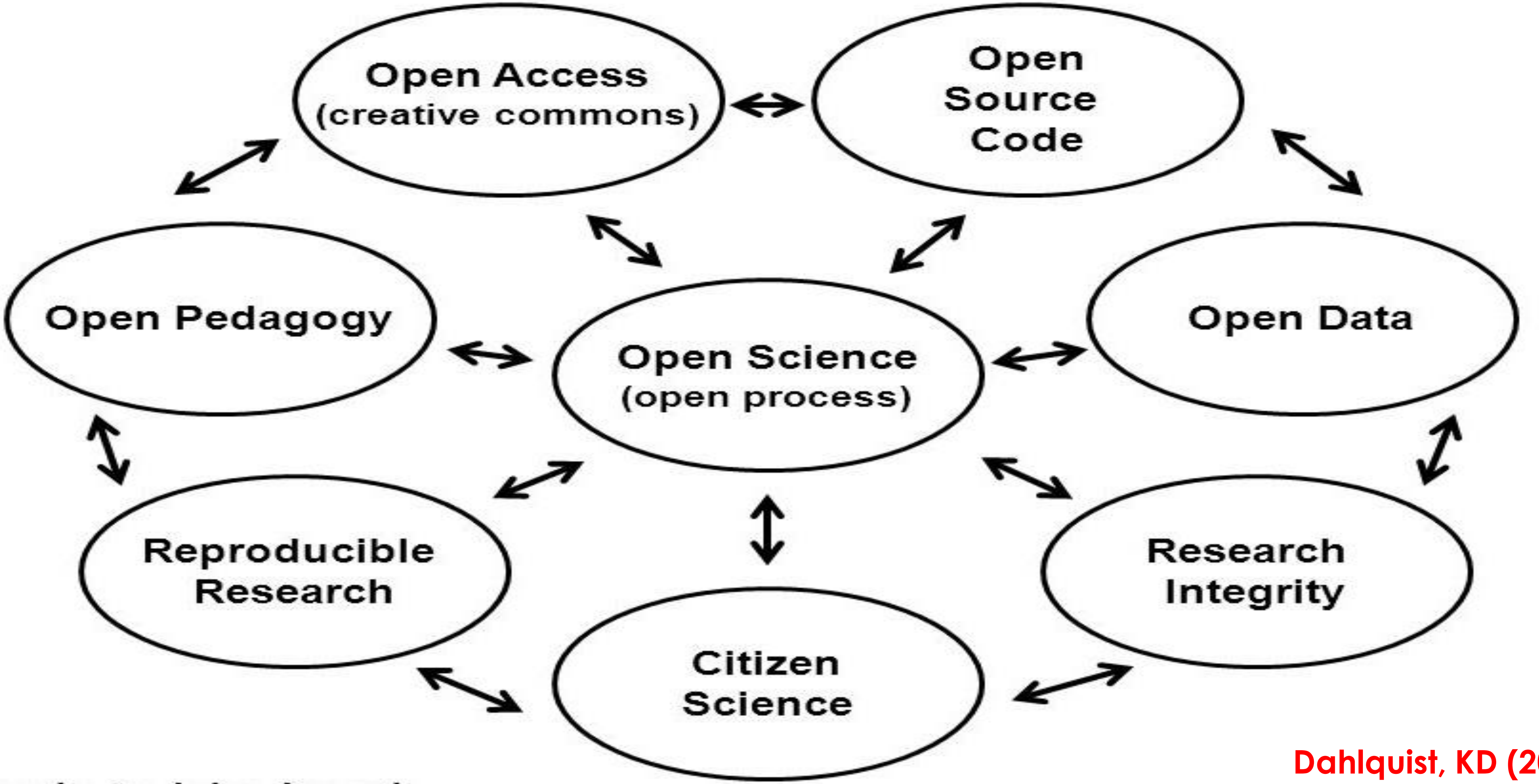
Making research results more accessible contributes to better and more efficient science, and to innovation in the public and private sectors.

Researchers can make their work open access by one of two ways;

- by depositing an open access copy of their published work in a repository
- by publishing in a journal that makes the work open access.

http://sparcopen.org/open-access/
https://aoasg.org.au/what-is-open-access/

Open Science Ecosystem



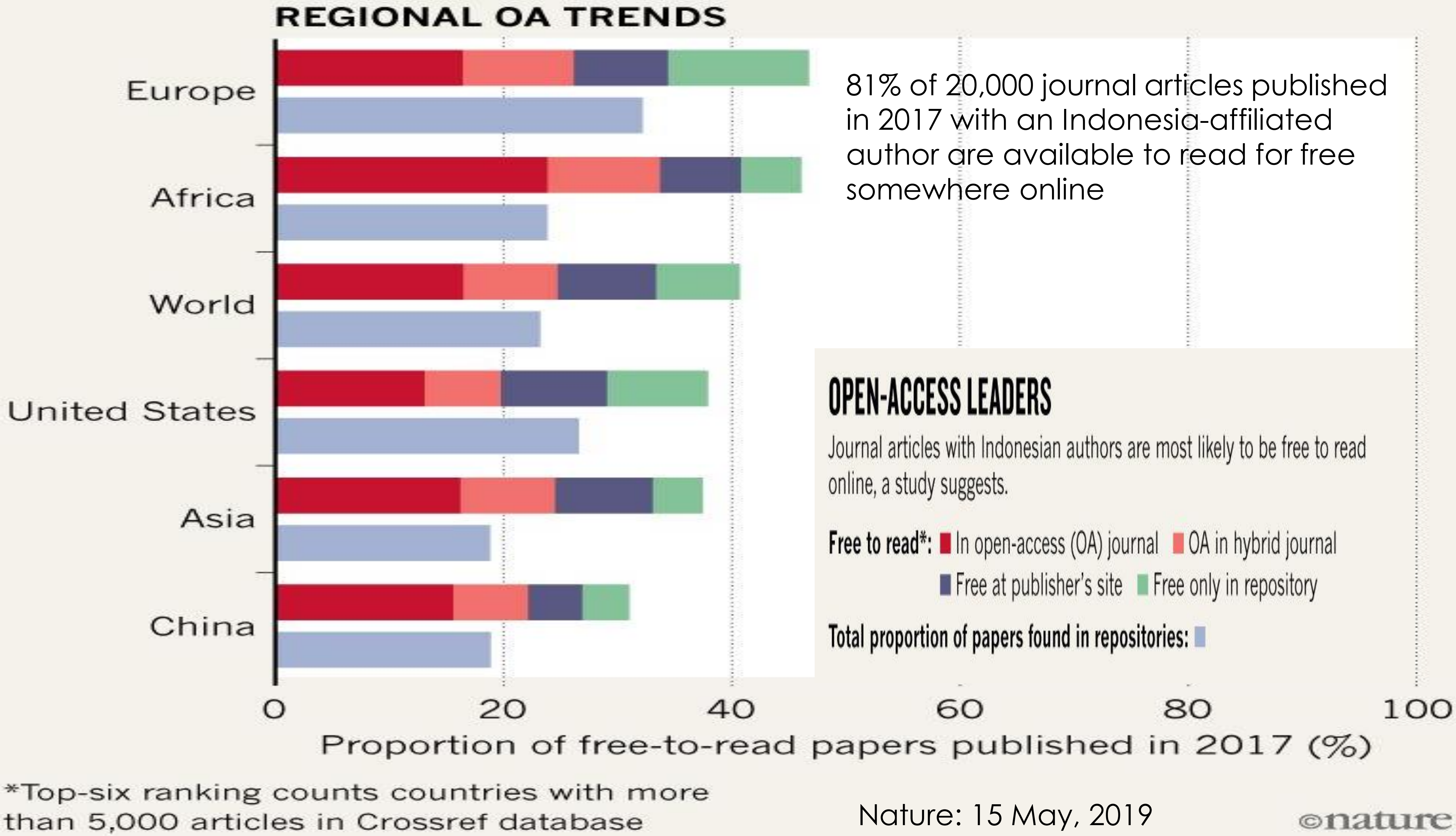
Dahlquist, KD (2015)

Open Science Claims

Claims for open access are mostly underpinned with

- science–related arguments (open access accelerates scientific communication);
- financial arguments (open access relieves the serials crisis);
- social arguments (open access reduces the digital divide);
- democracy–related arguments (open access facilitates participation); and,
- socio–political arguments (open access levels disparities).

Herb, U. (2010). Sociological implications of scientific publishing: open access, science, society, democracy and the digital divide



81% of 20,000 journal articles published in 2017 with an Indonesia-affiliated author are available to read for free somewhere online

Nature: 15 May, 2019

Science with and for Society

- The **EU 'Science with and for Society'** programme aimed at '**building capacities and developing innovative ways of connecting science to society'**.
- It allows all societal actors (researchers, citizens, policy makers, business etc.) to work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of European society. This approach to research and innovation is called **Responsible Research and Innovation (RRI).**

RRI objectives:

✓**engage society more broadly in its research and innovation activities,**
✓**increase access to scientific results**,
✓ensure gender equality, in both the research process and research content,
✓take into account the ethical dimension, and
✓promote formal and informal science education.

https://ec.europa.eu/programmes/horizon2020/en/h2020-section/science-and-society

Science with and for Society

- Build effective cooperation between science and society, to recruit new talent for science and to pair scientific excellence with social awareness and responsibility
- Implement institutional changes that foster RRI, for example in terms of knowledge, behaviours, and spreading of good practices in public and private governance frameworks, notably in RFOs and RPOs;
- Responsible research and innovation is cross-cutting across this programme and it seeks to involve society in discussing how science and technology can shape our future; putting the needs of ordinary citizens at its centre.

