PROCEEDINGS REPORT

INTERACTIVE WORKSHOP ON THE SOUTH ASIA DROUGHT MONITORING SYSTEM (SADMS)

Bangladesh Meteorological Department
Dhaka, BANGLADESH,

20 April 2015

Global Water Partnership South Asia | WMO | IWMI International Water Management Institute | CGIAR | Research Program on Climate Change, Agriculture and Food Security | CCAFS

www.gwp.org/en/gwp-south-asia

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ABBREVIATIONS AND ACRONYMS

ADAMS	Agriculture Drought Assessment Monitoring System
APAN	Asia Pacific Adaptation Network
BMD	Bangladesh Meteorological Department
BUET	Bangladesh University of Engineering Technology
BWP	Bangladesh Water Partnership
CCAFS	Climate Change Agricultural Food Security
CSI	Crop Sensitivity Index
CSUF	Climate Services User Forum
CWP	Country Water Partnership
DDM	Department of Disaster Management
GDP	Gross Domestic Product
GFCS	Global Framework for Climate Services
GLOF	Glacial Lake Outburst Flood
GWP	Global Water Partnership
GWP SAS	Global Water Partnership South Asia GWP SAS
IARI	Indian Agriculture Research Institute
ICID	International Commission for Irrigation and Drainage
ICIMOD	International Centre for Integrated Mountain Development
IDMP	WMO/GWP Integrated Drought Management Programme
IDM	Integrated Drought Management
IDSI	Integrated Drought Severity Index
IWM	Institute of Water Modelling
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
NADAMS	National Agricultural Drought Assessment Monitoring Systems
NDVI	Normalised Deference Vegetation Index
NDWI	Normalised Deference Water Index
OECD	Organisation for Economic Cooperation Development
PCI	Precipitation Condition Index
RCI	Rainfall Condition Index
RWP	Regional Water Partnership
SAARC DMC	South Asian Association for Regional Cooperation Disaster Management Centre
SADMS	South Asia Drought Monitoring System
SADEWS	South Asia Drought Early Warning
SASCOF	South Asian Climate Outlook Forum
SCI	Soil Moisture Condition Index
SPI	Standard Precipitation Index
STD	Standard Deviation
TCI	Temperature Condition Index
VCI	Vegetation Condition Index
WLE	Water, Land and Eco Systems
WMO	World Meteorological Organisation

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EXECUTIVE SUMMARY

The Interactive workshop on South Asia Drought Monitoring System (SADMS) held in Dhaka, Bangladesh on 20 April 2015. Nearly 30 climate and water experts, researchers, universities and decision makers, representing the South Asia region, International Water Management Institute (IWMI), Global Water Partnership South Asia (GWP SAS), Global Water Partnership Secretariat (GWPO) and World Meteorological Organization (WMO) attended the workshop. Afghanistan was not able attended due to inevitable circumstances.

The project "Development of South Asia Drought Monitoring System" was initiated as a joint undertaking of IWMI, G0WP SAS and the WMO/GWP IDMP. The workshop was an interim consultation with national counterparts to validate the system at the end of the Phase I of the project, before it is made operational and to tailor it with the end user requirements.

The objectives of the workshop were to;

1. Present a beta version of the SADMS in corporation with national partners in South Asia,
2. Have a dialogue with national partners of their country requirements to ensure it responds to the need of users,
3. Start a discussion on how to integrate the results of the SADMS to regional, national and state level decision making processes.
4. To have initial awareness on the final product and attract the attention of key actors in the water and climate community.

Overview of Drought Programme and SADMS Programme was given by IWMI and GWP SAS while the country representatives shared their experience on current drought monitoring activities and its implementation in their own countries with specific examples. The final session was dedicated to discuss the implementation and way forward of the SADMS.

The key recommendations to be addressed during the SADMS development and implementation given by institutions are; use simplified input data and gain user acceptance by having a clear understanding on the drought risks used in SADMS, include ground verification of the results, uncertainty to be communicated clearly to users, update the system by including outputs of National Climate Outlook Forums, involving the government agencies and users from the beginning in SADMS development and gaining their ownership towards the product and the product has the potential to be evolved into a SADEWS. Two possible models identified to maintain the sustainability of SADMS were; identifying nodes and sub nodes/mirror images of nodes at the country level or development of a regional level node for the countries who does not have similar capacity as the region and the regional node to act and serve equally to the corresponding countries.

ORGANISERS

Global Water Partnership South Asia

Global Water Partnership (GWP) was founded in 1996 to foster Integrated Water Resources Management (IWRM) which is defined as the coordinated development and management of water, land, and related resources in order to maximise economic and social welfare without compromising the sustainability of vital environmental systems. Since its inception, the GWP has built up a network of Regional Water Partnerships (RWPs). The Network currently comprises 13 Regional Water Partnerships and 85 Country Water Partnerships (CWPs), and includes over 3000 partners located in 178 countries.

The aim of Global Water Partnership South Asia (GWP SAS) is to support South Asian countries in the sustainable development and management of their water resources and to fully promote and apply an IWRM approach at the community, national and regional levels.

The International Water Management Institute

The International Water Management Institute (IWMI) is a non-profit, scientific research organisation focusing on the sustainable use of water and land resources in developing countries. It is headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. IWMI is a member of CGIAR, a global research partnership for a food-secure future.

World Meteorological Organization

The World Meteorological Organization (WMO) is a specialised agency of the United Nations on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. WMO has a membership of 191 Member States and Territories (for 2013). Established in 1950, WMO became the specialised agency of the United Nations in 1951 for meteorology (weather and climate), operational hydrology and related geophysical sciences.

As weather, climate and the water cycle know no national boundaries, international cooperation at a global scale is essential for the development of meteorology and operational hydrology as well as to reap the benefits from their application. WMO provides the framework for such international cooperation.

WMO/GWP Integrated Drought Management Programme (IDMP)

The Integrated Drought Management Programme (IDMP) was launched by WMO and GWP at the High Level Meeting on National Drought Policies in March 2013. The IDMP works with a wide range of partners with the objective of supporting stakeholders at all levels by providing them with policy and management guidance through globally coordinated generation of scientific information and sharing best practices and knowledge for integrated drought management. The IDMP is a contribution to the Global Framework for Climate Services (GFCS), especially with regards to GFCS priority areas of disaster risk reduction, water, agriculture and food security. It especially seeks to support regions and countries to develop more proactive drought policies and better predictive mechanisms and these guidelines are a contribution to this end; www.droughtmanagement.info

The Workshop on the South Asia Drought Monitoring System (SADMS) was held in conjunction with the 6th South Asian Climate Outlook Forum (SASCOF-6), which issued its seasonal outlook, predicting below-average rainfall over large tracts of South Asia during the forthcoming summer monsoon.

The Climate Service User Forum (CSUF) for the water community was also held in conjunction with SASCOF-6. A continuation of the initiative started at SASCOF-5 it aimed to further the link between climatological forecasting and hydrological forecasting with detailed discussion on how to improve water management decisions.

