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Using Space-based Applications and Information
Available through the
ESCAP-established Regional Cooperation Mechanisms
for Improving Disaster Risk Management

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Abbreviations

ADB	Asian Development Bank
ADPC	Asian Disaster Preparedness Center
ADRC	Asian Disaster Reduction Center
AIT	Asian Institute of Technology
UN-APCICT	United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development
APRSAF	Asia-Pacific Regional Space Agency Forum
APSCO	Asia-Pacific Space Cooperation Organization
ASEAN	Association of Southeast Asian Nations
BAKOSURTANAL	Badan Koordinasi Survei dan Pemetaan Nasional (National Coordinator for Survey and Mapping Agency, Indonesia)
CCD	Commissioner Central Division in Fiji
CNES	Centre national d'études spatiales
CNSA	China National Space Administration
CONAE	Comisión Nacional de Actividades Espaciales
CSA	Canadian Space Agency
CSSTEAP	Center for Space Science and Technology Education in Asia and the Pacific
DANs	data analysis nodes
DPNs	data provider nodes
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EMCI	Emergency Management Cook Islands
EO	Earth Observation
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAO	Food and Agriculture Organization of the United Nations
FGISC	Fiji Geospatial Information Support Centre
Geo-DRM	Geo-referenced information systems for Disaster Risk Management and Sustainable Development
GEOSS	Global Earth Observation System of Systems
GIS	Geographic Information Systems
GOS	Global Observing System
GSD	Geoscience Division
GVCs	Global Value Chains
ICI	Infrastructure Cook Islands
ICT	information and communications technology
DIMS	Nepal Disaster Information Management System
INPE	National Institute for Space Research
IPCC	Intergovernmental Panel on Climate Change
ISC	International Seismological Centre
ISRO	Indian Space Research Organisation
JAXA	Japan Aerospace Exploration Agency
KARI	Korea Aerospace Research Institute
LDCs	Least Developed Countries

LLDCs	Land-Locked Developing Countries
NDMO	National Disaster Management Office
NEMA	Mongolia National Emergency Management Authority
NOAA	National Oceanic and Atmospheric Administration
RESAP	Regional Space Applications Programme for Sustainable Development
Rio +20	United Nations Conference on Sustainable Development
SAARC	South Asian Association for Regional Cooperation
SAFE	Space Applications for Environment
SDGs	Sustainable Development Goals
SIDS	small island developing States
SPC	Secretariat of the Pacific Community
SSOPs	Synergized Standard Operating
TC	ESCAP/WMO Typhoon Committee
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNESCAP	United Nations Social and Economic Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management
UNISDR	United Nations Office for Disaster Risk Reduction
UNITAR	United Nations Institute for Training and Research
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
UNOOSA	United Nations Office for Outer Space Affairs
UNOSAT	United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme
UN-SPIDER	United Nations Platform for Space-based Information for Disaster Management and Emergency Response
USGS	United States Geological Survey
WCDRR	World Conference on Disaster Risk Reduction
WMO	World Meteorological Organization

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1. Introduction

The Asia-Pacific region is one of the most disaster-prone regions in the world. Natural disasters such as typhoons, floods, droughts and earthquakes have led to the loss of countless lives and property. Given the inter-regional nature of natural disasters, the Sendai Framework for Disaster Risk Reduction has highlighted the need for countries to work together. There is a need for increasing regional cooperation in Disaster Management. Space technology and GIS applications have been demonstrated to be effective tools in post-disaster relief and pre-disaster capacity building. As such, international cooperation in promoting regional space technology applications is a crucial task for countries to achieve sustainable development. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) has, over the past decades, promoted the regional exchange and capacity building in the effective use of these innovative technologies in disaster management. This report provides an overview on the various agreements on international cooperation in space technology applications for disaster management. This includes regional mechanisms specific to Asia-Pacific, many of which were led by ESCAP initiatives.

1.1 Impacts of natural disasters

The Asia-Pacific region has long been regarded as one of the most disaster prone in the world. The region is characterized by numerous active tectonic plate movements in South Asia, the Pacific and Indian Oceans, which has led to numerous devastating disaster events including the earthquakes in Afghanistan in October, 2015 and the Nepal Earthquakes in April and May, 2015. Many Asia-Pacific countries are exposed to various disaster events and their social-economic development are vulnerable to disaster impacts. Floods, tropical cyclones and droughts have led to severe economic and social impacts to many developing countries and have pushed back development progress (ESCAP, 2015b). The recent Cyclone Pam in Vanuatu has affected more than 60 per cent of the population, destroyed more than 17,000 houses and 95 per cent of the agriculture sector (ESCAP, 2015a). Nepal's devastating earthquakes in April 2015 has led to close to 9,000 casualties and more than 22,000 injuries. It has resulted in severe economic damage and pushed back the country's development progress. More than 2.5 per cent of Nepalese, around 700,000 people, were pushed into poverty due to impacts of the earthquake (ESCAP, 2015a).

In the past 45 years, more than 5000 disaster events have been recorded. Around 6 billion people were affected and required immediate assistance, this was over 85% of the global figure (ESCAP: 2015b). Total fatalities were more than half (56%) of the world total, representing more than 2 million people killed. Geophysical disasters including earthquakes and tsunamis accounted for the most deaths and hydrometeorological disasters such as droughts, floods and storms affected the most people. Looking at economic losses, in parallel with rapidly developing Asian economies, the damage of natural disasters has been steadily increasing. In the 1970s, disasters in Asia and the Pacific only accounted for around 28% of the global total. The same figure for the past decade is around 40% (ESCAP, 2015b). As countries in the region commit themselves to fostering economic growth, natural disasters pose a threat to this goal.

Natural disasters do not respect political boundaries. Large scale natural disasters are often trans-boundary in nature. Earthquakes occur along active fault lines and can affect all countries in its proximity. Many of the region's most populous cities such as Jakarta, Katmandu and Islamabad are situated in

seismic active areas and they are all at risk from earthquakes. Hydrometeorological disasters such as floods and tropical cyclones often hit multiple countries. Snowmelt and glacial lake outburst flood (GLOFs) in the high mountains has been a major cause of flooding events in countries near the Himalayan region including Bangladesh and Pakistan. Coastlines of ocean basins in Cambodia, China, Democratic People's Republic of Korea, Guam and Pacific island countries including Palau, Samoa and Cook Islands are constantly under the threat of tropical cyclones and typhoons.

Moreover, as regions engage in Global Value Chains (GVCs) and financial market developments, impacts of exogenous shocks in one country will likely ripple out to neighboring countries and trade partners. A prominent example of this is the Thailand floods of 2011, where Japanese companies with production plants situated in flood-affected areas experienced significant disruptions. Moreover, the supply of intermediate goods were adversely affected globally, with major automobile plants such as Toyota and Nissan having to suspend production because essential parts were not arriving on time (ESCAP, 2015a). Impacts of natural disasters need to be dealt with at a regional scale. Countries have an incentive to work together in the sharing of information, technology, skills and experience to provide timely and accurate. This not only helps assess exposure and vulnerability before disaster occurrence, but it can also offer rapid damage estimations and help with emergency relief.

Alongside the adoption of the Sustainable Development Goals (SDGs), which highlights the need for poverty eradication and sustainable economic growth, the recent Sendai Framework for Disaster Risk Reduction (SFDRR), outlined in the 3rd United Nations World Conference on Disaster Risk Reduction (WCDRR), has emphasized the need for regional cooperation and information exchange. More specifically, the framework outlined that “transboundary cooperation remains pivotal in supporting the efforts of member States as well as communities and businesses to reduce disaster risk”. To achieve this goal, one of the priorities is to boost efforts to understand disaster risk and strengthen disaster risk management. The same goals were highlighted in the recent United Nations Conference on Sustainable Development (Rio +20) in 2012, which set the agenda for SDGs. The role of space technology applications to this goal is pivotal. Countries are encouraged to promote real-time access to reliable data including GIS, remote sensing tools, climate observation infrastructure and information and communication technology (ICT) innovations. They are also requested to engage in international cooperation in technology transfer, in the goal of regional sharing of data and information relevant to disaster management.

At the moment, there are still significant hurdles in capacity building and information sharing among developing countries. In many countries the necessary technology infrastructure, personnel training and technical know-how are lacking. The main goal of ESCAP is to act as a regional platform for countries, organizations and research centers to come together and share information, technology innovations and experiences. ESCAP is actively involved in the development of regional, intergovernmental capacity building programmes, with the aim of fostering technical development, good-practices and evidence-based policymaking. This includes both those formed in Asia-Pacific and global partnerships that works in the Asia-Pacific region. These cooperative agreements have had unique development paths and lessons can be drawn from each of their experiences.

1.2 Opportunities for space applications in DRM

Geo-spatial and space-based applications have numerous applications in disaster risk reduction, disaster relief and reconstruction. There are numerous tools used to provide location-based data through geo-referenced information systems. A good geo-reference tool for disaster risk management captures the hazard, vulnerability and exposure characteristics (ESCAP, 2014b). Therefore, full utilization of these tools will involve combining socioeconomic data in identifying high risk areas and important sectors.

The main space technology tool for remote sensing are Earth Observation (EO) satellites. EO satellites are satellites designed for observing earth information from orbit. They have a wide variety of uses, including environmental monitoring, meteorology and map making. At the moment, there are more than 40 nations that with EO satellites, more than 100 satellites are in operation at any given time around the world (CEOS and ESA, 2015). These satellites carry a variety of sensors that enable a diverse range of measurements from space. Compared to traditional disaster monitoring methods, EO satellites have several advantages:

- The infrastructure (the satellite) is less vulnerable to natural disasters. This makes it a robust and stable candidate in providing accurate and timely data even in times of catastrophic disasters.
- Recent innovations in EO technology means that EO satellites have the capacity to collect information on a variety of scales, from regional, national to the district level. Users can collect detailed information of specific areas.
- Landscape inaccessible or hazardous to monitor or collect data on the ground can be sensed from space, greatly lowering the risk and cost involved in collecting comprehensive data for DRR.

