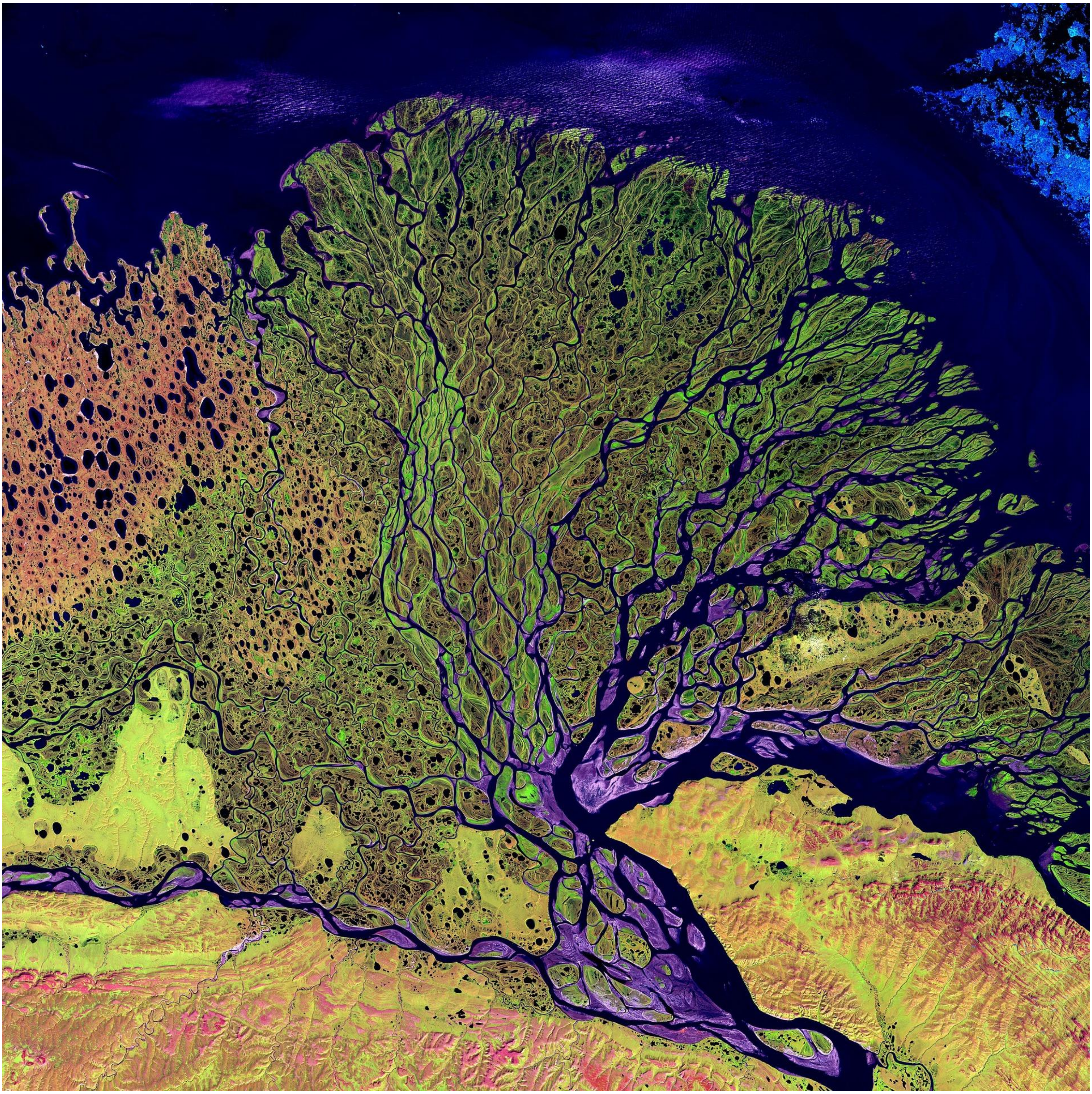

ICT in Disaster Risk Management Initiatives in Asia and the Pacific

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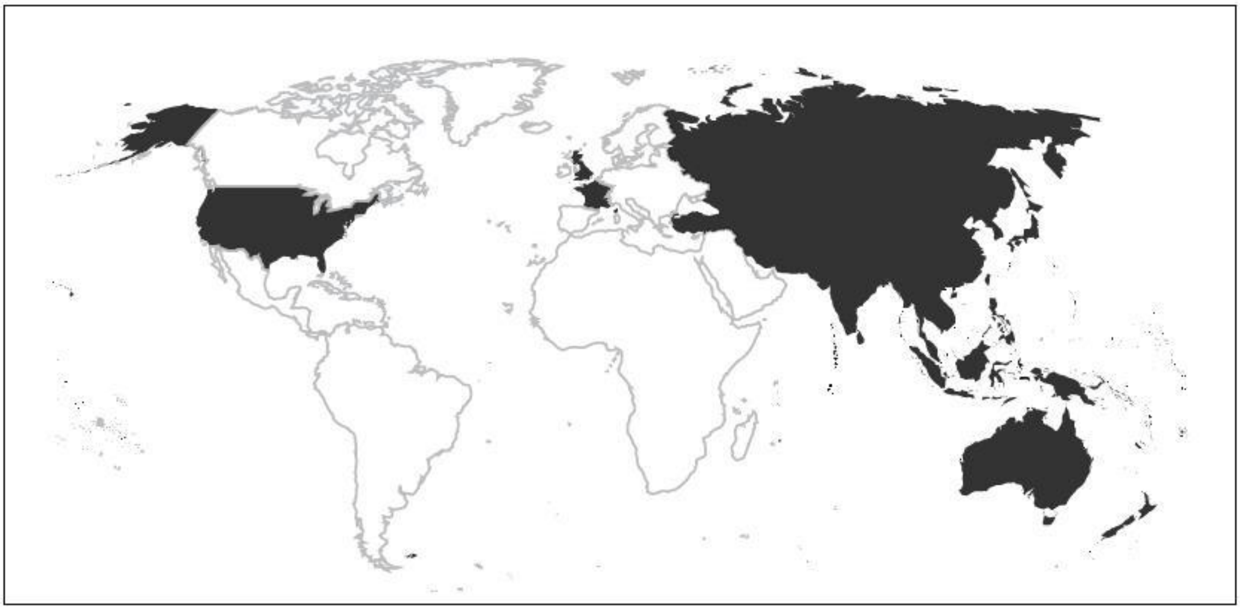

The shaded areas of the map indicate ESCAP members and associate members.

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Contents

1 Introduction

Asia-Pacific remains the region with the largest proportion of natural disasters in the world. The devastating earthquake in April 2015 in Nepal; the typhoons: *Pam* in April 2015 in Vanuatu, *Haiyan* in 2013, and *Pablo* in 2012 in the Philippines; the 2011 floods in Thailand; and the 2011 Tohoku earthquake and tsunami in Japan are some of the major disasters from the past few years. But in the period 2005-2014, the region had 1,625 reported disaster events—that is over 40 per cent of the global total.[1]

During this period, approximately 500,000 people lost their lives, around 1.4 billion people were affected, and there was USD 523 billion worth of economic damage—accounting for 60 per cent of global deaths, 80 per cent of those affected, and 45 per cent of economic losses.[2]

In 2014 alone, although there were no extreme catastrophes, the economic loss due to natural disasters was estimated at USD 60 billion, with around 80 million people affected by natural disasters, and over 6,000 fatalities.[3]

According to the World Economic and Social Survey,[5] the number of natural disasters increased five-fold between 1979 and 2010. Asia-Pacific's vulnerability to disasters is likely to increase with its large population size (4.4 billion) and high population densities in disaster prone areas. Around 60 per cent of Asia-Pacific city dwellers, 742 million people, are now at 'extreme' to 'high' disaster risk. By 2030, it is estimated that the number at 'high' or 'extreme' risk could reach 980 million.[6] Given the significance of Asia and the Pacific in the world's economy, major disasters in this region tend to have adverse global impacts.