INTRODUCTION

South Asia has the largest global concentration of water related risks, including severe impacts of full range of hydrological variability (floods and droughts); the largest global concentration of people without adequate sanitation; and growing environmental threats (GWP/OECD 2015) South Asia, with 20 per cent of the world's population and 40 per cent of the world's poor, is one of the most food insecure regions of the world. It has been estimated that of the total one billion food insecure people in the world, 30 per cent live in South Asia. The economic damage caused by drought in agriculture is huge and growing. Effective tools for monitoring drought, for an objective quantification of damages or for the design and implementation of preventive measures, remain limited. Information on the development and possibility of development is based solely on meteorological data, which are limited in principle. Conditions of vegetation and soil moisture are not yet monitored. Reliable detection of drought emergence and progression at regional level remains challenging.

A Needs and Capacity Assessment Survey on drought monitoring was conducted in Afghanistan, Bhutan, Bangladesh, Maldives, Nepal, India, Pakistan and Sri Lanka with the support of the CWPs of GWP SAS. It revealed that there is no validated system of early warning on drought that could meet the requirement for a high spatial resolution in any of the surveyed countries. Challenges that countries face include lack of hydrological/ meteorological measurement stations, missing access to satellite data, insufficient rainfall prediction capability, or shortage of well-trained staff. In the assessment, the respondents came to similar conclusions that agriculture is the most vulnerable sector to drought. The report recommends the involvement of users and relevant government agencies throughout the project. Their involvement will be the key to the drought monitor's success and particularly for housing and ownership of the system nationally and regionally. The report also states the need for clarity in the system to enhance understandability, considering the political nature of drought and the importance in data verification through on the ground observations.

In this context, the project on "***Development of South Asia Drought Monitoring System***" was initiated as a joint undertaking of IWMI, GWP SAS and the WMO/GWP IDMP. The key partners are intergovernmental, governmental and non-governmental organisations involved in drought monitoring, prediction, drought-risk reduction and management.

The primary objective of the project is to develop and implement an innovative approach for monitoring and assessment of the drought risk based on integration of meteorological data, vegetation condition from satellite imagery and targeted collection of ground truth moisture and crop-yield data that supports efforts directly at increased resilience to drought. The project will develop an online drought monitoring system for South Asia that will be based on spatial composite maps of drought indices updated approximately every week or two – as new Remote

Sensing data becomes available from public sources and processed for the purpose of the project.

The Phase I of the project was from July 2014 to April 2015 and the Interactive Workshop on the SADMS was held on 20 April 2015 in Dhaka, Bangladesh. The workshop was an interim consultation with national counterparts to validate the system at the end of the Phase I of the project, before it is made operational and to tailor it with the end user in mind.

Therefore, the objectives of the workshop were as follows;

1. Present a beta version of the SADMS in corporation with national partners in South Asia,
2. Have a dialogue with national partners of their country requirements to ensure it responds to the need of users,
3. Start a discussion on how to integrate the results of the SADMS to regional, national and state level decision making processes.
4. To have initial awareness on the final product and attract the attention of key actors in the water & climate community.

The workshop was hosted by Bangladesh Meteorological Department (BMD) and held in conjunction with the SASCOF VI and the second CSUF from 21 to 23 April 2015, Dhaka, Bangladesh.

More information on these activities is available at:
http://www.droughtmanagement.info/idmp-activities/south_asia/

INAGURATION SESSION

Mr Mohamad Ali Rasheed, Senior Mechanical Engineer – Planning and Development, BMD welcomed the participants on behalf of BMD. He presented the agenda of the meeting and introduced the dignitaries at the dais, Mr Frederik Pischke, GWP Project officer, Mr Mohamad Sha Alam Director of BMD and Prof Munawar Hussain, Executive Member of Bangladesh Water Partnership (BWP).

Welcome remarks by Mr Mohamad Sha Alam Director BMD

Mr Mohamad Sha Alam, the Director, BMD said, that water and climate experts of SAARC countries have gathered today because water and management of partnerships are vital to water management globally. He emphasised that South Asia has 20 per cent of the world population, 30 per cent of world poor and 30 per cent out of the total of one million food in-secured people in the world, live in South Asia. Currently, the economic damage on agriculture due to drought is growing. Therefore, monitoring drought and implementing preventive methods are essential especially for Nepal and Bangladesh as the countries' economy totally depends on Agriculture. Agriculture in these countries is heavily dependent on rain water, where water management is poor. He explained that extreme rainfall leads to floods and drought; both are hazardous and results crop losses.

He further said that, meteorology is becoming very challenging due to the high variability of weather patterns. The South-eastern monsoonal rainfall is very important to Bangladesh, but the rainfall variability is high leading to difficulties in monitoring.

In this context, he highlighted that developing environmental and weather parameters are very important for the region and the initiative of developing a SADMS is vital. Concluding his remarks he invited all participants to join and contribute for the improvement of the tool and wished success in the workshop.

Welcome remarks by Prof Monowar Hossain, Executive Director, Institute of Water Modelling (IWM), Bangladesh and Executive Member of BWP

Prof Monowar Hossain a Professor at Bangladesh University of Engineering Technology (BUET) and the Executive Director of the Institute of Water Modelling (IWM) which are partner organisations of the BWP. He welcomed the participants on behalf of the BWP.

By giving a brief introduction to the BWP he said, it is working very closely with GWP and WMO on matters related to climatic issues. BWP has recently initiated an activity on increasing the resilience of the coastal populations. BWP is also involved in different activities related to drought and floods. Furthermore, BWP is exploring the possibility of widening their knowledge and capacity and also sharing their knowledge with other regions i.e. Horn of Africa, who are affected by drought and related issues. This will assists in developing global networks.

South Asia with the population of one billion is highly vulnerable to natural disasters. Therefore it is imperative to monitor the disasters and produce policies towards reducing the effects of disasters and to find mechanisms to transmit this knowledge to the grassroots. The agriculture in Bangladesh is dependent on both surface and ground water, and these water resources are equally affected by floods and droughts. It is essential to differentiate the agricultural, meteorological, hydrological and social droughts in order to understand drought, people should start feeling the drought.

Prof Hossain concluded his remarks by saying that we need to pool our knowledge and devise policies to the respective governments. He thanked the organisers of this meeting for inviting him and wished success for the programme.

Welcome remarks by Frederik Pischke, WMO/GWP Project officer

Frederik Pischke delivered his speech on context, purpose and goals of the workshop. According to a recently released report on "securing water and sustainable growth" written by an International Task Force convened by GWP and Organisation for Economic Cooperation Development (OECD), annually, the water insecurity costs nearly USD 500 billion to the global economy. That figure does not take into account environmental impacts so the total drag on the world economy could be one per cent or more of global Gross Domestic Product (GDP). Particularly in vulnerable economies, 50 per cent reduction in drought effects could lead to 20 per cent increase in per capita GDP over a period of 30 years. Investing in water security will mitigate many of these losses and promote long term sustainable growth.

