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Sound practices in space technology applications for disaster risk reduction and inclusive and sustainable development

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1. INTRODUCTION

Asia-Pacific is the most disaster-prone region of the world. In recent years, it has faced a series of multiple exogenous shocks that transcend geographical boundaries and endanger our communities. The poor and the vulnerable are the ones most affected. Despite the rapid economic growth in the region, many developing countries are increasingly vulnerable to disasters, and the magnitude and frequency of extreme disasters are estimated to rise due to the effects of climate change. This necessitates building resilience of the region to extreme disasters in multi-dimensional ways.

Over the past few decades, Space technology and Geographic Information Systems (GIS) applications have become indispensible part of the modern information society. As disasters become more and more frequent and intense, the demand for these technologies is increasing in order to save lives, to minimize economic losses and to build resilience of the Asia-Pacific region. It is imperative that the policymakers and decision makers make concerted efforts to widen and deepen the use of space technology and GIS applications in the Asia-Pacific region to mitigate the effect of disasters.

1.1. Importance of space and GIS applications

Space technology and GIS applications play a crucial role in mitigation of disasters. Space-based technologies such as Earth observation satellites, communication satellites, meteorological satellites and global navigation satellite systems (GNSS) have played an important role in risk reduction and disaster management. They are key tools for comprehensive hazard and risk assessments, response, relief and disaster impact assessment. Space-derived and in-situ geographic information and geospatial data are extremely useful during times of emergency response and reconstruction, especially after the occurrence of major events such as earthquakes or floods (UN OOSA, 2013). In the case of large urban areas with a high population density, the use of these technologies can provide crucial information such as number of damaged buildings, affected populations and hazardous sites that can trigger secondary disasters. GIS are also utilized for urban planning, development and management of infrastructure and civil services. There is an urgent need to promote the applications of such technology by urban planners, engineers, and decision makers to innovate and improve resilience of the urban environment (UNISDR, 2013). Remote sensing, GIS and allied disciplines can be used in many areas such as:

- Assessment of crop area extent
- Management of water resources
- Yield assessment studies
- Land suitability assessment for agriculture
- Disaster Management
- Precision agriculture
- Urban Planning

Space based information and products are effectively being used for early warning and monitoring of slow onset disasters as well as rapid onset disasters. In case of certain hazard such as floods and droughts, for example, the MODIS Aqua and Terra products are available free of charge and can

be used to improve the monitoring and forecasting services. Applications of space technology and GIS can thus, provide accurate warnings of impending disasters, help map out hazards and vulnerabilities for evidence based policymaking and planning and help in disaster impact assessments for effective disaster risk management at the regional, sub-regional and national levels. Innovative technologies, especially space technology and GIS, play important roles among policymakers and decision makers to apply their knowledge and experience in building resilience to disasters. These applications can thus be effectively used in all stages of disaster management: preparedness, mitigation, response, relief and recovery.

1.2. Use of space based information for disaster risk reduction and sustainable development

The outcome document of the United Nations Nations Conference on Sustainable Development, entitled "The future we want",[1] and the United Nations system report on the post-2015 development agenda entitled "Realizing the Future We Want for All", clearly recognized that the use of space technology and GIS applications can contribute significantly to disaster risk reduction and management.

In recent times, Earth Observation data has played a key role in integrating climate change adaptation (CCA) and disaster risk reduction (DRR) through resilient land use planning in key sectors of development such as agriculture, water, environment, and energy among others. The convergence between DRR and CCA processes has been observed in certain types of projects that need to be recognized for scaling-up and replications in the region, especially through regional cooperation (Lal, et al. 2011). These are: Integrated Coastal Zone Management, Watershed Development Programme, Land Use Planning in areas sensitive to climate and disaster risks, River-basin Floodplain Management and Integrated Drought Mitigation. It is important to highlight that Earth Observation (EO) information products form the essential components to realize such projects.

The Hyogo Framework for Action 2005-2015, calls for the integration of disaster risk reduction into sustainable development policies and planning. Use of space technology, GIS and geospatial data could assist countries in achieving progress under the Hyogo Framework for Action. All disaster risk management interventions start from updated hazard, vulnerability and risk assessments, which are the products derived from space applications. These products are the key inputs for implementing resilient land use planning as well as integrating disaster risk reduction and climate change adaptation in key development sectors.