http://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

Science with and for Society

- Attractiveness of scientific careers,
- Gender equality,
- Integration of citizens' interests and values in R&I,
- Formal and informal science education,
- Accessibility and use of research results,
- Governance for the advancement of RRI and for the promotion of an ethics framework for research and innovation,
- Anticipation of potential environmental, health and safety impacts
- Improved knowledge on science communication

http://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

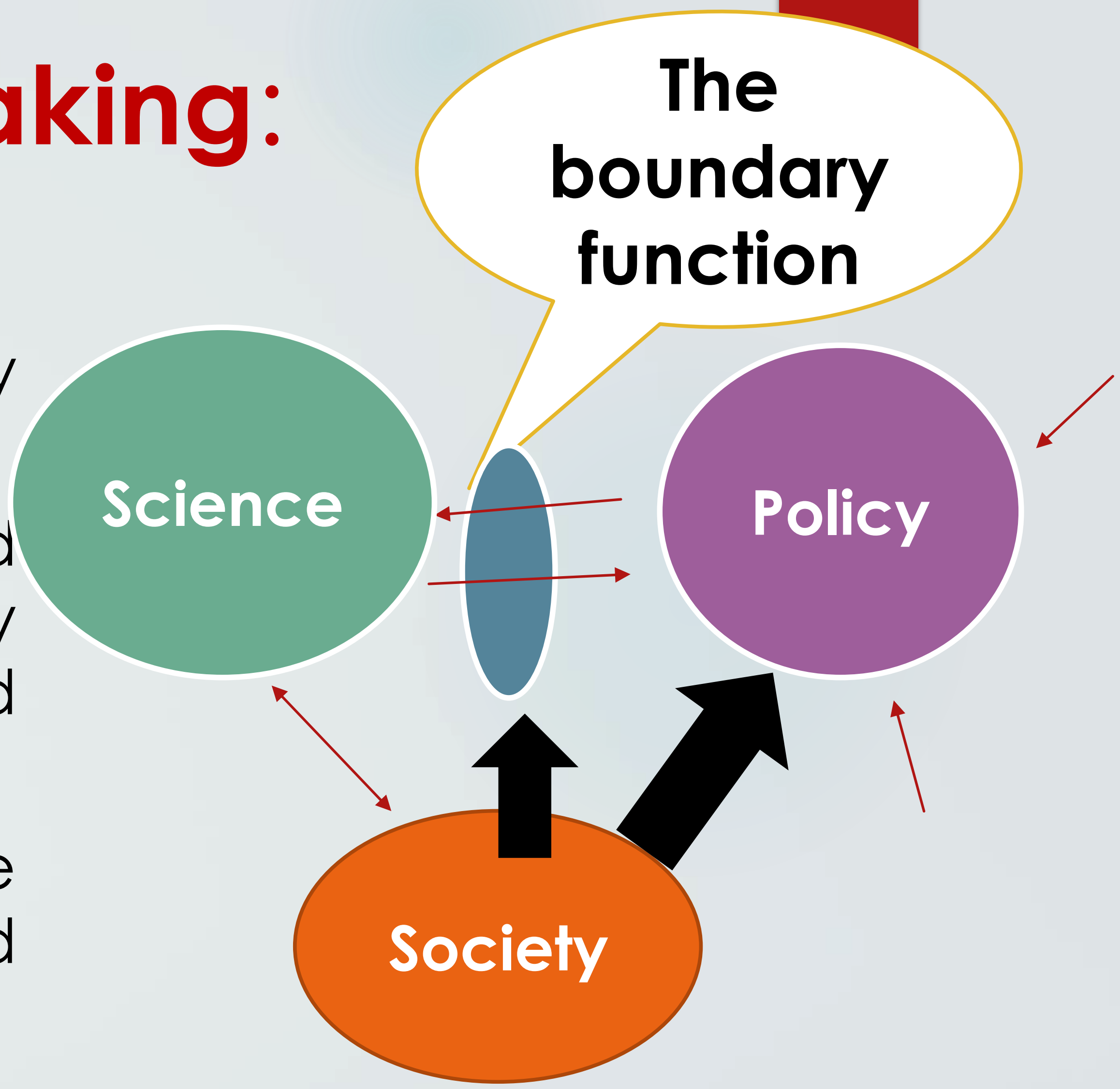
Science Diplomacy in 21st Century

- Scientists, engineers, and innovators to motivate and harness their talent to tackle global challenges, such as clean water, renewable energy, better education, food security, or biodefense against dangerous pathogens.
- Taking one man's trash to make another man's treasure and applying science and technology to solve sustainability challenges.
- Enable developing countries, to end hunger, eradicate extreme poverty, and secure gender equality.

Vhugan Turkian | DIPNOTE US Department of State official blog (26 April, 2016)

Science and policy making:

- Science and policy making are two very distinct cultures.
- The nature of interaction is influenced by context, culture and history and by the relationship between science and society
- There is increasing recognition of the importance of boundary roles and structures in linking these cultures.
- The nature of these boundary entities is variable and still evolving there will not be a one-size fits all model



Core principle

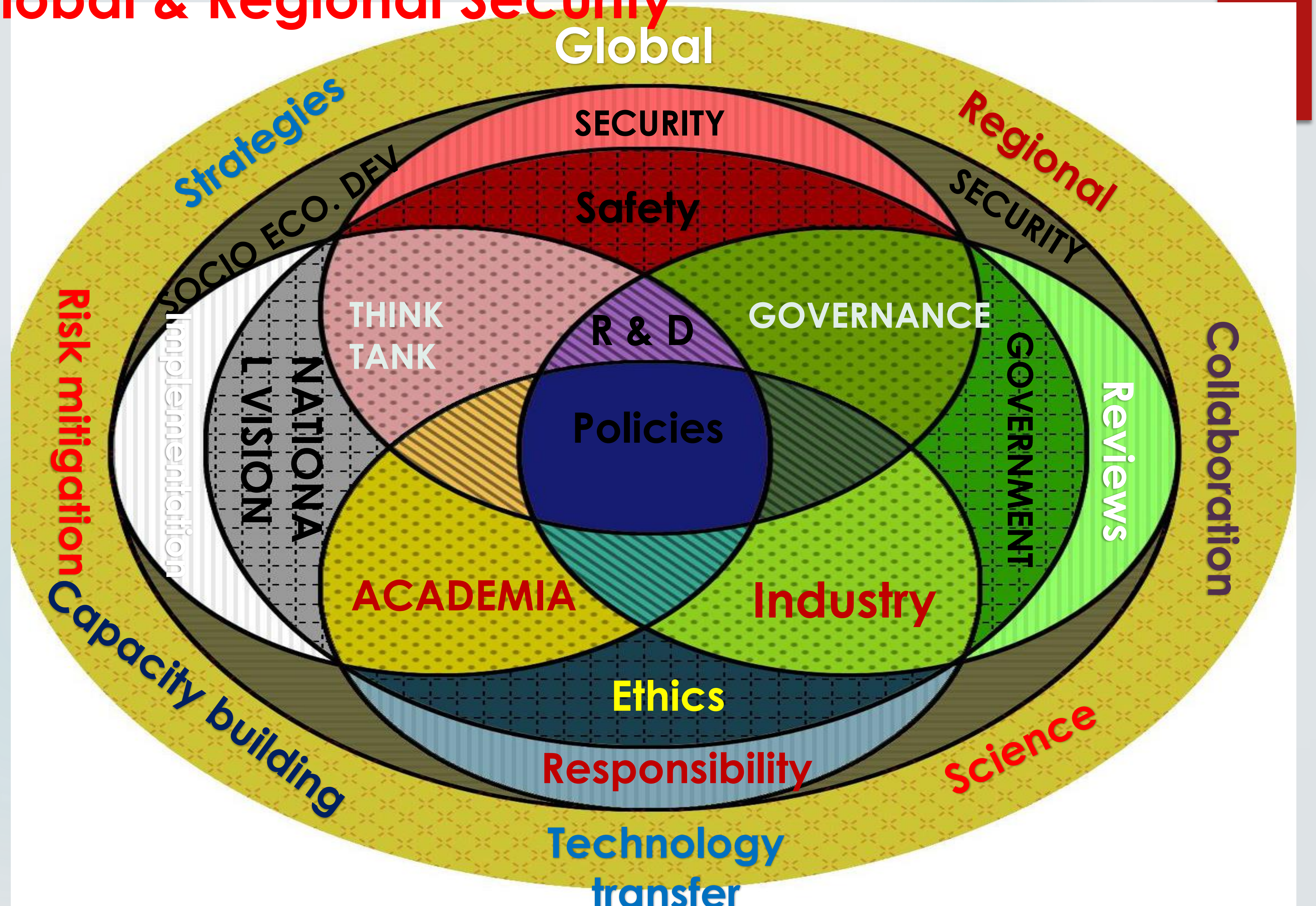
- Trust
- Independence
- Report to the top
- Distinguish science for policy from policy for science
- Avoid hubris.
- Recognize the limit of science.
- Brokerage not advocacy
- Engage the science community
- Engage the policy community

