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Science, technology and innovation for sustainable development

Note by the secretariat**

Summary

The present document summarizes the main findings of the theme study *Harnessing Science, Technology and Innovation for Inclusive and Sustainable Development in Asia and the Pacific*.

The study calls for Governments to put in place action-orientated science, technology and innovation (STI) programmes that are aligned to development strategies to meet the ambitions of the Sustainable Development Goals.

The study proposes a new conceptual framework for STI that is bound by the principles of openness, inclusivity and collaboration and moves the focus beyond the economic to integrate the social and environmental dimensions of sustainable development.

The study concludes by recommending areas for action by member States to create an enabling environment for STI, fully integrating the three dimensions into STI policy and facilitating regional STI collaboration.

The Economic and Social Commission for Asia and the Pacific gratefully acknowledges expert guidance on this document from the Executive Secretary's Science, Technology and Innovation Advisory Board.[1]

* E/ESCAP/72/L.1.

** The present document was submitted late owing to the need to incorporate inputs and recommendations of the first meeting of the Science, Technology and Innovation Advisory Board held after the deadline for submission.

[1] The Science, Technology and Innovation Advisory Board consists of members from Malaysia and Pakistan (as co-chairs), Australia, China, India, the Islamic Republic of Iran, Japan, the Republic of Korea, Singapore and Sri Lanka.

I. Introduction

A. Background

1. In the closing months of 2015, the General Assembly adopted an ambitious, all-encompassing agenda to guide the advancement of humankind for the next 15 years. The 2030 Agenda for Sustainable Development calls on all countries to advance the welfare of their citizens in a sustainable manner to ensure the long-term viability of all development and growth. A key means of implementation of the Sustainable Development Goals, which are part of the 2030 Agenda, is the effective use of science, technology and innovation.

2. On 29 May 2015, the Economic and Social Commission for Asia and the Pacific (ESCAP) adopted resolution 71/1, in which it decided to establish the Committee on Information and Communications Technology, Science, Technology and Innovation, thereby institutionalizing an intergovernmental process to deal with issues relating to science, technology and innovation (STI). At that same session, the seventy-first, member States decided that the 2016 theme topic for its seventy-second session would be "Science, technology and innovation for sustainable development".[2]

3. The present document outlines the major findings and recommendations of the theme study *Harnessing Science, Technology and Innovation for Inclusive and Sustainable Development in Asia and the Pacific* with the aim of promoting dialogue in the region on this topic. It proposes ways to enhance STI effectiveness across the region to enable all countries to meet the Sustainable Development Goals.

4. STI has the ability to create new economic opportunities, which means creating jobs and wealth in a manner that is environmentally sound and socially inclusive. As such, it has the potential to be one of the primary engines powering the achievement of the Sustainable Development Goals. However, to realize the potential of STI to meet the ambitions of the 2030 Agenda, it will be essential for countries to integrate the three dimensions of sustainable development by accelerating the shift towards a knowledge economy.[3]

5. To make the development of a strong knowledge economy the key cornerstone of all national development plans, dynamic STI action plans informed by the application of foresight[4] across all line ministries will be critical.

6. In these STI action plans, Governments should focus on creating an enabling environment for STI through innovative cross-sectoral policy and funding, the empowerment of a knowledge workforce through high-quality educational institutions and the establishment of the infrastructure required to

[2] Decision 71/38.

[3] The term "knowledge economy" was coined in the 1960s to describe a shift from traditional economies to ones where the production and use of knowledge are paramount. According to the World Bank, knowledge economies are defined by four pillars: institutional structures that provide incentives for entrepreneurship and the use of knowledge, skilled labour availability and good education systems, information and communications technology infrastructure and access, and, finally, a vibrant innovation landscape that includes academia, the private sector and civil society.

[4] Foresight can be defined as the ability to predict what will happen or be needed in the future (Oxford Dictionary).

create a strong foundation for STI. It will also be important to incentivize even greater levels of sustainable innovation from the private sector and research institutions, among others. Information and communications technology will enable a networked innovation system to foster collaboration and collective action and will play an important role in this ecosystem.

B. Why must science, technology and innovation integrate the three dimensions?

7. The balanced integration of the three dimensions of sustainable development should and must be the basis of future STI strategies – strategies that develop integrated STI government policies to address potential inequalities and market failures and incentivize businesses and investors (the private sector) as well as research institutions and non-governmental organizations (civil society) to maximize synergies and minimize trade-offs among the objectives of economic growth, inclusive social progress and environmental protection for all stakeholders of society, current and future.

8. Relying on science and technology in the context of achieving such integration is a new idea. Science and technology have evolved from a period where the focus was on the discovery of the world around us, to a period of trying to control that world, to a new period of transforming the world, which is now a very different era – what the World Economic Forum has termed the fourth industrial revolution.[5] This technological revolution will fundamentally alter the way people live, work and relate to one another through an increasingly interconnected world where ideas, knowledge and data flow more freely than ever before, potentially fuelling collaborative and open approaches to innovation. In this transformative era, the possibility, for the first time, to more effectively integrate broader societal goals beyond economic gain to encompass social and environmental objectives is within reach.

9. These changes can provide the tools for entrepreneurs and start-ups to innovate and grow through access to digital platforms for research, development, marketing, sales and distribution, while providing real-time information on impacts on society and the environment. These technologies have increased the access of micro, small and medium-sized enterprises to international markets at an unprecedented level. Given that micro, small and medium-sized enterprises account for more than 90 per cent of licensed companies in the Asia-Pacific region, employing more than half of the region's workforce, this has immediate and large implications for poverty reduction.[6]

10. Science and technology have the potential to feed back in on each other, disrupting the scientific process. Digital and fabrication technologies have already changed how technology interacts with the science world and have spurred a movement towards citizen science.[7]

11. However, this revolution is not without its challenges. While science and technology provide opportunities, Governments must ensure those

[5] Klaus Schwab, *The Fourth Industrial Revolution* (Geneva, World Economic Forum, 2016). Available from www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab.

