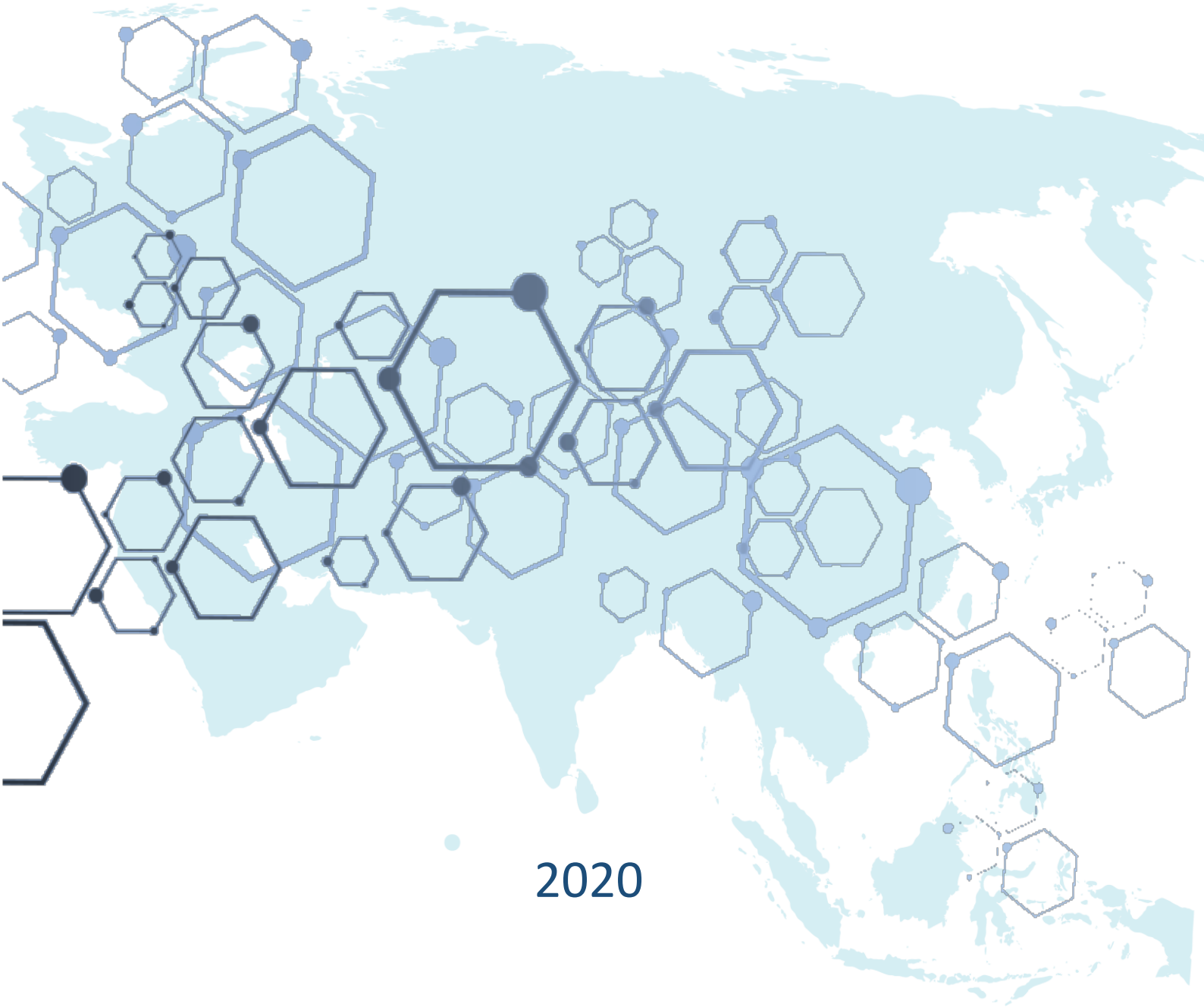
SCIENCE AND TECHNOLOGY STATUS FOR DISASTER RISK REDUCTION IN ASIA PACIFIC



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UNDRR
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AP-STAAG
Asia-Pacific Science, Technology and Academia Advisory Group

SENDAI FRAMEWORK
FOR DISASTER RISK REDUCTION 2015-2030

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SCIENCE AND TECHNOLOGY STATUS FOR DISASTER RISK REDUCTION IN ASIA PACIFIC 2020

UNDRR Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG)

ABOUT THE REPORT

This publication is developed by a group of individuals from the UNDRR Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG) with contributions and support from researchers, scientists from different countries in the Asia-Pacific region. The publication is based on a qualitative survey and submission of case studies on application of science and technology for disaster risk reduction specific to four Priorities for Action of the Sendai Framework for Disaster Risk Reduction. A total of 69 responses were received representing government, UN agencies, network of universities and the U-Inspire Alliance. A total of 23 case studies were also received from 11 countries, besides four case studies on specific themes.