In a pre-disaster context, EO satellites are useful tools in early warning and risk identification. The satellites can help track a range of hydrometeorological disasters such as tropical cyclones, droughts and floods. Moreover, information such as land cover, social-economic data, hazard damage and risky areas can all be extracted from satellite data. They help in identifying critical infrastructure, transport networks and vital public service facilities. Looking at their distribution and structural characteristics, analysis can be made on their resilience and this is factored in to formulate the risk a region faces. This is crucial in highlighting vulnerable clusters and allocating resources for disaster risk reduction (DRR) among different regions.

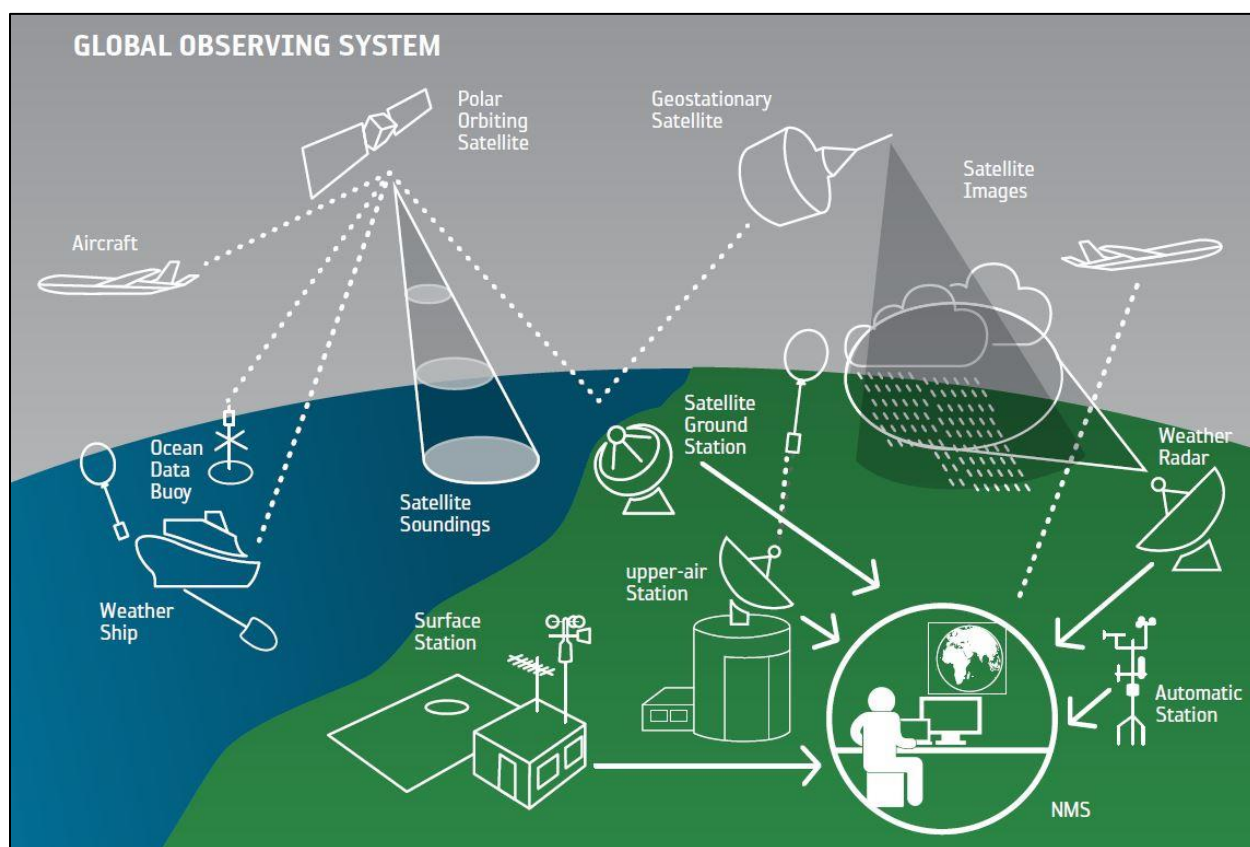
Over the years, the use of geospatial information has been highly valuable to Asia-Pacific countries. They were highly valued in humanitarian responses after earthquakes and floods. Also, it proved to be helpful in urban planning because it can show land use distribution and classification alongside disaster risks (ESCAP, 2015a). There is increased demand for higher resolution and smaller scaled maps for detailed depictions. Moreover, increased frequency in updates of geospatial information is requested by many users of such information (ibid.)

One application of this technology is in assessing drought risks. Many of the ecological factors of drought occurrences can be measured using satellites. For example, satellites can provide indicators on rainfall patterns through measuring temperature and sea levels. Also, groundwater, an important determination on the vulnerability to drought and vegetation stress, can be monitored by satellites. When groundwater level

falls, it indicates that the land restorative capacity is lower and that there is a higher risk of prolonged drought.

Another use of the EO satellites is monitoring and warning of extreme events. Satellites operated by the world's space and meteorological agencies contribute to the Global Observing System (GOS), which provides meteorological and environmental observations to warn about extreme weather events. The satellites gather data that cannot be acquired using terrestrial methods. It allows more accurate and fast warning of extreme weather events including hurricanes, typhoons, cyclones and tornados. From Figure 1, specific weather satellites, with unique data gathering capacities, collect data from land and sea and feeds relevant information to the user through communication networks. This, combined with ground level infrastructure, can help provide a comprehensive picture of current weather conditions and potential risks.

Figure 1 - The Global Observing System



Source: CEOS and ESA, 2015

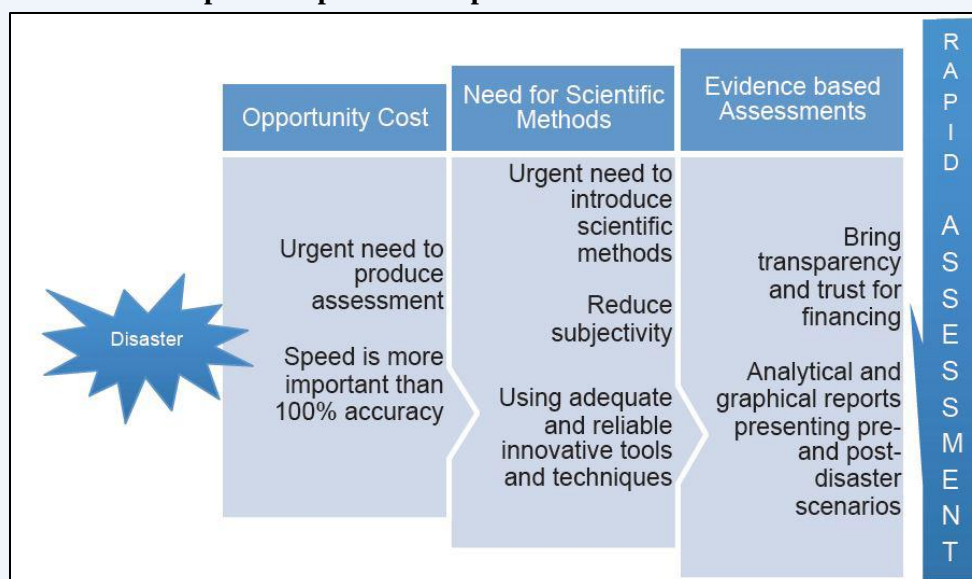
In disaster response and recovery, EO satellites can provide timely and accurate satellite information. This is useful for rapid damage assessments on the localities, severity and also the emergence of new risks. One example of this is the rapid assessment tools used by SAARC countries (Box 1). It can help identify safe and unsafe areas, prioritize infrastructure repair, direct resources to those most in need and help in recovery planning. In disaster recovery, EO satellites can provide systematic monitoring of progress. Examples of this include using high-resolution images to assess the recovery of infrastructure after major storms or earthquakes. Collecting this information regularly will provide a timeline for recovery. This can

help in decision making in the allocation of recovery resources. The International Charter on Space and Major Disasters, a partnership of space agencies that provides rapid satellite tasking and immediate response in time of disasters, is an example of how satellite technology is recognized and utilized internationally and adopted for disaster response (more on this in section 3). Given the transboundary nature of natural disasters, no single country can have all the data necessary for impact analysis and recovery information. It is important for countries to engage in regional platforms to share knowledge and experience on utilizing these tools.

Box 1: Rapid Assessment for Resilient Recovery

The Rapid Assessment for Resilient Recover is a PDNA tool. It supports The South Asia recovery framework, set up by The SAARC Disaster Management Centre. The rapid assessment takes into account the damage and losses for key sectors such as housing and infrastructure and agriculture, with disaster risk reduction as a cross cutting sector.

Graphical depiction of rapid assessment considerations



ESCAP and SAARC Disaster Management Centre are jointly developing a step-by-step guide on conducting rapid damage assessments for the selected sectors using space technology and geospatial modelling, crowdsourcing and other web-based technology. The manual was pilot tested following the PDNA for the 2015 Nepal earthquakes and the methodology was reviewed by experts.

The manual aims to make post-disaster assessments more timely and evidence-based. It can also help users monitor recovery processes. It is targeted at managers and practitioners from government agencies that are responsible for post-disaster relief, response, recovery and reconstruction.

