

UNITED NATIONS ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Regional Forum on Space Technology Applications for Drought Monitoring and Early Warning

Colombo, Sri Lanka, 1 - 2 July 2014

I. Conclusions and Recommendations

- 1) The member States agreed on the future plan of the Regional Cooperative Mechanism on Drought Monitoring and Early Warning (Regional Drought Mechanism) introduced by the ESCAP secretariat.
- 2) Based on the discussions on the needs and gaps, local stakeholders agreed to strive to respond to local level gaps and needs which could not be fulfilled by other partners. Where possible, ESCAP would continue to support efforts of the member States including through strengthening working relationships with other organizations to address the challenges faced by these countries.
- 3) China and India agreed on long term support to ESCAP in implementing the Mechanism and committed to strengthen their support to Sri Lanka and other pilot countries on satellite-derived data, products and services as well as technical assistance for effective drought monitoring and early warning.
- 4) Standard operating procedures (SOPs) of the Regional Service Nodes introduced by China and India were agreed by the participating countries.
- 5) The Forum strengthened the institutional capacity of key Ministries of Sri Lanka to implement the Regional Drought Mechanism. They committed to work closely with ESCAP and Regional Service Nodes on implementing the Mechanism and share their experience with other drought-prone countries in the region.
- 6) Agreement was made to begin operationalizing the Mechanism in other pilot countries. Cambodia and Myanmar invited ESCAP to conduct technical advisory services and institutional capacity development.
- 7) The representative from Mongolia agreed to start the work of Phase II. The in situ hydro, meteorology and other drought related information will be combined with space-derived data for effective drought monitoring in late 2014.
- 8) Experiences in other countries of Asia-Pacific were shared, which can contribute to the implementation of the Mechanism.
- 9) Representatives from the Republic of Korea and the Russian Federation indicated that they will consider options for supporting the implementation of the Mechanism, and also extending support to ESCAP's space applications programme for sustainable development.
- 10) Agreement was made to strengthen partnership between UN agencies and other organizations. Considering RIMES and UNCCD have been the strategic partners of the Mechanism already, WMO

and GWP agreed to prepare a MOA with ESCAP to build synergy with their work and the Regional Drought Mechanism. FAO agreed to discuss possible collaboration further.

II. Summary of Discussions and Presentations

A. Introduction

A comparison of the data on drought reveals that Asia and the Pacific region had the largest number of people affected compared with other regions. A total of 123 drought events in the region affected more than 1.31 billion people and caused damage amounting to over \$53 billion over the last three decades.¹ Compared to other disasters, drought is a slow onset event which is sometimes difficult to recognize until the damage to agriculture and water supplies is done. Given the importance of agriculture for many countries in Asia and the Pacific, monitoring and early warning are extremely valuable for mitigating possible impacts and for disaster relief.

Many countries in the region face tremendous challenges in the area of utilizing space derived information for monitoring and early warning of drought. These challenges include a limited capacity to access and analyse critical information, lack of effective methodologies to combine space-based information products with ground-based information for appropriate decision-making, limited regional platforms for sharing knowledge and good practices, and a lack of coordination among agencies and institutions at the national level.

Similar to many countries in the region, the six pilot countries of Afghanistan, Cambodia, Mongolia, Myanmar, Nepal and Sri Lanka all suffer from drought, though the contributing factors can differ between countries. While unpredictable rainfall patterns and rising temperatures affect Cambodia, Myanmar and Sri Lanka, drought in Afghanistan relates to the availability of runoff from winter snow, and dzud in Mongolia can create drought conditions in summer due to heavy snow and difficult winter conditions.

A large portion of the population in these countries depends on agriculture and animal herding for their livelihoods. In Mongolia, the winter dzud in 2010 which followed a summer drought in 2009 resulted in the loss of nearly a quarter of the total livestock in the country. Severe drought in Sri Lanka in 2004 resulted in the loss of almost 1 million metric tons of rice. In 2012 in Sri Lanka also lost 30 per cent of the total crops grown. In Myanmar, 57 townships in the dry zone and an estimated 8,000 villages face water shortages regularly due to drought conditions.

A. Drought monitoring and early warning in Asia-Pacific

The Regional Drought Mechanism has been configured to (i) provide the access to in-season earth observation satellite data and products, (ii) impart specialized capacity development training, and (iii) establish the sustained institutional partnership and networks for the regular flow of information and knowledge as well as technology transfer. The Mechanism is supported by regional service nodes,

¹ Data from the International Disaster Database.

specifically the National Remote Sensing Centre of China and National Remote Sensing Centre of Indian Space Research Organization.