[6] Asian Development Bank, *Asia SME Finance Monitor 2013* (Manila, 2014). Available from http://adb.org/sites/default/files/pub/2014/asia-sme-finance-monitor-2013.pdf.

[7] Citizen science (also known as crowd science, crowd-sourced science, civic science, volunteer monitoring or networked science) is scientific research conducted, in whole or in part, by amateur or non-professional scientists.

opportunities enhance welfare. They must also supply the catalysing environment to push through science and technological breakthroughs to innovative products and services. To date, those who have gained the most from the transformative stage of STI have been people able to afford and access the digital world, which in itself creates problems across the three dimensions. The Asia-Pacific region is the most digitally divided region in the world, with only 6 per cent of the population in developing countries connected to high-speed internet.[8] The revolution also has obvious implications for income inequality, particularly in its potential to disrupt labour markets. The World Economic Forum is predicting a net employment impact of more than 5.1 million jobs lost between 2015 and 2020 due to robotics and automation alone.[9] The potential of big data[10] is coupled with concerns about privacy and security, while innovations reducing transportation costs have led to massive increases in air travel and its associated emissions.

12. The conflicts and trade-offs between technological advancement for economic growth, social inequality and environmental outcomes are a fundamental reason why STI must have an integrated approach if the world is to meet the ambitions of the 2030 Agenda. It is also the reason STI itself can help achieve that integration, by providing heretofore untapped information about the societal, environmental and economic impacts of human behaviour.

13. The progression from hunter-gatherer to the age of farming to the dawn of the industrial revolution 12,000 years later mark seminal transitions in human history, lifestyle and well-being. Now in the digital age, civilization may be in the midst of another equally great transformation driven by the knowledge economy. In the past, an abundant labour force and exploitation of natural resources were the engines of growth. Now, companies mine data in search of riches. Information is widely believed to be the future source of prosperity.[11] If, historically, STI policy had the characteristics of industrial-scale businesses, competiveness and scientific advancement, today's era is very much characterized by start-ups, openness and digital technology. In the past, STI helped people to make sense of and change the world. In the current era, STI is creating new worlds, blurring the lines between the physical and virtual. Although this revolution is moving at an unprecedented pace when compared to the previous industrial revolutions, there is an opportunity to shape it for the global good.

14. Thus, the immediate challenge for countries in the region is to fully integrate the three dimensions across the full policy spectrum. While it is clear that STI is important and that it can enrich each of the individual dimensions of sustainable development, what is not clear is the best way for member States to effectively integrate these streams of research, analysis,

[8] Shamika Sirimanne, "The Asia-Pacific information superhighway and regional cooperation for better ICT connectivity", paper presented at the first meeting of the Working Group on the Asia-Pacific Information Superhighway, Incheon, Republic of Korea, 1 and 2 September 2015.

[9] World Economic Forum, *The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution* (Geneva, 2016). Available from www3.weforum.org/docs/WEF_Future_of_Jobs.pdf.

[10] Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision-making and process automation (Gartner definition).

[11] SciDev.Net, "What is a knowledge economy?", 16 April 2015. Available from www.scidev.net/global/knowledge-economy/feature/knowledge-economy-ict-developing-nations.html.

application and change so that the policy whole becomes much more than the sum of each of its individual parts. It is also unclear how that process differs depending on a country's level of economic development. STI can facilitate this integration, but it will require a fundamental shift in the way countries in the region have traditionally framed STI policy. To achieve the Sustainable Development Goals, Governments must incentivize the critical actors in society, starting with businesses and investors, to fully incorporate the social and environmental impact alongside economic return.

II. Definitions, conceptual framework and enabling environment

A. Defining science, technology and innovation

15. While science, technology and innovation are inextricably connected, on an individual level they are profoundly different concepts with sometimes overlapping but often very different ecosystems and drivers.

16. Science can be defined as the systematic study of the physical or material world (natural science) and of society (social science) that generates, or creates, knowledge from which data and information is drawn.

17. Technology can be defined as the application of scientific knowledge to develop techniques to produce a product and/or deliver a service or as the application of scientific knowledge for practical ends.

18. Innovation can be defined as deriving the benefits from a new or significantly improved product (good or service), or process (such as a new marketing method) or a new organizational method (such as in business practices, workplace organization or external relations).[12] A key point to differentiate innovation from improvement is that innovation derives significantly (as opposed to incrementally) more impact (economic, social and environmental) from existing products, processes and services or from a combination of proven and new science and technology to develop new products, processes or services. Social innovation can similarly be defined with the addition that it simultaneously meets social needs while creating new social relationships or collaborations. In other words, they are innovations that change society and enhance its capacity to act.[13]

19. The theme study conceptualizes STI as an integrated life cycle where science leads to new technologies from which innovations develop. Innovative ways of doing things can change and influence the development of science and how and what technologies are brought forth which, in turn, also influence the innovation process.

B. A new conceptual framework for science, technology and innovation for inclusive and sustainable development

20. Asian-Pacific countries are tremendously diverse, both with respect to their STI capacities as well as the evolutionary history of their STI policies and frameworks. Laid down on a spectrum, the current STI capacities within

[12] Organization for Economic Cooperation and Development and Eurostat, *Oslo Manual – Guidelines for Collecting and Interpreting Innovation Data* (Paris, 2005).

[13] Robin Murray, Julie Caulier-Grice and Geoff Mulgan, "The Open Book of Social Innovation", Social Innovator Series: Ways to Design, Develop and Grow Social Innovation (London, The Young Foundation and Nesta, 2010). Available from www.nesta.org.uk/sites/default/files/the_open_book_of_social_innovation.pdf.

the region range from non-existent to catch-up to knowledge-driven economies, with all of the stages in between.[14] As a consequence, the STI policies espoused by Governments in the region differ greatly in their respective forms and functions.

