APPENDIX

# Contributions from the Association of Southeast Asian Nations (ASEAN) partners

After the project wrap-up workshop in Jakarta, participants were asked to provide an abstract summarising the prominent challenges and solutions in their home countries. It encompasses various issues such as remote sensing and disaster risk reduction.

The abstracts presented below are sorted by alphabetical order of the countries.

## Indonesia (1/2)

### The use of satellite data for identifying potential fishing grounds in Indonesia's Seas

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High-quality data on the marine environment plays a vital role in resources management. Indonesia, with large marine areas, needs to be managed properly to support sustainable use of marine and coastal resources. The demand for the use of low-cost satellite data for operational fisheries oceanography in Indonesia's Seas is high. Several studies on the use of satellite data have shown valuable results for fisheries management. Various satellite remote sensing data have provided real data that can be used to monitor marine

resources. The command uses satellite data including those from Aqua's and Terra's moderate-resolution imaging spectroradiometer (MODIS), GeoEye's OrbView-2's Sea-Viewing Wide Field-of-View Sensor (SeaWiFs), Terra's Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), Landsat, and the National Oceanic and Atmospheric Administration. This paper gives an overview of the application of remote satellite sensed data for identifying potential fishing grounds (PFGs) around Indonesia's Seas. Remotely sensed data are used as primary data to analyse PFG maps such as sea surface temperature, sea surface chlorophyll-a, front, and photosynthetically available radiation (PAR) data. The PFG maps were semi-automatically processed, combining computer and human processes. The PFG maps have three products – national PFG, harbour PFG, and specific area PFG. The PFG maps were distributed routinely through several sources: website, facsimile, and mobile applications (NELPIN = nelayan pintar). The PFG maps were validated by using several approaches, such as research activities, feedback from local governments/users, overlay fishing vessels from radar detection, and overlay Visible Infrared Imaging Radiometer Suite (VIIRS) data. Using radar technology (for identification of fishing vessels), we were able to validate the PFG maps. For example, in this paper, we attempted to analyse and overlay the PFG maps and the distribution of fishing vessels in Natuna Sea (Fisheries Management Area/FMA-711). We found that the accuracy of the PFG maps varied, with an average accuracy of about 40%. In addition, we also conducted validation using VIIRS (night time images) data. This application showed that low-cost satellite data has become an ideal tool for identifying potential fishing grounds. These results show that the enhancement of PFG maps still needs to be considered to support operational fisheries. Enhancing PFG maps through automatic systems and increasing their accuracy are highly required.

**Keywords:** satellite data, fisheries oceanography, potential fishing ground, Indonesia's Seas.

# Indonesia (2/2)

## Satellite Remote Sensing Application for Economic Development in Indonesia

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Why is remote sensing necessary in Indonesia? Indonesia is a large country with 1,879,183 km2 of land and 3,544,743 km2 of ocean. Without remote sensing, Indonesia will have difficulties monitoring the country. Indonesia abides by Space Act No. 21/2013, which mandates the Lembaga Penerbangan dan Antariksa Nasional (LAPAN) to provide remote sensing data with minimum cloud coverage and provides the standard methodology for remote sensing data processing and analysis. For these reasons, LAPAN developed three ground stations to receive remote sensing data. They are in Parepare (South Sulawesi), Rumpin (West Java), and Pekayon (Jakarta). These three ground stations can cover all of Indonesia and receive low-resolution data (Terra/Aqua MODIS, NOAA, Suomi NPP, and Himawari-8), medium-resolution data (Landsat-7 and Landsat-8), and high-resolution data (SPOT 6/7). These data are free for government institutions. Other data provided by LAPAN are very high-resolution data such as Pleiades, Quickbird, Worldview, and some synthetic aperture radar (SAR) imageries. To further service users, LAPAN also provides cloud-free mosaic data of Landsat-8. It is now available from 1999 to 2016. It is useful for land use mapping with a maximum scale of 1: 100,000. It is also useful for forest change and degradation.

How does this affect economic development? What applications have been used in Indonesia? Remote sensing technology has been applied in many sectors, but it can be divided into five categories: (1) land resources, (2) coastal and marine resources, (3) environment, (4) disaster mitigation, and (5) other strategic applications. Agriculture, forestry, mining, regional planning, and water resources are in the land resources category. PFGs, mangroves, coral reefs, and water quality are in the coastal and marine resources. Hazardous waste, deforestations, land use changes, and oil spills are in the environment categories. Floods, landslides, volcano eruptions, forest fires, and drought detection and monitoring are in the disaster mitigation category. Tax, drag

planting, and security assessments are in the other strategic applications. All those applications have been done in the remote sensing applications centre of LAPAN. In relation to economic development in Indonesia, LAPAN provides the remote sensing data and many applications to support economic development. There are several applications that have been done that support the ministries. The monitoring of paddy growth every 8 days can be used in estimating paddy production, in deciding to import rice from other countries, and in deciding fertiliser and farmer machine distributions. PFGs can be used to increase fish catch numbers of and the efficiency of oil. Remote sensing can also be used to increase the taxes to be paid by taxpayers, especially for plantations, mining, and forestry companies. These applications must be improved in other provinces to increase the tax payments. Another application that can support economic development is the identification of mining areas. It can help the government or mining company identify the location of mining areas. It will increase the number of mining exploitation and increase the country's income.