Source: ESCAP, 2015a

Various organizations exist to make use of space technology tools in disaster management. In addition to ESCAP's regional cooperation mechanism, Table 1 provides a brief description of a number of current operating initiatives in Asia-Pacific and the global platform. Many of them focus on specific high exposure regions including Pacific Island Countries. Their work involves providing timely information on disaster occurrence, disaster risk management capacity building, initiating pilot projects and advancing information sharing and data acquisition tools.

Table 1 - List of international/regional initiatives working on space applications for DRM

Name	Main work and notable achievements
United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)	A gateway to space information for disaster management support to connect disaster management, risk management and space communities. It is also a facilitator of capacity-building and institutional strengthening, in particular for developing countries.
United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)	Provide a platform for coordination and dialogue to promote common practices of geospatial data and services. The goal is to strengthen national capacity on utilizing geospatial data as well as sharing best practices and experiences on national, regional and international levels
Global Earth Observation System of Systems (GEOSS)	Providing decision-support tools to link together existing and planned observing systems globally. The 'GEOSS Portal' offers a single Internet access point for users seeking data, imagery and analytical software. It connects users to existing databases and portals. For users with limited or no access to the Internet, similar information is available via the 'GEONETCast' network of telecommunication satellites. GEO holds Asia-Pacific Symposiums regularly. The most recent one, "Towards the Next Decade of GEOSS in the Asia-Pacific Region", was held in Beijing, China. It aims to further strengthen networking and experience sharing between members. Disaster monitoring using GEO data was among one of the focus areas.
The International Seismological Centre (ISC)	Collects, archives and processes seismic station and network bulletins and provides summary reports on world seismicity. The main result is the ISC Bulletin, which is a record of the earth's seismicity collected from over 130 agencies worldwide
The Pacific Tsunami Warning Centre	Tsunami early warning systems, operated by the National Oceanic and Atmospheric Administration (NOAA) from the U.S. Department of Commerce
Asian Disaster Preparedness	Deploys information and systems to reduce local, national and

Center (ADPC)	regional disaster risks. It focuses on DRM capacity building, improving DRM systems, climate change adaptation, mainstreaming DRM into national and local development and undertaking disaster risk assessments
Asia-Pacific Regional Space Agency Forum (APRSAF)	Enhance space activities in the Asia-Pacific Region. It has supported the establishment of numerous international projects including Sentinel Asia, Space Applications for Environment (SAFE) and Climate R3: Regional Readiness Review for Key Climate Missions
Secretariat of the Pacific Community (SPC) Geoscience Division (GSD)	Promote the application of geoscience technology to realize new opportunities and address challenges in Pacific island economies. This is done through providing technical support in geoscience development, water and sanitation and disaster reduction programmes to members
Asia Disaster Reduction Centre (ADRC)	Focus on enhancing disaster resilience to build safe communities and promote sustainable development. This is done through promoting cooperation in organizing key capacity building programmes, regional cooperation initiatives and development planning guidelines

2. ESCAP-established regional cooperation mechanisms and initiatives on space technology applications

ESCAP acts as the regional arm of the United Nations, its uniqueness lies in its role in providing a multilateral platform for sharing knowledge, engaging in policy dialogue, building consensus and the effective use of innovative tools towards sustainable and resilient development in the region. It is the only UN regional Commission that applies space technology applications to address the challenges of building resilience in multi-dimensional ways. The uniqueness of ESCAP lies in 5 main tasks:

First, ESCAP is the major player in the Asia-Pacific region in fostering regional cooperation and information exchange. For example, ESCAP holds biennial committee meetings, attended by member countries, on future development plans on DRR. The recent meeting, held in October 2015 in Bangkok, Thailand, not only provided a platform for countries to exchange their views on national disaster-related development, but also gave ESCAP the opportunity to decide on its focus of work in the future. The exchange of information and dialogues can help focus efforts efficiently and address key gaps in DRR.

Second, ESCAP offers a coordination role in regional cooperation mechanisms. Examples of this include RESAP, the Regional Drought Mechanism and Geo-DRM. Countries use ESCAP to situate themselves

within various cooperative frameworks. This way the division of work among countries has been clearly defined and the benefits of working together are greatly enhanced.

Third, ESCAP is actively engaged in capacity building and training in innovative technologies in DRR. Recent training programmes in space technologies has helped numerous disaster-prone countries such as Bangladesh, Mongolia, Sri Lanka and Vanuatu develop essential technical skills in acquiring remote sensing data and analyzing GIS products. This will be extremely useful in disaster prevention, risk assessment and post-disaster response and recovery.

Forth, ESCAP is uniquely situated as a regional hub. Countries use ESCAP as a platform for national policy makers to decide on global standards and goals. It can represent countries in voicing regional concerns, requests and policy directions.

Fifth, ESCAP is a multidisciplinary organization with work ranging from environmental conservation to macroeconomic development. This gives it the unique advantage of integrating expertise from many fields in its DRR planning and development. The recent Asia-Pacific Disaster Report 2015 itself has involved reviews and comments from trade, transport, economic development and environment sectors. With such diverse interdisciplinary cooperation member countries can better develop comprehensive strategies which incorporate all sectors.

ESCAP is well positioned as a regional hub for harnessing and sharing latest advances in technologies, especially space technology and GIS applications, to address and support disaster risk identification, early warning, response, and post-disaster damage and loss assessment. This section will highlight some of the major work of ESCAP, in recent years, in promoting space technology applications for disaster risk reduction, while coordinating existing global and regional initiatives, programmes and resources.

2.1 Regional Space Application Programme for Sustainable Development (RESAP)

From the resolutions 68/5 and 69/11, applications of space technology and GIS need to be highlighted. In the Rio+20 outcome document, the importance of information and communications technologies in the areas of space and GIS applications were further reiterated. This reflects the importance placed on comprehensive disaster risk assessments and the sharing of this knowledge and information, including reliable geo-referenced information and the early warning systems. In light of this development direction, ESCAP has taken steps to address the challenges of building resilience in multi-dimensional ways. Through the Regional Space Applications Program for Sustainable Development (RESAP), ESCAP is promoting the application of space technology and GIS for supporting disaster risk reduction and inclusive and sustainable development.

RESAP was launched in 1994 during the Ministerial Conference on Space Applications for Development in Asia and the Pacific. Its goal is to enhance regional coordination and cooperation through the promotion of effective applications of space technology for sustainable development in the Asia-Pacific region. The programme aims to assist developing countries and other members to integrate space technology applications into sustainable development planning. The mandate of RESAP includes the following:

- Promote and coordinate regional space cooperation for development
- Organize and implement space application projects of regional interest
- Provide policies, models, techniques, information and analysis
- Conduct studies related to various issues on space applications
- Establish regional networks comprising of national focal points and working groups in major space technology application fields
- Promote national capacity-building for space applications

There are currently 25 member countries under the RESAP framework. The structure of RESAP consists of an intergovernmental consultative committee, which is the decision-making body of RESAP. As of 2015, the member countries of the committee are as follows: Australia, Azerbaijan, Bangladesh, Bhutan, China, Fiji, Hong Kong, China, India, Indonesia, The Islamic Republic of Iran, Japan, Macau, China, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, The Republic of Korea, Russian Federation, Singapore, Sri Lanka, Thailand, Vanuatu, Viet Nam. The training network of RESAP consists of various institutions from the member countries, including the BAKOSURTANAL (National Coordinator for Survey and Mapping Agency, Indonesia, Indonesia), Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) in India and academic institutions in China. The three countries form a corporative network, where a “critical mass” of professionals can be made available to use the latest technologies in support of sustainable development and to provide consultancy in technical aspects of policymaking.

Since its inception, ESCAP has been working closely to promote the use of GIS tools in both DRR and disaster response. At the onset of emergency disaster events, ESCAP member States can request support in geo-spatial information. RESAP responds through mobilizing satellite derived products and services through its network of space agencies. This include scenes of near real-time and archived satellite imagery as well as damage maps, provided by RESAP members and ESCAP’s strategic partners such as UNITAR/UNOSAT. Over the past years, more than 300 satellite images and damage maps have been mobilized for the purposes of disaster early warning, preparedness, response, relief and damage assessment.

In 2012, Typhoons Haikui and Bopha hit the Philippines. ESCAP coordinated with RESAP members as well as its strategic partners, including UNITAR/UNOSAT, UN-SPIDER, International Charter Space and Major Disaster and Sentinel Asia to contribute to near real-time satellite imagery and products to the Philippines and the Association of Southeast Asian Nations (ASEAN). Several other countries have also benefited from similar products and services during disasters. In 2013, cyclones, severe rain and floods hit Bangladesh, Myanmar, China and Pakistan. In many incidents, ESCAP, together with other strategic partners, mobilized near real-time satellites to provide images through the RESAP network of space agencies. These efforts have resulted in the timely provision of more than 150 scenes of near real-time and archived satellite imagery, which were provided by China, India, Japan, Thailand and other RESAP members, as well as UNOSAT. After the super typhoon Haiyan hit the Philippines in 2013, 19 scenes from the remote sensing satellite RISAT-1 and high resolution images from Cartosat earth observation satellites were provided. This aided disaster response and damage assessment.

In 2015, RESAP mobilized 150 satellite images in total. They were provided free of charge by RESAP members and UNOSAT, and had an estimated monetary value of more than \$600,000 (ESCAP, 2015a), a significant amount for many developing countries that face devastation from natural disasters. In the aftermath of the Nepal earthquakes and Cyclone Pam in Vanuatu, RESAP was the platform for providing a number of near real-time imagery from China, India and Viet Nam. Satellites were mobilized to provide scenes before and after the occurrence of the earthquake. In Vanuatu, immediately after the impacts of Cyclone Pam, satellite imagery was provided to support disaster response.