NIH (2009) defines RCS as

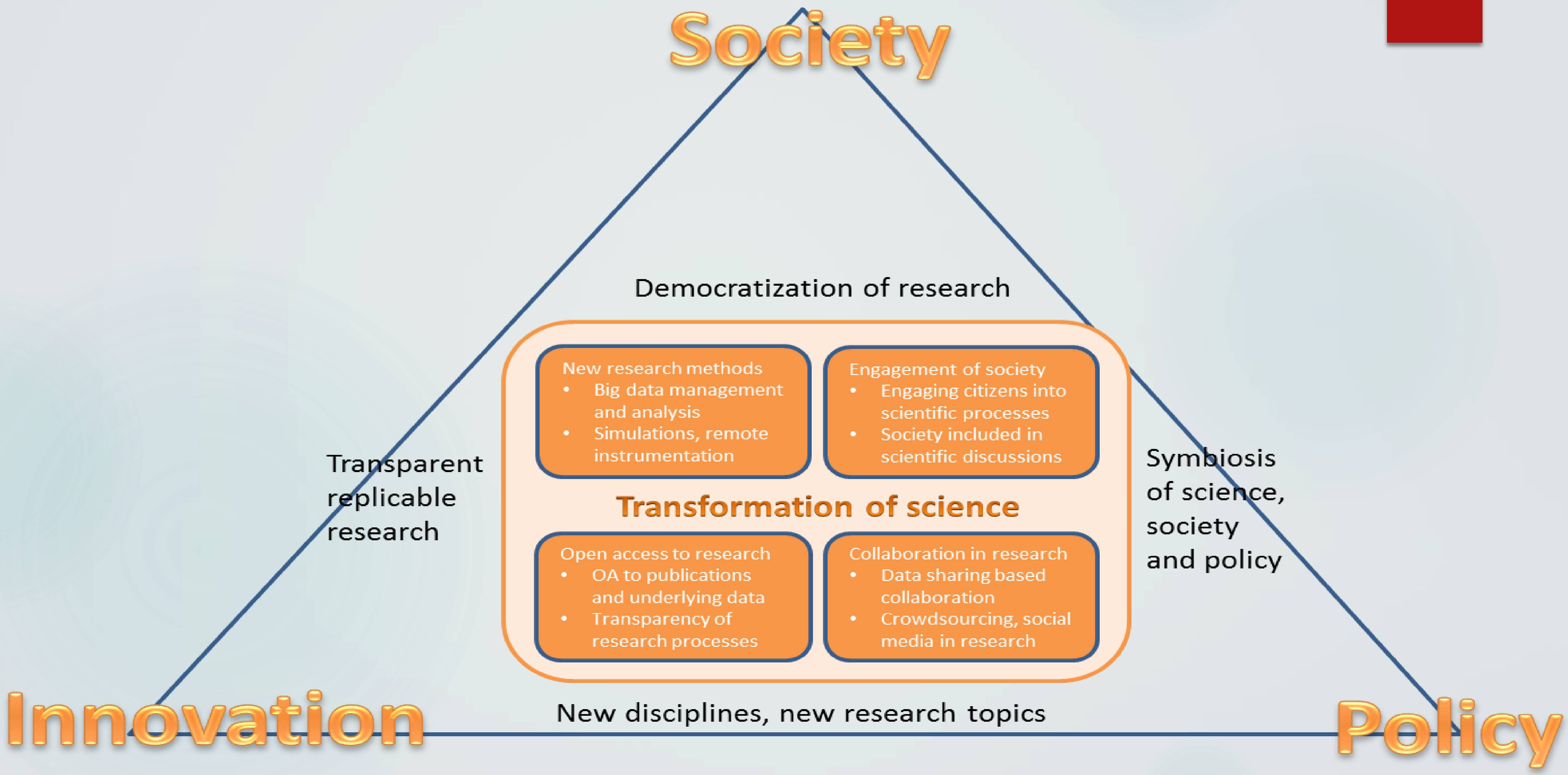
"the practice of scientific investigation with integrity. It involves the awareness and application of established professional norms and ethical principles in the performance of all activities related to scientific research"

Nature, 12 march 2014

BWC: Global & Regional Security



Technological innovations in basic and applied science may contribute to an inclusive society based on the principles of humanism



http://www.oi-net.eu/

Inclusive Society and Sustainable Development

“a people-centred, inclusive and development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and people to achieve their full potential in promoting their sustainable development and improving their quality of life ….”

An excerpt from Outcome document of two phases (Geneva, 2003, Tunis, 2005) of **UN World Summit on the Information Society**

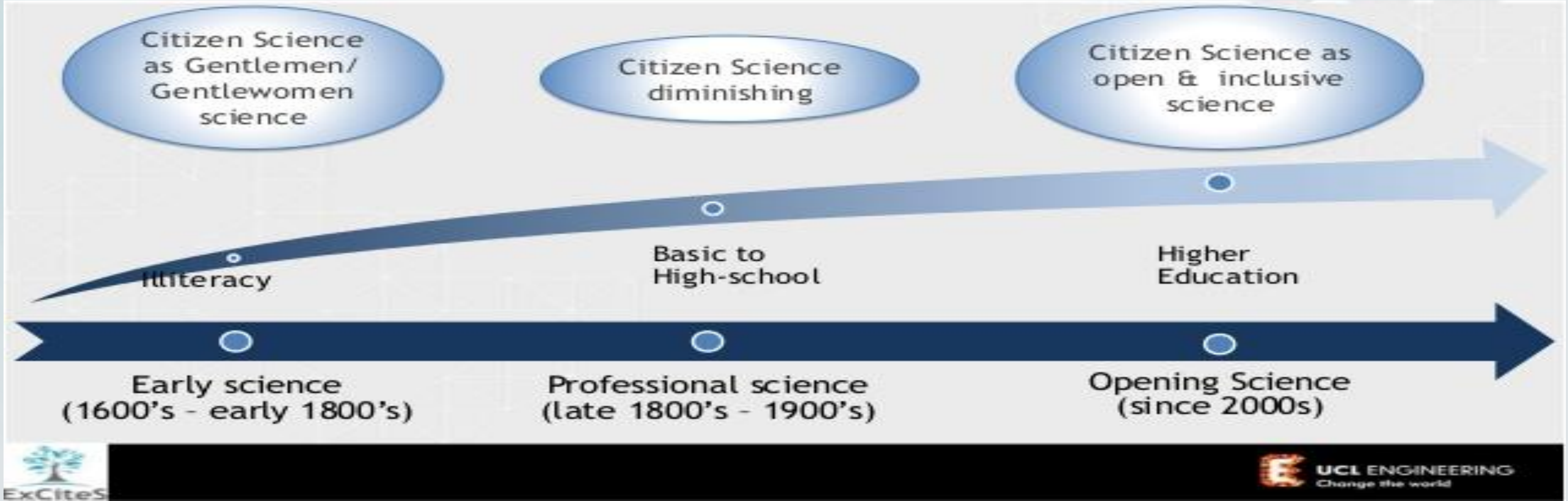
Open Access is a key enabler of **Open Science**, which in turn will lead to a more **Open Society**

Citizen Science

- Citizen science is a broad term, covering that part of [Open Science] in which citizens can participate in the scientific research process in different possible ways:

  as observers, as funders, in identifying images or analyzing data, or providing data themselves

- This allows for the democratisation of science, and is also linked to stakeholders' engagement and public participation



Open in Action

With the theme of [Open in Action], International Open Access Week 2016 served as a call for researchers, policymakers, funders and publishers around the globe to take "concrete steps to open up research and scholarship

Centre for Open Data Enterprise based in Washington DC set the following goals for the US administration to take into account based on US commitment with the theme "open in action" of International Open Access Week 2016;

Goal I: Enhance the government open data ecosystem

Goal II: Deliver direct benefits to citizens and communities

Goal III: Share scientific research data to spur innovation and scientific discovery

Goal IV: Help businesses and entrepreneurs use government data as a resource

http://opendataenterprise.org/about.html

Democratizing Research

- Over the coming years, citizens will be playing an expanded role in scientific research and will contribute more actively to defining the research agenda
- What democratization means, in science is
- creating institutions and practices that fully incorporate principles of accessibility, transparency, and accountability
- considering the societal outcomes of research at least as attentively as the scientific and technological outputs
- insisting that in addition to being rigorous, science be popular, relevant, and participatory

Guston, David H. "Forget Politicizing Science. Let's Democratize Science!" *Issues in Science and Technology* 21, no. 1 (Fall 2004).

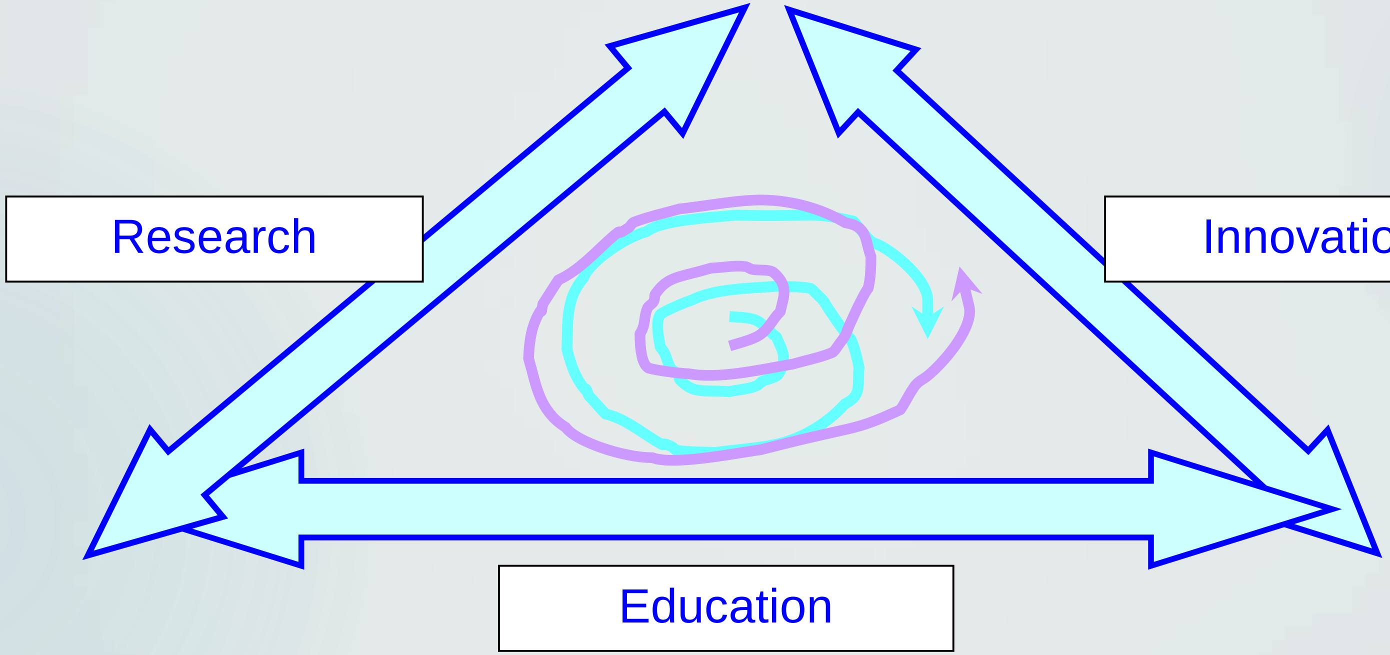
Contribution to the public good

- Scientists are judged
- Education → Research → Economy/Innovation

- Other areas where scientists shall be working directly for the public good. e.g. educating the next generation of leaders,
  - addressing important social issues,
  - making scientific discoveries and acting as guardians of culture.
- Universities are often the most influential public institutions in their area – not just as the largest employer but also as drivers of innovation, centres of cultural life, and business activity.