The next question is, 'What are the challenges?' and 'How do we convince users?' This paper answers these two questions. The first challenge is convincing users. To convince the user, the remote sensing application should be accurate and up-to-date. Accuracy can be assured through good research and up-to-date information can be provided through high-temporal-resolution of remote sensing data and automatic image processing. Research collaborations with users are necessary to meet the requirements of users. LAPAN has collaborations with many government institutions, local governments, private companies, and foreign institutions. This will deal with the first challenge. The second challenge is the human resources. Increasing the capacity of human resources is needed, not only in terms of quality but also quantity. The number of people who deal with remote sensing activities is quite low. To tackle this challenge, LAPAN has a programme on technical training for local governments to increase the capacity and the number of people with remote sensing skills. The last challenge concerns the independence of the technology. At present, almost all remote sensing data come from other countries. Indonesia does not own a remote sensing satellite and its development is necessary.

**Keywords:** remote sensing, economic development, challenge, technology independence.

# Lao People's Democratic Republic

## National Policy on Disaster Management and Climate Change

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Lao People's Democratic Republic (Lao PDR) is very vulnerable to the climate. Its contribution to global greenhouse (GHG) emissions was only 51,000 Gg or 0.001% of total global emissions. Despite this, Lao PDR has ambitious plans to reduce its GHG emissions while at the same time increase its resilience to the negative impacts of climate change. The country is also experiencing increasingly frequent episodes of drought. Severe drought occurred in 1996, 1998, and 2003. It is estimated that 6 out of 17 provinces are already at high risk of drought. Droughts adversely affect water resources, hydroelectricity generation, and agricultural production, resulting in widespread economic losses.
The Natural Resources and Environment Sector Working Group (NRE SWG) was established by the government under Government Notice No. 773 dated 10 November 2011 as part of the Round Table Meeting.

The Environment and Climate Change Sub-Sector Working Group and the Disaster Division under the Water Sub-sector Working Group were merged and will be working as one group under the name: Disaster, Climate Change, and Environment Sub-sector Working Group (DCCESSWG). DCCESSWG consists of four departments and one institute – (i) Department of Disaster Management and Climate Change (DDMCC); (ii) Department of Environmental Quality Promotion (DEQP); (iii) Department of Pollution Control (DPC); (iv) Department of Environmental and Social Impact Assessment (ESIA); and (v) Natural Resources and Environment Research Institute (NREI).

The objective of the working group is mainly to support the Ministry of Natural Resources and Environment (MONRE) in the implementation of the following:

- The MONRE 10-Year Strategy (2016–2025) and the 5-Year Plan (2016–2020), particularly Action No. 5 on environment, climate change, and disaster. The 5-year action plan sets the direction for implementing MONRE's

first Natural Resources and Environment Strategy (2016–2025), with the overall goal of 'making Lao PDR green, clean and beautiful, based on green economic growth, to ensure sustainable resilient development and climate change'.

- The Eighth National Economic and Social Development Plan (8th NESDP) for 2016–2020, in particular outcome 3, output 1 – environmental protection and sustainable natural resources management; and output 2 – preparedness for natural disasters and risk mitigation. The long-term direction of the natural resources and environment sector focuses on five key themes: (i) sustainable management and planning of the use of natural resources and environment, (ii) sustainable environment planning for city and rural development; (iii) strengthening the capacity of Lao PDR on climate change adaptation and mitigation; (iv) enhancing regional and international integration; and (v) building MONRE's institutional capacity effectively, efficiently, and sustainably.
- Sustainable Development Goals (SDGs) focusing on the issues and topics (themes) related the environment, climate change, and disaster (SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable; SDG 13: Take urgent action to combat climate change and its impact; SDG 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development; and SDG17: Strengthen the means of implementation and revitalise the global partnership for sustainable development).

**Lao PDR's Policy Instrument for Disaster Management and Climate Change**

1. The law on Disaster Risk Management and Climate Change (to be considered for approval at the end of 2018). We have completed consultation on the current draft with eight northern provinces.
2. The integration of climate change and disaster preparedness into the Environment Protection Law (2012 revised version) and the 8th National Social-Economic Development Plan.
3. The National Adaptation Programme of Action, which was approved in 2009. The National Adaptation Programme of Action (2009) maps out a country-driven programme to address immediate and projected climate change adaptation requirements in agriculture, forestry, water

resources, and public health sectors. The adaptation programme was further developed by the National Strategy on Climate Change (NSCC) to cover the main sectors of the economy – agriculture, forestry and land use change, water, transport and energy, urban development, industry, and public health sectors.

4. The First and Second National Communication on Climate Change (approved in 2000 and 2013 respectively). Lao PDR is preparing for the 3rd National Consultation like other countries.
5. The National Strategy on Climate Change, which was approved in 2010.
6. The Climate Change Action Plan 2013–2020, which was approved in 2013. The action plan has four main key initiatives – (i) Strengthening institutional resource capacity on climate change, including organisational arrangements; technical capacity; national focal point; technical working group on climate change; and climate finance – fiscal system; management of international assistance; participation in carbon/climate finance; (ii) Enhancing the capacity for adaptation; (iii) Enhancing the capacity for mitigation; and (iv) Strengthening education and public awareness.
7. The Guidelines on the Development and Consideration of the Proposed Clean Development Mechanism (CDM) Project in Lao PDR, which was approved in 2012.
8. The signed bilateral document with Japan to launch the Joint Crediting Mechanism, approved in 2013.
9. The Guideline on ecosystem-based adaptation (EbA), which was approved in 2014.
10. The National Intended Determined Contribution (INDC) of Lao PDR to the United Nations Framework Convention on Climate Change (UNFCCC) on 1 October 2015. This INDC has been prepared through an inclusive stakeholder consultation process, including line ministries, research institutions, civil organisations, provincial governments, private sector, and international development partners. The main sources of information to prepare this document were the 7th and 8th Five-Year National Socio-Economic Development Plan (2011–2015 and 2016–2020), with a vision to 2030, the National Climate Change Strategy (2010), Forestry Strategy to the Year 2020 of the Lao PDR (2005), Renewable Energy Development Strategy (2011), Sustainable Transport Development Strategy (2010), Climate Change Action Plan of Lao PDR for 2013–2020 (2013), National Adaptation Programme of Action (2009), the Second National

Communication to the UNFCCC (2013), and Investment and Financial Flows to address climate change in the energy, agriculture, and water sectors (2015).