He introduced GWP to the participants. GWP vision is a "Water Secure World" which is a global network with 3,000 partner organisations in 178 countries. GWP is a partnership for sustainable development where it is being active since 1996, established as an outcome of the 1992 Earth Summit held in Rio. The GWP is a non-profit action network advocating, facilitating and supporting change processes for the sustainable management of water resources. It is a partnership of government entities, public institutions, private companies, professional organisations, multilateral development agencies and others concerns with water issues. Aiming to provide a neutral platform for multi-stakeholder dialogue, it facilitates and exchanges ideas between global, regional and national level. i.e. BWP is setting an example on how the regions can be connected and approached and share lessons learnt. GWP is providing resources and contributing in technical knowledge to building capacities for improving water management. Mr Pischke said in 2014, IWMI, WMO and GWP set out to strengthen the monitoring capacity of drought in South Asia - a part of the IDMP.

While giving a brief introduction to SADMS he said, based on the detailed needs assessment carried out in late 2013, which was led by GWP SAS with the CWPs in the region and the first discussion was held at the workshop held in Pune in 2014 with the support of IWMI and IDMP back to back with SASCOF 5. The national experts provided inputs to launch the initiative. He is happy that this workshop is being held in conjunction with SASCOF 6 and CSUF 2 hosted by BMD, supported by WMO and ICID. Part of the GFCSs it aims to make a connection between climate information providers and users.

On behalf of GWP, he thanked BMD for support in organising the workshop while recognising and appreciating the work of WMO and ICID for ensuring the right synergies are made. He said that he is expecting to observe good discussion especially this is being held in conjunction with other meetings, and to see how different outputs emanating from the discussions can be feed together.

He emphasised that this is an interim consultation with national counter parts to validate the system before it is made operational and tailor it according to user requirements. The drought monitoring can only be succeeded if it responses to the needs of farmers, managers of water users and operators who are affected by drought. The success of the new SADMS would depend on how efficiently and effectively the data is being updated and transmitted to the end users. The participants' advice and suggestions for improvement of the SADMS and how they can be involved in its implementation is vital at this stage.

Mr Pischke presented the objective of the workshop;

1. Present the beta version of the SA DMS and cooperate with national partners in South Asia which is lead by IWMI,
2. To have an initial awareness of the climate product and attract/attention of water and climate communities,
3. Have a real dialogue with national partners on the country requirements to ensure that the response of SADMS are according to the need of the users,
4. Achieve some clarity on the details of the system and articulate participants' expectation and needs,
5. Finally, start a discussion on how to integrate the results of the monitoring system to reach national and local decision makers.

Mr Rasheed requested all the participants to give a self-introduction following Mr Pischke's address.

TECHNICAL SESSION 1- OVERVIEW OF DROUGHT PROGRAMME AND SADMS PROGRAMME

This session was chaired by Mr Avinash Tyagi, Secretary General of International Commission on Irrigation and Drainage (ICID), India

Dr Vladimir Smakhtin, Theme Leader - Water Availability Risk and Resilience, IWMI

Dr Smakhtin introducing IWMI explained that IWMI is focus on developing countries and primarily working in Africa and Asia. It has ten different offices having the Head Quarters in Sri Lanka. In discussing the work ongoing in partnership with GWP and WMO, he thanked the additional sponsors for the project CGIAR, CCAFS (Climate Change Agricultural Food Security) and WLE (Water, Land and Eco Systems).

He indicated in general, floods and drought is a manifestation of water resources availability, either it is "too little water" or "too much water". Dr Smakhtin gave some statistics to highlight how severe the hazard is. With reference to the online disaster database developed by IWMI on average around 20,000 people killed annually due to droughts whereas only 1/3 of it by floods. Comparatively the terrorism kills nearly 12,000 annually. More than 50 million people are affected by drought whereas 90 million people are affected by flood per annum. Therefore flood take more toll than droughts which includes displacements etc. In total about USD 165,000 billion economic damage caused by both floods and droughts per year, which is more than the current annual flow of development aids - from developed countries to developing countries.

He mentioned that 95 per cent of all affected people by floods and droughts are in Asia. Floods and droughts account for about 90 per cent of the people affected by all natural disasters globally. Frequency and intensity of these events increases with the changing climate. Therefore the annual damages may rise to over USD 400 billion globally by 2030 and needs proper attention.

With reference to the results of the world economic forum study where the number of different risks were documented, He highlighted three specific cases which are both in high risk and impact area - extreme weather events, natural calamities-partly floods and droughts, water crisis which both floods and droughts contribute immensely.

He indicated that, coping up with these is beyond the policies and more related to technology. Dr Smakhtin discussed about possible interventions,

- continue in developing and rethinking water storage - which is in the agenda of development agencies and IWMI is also trying to rethink the whole concept

- conjunctive Drought and Flood Management with the main focus on natural infrastructure – river basins and aquifers, people exploits these systems in using the ecosystems provided by them.
- understanding and quantification of flood and drought risks and hotspots – this would led to understand where to invest – the specific locations in countries, also there is a need to understand the risks and its intensity etc.
- monitoring and forecasting of these events – though it is quite difficult to forecast droughts it is possible to forecast floods; whereas droughts can be monitored precisely with the existing developments.

Later in his presentation he elaborated on the above four interventions as below.

- Rethinking about water storage; he explained about water storage continuum, sub surface and surface storages and different forms of access to these storages. There are very few countries that have plans for in country water storage development, and still some are spontaneous.
- Conjunctive flood and drought management; he indicated that drought and floods management communities have been separated for decades, apparently these disasters exists all around the world, at same locations, just in different times. For example in Mekong river basin in South East Asia – which is in Thailand territory in the bay of Bangkok, in dry season water is a challenge for the community and in wet season there is not enough infrastructure to capture the water and the city gets flooded. The situation is common in Asia. By suggesting the concept of conjunctive flood and drought management he said, it is needed to aggressively capture the surplus foods during wet season and put it underground using natural infrastructure this would avoid flooding, the urban communities need to invest on these initiatives. These actions would take time but still these are environmentally friendly solution which allows more water use especially for upstream agriculture.
- Risk analysis of flood and droughts; the analysis are being conducted by Dr Amarnath Giriraj's team at IWMI and it is online, more details can be obtained from the websites; http://waterdata.iwmi.org/FloodMapping.php and http://waterdata.iwmi.org/droughtmap.php
- Monitoring and forecasting for both flood and droughts will be discussed in the workshop. The drought severity is measured by deviation of a drought parameter from normal condition, the drought severity is measured using number of parameters i.e. vegetation, metrology and hydrology etc. and they can be simple or composite parameters. The deviation from normal can define from historical data.