21. At early stages of STI engagement, most countries' policy focus is on technology transfer or other forms of exogenous delivery. Thus the relationship between policy and domestic STI is that of managing a one-way inflow. As countries move away from exogenous delivery to endogenous development, STI policies and strategies have traditionally become more complex as different institutional actors arise and the need to coordinate becomes apparent. Most policy platforms, then, evolve using a concept called a national innovation system.

22. A national innovation system is a multifaceted concept, intended to provide flexibility for implementation. However, there are universal aspects; key among them is the recognition of the fundamental role of institutions, the importance of linkages among stakeholders and the basal nature of knowledge and learning for moving forward.

23. By design, a national innovation system reflects a development path for STI capacities of a country. At earlier phases of STI development, including catch-up and post-catch stages, national innovation systems typically build upon education and industrial policies with the aim of establishing and improving productive capacity. At later stages, national innovation systems take on increasingly complex challenges, the solutions to which require intricate linkages to commerce, finance, health and beyond. In general, access to science and technology predate improved utilization as a policy priority. Innovation, and the creation of new knowledge and technologies, follows more effortlessly once progress on these fundamental objectives are at sufficient levels.

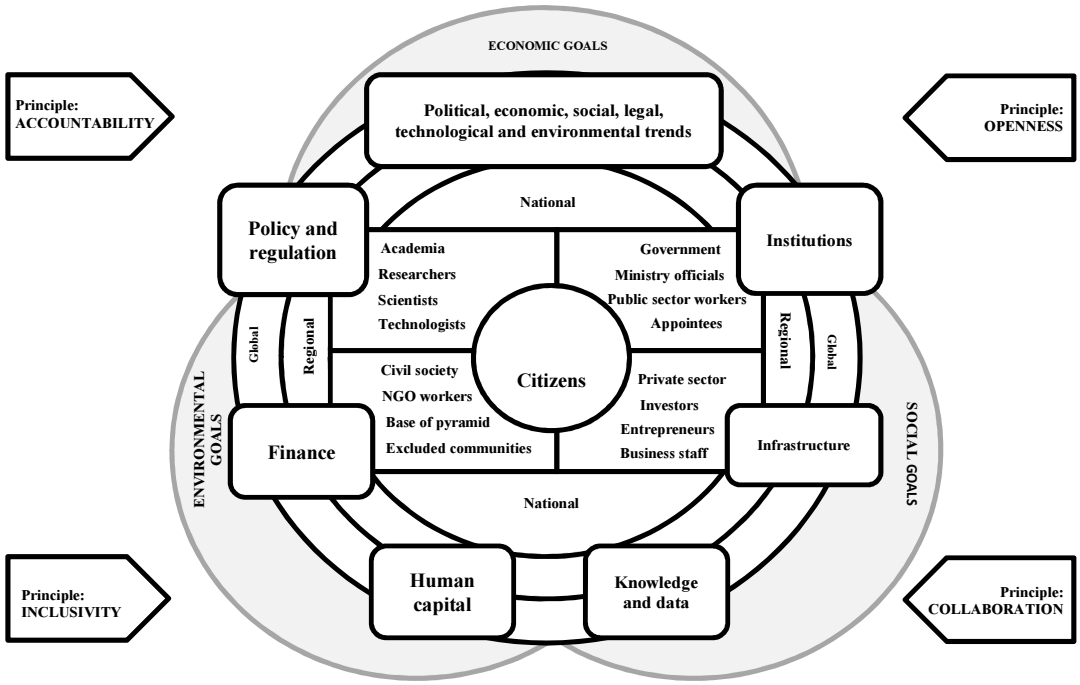
24. Accommodating the Sustainable Development Goals requires a rethinking of how national innovation systems operate and how they are developed. Traditionally, industrial and economic competitiveness have been at the core of the national innovation system concept. In order to support the attainment of the Goals, it is necessary to broaden the concept by giving equal emphasis to social progress and environmental protection.

25. Thus the objectives of future national innovation systems for inclusive and sustainable development must go beyond the economic imperative, take into account a more diverse range of actors, place greater emphasis on regional and global dimensions, and be bound by a set of principles that ensures openness and inclusivity. In short, there is a need for a new systems framework.

[14] One data-driven method to capturing the region's diversity with regard to STI development is to categorize countries into four quartiles according to their score in the latest Global Innovation Index of the World Intellectual Property Organization (2015) so that the first quartile represents catch-up economies, the second quartile represents post-catch-up economies, the third quartile represents emerging economies and the fourth quartile represents the knowledge-driven economies, where the terminology for STI development status reflects the World Economic Forum terminology on competitiveness (World Economic Forum, *The Global Competitiveness Report 2013-2014: Full Data Edition* (Geneva, 2013)). In ascending order of scores, the first quartile comprises Myanmar, Nepal, Pakistan Bangladesh, Bhutan, Fiji, Tajikistan, Kyrgyzstan, the Islamic Republic of Iran and Indonesia. The second quartile comprises Cambodia, Sri Lanka, the Philippines, Kazakhstan, India, Mongolia, Thailand and Viet Nam. The third quartile comprises Malaysia and China. The fourth quartile comprises Japan, Australia, New Zealand, the Republic of Korea, Hong Kong, China, and Singapore.

26. In response to this tangible demand, a new STI conceptual framework for inclusive and sustainable development is proposed (figure). This framework enhances existing frameworks and encompasses the inherently complex yet fluid nature of the life-cycle STI system mainly by (a) integrating the social and environmental as well as the economic dimensions of sustainable development; (b) adhering to the principles of openness, inclusivity and collaboration; (c) incorporating the role of a more diverse range of actors; and (d) reflecting the regional and global dimensions of STI.