In addition to disaster response, RESAP's capacity-building programmes, especially in high-risk developing countries that lack technical capacity, benefitted numerous policymakers in more than 20 member States. The goal is to address technical gaps and emerging challenges in integrating space technologies and GIS for disaster risk management. Over the years, ESCAP has conducted a series of workshops and specialized training sessions, which benefitted numerous policy makers and professionals in the region. Most of these capacity-building activities were conducted through the nodes of RESAP training networks at the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) in Dehradun, India, the National Coordination Agency for Surveys and Mapping in Indonesia and training partners at the Chinese University of Hong Kong, China. These programmes are delivered in close collaboration with other organizations, including UNITAR/UNOSAT; secretariat of the United Nations Convention to Combat Desertification (UNCCD); UN-SPIDER; Applied Geoscience and Technology Division of the Secretariat of the Pacific Community; Pacific Islands Telecommunications Association; Geo-Informatics Center of the Asian Institute of Technology; International Water Management Institute; and with technical and financial support from China, India, Indonesia, Japan and the Republic of Korea.

2.2 Regional Plan of Action for Space and GIS Applications for DRR and Sustainable Development (2012-2017)

The Asia-Pacific Regional Plan of Action for Applications of Space Technology and GIS for DRR and Sustainable Development 2012-2017 is a result of the ESCAP resolution 69/11 agreed upon in 2013. The resolution recognizes the contributions space technology and GIS to DRR and sustainable development in the Asia-Pacific region. It further calls on the support of member States to continuously support and implement space application programmes, projects and capacity-building initiatives.

In particular, the resolution recognized ESCAP's role in supporting developing countries in building capacity to harness space and GIS applications. It has highlighted that regional cooperation in space applications can play a critical role in strengthening cross boarder linkage in DRR, response and recovery, plus long term development planning. Currently, space technology applications are still under-utilized because of a lack of capacity in developing countries in terms of human, scientific, technological, organizational and institutional resources. This makes regional cooperation essential in sharing expertise and technical exchange. ESCAP was requested to enhance efforts of national and regional level and deepen the contribution of space technology applications in addressing disaster management issues. The practical and operational use of space applications and GIS should be made accessible, cost-efficient and reliable.

In the context of disaster risk reduction and management, the Regional Plan of Action has outlined a number of actions to be carried out at the regional, sub-regional, and national levels. At the regional and sub-regional levels, the resolution highlighted that linkages and networks among relevant initiatives should be enhanced and harmonized. Such initiatives include the United Nations Institute for Training and Research (UNITAR), its Operational Satellite Applications Programme (UNOSAT), The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) and the United Nations Global Geospatial Information Management (UN-GGIM). They provide earth observation information and support satellite communication capabilities to foster disaster-related information exchange.

Furthermore, ESCAP was tasked by member States to promote existing regional initiatives in the Asia-Pacific region, including the Regional Space Applications Programme for Sustainable Development (RESAP), the International Charter on Space and Major Disasters, Sentinel Asia, Asia-Pacific Regional Space Agency Forum. The widening and deepening of these regional cooperative mechanisms, especially for developing countries, is highlighted. ESCAP was also requested to strengthen regional platforms for expertise sharing, capacity building, improving country access for space-derived information including earth observation products and services and establishing and maintaining regional early warning systems of multiple hazards.

The current Regional Plan of Action places emphasis on regional information exchange, capacity building and development of good practices. Regional information sharing platforms, including the Asia-Pacific Gateway for Disaster Risk Reduction and Management and Sentinel Asia, should be promoted and enhanced in its operational capacity and accessibility to member countries. Services such as disaster monitoring, hazard zoning, risk assessment and mapping and early warning systems need to be shared and developed regionally. Moreover, capacity building activities should be given high priority, especially in the context of high-risk and low capacity developing countries. This not only includes current, existing regional initiatives, but it should also bring together relevant United Nations agencies and institutions, sub-regional organizations, expert groups and non-governmental organizations, such as Asia and the Pacific Training Center for Information and Communication Technology for Development (APCICT), the WMO and the South Asian Association for Regional Cooperation (SAARC) Disaster Management Center. The platforms organized by ESCAP should enable countries to share information, develop good practices and build regional resilience to natural disasters.

Following the resolution 69/11, the United Nations General Assembly's Committee on the Peaceful Uses of Outer Space, in its 57th session, has further highlighted ESCAP's role in regional cooperation of applying space technology in DRR and sustainable development. The committee recognized the benefit of space technology in acquiring disaster data for rapid impact analysis and long term risk reduction, for developing countries in particular. The role as a provider of capacity building programmes for policymakers was encouraged and ESCAP was requested to continue its efforts in streamlining the effective use of space technologies among countries in the region.

2.3 Regional Cooperative Mechanism for Drought Monitoring and Early Warning

Drought is an insidious disaster. If left unchecked, it can lead to severe hindrance to development gains and people's livelihoods. Compared to other natural disasters, drought gets relatively less attention from policymakers even though it has serious long-term socioeconomic implications. Owing to its slow and gradual onset and its unique forms of manifestation in Asia-Pacific (for example, droughts can occur during severe winters and even during monsoons), droughts are generally not well understood and inadequate attention is given by policymakers (ESCAP, 2015a). The 4th Assessment Report of Working Group I of the Intergovernmental Panel on Climate Change (IPCC) has highlighted that the area of land affected by drought events since the 1970s have increased significantly. This has led to increased risk in livelihoods of millions of people, many of them of rural population, who depend directly on fertile land as a source of livelihoods. In many regions in Asia-Pacific, the frequency, severity and duration of droughts will likely increase due to changes in climatic conditions, and it is therefore critical and urgent for countries to place stronger emphasis on drought response and preparedness mechanisms. This includes advancing space technologies for better drought monitoring and early warning through strengthened regional cooperation among drought-prone countries.

Over the past 45 years, around 150 drought events have affected more than 1.62 million people, caused economic damage of more than US\$ 53 billion (in 2005 prices) and killed around 5,700 (ESCAP, 2015b). In some cases, severe drought has had devastating effects on vulnerable groups and natural resources. Water availability, an important aspect of agriculture sustainability, can be seriously hindered by prolonged drought events. Droughts can also lead to long-term environmental degradation and biodiversity loss. Combinations of droughts with human activities lead to desertification of vulnerable arid, semiarid and dry sub-humid areas, resulting in soil degradation. It is important to analyze the impacts of drought as an inter-related system of land degradation, desertification, deterioration of ecosystems, agriculture loss and negative impacts to socioeconomic development.

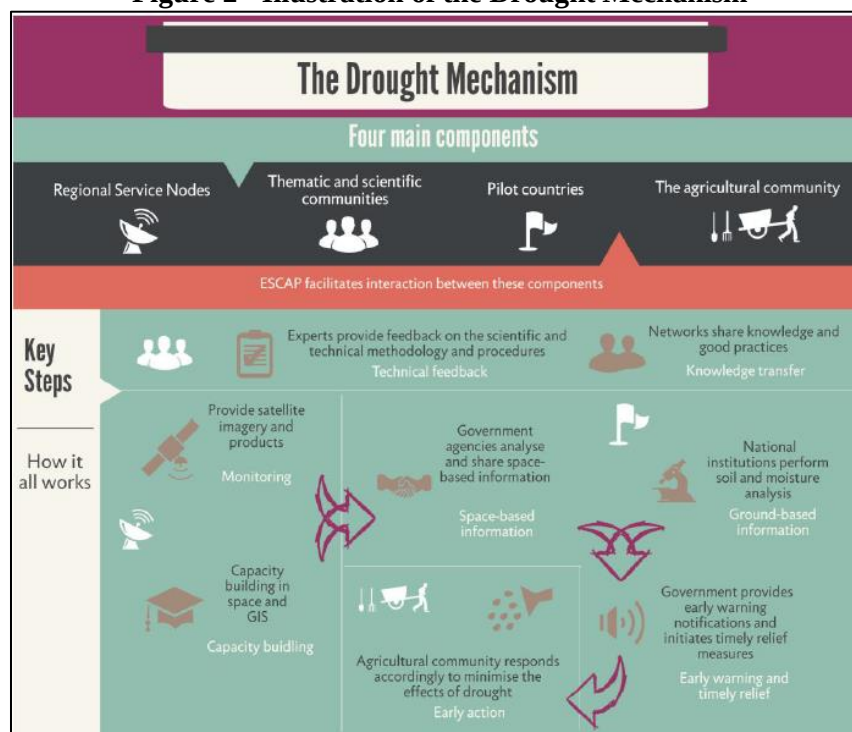
Drought events are widespread and trans-boundary. Effective management of drought requires the commitment of long term action plans between countries. Regional cooperative mechanisms can assist stakeholders, particularly local and national governments, to better understand and manage drought risks in coverage, severity and intensity.

Currently, many countries lack the technical capacity in accessing and analyzing data for drought monitoring and prediction; there is also a lack of consistent methodology in combining remote sensing data with on-the-ground information, such as land and soil status, geographic characteristics and seasonal patterns. Moreover, there are little coordination among agencies and institutions at the national level. At the regional level, very few regional mechanisms exist to share knowledge and good practices for developing countries. Countries in the region face challenges in drought monitoring and early warning. They include (1) a lack of technical skill in accessing and analyzing critical information; (2) effective methodology in combining space application products with ground-based information; (3) regional platforms for sharing knowledge and good practices; and (4) coordination among agencies and institutions at the national level.