He further said that IWMI has the experience of developing a prototype drought monitoring system for South West Asia, which is online. The System was developed using remote sensing and publicly available data due to project limitations. However, it remains static and not updated and maintained due to lack ownership by respective agencies. Therefore in the SADMS project, IWMI is expecting the below;

- Builds on existing expertise in drought monitoring in Asia
- feature near-real time, weekly high-spatial resolution information on drought severity online
- integrate remote sensing and ground data for better drought characterisation (vegetation indices, rainfall, soil, etc.),
- aims to support regionally coordinated drought mitigation efforts that can be further tailored to analysis at the national level
- needs to deliver timely and targeted messages to main economics sectors and communities that trigger certain anti-drought action(s) by decision makers
- needs to be continuously maintained and hence needs a business model - who it will be run by, how much money is required.

With the conclusion of Dr Smakhtin's presentation Mr Avinash Tyagi, Chair of the session highlighted three major points extracted from Dr Smakhtin's speech; includes water storage continuum, drought parameter indices and a business model and reiterated that the participants need to concentrate on those during the rest of the day. He invited Mr Frederik Pischke to present the IDMP.

Mr Frederik Pischke, WMO/GWP Project officer

Mr Frederik Pischke gave a brief background on Integrated Drought Management Programmed (IDMP), which was launched by WMO and GWP in 2013 at a High-Level Meeting on National Drought Policies (HMNDP) to support implementation of the HMNDP outcomes. Further he gave excerpt of HMNDP final declaration and the approach of the IDMP which includes a proactive rather than reactive approach to drought management, horizontal integration, vertical integration, knowledge sharing, demonstration projects and capacity development. The programme is based on the governance and partner engagement. Knowledge and awareness and innovative practices can be shared in capacity development which ultimately leads to action on Integrated Drought Management (IDM) at Regional and National level.

He presented the set of partners who have expressed their interest to work together on IDM; which includes UN agencies, research institutes/universities and climate and agriculture experts. He further said that IDMP is a part of the GFCS, which aims is to connect the information provider with the users of the information. The goal of GFCS is to enable better management of the risks of climate variability and change and adaptation to climate change at all levels, through development and incorporation of science-based climate information and prediction into planning, policy and practice.

Mr Pischke elaborated on the Regional and country programmes of IDMP and the website www.droughtmanagement.info/idmp-activities/ which gives more information on the initiatives. The regions where ongoing IDMP initiatives are; Central and Eastern Europe, Horn of Africa, West Africa, South Asia, Central America, South America. There are two National initiatives; PRONACOSE Mexico and support to Turkish Government. The first publication developed as part of IDMP are the "National Drought Management Policy Guidelines" developed by Don Wilhite from National Drought Mitigation Centre at the University of Nebraska-Lincoln.

He indicated the publications and tools and guidelines on IDM can be obtained online from the IDMP web library and IDMP is in the process of developing and launching a helpdesk.

In concluding his remarks he elaborated the way forward of the SADMS,

- Regional Drought Monitoring System to support regionally coordinated drought mitigation efforts that can be further tailored to the national level
- Moving from crisis management to risk management
- User ownership through GWP South Asian Regional Water Partnership with the Country Water Partnerships in Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka to work with relevant actors from Government, research and civil society in the region to ensure the system addresses needs.
- Technical development by International Water Management Institute integrating remote sensing and ground truth data (vegetation indices, rainfall data, soil information, hydrological data)
- Government support through WMO Climate Outlook Fora, Regional Climate Centres and HydroMet Services as platforms for knowledge exchange and user involvement

He further explained the expected outputs of the SADMS:

- Enhanced understanding and quantification of drought's magnitude, spatial extent, and potential impact to capture the complexity of drought onset, progression, and extent;
- Produce historical to current high spatial and temporal drought risk maps to provide current view of drought propagation on a regular basis;
- Identify drought hotspots, support preparedness and drought mitigation and provide early warning at regional, national, state and community level
- Operational drought monitoring system(s) installed in national centre(s) and regional hub
- National capacity in drought monitoring built in all participating countries to address the gaps identified through the needs assessment
- Regional sharing and dissemination of operational drought information users can download at country level for subsequent analysis

Priyanka Dissanayake, Regional Coordinator, GWP SAS

Ms Priyanka Dissanayake started her presentation by giving a brief introduction to GWP SAS. She emphasised that drought has drastic effects on agriculture in South Asia and many are dependent on agriculture and it is the most vulnerable sector.

Other drought related activities, other than SADMS where GWP SAS is involved; GWP SAS is the thematic node for water for Asia Pacific Adaptation Network (APAN) and GWP SAS developed knowledge products which include a Policy Brief on "Coping with increased intensities of floods and droughts in South Asia" in 2013 and Policy Brief on "Developing Climate Resilient Water Management Plans/ Agriculture Systems for Water Stressed Areas in South Asia" in 2014. She emphasised that communicating the problem effectively to the policy makes is important. The engagement of GWP SAS with other networks in the region will send the message across to all actors in the region.

GWP SAS also conducting drought related activities at CWP level too; and she has given the example of an activity carried out by Pakistan Water Partnership in Tharparkar desert area.

PWP carried out the fact finding Mission and Drought Master Planning Appraisal Mission from 16 to 21 April 2014 with the following objectives;

- Provide government with assessment of on-ground situation based on rapid reconnaissance, discussions with stakeholders and overall observations and conclusions drawn by the team
- Propose a development agenda around water development to help initiate detailed development strategy

She presented the following activities carried out in two villages of District Tharparkar and emphasised its impacts on improving water quality, sanitation, hygiene, water security and livestock food security.

- Demonstration of Bio Sand Water Filter
- Traditional Methods of Soap Making
- Distribution of Hybrid Napier
- Distribution of Medicine
- Rain Water Harvesting

She pointed out that except Maldives the other countries in the region do not practice rain water harvesting and more attention has to be paid in this regard. She mentioned that more than 130 children died in Tharparkar district early this year due to the impacts of drought.

With reference to the needs assessment survey she said; the survey looked at three variables in the eight countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) in South Asia, the existence of drought early warning system, capability to contribute to drought monitoring/early warning and requirement for infrastructural support. The assessment concluded that;

- No validated system of drought monitoring that could meet the requirement for a high spatial resolution in any of the surveyed countries.
- Challenges that the countries face at present in drought monitoring are;
  - lack of hydrological / meteorological measurement stations
  - missing access to satellite data
  - insufficient rainfall prediction capability
  - shortage of well-trained staff
- Development of an institutional mechanism of functional collaboration across ministries and departments at the sub-national, national and regional/international level is also essential
- There is a need to shift emphasis from disaster response to risk management: to improve drought forecasting; to establish early warning systems and to improve communication flow.

Ground verification field work was conducted in Sri Lanka in May 2014 prior to initiating the IDMP activities. The goal of the project is to deliver a newly integrated drought monitoring method. At present countries in South Asia use traditional methods in drought assessment and monitoring, therefore the plan is to integrate it with remote sensing technology she said.