The Mechanism functions by allowing member States to obtain free of charge access to otherwise costly satellite imagery, including high resolution products covering 10 to 50 square meter areas of land. Capacity building is also developed through the Mechanism on how to use these images with geographical information systems (GIS). The relevant government agencies would in turn analyze and share space-based information among stakeholders, while the national institutions would collect ground based information such as soil and moisture analysis. Using this information, government agencies would issue early warnings and initiate timely relief measures. The goal of the Mechanism is to support the agricultural community to respond accordingly to minimize the impacts of drought. Currently pilot projects under the Mechanism are being implemented in Mongolia and Sri Lanka, with future activities planned at the request of the Governments of Afghanistan, Cambodia, Myanmar and Nepal.

The discussion focused on the technical aspects of drought monitoring and challenges faced by countries around the world, including in the pilot countries of Mongolia and Sri Lanka where activities are already underway, particularly through presentations by the regional service node in China. Emphasis was given to the need for different methodologies, indicators and approaches for monitoring and analysis due to the varying characteristics of geographical zones. These approaches included the use of satellite remote sensing applications to monitor rainfall patterns, soil anomalies and soil moisture, and vegetation condition. Models discussed included the Tropical Rainfall Measuring Mission (TRMM of NASA) which indicates rainfall patterns that reflect drought conditions, the soil moisture anomaly method using data from AMSR-E (NASA's AQUA project) and MWRI (China's FY-3) for long term soil moisture evaporation analysis. The Normalized Difference Vegetation Index (NDVI) anomaly or ANDVI method using MODIS (AQUA) NDVI 16-day products and MODIS (TERRA also NASA) NDVI 16-day products, was also described as a method to evaluate crop conditions for comparison between the same periods year on year. The Vegetation Health Index (VHI) is used to look at the ratio of drought compared to an entire cultivated area.

In India, satellites were being used as part of a holistic disaster management support (DMS) system. Improved methodologies were being utilized for agricultural drought assessment, which uses relevant indicators such as Vegetation Index (VI) anomaly assessments and ANDVI more effectively. "Mild", "moderate" or "severe" drought warnings are issued to union and state governments, the Agricultural Ministry and the Relief Commissioners. The NADAM data analysis system is used for raw data processing and NDVI generation among other critical functions, and government organizations were using the information provided by the system for improved disaster related work. The Bhuvan Geoportal, provided by the service node from India, would be used for the Sri Lanka pilot project. NDVI anomalies, among other indicators, would be computed using this portal and its related software, and smart phones would be used for field data collection.

B. Outcomes in implementing the Regional Drought Mechanism in pilot countries

Details about the characteristics and impacts of drought were presented along with the experience in countries of the region on monitoring and early warning, including Mongolia, Sri Lanka, Cambodia and Myanmar. The experience and programmes of the FAO and WMO were also presented and the potential to synergize and combine the work of these organizations with that of the Mechanism was discussed.

Some of the specific gaps and needs identified were:

1. More capacity building on the application of earth observation (EO) applications for drought monitoring and early warning was needed.
2. Access to more near real time/in-season satellite imagery and data (medium to high resolution) that can be used by relevant organizations at the national level was of critical importance.
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. Support was needed for local focal agencies to fast-track implementation of mechanisms for national level institutional cooperation for more reliable drought monitoring and early warning in line with initiatives such as the National Spatial Data Infrastructure (NSDI) for information and data sharing between relevant Institutions.
5. Assistance is needed, through regional cooperation where applicable, to develop methodologies (using EO and remote sensing) applicable at national and sub-national levels to better understand drought related factors such as total cultivated paddy field area.
6. In the case of Sri Lanka, assistance was required with implementation and capacity building on a common geoportal in conjunction with existing portals, such as Bhuvan and Sri Lanka Water Information System/South-Asia Drought Monitoring Portal.
7. Support was needed by local organizations to develop mechanisms to ensure the accuracy of ground level information and data collection.
8. Assistance was needed, through regional cooperation where applicable, to develop indicators that are applicable at sub-national levels (for example for small plots of land) to improve the accuracy of drought monitoring and early warning.
9. Assistance and facilitation was needed to leverage regional cooperation to better carry out sub-seasonal forecasts and prediction of intra-seasonal variability of rainfall.

In Sri Lanka, rainfall and temperature variations over the past few decades, and predicted patterns for the future, indicate that drought conditions will be more severe and frequent, increasing the vulnerability of food crops and in turn livelihoods of farmers. Advanced and innovative approaches to drought monitoring and early warning which have not been employed as yet must be developed.

Tapping into local traditional knowledge on water management, as well as satellite applications, would increase the effectiveness of drought monitoring and early warning. Through the pilot project, local practitioners were already gaining valuable knowledge and skills from the capacity building efforts including in the area of indicators and satellite imagery. The key stakeholders involved include the Department of Agrarian Development, the Department of Agriculture, the Department of Meteorology, the Department of Irrigation, the Mahaweli Authority, the Department of Census & Statistics, and the Disaster Management Center.

In Sri Lanka, the existing interagency working group which is comprised of the relevant agencies dealing with drought, have found that there were gaps when it comes to coordination and cooperation and that there is a need for a comprehensive mechanism for handling drought situations. These gaps affected the work of the organizations dealing with drought in Sri Lanka. The linkages among the agencies dealing with crops and water can be strengthened further to improve monitoring and early warning.