A science, technology and innovation conceptual framework for inclusive and sustainable development



Source: United Nations, Economic and Social Commission for Asia and the Pacific, *Harnessing Science, Technology and Innovation for Inclusive and Sustainable Development in Asia and the Pacific* (forthcoming).

Abbreviation: NGO, non-governmental organization.

27. The theme study explores all parts of this conceptual framework while developing several elements in greater depth through analysis and case studies. It also touches on those factors influencing and informing the framework, namely:

- Trends: the megatrends emerging in the region, focusing on the challenges and opportunities they present for STI.
- Data: the key role data and indicators will play in STI implementation, not just to measure the pulse of STI, but in stimulating new technologies and innovations in a country, the region and around the globe.
- Policy and regulation: how policies can be designed to address the three dimensions of sustainable development, to develop a knowledge workforce and to put in place the infrastructure to support effective STI development.

- National/regional/global dimensions: national institutions, regional platforms and global mechanisms have been developed to support STI but more needs to be done on integrating these various efforts and on leveraging the benefits of collaboration.
- Government: how Governments can more effectively support scientists, technologists, innovators and entrepreneurs.
- Finance: how the right financing models and incentives can stimulate investment in STI, and how STI itself can support these new financing models.
- Principles: the importance of applying the principles of openness and inclusivity.

28. This framework highlights the importance of a systemic approach to the development of STI capability and its employment for overall welfare enhancement. It can be a meaningful tool for policymakers to form a conceptual and empirical basis for devising appropriate policy measures and to develop more effective STI systems that are appropriate for individual countries. While a national innovation system approach overall has been very successful in underscoring the importance of various interlinkages, applying the model to design STI policies and strategies for inclusive and sustainable development will not be without cost.

29. STI development and the implementation of a national innovation system for the Sustainable Development Goals necessitate interministerial collaboration and the engagement of important actors, such as research bodies and corporations. Expanding the scope of the actors involved often translates into longer lead times between needs identification and policy implementation. However, this up-front investment is necessary to secure long-term viability and to ensure programme effectiveness. This is particularly true when capturing the social benefits and costs generated by STI through enhanced interaction between government and civil society.

30. The 2030 Agenda contains a strong exhortation to leave no one behind. Consequently, the principles of inclusivity and stakeholder engagement are vital components of STI frameworks supporting sustainable development through the democratization of innovation.[15] If the end users of sustainability-oriented innovations are indeed to become part of the innovation process, they need to be at the centre of a national innovation system for the Sustainable Development Goals.

31. As noted above, universality is inherent in both STI and the Sustainable Development Goals. As such, effectively harnessing one to achieve the other requires cross-border collaboration. The three dimensions of sustainable development have implications and demand action beyond national boundaries. At the same time, the ever increasing interconnectedness of society demands a larger platform of interaction. National innovation systems are increasingly influencing, and being influenced by, regional and global knowledge flows.

[15] Eric Von Hippel, *Democratizing Innovation* (Cambridge, MIT Press, 2005). Available from web.mit.edu/evhippel/www/books/DI/DemocInn.pdf.

C. Planning and foresight

32. The global environment within which national innovation systems that support the Sustainable Development Goals must be put in place is extremely fluid. In addition to the myriad changes at the local level, there are broad, universal trends which will affect all. These megatrends can be defined as large, transformative global forces that define the future by having a far-reaching impact on business, economies, industries, societies and individuals.[16] There are numerous megatrends that present both opportunities and challenges to economies, societies and the environment.

33. Economic integration, digital currency, e-commerce, innovative finance, 3-D printing and robotics will have an impact on trade, investment and the type of jobs future economies will offer. Scientific breakthroughs in genomics, the shifting demographic and the rapidly growing urban population will have a profound impact on the well-being of society. Climate change is possibly the biggest challenge humankind has ever faced. In addition, rapidly expanded digital connectivity and the data revolution, including big data, have surfaced an explosion of information that, for the first time, could support policymakers' understanding of the interlinked benefits of and trade-offs between the economic, societal and environmental impacts that these trends present.

34. One of the biggest challenges facing society and governments alike is the pace at which the changes occur. These trends are moving at an unprecedented speed and many governments find it difficult to understand, let alone develop, appropriate policy, amplify their benefits or mitigate their risks. In this regard, the application of foresight will be crucial for policymakers who wish to be proactive as opposed to reactive in the face of change.

35. Governments in the region have explored the application of foresight and several case studies are presented in the theme study. The overall lesson of these case studies is that the exercise not only provides an actionable and applicable outcome document but that the process itself helps policymakers come to terms with the concepts and the larger implications of change. This provides a much needed perspective and reduces the risk of getting lost in the details of complex issues.[17]

D. Measuring the pulse of science, technology and innovation

36. The Asia-Pacific region is home to some of the most technologically advanced economies in the world, as well as to some of the most technologically deprived. Overall, the region relies on a handful of countries to push forward the STI agenda, and thus, if the goal of no one left behind is to be realized, STI activity must become more widespread. However, that is not to say the region has not recorded some impressive gains in the area of STI in recent times. Some noteworthy indicators include:

- The region's share of world expenditure on research and development rose from 36 per cent in 2007 to 44 per cent in 2013,

[16] See, for example, Ernst and Young, *Megatrends 2015: Making Sense of a World in Motion*, for a discussion of megatrends. Available from www.ey.com/Publication/vwLUAssets/ey-megatrends-report-2015/$FILE/ey-megatrends-report-2015.pdf.

[17] See, for example, http://foresight-journal.hse.ru/en/.

while the Americas (32 per cent in 2013) and Europe (23 per cent in 2013) have seen decreases in their share, with Africa (1 per cent in 2013) remaining flat. In total, the Asia-Pacific region spent $643 billion in 2013 on research and development.