1.1 Objective and Methodology

The objective of this paper is to identify innovative initiatives in the Asia-Pacific region that utilize information and communication technologies (ICTs) to enhance disaster risk management. After an overview of ICT in disaster risk management in section 2, the third section provides some examples of innovative ICT solutions used in hazard, vulnerability and risk assessment initiatives in the Asia-Pacific region. The focus and angle of analysis is on public-private partnerships (PPPs), e-resilience and community involvement.

The methodology used for developing the paper is largely secondary research of public information published in journals, publications, conference proceedings, and on the Internet. Information was also obtained by e-mail correspondence with some of the researchers and practitioners working in ICT and disaster risk management. As a result, information on initiatives that have not been published yet or

[1] United Nations Economic and Social Commission for Asia and the Pacific, *Asia-Pacific Disaster Report 2015: Disasters Without Borders – Regional Resilience for Sustainable Development* (Bangkok, 2016). Available from http://www.unescap.org/sites/default/files/APDR2015%20Full%20Report.pdf.
[2] Ibid.
[3] United Nations Economic and Social Commission for Asia and the Pacific, "Disasters in Asia and the Pacific: 2014 Year in Review". Available from http://www.unescap.org/sites/default/files/Year%20In%20Review_Final_FullVersion.pdf.
[5] United Nations, *World Economic and Social Survey 2011: The Great Green Technological Transformation* (New York, 2011).
[6] United Nations Economic and Social Commission for Asia and the Pacific, *Asia-Pacific Disaster Report 2015: Disasters Without Borders – Regional Resilience for Sustainable Development* (Bangkok, 2016). Available from http://www.unescap.org/sites/default/files/APDR2015%20Full%20Report.pdf.

shared publicly, including information from private organizations, may not have been included in this paper.