11. The ratified Paris Agreement on Climate Change to the UNFCCC on 7 September 2016.
12. The completion of the National Progress Reports on the Hyogo Framework for Action in five editions, (2005–2009, 2009–2011, 2011–2013, 2013–2015, and 2005–2015).
13. The completion of the Response and Preparedness Planning in three provinces: Vientiane Capital, Vientiane, and Bolikhamxay.
14. The development of the Guidelines on the Feasibility Study on the Emergency Operation Center Development for disasters.
15. The completion of the Contingency Plan of two provinces: Louang Prabang and Oudomxay (World Food Programme).
16. The ongoing awareness raising and education on climate change and disasters.

**LAO PDR's efforts to implement key policies**

1. Mainstreaming climate change and disaster management into the key sectors' policies, strategies, action plans, NSEDP 8 (2016–2020), and contributing to the achievement of SDGs and green growth.
2. Implementing climate change adaptation in relevant sectors, particularly the agriculture, forestry, and public health sectors.
3. Encouraging line ministries, private sectors, and relevant stakeholders to contribute to carbon trading through the Clean Development Mechanism (CDM) and the Joint Crediting Mechanism (JCM).
4. Completing Response and Preparedness Planning in three provinces: Vientiane Capital, Vientiane, and Bolikhamxay Province.
5. Establishing provincial, district, and vulnerable villages committees and coordinators.

**Disaster Preparedness and Response Mechanism**

The National Disaster Prevention and Control Committee (NDPCC) has been established to support disaster management and climate change activities, including emergency and disaster response. Ministerial focal points play a key

role in the day-to-day coordination and communication before and during emergencies, e.g. meetings with the Department of Disaster Management and Climate Change (DDMCC) prior to the monsoon period to assess resources' capacity to cope with emergencies; conduct situation analysis based on early warning information; planning and preparing for site visit, if necessary; and other related matters.

There are 13 main ministries involved in disaster management and climate change:

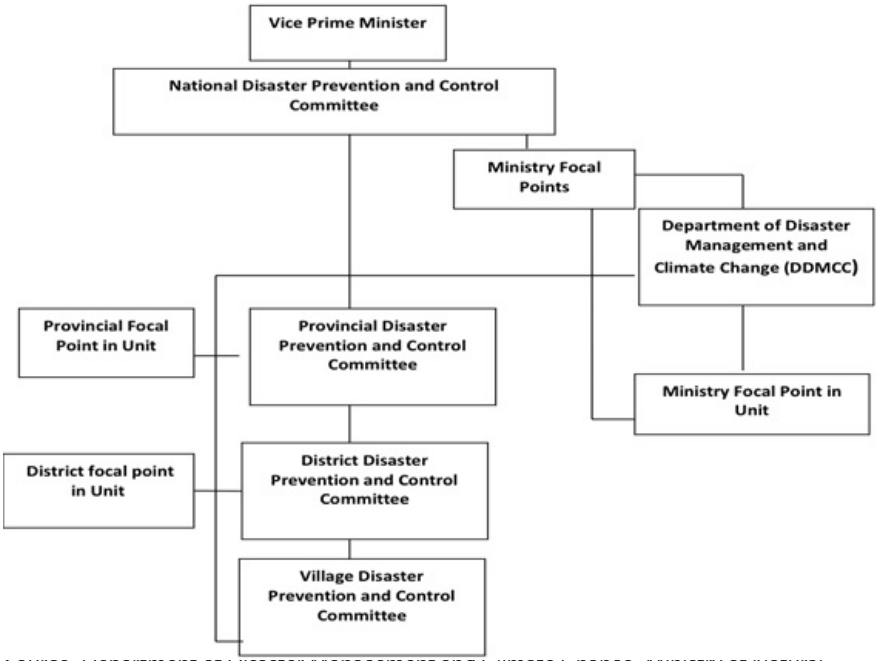
1. Ministry of Agriculture and Forestry (MAF), responsible for (i) seedling, replanting, nursery, structure recovery, etc.; and (ii) ensuring that local-based personnel and machineries are ready and checked regularly;
2. Ministry of Public Work and Transport (MPWT), responsible for (i) road, bridge and other public work recovery; and (ii) ensuring that local-based personnel and machineries are ready and checked regularly;
3. Ministry of Health (MOH), responsible for (i) ensuring that rapid physician teams are ready at national and local levels; (ii) preparing contracts on availability of medicines at pharmaceutical factories; (iii) preparing contracts on transportation with private transport companies; (iv) ensuring local hospitals and health care centres are ready, including increasing resiliency level; and (v) ensuring the availability of on-site clean water supply machines;
4. Ministry of Public Security, responsible for (i) rescuing and assisting affected populations; and (ii) ensuring availability of security guards and facilitating extreme and complicated events;
5. Ministry of Labor and Social Welfare (MLSW), responsible for providing (i) relief and humanitarian assistance; (ii) primary need items (food and non-food); and (iii) basic housing equipment;
6. Ministry of Education and Sport, responsible for the provision of (i) youth volunteers for rescue operations; (ii) information and communication to parents about the situation of their kids during emergencies; and (iii) school areas as evacuation sites/shelters;
7. Lao Red Cross, responsible for the provision of (i) relief and humanitarian assistance; (ii) first aid delivery; and (iii) rescue;
8. Ministry of National Defense, responsible for (i) provision of main personnel and machinery inputs during disaster events; and (ii) fast-tracking protocols for responding;