- The region's share of global researchers rose from 41 per cent in 2007 to 44 per cent in 2013, while the Americas (22 per cent in 2013) saw a decrease and Europe (31 per cent in 2013) and Africa (2 per cent in 2013) remained flat.
- The rise in these inputs has generated a 69 per cent increase in scientific publications from the Asia-Pacific region between 2008 and 2014.
- The increasing scientific activity has also led to an increase in regional patent applications submitted to the Patents and Trademark Office of the United States of America, 86,000 in 2013, a 78 per cent increase over 2008.
- In 2013, the region received 60 per cent of the world's granted patents and, importantly, 94.1 per cent of utility patents, which are associated with more immediate application. Since 2004, these shares have grown 11 per cent and 18.6 per cent respectively.[18]

37. However, as noted above, these aggregate figures belie the wide gaps in STI performance that exist in the region. They hide the fact that many countries in the Asia-Pacific region have no expenditures on research and development at all. This diversity is best exemplified by the fact that the number of countries ranked in the top quartile of the Global Innovation Index is the same as the number ranked in the bottom.[19]

38. Successful implementation of the Sustainable Development Goals is contingent on the timeliness and quality of data. In the case of STI, much work is needed by the global community to establish and operationalize a set of indicators which will provide a useful guide for policymakers over the next decades. Developing data series of comparable quality and access remains a big challenge for developing and developed economies alike.

39. Capturing the true nature of innovation and moving beyond proxies such as patenting activity and research and development expenditures which do not represent all facets of the phenomena is a challenge. Data will be critical in identifying and understanding the drivers of hidden innovation that could equally have the potential for positive impact.[20] There is a risk that Governments will focus policy on those areas where measures are readily available and miss areas where they could be more effective.

40. Finally, many countries continue to neglect a large and potentially powerful resource by ignoring the role of women in STI. While attitudes to

[18] United Nations Educational, Scientific and Cultural Organization, *UNESCO Science Report: Towards 2030* (Paris, 2015). Available from http://en.unesco.org/unesco_science_report.

[19] The Global Innovation Index is an attempt to capture the multidimensional facets of innovation. More information can be found from www.globalinnovationindex.org/content/page/GII-Home.

[20] Hidden innovation refers to innovation activities not reflected in traditional indicators such as investment in research and development or patents awarded. See more at www.nesta.org.uk/sites/default/files/hidden_innovation.pdf.

gender issues in STI are slowly changing, on the whole, women constitute a minority in the research world. Women constitute only 18.9 per cent of the scientific workforce in Asia, compared with 34 per cent in Europe, 39.2 per cent in Africa and 45.2 per cent in Latin America.

E. How can the three dimensions be integrated through and in science, technology and innovation?

1. Government policy on science, technology and innovation

41. While it is well acknowledged that to meet the ambitions of the 2030 Agenda, cross-cutting, multisectoral, multidisciplinary approaches are essential, to date, holistic efforts have been piecemeal. Experience across the region is mixed, with some Governments achieving great success using STI policy to stimulate economic growth while other countries have yet to put STI policies in place. Some Governments are using STI to lead in the area of workforce development, by focusing on strong education policies, especially in higher education and vocational training, with the understanding that scientific education is a pre-condition to both the development and implementation of STI. Others have focused on supporting industrial development, by providing large incentives for private sector initiatives in STI.[21]

42. The rise of public sector innovation has also led to improvements in the health and wealth of societies. Experience has shown how the rise of so-called digital government in the region can lead to improvements in the efficiency and effectiveness of social services.[22] The Sustainable Development Goals include a target on providing legal identity for all, including birth registration. Countries that resolve the digital identity challenge will be better positioned to create social and economic value. A birth certificate can safeguard a child's right to education, health and justice, provide protection from violence, early marriage and child labour, and empower them economically in the future through access to the formal finance sector.

43. Some of the most forward-looking regional STI policy initiatives have been implemented around social innovation.[23] Governments in the region have implemented some of the most cutting-edge social innovation policies in the world through the promotion of social enterprise. A social enterprise can be defined as an organization committed to explicitly including social and/or environmental returns as part of its core business profit or return on investment.[24] By taking into account the fact that the three dimensions of sustainable development will be key to achieving the Sustainable Development Goals, the concept of social enterprise provides a promising vehicle for the private sector to deliver on the Goals.

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[21] The theme study explores several case studies outlining experience and lessons learned in these areas.

[22] The theme study explores the case of Pakistan's work with the United Nations Children's Fund; for more information, see www.unicef.org/pakistan/Birthregistration_LR.pdf.

[23] The theme study provides case studies on regional experiences with social innovation.

[24] Shelagh Whitley, Emily Darko, and Grace Howells, *Impact Investing and Beyond: Mapping Support to Social Enterprises in Emerging Markets* (London, Overseas Development Institute, 2013). Available from www.cbd.int/financial/privatesector/g-datasocialinvest-odi.pdf.

2. Instilling shared values in business

44. Businesses are key players in realizing the ambitions of the 2030 Agenda and are uniquely equipped to deliver innovative changes on a large scale. However, in order to create positive economic and societal change at scale, corporations in particular need to move beyond the concept of corporate social responsibility and, adopting a social enterprise-type approach, internalize the return from creating shared value. Creating shared value is the practice of creating economic value in a way that also creates value for society by addressing its needs and challenges. Shared value goes beyond the idea of corporate social responsibility by moving it from a public relations responsibility to a corporate financial reporting responsibility. Creating shared value needs to be at the core of a business's strategy and part of its metric of results.