In light of the need to address drought in Asia-Pacific, ESCAP launched the Regional Cooperative Mechanism for Disaster Monitoring and Early Warning. The Mechanism mobilizes regional resources in space technology and GIS applications to improve national capacities in analyzing space and in-season

ground data and information. Countries with no space programmes are able to, through regional cooperation, get access to space-based data, products and services. It is consisted of 4 main components (depicted graphically in **Error! Reference source not found.**):

Figure 2 - Illustration of the Drought Mechanism



Source: ESCAP, 2014e

- **Regional service nodes:** satellite imagery and services as well as capacity development are provided to pilot countries by national remote sensing centers from other countries in the region. At present, these services are provided by China and India.
- **Thematic and scientific communities:** diverse groups networked together under common thematic areas to advice on drought monitoring, preparedness and appropriate action.
- **Pilot countries:** drought-prone countries selected upon request to participate as beneficiaries of cutting-edge science and technology to better prepare for drought.
- **The agricultural community:** direct beneficiaries on the ground who can directly reduce the impacts of drought based on sound knowledge and timely warning information from the government.

At the moment, the drought mechanism is supported by regional service nodes to provide space-based products and offer capacity building programmes for developing countries. Currently, seven countries: Afghanistan, Cambodia, Kyrgyzstan, Mongolia, Myanmar, Nepal and Sri Lanka have requested to join the Mechanism's pilot programme. Satellite products and services are provided by China and India's remote sensing centers - National Remote Sensing Centre of China and the National Remote Sensing Centre of the Indian Space Research Organization. Participating pilot countries can benefit from enhanced

access to space-based data, products and services. Experts from ESCAP and the service nodes work with national implementation teams of member countries to determine specific drought conditions, gaps and needs individual countries. They will also help with institutional capacity building and construct appropriate climatic, social-economic models to better assess and predict drought occurrences and environmental and agricultural impacts.

The advantage of the drought mechanism is that in-season monitoring can offer free and timely access to space-derived information to participating countries. They will receive training on capacity building, national coordination mechanisms and policy recommendations through regional cooperation and strategic partnerships. Government authorities and agriculture communities, the groups most likely affected by drought events, will be able to make evidence-based decisions on preparing and responding to droughts. This can strengthen mechanisms such as better water management, adjustable crop cycles, drought resistant crop types and timely relief measures.

Since 2014, various regional forums, workshops, institutional capacity building trainings and interagency briefings have been organized through the Regional Drought Mechanism's regional service nodes. Pilot countries and other drought-prone countries shared their own experiences in tackling drought. Countries also drew up work plans, endorsed the contributions of service nodes and built strategic partnerships with key organizations in the field of agriculture, irrigation and drought monitoring. ESCAP is currently in discussions with various initiatives, including the Group on Earth Observations Global Agricultural Monitoring Initiative and Asia-RiCE, on opportunities of extending drought monitoring to crop monitoring.

Pilot programmes in Sri Lanka and Mongolia have made good progress. In February 2014, technical advisory services and customized training programmes were provided to personnel in Sri Lanka and a roadmap for implementation was developed. ESCAP and the National Remote Sensing Centre of the Indian Space Research Organization in Hyderabad, India organized training sessions for experts from key local ministries on the effective use of data for drought monitoring. In February 2015, an additional one-week training course was held in Sri Lanka in February 2015 on the installation and implementation of the drought monitoring system developed by the two regional service nodes.

In Mongolia, experts from the two service nodes trained staff from the National Remote Sensing Centre of Mongolia. Topics included how to compile and analyze space derived data and how to develop and assess indices appropriate for Mongolia. In addition, a drought monitoring system is now operational in the National Remote Sensing Centre of Mongolia. Mongolia developed drought maps using new methodologies and validating them in the central part of the country vulnerable to severe droughts.

Currently, the experiences of pilot countries and other drought-plagued areas in Asia-Pacific has highlighted various areas for strengthening and improvement, they include:

1. Increased capacity building and training in the use of Earth Observation data products in the context of drought monitoring and early warning

2. There is currently a lack of access to more real-time and in-season satellite imagery and data with medium to high resolution. These resources can be used by international organizations and government departments to better respond to drought
3. More training and access to new and more advanced spatial and statistical analysis software applications (i.e. ArcGIS and other open source software) for drought monitoring and early warning was also deemed important
4. Local level agencies need support in the implementation of mechanisms in information and data sharing for reliable drought monitoring and early warning
5. Assistance is needed in developing methodologies (using Earth Observation and remote sensing data) that is applicable to national and sub-national levels to better understand drought-related factors
6. Technical assistance is needed for some countries in building a common Geo-portal in conjunction with other existing portals
7. There is need in developing support mechanisms by local institutions to ensure data accuracy of ground level information and data
8. Assistance is needed in promoting regional cooperation in carrying out forecasts and prediction intra-seasonal variability of rainfall

Results of pilot projects have reflected the role of ESCAP in helping countries develop strategic partnerships and regional platforms for countries to participate. High risk countries see the value in using geo-spatial technologies in alleviating negative impacts of severe drought. The Regional Drought Mechanism has proved to be an important tool to achieve improved drought prediction and monitoring through capacity building and encouraging country level exchange of good-practices. Future success in implementation would rely on the support and commitment of members and various organizations.

2.4 Geo-referenced Information Systems for DRM (Geo-DRM)

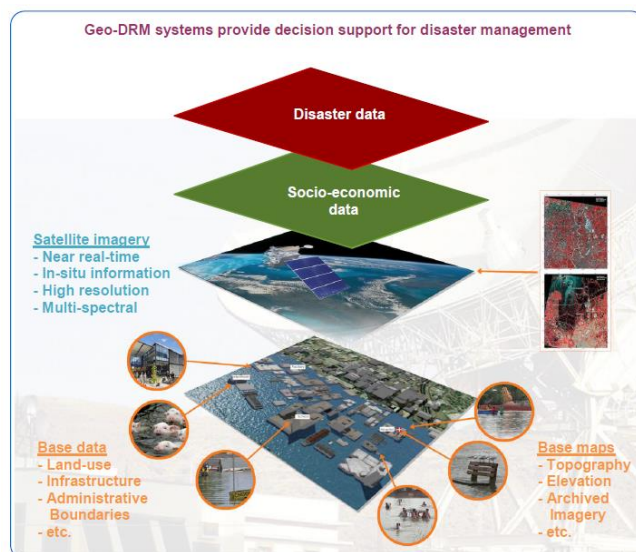
The effectiveness of disaster risk reduction and disaster response depends greatly on the efficiency of information management. During disasters, authorities need up-to-date geospatial information to make appropriate decisions quickly. Moreover, given the transboundary nature of many natural disasters, impacts are rarely confined within one country. Very often affected countries within a region need to share disaster impact information with each other to make accurate assessments on needs and response measures. Insufficient information exchange between key decision makers can severely slow down the rescue and response process. It is essential that mechanisms exist to integrate a variety of relevant data and distributes this information, at a regional scale, through service providers.

While geospatial data through satellite imagery and on-the-ground field data are often not difficult to obtain, these data are seldom looked at in congruence because they often come in different formats. Moreover, while developed countries have well established institutions to collect and process geo-referenced data, high risk developing countries are lacking in capacity to obtain consistent and standardized information. This is a particular pressing issue in Asia-Pacific's Least Developed Countries (LDCs), Land-locked Developing Countries (LLDCs) and small island developing States (SIDS). It can be a major bottleneck in the efforts towards effective disaster management at a regional level and requires the cooperation among both developed and developing nations.

Since 2012, ESCAP has embarked on a project: “Improving disaster risk preparedness in the ESCAP region”. The project aims to strengthen, at a regional level, government capacities for the implementation of disaster preparedness and timely response. The project targets up to 30 ESCAP member countries including LDCs, LLDCs, SIDS and other disaster-prone/high risk developing countries. The target group includes senior level policy and decision makers as well as the middle level/professional staff in those countries who have responsibility or are involved in managing disaster risk. The expected accomplishments are to help governments set up a geo-referenced information platform for DRR and to establish a regional community of countries, to share good practices and geospatial data infrastructure for disaster risk identification, preparedness and analysis.

One of the main outcomes of the project was the development of Geo-DRM portals. Geo-DRM portals provide tools for evidence-based policymaking. While many governments have accumulated data on demographic, economic, geographic, and disaster exposure features of their country, these data are often scattered and it is difficult to obtain a comprehensive picture of disaster vulnerability or potential damages. Geo-DRM portals combine socioeconomic data with satellite imagery to provide a multi-disciplinary context to the disaster-affected or disaster-prone areas. Geo-referenced information is layered with different indicators to provide a holistic image of the region concerned, including information important for disaster risk management (as depicted in Figure 3). It has the capacity to not only analyze complex situations, but also the flexibility to customize information for multiple purposes. The combined picture is presented in one platform, and can be made available at any stage of the disaster cycle for rapid review of the situation. Moreover, because geo-reference information and demographic data can be made available through the internet, multi-layered information can be distributed quickly. This allows many layers of the image to be integrated and shared for decision makers quickly, accurately and be comprehensive enough to provide evidence-based policy recommendations.

Figure 3 - Illustration of the Geo-DRM framework



Typically, the Geo-DRM aims to ensure the below information be available and can be combined quickly for purposes of DRR, disaster response and damage estimation:

- Geospatial data such as maps, satellite data, aerial photographs
- Socioeconomic data and statistical information
- Disaster data
- Metadata-for easy search and browsing
- Base data such as base maps
- Query framework for simple information retrieval
- Report function to develop information products such as maps, tables and charts

Geo-DRM portals should be positioned within national policymaking bodies to be able to provide centralized, credible information and be adequately financed. The developments of these portals need to be accompanied by improvements in information sharing across different government sectors, to ensure that appropriate information can be transmitted during times of need. ESCAP has been promoting the use of Geo-DRM since 2012. Pilot schemes, which focused mainly on countries with special needs, were introduced in Bangladesh, the Cook Islands, Fiji, Kyrgyzstan, Mongolia and Nepal. The projects were based on not only country efforts, but also collaborations from many countries and international organizations in the region. The aim is to build institutional capacity in utilizing space and GIS technologies. It established Geo-DRM portals and a platform for GIS experts and disaster management professionals from across the region to share good practices. Results have been largely positive. Other member countries including Afghanistan, Bhutan, Cambodia, Kiribati, Lao People's Democratic Republic, the Maldives and Myanmar have also expressed interest in developing their own Geo-DRM portal. Table 2 provides a description of the status of pilot countries with regard to their Geo-DRM portal.