INNOVATION-, EDUCATION-, RESEARCH PROCESSES

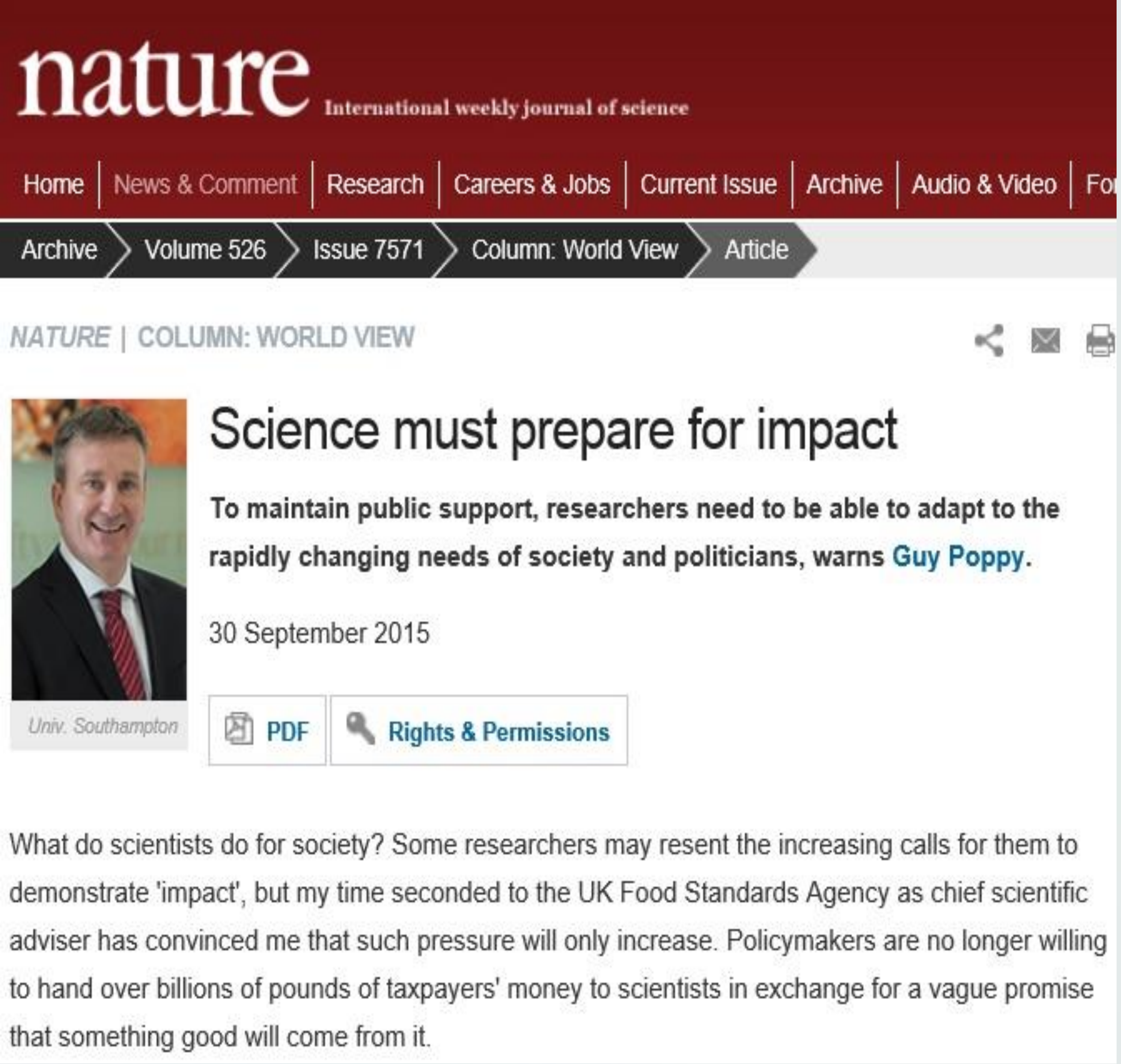
The „Knowledge Triangle“



Three legs rather than three nodes

Adopted from: Josef Hochgerner (Vienna)

IMPACT OF SCIENCE



nature International weekly journal of science

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | Fo

Archive > Volume 526 > Issue 7571 > Column: World View > Article

NATURE | COLUMN: WORLD VIEW

Univ. Southampton

Science must prepare for impact

To maintain public support, researchers need to be able to adapt to the rapidly changing needs of society and politicians, warns Guy Poppy.

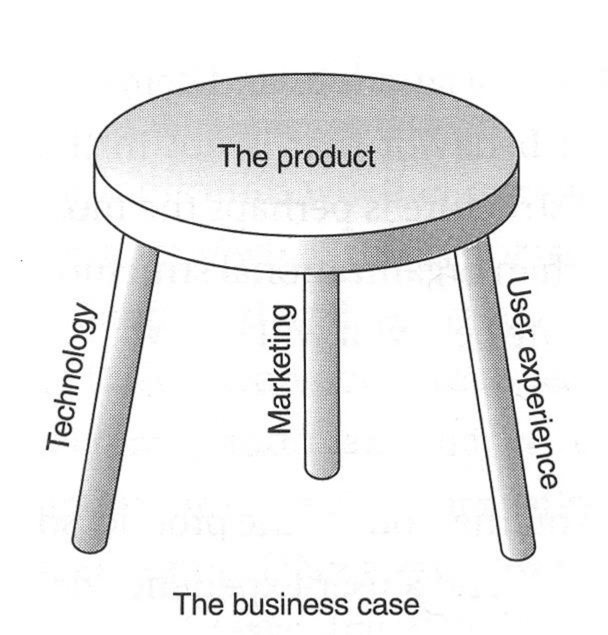
30 September 2015

PDF | Rights & Permissions

What do scientists do for society? Some researchers may resent the increasing calls for them to demonstrate 'impact', but my time seconded to the UK Food Standards Agency as chief scientific adviser has convinced me that such pressure will only increase. Policymakers are no longer willing to hand over billions of pounds of taxpayers' money to scientists in exchange for a vague promise that something good will come from it.

What is expected?

Project evaluators will expect **creative multidisciplinary networks,** actively involving stakeholders from different fields and disciplines - including the humanities, social sciences and policy-makers in cities and regions. To achieve **a deeper understanding of science and innovation as motors of an innovative, sustainable and inclusive society**, science communicators, stakeholders and policy makers in cities and regions will have a key role to play!



Synthetic biology from 2050 onwards

- Larger and more complex life forms created (multi-celled animals)

- By 2056, debates occurring over "synthetic people" entering the population. What rights and freedoms would they have? moral, ethical and legal arguments raised

http://www.futuretimeline.net/21stcentury/2050-2059

Fears grow over lab-bred flu

Scientists call for stricter biosafety measures for dangerous avian-influenza variants.

- It is a nightmare scenario: a human pandemic caused by the accidental release of a man-made form of the lethal avian influenza virus H5N1.
- Newly created mutant H5N1 variants that can be transmitted between ferrets merely breathing the same air, generally an indicator that the virus could also spread easily among humans, with a fatality rate akin to wild-type H5N1 —greater than the mortality rate of roughly 2.5% seen during the catastrophic flu pandemic of 1918

(R. A. M. Fouchier *et al. Nature* **481**, 443; 2012); Butle News Nature: vol 480: 7378 (2011)

Call for 60-day suspension of mutant flu research

Bioterrorism & accidentally escape are potential risk of such research; which may cause a H5N1 pandemic.

Science is the most ethical!

"There is an ethical obligation to emergent technologies to alleviate human suffering"

Nuffield Council

Not to have science is the most unethical!

Our responsibility: Science for the Future of Man!

"The United Nations Drugs Control Programme is fronting the fungus project, it is the Americans who are the real sponsors with the British making a £100,000 contribution."

Targets: Columbia, Afghanistan

Human Health Hazards

- Fusarium infection (fusariosis) – 70% mortality rate
- Greatest risk for immunocompromised patients
- Dermal and respiratory difficulties
- Production of mycotoxins with deleterious effects
- Indirect effects – crippled traditional medicine, crop loss;

Wise decision

Caution	Wisdom	Courage
• Pursue a technology when its long term effects are fully understood	• Giving proper weight to both the risks and the benefits	• To take a step forward if potential benefit outweigh its risks

Regulation

Recall censorship debate (and relevant issues regarding of vetting of research).

Who should decide?

1. Government?
2. Individual scientists (and/or relevant scientific bodies) guided by codes of conduct—i.e. "voluntary self-governance")?

Perhaps neither is satisfactory. There are hybrid solutions, for which legally binding codes of conduct may play an important role.

CRISPR germline engineering

- Editing human germline genes may act as boon in some genetic and other disorders. Recent editing of the genome of the human embryo with the CRISPR/Cas9 editing tool generated a debate amongst top scientists of the world for the ethical considerations regarding its effect on the future generations

- These are the changes in the germline intended to be passed on to the next generation so that the devastating and disease causing genes can be eradicated forever

- Concern about unintended effects whose disadvantages might grossly outweigh any advantages that genome editing confers
- Designer babies

Traditional Islamic approach can enrich CRISPR twins debate

Research methodology in traditional islamic scholarship uses five principles to resolve such ethical dilemmas.

i) *Qasd*, relates to intention — valid in this case, if the aim was to improve social welfare by protecting the twins against transmission of HIV from their infected father.

ii) *Yaqin*, concerns certainty; however, the long-term safety of CRISPR technology is uncertain.

iii) *Darar*, alludes to the avoidance of injury; here, the balance of risk and benefit to the twins and their progeny is not yet understood, and so the parents' consent was not properly informed.

iv) *Darura*, refers to necessity — questionable in this case, because established and safe alternatives exist for protecting people from HIV.

v) *Urf*, relates to custom — in this instance, to the social context and acceptance of using the technology; and the public is uneasy about gene editing.

Nature **566**, 455 (2019)

Sara Reardon
Reporter at Nature Publishing Group

BIOTECHNOLOGY

Global summit reveals divergent views on human gene editing

Representatives discuss the ethical, social and legal issues that unite and divide them.