45. Shared value has the potential to reshape capitalism and its relationship to society. It calls for a more complete internalization of the externalities arising from corporate activity (both positive and negative). It could also drive the next wave of innovation and productivity growth in the global economy by stimulating new ways to organize business or services to assist businesses to meet these new standards. However, the understanding of shared value and in particular the implementation of its principles is still in its genesis.[25]

46. Impact investing is another emerging means of integrating economic benefit with the social and environmental aspects in an innovative way. Impact investing is a type of investing that seeks to ensure that investments generate social and environmental value as well as financial return.[26] The theme study further defines impact investing as investments that serve or invest in those at the base of the pyramid, which is defined as people living on less than $2 per day. Incorporating, as it does, the three dimensions of sustainable development, this form of investment has been generating momentum both in the developed and developing world. Impact investing has emerged as an alternative asset class that has the potential to channel significant private capital in addressing the world's social and environmental challenges. It has been estimated that the impact investment market has the potential to absorb between $400 billion and $1 trillion by 2021.[27] However, as the theme study discusses, to date, this potential has not been realized.

47. In short, to address the people, planet and prosperity elements of the Sustainable Development Goals, designing and implementing effective three dimensional STI policies are a necessary but far from easy task. The integration of the three dimensions in, and through, STI policy is the most critical shift required to meet the ambitions of the 2030 Agenda.

[25] Michael E. Porter and Mark R. Kramer, "Creating shared value", *Harvard Business Review*, Nos. 1-2 (January-February 2011).

[26] Monitor Institute, *Investing for Social and Environmental Impact* (San Francisco, 2009). Available from http://monitorinstitute.com/downloads/what-we-think/impact-investing/Impact_Investing.pdf.

[27] J.P. Morgan, Rockefeller Foundation and Global Impact Investing Network, *Impact Investments: An Emerging Asset Class* (2010). Available from http://ventureatlanta.org/wp-content/uploads/2011/11/JP-Morgan-impact_investments_nov2010.pdf.

F. Defining effective institutional architecture for science, technology and innovation

48. Governments in the region have used mixed approaches to provide institutional support for STI. Most Governments have avoided setting up new specialized agencies and instead have simply expanded the mandates of existing science and technology agencies to deal with innovation policies. With this institutional alignment, policymakers have tended to equate innovation with science and technology research and development. Other Governments have aligned innovation policy with Ministries of Information and Communications Technology or Ministries of Trade and Industry, equating innovation more with technology and entrepreneurship.[28]

49. While the existing institutional structure supporting STI policy has, to date, been rather ad hoc, what the leading STI countries in the region have in common is a whole-of-government approach with an overarching governance structure for STI, backed by strong leadership that has oversight of STI strategy. Such a governance structure has allowed those countries to take a much more holistic and strategic view and has proven successful in mainstreaming STI across individual line ministries. It also improves monitoring to ensure that high-quality assurance and standards, as well as enforceable intellectual property rights regimes, are applied.

50. On a broader, supranational level, subregional institutions for STI cooperation do exist, as do North-South STI platforms. However, they are disparate and unconnected and thus do not fully harness the vast knowledge and potential in the region. They also exclude many of the Commission's member countries. The recently mandated Committee on Information and Communications Technology, Science, Technology and Innovation, which will meet for the first time in 2016, presents a unique opportunity to create a truly integrated and inclusive approach to knowledge-sharing and networking in the region.

51. On a global scale, the Technology Facilitation Mechanism and the technology bank have been established in recognition of the key role of technology development, dissemination and transfer in the implementation of the 2030 Agenda. While both of these global initiatives are at very early stages, they will be vital to ensure the national and regional contexts are understood and incorporated into any global agenda. Considering the wide range of expertise required across sectors, regions, subregions and technologies, together with the wide and diverse regional and national experience, an effective delivery mechanism that bridges these three levels (national, regional and global) is necessary to support the needs of member States.

G. How Governments can support scientists, technologists, innovators and entrepreneurs

52. The means of progress in any STI system are diverse. Some are well-known and easily identifiable, such as research and academic institutions, government bodies and corporations. Others are less obvious, such as start-up enterprises, public bodies and civil society, but can lead to profound change. Citizens are an increasingly important part of the STI system. Some Governments in the region have recognized this and have begun to experiment with engaging citizens in problem identification, leading to the development of solutions with interesting results.[29,30]

[28] See, for example, http://mineconomy.am/eng/38/gortsaruyt.html.

[29] The theme study will provide case studies of how Governments have supported these efforts.

[30] The theme study includes case studies on positive examples of citizen-initiated solutions.

53. The theme study shows how strategies focusing on supporting the development of frontier science and technology through academia and public-private partnerships and creating a culture of entrepreneurship, public sector innovation and citizen-centric innovation have demonstrated the most effective results in stimulating advancements in STI.

54. Technology transfer has also been used as a strategy to facilitate technology catch-up and develop national STI capability. While the evidence of broader gains from foreign direct investment-induced technology transfer is mixed, there is a clear link between open markets and increases in productivity. Open markets expose businesses to new concepts and methods and create more competitive firms.

55. Governments in the region have also implemented strategies to foster cross-sector collaboration through the establishment of science parks, tech clusters and innovation hubs to create a dynamic, vibrant and collaborative ecosystem for STI. The theme study examines several case studies along this line. The main takeaway from the experience is that creating an open, interactive environment where the various actors come together and continually re-invent the underlying networks and ecosystems can spur the innovative application of scientific and technological advancements for positive economic, social and environmental impact.

H. How Governments have funded and incentivized investment in science, technology and innovation

56. The most traditional way Governments have supported STI is through research and development funding, predominantly channelled to academic and education institutions. Governments have also incentivized STI investment by deploying various financial and fiscal instruments like directed subsidies and tax breaks.