Table 2 - Experiences of Geo-DRM pilot countries

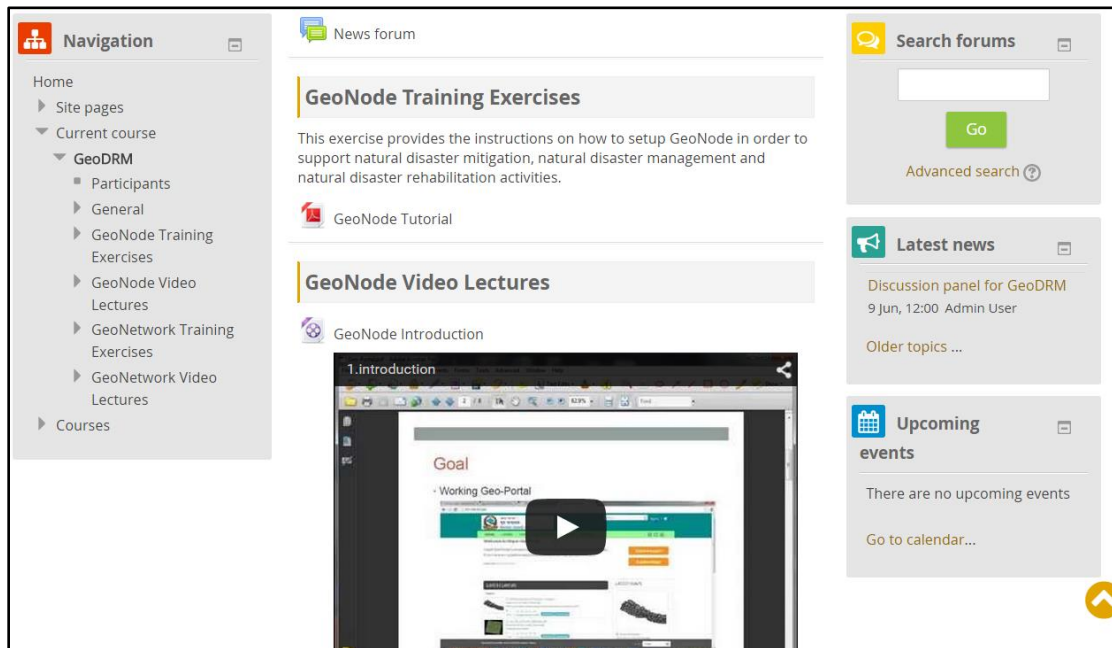
Country	Experiences
Bangladesh	Bangladesh has strong institutional framework and structure in using space information for DRM. Currently, geospatial database exists for the calculation of operational data. At the moment, there are opportunities in further applying satellite imagery in disaster response, and to use space information to strengthen early warning on floods and cyclones.
Cook Islands	The Cook Islands has now successfully formed a GIS taskforce consisting of GIS experts from other ministries. The portal was launched since 2014, and it was established by the partnership between the Emergency Management Cook Islands (EMCI) and Infrastructure Cook Islands (ICI).
Fiji	Until 2014, Geo-portals were installed in three agencies: The National Disaster Management Office (NDMO), Commissioner Central Division (CCD) and the Fiji Geospatial Information Support Centre (FGISC). There are currently a lack of knowledge in metadata, technical skills in the use and analysis of remote sensing data, and the sharing of GIS information. ESCAP was encouraged to provide more

	technical assistance and training in relevant tools.
Kyrgyzstan	Geo-DRM networks are still being developed and available data is being used internally within the Ministry of Emergency Situations and Crisis Management. Experts from the Ministry of Emergency Situations have noted the usefulness of new technologies in emergency response, public awareness and reducing disaster risks. Currently there is a database platform for disaster risk management in Kyrgyzstan based on the software Geo-Node.
Mongolia	Mongolia has established their geo-DRM portal, through the support of ESCAP, at the National Emergency Management Authority (NEMA) and has created layers using natural disaster information. It is using the portal for mapping fodder resources, groundwater, land use, ecosystems, provincial borders, forests, soil information, grasslands and special protected areas. Mongolia is currently utilizing natural and man-made disaster data and will connect the portal to the emergency operation and early warning center of NEMA. The Mongolian government is also implementing a project with the South Korean Communications provider KT, on a Disaster Early Warning System which will disseminate warning messages to the public automatically through TV, FM radio, siren towers and cellular phones.
Nepal	Nepal has formally launched the Disaster Information Management System (DIMS) and it is being hosted and managed by the Ministry of Home Affairs. It was highlighted that there is a need for a comprehensive national database and a unified system of up-to-date information for pre and post disaster situations and its dissemination. Currently a data management geo-portal has been established to encourage the creation and sharing of disaster related data. Stakeholders are using the system are continually uploading disaster related data.

Source: Compiled by ESCAP using country responses in various group meetings

In addition to pilot programmes, ESCAP also helped in undertaking a number of activities in providing a regional platform for the exchange of experiences and knowledge in Geo-DRM portals. In ESCAP organized expert group meetings, countries such as Indonesia and the Philippines, with existing Geo-DRM portals, showcased good practices and experiences with other member States. Non-pilot county member States also expressed interest in developing their own Geo-DRM portals. Bhutan, Myanmar and Maldives, in the recent expert group meeting in 2014, has presented plans to set up the infrastructure and train necessary personnel to prepare for Geo-DRM set up. Lao People's Democratic Republic has also noted that ESCAP can play an important role in assisting and improving countries' capacities in related issues. These include expert group meetings, regional workshops and technical training sessions. Since mid-2012, ESCAP has organized more than 14 specialized training for more than 380 policymakers, officials, planners, professionals, researchers and project managers. Bangladesh, Cook Islands, Fiji, Kyrgyzstan, Mongolia and Nepal had established the national Geo-DRM portal. The goals are mainly to enhance national capacity to utilize Geo-DRM portals in responding to and mitigating disaster risks. Training and sharing of good practices are provided by successful cases and experts.

Figure 4 - Screenshot of a course in the Geo-DRM e-learning platform



Source: <http://137.189.162.178/course/view.php?id=6>

As a further effort to provide technical assistance and support the utilization of space technology and GIS applications, and also under the implementation of the resolution 69/11 at the regional level, ESCAP has developed an e-learning platform on GIS and space applications technology. The aim is to support easy and unlimited access to space technology information and GIS applications and to improve the cost efficiency of distributing these programmes. The platform includes expert forum discussions, courses on specific topics and guide on rapid deployment of technical assistance in the aftermath of disasters. At the moment, a few key courses are available in the platform, which includes (1) Introduction to space technology and GIS applications; (2) Design of Geo-referenced Information Systems (Geo-DRM); (3) Spatial and Non-spatial Data Management and (4) Application of Good Practices. A screenshot of the platform is shown in Figure 4.

Since the set-up of Geo-DRM portals, countries have mostly responded positively on the effectiveness in sharing and improving information for DRR. ESCAP's role as a regional sharing platform and a provider of training and capacity building programmes area also highly appreciated. At the moment, among pilot counties, there is a high demand for technical assistance and training, especially for GIS systems and understanding geo-referenced data at the local level. Some countries have highlighted issues encountered in the creation and use of information systems, including costly software, compatibility issues, lack of high-resolution satellite imagery and the need for qualified personnel. A further issue is the reluctance for some countries to share data. Also, data among different countries are seldom in a consistent format, and that the transfer of information, especially in times of emergency, can be hindered if the receiving country have trouble accessing the data format of the provider.

The future role of ESCAP in Geo-DRM seems to be focused on regional good-practice sharing and capacity building. Training and capacity building is a continuous process and current training sessions are often for short periods and can only give a brief overview of geo-spatial technology in DRR. More in-depth, long-term capacity development to consolidate knowledge and experience is needed. Also, Geo-DRM needs are different for different countries, and there is a demand to customize specific portals to countries' needs. Currently, customization can be achieved through access to virtual servers in Hong Kong, China and Bangkok. There are also numerous training courses available for using Geo-DRM portals in a more in-depth way. However, ESCAP's role, as requested by member countries, is to act as a regional platform for countries to issue specific requests in terms of training requirements. ESCAP is committed to organizing training, awareness building and technical support programmes with member countries and also other relevant organizations including SOPAC for the Pacific region, AIT for the South-East Asia region and CSSTEP, India, for South Asia sub-region.

3. Other regional and international cooperative mechanisms

In addition to ESCAP-led mechanisms, numerous international initiatives exist in the field of promoting the use of space technology in disaster management. This report will focus on The Typhoon Committee, The Disaster Charter and JAXA Sentinel Asia, three mechanisms that have been active in the Asia-Pacific region and have close relationships with ESCAP and other UN agencies.

3.1 The Typhoon Committee

The ESCAP/WMO Typhoon Committee (TC) is an intergovernmental body organized under the joint efforts of ESCAP and the World Meteorological Organization (WMO). Currently, there are 14 member countries from across the world, namely Cambodia; China; Democratic People's Republic of Korea; Hong Kong, China; Japan; Lao People's Democratic Republic; Macao, China; Malaysia; the Philippines; Republic of Korea; Singapore; Thailand; Viet Nam and the United States of America. The aim of the committee is to promote and coordinate the planning and implementation of measures required for minimizing the loss of life and material damage caused by typhoons in Asia and the Pacific.