In order to identify information sources, a keyword search was undertaken using Internet search engines, library, scientific and open access journal catalogues, and social media. The keywords (along with their synonyms and conceptually-related terms) used include: Asia-Pacific, geographic information system (GIS), geospatial, satellite, disaster management, crisis mapping, disaster communication, crisis communication, technology, information and communication technology, ICT, application, social media, rescue robotics, drones, and unmanned aerial vehicle (UAV).

2 ICT in Disaster Risk Management

Science and technology can greatly contribute to disaster risk reduction as exemplified and presented in the series of Geo-information for Disaster Management (Gi4DM) annual conference proceedings since 2005,[8] and a number of other pertinent publications.[9]

ICTs in particular are able to provide more sophisticated disaster preparedness, response and recovery solutions. Rapid advances in imaging sensors and information technologies, for instance, offer the possibility to identify, map and analyse with unprecedented detail, the facts and figures before, during and after a disaster.

Social media, crowdsourcing and community sensing were extensively used for the first time in the immediate aftermath of the Haiti earthquake in 2010, and helped communities by giving them the tools to actively engage in the disaster risk management process.[14]

The range of ICT applications in disaster risk reduction can be aligned to the four phases in disaster risk management (areas with particularly high potential to benefit from the use of ICTs are highlighted in italics):

1. **Mitigation** – Minimizing the effects of disaster. Examples: building codes and zoning, *vulnerability analyses, public education.*
2. **Preparedness** – Planning how to respond. Examples: preparedness plans, *emergency exercises and training, early warning systems*.
3. **Response** – Efforts to minimize the hazards created by a disaster. Examples: search and rescue *(robotics), crisis mapping, information management*.
4. **Recovery** – Returning the community to normal state. Examples: temporary housing (*rapid prototyping technologies*), grants, medical care.

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[8] See http://www.gi4dm.net/.

[9] Joint Research Centre, *Science for Disaster Risk Reduction and Response JRC Thematic Report* (Luxembourg, European Commission Publications Office, 2014). Available from http://dx.publications.europa.eu/10.2788/65084; UNISDR, "Science is Used for Disaster Risk Reduction", 2015. Available from http://www.preventionweb.net/publications/view/42848; UNISDR, "Using Science for Disaster Risk Reduction", 2013. Available from http://www.unisdr.org/we/inform/publications/32609; UNOOSA, *Geoinformation for Disaster and Risk Management* (Copenhagen, Joint Board of Geospatial Information Societies, 2010); and Scott Madry, *Space Systems for Disaster Warning, Response, and Recovery*, SpringerBriefs in Space Development (New York, Springer, 2015). Available from http://link.springer.com/10.1007/978-1-4939-1513-2.

[14] Joint Research Centre, *Science for Disaster Risk Reduction and Response JRC Thematic Report* (Luxembourg, European Commission Publications Office, 2014). Available from http://dx.publications.europa.eu/10.2788/65084.

The main categories of ICT used in disaster risk management are as follows:

- **ICT infrastructure** – Applications and provisions to help realize the benefits of ICTs even in situations where the main communication infrastructure has been severely affected. Examples include: DistressNet,[15] TVWS initiative in the Philippines[16] to solve last-mile Internet connectivity issues, mobile ICT infrastructure units,[17] satellite communications.
- **Information management** – ICTs used to coordinate and direct the flow of information from a variety of sources to a number of end users such as decision makers, emergency responders, rescue staff, etc. These systems are by now well established and the most widely used form of ICT in disaster risk management. Examples include: Sahana,[18] a free and open source disaster risk management system that was developed in Sri Lanka in the aftermath of the Indian Ocean Tsunami in 2004 and is now widely used; Ushahidi,[20] an open-source crisis-mapping software; ESRI ArcGIS,[21] a general purpose, commercial, GIS platform to manage and analyse geospatial information; and Humanitarian ID,[22] a service provided by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) for centralized contact management available to everyone working in humanitarian crises and disasters.
- **Remote sensing and geospatial information[23]** – Space-based information derived from the analysis of satellite imagery has been one of the longest standing applications of ICT in disaster risk reduction, and is widely used in hazard and risk mapping.[24] Examples of its use include the assessment of tsunami risk in Indonesia,[25] and mapping of the impact of extreme floods on agriculture in Viet Nam.[26] Remote sensing and geospatial information is also used in the development of early warning systems, such as project NOAH[27] by the Department of