In Mongolia, pilot project activities were already enhancing the capacity for drought/dzud monitoring and early warning. The first year focused on accurate determination of drought using remote sensing data while the second year will involve establishing a drought/dzud early warning information system. Various expert group meetings and activities had been carried out so far. Remote sensing related indicators were being refined and field data gathering efforts and improved techniques were also being developed. Currently, national funding to carry out field data gathering was a challenge.

In Cambodia and Myanmar, a need for more comprehensive drought monitoring and early warning was identified, with activities commencing soon. The effects of drought appear to be increasing as a result of higher temperatures, water crises and possible climate change related factors, resulting in land degradation, lower yields, crop damage and failure, increased livestock deaths and increased risk of wildfire. Since agriculture contributed to over 40 per cent of GDP in Myanmar, drought was considered a serious impediment to the livelihoods of the people. In Viet Nam, drought affects all the regions. Remote sensing and satellite applications were currently being used and more research into these areas was underway.

Drought is an annual phenomenon in Bangladesh and can be very severe in some parts of the country. About 2.18 million tons of rice was damaged due to drought from 1973 to 1987. Presently drought is managed mainly through irrigation in response to single events. An operational drought monitoring system that dispatches early warnings, including predictions and actual information on extent and intensity, does not exist in the country. Similarly, in Pakistan droughts are very frequent and can be devastating. Work is being done to issue early warnings, but a more systematic approach is needed through further utilization of satellite applications.

In the Philippines, damage to rice harvests and related losses has accumulated over the years prompting research and development of mechanisms for monitoring and early warning. It was recognized that using remote sensing for this purpose would help alleviate the impacts of drought. In the Republic of Korea, drought monitoring and early warning was at a more advanced stage with various agencies already sharing digital and other information through advanced ground and space based systems that

were interconnected. However, there were still problems encountered due to the complexity of the data that was being shared and the sheer magnitude of linkages involved in the communication process. A similar situation exists in the Russian Federation where the technology, including satellite applications, was advanced. There were also challenges related to accurate drought prediction and early warning due to the definition of what is considered a drought event.

The work carried out by FAO included the FAO-Agriculture Stress Index System (ASIS), institutional strengthening, policy formulation support, capacity development and the development of publications relating to disaster risk reduction. The WMO was also currently doing extensive work on drought by working with many countries and international partners, including ESCAP.

C. Drought scenarios in Asia-Pacific

The need for building longer time scales for drought and climate modeling capitalizing on science, technology and innovation for adaptation and resilience was noted. El Nino/La Nina impacts on the Asia-Pacific region were also discussed in detail based on the research and activities of the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES). Other presentations included implementation of the integrated drought management programme's (IDMP) South Asian Drought Monitoring System of the Global Water Partnership (GWP), and ongoing drought monitoring research by the International Water Management Institute (IWMI) in South Asia using remote sensing and water resources management.

D. Regional support for drought monitoring

Standard operating procedures (SOPs) for the regional service nodes were discussed in detail and it was agreed that the pilot countries would work with the service nodes to build the effectiveness of the Mechanism. These SOPs would be customized to meet the specific needs of each pilot country. Establishment of a thematic working group (TWG) for drought monitoring as part of RESAP was discussed as well as the development of the SOPs for the ad-hoc Secretariat of the Regional Drought Mechanism, and strategic partnerships needed.

E. The way forward

The success of the pilot projects in Mongolia and Sri Lanka would feed into the work in Cambodia and Myanmar as well as other countries which show interest to participate. Development of strategic partnerships with the support of ESCAP and other international organizations, using existing modalities such as the Regional Drought Monitoring Mechanism were critical to improving resilience.

For Sri Lanka, it was evident that the regional service nodes, ESCAP and other international partners would continue to provide support in regard to drought monitoring and early warning. However, the way forward required more commitment and actions from the various agencies. Discussions were already underway to fill the gaps that could not be met by other partners on the local level. The conclusions and list of recommendations, outlined in Part I of this report, were agreed during the wrap-up session.

III. Organization of the Meeting

A. Opening, duration and organization

The Regional Forum on Space Technology Applications for Drought Monitoring and Early Warning was organized in Colombo, Sri Lanka, from 1 to 2 July 2014 to review the success and key outcomes of the activities in pilot countries and identify the gaps and challenges of implementing activities under the Regional Drought Mechanism. The meeting was also convened to discuss administrative issues important for operationalizing the pilot projects on Drought Monitoring and Early Warning, such as the development of standard operating procedures (SOPs) for the regional services nodes, the terms of reference of the Thematic Working Group under the Regional Space Applications Programme for Sustainable Development (RESAP), to guide development of the Mechanism and the development of strategic partnerships with key institutions. The meeting was organized by ESCAP in collaboration with the local partner Arthur C. Clarke Institute for Modern Technologies (ACCIMT).