BY SARA REARDON

When nearly 500 scientists, ethicists, legal experts and advocacy groups from more than 20 countries came together in Washington DC last week to produce guidelines for the use of gene editing in humans, the meeting served as a potent reminder of how far genetic engineering has permeated society.

In 1975, a group of mostly US scientists met at an iconic conference in Asilomar, California, and set stringent guidelines for moving forward with powerful new research tools that enabled the mixing of DNA between species. Forty years later, it took a much more diverse group to reach a much less definitive agreement: a recommendation not to stop human-gene-editing research outright, but to refrain

YORGOS NIKAS/SPL

The genetic modification of human embryos (orange cells) is a controversial topic.

❑ WHAT SCIENTIST DO FOR SOCIETY?

Some researchers may resent the increasing calls for them to demonstrate ‘impact’

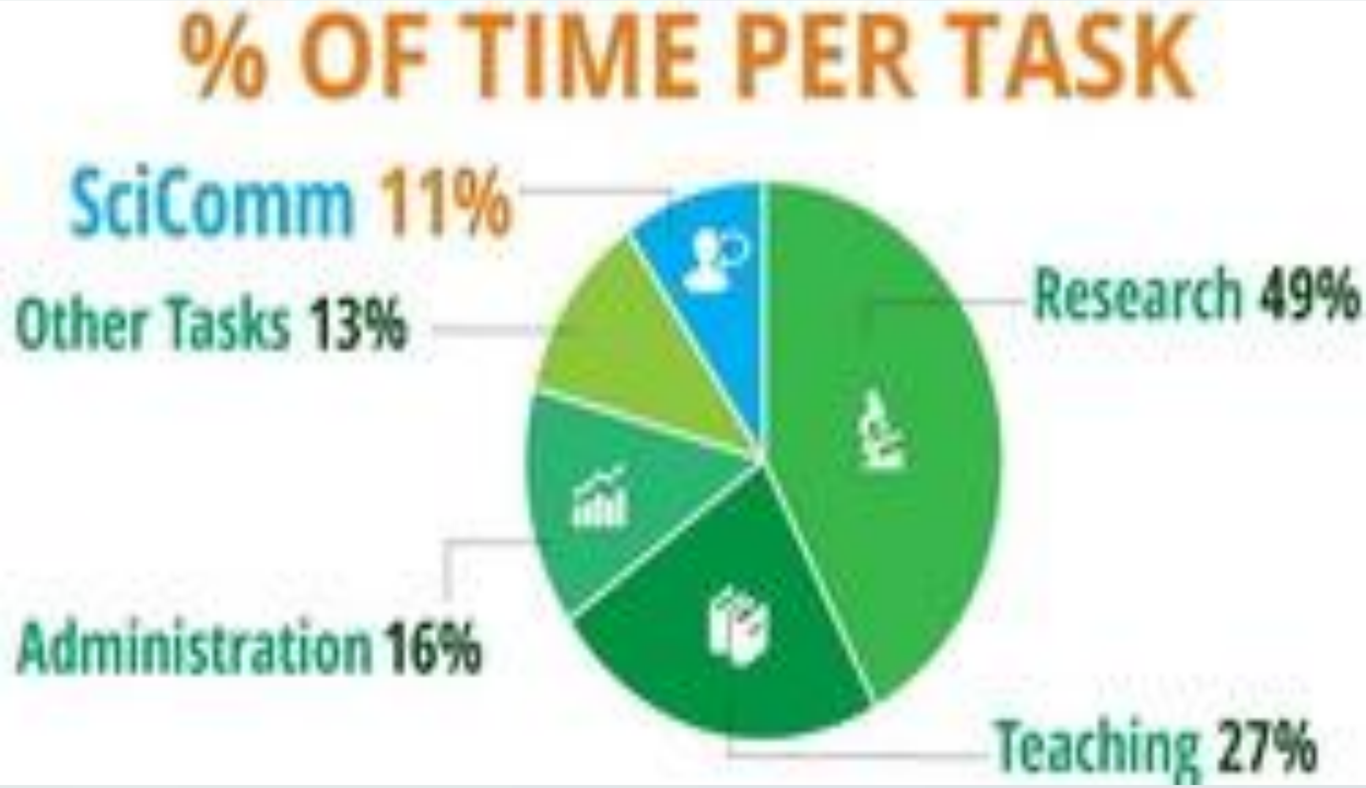
Policymakers are no longer willing to hand over billions of pounds of taxpayers’ money to scientists in exchange for a vague promise that something good will come from it.

Academics and leaders of the scientific community must realize that the system is failing to prepare researchers to meet wider society’s requirements.

Nature 526 (7571): 30 Sep. 2015

Scientists Value Scicom But Spend Little Time Communicating Biotech to the Public

- Studies have shown that university professors and public sector scientists are regarded by the public as highly credible sources of information on biotechnology. Thus, their role incommunicating biotechnology is critical.
- ISAAA conducted a survey to investigate how scientists and academics view science communication (scicom) and their role in public awareness and understanding. Over 200 respondents from 63 different research institutions and universities in Indonesia, Malaysia, and the Philippines were involved in the study.
- Results showed that although the scientists and academics recognize the importance of science communication, they only devote a small portion of their time in public engagement.



http://www.isaaa.org/resources/infographics/scicomm2014/scicomposter2014.jpg.

A "Youth Bulge": Demographic Dividend or Tsunami?

B.M. GOURLEY

Publish-or-perish: Peer review and the corruption of science

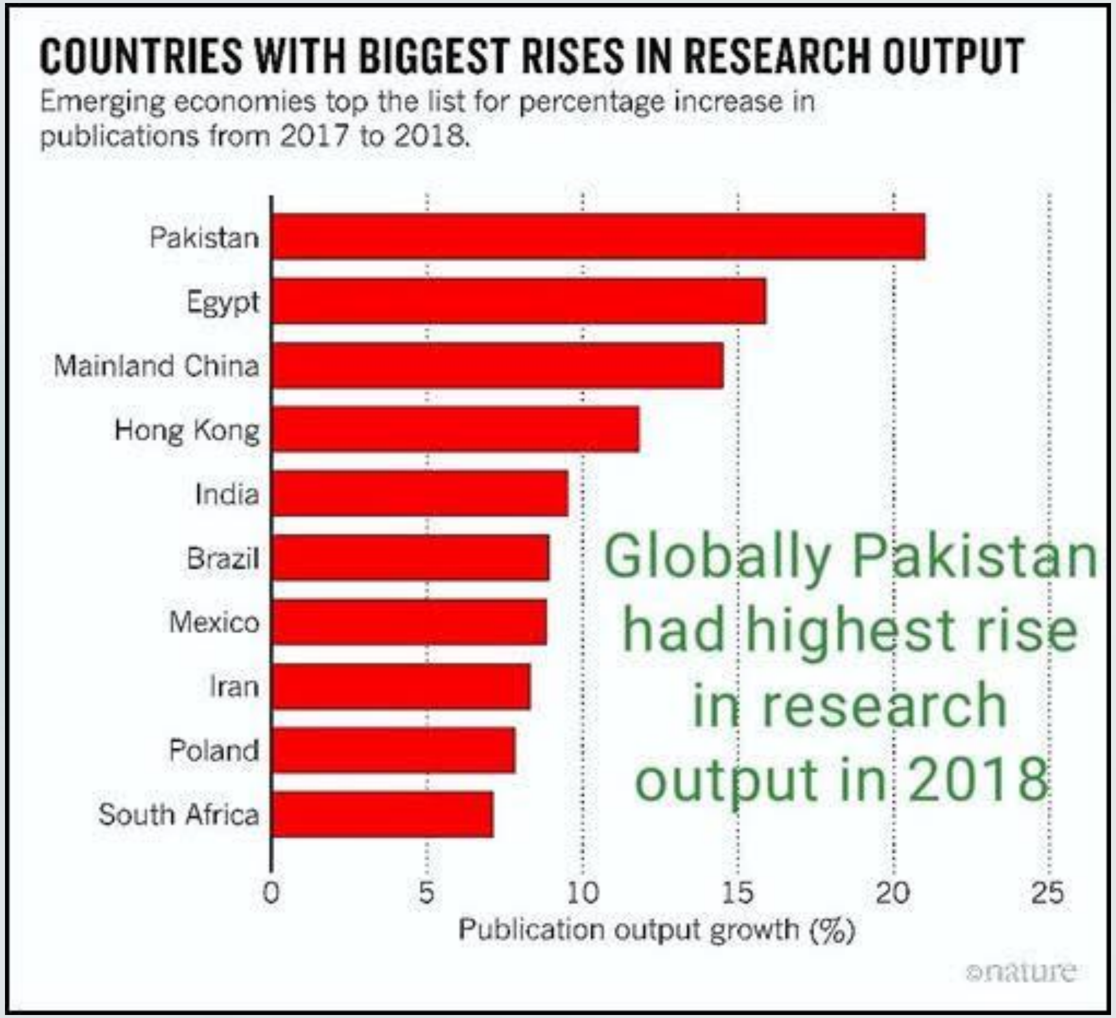
- Pressure on scientists to publish has led to a situation where any paper, however bad, can now be printed in a journal that claims to be peer-reviewed
- <u>An estimated 1.3 million papers in 23,750 journals in 2006</u>
- There simply aren't enough competent people to do the job. The overwhelming effect of the huge (and unpaid) effort that is put into reviewing papers is to maintain a status hierarchy of journals.
- US National Library of Medicine indexes <u>39 journals that deal with alternative medicine</u>. They are all "peer-reviewed", but rarely publish anything worth reading.

Source: http://www.guardian.co.uk/science/2011/sep/05/publish-perish-peer-review-science

Monday 5 Sep. 2011

Pakistan & Egypt had highest rise in research output in 2018

Global Production of Scientific papers hit an all time high this year, estimates show, with emerging economies rising fastest.



- Emerging economies showed some of the largest increases in research output in 2018, according to estimates from the publishing-services company Clarivate Analytics. **Pakistan & Egypt topped the list in percentage terms, with rises of 21% and 15.9%,** respectively.
- China's publications rose by about 15%, and India, Brazil, Mexico and Iran all saw their output grow by more than 8% compared with 2017 .
- **Globally, research output rose by around 5% in 2018**, to an estimated 1,6m papers listed in a vast science-citation database Web of Science, the highest ever (see 'Research output rose again in 2018').
- "**In 1980, only 5 countries did 90% of all science** — the United States, the United Kingdom, France, Germany and Japan," she says. "Now there are 20 countries within the top producing group."