The study is presented in three parts:

Part-1, based on the survey responses, presents the regional analysis of the progress in Science and Technology roadmap for disaster risk reduction.

Part-2 of the report presents a regional status update of six selected themes namely; 1) NATECH 2) Eco-DRR 3) Capacities Building in Higher Education 4) Socio-Economic of Resilient Infrastructure 5) Space application 6) Urban Resilience and Climate Change.

Part-3 includes 27 examples on different themes and actions as listed under the Science and Technology Roadmap. They highlight actions being taken in different countries of the region so to achieve one or more outputs of the roadmap.

The publication is commissioned by the United Nations Office of Disaster Risk Reduction and supported by the U-Inspire Alliance.

FOREWORD

The Asia-Pacific region is facing an increase in the number of disasters, leading to immense human, physical, environment and economic losses. The increasing trend of disasters and the growth of new hazard risks throughout Asia and the Pacific due to climate change are reminders of the need to encourage a multi-sectoral approach to mitigate and reduce future risks.

Among the various sectors, science and technology stands out as especially in critical to disaster risk reduction; from furthering our understanding of risk, to facilitating informed decision-making, and developing new methods to building resilience and minimizing disaster impacts. Realizing its importance, the Sendai Framework for Disaster Risk Reduction 2015-2030 calls for the integration of science and technology into the implementation of the Framework's four priorities for action, at the global, regional, national and local levels. This has led the UN Office for Disaster Risk Reduction (UNDRR) to establish the Science and Technology Advisory Group and its regional sub-groups. Guided by their own regional roadmap Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG) was created to contextualize global efforts to address the unique needs of the region and to support the coherent implementation of the post-2015 frameworks.

In many regards, Asia-Pacific is already ahead of the world when it comes to utilizing science and technology towards risk reduction. The region is home to a number of universities that have developed curricula and courses around disaster risk reduction and have fostered research among a new generation of scholars. The advancements made in research cut across disciplines to include basic science, engineering and technology, social sciences and humanities, and have led to the development of new knowledge and innovations to support building sustainable and disaster resilient societies.

The Science and Technology Status report is an attempt to capture some of this progress across geographies, stakeholders and disciplines in the Asia-Pacific region. Specifically, the report examines progress in a number of thematic areas and against the priorities of the Sendai Framework. The report shows that there is plenty of reason for optimism as the region has made strides in capacity building around understanding disaster risks and the dissemination of scientific knowledge to various stakeholders. At the same time, the report highlights areas of concern where more work is needed to integrate knowledge into policy and practice.

The creation of sound policies and scientific applications requires the cooperation of both the scientific community and DRR practitioners. I hope this report will help enrich the discussion on what can be done to strengthen the connection between science and policy. The resulting synergy will mean empowering local communities and practitioners in the field with the best tools and knowledge to accelerate progress towards climate and disaster risk-informed development and save lives.

Loretta Hieber Girardet
Chief, UNDRR Regional Office for Asia and the Pacific

MESSAGE FROM AP-STAAG

The Science and Technology Roadmap to Support the Implementation of the Sendai Framework for Disaster Risk Reduction was developed in 2016 and subsequently contextualized in 2018 to enhance its coherence with other global frameworks such as the 2030 Agenda for Sustainable Development, Paris Agreement, and the New Urban Agenda. The revised S&T roadmap includes four expected outcomes and 58 actions structured around the four Priority for Actions of the Sendai Framework.

The roadmap is envisioned as a mechanism to foster collaboration among the scientific communities and other stakeholders for the coherence and implementation of methodologies and tools relevant to disaster risk reduction around common priorities and actions. The roadmap is considered a working document, to be periodically reviewed and updated in the event of future evolution of knowledge, new technologies, new Sendai Framework hazards and increasing importance of indigenous and local knowledge as well as citizen science.

The Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG), formed shortly after the adoption of the Sendai Framework in 2015, has remained an active regional network of the S&T community in the region. This is evident from the substantive knowledge and research products developed by its members as well as jointly by the group. The organisation of regional gatherings of S&T community, e.g. 2016 in Bangkok and 2018 in Beijing has also strengthened the collaboration to advance the science-policy-practice nexus. The AP-STAAG is pleased to release this report at the 2020 Asia-Pacific S&T Conference on Disaster Risk Reduction, being organized in Kuala Lumpur, Malaysia as well as virtually.

The report finds that the maximum progress in implementation of the S&T roadmap has been made for Priority of Action 2 while the least has been made for Priority of Action 4. Among specific actions, major progress has been made in promoting disaster risk assessment in planning and development while incorporating build back better in insurance policies needs strengthening in future. This progress is in line with the commitments made by the AP-STAAG at the 2019 Global Platform where the AP-STAAG also emphasized the action of investment on developing young professionals in the field of multi-disciplinary disaster risk reduction, exemplified by the central role played by the U-Inspire Alliance in development of this report.

The status report of the S&T Roadmap is, hence, an important step for monitoring the progress in implementation of the Sendai Framework and is expected to advance the disaster risk reduction research agenda further in the Asia-Pacific region.

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Regional Status of Urban Resilience and Climate Change

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Introduction

Urban resilience has evolved conceptually with multiple interpretations across policy, practice and research disciplines. The review of a decade of literature reveals that the central elements for urban resilience are resisting, recovering, adapting and transforming (Ribeiro and Goncalves 2019). In the context of climate change and disaster risk reduction (DRR), the traditional perspective of resilience as the simple ability to withstand and recover from a disruption has now widened, to include the capability to adapt and transform to shifting societal and environmental conditions. Some disruptions may be anticipated over time but others remain unknown. While urban resilience is a common goal in policy, its translation into practice through specific risk management strategies is challenging. Strategies that focus solely on infrastructure solutions are inflexible and preconfigure future conditions that may give rise to issues of inequity and justice, particularly where there is community displacement (Herbeck and Flitner 2019; Laeni et al. 2019). Research on the multiple dimensions of urban development, planning and management has to be enhanced to strengthen the systems and processes that constitute the urban metabolism, to meet the needs of a dynamic and uncertain future (Ribeiro and Goncalves 2019). Holistic and integrated approaches that take into account advances in science and technology, the role of multiple stakeholders as well as the socio-economic, institutional and political dimensions is critical to build urban resilience as the climate changes.

New research insights including tools and methods to measure resilience is required for policy and practice in cities. Progress in this aspect could be captured through a systematic and comprehensive assessment of scientific knowledge on urban resilience and climate change at the global level. This assessment is being led by the Intergovernmental Panel on

Climate Change (IPCC), which will support a Special Report on Climate Change and Cities in the Seventh Assessment (AR7) cycle (Decision IPCC/XLIII-6 # 6). The IPCC also supported a global conference on cities in 2018 as part of the Sixth Assessment (AR6) cycle to foster new scientific knowledge for cities based on science, practice and policy to marshal research that will lead to peer-reviewed publications (www.ipcc.ch). Initiatives that promote research and peer-reviewed publications are encouraged by the IPCC to support the proposed Special Report, particularly to highlight the regional dimension and poorly covered areas.

This was the context for the Workshop on Building Disaster and Climate Resilience in Cities in Kuala Lumpur on 15-16 October 2019; to capture current status of knowledge and link scientists from multiple disciplines, to promote research that is relevant to the region. The Workshop was convened by the Asian Network on Climate Science and Technology (ANCST), coordinated by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), in conjunction with the Asia-Pacific Network for Global Change Research (APN) and International Science Council Regional Office for Asia and the Pacific (ISC-ROAP), with support from members of the UNDRR Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG). National Partners included the National Disaster Management Agency (NADMA) Malaysia, Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia (MESTECC), Academy of Sciences Malaysia and the City Hall of Kuala Lumpur (DBKL). A total of 141 participants of multidisciplinary background from academia, government, non-government organisations and the private sector, representing 14 countries from the Asia Pacific and international organisations attended the Workshop; to share progress in science and technology on climate change, DRR and their interactions in cities.