9. Ministry of Planning and Investment (MPI) in coordination with MONRE and line agencies, responsible for (i) consideration of outcomes of common rapid assessments for early relief and recovery proposals to the government; and (ii) medium- and long-term recovery and rehabilitation planning;
10. Ministry of Finance (MOF), responsible for (i) state reserve fund and (ii) cash and non-cash items (rice, fuel, etc.);
11. Ministry of Information, Culture and Tourism, responsible for (i) media and information disclosure regarding Early Warning System; and (2) recommendations on best practice/behaviour in emergencies;
12. Ministry of Foreign Affairs (MOFA), responsible for leading broader resource mobilisation efforts and issuing requests for assistance to the international community to support the national disaster response efforts;
13. Ministry of Natural Resources and Environment (MONRE)

(a) Department of Disaster Management and Climate Change (DDMCC), serves as the Secretariat to the NDPCC/government; prepares national disaster preparedness and emergency response plans, as well as strategic policy coordination of all disaster relief operations, and data collection and assessments;

(b) Department of Meteorology and Hydrology (DMH), responsible for weather-related early warning information, including weather forecasts, precipitation levels, and flood risk; provides hydro-meteorological and forecasting information, including warning bulletins to NDPCC, DDMCC and to sub-national government structures and the public; issues daily updates to DDMCC, via email, fax, or phone during the wet season; DDMCC contacts PDPCCs directly to share serious early warning; and prepares Early Warning System and recommendations for best practice/behaviour in emergencies.

**National Disaster Management Structure in Lao PDR**




Source: Department of Disaster Management and Climate Change, Ministry of Natural Resource and Environment (Lao PDR).

## Lao Disaster Information System (LaoDi)

This initiative aims to strengthen the capacities of Lao PDR to provide information on disaster damage and loss to support national planning and the Sendai1 Framework. LaoDi provides authorised users with access to disaster data that enables them to monitor and analyse vulnerabilities in specific areas in Lao PDR, and share the collected data with line ministries and stakeholders. LaoDi was developed to record, store, and analyse loss and damage data in Lao PDR. It was established by DDMCC with technical and financial support from the United Nations Development Programme (UNDP) and the Asian Development Bank (ADB).

LaoDi has two modules: the Administration Module and the Analysis Module.

1. Administration Module is designed for authorised users such as the administrator or a super user. In this module, the user can (i) manage the database (add, update, or delete); (ii) manage the region (provinces, districts, and villages); (iii) manage the collected data (delete, modify, and update); (iv) manage the maps; and (v) create and manage other users.
2. Analysis Module is for general users to access. The user can (i) analyse the collected data by queries; (ii) identify the vulnerable areas by province and district but not yet by villages or by village cluster; (iii) identify the vulnerable areas by causes and types of disasters; and (iv) report the analysed result with graphs, tables, and maps.

LaoDi data can be exported to Microsoft Excel by statistics and crosstab statistics tools, while data analysis can be done using the chart and thematic map tool. Data analysis can be done at national, provincial, district, and village levels from selections of query criteria. LaoDi data is up and running and will be updated by DDMCC and MONRE. It is open and accessible to the public at www.laodi.laodisaster.gov.la.

LaoDi online application used DesInventar methodology (www.desinventar.net). The database platform and methodology have been implemented in 25 countries in the Asia–Pacific region as well as America, Africa, and Europe. LaoDi was established in Lao PDR by DDMCC after a series of consultation workshops between DDMCC officials and UNDP, followed by validation with key line ministries who will be provided with data on disaster loss and damage. LaoDi focuses on direct loss and damage data resulting from natural disasters in Lao PDR, including human life, housing, road, agriculture, education, and health. LaoDi data was collected from the Provincial Disaster Management Committee (PDMC), the District Disaster Management Committees (DDMC), the Ministry of Agriculture and Forestry (MAF), Ministry of Public Works and Transport (MPWT), Ministry of Labor and Social Welfare (MLSW), Ministry of Health (MoH), Ministry of Education, and the provincial departments of these line ministries.

Data on loss and damage from natural disasters are primarily collected from the Provincial Disaster Management Committee, which also is the focal point

secretariat. However, if data is not available from PDMC, the data is based on the following ministries:

- Ministry of Labor and Social Welfare (MLSW) – data on human life and housing;
- Ministry of Pubic Work and Social Welfare (MPWT) – data on road sectors;
- Ministry of Agriculture and Forestry (MAF) – data on agriculture;
- Ministry of Health (MH) – data on hospital and health centres; and
- Ministry of Education and Sports (MES) – data on schools.