1.3. Current status

The Asia-Pacific region has made significant progress in the area of space technology and GIS applications. There are numerous earth observation satellite resources and GIS data resources that can be used in the Asia and the Pacific region. Comprehensive observation satellites, including multispectral, hyperspectral and radar satellites with high spatial resolution and high temporal resolution, are available from the satellites of China, India, Japan, Republic of Korea, Russian Federation, Thailand, Vietnam and other countries in the region. There are many good practices, lessons and experiences in the use of space technology and GIS applications that can be shared among the countries in the Asia-Pacific region.

However, most Asia-Pacific countries especially the LDCs, LLDCs and SIDS, do not currently have their own space technology for disaster risk reduction and sustainable development, although there is an increased level of awareness among these countries about the potential benefit from the use of these technologies. The countries that do not have space assets and institutional capacity can benefit greatly from

1 General Assembly resolution 66/288, annex.

existing regional/international cooperation for capacity building and technology transfer, such as the free remote sensing data. These data, upon the analysis, can be used for hazard zonation, vulnerability and risk assessment for resilient development planning.

1.4. Challenges

Despite several efforts, harnessing the potential of space technology and GIS applications for Disaster Risk Reduction and Management (DRR/M) continues to be hindered in many developing countries, particularly in countries with special needs (CSNs) in the Asia-Pacific region. Space technology and GIS applications continue to be underutilized primarily because of the lack of capacity in developing countries in terms of human, scientific, technological, organizational and institutional resources; lack of access to high resolution data, low expertise for the operational applications of these technical tools, lack of sharing of such data and lack of appropriate policies.

Institutional challenges: Many developing countries and least developed countries in the Asia-Pacific region do not have the institutional capacity for the effective application of space-based products. Moreover, the different ministries and departments often work in silos with no proper coordination or data sharing mechanisms in place. Steps should be taken to ensure the sharing and use of geospatial information within Ministries/Departments. National Spatial Data Infrastructure (NSDI) needs to be promoted to enable the data sharing more effectively. Countries such as India, China, Japan, Republic of Korea, Thailand and Malaysia, already have well established NSDI and other countries such as Philippines, Indonesia, Iran and Mongolia are in the process of establishing their NSDI. The NSDI can help in good governance of crucial geospatial data between national, provincial and local governments.

Affordability and lack of technical capacity: Though a number of space-based products are now available free of costs, space agencies face challenges in providing a large amounts of data free of charge. For most of the countries in the Asia-Pacific region, especially the countries with special needs (CSNs), the availability of high-resolution data and radar satellite data still remains a challenge due to their relatively prohibitive cost. Even if the data are made available, many countries lack the technical capacity to analyze and use the data effectively. Low level of internet penetration due to the digital divide in many developing countries exacerbates the problem even further.

Policy issues: Effective application of space technology and GIS in a country needs both access to key technical and information resources as well as appropriate institutional arrangement to make it applicable and affordable to substantively supporting relevant decision-making. When most of the countries in the Asia-Pacific have built capacities for satellite data application in disaster reduction and management, a lot of these activities still remain at pilot or experimental stages and without sustainability. One major reason is the lack of policy and subsequent institutional arrangement at national level. Due to lack of appropriate policies despite the increase in availability of data and information, knowledge and expertise related to DRR/M, such information do not effectively reach the relevant decision makers. Moreover, lack of clear policies leads to duplication and delay in coordination mechanisms. Considerable base line data and maps are available with line ministries and different departments of Governments in developing countries in this region. There is a need to share those data for maximizing inter-sectoral benefits.

2. Sound practices

This technical paper presents some of the sound practices in using space technology and GIS applications for DRR drawing from developed as well as developing country examples. These case studies and best practices highlight the important role of space technology and GIS applications in mitigating the damage and losses from various severe disasters such as floods, earthquakes and drought that perennially affect the region as well as for natural resource management and climate change adaptation for sustainable development. In the case of certain disasters such as earthquake, which are almost impossible to predict, these technologies can be successfully used for disaster impact and damage assessment and for reconstruction activities.