A cursory outlook of current status of knowledge on climate science and technology in cities is presented in this article, drawing on findings of the Workshop. The first part provides a snapshot of key findings presented at the Workshop, and knowledge gaps are highlighted in this context. This is followed by a discussion on selected enablers for building disaster resilience in the Asia Pacific. Such enablers include taking a systems approach, stimulating public-private participation, galvanizing knowledge-empowered youths and promoting open science communication and engagement.

Highlights on Urban Hazards

Multi-hazard Platform: The Kuala Lumpur Multi-hazard Platform (KL-MHP) is a visual decision-making theatre that displays the modelled products of geophysical and atmospheric hazards driven by meteorological forecasts, to graphically communicate risk (Hunt and Pereira 2019). Meteorological products such as the hourly rainfall, humidity, temperature and wind forecasts at the street level are displayed in the KL-MHP. In addition, the system also displays areas susceptible to geophysical hazards such as pluvial floods, landslides and sinkholes as well as forecasts of atmospheric hazards such as heat, strong winds and air pollution. The KL-MHP draws on daily information from the Meteorology Department of Malaysia to assist decision-making within the City Hall of Kuala Lumpur (Pereira et al. 2019). Such scientific information and early warning is strengthening urban resilience in Kuala Lumpur. This is particularly relevant in light of the expected intensity and frequency extremes events in tropical regions due to climate change (IPCC 2018). City scale meteorological modelling is increasingly

The IPCC supported a global conference on cities in 2018 as part of the Sixth Assessment (AR6) cycle to foster new scientific knowledge for cities based on science, practice and policy to marshal research that will lead to peer-reviewed publications.

Figure 5: The Kuala Lumpur Multi-hazard Platform, located in the City Hall of Kuala Lumpur displays modelled products of geophysical and atmospheric hazards driven by meteorological forecasts, to support disaster alert, risk communication and emergency response in the city.

important for tropical Southeast Asia (Abdullah et al. 2019). The limitation for forecasting at the city scale relates to the distribution of deep mesoscale convective systems (monsoonal region), which may differ as it is strongly influenced by its unique topographic orientation. More work is required for determination of convection initiation at high resolution. Future work is also required for the application of low cost sensors as supporting methods for air quality or landslide monitoring, which could be linked to the KL-MHP.

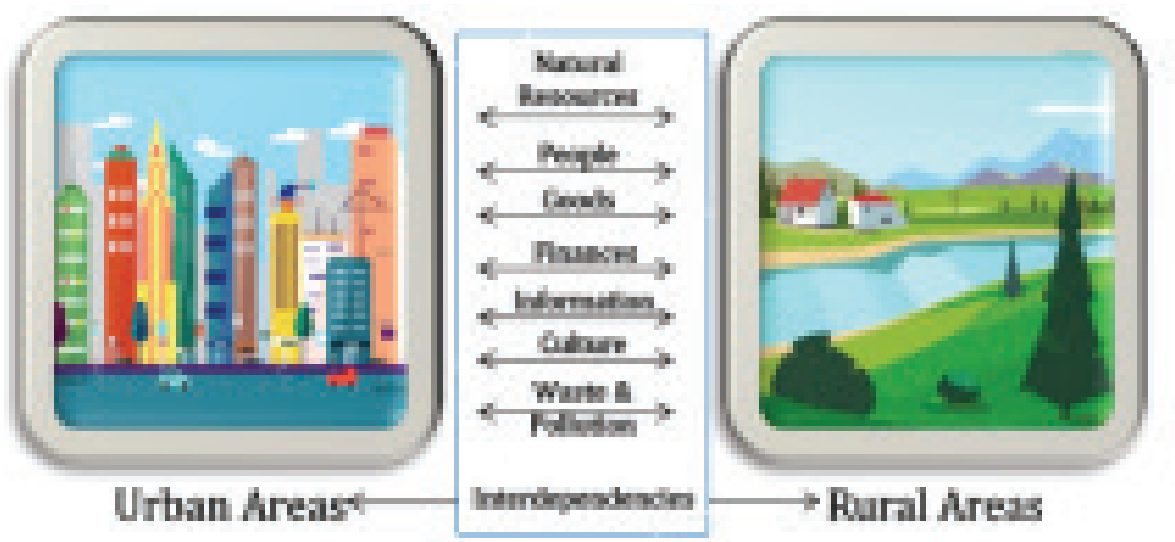
Urban-Rural Linkage Approach: The urban-rural linkage approach encompasses complementary assets between urban and rural areas that are linked through various mechanisms as a useful means of enhancing collective resilience (Shaw 2019). The application of the concept was demonstrated through two cases; Kanagawa, Japan and Nagpur, India. In both these cities, there is a strong urban-rural linkage, where there is a common watershed providing the source of water. The Kanagawa Prefecture introduced a new taxation system that imposes USD 8 per year for each household, which is then used to improve the watershed environment. In the case of Nagpur, India, the rural-rural, rural-urban and collective linkages are being investigated at various levels, focusing on water supply. It is important for other cities in the region to learn from this approach to identify pathways for advancing urban resilience.