Currently available data in LaoDi:

- Historical data between 1990 and 2012 received from MLSW;
- Updated Data from the annual reports of DDMCC between 2014 and 2016;
- A total of 4,448 data card (records) up to district level with five main sectors (agriculture, education, health, labour, and road sectors);
- Around 150 road-related data: roads and bridges data;
- Around 50 data variables (data types): number of deaths of people; injured people; missing people; destroyed houses; destroyed crops; damaged roads; 16 main disaster events; floods; droughts; cool waves, and many more.

Expected data from LaoDi

- Direct disaster data of five main sectors: (i) agriculture; (ii) education; (iii) health; (iv) labour and social; and (v) road;
- Data variables will be more than 170 (e.g. number of people deaths, destroyed houses, etc.);
- Around 20 main disaster events (floods, droughts, cool waves, etc.); and
- Regular up-to-date data received from provinces via online data entry and up to village level.

LaoDi is still operated offline, but it works using the Local Area Network (LAN) of the DDMCC office.

**Key Challenges**

- Lack of human capacity in disaster risk management and emergency responses;
- Information and data are not yet updated;
- Some data and information are not yet available;
- Local infrastructure to support geo-based infrastructure is still young; and
- Lack of investment.

**Keywords:** remote sensing, economic development, challenge, technology independence.

# Malaysia

## Geospatial Technologies in Malaysian Disaster Planning and Management

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The ASEAN Socia-Cultural Community (ASCC) Blueprint 2015–2025 is a crucial step forward in creating a more resilient and self-sustainable community and region. This paper shares the Malaysian approach and hopes the cooperation and ASEAN spirit will lead to the materialisation of this highly valued blueprint.

The National Security Council (NSC) is a federal agency under the Prime Minister's Department mandated with the responsibility of managing and coordinating the implementation of policies related to the security of Malaysia and providing policies and mechanisms for national disaster management and relief. The three core functions of the NSC are: defending national sovereignty and strategic importance; crisis and disaster management; and border management of land, maritime, and air. The National Disaster Management Agency (NADMA) was set up in 2015 to coordinate government agencies tackling disasters such as the Malaysian Armed Forces, Police, Malaysian Civil Defence Department, Fire and Rescue Department, the People's Volunteer Corps (RELA), Social Welfare Department, and other relevant agencies. NADMA's Geographic Information System (GIS) Centre at Cyberjaya, which will be using the dashboard concept, is expected to be operational in 2018 with the Malaysian Space Agency (ANGKASA) providing geospatial data processing infrastructure and support. The core agencies providing geospatial data for disaster management are: Malaysian Meteorological Department (MMD), National Survey and Mapping Department (JUPEM), National Remote Sensing Agency (ARSM), ANGKASA, Malaysian Centre for Geospatial Data Infrastructure (MaCGDI), Public Works Department (JKR), and Drainage and Irrigation Department (JPS). Low-cost satellites are gaining interest from the state government and university research centres, especially for environmental monitoring. A framework of cooperation is being formalised for cooperation between Malaysian universities and ANGKASA on satellite research and

development, with a low-cost micro-satellite program with Hokkaido/Tohoku University being planned. Research on deep learning and artificial intelligence has made a sound footing at local universities and there is a good potential to develop application systems from current research levels. Big data holds a major potential to contribute to disaster management and the role of MacGDI to enable data sharing, and a free flow of data will enhance the useful applications of geospatial data. The national geospatial policy currently being formulated will catalyse this cooperation. The use of high-precision satellite positioning will help in getting better mapping and location information for better disaster management decision-making. Currently, a high precision multi-global navigation satellite system (GNSS) is being tested at an oil palm plantation by the Japan Aerospace Exploration Agency, in collaboration with Keio University, Tokyo University, and Universiti Putra Malaysia. The results of such collaboration will not only benefit agriculture, but the resulting high-accuracy maps can aid in disaster management, particularly in flood mitigation. For greater acceptance of technology, the production of easy-to-operate and beneficial devices become necessary. The Internet of Things (IoT) is one example of such a development that has received support of the Malaysian Government. Plans are afoot to create an entrepreneurship industry in this field and the Malaysian Institute of Microelectronics Systems (MIMOS) has been entrusted with this leadership role. MIMOS has created a roadmap for the national IoT strategy (http://mimos.my/iot/National_IoT_Strategic_Roadmap_Summary.pdf).

The major cost component during disaster management implementation is logistics management, which can account for about 80% of the total cost of a disaster response. It is not only an issue of cost, but also the need for timely and efficient coordination as disaster logistics management is currently being handled by multiple government organisations with different objectives and stakeholders. Although each agency has a working logistics management system, there is no apparent communication with each other. There is no real-time system on the availability and current location of resources and assets that have been allocated for the purpose. Based on feedback from experienced ground personnel who have been involved in dozens of disaster operations, the main problem that needs to be addressed is the communication problem. The communication flaws are due to the weaknesses of the personnel, the weaknesses of some agencies' standard operating procedures (SOPs), command and order, and the radio emergency communication system itself.

The empowerment of local communities against natural hazards not only supports disaster prevention efforts but, when implemented as a web GIS as in the case of Ulu Klang Highlands community, helps in the development of a community-friendly web GIS-based information system; the integration of the website with data from meteorological and other relevant sources; the empowerment of the community to upload relevant environment sensitive information; and the production of updated maps that can be printed and downloaded by local residents. These brought benefits to the residents as they were able to view and have easy access to the map and other relevant information on the web, such as rainfall data. They can be active players in monitoring their local topography and environment and can link directly to meteorological and other external data sources.

Based on the assessment of the current situation, some potential projects that can benefit from the integrated use of space and geospatial technologies are cross-boundary haze, illegal human trafficking, crowd sourcing information, and illegal land cutting and land clearing.