Nature 21 Dec. 2018

Research Values

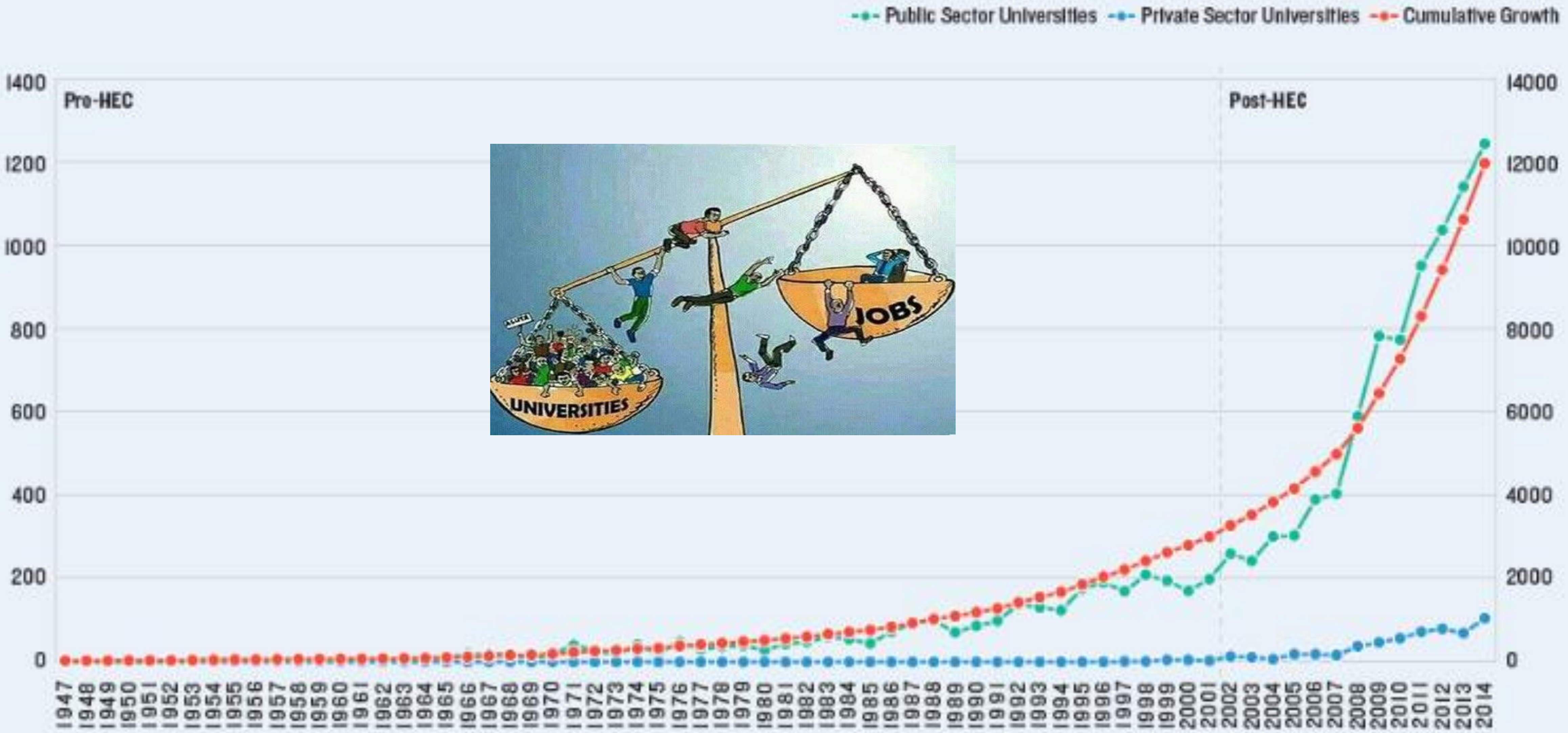
Responsible conduct in research is based on many of the same human values that apply in daily life, but these values have specific implications in the context of research.

Seven overlapping fundamental values:

- Honesty;
- Fairness;
- Objectivity;
- Reliability;
- Skepticism;
- Accountability;
- Openness;

Responsible Conduct in the Global Research Enterprise: A Policy Repor IAP Secretariat (Italy, Sep 2012)

Number of PhDs in Pakistan



Source: Higher Education Commission

Universities challenged

•The accelerating pace of change in today's world means that universities must modify how they fulfil their function of seeking and sharing knowledge.

"The very foundations of the centuries-old university concept are under attack as never before."

A university, to linguists, is a derivation of a Latin description of a community of teachers and scholars.

Universities have always changed with the times. But there is a growing sense that the pace of that change is accelerating. **More fundamentally, universities are losing control of the process. Change is being forced on them.**

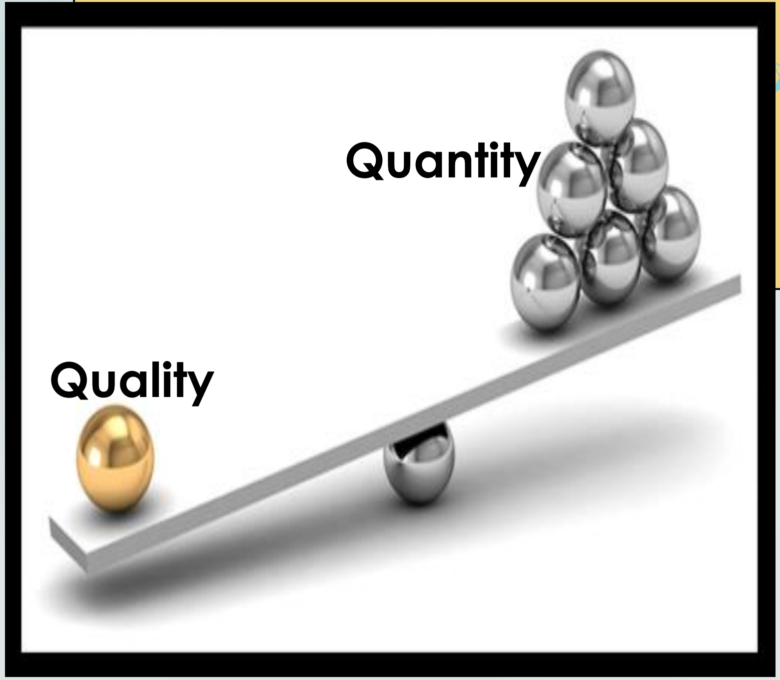
Pay to Play Publishing

- **Pay Money and Publish what ever you want !!!**

Nature, 534, 326 (16 June 2016)

Measures against Fake Journals

- Universities and colleges should stop using the quantity of published articles as a measure of academic performance.
- The measure should be <u>Quality</u> rather than <u>Quantity</u>
  - Researchers and respectable journals should not cite articles from predatory journals.
  - Academic library databases should exclude metadata for such publications



Nature, 534, 326 (16 June 2016)

The Disaster of the Impact Factor

At the time of its inception in 1955 (Garfield 1955), the inventor of the impact factor did not imagine that 1 day his tool would become a controversial and abusive measure, as he confessed 44 years later (Garfield 1999).

- The impact factor became a major detrimental factor of quality, creating huge pressures on authors, editors, stakeholders and funders. More tragically, in some countries the number of publications in journals with "high impact factors" condition the allocation of government funding for entire institutions (Plos Medicine Editorial 2006). Based on the assumption that IF reflects scientific quality, the impact factor produces a widespread impression of prestige and reputation, though no experimental data support this hypothesis (Brembs et al. 2013).

Sci Eng Ethics 2014

The Disaster of the Impact Factor

Elitist journals tend also to restrict submission of review articles to "by invitation only", in such a way that only senior authors with long career experiences are invited to submit "citable" papers to boost the journal impact factor. Junior authors, on the other hand, are often rejected if they are not endorsed by at least one veteran co-author.

Another disastrous effect of the impact factor fashion is the newborn universities ranking system.

Issues to Be Considered

Values such as publishers' freedom and scientists' legal right to publish;

Scientists' responsibility to be aware and to reflect on the ways their work will be used;

Potential benefits and burdens of publishing certain discoveries;

'There is too much out there available already'.

‘Science affects society in innumerable ways, and so society should surely have at least some control over science.’ (Selgelid, 2009)

Great competence is required of both scientists and publishers in making reasonable judgements;

Need of collaboration among editors, researchers, policy-makers and security experts to establish guidelines and procedures, and ensure that no sensitive information is released;

Comparison of credit and responsibility paradigms

Fame & Fortune	Shame & Penalty
Credit paradigm	**Responsibility paradigm**
Assumes worthy work deserving fame and focuses on the question: how much fame does one deserve for the effort?	Assumes flawed work deserving shame and focuses on the question: how much shame is one willing to assume?

My co-authors names appeared on these papers in good faith, and neither of them was aware of the accuracy of these efforts nor were they responsible for any of them.