The meeting was opened and the Key Note speech was delivered by the Minister of Technology and Transport, Honorable Patali Champika Ranawaka. During the 2 day forum, 30 presentations were made by representatives from 13 member States, 7 Government of Sri Lanka organizations, and 7 International agencies including ESCAP, Food and Agriculture Organization (FAO), World Meteorological Organization (WMO), Regional Integrated Multi-Hazard Early Warning Systems for Africa and Asia (RIMES), Integrated Water Management Institute (IWMI), Consortium for Global Integrated Agriculture Research (CGIAR), Global Water Partnership (GWP).

B. Attendance

The meeting was attended by representatives from 13 member States, 7 International Agencies, 24 Departments and organizations from Sri Lanka including Universities and private sector organizations.

Regional Forum on Space Technology Applications for Drought Monitoring and Early Warning

Mount Lavinia Hotel, Galkissa
Colombo, Sri Lanka, 1 - 2 July 2014

Programme

DAY 1		
Registration 08:30 - 08:55		
09:00-10:00 Opening Session		
5 min	09:00-09:05	Lightning of the Traditional Oil Lamp
5 min	09:05-09:10	National Anthem
10 min	09:10- 09:20	Welcome Address by Prof. H. Y. Ranjith Perera, Chairman, Arthur C. Clarke Institute for Modern Technologies (ACCIMT)
10 min	09:20-09:30	Welcome remarks by Shamika Sirimanne, Director, Information and Communications Technology and Disaster Risk Reduction Division, ESCAP
10 min	09:30-09:40	Introduction to the Forum by Eng. Sanath Panawennage, Director General & CEO, ACCIMT
20 min	09:40-10:00	Keynote speech by Hon Patali Champika Ranawaka, Minister of Technology and Research, Sri Lanka
10:00-10:20 Coffee break		
10:20-11:15 Drought monitoring and early warning in Asia-Pacific (Chair: ACCIMT)		
15 min	10:20-10:35	<i>Introduction to the Regional Drought Mechanism</i> , Mr. Keran Wang, Chief, Space Applications Section, ESCAP
15 min	10:35-10:50	<i>Monitoring drought from space - experience from China</i> , Dr. Bingfang WU, Institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Sciences (CAS), Representing the Regional Service Node in China for the Regional Drought Mechanism
15 min	10:50-11:05	<i>Monitoring drought from space - experience from India</i> , Dr. PG Diwakar, National Remote Sensing Center, Indian Space Research Organization (ISRO), Representing the Regional Service Node in India for the Regional Drought Mechanism
10 min	11:05-11:15	<i>Discussion – technical aspects of drought monitoring and challenges from the perspective of the Regional Service Nodes</i>

11:15-12:45 Outcomes in implementing the Regional Drought Mechanism in pilot countries (Chair: RIMES)		
20 min	11:15-11:35	<i>Country Drought Profile and Role of the Dept. of Agrarian Development in the context of the project</i> , Eng. Prabath Witharana, Department of Agrarian Development
12:45-13:45 Lunch		
20 min	13:45-14:05	<i>Drought monitoring in Sri Lanka - lessons learned and the way forward</i> , Ms. Chandima Subasinghe, Research Scientist, ACCIMT
25 min	14:05-14:30	<i>Drought monitoring in Mongolia - lessons learned and the way forward</i> , Ms. B. Davdai, National Remote Sensing Center, Ministry for Nature, Environment and Tourism, Mongolia
20 min	14:30-14:50	<i>Drought and the potential for early warning in Cambodia</i> , Mr Phoeun Sophak, National DRR Forum Coordinator & Executive Assistant to the Secretary General, National Committee for Disaster Management, Cambodia
20 min	14:50-15:10	<i>Drought and the potential for early warning in Myanmar</i> , Ms. May Khin Chaw, Department of Meteorology and Hydrology, Myanmar
20 min	15:10-15:30	<i>FAO's perspective on drought preparedness and response</i> , Mr. Yuji Niino, Land Management Officer, FAO
20 min	15:30-15:50	<i>WMO Overview on Drought Monitoring Systems – Integrated Drought Management Programme</i> , Mr. Jose Luis Camacho Ruiz, Scientific Officer, WMO
	15:50-16:00	Discussion
16:00-16:15 Coffee Break		
15:40-17:05 Outcomes in implementing the Regional Drought Mechanism in pilot countries - Good practices in drought monitoring and early warning (Chair: FAO)		
15 min	16:15-16:30	<i>Drought Monitoring in Bangladesh: Present Status and Future Programs</i> , Mr. A. Z. Md. Zahedul Islamm, Principal Scientific Officer, Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Bangladesh
10 min	16:30-16:40	<i>Role of the Dept. of Agriculture in the context of the project</i> , Ms. W.M.U.K. Rathnayake, Research Officer, Department of Agriculture
15 min	16:40-16:55	<i>Space technology for early warning and climate monitoring</i> , Dr. Yu, Senior Researcher, National Disaster Management Institute (NDMI), Republic of Korea
10 min	17:05-17:15	<i>Role of the Dept. of Meteorology in the context of the project</i> , Ms Shiromani Jayawardane, Deputy Director, Department of Meteorology
15 min	17:15-17:30	<i>Drought monitoring and management in Pakistan</i> , Mr. Rahmatullah Jilani, Director Earth Sciences, Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), National Space Agency of Pakistan
10 min	16:45-16:55	<i>Role of the Dept. of Irrigation in the context of the project</i> , Eng. L.G.A Edirisinghe, Chief Engineer, Department of Irrigation