The TC has been set up since 1964 at the 20th session of the Economics Commission for Asia and the Far East, the UN regional commission and what is now ESCAP, alongside the World Meteorological Organization (WMO). This was a response to the need to develop a regional platform for the study of typhoons and to improve existing meteorological observation networks, information and communication facilities, forecasting and warning systems. Moreover, the group also looked at hydrological disaster management measures including flood prevention, response, monitoring and prediction systems for regions along key river basins.

Currently, the main work of the Typhoon Committee is to regularly review progress made in various fields in typhoon damage prevention. It advises governments on plans and measures to strengthen meteorological and hydrological facilities, community preparedness of disaster response and risk reduction. It is also responsible for the establishment of programmes and facilities to build technical capacity in the fields of typhoon forecasting and warning, hydrology and flood control. Moreover, the

committee facilitates research programmes and activities concerning typhoon knowledge. It can provide financial support to countries in need through organizations including the United Nations Development Program (UNDP).

Member countries hold annual sessions to discuss progress made and the current status of various programmes. They also draw up work programmes and long term development plans based on countries' development priorities and needs. In the most recent Strategic Plan 2012-2016, the Typhoon Committee identified 7 "Key Results Areas" for special emphasis (ESCAP/WMO, 2012). One of them is to enhance the Typhoon Committee's effectiveness, efficiency and international collaboration. In addition, the recent joint session of the Typhoon Committee and the WMO/ESCAP Panel of Tropical Cyclones (PTC) has led to concerted efforts in collaboration to share knowledge, reviewing advances in science and technology, and identifying gaps at the regional level. TC and PTC member countries have agreed to a set of measures in fostering regional cooperation, including joint projects, information sharing and sharing satellite products. This was done with the special aim of assisting least developed countries at high risk of hydrometeorological disasters.

In addition to information sharing, the TC also facilitates capacity building training sessions to enhance regional technical capacity in adopting disaster-related technologies. One example of this is the Training Workshop on Synergized Standard Operating Procedures (SSOPs) for Coastal Multi-Hazards Early Warning Systems, which was held in China in 2014 (ESCAP, 2015c). The programme was attended by 33 participants from 12 countries including policymakers, disaster management personnel and media professionals. The aim was to recommend a system of Standard Operating Procedures for the use of early warning systems for natural disasters. Moreover, numerous training seminars and research fellowships are planned for the coming years, with the goal to boost country capacity in using advanced space technology in forecasting and assessing hydrometeorological disasters.

3.2 The Disaster Charter

The International Charter on Space and Major Disasters aims to provide a unified system of space data acquisition and delivery to countries affected by disasters through Authorized Users (AUs). The goal is to use fast and reliable data to help reduce the effects of disasters on human life and property. It is currently the main global mechanism for countries to access EO satellite data rapidly during a disaster. The Charter has 15 member organizations and can provide rapid access to a range of data sources (Table 3). It focuses on disasters with fast onset, and collects data specific on disaster impacts in times of immediate needs.

Table 3 - Disaster charter member organizations

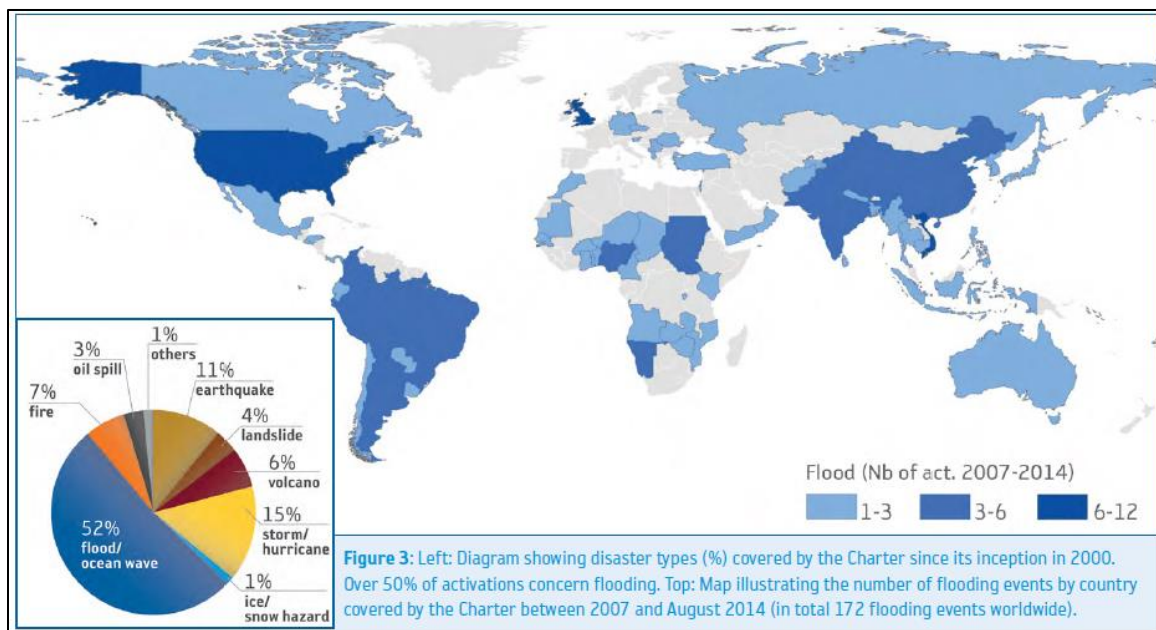
Member organizations	Space resources
European Space Agency (ESA)	ERS, ENVISAT, Sentinel-1A
Centre national d'études spatiales (CNES)	SPOT, Pléiades, Formosat
Canadian Space Agency (CSA)	RADARSAT
Indian Space Research Organisation (ISRO)	IRS
National Oceanic and Atmospheric Administration (NOAA)	POES, GOES

Argentina's Comisión Nacional de Actividades Espaciales (CONAE)	SAC-C
Japan Aerospace Exploration Agency (JAXA)	ALOS
United States Geological Survey (USGS)	Landsat, Quickbird, GeoEye-1
UK Space Agency & DMC International Imaging (DMCii)	UK-DMC, ALSAT-1, NigeriaSat, BILSAT-1
China National Space Administration (CNSA)	FY, SJ, ZY satellite series
German Aerospace Center (DLR)	TerraSAR-X, TanDEM-X
Korea Aerospace Research Institute (KARI)	KOMPSAT-2
National Institute For Space Research (INPE)	CBERS
European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)	Meteosat and Metop satellite series
The Russian Federal Space Agency (Roscosmos)	RESURS-DK1, RESURS-P, METEOR-M No1, KANOPUS-V

Source: <https://www.disasterscharter.org/web/guest/charter-members>

The charter uses radar and optical satellites operated by the 15 member organizations. The satellite sensors can be functional in a variety of weather conditions. It is also adapted in flood impact estimation. Optical satellites are used for damage mapping, which uses medium resolution imagery to create a depiction of overall effects. It can also take high to very high resolution images to depict infrastructure damage, such as destruction of road networks or individual buildings. These tools can create maps and geocoded image overlays that show affected areas, damaged infrastructure, hotspots of high response needs and other geographical characteristics that are specific to different disaster types.

Figure 5 - Distribution of disasters that required Charter activation



Source: CEOS and ESA, 2015

The international charter is frequently used for climate related disasters including floods and storms. Referring to Figure 5, hydrometeorological disasters represent more than 70 per cent of all charter activations with around 20 per cent are from geophysical disasters. At the moment, only a predefined list of AUs can activate the disaster charter. They are usually disaster management agencies of member countries.

Over the years, the disaster charter has been expanding its user base through cooperation with the United Nations Office for Outer Space Affairs (UNOOSA), the United Nations Institute for Training and Research (UNITAR) and the United Nations Operational Satellite Applications Programme (UNOSAT). Since 2012, the charter adopted the principle of Universal Access, granting national disaster management authorities AU access. This has benefitted many countries which, previously, did not have the institutional capacity or infrastructure to pursue space applications for disaster management. It also gave the Charter access to a much wider global network of specialists and users to develop capacity and can potentially benefit much more people. The Charter is currently working closely with UN organizations and countries to improve awareness on the benefits of space technology in DRR.

Today, the disaster charter acts as a regional platform for countries with urgent needs to obtain disaster response data. In 2015, flooding events in Bangladesh, Myanmar and Viet Nam have all led to requests for satellite images to assess flood levels in different districts and the water level of nearby rivers. This not only helped in disaster response efforts, but also provided better analysis on the degree of impacts and affected regions. The platform can make it much quicker and cost-effective for countries to gain access to space technology applications, especially in times of national emergencies.