The case studies are listed down in terms of various direct and indirect application of Space technology and GIS in areas such as early warning, monitoring, risk assessment, damage assessment and mapping of severe disasters such as floods, flash floods, earthquakes, drought and well as for natural resource management and climate change adaptation for achieving sustainable development goals.

The cases were chosen based on the following criteria:

(i) Timely provision of satellite data at real time or near real time to mitigate the damage and losses from the disaster
(ii) Effective policies and institutional mechanisms in place for the use of space technology and GIS applications
(iii) Potential to replicate the good practice to other countries in the region in case of similar disasters
(iv) Broadening and deepening the use of space technology and GIS applications through regional cooperative mechanisms

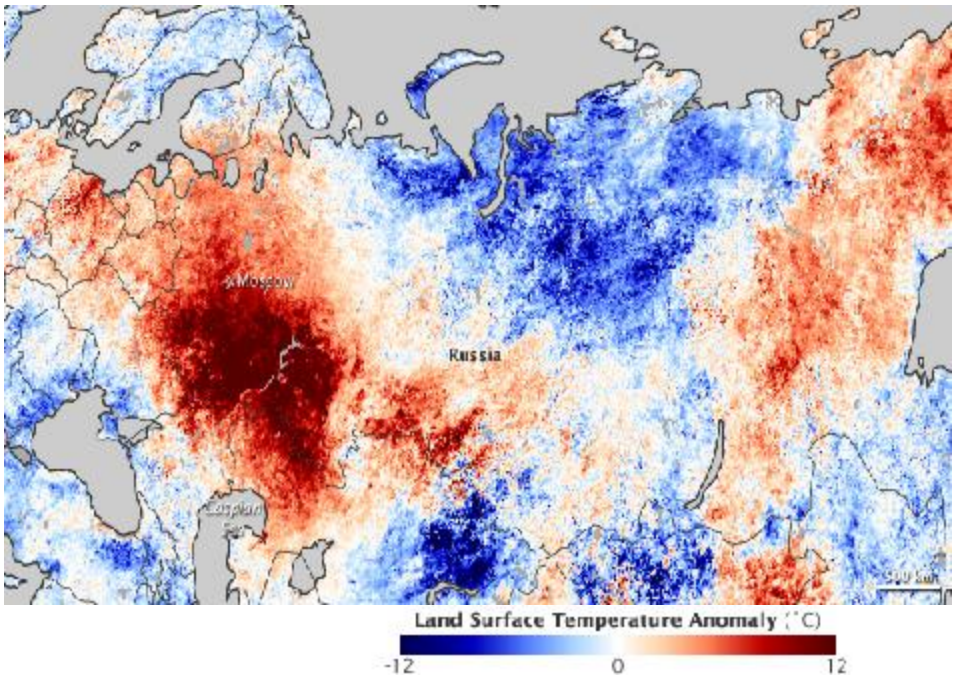
2.1. Use of remote sensing and GIS tools for monitoring and mapping risks

Remote Sensing (RS) and GIS tools are often used to better comprehend different terrain, climatic and socio-economic exposures through monitoring, mapping and modeling risks (APDR, 2012). These applications can thus provide important information to governments and decision makers to send support and relief to the affected areas and can also help researchers and scientists to better understand the root cause of such occurrences (Ibid.).

2.1.1. Russian heatwave in 2010

The example of the Russian heatwave in 2010 is a case in point. Russia experienced anomalous weather conditions from June 2010 until September 2010 when it was hit by an extreme heat wave that caused the highest temperatures recorded in 130 years. The figure 1. shows the Temperature Anomalies in 2010-Temperature from July 20–27, 2010, compared to those for the same dates from 2000 to 2008. The anomalies are based on land surface temperatures observed by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. Spatial and temporal comparisons of satellite imagery highlighted the vast geographical areas suffering from the heat waves and thus facilitated timely provision of support to the affected population in those areas. Furthermore, MODIS data was also used to create a satellite vegetation index image to highlight the damage done to plants throughout the southern parts of Russia. Space technology was used by scientists to further research the cause of the Russian weather anomaly and to assess the predictability of such extreme events in future.