15 min	16:55-17:10	<i>Philippine experience on drought monitoring</i> , Mr. Raul C. Sabularse, Deputy Executive Director, Philippine Council for Industry Energy and Emerging Technology Research and Development (PCIERD)
10 min	17:10-17:20	<i>Role of the Mahaweli Authority in the context of the project</i> , Mrs. J.M.I.H. Indika, Physical Planner, Mahaweli Authority
10 min	17:20-17:30	Daily wrap up by ESCAP/ACCIMT
DAY 2		
09:00-10:20 Outcomes in implementing the Regional Drought Mechanism in pilot countries - Good practices in drought monitoring and early warning (continued)		
15 min	09:00-09:15	<i>Use of Satellite and In-Situ Data for Drought Monitoring in the Russian Federation</i> , Mr. Oleg Virchenko, National Institute on Agricultural Meteorology, Russian Federation
10 min	09:15-09:25	<i>Role of the Dept. of Census & Statistics in the context of the project</i> , Department of Census & Statistics (to be confirmed)
15 min	09:25-09:40	<i>Drought monitoring and management in Viet Nam</i> , Mr. Dat Ngoc Dinh, Deputy Head of Department, Space Technology Institute, Viet Nam
10 min	09:40-09:50	<i>Role of the Disaster Management Center in the context of the project</i> , Disaster Management Center
30 min	09:50-10:20	Discussion – perspectives from non-pilot countries and how they can be adapted to monitoring drought?
10:20-10:35 Coffee Break		
10:35-12:05 Drought scenarios in Asia-Pacific (Chair: WMO)		
20 min	10:35-10:55	<i>Managing Drought in Changing Climate: Capitalizing on Science, Technology and Innovation for adaptation and resilience</i> , Mr. Sanjay Kumar Srivastava, Chief, Disaster Risk Reduction Section, ESCAP
20 min	10:55-11:15	<i>El Nino/La Nina impacts on Asia-Pacific</i> , Mr. A.R. Subbiah from the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)
15 min	11:15-11:30	<i>Implementation of integrated drought management programme (IDMP) South Asian Drought Monitoring System</i> , Ms. Priyanka Dissanayake, Regional Coordinator, Global Water Partnership (GWP)
15 min	11:30-11:45	<i>Ongoing Drought Monitoring Research in South Asia</i> , Mr. Giriraj Amarnath, Researcher, Remote Sensing & Water Resources, International Water Management Institute (IWMI)
20 min	11:45-12:05	Discussion – building longer time scales into drought or climate modeling.
12:05-12:45 Regional support for drought monitoring, (Chair: ACCIMT)		
20 min each	12:05-12:45	<i>Developing a SOP for the regional service nodes</i> <ol style="list-style-type: none"> 1. Mr. Wu Guoxiang, Senior Advisor, National Remote Sensing Center of China, Ministry of Science and Technology 2. Dr Sesha Sai, Group Head, Agricultural Sciences & Applications, National Remote Sensing Center, Indian Space Research Organization (ISRO)

12:45-13:45 Lunch		
13:45-15:00 Regional support for drought monitoring (continued)		
20 min	13:45-14:05	<i>Establishing a Thematic Working Group (TWG) for drought monitoring - Introduction and discussion on TOR of TWG</i> Kelly Hayden, Space Applications Section, IDD, ESCAP
20 min	14:05-14:25	<i>Developing the SOP for the ad hoc Secretariat of the Regional Drought Mechanism</i> Sanjay Kumar Srivastava, Chief, Disaster Risk Reduction Section, IDD, ESCAP
20 min	14:25-14:45	<i>Developing strategic partnerships with international organizations,</i> Mr. A.R. Subbiah, Director, Regional Integrated Multi-Hazard Early Warning System
15 min	14:45-15:00	<i>Discussion – building stronger partnerships and regional support</i>
15:00-15:20 Coffee Break, Secretariat prepare the Summary		
15:45-16:30 Way forward		
15 min	15:20-15:35	<i>The way forward for drought monitoring and response in Sri Lanka – building national institutional capacity,</i> Eng. Sanath Panawennage, Director General & CEO, ACCIMT
20 min	15:35-15:55	Wrap up summary, ESCAP
5 min	15:55-16:00	Close session