There are three Phases in the project;
Phase I) development and calibration/testing of the monitoring method,
Phase II) development of the operational online prototype drought monitoring system and
Phase III) capacity building and the DMS to be installed in national centre(s), but subjected to interest and necessary facilities or/and in an identified regional Hub. Third phase is more challenging as it involves uptake of the system by the national agencies. IWMI has faced difficulties in the uptake phase of the similar work done in the past.

The beneficiaries of the product include; Ministry of Agriculture, National Disaster Management Centres, Farmers and decision makers and non-governmental agencies. Now the project is at the completion of the 1st phase and the workshop is aimed at user consultation in SADMS product development. She reiterated the objectives of the workshop and emphasised that it is important to ensure that SADMS responds to the need of users. Results of the SADMS are integrated to regional, national and state level decision making processes and to have initial awareness on the final product and attract the attention of key actors in the water and climate community.

Key recommendations given by institutions to be addressed during the SADMS development and implementation are; keep the input data simple and ensure that there is an understanding on what basis drought risks are being generated for SA DMS to gain acceptance by users, include ground verification of the results, uncertainty to be communicated clearly to users, make efforts to include the outputs of the SASCOF as well as any National Climate Outlook Forums, involving and gaining the ownership of government agencies and the users from the beginning in SADMS development –which can be facilitated by CWPs and the product has the potential to be used as a South Asia Drought Early Warning (SADEWS).

Ms Dissanayake finally presented the Existing Cooperation Mechanisms in South Asia and mentioned that SAARC Disaster Management Centre (DMC) has the mandate for disaster management in South Asia. They have the identified five broad areas of regional cooperation including;

- Drought Monitoring and Early Warning
- Drought Research and Documentation
- Training and Capacity Building for Drought Management
- Sharing of Good Practices on Drought Risk Management
- Development of a South Asia Drought Network

SAARC DMC has National Focal Points, mostly the disaster management authorities and ministries of home affairs in South Asian countries, however, many other agencies could be involved in drought management activities. Ms Dissanayake concluded that interagency coordination is important and translating monitoring into early warning and communicating the early warning message is still a problem in most of the South Asian countries. Therefore, the responsibilities of early warning needs to be clearly identified and defined in order for the SADMS to be evolved in to a SADEWS.

Mr Tyagi announced the last presentation of the 1st Session by Dr Giriraj Amarnath;

Dr Giriraj Amarnath, Senior Researcher - Remote Sensing and Water Resources, IWMI:

He said it is a great opportunity to present the current status and progress of the SADMS project and it is of hard work in a period of 10 months.

Since the overarching goals were discussed by the previous presenters, he started his discussion with specific objectives. The objectives include;

- Better scientific understanding and inputs for drought monitoring and management;
  - Drought monitoring, early warning and risk assessment;
  - Development of operational online drought monitoring system;
- Capacity building, customization for national needs and dissemination of the monitoring product;
- Policy and planning for drought preparedness and mitigation across sectors; and
- Drought risk reduction and response.

The project partners are WMO, GWP, GWP SAS hosted by IWMI and Research Programme on Climate Change Agriculture and Food Security (CCAFS) and IWMI. There are two Technical Partners from India –Symbiosis International University of Pune and Institute of Technology which provided content support for developing tool based systems and field level investigation in Maharashtra. The identified end users are National Disaster Monitoring/ Management Centres, Irrigation Department, Maharashtra State and Disaster Management Authority, SAARC and UN Office for Outer Space Affairs.

He discussed about historical drought trends in South Asia;
Since 2000, 14 major drought occurrences were reported in South Asian countries and observed 305 deaths, 360 million people were affected and 1.6 billion economic losses in damages. South Asia region has been among the perennially drought-prone regions of the world. Afghanistan, India, Pakistan and Sri Lanka have reported droughts at least once in every three year period in the past five decades, while Bangladesh and Nepal also suffered from drought frequently. The frequent occurrence of drought, coupled with the impact of global warming, possesses an increasingly severe threat to agricultural production in South Asia. Drought is making a big toll in GDP and poverty in the region.

With this background he said trend in occurrences of drought, both in magnitude and frequency is increasing whereas the knowledge on the spatial distribution across South Asia is limited. Therefore through this project IWMI with its partners are developing comprehensive database using multiple-data sources. Development of drought monitoring tools is not new to IWMI and IWMI has previously developed an online Drought Monitoring System for South West Asia as already indicated by Dr Smakhtin.

He gave an overview of the project; the product will feature historical and near-real time weekly high-spatial resolution drought severity maps, integrates remote sensing and ground truth data including; vegetation indices, rainfall data, soil information and hydrological data and supports regionally coordinated drought mitigation efforts that can be further tailored to analysis at the national level.

Dr Amarnath elaborated the Drought Monitoring Approach. Following methodologies were used to correct the Vegetation Time Series for Long Term Monitoring.
Step 1: Cloud Removal using Land Data Operational Products Evaluation (LDOPE) tool
Step 2: Additional Filter using Blue reflectance band >0.2 threshold
Step 3: Drop out removal using Statistical Outlier with ±2 standard deviation (STD) by neighbourhood method
Step 4: Fourier time series analysis to determine seasonal changes in vegetation growth, Crop anomaly and Extraction of Peak growth time

He further said that only the corrected Normalized Difference Vegetation Index (NDVI) images will be used for calculation of vegetation indices which will be feed into the next stage.

Primarily four different data sets are being used for monitoring. The first explains the land surface temperature, second provides reflection information for calculating the vegetation parameter, in the TRMM - three different rainfall data are used which allows calculating the precipitation. ESACCI is a group developed product based on the climate change initiative programme for soil moisture product. The data are available for every eight day interval in high resolution. IWMI developed a methodology to downscale the rainfall and soil moisture data as these cannot be used directly. Then he explained the data preparation stage and the normalisation process using four indices -Temperature Condition Index (TCI), Vegetation Condition Index (VCI), Rainfall condition Index (RCI) and Soil Moisture Condition Index (SCI). These inputs were integrated to Principal Component Analysis the best correlation that can explain the target pixel. This is to be used for Integrated Drought Severity Index (IDSI) – which is integrating the climate, vegetation and the rainfall. The Validation Phase is being done using in-situ Meteorological data and Statistical Data.

He then explained about the Calculation of Drought Monitoring Indices. There are three indexes;

1) Vegetation Condition Index (VCI). VCI is an indicator which provides the status of the vegetation cover as a function of the NDVI minimum and maximum.
2) Temperature Condition Index (TCI) Explains brightness of the temperature of a given hot spot, in contrast to VCI high LST- high land surface temperature in the vegetation growing season indicates unfavourable conditions while low LST indicates mostly favourable condition
3) Precipitation Condition Index (PCI). TRMM data provides meteorological drought information and has spatial and temporal climate component but it cannot be directly analysed with VCI and TCI. PCI was developed and tested in various locations and observed how the precipitation conditions are changing over a period of time.