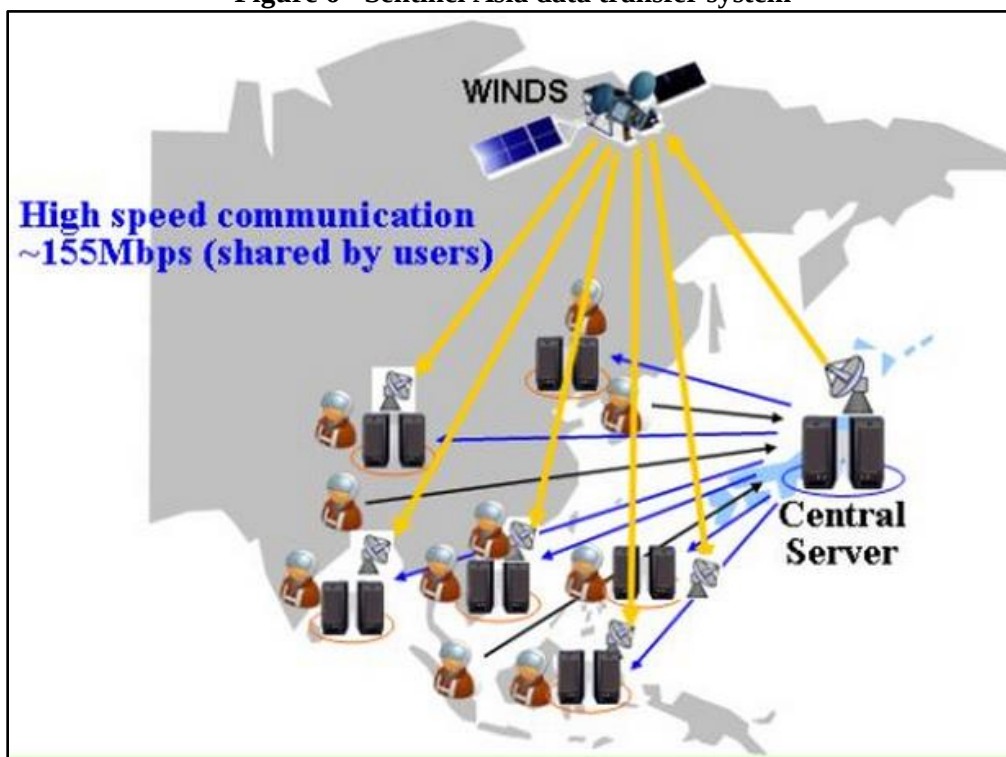
3.3 Sentinel Asia

Sentinel Asia is a voluntary-based initiative led by the Asia-Pacific Regional Space Agency Forum (APRSAF) to support disaster management activity in the Asia-Pacific region through applying Web-GIS technology and space based technology for disaster management. The Japan Aerospace Exploration Agency (JAXA)'s Sentinel Asia, over the internet, shares information collected from EO satellites and other space technology tools. The Sentinel Asia initiative brings together regional space agencies and disaster risk management authorities for humanitarian purposes. The aim is to mitigate and prevent damage caused by natural disasters including typhoons, floods, earthquakes, tsunamis, volcano eruptions and wildfires. Its main activities include:¹

- Emergency utilization of EO satellites in case of major disasters
- Acceptance of satellite data requests from countries in the Asia-Pacific region
- Wildfire monitoring, flood monitoring and GLOF monitoring
- Satellite image and data utilization capacity building programmes for disaster management

¹ Source: https://sentinel.tksc.jaxa.jp/sentinel2/MB_HTML/About/About.htm

Figure 6 - Sentinel Asia data transfer system



Source: https://sentinel.tksc.jaxa.jp/sentinel2/MB_HTML/About/About.htm

Currently, Sentinel Asia has 15 international organizations and 83 participating national level organizations from 25 countries as members.² This includes organizations actively involved in space technology and disaster risk reduction such as UNESCAP, World Bank, the Asian Development Bank (ADB) and the Asian Disaster Preparedness Center (ADPC) and spacefaring nations including Australia, China, Japan and India. It provides a number of main satellite data products, which includes information and data on satellite imagery, on-site images, wildfire hotspots, rainfall (short term and long term), meteorological satellite imagery. As illustrated in Figure 6, data is transferred from the central servers (located in Japan) to local servers through both the internet and the communication satellite WINDS. WINDS is particularly useful when there is a need to transfer large files, which can be difficult and time consuming via the internet.

Sentinel Asia is also intended as a regional enhancement to the International Charter, as any country in the region can join the Sentinel Asia network and request, through Sentinel Asia, disaster related satellite information from the International Charter. The group promotes cooperation among the space community, the disaster management community, member countries and international organizations. Sentinel Asia's Joint Project Team is available to all APRASF participants. It acts as a platform for countries and organizations to contribute their experiences and technical capacities in disaster-related issues.

In times of disasters, Sentinel Asia's "data provider nodes (DPNs)", which consists of several regional space agencies and related institutions, provide satellite data for analysis and processing in the "data

² Source: https://sentinel.tksc.jaxa.jp/sentinel2/MB_HTML/JPTMember/JPTMember.htm

analysis nodes (DANs)". This makes it easier for end-users to obtain comprehensible geo-spatial information in the form of images and data sets. Such near real-time "disaster information products" can be an extremely useful asset for the coordination of disaster response efforts. At the moment, the primary DAN for collecting and analyzing raw satellite data is the Asian Institute of Technology (AIT) in Thailand.

Sentinel Asia is actively involved in promoting regional capacity building in using space technologies for DRR. Since 2007, the group has initiated operation training sessions for Sentinel Asia Systems. Moreover, Sentinel Asia has, in collaboration with AIT, organized activities called "Mini Projects", aimed at providing first-hand experiences to participating agencies in satellite data handling, modeling and validation. It is hoped that organizations will not only learn to independently handle satellite data, but also gain skills in using relevant software and GIS tools. In 2013, mini-projects were held in Bangladesh, Myanmar, the Philippines and Sri Lanka. The activity is expected to be expanded to many countries in the Asia-Pacific region in the future.

4. Policy recommendations

Since the adoption of the SDGs and SFDRR, the world community has been given an updated set of priorities in the pursuit of DRR and sustainable development. DRR requires a wide range of information and data. They are used by various stakeholders not only to assess risk, but also to make appropriate investments and strategize on future development plans. ESCAP's 2015 Asia Pacific Disaster Report has highlighted key information requirements for different stakeholders. This information is essential for the achievement of SFDRR priorities in understanding disaster risk, strengthening risk governance, effective investments in resilience and enhancing disaster preparedness for response. They also play an important role in achieving SDGs, especially in goal 1 (End poverty in all its forms everywhere), goal 11 (Making human settlements inclusive, safe, resilient and sustainable) and goal 13 (Taking urgent action to combat climate change and its impacts). Table 4 lists these information needs.

Table 4 - Information needs of different stakeholders

Stakeholder	Purpose	Information
General public	General information on risks over large areas	Basic Web GIS application on which they can overlay the location of major hazard types with high-resolution imagery or topographic maps
	Community-based DRR projects	Simple maps of neighborhood with risk class, buildings, evacuation routes, and other features
Businesses	Investment policies and location planning	General information about hazards and risks in both graphical and map format
Technical staff of (local) authorities	Land use regulation / zoning	Maps and simple legends in three classes: construction restricted, construction allowed, further investigation required
	Building codes	Maps indicating the type of buildings allowed (building type, number of floors)
	Spatial planning	Hazard maps, with simple legends related to probabilities and

		possible consequences
	Environmental Impact Assessment	Maps and possible loss figures for future scenarios
	Disaster preparedness	Real time simple and concise Web based information in both maps and graphical forms
Decision makers / local authorities	Decision-making on DRR measures	Statistical information, loss exceedance curves, F-N curves, maps
	Investments	Economic losses, projected economic losses for future scenarios
	environmental assessment	General statistical information for administrative units
NGOs	Promote sustainable development	This can vary from simple maps to web-based applications, depending on the objectives
Scientists / technical staff of hazard data producers	Hazard information exchange to public and other agencies	WebGIS applications where they can access the basic information
	Exchange of basic information for hazard and risk assessment	Spatial data infrastructure / clearing house for exchanging information
Insurance Industry	Development of insurance policies	Loss exceedance curves of economic losses
Media	Risk communication	Animations of hazard phenomena that clearly illustrate the problem

Source: ESCAP, 2015a

As reflected by ESCAP's Asia-Pacific Disaster Report 2015, many disasters are transboundary in nature and require the strong resilience of not a single country but the entire region to ameliorate its impacts effectively. Moreover, given the increased regional economic connectedness, trade and production activities are seldom carried out at the national level alone. Natural disasters can lead to shocks not only in the affected country, but also economic activities in neighboring countries. It is through regional capacity building can economies become truly resilient to natural disasters. Providing accurate and timely information for preparedness and response needs to be done on a regional level. Adopting innovative technologies, including space applications and remote sensing, are important tools in enabling this. There is a genuine incentive for countries with strong space technology institutions to participate in helping developing countries build capacities in this field.

Developed countries such as Australia, Japan and Republic of Korea have made significant progress in integrating space technology into policy planning. They have reaped the benefits of the vast quantities of data and analytical products. However, for many developing countries, especially LDCs and SIDS that have high disaster exposures. Budgetary constraints and lack of technical personnel have made them lag behind in this field. As a result, valuable resources for addressing disaster risks were not made accessible to them. There is a need to foster international cooperation in collaborated efforts to reduce disaster risk. It is to every country's interest that space technology be developed and efficiently utilized at the regional scale.

Over the years, there have been significant efforts by the international community in setting up global platforms and data exchange networks in the field of space technology for DRR. ESCAP is no exception. Since the inception of the 5-year plan on space applications for DRR, ESCAP has established and participated in numerous international cooperation and capacity building programmes alongside other UN organizations and member States. These programmes were designed in the hope that member States in the region can actively participate in knowledge exchange and have the regional platform to explain their unique needs in terms of innovative technologies. Through fostering communication between countries in the region, developing countries can have a better understanding on best practices of innovative technological adoptions and developed economies can have the opportunity to share and expand their expertise overseas, not only in the name of regional aid and technical support but also new business opportunities and long-term regional sustainable development endeavors.

No country can withstand the impacts of natural disasters alone. Regional cooperation is essential for the Asia-Pacific to build resilience and achieve sustainable development. ESCAP, as the regional platform for member countries in the Asia-Pacific region, stands as a unique institution to promote activities, programmes and tools for countries to exchange experience and knowledge, and to work together to address the growing threats natural disasters pose to sustainable development.

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