**Regional Forum on Space Technology Applications for Drought Monitoring
and Early Warning
Colombo, Sri Lanka, 1-2 July 2014**

LIST OF PARTICIPANTS

BANGLADESH

Mr. A. Z. Md. Zahedul Islam, Principal Scientific Officer, Bangladesh Space Research and Remote Sensing Organization (SPARRSO), Agargaon, Sher-e-Bangla Nagar, Dhaka-1207, Tel: +88-02-8124198, Fax: +88-02-9122473, Mob: +88-01715028741, Email: azmd_zahed@yahoo.com

BHUTAN

Mr. Sonam Tobgay, Survey Engineer, Cadastral Information Division, National Land Commission, Kawangjansa, P.O. Box 142, Thimphu, Mob: +975-17651793, Email: stobgay7@gmail.com

CAMBODIA

Mr. Sophak Phoeun, National Disaster Risk Reduction (DRR) Forum, and Executive Assistant to H.E. Ly Thuch, Vice President, National Committee for Disaster Management, National Committee for Disaster Management (NCDM), No. 516, Sangkat Toul Sangke, Khan Russey Keo, Phnom Penh, Tel: +855 23 882605, Fax: +855 23 882605, Mob: +855 17 377747, Email: sophakphoeun@ncdm.gov.kh

Mr. Phlang Ponleu Rath, Director, Department of Disaster Information Management, National Committee for Disaster Management, St. 156, Sangkat Toul Sangke, Khan Rouesset Keo, Phnom Penh, Tel: +855 23 882045, Fax: +855 23 882045, Mob: +855 17 868425, Email: ponleurath@ncdm.gov.kh

CHINA

Mr. Guoxiang WU, Senior Advisor, National Remote Sensing Center, No. 15b, Fuxing Road, Beijing 100862, Tel: +86-10-58881195, Fax: +8610-58881185, Mob: +8613 681107759, Email: wugx77@hotmail.com

Mr. Bingfang WU, Professor, Institute of Remote Sensing and Digital Earth, Chinese Academy of Science, No. 1, Beichen West Road, Dhaoyang District, Beijing 100101, Email: wubf@radi.ac.cn

INDIA

Mr. P.G. Diwakar, Director, EOS, ISRO HQ, Bangalore, Tel: +91 80 2341 6356, Fax: +91 80 2341 5298, Email: scientificsecretary@isro.gov.in

Mr. Sessa Sai Venkata Rama Mullapudi, 12-13-70, FF2 Bhavani Mansions, Street No. 4, Tarnaka, Hyderabad, Tel: 91-40-2700 2893, Email: seshasai_mvr@nrsc.gov.in, seshasaimvr@rediffmail.com, seshasaimvr@rediffmail.com, seshasai_mvr@nrsc.gov.in

MONGOLIA

Ms. Bulgan Davdai, Remote Sensing Engineer, Environmental Information Center/National Remote Sensing Center, EIC, Juulchiny Street – 5, Baga Toiruu-3, Ulaanbaatar 15160, Mongolia, Tel: +976-70110638, Fax: +976-329968, Mob: +976-99936442, Email: nd_bulgan@yahoo.com

MYANMAR

Ms. May Khin Chaw, Deputy Director, Department of Meteorology & Hydrology, Ministry of Transport, Nay Pyi Taw, Myanmar, Tel: +95-674-11031, Fax: +95-674-11449, Mob: +95-9250190161, Email: mkhinc@gmail.com

NEPAL

Mr. Rishi R. Sharma, Director General and Permanent Representative of Nepal with WMO Department of Hydrology and Meteorology P.O. Box 406 Babarmahal, Kathmandu, Tel: +977 1 4262974, Mob: +977 985 11 47653 Fax: +977 1 4254890, Email: dg@dhm.gov.np, rishisharm@yahoo.com

PAKISTAN

Mr. Rahmatullah Jilani, Director Earth Sciences, Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), National Space Agency of Pakistan, SUPARCO Headquarters, SUPARCO Road, P.O. Box 8402, Karachi-75270, Email: rahmatullahjilani@gmail.com, diradrpc@suparco.gov.pk

PHILIPPINES

Mr. Raul C. Sabularse, Deputy Executive Director, Philippine Council for Industry Energy and Emerging Technology Research and Development (PCIERD), 4th Floor, Science Heritage Bldg., Gen Santos Ave., Bicutan Taguig City, Tel: +632-837-2926, Fax: +632-837-2925, Email: raulsabu@gmail.com

KOREA (REPUBLIC OF)

Mr. Jung Hum Yu, Senior Researcher, National Disaster Management Institute, 136 Mapo-daero, Mapo-Gu, Seoul, Tel: +82-2-2078-7771, Fax: +82-2-2078-7789, Mob: +82-10-3436-2739, Email: ru2000@korea.kr