57. However, Governments, for a variety of reasons, are looking to move beyond these traditional methods to support innovative societies. The recent establishment of state-backed venture capital funds to support start-up enterprises is an emerging trend signalling an understanding of the importance of entrepreneurs in the innovation system.[31] While some Governments have established their own venture capital funds, others, unable to support the necessary cash outlays, are acting as backers, helping to reduce the commercial risk of such start-ups, making them more attractive to conventional venture funds.

58. Another development in funding has been a recent surge in innovation initiatives within international development donor Governments. However, these initiatives go beyond new funds to support of labs and other STI networks. Donors are increasingly seeing innovation as a tool to increase the pace and impact of their poverty alleviation efforts and have experimented with different models to manage the inherent risk of innovation, scale the very best ideas and "crowd in" a diverse range of funders and actors in order to deliver more cost-effective and high-impact aid. While early innovation efforts where often siloed experiments, there has been a movement towards multilateral, multisectoral, donor innovation initiatives. A critical challenge for donor agencies will be how to embed innovation and a mindset that is comfortable with change, rather than an add-on to a mainstream culture of linear innovation.

[31] www.reuters.com/article/us-china-venturecapital-idUSKBN0KO05Q20150115.

59. Philanthropy has the potential to play a role in funding research and development and innovation with high-potential economic, environmental and/or social returns. The new age philanthropic foundations have been playing a critical role in funding areas with important societal and environmental benefits. Although foundations are subject to fiduciary oversight, they are neither bound to shareholder returns (as firms are) nor accountable to a political election cycle (as governments are). They are uniquely able to invest in experimental and high-risk, high-potential research and development.[32]

60. While currently the most notable globally active philanthropic funders in international development are based in the United States, there are pockets of activity emerging in Asia.[33] These emerging efforts are critical in South-South efforts to build networks to support and re-inforce regional solutions to regional issues. However, in order to incentivize philanthropy, Governments will need to incentivize giving.

I. Emerging approaches to innovation

61. New evidence concerning what works in stimulating innovation is building every day. Much of this revolves around the increasing access to information and the speed with which that information changes. Open innovation, described as the process of harnessing the distributed and collective intelligence of crowds, is predicated on this increased access. It is based on a number of principles, including collaboration, sharing, self-organization, decentralization, transparency of process and plurality of participants.[34] It has taken on a wider meaning and application thanks to the Internet, which has enabled large numbers of people to interact and contribute at a relatively low cost.[35] The concept of open science has emerged from the open innovation movement. Open science moves beyond open access research articles, towards encompassing those things underpinning research, such as data, software codes, protocols and workflows. The intention is for people to use, re-use, build-upon and distribute content without legal, technological or social restrictions. In some cases, open science also entails the opening up of the entire research process from agenda setting, to experimentation, to the dissemination of findings. Some Governments have begun to support this approach by requiring grant recipients to make their data, as well as findings, publicly available. Open science utilizes the prevalence of the Internet and associated digital tools to enable greater local and global research collaboration. While open science is lauded by many as a guiding principle, the practice is far from universal in the global North, and awareness of its benefits and practices is even less prominent in the global South.[36]

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[32] Gabriel Kasper and Justin Marcoux, "The re-emerging art of funding innovation", *Stanford Social Innovation Review* (Spring 2014). Available from http://ssir.org/articles/entry/the_re_emerging_art_of_funding_innovation.

[33] www.wsj.com/articles/SB10001424052702304788404579521391392085498.

[34] Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston, Harvard Business School Press, 2003) and Henry Chesbrough, Wim Vanhaverbeke and Joel West, eds., *Open Innovation: Researching a New Paradigm* (Oxford, Oxford University Press, 2006).

[35] See for example, Don Tapscott and Anthony D. Williams, *Wikinomics: How Mass Collaboration Changes Everything* (London, Penguin Group, 2006); Charles Leadbeater, *We-Think: Mass Innovation, not Mass Production* (London, Profile Books, 2008); James Surowiecki, *The Wisdom of Crowds* (London, Anchor Books, 2004); and Eric Von Hippel, *Democratizing Innovation* (Cambridge, Massachusetts, MIT Press, 2005).

[36] http://ocsdnet.org/about-ocsdnet/about-ocs/.

62. Innovative ideas can come from anywhere. The process of innovation can become stronger and more sustainable with public engagement by all in society, especially women, young people and indigenous communities. Indeed, those in most need of innovative solutions (those at the so-called base of the pyramid) are often the best source of innovative ideas. While the term "inclusive innovation" has several definitions, it generally refers to innovation supporting, or stemming from, such underrepresented parts of society.[37] It can be defined as any innovation that helps expand affordable access to quality products and services that create and increase livelihood opportunities for excluded populations.[38] However defined, inclusive innovation is a no-cost way for Governments to access new ways of thinking from non-traditional sources.

III. Recommendations

63. The theme study makes five broad recommendations, within which more detailed action items are enumerated. For those action items to have real meaning, they must be supported by stakeholders across the political spectrum and, importantly, be associated with explicit time bounds. As member States have committed to a 15-year time horizon in the 2030 Agenda, the recommendations have been categorized as short term (one year), medium term (three years) and long term (five years). The five recommendations are:

Recommendation 1: Provide visionary leadership for STI as an integral component of the Sustainable Development Goals strategies by (a) strengthening governance through the positioning of the mandate for STI in the office of the head of Government to ensure strategic implementation and appropriate political backing (short term); (b) conducting regular foresight exercises to inform STI action plans aligned to the Sustainable Development Goals and integrated across all line ministries (short term) with ESCAP support in ascertaining the necessary expertise to craft these plans; (c) institutionalizing regular reporting on STI indicators and monitoring of STI policy across all line ministries (short term); and (d) institutionalizing reporting on social and environmental impact of operations and investments by the private sector (short term).