Although there is ASEAN cooperation and agreement on trans-boundary haze pollution, well-integrated and efficiently executed geospatial applications will help in the success of combating trans-boundary haze, especially through effective data sharing procedures. Illegal human trafficking is also a problem awaiting a geospatial solution. This activity is directly a geospatial phenomenon as no illegal human trafficking can occur without the geographical movement of the victim. Current mobile telephone technology can be an innovative tool in helping trace this illegal human movement. As greater masses of people are exposed to technology, the time is ripe for educating and cultivating crowd sourcing data from people on the ground. In the case of Malaysia, the Civil Defence Agency alone has one million people who are ground volunteers. Tools such as low-cost, high-accuracy multi-GNSS receivers will enable these volunteers to supply ground data with very high accuracy. As for land cutting and clearance activities, the monitoring and enforcement of illegal and dangerous cutting and clearing of land can help avoid landslides, mud floods, and related disasters, which have had catastrophic consequences in the past.

In conclusion, it is indisputable that space and geospatial data are critical requirements for building a resilient society. The use of these data, together with

data infrastructure and data sharing, is a fundamental part of a resilient system. Communication, training, and retraining are vital components of capacity building that cannot be overlooked. With the current pace of technological changes, having a society that is up-to-date, knowledgeable, and skillful in the use of geospatial technology will be an asset to the country and the ASEAN region. The wisdom and efficiency in utilising these geospatial technologies will ensure a safe and secure society for generations to co me.

# Myanmar

## Presentation Summary by Myanmar on the ERIA Research Project Wrap-up Meeting

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Myanmar is prone to natural disasters and the frequency and intensity of these disasters are increasing. According to global reports, Myanmar ranks 42 out of 171 countries in terms of disaster frequency, while it ranks 15 in terms of disaster response readiness.

After the catastrophic cyclone Nargis in 2008, which triggered damage and loss of about 21% of total gross domestic product (GDP) in the 2007 fiscal year, Myanmar had put emphasis on disaster risk reduction. The country bears an average annual loss of about 3% of GDP due to natural disasters. In 2015, it also suffered nationwide flood and severe landslides in the mountainous regions, especially in the western part of the country, with damage and losses reaching 3.1% total of GDP. The Government of Myanmar has laid down its development vision – 'A developed nation (middle-income country) that is integrated into the global community' – in its National Comprehensive Development Plan (NCDP) 2030. A disaster can draw back its development gains and can interrupt the development and sustainability of the country. Thus, to achieve resilient development in Myanmar, the National Disaster Management Committee (NDMC), chaired by the Vice President of the Government of the Union of Myanmar, has been tasked with promoting the disaster management system in Myanmar in line with global and regional frameworks.

The NDMC is the highest decision-making body and there are 12 working committees under its supervision. The Relief and Resettlement Department (RRD) of the Ministry of Social Welfare is the focal department for disaster management. Myanmar also enacted the Disaster Management Law (2013) and Disaster Management Rules (2015), as law enforcement is necessary to ensure that disaster risk reduction and management activities are carried out without any interruption. Moreover, the Myanmar Government developed the Myanmar Action Plans on Disaster Risk Reduction (MAPDRR) 2012, and it is now under revision in line with the Sendai Framework for Disaster Risk Reduction (SFDRR), the sustainable development goals (SDGs), and other regional and global frameworks.

Based on the experience and lessons learnt from the 2012 MAPDRR, the 2017 MAPDRR will be comprised of four areas which include: 'Assessing disaster and extreme events risk and creating public awareness on DRR in Myanmar'. There will be eight priority actions for risk reduction by mainly applying the space-based and geospatial technologies.

Since 2012, Myanmar has been upgrading its disaster management system by utilising advanced technology like space technology and it received the Technical Advisory Mission (TAM) of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN–SPIDER) of the United Nations Office for Outer Space Affairs (UNOOSA). The TAM recommended the extensive use of space technology in disaster management. The Myanmar Government understands that advanced and technology-based disaster management mechanisms have become the crucial and necessary requirements for a community that is resilient to natural disasters and for sustainable development. The RRD reformed its organisational structure by establishing the Emergency Operations Centre (EOC) as one of the operating organs of RRD in 2013. EOC is comprised of four units, including a technical unit for handling space-based and geospatial information. This technical unit is still in the nurturing stage, until the human resource becomes capable of analysing the satellite imageries and risks to contribute to disaster management activities. It is still necessary to get the capacity development measures for the technical skills improvement and experiences as well.

Myanmar also tried to be a member of international communities utilising space technology in disaster emergency and management, and it got the technical assistance and data and information in disaster emergency from Sentinel Asia and the International Charter. Being a member of the Asian Disaster Reduction Centre (ADRC), Myanmar has the right to request data from Sentinel Asia. RRD, Myanmar's national disaster management organisation, has become the authorised user of the international charter to achieve a speedy activation process. Moreover, Myanmar has the option to access space technology, which is in line with the procedural guidelines on the 'utilization of Earth observation data during emergency response' developed for the ASEAN group.