[15] Harsha Chenji, Wei Zhang, Radu Stoleru and Clint Arnett, “DistressNet: A Disaster Response System Providing Constant Availability Cloud-like Services”, *Ad Hoc Networks*, vol. 11, no. 8 (November 2013): pp.2440-60.
[16] Tam Noda, "Phl gov't, Microsoft partner to boost TV White Space tech", *Philstar.com*, 11 July 2013. Available from http://www.philstar.com/business/2013/07/11/964278/phl-govt-microsoft-partner-boost-tv-white-space-tech.
[17] Movable & Deployable ICT Resource Unit Project. Accessed 7 April 2015. Available from http://www.mdru.org/index.php/2-uncategorised/2-about-mdru.
[18] Sahana Software Foundation. Accessed 3 May 2015. Available from http://sahanafoundation.org/; and Khanh Ngo Duc, Tuong-Thuy Vu and Yifang Ban, “Ushahidi and Sahana Eden Open-Source Platforms to Assist Disaster Relief: Geospatial Components and Capabilities”, in *Geoinformation for Informed Decisions*, Alias Abdul Rahman, Pawel Boguslawski, François Anton, Mohamad Nor Said and Kamaludin Mohd Omar, eds. (Springer International Publishing, 2014). Available from http://link.springer.com/10.1007/978-3-319-03644-1_12.
[20] See http://www.ushahidi.com/.
[21] See http://www.esri.com/software/arcgis.
[22] See http://humanitarian.id/.
[23] Scott Madry, *Space Systems for Disaster Warning, Response, and Recovery*, SpringerBriefs in Space Development (New York, Springer, 2015). Available from http://link.springer.com/10.1007/978-1-4939-1513-2.
[24] Paul N. Conrad, *An Overview of Hazard Mapping in Cambodia: Current State and the Way Forward* (Phnom Penh, People in Need Cambodia, 2013). Available from http://www.preventionweb.net/publications/view/36110.
[25] G. Strunz and others, “Tsunami Risk Assessment in Indonesia”, *Natural Hazards and Earth System Science*, vol. 11, no. 1 (January 2011).
[26] Vu Ngoc Chau and others, “Using GIS to Map Impacts upon Agriculture from Extreme Floods in Vietnam”, *Applied Geography*, vol. 41 (July 2013): pp. 65-74.
[27] J. Tablazon and others, “Developing an Early Warning System for Storm Surge Inundation in the Philippines”, *Natural Hazards and Earth System Sciences Discussions*, vol. 2, no. 10 (October 2014): pp. 6241-70.

Science and Technology of the Philippines, whose lead scientist was recently honoured with Europe's premier geosciences union award.[28]

- **Analysis of crowdsourced and social media data** – Contributes to the creation of timely situational awareness in disaster response (for further details see section 3.1).
- **Robotics and rapid prototyping** – Robots and other (semi-) autonomous vehicles are mostly used during response for search and rescue missions. Whereas rapid prototyping technology (such as 3D printing and laser cutting) are also used in the recovery phase. 3D printing of spare parts and other urgently needed supplies locally can drastically ease logistical bottlenecks and is already becoming a reality.[31]

2.1 E-Resilience

A generally accepted definition of resilience includes the ability to withstand an external disturbance. Another definition of resilience is the ability to change in the face of an external disturbance; changing in a way that enables survival of the system.[32] Put differently, resilience is the systemic ability to withstand external shocks.

In their report, "Linking ICTs and Climate Change Adaptation: A Conceptual Framework for E-Resilience and E-adaptation,"[33] Ospina and Heeks identify the following sub-properties of resilience:

a. **Robustness** is the ability of the system to maintain its characteristics and performance under external disturbances.
b. **Scale** refers to the range of resources and structures a system can resort to in order to deal with disturbances.
c. **Redundancy** refers to the duplication of a system's functional architecture in order to increase reliability.
d. **Rapidity** refers to how quickly resources and critical infrastructure can be accessed and mobilized.
e. **Flexibility** refers to the degree of a system for change while at the same time being able to maintain its characteristics and functionality.
f. **Self-organization** is the ability of a system to change its structure and characteristics independently.
g. **Learning** refers to the capacity of a system to evolve and improve based on feedback gained from experience.

Reflecting upon these sub-properties in the light of ICTs sheds some light on the potential role of ICT for resilience (e-resilience):