Dr Amarnath discussed about Spatial Downscaling of Soil Moisture; he said the team used different sets of data to develop final one kilometre downscale Soil Moisture Product, which is a useful input in drought monitoring process and can generate weekly maps. He gave some examples of Drought Monitoring Products based on the three indices and finally displayed a map with IDSI. Examples for IDSI maps for Sri Lanka, South India and Maharashtra were displayed while the drought severity has been categorised as, severe, alert, watch and normal.

He also compared the Global Drought product Vs. SADMS – one of the products is the maps developed by University of Montana and some differences in the maps are visible and the group is in the process of analysing the differences.

Since it is more convenient to use a tool to do the analysis, IWMI collaborated with a partner and developed a Drought Monitoring System (DMS) Tool called Agriculture Drought Assessment and Monitoring System (ADAMS). This DMS tool allows automated image processing and calculation of drought monitoring indices etc. The tool is being developed using ArcGIS ArcObject and Visual Basic and is freely available to be used by anyone. In addition a Drought Management Scenario for early warning process and Impact analysis module will be developed in 2015.

He further elaborated on the Socio Economic Vulnerability Assessment for Maharashtra and Bihar States in India. Maharashtra is a drought prone district while Bihar is affected both by floods and droughts. The Socio Economic Vulnerability was assessed using three different indices. I) Human Development Index with three different parameters - Life Expectancy Index, Education Index and Income Index which were mainly collected from Government and UNESCO analysis ii) Infrastructure Index and iii) Crop Sensitivity Index based on the crop yields calculated for District level. The overall data is limited especially for education and income in Bihar. It is expected to develop a map combining socio economic drought vulnerability with bio physical drought hazard map to get the impact in drought vulnerable districts. SPSS tool was used with PCA factor analysis and rankings were obtained.

The Crop Sensitivity Index (CSI) was calculated using Expected yield vs. Actual Yield based on the available data for 2003 to 2010. This information will feed into vulnerability calculation and to develop the social economic vulnerability map which has district level information.
The tool was introduced to the relevant partners in respective countries and some initial discussions on SADMS development have already taken place. Both IWMI Sri Lanka programme and Sri Lanka Water Partnership has good association with Irrigation Department in Sri Lanka and had directors, civil engineers and farmer union association participating in discussions field missions were conducted in the Kurunegala District, Sri Lanka and also in Mharashtra, India.

He concluded by presenting the outputs of the SADMS project;

- Enhanced understanding and quantification of drought's magnitude, spatial extent, and potential impact – through a combination of climate, vegetation and bio physical indicators
- On-line prototype drought monitoring tool
- Identified hot-spot areas –where droughts are more intense and frequent
- Operational drought monitoring system(s) installed in national centre(s), or / and identified regional hub

- National capacity in drought monitoring built in all participating countries to address the gaps identified through needs assessment
- Regional sharing and dissemination of operational drought information to the users to download at country level for subsequent analysis;

Finally the comprehensive drought impacts reporting system was discussed in detail.

The Chair Mr Tyagi thanked for the comprehensive presentation and the team for undertaking the activity. Given the time limitation, few minutes were allocated for possible questions – the questions to be especially focused on the scientific aspects of the product.

Question by Angela Klauschen: How this tool is going to help the farmers? and is there any possibility for the farmers to involve in shaping the tool?

Question by Md. Shadekul Alam, Assistant Director, BMD: Who is continuously feeding information to this product? Is there a country level or regional level stakeholder authority who would update the data? Is it the responsibility of Meteorology and the Hydrological services? End users and the people who are in the middle do not need to know the much about the science/technology behind this.

Answer by Mr Tyagi: The developed product is not going directly to the farmers. What is expected in this workshop is to understand the science behind the product development and to have a clear understanding on meteorological and hydrological aspects.

Dr Vladimir indicated that team would like to listen to the country representatives first and do not want to impose the ideas of the team. Reflecting on Angela's question he mentioned that the system does not get to the farmers directly and they do not need to know the comprehensive science behind the product.

He gave an example of IWMI's work (with the support of IFAD) over past several years in Africa bridging the high science (RS and other technologies) as core justification for the message which is communicated in a very lay form to the farmers through the mobile services. A lot of work was required to convert the information in a step by step process into to the message that farmer receive in their mobile phone through short messaging services. Through Farmer cooperatives the farmers registered themselves with the system (bio mass production monitoring), on routine basis (for several seasons' couple of years) information was processed. The farmer will know when to apply water, which part of the field is not producing the biomass. Mobile phones can be used very effectively in early warning in floods and droughts. Another way to send the information is through agricultural extension services where certain level of technical info can go. Then the information can be converted to the local language and a level to be understood by the farmers.

He gave another example where the Drought Monitoring tools are effectively used; Economist journal reports to the general public the information (status quo of what was happening and happened month ago etc.) on drought in California from the US drought monitor. The product is expected to give the regional view on drought which the response agencies (national and regional) can make use of.

Dr Amarnath emphasised that the targeted audience for SADMS is not the farmers but the decision makers who are working directly on drought mitigation/compensations. Field level officers who provide compensation to households want to know information to calculate the compensation for House Hold who are affected by drought. Make all the relevant authorities such as water resources, irrigation and agriculture aware that the tool is available and it can be used to give the answers. That information (level of severity no of total people affected) can feed into planning commission and Ministry of Finance where the funds are allocated for interventions or compensation. The farmers will be supported by the relevant local authority.

SESSION II: SADMS USER ENGAGEMENT: COUNTRY PRESENTATION

Dr Smakhtin was the Session Chair and he introduced that there will be seven country presentations from Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka. Unfortunately Afghanistan participants could not attend the workshop due to a visa problem.

The first presenter was Dr Ravinder Kaur, Project Director -Water Technology Centre and Director (Acting), Indian Agricultural Research Institute (IARI), New Delhi, India

Presentation on Drought Monitoring – State of the Art and Way Forward in India

Dr Ravinder Kaur described how Drought Monitoring is carried out by Indian Meteorological Department (IMD). The IMD is carrying out meteorological drought monitoring since 1875 based on meteorological indices such as Percent deviation of Rainfall from Normal, Aridity Anomaly Index (AAI) and Standardized Precipitation Index (SPI).

The Drought Assessment using space tool is done using the National Agricultural Drought Assessment and Monitoring System (NADAMS) by National Remote Sensing Centre (NRCS) in India. In this system, drought is being assessed by space by making use of the NDVI which is a combination of changing crop calendar, abnormal weather events and agricultural drought situation etc. to declare droughts and drought warnings in the country.

While explaining the research activities conducted by the IARI, Agricultural Drought Monitoring using NDVI and Normalized Difference Water Index (NDWI) were compared. Hydrologic Drought Monitoring through Standardized Water Level Index was validated in Dhar District in Madya Pradesh, one of the drought prone areas in India. Meteorological and Biophysical Drought Indices were explained and said the team started developing Drought Monitoring tools that use Composite Indices. Therefore to develop the given Aggregate Drought Index (ADI) they have used Meteorological, Hydrological and Agricultural Droughts and validated in the product in Uthra Pradesh in India.