Furthermore, RRD tried to allocate budget for purchasing high-resolution satellite imageries in the next fiscal year to have the chance to utilise satellite imageries at the relocation stage after some disaster emergencies and risk assessment measures. In addition, the training course on Geoinformatics Applications in Disaster Management has been developed and this course is being used in the Disaster Management Training Centre (DMTC) of RRD to train government officials and staff who are responsible for disaster management in Myanmar. The objective of the training is to 'raise awareness amongst the participants and to develop basic skills for effectively utilising the Geographic Information Systems (GIS) and remote sensing (RS)/space-based information in disaster management'. This course is comprised of four modules – Disaster Management Terminologies and Concepts; Introduction to GIS, Remote Sensing, Global Positioning System (GPS) and Internet Mapping Services; Geoinformatics for Mapping and Monitoring of Hazards, Vulnerability and Risk Assessment; and Geoinformatics for Disaster Management Planning and Emergency Response.

Disaster risk reduction and management is the cross-cutting issue and it is very crucial for national development and sustainability. To ensure sustainable development, it is vital to be disaster resilient and disaster risk reduction measures are critical for making the best use of space-based and geospatial technologies. Moreover, it is important to disseminate the results and products acquired from these technologies not only to concerned agencies to enable them to practice using them in their work in DRR but also to the communities for their awareness raising. Exchanging knowledge and best practices on using space-based and geospatial technologies through regional and global meetings

and workshops are very helpful to widely use and apply the technologies in disaster management.

## Philipines

### Disaster Risk Reduction and Management (DRRM) in the Philippines and the Southeast Asian Region through Space Technology

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The Philippines is located near the equator and along the Pacific Ring of Fire, which makes it vulnerable to natural disasters such as typhoons, earthquakes, and volcanic eruptions, endangering the natural resources and biodiversity that the country is endowed with. A major disaster that struck the Philippines was Typhoon Haiyan (local name: Typhoon Yolanda). The typhoon caused damage estimated at ₱89.6 billion (US$1.77 billion), with 6,300 deaths and 1,081 missing. This scenario is a major concern for the Philippines and measures need to be adapted given that a similar disasters may occur in future given the country's location. An effective Disaster Risk Reduction and Management (DRRM) measure that can be taken by the country is the use of space technology, particularly satellite technology.

The country is gradually emerging as a space-faring nation, as evidenced by its continuous space development efforts throughout the past years. Looking ahead, the Philippines, through the National Space Promotion, Awareness, and Capabilities Enhancement (SPACE) Development Program (or NSDP), developed strategic roadmaps for the future space programme of the country. These roadmaps include the Satellite Development Roadmap, which contains the satellite requirements of the Philippines for the next 15 years. Satellite technology for the Philippines would bring enormous benefits for the country, particularly on applications for national security, agriculture, and disaster management. While all the satellites being planned by the Philippines have a direct or indirect application for disaster management (in terms of communications and Earth observation applications), there are satellites that greatly contribute to this use. Planned satellites that have immense applications

for disaster management include a synthetic aperture radar (SAR) satellite and a microwave satellite for precipitation monitoring.

The coupled use of SAR and microwave satellites can greatly enhance DRRM efforts throughout the country. By measuring precipitation and rainfall using a microwave satellite, combined with data from the SAR satellite, timely comprehensive results can be distributed to various decision-makers and policymakers in critical times of disasters, thereby enhancing humanitarian aid for the affected areas.

Given this strategic plan of the Philippines to develop satellites for disaster management and being in a prominent location for typhoons and disasters, the country can lead the way for the Southeast Asian Region. As the country is strategically located between the Pacific Ocean and mainland Southeast Asia, typhoons mostly cross the Philippine archipelago onto either East Asia or Southeast Asia, putting the country at the forefront of typhoons. Therefore, an effective utilisation of satellite technology for disaster management in the country would help the whole region as it would reduce the risk of disaster for the other countries. An 'ASEAN Satellite Constellation' of SAR and/or microwave satellites would prove valuable for the region, as it would mean greater regional coverage.

However, the physical infrastructure for satellite technology would not be effective without satellite information sharing. Thus, there is a need for the countries in the region to engage in satellite information sharing to promote interoperability and interconnectivity throughout the region in terms of satellite technology. A Satellite Data Sharing Policy for the Southeast Asian Region on disaster management, consonant with each country's policies and not endangering the security of each nation, would prove useful.
Lastly, a regional centre for water information can be established in the Philippines to pool researchers and technologists from Southeast Asia and to facilitate satellite data sharing amongst countries. This regional centre can be the centerpiece in Southeast Asia in terms of utilising water information for disaster management.

The Philippines has been at the forefront of disasters and typhoons in Southeast Asia, as manifested by 2013 Typhoon Haiyan that struck the country. No other

typhoon to date matches the devastation it brought. With the Philippines slowly emerging as a space-faring nation, plans for its future space programme, and the development and utilisation of various satellites for disaster management are at the forefront of its strategy. The use of SAR and microwave satellites, not only in the Philippines but also in Southeast Asia, would be valuable. A satellite data sharing policy for the region should also be discussed to effectively utilise the satellite data. Lastly, a regional centre for water information can be established in the Philippines, which would play a vital role in the region in the facilitation of water information and research.

## Thailand

### Thailand Disaster Risk Management Using Space Technology

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Thailand is less susceptible to natural hazards than the other countries in the Asia–Pacific. The geography and location of Thailand help insulate the country from many of the impacts of meteorological and geophysical natural disasters. However, Thailand's agricultural industry and highly developed urban areas leave sizable portions of the population and the economy vulnerable to disasters such as flooding, drought, landslides, and forest fires.