Mr. Gunshik Shin, Senior Researcher, National Disaster Management Institute, 136 Mapo-daero, Mapo-Gu, Seoul, Tel: +82-2-2078-7747, Fax: +82-2-2078-7789, Mob: +82-10-6617-9994, Email: gshik.shin@korea.kr

RUSSIAN FEDERATION

Mr. Oleg Virchenko, Head of Division, National Institute on Agricultural Meteorology, 82, Lenin St., Obningn, Koluge Region, Tel: +7-484-39-44599, Fax: +7-484-39-44388, Mob: +7-910-914-9936, Email: v_oleg2000@yahoo.com

SRI LANKA

Mr. D. D. Prabath Witharana, Engineer, Department of Agrarian Development, Department of Agrarian Development, Email: watmngcolombo@yahoo.com

Mr. Z. A. M. Faizal, Commissioner (Development), Department of Agrarian Development, Email: faizalzam@yahoo.com

Mr. A. Z. J. Singarayer, Senior Engineer Assistant, Department of Agrarian Development, Email: Jeenosingarayer@gmail.com

Mr. L. G. A. Edirisinghe, Chief Engineer, Department of Irrigation, Email: anandaedirisinghe@yahoo.com

Mr. K. K. A. Piyasena, Chief Engineer, Department of Irrigation, Email: arunapiyas@yahoo.com

Eng. J. J. Abeysekara, Irrigation Engineer, Department of Irrigation, Email: eng.jayanath@gmail.com

Mr. L.R.H. Perera, Chief Engineer, Department of Irrigation, Email: lrhperera@yahoo.com

Ms. Janaki Eegaswewa, Director of Irrigation, Department of Irrigation, Email: diwm.irrigation@gmail.com

Mr. W. P. S. Sisirathna, Statistician, Department of Census & Statistics, Email: samanthastat@yahoo.com

Mr. Srimal Samarasiri, AD (R&D), Disaster Management Center, Email: srimal@dmc.gov.lk

Mr. Pradeep Kodippili, Assistance Director, Early Warning, Disaster Management Center

Mr. Nuwan Prasantha Madawan Arachchi, Assistance Director, Disaster Management Center

Mr. S.R.Jayasekara, Director, Department of Meteorology, Email: siriranjith1957@gmail.com

- Ms. Shiromani Jayawardane, Deputy Director, Department of Meteorology, Email: shirojaya2000@yahoo.com
- Mr. Athula Priyantha, Meteorological Officer, Department of Meteorology, Email: athulapriyantha@hotmail.com
- Mr. B.J.Jayasekera, Communication Officer, Department of Meteorology, Email: JayasekaraBj@yahoo.com
- Mr. H.R.C.Herath, Director Land Use Planning, Department of Meteorology, Email: Herath73@yahoo.com
- Mr. H.S. Leelananda, Director Land Use Planning, Mahaweli Authority, Email: leela1968@gmail.com
- Mr. S.M.Piyathalaka, Water Mgmt. Sect. Mahaweli Authority, Email: hypermalu@gmail.com
- Mr. Lahiru Pratbath Gangabada, Project Planning Office, Mahaweli Authority, Email: lahirutcp@gmail.com
- Mrs. J.M.I.H. Indika, Physical Planner, Mahaweli Authority, Email: jindikaharshani@yahoo.com
- Mr. A. K. Hettiarachchi, Development Assistant, Department of Agriculture, Email: ajithks@yahoo.com
- Ms. W.M.U.K. Rathnayake, Research Officer, Department of Agriculture, Email: upulr@yahoo.co.uk
- Ms. D.G.P.S. Delpitiya, Research Officer, Department of Agriculture, Email: punya14@yahoo.com
- Ms. M.D.M. Gunawardhana, Research Officer, Department of Agriculture, Email: dilanimanjula@gmail.com
- Mr. Sanath Panawennage, Director General & CEO, **Arthur C Clarke Institute of Modern Technologies**, Email: sanathslbc@yahoo.com
- Ms. Kamani Ediriweera, Deputy Director General, **Arthur C Clarke Institute of Modern Technologies**, Email: kamani@accmt.ac.lk
- Mr. Saraj Gunasekara, Senior Research Scientist, Arthur C Clarke Institute of Modern Technologies, Email: saraj@accmt.ac.lk
- Mr. Mohamed Rila, Research Scientist, Arthur C Clarke Institute of Modern Technologies, Email: armohomedrila@yahoo.com
- Mr. Sampath Marasinghe, Research Scientist, Arthur C Clarke Institute of Modern Technologies, Email: sampath@accmt.ac.lk

Mr. Lavanan Vengadasalam, Research Engineer, Arthur C Clarke Institute of Modern Technologies, **Email:** lavanan@accmt.ac.lk

Ms. Chandima Subasinghe, Research Scientist, Arthur C Clarke Institute of Modern Technologies, **Email:** Chandima1983gmail.com