Dr Kaur described further about Agricultural Risk Management through Near Real Time Crop Condition Monitoring which is derived from satellite derived parameters that include

- NDVI -> Crop Condition Index (CCI)
- LST (Day) -> Temperature Condition Index (TCI_D)
- LST (Night) -> Temperature Condition Index (TCI_N)
- Rainfall -> Standardized Precipitation Index (SPI)
- Soil Moisture (still under development)

This allows visualisation at country level as periodic and seasonal maps and district level as temporal profile of parameters in current season as compared to previous year and average. District level visualisation or National level visualisation is possible. Rabi season Wheat in Haryana and Punjab was validated.

She described the Indian Drought Monitoring and Declaration Process and mentioned that drought is a state subject in India. Generally, two or three parameters are used in drought declaration; one is the area remained unsown (abandoned in a season) or observed yield at the end of a season (Oct/Nov). It is basically post drought management and not early warning. Once the drought is declared a memorandum of scarcity is passed by state government and then that is verified by the Central Government in order to provide funding for drought management and to decide on Relief Quantum. However, there is no set drought declaration process and the criteria vary from state to state. In Andhra Pradesh criteria is based on block level rainfall, block level crop zone areas, yield reduction and dry spells, in Karnataka rainfall and dry spell, in Maharashtra only yield loss, in Odissa rain fall and crop assessment in Rajastan, Uttar Pradesh and Jammu and Kashmir yield loss. Therefore, in conclusion there is no common criteria used in the drought declaration process.

She highlighted now it is high time to develop an effective prototype tool like the one IWMI is developing, by including near real time drought monitoring and early warning based on composite indices because a single indicator alone is not able to monitor the drought precisely, which provide quantitatively estimation of Drought impacts on agriculture. IARI Main focus will be only on agriculture. A Memorandum of Understanding was signed between IARI and University of Nebraska/Daugherty Water for Food Institute in order to accomplish this target.

Mr Azmat Hayat Khan, Director, National Drought Monitoring Centre, Pakistan Meteorological Department, Islamabad, Pakistan.

He described the setup of a National and four Regional Drought Monitoring Centres in Pakistan. National Drought Monitoring Centre of Pakistan Meteorological Department (PMD) share the mandate at national level to monitor drought and advise the government on drought related matters.

The National Drought Monitoring Centre issue fortnightly/monthly drought monitor and advisories in different regions of the country based on various drought indices and advising government agencies on drought related matters including drought declaration. There are around 348 manual rain gauges in the country in addition to 80 meteorological stations set up with communities and governmental institutions to measure rainfall in a more effective manner.

The Products which are delivered by these centres are;

- Percentage Area Weighted Departure of Rainfall
- Cumulative Precipitation Anomaly (CPA) Index
- Soil Moisture Anomaly – getting data from NOAA and in few stations monitor own soil monitor level and which is incorporated into develop the National profile on soil moisture anomaly
- Standard Precipitation Index (SPI)
- Reservoir Data –major (Tarbela, Mangla, Rawal, Simly, Khanpur) and local reservoirs
- Calculating the frequency of drought in the regional or provincial level by using Regional Drought Identification Model (REDIM)
- Satellite derived Products -Normalized Difference Vegetation Index (NDVI), LST and Temperature Vegetation Dryness Index (TVDI)

He highlighted that drought prediction and early warning is in practice in PMD. He elaborated that during the winter 2015 forecast, it was predicted that the drought conditions would aggravate in the Southern Pakistan due to below normal precipitation. This was issued in January and in April 2015, it is witnessed that Balochistan and in Sindh received largely below normal rainfall and it can be concluded that now there are severe drought conditions (especially in Sindh). The information is disseminated to the stakeholders via, monthly bulletins, traditional communication methods such as E-mails, fax and telephone calls and website: http://www.pmd.gov.pk/ndmc.

Monthly bulletins are regularly issued by NDMC and these products sent to all disaster management authorities and rehabilitation agencies. The DRM agencies further disseminate these bulletins at sub-regional and local level and also incorporate in their contingency plans. The Drought monitor is developed for the entire country using the above products. This information is also available in the website and a GIS based website for drought centre is also being developed. Past information is also available in the website and the temporal variations can be observed with a click.

He indicated that the Monsoon season (July –September) rainfall in the southern part of country is not assured for the farmers.

- Highlighting Tharpakar region - at present severe drought condition is being observed. In conclusion he said that the analysis of ground observations and satellite data depicts that; moderate to severe drought conditions prevail in Tharparkar. Frequency analysis shows that, on average, four out of ten years are drought years.
- NOAA Satellite derived moisture anomaly depicts that vegetation stress is there in the area.
- NDVI data from MODIS satellite depicts some green vegetation exists in the area. The comparison with average depicts negative anomaly; means vegetation stress.
- There is 60 per cent probability that El Nino conditions will prevail during coming monsoon season and Pacific Ocean is likely to exhibit warming trend.
- During the intensification of El-Nino events, arid regions of Pakistan receive moderately below normal rainfall
- Therefore the drought conditions may further aggravate towards the end of year.

He emphasised that reporting, monitoring and prediction of drought events are important. Tharparkar is the most severely drought affected area in Pakistan and after 2013 monsoon there was no rain. The district of Tharpakar with five rain gauge stations, is the worst affected. The community managed stations also showed similar pattern as the PMD station. There are satellite derived products and NDVI data available up to sub-district level and the drought monitor is developed based on that. The disaster management authorities have information on the population density and livestock density and the level of response is decided accordingly. The upper limit for drought declaration is 65 per cent area is under the rainfall deficit and the intensity of drought is based on how much moisture deficit is there.

Mr Ibrahim Jaleel, Assistant Director, Water and Sanitation Department, Ministry of Environment and Energy, Maldives
Drought Monitoring Mechanism in the country:

Mr Ibrahim Jaleel introduced the respective government authorities for different water related issues in Maldives; The Water and Sanitation Department of Ministry of Environment and

Energy is responsible for policy planning and enhancing the rain water harvesting capacity of the country. Maldives Meteorological Service is the responsible agency for monitoring rainfall patters including droughts and National Disaster Management Centre (NDMC) is responsible for coordinating all disasters including water related disasters in the Maldives.

The North and the central regions of the country is more prone to droughts. Drought is not clearly defined in the Maldives in terms of rainfall. Quite often it is considered as drought when NDMC receives requests for supplying water from islands. Most of the islands use rain water for drinking and cooking. The supplied desalinated water during the dry period is wasted when they receive rain. Therefore, NDMC supply desalinated water in phases during the dry season depending on the requests. 39 per cent of the population receives de-salinated piped water. The other 61 per cent is dependent on rainwater harvesting. Therefore if there is no rainfall they increase their vulnerability to drought. In order to mitigate this scenario, the Ministry of Environment and Energy has initiated dry period projects in view of enhancing the capacity of rain water harvesting in the islands. Even though the capacity and the infrastructure are there people normally collect rainwater during the monsoon season. It was noticed that if water is collect throughout the year would reduce the water shortage in the country. It is expected that 36 islands will have Reverse Osmosis by 2017; integrated desalinated water and rainwater management where rain water and desalinated water are mixed and will use as a more sustainable approach where the operational cost is low.