Smart Cities and Resilient Infrastructure: In India, institutional arrangements such as linkages with national disaster management agencies as well as city authorities and involvement of vulnerable groups are given priority (Mukherjee 2019). There are several initiatives in smart cities, which take into account geo-intelligence and cyber-physical systems as well as disaster risks. The economic factor has highlighted the interest of both the government and the community, which helped in building disaster resilience by using innovative approaches such as geo-intelligence and cyber-physical systems. The evidence indicates that there is significant positive relationship between the smartness of a city and its overall resilience (Zhu et al. 2019). The level

of resilience is dependent upon infrastructural, economic, social, institutional and environmental conditions. In China, risk and impact assessment of urban infrastructure is increasingly important for building resilience of critical infrastructure. Exposure analysis and modelled flood induced failure and system impact analysis is being conducted for road networks in China (Yang et al 2019). In addition to scientific and evidence-based disaster risk analysis and assessment, effective governance and place-based approaches including capacity building for emergencies are essential for resilient infrastructure (Inaoka et al 2019; Monstadt 2019). Further investigation is required on resilient infrastructure and smart cities in the Asia Pacific.

Knowledge Gaps: Urban Geoscience is increasingly important in terms of the construction environment, geological hazards as well as subsurface and resource management (Banks et al. 2019). Rapid urbanization, pressure on space, population growth, environmental change and climate change are important drivers. The urban environment is relatively rich in data. There are various types of technologies that can be deployed to acquire data including InSAR and other satellite data, drone, LiDAR, and sensor technologies, among others. Knowledge gaps in the region, particularly in the tropics, relate to surface and subsurface geological and hydrogeological uncertainty, weathering profile and erosion rates. Research on landslide susceptibility and determination of rainfall thresholds are challenging in the tropics (Arnhardt et al. 2019). Analysis using heuristical and statistical methods can effectively map out zones that have a high potential for slope failure, although both have limitations and uncertainties. The probabilistic approach that has been adopted using limit equilibrium-based analysis and the BGS water balance model, which integrates the correlation between the soil and hydrological properties to understand the evolving ground saturation condition are areas that need further work to identify rainfall thresholds for landslides. The development of a robust methodology for the determination of rainfall threshold levels for landslides will be very useful for the tropics. Cities offer the best opportunity for new holistic and integrated approaches in conjunction with social acceptance, which link disaster risks, climate change adaptation and climate change mitigation. The urban climate can be modified and optimized artificially by urban vegetation to reduce the urban heat effect and green buildings can promote emission reduction, for example solar panels on roof-tops of apartments as in Wuhan, China (Hunt and Pereira 2019). Integrated approaches could also be applied for modification of water systems to reduce pollution. Global warming of 1.5oC is expected to intensity and increase the frequency

Figure 6: A basic definition of urban rural linkage is that they consist of flows of goods, people, finance, etc. over space and time (Shaw 2019).



extremes events (IPCC 2018). New aspects of critical hazards can be expected i.e. extremes of temperatures associated with low wind speeds, oceanic stagnation, extremes and variability of local extreme events such as urban flash floods, storm surges as well as population migration, particularly in coastal regions; that implications tropical urban areas and have to further investigated (Hunt and Pereira 2019). In Kuala Lumpur, detailed pluvial flood modeling of 5 m resolution has been developed by simulating the condition of various return periods to develop a flood risk map, which is essential for the insurance sector (Smith 2019). This can be replicated for other cities in the region.