Over the past 2 decades, space technology has become a significant part of Thailand's daily lives and it plays important roles in disaster risk reduction and management. Thailand has been involved in satellite remote sensing since the launch of NASA's Earth Resources Technology Satellite 1 (ERTS-1) Programme in 1971 through the Thailand Remote Sensing Programme (TRSP) under the National Research Council of Thailand (NRCT). In 2000, Geo-Informatics and Space Technology Development Agency (GISTDA), a public organisation, was established to enhance the utilisation of remote sensing and the geographic information system (GIS). GISTDA is responsible for space technology application in Thailand, particularly disaster management. The Thailand Monitoring System (TMS) was initiated by GISTDA to cope with and monitor

disasters and it publishes online analytic geo-information from satellite imagery daily for related organisations and the private sector. The system includes flood, drought, and forest fire, and can be accessed at tms.gistda.or.th.

Flooding is the most serious hazard in Thailand and every part of the country struggles with flood-related damage every year. During the monsoon season in Thailand, GISTDA monitors the flood situation and agricultural areas every seven days. GISTDA uses RADARSAT data to monitor agricultural areas and evaluate damaged zones for general areas; and Cosmo-SkyMed data to monitor critical areas due to its constellation capability (four satellites). Hourly, daily, weekly, and monthly rain cloud information from COMS (Communication, Ocean and Meteorological Satellite) satellite are available to the government and are published online via web service (flood.gistda.or.th).

Drought is an increasingly serious hazard for parts of central and eastern Thailand. Drought conditions are most common from January through to May and are alleviated by the onset of the monsoon season. GISTDA uses a set of MODIS data (seven days) to calculate drought indices, normalised difference vegetation index (NDVI), and normalised difference water index (NDWI) for drought risk area assessment and these are published weekly at http://drought.gistda.or.th. This information is necessary for the government to warn and assist farmers. Moreover, surface water database from LANDSAT satellite image has been collected for drought monitoring as it is an indicator of water shortage. GISTDA also developed the Field Server Ground Station to automatically collect field data such as humidity, soil moisture, rain volume, crop growing, etc. This data will be integrated with satellite data for precise data. Currently, there are 25 stations spread across the whole country in different crop types.

Forest fires occur during the dry season from December to May, with their peak in February to March. Fires, mostly classified as surface fires, mainly occur in mixed deciduous forests, dry dipterocarp forests, forest plantations and, to some extent, dry evergreen forests, hill evergreen forests, or even in some parts of the tropical rainforest. These surface fires consume surface litter, other loose debris on the forest floor, and small vegetation. In Thailand, forest fire is reported daily (fire.gistda.or.th) and the Transport Management System publishes daily hotspots using TERRA/AQUA–MODIS data such as haze and smoke. GISTDA also generates weekly wildfire risk areas analysed from hotspots

accumulated for 10 years, land use, burnt NDWI areas, and weather to predict the fire trend each year. Every 16 days, data about burnt areas are extracted using LANDSAT-8 satellite image. GISTDA established the GISTDA Forest Fire and Smoke Operation Center in nine provinces in northern Thailand where forest fire is a common issue. These centres will receive remote sensing and GIS data from GISTDA to support forest fire management and the training of experts on data interpretation and effective use of GISTDA forms. Currently, GISTDA receives daily hotspot data from SUOMI–NPP satellite (twice a day), integrated with data. By doing this, Thailand will have more detailed information on forest fire and the number of hot spots may significantly increase because the number of rounds and resolution of the satellite. Mobile application for alerts and reports on the situation in the fire area was developed to get more precise fire location data.

Based on GISTDA experiences, space technology will play a vital role in disaster management in the future. Satellite images give overview information of disaster situations, which are necessary for understanding, management, and decision-making. Precise location information on the constellation of GNSS will lead to the exact location for timely rescues and assistance. Correct information integrated with appropriate management processing and new technology will result in rapid resolution of a situation. For example, the hot spot situation in the northern part of Thailand has continued to decline every year because sufficient information from space technology has led to the understanding and management of the right points and locations.

**Keywords:** space, technology, natural disasters, Thailand

# Viet Nam

## Potential of Geospatial/Space-based Service in Viet Nam

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The 2016 World Disaster Report showed that Viet Nam is one of the five countries in the world that has been most affected by natural disasters and climate change. In the last 10 years, according to the Ministry of Natural Resource and Environment (MONRE), there have been around 500 deaths and the damage caused by disasters is estimated at 1.5% of the country's GDP per year. There are many types of disasters in Viet Nam. The top five high frequency disasters are: flooding, storm, drought, flash flooding, and erosion/sedimentation.

Space-based services for disaster management in Viet Nam are currently used by research institutions as well as management agencies. Viet Nam is building up an infrastructure for geospatial data called Viet Nam Data Cube. This will be an open sharing system for all available geospatial data in Viet Nam, including free satellite data such as Landsat, MODIS, Sentinel; Viet Nam's satellite data (VNREDSat 1; LOTUSat 1 and 2); and other data. Viet Nam Data Cube is being built based on the data cube (http://ceos-cube.org/). It will provide ease of use and access to space-based data with multiple dataset interoperability and spatial consistency. It is also combined with built-in data processing algorithm and API (application programming interface), which can be used for 'Analysis Ready' data products for all users. Viet Nam Data Cube was planned to be launched in January 2018 with two applications: forest monitoring and water quality monitoring. The opening of the space-based data and service of Viet Nam Data Cube can be considered for space-based service for disaster management in Viet Nam as well as in other ASEAN countries. However, the investment issues that need to be clarified are: infrastructure (Data Cube-based); data system (Data Cube similar); software; trained professionals; and web-based services system. This system will help ASEAN countries have a shared understanding, Earth observation and geospatial data, and help in early warning and rescue information.