Figure 1: shows the regions in Russia that experienced the weather anomaly



Source: NASA Earth Observatory (2010)2
Space technology was used by scientists to further research the cause of the Russian weather anomaly and to assess the predictability of such extreme events in future.

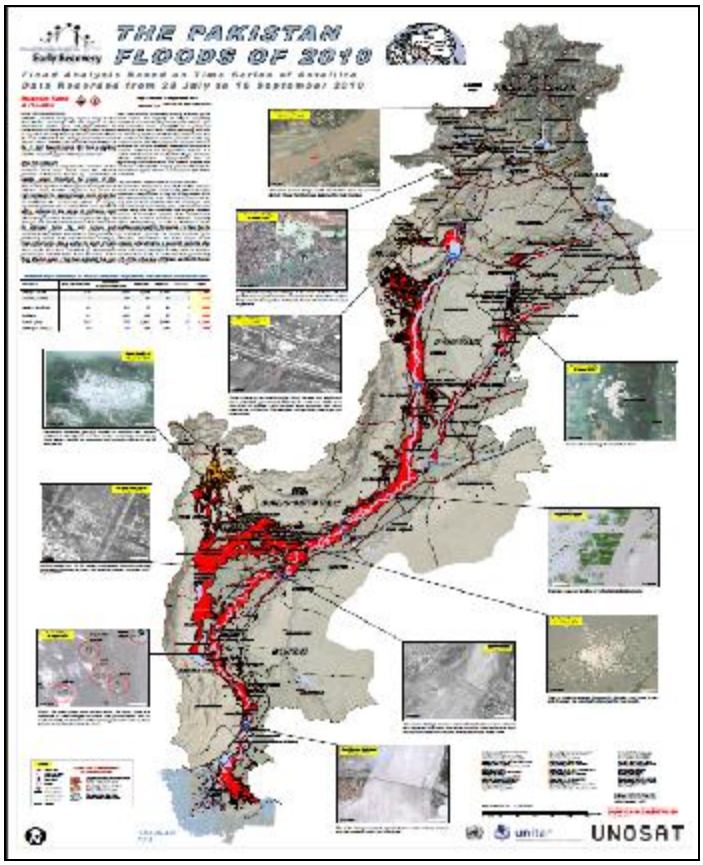
2.1.2. Use of EO products for humanitarian assistance and damage and needs assessment (DNA): Pakistan floods 2010

The following case study is a very good example of how EO products were used for humanitarian assistance and preliminary damage and needs assessment with the help of regional cooperation mechanisms.

Case Study: The historic Pakistan floods 2010, which affected more than 20 million people, consumed around 2000 lives and caused unprecedented damage and losses to the economic and social assets, witnessed extensive use of EO products in support of humanitarian assistance as well as preliminary damage and needs assessment (DNA). In fact, the flood waves, which started from July and continued till October-November 2010, were captured by constellation of 17 satellites with more than a combined total of 22 sensors – their products were available in the public domain (figure 2.). The large variety of value added products facilitated informed decision making processes at various levels. At the country level, the Space and Upper Atmosphere Research Commission (SUPARCO), the space agency of Pakistan worked closely with Pakistan's National Disaster Management Authority (NDMA) and provincial governments to provide the EO information products, which served as the only reliable means of information pertaining to the flood extent and damage to the infrastructure and agriculture (Iqbal, 2011).

2 http://earthobservatory.nasa.gov/IOTD/view.php?id=45069

Figure 2: Map of the Pakistan Floods of 2010



Source: UNITAR/UNOSAT image. http://unosat-maps.web.cern.ch/unosat-maps/PK/FL20100802PAK/UNOSAT_PAK_FL2010_EarlyRecoveryOverview_v2_LR.pdf (accessed on 15th November, 2013)

Role of space technology applications in humanitarian assistance

SUPARCO played an important role in the disaster relief exercise by using satellite remote sensing monitoring technology to provide timely situation update reports to the relevant stakeholders. The Pakistan floods were also a good case in point of the effective use of regional cooperation mechanisms in using space technology and GIS applications. For example, the existing mechanism viz., International Space Charter, Sentinel Asia, UNITAR, and UNSPIDER helped in providing near real-time access to EO products to the end-users such as Relief agencies of Government of Pakistan, UNOCHA, WFP, UNHABITAT, FAO,