Enablers for Building Urban Resilience Systems Approach: It was emphasized that cities could benefit from a "system-of-systems" for assessing the resilience of infrastructure, which links physical and cyber systems through an integration of sensor data from networks, people, and artificial intelligence (Jonas 2019). The idea of "sensemaking" in conceptualizing resilience indicates how to increase the availability of information so that decision makers would know how to deal with the problem effectively. The discussion on the recovery strategy practised in other countries, such as giving priority to damaged and disrupted infrastructure in China, and attending to new infrastructure and upgrading in Japan, should both be learned from and emulated. The authorities should also concentrate on small-scale hazards that are more frequent to understand their accumulated impact. It was noted that changes are slowly taking place among politicians, policymakers and people as well. They are starting to think about forecasting, uncertainties, limitations of knowledge as well as a systems approach which is helpful for progress in building urban resilience.

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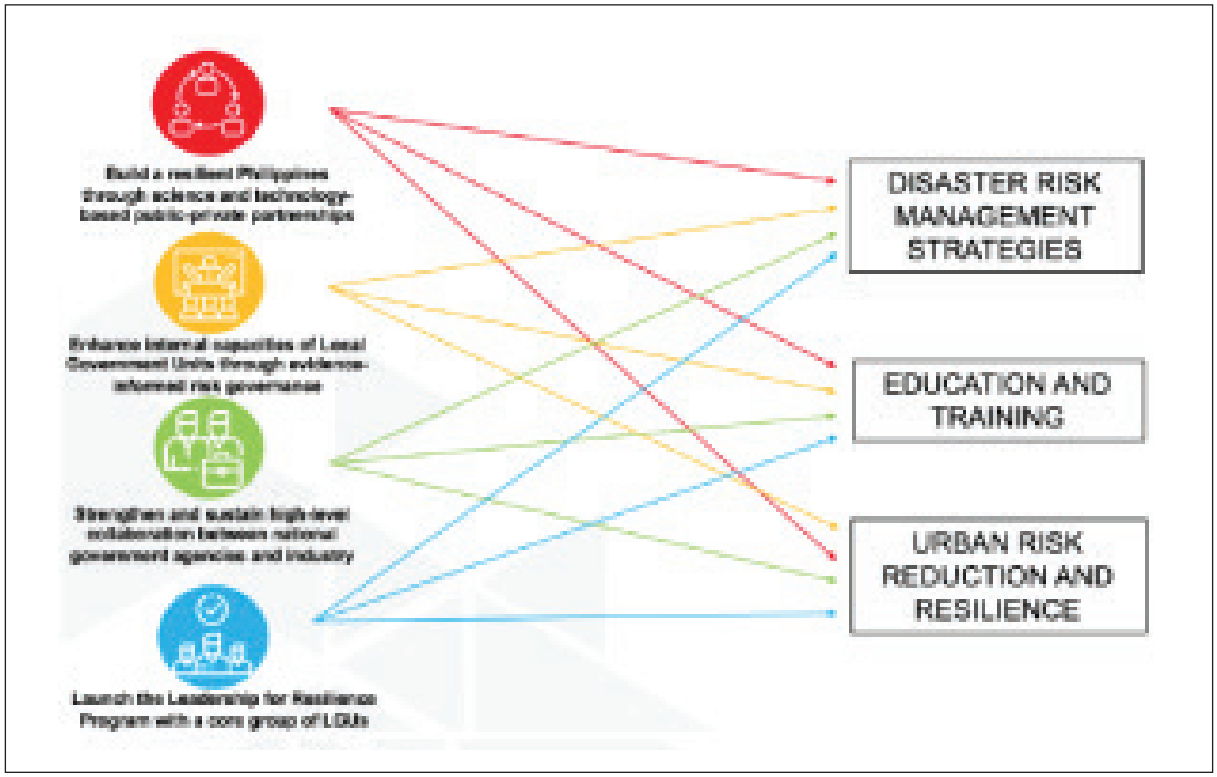
Public-Private Participation: The role of public-private partnership in building resilience and how to move this from science to action was also emphasized (Loyzaga 2019). The National Resilience Council of the Philippines has evidence-based risk governance consisting of a comprehensive strategy, education and training on urban risk reduction and resilience. The components of the disaster resilience efforts include private, public and local government stakeholders as well as the community.