Recommendation 2: Lay the foundations for STI development through high-quality institutions and infrastructure by (a) increasing the quality of physical infrastructure (laboratories, innovation hubs, science parks, maker spaces and Internet infrastructure) (long term); (b) leveraging educational technologies such as distance learning (medium term); (c) aiming for internationally accredited standards for research (long term); (d) ensuring institutional and regulatory compliance, including corporate law and intellectual property (medium term); and (e) providing high-quality support services to entrepreneurs (business planning, financial management, risk management, legal advice and marketing) (medium term).

Recommendation 3: Commit to funding and incentivizing investment in STI by (a) allocating a specified percentage of gross domestic product to (i) education with targeted allocation for higher or vocational education, (ii) research and development and (iii) venture funds for start-ups

[37] Christopher Foster and Richard Heeks "Policies to support inclusive innovation", Development Informatics Working Paper No. 61 (Manchester, Centre for Development Informatics, 2015). Available from www.seed.manchester.ac.uk/medialibrary/IDPM/working_papers/di/di_wp61.pdf.

[38] World Bank definition.

(medium term); (b) granting special "pioneering" status to high-tech industries with suitable long-term tax-free status to promote manufacturing in high-tech fields (short term); (c) underwriting risk taking by private firms and investors (medium term); (d) rewarding businesses that set up systems which explicitly address the three dimensions of the Sustainable Development Goals, through public procurement policies, matching grants and tax incentives; and (e) incentivizing investment for the social and environmental good as well as economic return (medium term).

Recommendation 4: Create a knowledge economy by (a) increasing the absorptive capacity of industry to productively use external and internal knowledge by enabling the hiring of highly skilled personnel, encouraging the movement of scientists, engineers and other professionals between member States, and incentivizing on-job training (medium term); (b) establishing innovation hubs in universities to nurture a stronger science-innovation mindset (medium term); (c) exposing students to problem-solving skills, critical thinking and innovation, science and technology curriculum (medium term); and (d) creating a critical mass of high-quality STI professionals, progressively increasing to 2,500 highly qualified professionals involved in research and development per million (long term).

Recommendation 5: Enable open, collaborative and inclusive knowledge economies by (a) consulting all stakeholders in the preparation of STI strategies, specifically to ensure economic, social and environmental dimensions are reflected (short term); (b) committing to an open knowledge-sharing ecosystem to foster cross-sector STI collaboration through physical and virtual knowledge-sharing infrastructure (medium term); (c) applying open and inclusive approaches to innovation by engaging a diversity of actors, including women, the poor and indigenous persons (medium term); (d) opening up science through open universities, international access programmes, digital libraries and online training programmes so that knowledge and creativity move effortlessly over and beyond geographical borders; (e) promoting sharing of technical knowledge among countries and providing incentives to promote inter-country technology collaboration, development, trade and transfer (medium term); (f) pooling funds for research and development and early stage enterprise investment; and (g) establishing a regional platform for government officials, scientists, technologists, innovators and investors to effectively discuss, collaborate and harness STI for inclusive and sustainable development (short term).

64. The domains of science, technology and innovation are broad and complex, with linkages across several sectors and a diversity of stakeholders. In addition, countries in the Asia-Pacific region are at different levels of socioeconomic and STI development. The recommendations presented above need to be tailored to each country-specific context and needs but, if implemented, can provide the mechanisms to leverage STI to fully integrate the three dimensions of sustainable development.

IV. The role of the Commission

65. Current intergovernment STI cooperation in the region is disjointed and ad hoc. ESCAP, as the region's primary intergovernmental forum, provides a unique opportunity to link these disparate efforts, creating a whole that is greater than the sum of its parts. The most immediate avenue is the inaugural meeting of the Committee on Information and Communications Technology, Science, Technology and Innovation, which will take place in 2016. This Committee presents a unique opportunity to create a truly regional and integrated STI platform to share knowledge across the subregions and capture the diversity and dynamism of STI across the region.

66. While the Committee on Information and Communications Technology, Science, Technology and Innovation will provide an important venue to ensure the region remains on track, the biannual meeting schedule may hamper countries' ability to keep pace with the fast-changing landscape of STI. Thus, an additional avenue of cooperation would be the establishment of an innovation forum, which could be convened more regularly. This innovation forum would complement the Commission on Science and Technology for Development of the United Nations Conference on Trade and Development and the various science forums organized by the United Nations Educational, Scientific and Cultural Organization and provide a unique opportunity for countries to exchange experiences in identifying opportunities and challenges. Activities could include baselining activities, developing blueprints for STI implementation for the Sustainable Development Goals, outcome monitoring, developing regional standards and cooperation agreements, implementing skills-based exchange programmes and determining the contours of an open innovation/ science regime across the region. To take advantage of the regions vibrant STI ecosystem and to support member States in meeting their ambitions and commitments, ESCAP could support collaboration between member States by:

(a) Acting as a bridge between the numerous subregional STI platforms (such as the Association of Southeast Asian Nations, Asia-Pacific Economic Cooperation and South Asian Association for Regional Cooperation) to ensure that the region as a whole is fully informed about STI developments, challenges and opportunities;

(b) Coordinating a regional cross-government network on STI in support of knowledge-sharing on STI for the implementation of the Sustainable Development Goals;

(c) Holding an annual multi-stakeholder innovation forum for the Sustainable Development Goals;

(d) Ensuring that regional needs and knowledge are integrated into the global STI agenda (for example, for the Transitional Funding Mechanism and the technology bank);

(e) Hosting an online platform as a gateway for information on regional STI needs, solutions initiatives and policy developments.

67. This platform could support more specific areas of work, such as providing analysis and best practice assessments of STI policy; advocating for and facilitating commitments to key STI policy initiatives in the region (such as responsible business and social finance); and supporting donors in the region who have invested in innovative knowledge-sharing platforms (such as the Global Innovation Exchange[39]) to increase engagement from countries in the region.

[39] www.globalinnovationexchange.org/.