Source: Environ. Sci. Technol. (2015)

Scientists' Obligations

Obligation to honour the trust that their colleagues place in them **– a responsibility of researchers to mentor the next generation who will build their work on the current research discoveries;**

Obligation to themselves **– irresponsible conduct in research can make it impossible to achieve a goal;**

Obligation to act in ways that serve the public **– to cause no harm**

Issues to Be Considered

Research – based on the ethical values of honesty, fairness, objectivity, openness, trustworthiness, and respect;

Scientific standard – the application of these values in the context of research;

Scientific misconduct – fabrication, falsification, or plagiarism (FFP)

Questionable research practices – violations other than FFP

A special issue explores the study of inequality, and how socio-economic divides affect the science workforce

Science and inequality

Nature Volume: 537, Pages: 465 Date published: (22 September 2016)

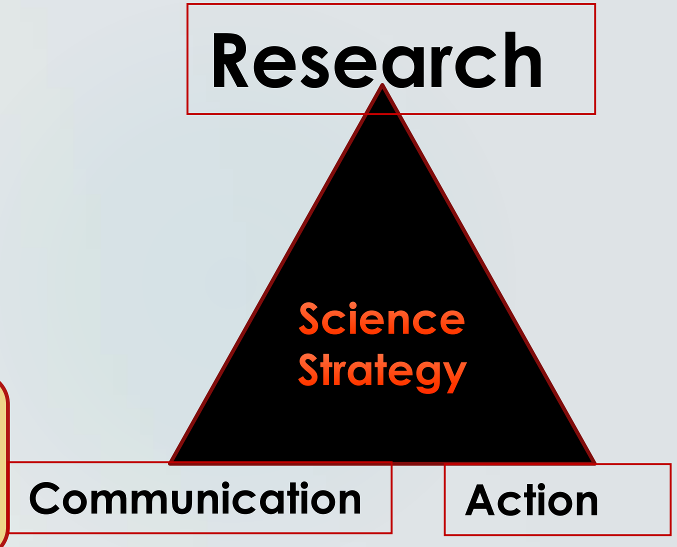
- In every society on Earth, at least some fraction of the citizens find their talents being sacrificed to poverty, prejudice, poor schooling and lack of opportunity.
- Science is comparatively open: many top-rank inventors and researchers have risen from humble beginnings through a combination of brilliance and luck. Even so, the field is losing out on millions of bright but underprivileged students. And now that researchers have begun to grapple with ways to increase gender and ethnic diversity in science, many are calling for socio-economic status to be the next big topic of debate.
- On the subject of inequality, it seems, science still has a lot of work to do

Nature Volume: 537, Pages: 465 Date published: (22 September 2016)

Summary of Challenges while making strategy for Knowledge economy

Challenges

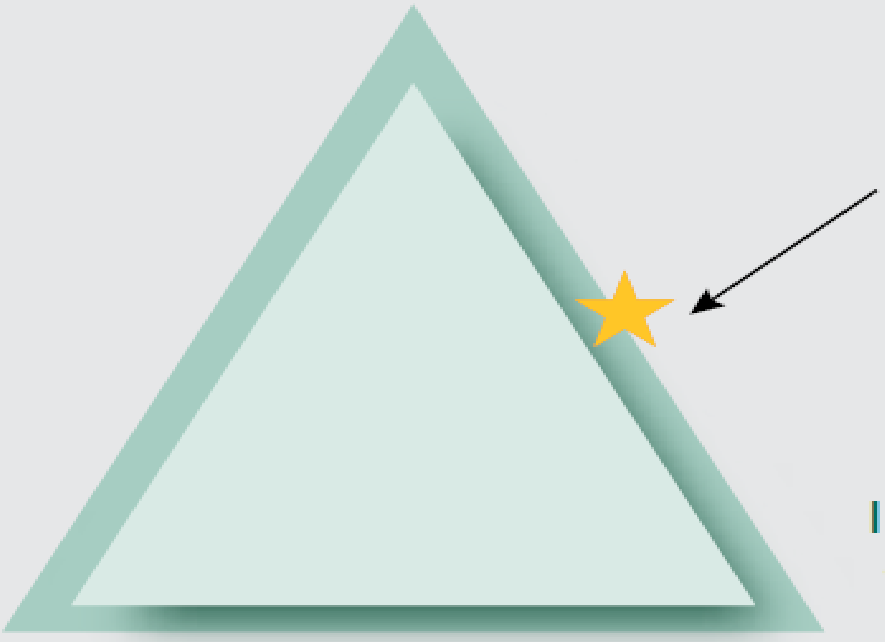
- Challenges
  - Globalization
  - Competition
- Public Scrutiny (Media)
- Multidisciplinary
- Purpose
  - Methodological Revolution
  - Translation of knowledge in action
- Translation of knowledge in action
  - Communication
- Equity/ Fair Play




Success
Humility
Sincerity
Hardworking
Knowledge
Ego
Jealousy
Cheat
Laziness
Moosa Hamad
16-01-2015

Exhibit 2 | Transformation Leadership Must Be Directive and Inclusive

Directive leadership
- Defines vision and strategic priorities
- Sets transformation ambition and milestones
- Holds employees accountable for outcomes



TRANSFORMATIONAL LEADERSHIP
(directive *and* inclusive)

Delegating leadership
- Defines vision and strategic priorities
- Delegates execution to organization

Inclusive leadership
- Involves employees early and emphasizes collaboration
- Mobilizes and empowers teams
- Actively seeks feedback

Source: BCG analysis.

APPENDIX A

CONFERENCE ORGANIZING COMMITTEE

Dr. Abdel Salam Majali	FIAS, President, IAS.
Dr. Adnan Badran	FIAS, Treasurer, IAS.
Dr. Abdullah Al Musa	Director General, IAS.
Ms. Taghreed Saqer	Executive Secretary, IAS.
Ms. Najwa F. Daghestani	Program Manager, IAS.

APPENDIX B

22nd Islamic World Academy of Sciences Conference

Landscape of Science, Technology and Innovation in the Islamic Countries.

List of Participants (22nd IAS virtual Conference)
1 December 2020

No.	Name	Email	Job Title	Organization	Country
1.	HRH Prince El Hassan Bin Talal		Founding Patron	Islamic World Academy of Sciences	Jordan
2.	HRH Princess Sumaya bint El Hassan	President@rss.jo	President	Royal Scientific Society	Jordan
3.	Abdeslam Hoummada	a.hoummada@academiesciences.ma	Scientific Director	Hassan II Academy of Science and Technology	Morocco
4.	Abdulla Al Jarrah	ajarrah@yu.edu.jo	Professor	Yarmouk University	Jordan
5.	Abdullah Al-Musa	ias@go.com.jo	Director General	Islamic World Academy of Sciences	Jordan
6.	Abeer Arafat	abeer.arafat@rss.jo	Assistant to the President for Organisational Knowledge Documentation	Royal Scientific Society	Jordan
7.	Adnan Shihabeldin	dgo@kfas.org.kw	Director General	Kuwait Foundation for the Advancement of Sciences	Kuwait
8.	Adnan Badran	abadran@uop.edu.jo	Chancellor	Petra University	Jordan
9.	Ahmad Tamimi	aftamimi@hotmail.com	Professor	University of Jordan	USA
10.	Ahmad Elbitar	abitar@lari.gov.lb	Research Assistant	Lebanese Agricultural Research Institute	Lebanon
11.	Ahmad T. Al-Taani	ahmadta@yu.edu.jo	Professor of AI	Yarmouk University	Jordan

No.	Name	Email	Job Title	Organization	Country
12.	Ahmed Bani Mustafa	a.banimustafa@iu.edu.jo	Assistant Professor/ Head of Software Engineering Department	ISRA University	Jordan
13.	Aicha Blama Merzaia	blama.aicha@gmail.com	Researcher Sociologist	INRAA	Algeria
14.	Aicha Bammoun	abammoun@icesco.org	Director of program	ICESCO	Morocco
15.	Aini Ideris	aiini@upm.edu.my	Professor	Universiti Putra Malaysia	Malaysia
16.	Alaa Ghidan	alaa_ghidan@yahoo.com	Scientist	Higher Council of science and technology	Jordan
17.	Aldjia Oudjiane	oudjianealdjia77@gmail.com	Attaché de Recherche	Inraa	Algeria
18.	Ali Ajeel	Ajeelali5@gmail.com	Head of department	Directorate of seeds testing and certification	Iraq
19.	Ali A. Moosavi-Movahedi	moosavi@ut.ac.ir	Professor	University of Tehran	Iran
20.	Amani Albedah	aalbedah@kfas.org.kw	DDG-Support Programs and functions	Kuwait Foundation for the Advancement of Sciences	Kuwait
21.	Amdulla O. Mehrabov	amekh@metu.edu.tr	Faculty Member, Prof. Dr.	Middle East Technical University, Ankara, Turkey	Turkey
22.	Amokrane Mahdeb	mahdeb@yahoo.fr	Chercheur	Inraa	Algeria
23.	Anwar Nasim	dranwarnasim@gmail.com	Former president of Pakistan Academy of sciences	Pakistan Academy of sciences	Canada
24.	Anwar Haddad	p@jodate.org	Chairman of Jordan Dates Association	Jordan Dates Association	Jordan
25.	Ayah Abdin	ayah.abdin@rss.jo	Director of Marketing & Communication	Royal Scientific Society	Jordan
26.	Baha Khasawneh	Baha@psut.edu.jo	Faculty Professor	PSUT	Jordan
27.	Bambang Hidayat	bhidayat07@hotmail.com	Professor	Academy of Sciences Indonesia	Indonesia
28.	Basheer Nusairat	bmnusairat@just.edu.jo	Assistant Professor	Jordan University of Science and Technology	Jordan
29.	Bassam Snobar	snobar@ju.edu.jo	Professor	The University of Jordan	Jordan
30.	Bassam Hayek	Bassam.hayek@rss.jo	Advisor	RSS	Jordan

No.	Name	Email	Job Title	Organization	Country
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35.	Elias Baydoun	eliasbay@aub.edu.lb	Professor	American University of Beirut	Lebanon
36.	Fadila Al-Sasamreen	fslamian@kisr.edu.kw	Researcher	KISR	Kuwait
37.	Farida Alane	alanefarida@hotmail.fr	Food value of some populations of Algerian annual alfalfa	INRAA	Algeria
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APPENDIX C

PATRONS OF THE ISLAMIC-WORLD ACADEMY OF SCIENCES

His Excellency the President of the Islamic Republic of Pakistan.

His Royal Highness Prince El-Hassan Ibn Talal of the Hashemite Kingdom of Jordan, Founding Patron.

HONORARY FELLOWS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

(in alphabetical order)

Prof. **Richard R. Ernst**, 1991 Nobel Laureate (Chemistry), Switzerland.
Mr **Fouad Alghanim**, President, Alghanim Group, Kuwait.
Prof. Ekmeleddin **Ihsanoglu,** OIC Secretary General, Turkey.
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**, 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**, former President of the Republic of Tatarstan/Russian Federation.
His Excellency Sheikh **Hamad Bin Jassim Bin Jabr Al Thani**, Prime Minster of Qatar, Qatar.

CORPORATE MEMBERS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

The Jordan Islamic Bank.
Jordan Phosphate Mines Company.
Petra University (UOP), Jordan.