Mr. Indika Medagangoda Research Scientist, Arthur C Clarke Institute of Modern Technologies, **Email:** indika@accmt.ac.lk

Mr. Janaka Addassuriya Research Scientist, Arthur C Clarke Institute of Modern Technologies, **Email:** janaka@accmt.ac.lk

VIET NAM

Mr. Dat Ngoc Dinh, Deputy Head of Department, Space Technology for Environment Research Space Technology Institute 18 Hoang Quoc Viet, Hanoi, Tel: +84-4-3791-3801, Fax: +84-4-3791-4622, Mob: +84-915089159, Email: dndat.gis@gmail.com, dndat@sti.vast.vn

UNITED NATIONS SPECIALIZED AGENCIES AND RELATED ORGANIZATIONS

<p>Food and Agriculture Organization of the United Nations (FAO)</p>	<p>Mr. Yuji Nino Land Management Officer 39 Pra Atit Road Bangkok 10200, Thailand Tel: +66 2 697 4213, Fax: +66 2 697 4445 Mob: ++66 81 869 1925 Email: yuji.niino@fao.org</p>
<p>World Meteorological Organization (WMO)</p>	<p>Mr. Jose Camacho Scientific Officer Agricultural Meteorology Division Climate and Water Department 7bis Avenue de la Paix, H-1211 Geneva 2, Switzerland Tel: +41-22-7308357, Mob: +33-647-565434 Email: jcamacho@wmo.int</p>

OTHER ENTITIES

<p>International Water Management Institute (IWMI)</p>	<p>Mr. Jeremy Bird Director General Telephone: +94-11 2880000, 2784080 Fax: +94-11 2786854 Email: b.jeremy@cgiar.org, iwmi@cgiar.org</p> <p>Ms. Priyanka Dissanayake Regional Coordinator Global Water Partnership – South Asia (GWP-SAS) Office Telephone: +94-11-2880000 Ext. 3301 Fax: +94-11-2786854 E mail: p.dissanayake@cgiar.org</p> <p>Mr. Giriraj Amarnath Researcher Remote Sensing & Water Resources Tel: +94-11-2880000, Mob: +94-773295303 Email: a.giriraj@cgiar.org</p> <p>Mr. Vladimir Smakhtin Theme Leader Water Availability and Access Telephone: +94-11 2880000, 2784080 Fax: +94-11 2786854 Email: s.vladimir@cgiar.org, iwmi@cgiar.org</p> <p>Mr. Lal Induruwage Program Manager GWP South Asia Email l.induruwage@cgiar.org</p> <p>International Water Management Institute 127, Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka</p>
<p>Regional Integrated Multi-Hazard Early Warning System (RIMES)</p>	<p>Mr. A.R. Subbiah Director Email: subbiah@rimes.int</p> <p>Mr. Itesh Dash System Analyst, Hydrometeorological Systems</p>

	<p>Email: itesh@rimes.int</p> <p>Mr. Khagendra Prahad Bharambe Agro-Climate Decision Support System Specialist Email: khagendra@rimes.int</p> <p>Ms. Ruby Rose Policarpio Institutional Development Specialist Mb: 084 4369583 Email: ruby@rimes.int</p> <p>Mr. Jothiganesh Shanmugasundaram Email: jothiganesh@rimes.int</p> <p>Mr. Ramraj Narasimhan Team Leader-Climate Risk Management</p> <p>1st Floor, Outreach Building, Asian Institute of Technology (AIT) Campus 58 Moo 9, Paholyothin Road, Klong Nung (PO Box 4), Klong Luang, Pathumthani 12120 Thailand Tel: +662 516 5900 to 01 Fax: +662 516 5902</p>
--	---

ESCAP SECRETARIAT

Ms. Shamika Sirimanne	<p>Director Information and Communications Technology and Disaster Risk Reduction Division (IDD) Bangkok, Thailand Tel: +662 2881638 Fax: +662 2883012/1085 Email: Sirimanne@un.org</p>
Mr. Keran Wang	<p>Chief Space Applications Section Information and Communications Technology and Disaster Risk Reduction Division (IDD) Bangkok, Thailand Tel: +662 2881456 Fax: +662 2883012/1085 Email: wangk@un.org</p>
Mr. Sanjay Kumar Srivastava	<p>Chief Disaster Risk Reduction Section Information and Communications Technology and Disaster Risk Reduction Division (IDD)</p>

	Bangkok, Thailand Tel: +662 2882633 Fax: +662 2883012/1085 Email: Srivastava@un.org
Ms. Kelly Hayden	Economic Affairs Officer Space Applications Section Information and Communications Technology and Disaster Risk Reduction Division (IDD) Bangkok, Thailand Tel: +662 2881544 Fax: +662 2883012/1085 Email: haydenk@un.org
Mr. Preminda Fernando	Consultant Space Applications Section Information and Communications Technology and Disaster Risk Reduction Division (IDD) Bangkok, Thailand Email: prenzila@truemail.co.th