Knowledge Empowered Youths: The medium and long-term strategy of the UNESCO Regional Science Bureau for Asia and the Pacific gives emphasis to the four priority actions and seven goals of the Sendai Framework on DRR (Khan 2019). UNESCO established the U-INSPIRE Alliance in 2019 to mobilize youth and young professionals in science, engineering, technology and innovation for DRR and climate change. Since its establishment, members of the Alliance have also met to discuss career pathways in DRR and develop future plans to navigate the science-policy interface (Ismail 2019a). The workshops convened by science institutions in the Asia Pacific led by ANCST, APN and ISC-ROAP in conjunction with partners have provided better understanding of the DRR, climate change and its challenges; and connected senior researchers to youths from different backgrounds in the region (Pereira and Hunt 2019; Pereira and Nurfashareena 2019). This has also facilitated discussion with a high-level delegation from the IPCC on enhancing participation of youth and young professionals from the Asia Pacific in their report preparation process (Ismail 2019b). The U-Inspire Chapters of the Asia Pacific have also created links with the youth network in Africa to serve as a catalyst for future initiatives in both regions. A U-Inspire Stage will commence at the 2020 Asia Pacific S&T Conference on DRR in Kuala Lumpur, where the scientific findings presented will be channelled to peer-reviewed publications. The

Figure 7: The National Resilience Council of the Philippines promotes evidence–based risk governance through public-private partnerships (Loyzaga 2019).



U-Inspire initiative has generated a huge expectation; the involvement of youth and young professionals should be nurtured to fill knowledge gaps in the Asia Pacific.

Open Science Communication and Engagement: The Australian perspective for building resilience in cities focuses on working across the value chain (Hazelwood 2019). It involves supporting community safety and national probabilistic hazard assessment. The probabilistic hazard assessment covers tropical cyclones, seismic hazards and tsunami hazard assessment; multiple maps are used for hazard prediction. The public has access to this hazard information to help them to understand better. The information and understanding is not only communicated to the community but necessary information is also collected from them. In Thailand, the Water Resource Management Operation Center is using information on demand, supply, logistic, management and money to increase the understanding of local communities regarding their water supply, water demand, waterway, use of the water table and costs of water resource management (Weesakul 2019). Simplified information and effective channels of communication are important for building resilience. Targeted communication strategies are also required to inform the various stakeholders regarding hazards and risks (Poole 2019). Many great ideas have been successfully implemented but the challenges lie in communication. It is vital that the public be informed of scientific findings and successful initiatives in DRR and climate change. The promotion of open data and access is vital to advance open communication and community engagement in the region.

Conclusion

A key achievement of the Workshop on Building Disaster and Climate Resilience in Cities in Kuala Lumpur on 15-16 October 2019, which was convened by the Asian Network on Climate

Science and Technology (ANCST), Asia-Pacific Network for Global Change Research (APN) and International Science Council Regional Office for Asia and the Pacific (ISC-ROAP), with partners including the UNDRR Asia-Pacific Science, Technology and Academia Advisory Group (AP-STAAG), was to connect senior and young researchers working on urban resilience and climate change in the Asia Pacific. It also contributed a considerable step forward in connecting researchers, institutions, policymakers, and practitioners in sharing research advances. The initiative to bring young scientists into the research domain and to connect them with experienced researchers can yield a prolific output if data and information sharing is properly executed.

A highlight of the Workshop was the launch of the Kuala Lumpur Multi-hazard Platform, a visual decision-making theatre to graphically communicate risk for decision making. The MHP could serve as a useful tool to address the challenges of downscaling climate information and upscaling local information, to bridge the gap between climate change and resilient cities. Another highlight was the urban-rural linkages approach applied in Kanagawa, Japan and Nagpur, India, which could be emulated elsewhere in the region, to promote innovative approaches to generate financial resources. Further investigation is required on smart cities and resilient infrastructure as well as urban geoscience in the region, to provide insights for building resilience. Urban resilience in the Asia Pacific could benefit from a systems approach, public-private participation, knowledge-empowered youths and promotion of open data and access, to advance community engagement. Youth and young professionals offer the best potential to fill knowledge gaps in the Asia Pacific.

Acknowledgment

The authors would like to thank the Asia-Pacific Network for Global Change Research (APN) and International Science Council Regional Office for Asia and the Pacific (ISC-ROAP) for sponsoring young scientists to attend the Workshop. Acknowledgment also goes to the Newton-Ungku Omar Fund, administered by the Malaysian Industry-Government Group for High Technology (MIGHT) and Innovate UK; as well as all workshop partners, speakers, moderators and participants for their support.