LIST OF FELLOWS OF THE ISLAMIC WORLD ACADEMY OF SCIENCES

1.	1 Prof. Mohammad Abdollahi	Iran
2.	Prof. Zakri Abdul Hamid	Malaysia
3.	Prof. Omar Abdul Rahman	Malaysia
4.	Prof. Bobomurat Ahmedov	Uzbekistan
5.	Prof. Askar Akayev	Kyrgyzstan
6.	Prof. M. Sajjad Alam	Bangladesh/USA
7.	Prof. Liaquat Ali	Bangladesh
8.	Prof. M. Shamsher Ali	Bangladesh
9.	Prof. Qurashi Mohammed Ali	Sudan
10.	Prof. Huda Saleh Mehdi Ammash	Iraq
11.	Prof. Shazia Anjum	Pakistan
12.	Prof. Muhammad Asghar	France
13.	Prof. Muhammad Ashraf	Pakistan
14.	Prof. Allaberen Ashyralyev	Turkmenistan
15.	Prof. Saleh A Al-Athel	Saudi Arabia
16.	Prof. Ahmad Abdullah Azad	Bangladesh/Australia
17.	Prof. Agadjan Babaev	Turkmenistan
18.	Prof. Adnan Badran	Jordan
19.	Prof. Shah Nor Bin Basri	Malaysia
20.	Prof. Elias Baydoun	Lebanon
21.	Prof. Farouk El-Baz	USA
22.	Prof. Kazem Behbehani	Kuwait
23.	Prof. Azret Yusupovich Bekkiev	Balkar/Russia
24.	Prof. Rafik Boukhris	Tunisia
25.	Prof. David (Mohamed Daud) A. Bradley	UK
26.	Prof. Noor Mohammad Butt	Pakistan
27.	Prof. Mohamed Thameur Chaibi	Tunisia
28.	Prof. Muhammad Iqbal Choudhary	Pakistan
29.	Prof. Abdallah Daar	Oman/ Canada
30.	Prof. Ali Al-Daffa'	Saudi Arabia
31.	Prof. Mamadou Daffe	Mali/France
32.	Prof. Ramazan Demir	Turkey
33.	Prof. Oussaynou Fall Dia	Senegal
34.	Prof. Mehmet Ergin	Turkey

35.	Prof. Sehamuddin Galadari	UAE
36.	Prof. Nesreen Ghaddar	Lebanon
37.	Prof. Mehdi Golshani	Iran
38.	Prof. Kadyr G Gulamov	Uzbekistan
39.	Prof. Ameenah Gurib-Fakim	Mauritius
40.	Prof. Hashim M El-Hadi	Sudan
41.	Prof. Kemal Hanjalic	Bosnia-Herzegovina
42.	Prof. Mohamed H A Hassan	Sudan
43.	Prof. Tasawar Hayat	Pakistan
44.	Prof. Bambang Hidayat	Indonesia
45.	Prof. Rabia Hussain	Pakistan
46.	Prof. Abdul Latif Ibrahim	Malaysia
47.	Prof. Aini Ideris	Malaysia
48.	Prof. Asma Ismail	Malaysia
49.	Prof. Mohammad Shamim Jairajpuri	India
50.	Prof. Mohammad Qasim Jan	Pakistan
51.	Prof. Afaf Kamal-Edin	Sudan
52.	Prof. Hamza El-Kettani	Morocco
53.	Prof. Idriss Khalil	Morocco
54.	Prof. Abdul Qadeer Khan	Pakistan
55.	Prof. Hameed Ahmed Khan	Pakistan
56.	Prof. Mostefa Khiati	Algeria
57.	Prof. Hala Jarallah El Khozondar	Gaza/ Palestine
58.	Prof. Abdelhafid Lahlaidi	Morocco
59.	Prof. Zohra Ben Lakhdar	Tunisia
60.	Prof. Malek Maaza	Algeria
61.	Prof. Abdel Salam Majali	Jordan
62.	Prof. Ahmed Marrakchi	Tunisia
63.	Prof. Akhmet Mazgarov	Tatarstan/Russia
64.	Prof. Amdoulla Mehrabov	Azerbaijan
65.	Prof. Shaher Al-Momani	Jordan
66.	Prof. Ali A. Moosavi-Movahedi	Iran
67.	Prof. Sami Al- Mudhaffar	Iraq
68.	Prof. Zaghloul El-Naggar	Egypt
69.	Prof. Ibrahim Saleh Al- Naimi	Qatar
70.	Prof. Anwar Nasim	Pakistan
71.	Prof. Munir Nayfeh	Jordan/ United States

72.	Prof. Robert Nigmatulin	Tatarstan/ Russia
73.	Prof. Shekoufeh Nikfar	Iran
74.	Prof. Gulsen Oner	Turkey
75.	Prof. Ilkay Erdogan Orhan	Turkey
76.	Prof. Ramdane Ouahes	Algeria
77.	Prof. Sinasi Ozsoylu	Turkey
78.	Prof. Munir Ozturk	Turkey
79.	Prof. Iqbal Parker	South Africa
80.	Prof. Syed Muhammad Qaim	Germany
81.	Prof. Atta-ur-Rahman	Pakistan
82.	Prof. Hussein Samir Salama	Egypt
83.	Prof. Eldar Yunisoglu Salayev	Azerbaijan
84.	Prof. Jawad A. Salehi	Iran
85.	Prof. Boudjema Samraoui	Algeria
86.	Prof. Lorenzo Savioli	Italy
87.	Prof. Mohammed Musa Shabat	Gaza/ Palestine
88.	Prof. Misbah-Ud-Din Shami	Pakistan
89.	Prof. Ali Al-Shamlan	Kuwait
90.	Prof. Ahmad Shamsul-Islam	Bangladesh
91.	Prof. Muthana Shanshal	Iraq
92.	Prof. Zabta Khan Shinwari	Pakistan
93.	Prof. Ahmedou M Sow	Senegal
94.	Prof. Mahmoud Tebyani	Iran
95.	Prof. Ahmet Hikmet Ucisik	Turkey
96.	Prof. Gulnar Vagapova	Tatarstan/ Russia
97.	Prof. Omar M. Yaghi	Jordan/USA
98.	Prof. Jackie Ying	Singapore/USA
99.	Prof. Bekhzad Yuldashev	Uzbekistan
100.	Prof. Khatijah Mohd Yusoff	Malaysia
101.	Prof. Salim Yusuf	Canada
102.	Prof. Mikhael Zalikhanov	Balkar/Russia

APPENDIX D

LAUREATES OF THE IAS-COMSTECH IBRAHIM MEMORIAL AWARD

Prof. Ugur **Dilmen**	1996	Turkey.
Prof. Mohammad **Abdollahi**	2005	Iran.
Prof. Mohammed Manna **Al-Qattan**	2007	Saudi Arabia.
Dr Faris **Gavrankapetanovic**	2009	Bosnia.
Dr Saima **Riazuddin**	2011	Pakistan.
Prof. Liaquat **Ali**	2013	Bangladesh.
Prof. Jackie **Ying**	2015	Singapore.
Prof. Ameenah **Gurib-Fakim**	2017	Mauritius.

APPENDIX E

COUNCIL OF THE ISLAMIC WORLD ACADEMY OF SCIENCES (2017-2021)

President:	**Abdel Salam Majali**	Jordan.
Vice-President:	**Noor M. Butt**	Pakistan.
Vice-President:	**Munir Ozturk**	Turkey.
Vice-President:	**Khatijah Mohd Yusoff**	Malaysia.
Treasurer:	**Adnan Badran**	Jordan.
Secretary General:	**Ahmad Abdullah Azad**	Australia.
Member:	**M. Shamsher Ali**	Bangladesh.
Member:	**Mohammed Asghar**	France.
Member:	**Mostefa Khiati**	Algeria.
Member:	**Amdoulla Mehrabov**	Azerbaijan.
Member:	**Muthana Shanshal**	Iraq.

IAS EXECUTIVE STAFF

Dr. Abdullah Al Musa	Director General.
Ms. Taghreed Saqer	Executive Secretary.
Ms. Najwa F. Daghestani	Programs Manager.
Mr. Ahmad Nassar	Finance Officer.
Mr. Hamdi Bader Ahmad	Driver.

APPENDIX F

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.* Proceedings 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). Online.**
- *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). Online.**
- *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). Online.**
- *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). Online.**
- *Science Technology and Innovation for Socioeconomic Development of OIC-Member Countries Towards Vision 1441.* Proceedings 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). Online.**
- *Higher Education Excellence for Development in the Islamic World* . Proceedings 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). Online.**
- *Science, Technology and Innovation for Sustainable Development in the Islamic World: The Policies and Politics Rapprochement*. Proceedings 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). Online.**
- *Towards the Knowledge Society in the Islamic World: Knowledge Production, Application and Dissemination,* Proceedings of the seventeenth international conference, Shah Alam *(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). Online.**
- *The Islamic World and the West: Rebuilding Bridges through Science and Technology,* Proceedings of the eighteenth international conference, Doha (Qatar), (2011). Published by the Islamic World Academy of Sciences, **Editor: Moneef R. Zou'bi (Jordan) (ISBN 978-9957-412-24-1). Online.**

- *Science and Technology in Muslim World: Achievements and Prospects,* Proceedings of the IAS Symposium, Astana, Kazakhstan, (2012). Published by the Islamic World Academy of Sciences, **Editor: Moneef R. Zou'bi (Jordan)**. **Online**.
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APPENDIX G

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 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 Fund for Economic and Social Development (AFESD), Kuwait.
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.
Jordan Islamic Bank, Jordan.
Dr Mahmood Abu Shairah, Jordan.
Necmettin Erbakan Üniversitesi, Turkey.
Turkish Academy of Sciences (TÜBA), Turkey.
Hikma Pharmaceuticals, Jordan.
Dr Ahmed Saif Balhasa, UAE.

Dr Adnan Mjalli, USA.
Mr Ahmed Abu Ghazaleh (Arab Wings), Jordan.
Cairo Amman Bank, Jordan.
The Inter-Islamic Network on Water Resources Development and Management (INWRDAM), Jordan.