Q1: What is the Source of drinking water? Rainwater for most of the outer islands
Q2 by Mr Tyagi: What is the percentage of desalinated water? It is 39 per cent
Q3 by Mr Tyagi: Why the percentage is high? The capital is supplied with RO. Population is concentrated in the capital.
Q4 Dr Smakhtin: How do you discharge brine and what do you do with the brine? It is being discharged to the lagoon or ocean and just discharge without treatment.
Q5 from Ms Priyanka Dissanayake: Can you elaborate on the costs involved in supplying desalinated water to the island in drought situation?
Answer: It is a quite expensive procedure supplied through vessels to the islands. Most of the time desalinated water needs to be supplied from Male' and millions 3-12 million rufiyaa is spent on supplying water each year and number of islands experiencing shortage of rainwater is increasing.

Mr Shiva Pd. Nepal, Senior Divisional Meteorologist (Agro-Meteorology Section), Department of Hydrology and Meteorology (DHM), Nepal

Nepal is strongly influenced by Monsoon and there are four Seasons; Pre- Monsoon (March-May), Monsoon (June-September), Post Monsoon (October-November) and winter (December-February). Almost 80 per cent of the rainfall comes in the monsoonal season, and he showed the monthly variation of rainfall from June to September. November is the driest month of the year. While explaining the monsoon and winter Rainfall Pattern and Monsoonal Trends to the audience Mr Shiva said Nepal is experiencing a decrease in the frequency of rainfall and increase in the frequency of heavy rainfall events (> 100 mm/day). The winter precipitation of the country is decreasing and winter droughts becoming more frequent, therefore severe extreme droughts observed in the recent decade.

The climate activities undertaken by DHM include;

- Extreme rainfall and air temperature monitoring
- Daily temperature monitoring and Rainfall monitoring
- Monsoon monitoring
- Weekly, monthly and seasonal climatic reports
- Annual book publications

Mr Shiva discussed about a Pilot Programme for Climate Resilience (PPCR) - Building Resilience to Climate Related Hazards (BRCH) funded by World Bank. Under this project they will be developing agricultural management information system services to help farmers to mitigate climate-related production risks. The project will also establish three Radio sound stations, 100 AWS (15 Agro met) and 74 hydrological stations, three weather radar stations to cover entire Nepal and a GIS Lab. DHM is planning to improve the forecasting skills from three to five days to improve the seasonal forecasting skills. An Agro Advisory and weather based crop insurance will be developed for famers in 25 pilot districts.

Other drought related activities in Nepal;

- Winter Drought monitoring - few case studies were using SPI conducted by DHM.
- Satellite remote sensing based Crop Monitoring System will be developed by ICIMOD.
- Agro Advisory and weather based Crop insurance for Formers in 25 Pilot districts in Nepal – the PPCR project with the involvement of Ministry of Agriculture, DHM and National Agriculture Research Council.
- Use of space technology for Drought Monitoring and Early Warning in Nepal implemented by UNESCAP – Nepal is being selected as a pilot country and the project will start in 2015. The countries Sri Lanka, Mongolia and Myanmar have already started implementing the project as pilot countries.

Mr K. Sivapalasundaram, Director of Irrigation (Drainage, Flood System and Disaster Management), Sri Lanka

At present there is no drought early warning system in operation in Sri Lanka. The drought situation in the country is monitored through real time rainfall and reservoir related information. Department of Meteorology maintains about 400 rain gauge stations whereas

Irrigation Department maintains about 100 rain gauge stations. Comparison of the observed rainfall situation with average conditions results in identifying the dry, normal or wet conditions.

The Irrigation Department maintains daily storage records of 250 reservoirs and the daily storage and sluice issues are monitored at the Head Office level. Then a graph of monthly storage is being drawn and compared with annual patterns. More attention on field water management is taken especially in drought periods.

Mr Sivapalasundaram said the national level cultivation data is being collected by the Department of Agriculture. Seasonal cultivation calendar and crop area etc. are being decided at cultivation meetings based on available storage of water and seasonal forecast. Conversely the decided crop area is an indication of the prevailing drought situation.

He further presented the tables containing the level of damages occurred for cultivations in Sri Lanka caused by droughts in 2013/2014 *Maha* cultivation and 2014 *Yala* cultivation and floods in 2014/2015 *Maha* cultivation.

Mr Phuntsho Wangdi, Secretary to Dzongkhag Tshogdu, Department of Disaster Management Ministry of Home and Cultural Affairs, Bhutan presentation on Overview of Drought in Bhutan

Since the droughts are not prominent in Bhutan Mr Wangdi rephrased the topic as water scarcity in Bhutan.

After giving an introduction to the country he discussed about the natural hazards in Bhutan. Earthquake, Glacial Lake Outburst Flood (GLOF), flash floods, landslides, forest fires and others including strong winds are highlighted as natural hazards which are common in Bhutan.

Due to the topography of the country the water bodies are unevenly distributed The Forest fires are caused by prevailing water scarcity. The country is also experiencing a change in rainfall pattern.

Two projects have been launched for promoting food self-sufficiency (is one of the mandates in the country) in Bhutan those includes; Lingmutey watershed in Wangdiphodrang and Bajo irrigation channel siphon project.

There are no drought early warning systems installed in Bhutan, whereas presently flood early warning system are being installed along Pho Chu and Mochu Basins in Punakha.

The agencies who are responsible for disasters in Bhutan are, Ministry of Agriculture and Forest, Department of Agriculture and livestock, Department of Public Health under Ministry of Health and Department of Disaster Management.

The Department of Disaster Management (DDM) serves as the secretariat and executive arm of the National Disaster Management Authority (NDMA) and also function as the National Coordinating Agency for disaster management. The functions of DDM include;

- prepare the National Plan in coordination with relevant Agencies;
- formulate national standards, guidelines and standard operating procedures for disaster management;
- develop and implement public education, awareness and capacity building programme on disaster management;
- develop standard training module and curriculum on disaster management in coordination with the relevant agencies;
- facilitate the formulation of hazard zonation and vulnerability maps by relevant agencies;

He further discussed the institutional setup of DDM. Two-way communication is happening from National Disaster Management Authority to the Sub- District Disaster Management Committees at the grassroots level. The Inter Ministerial Task Force and National Emergency Operation Centre are also in place to facilitate the preparedness.

The steps taken for emergency preparedness are;

- Institutional, Legislative and Policy Frameworks including sensitizing the Disaster Management Act 2013 and formulating rules and regulations
- Hazard, Vulnerability and Risk Assessment - hazard zonation and mapping and developing a vulnerability checklist and conducting regular assessments
- Developing Disaster Preparedness Plans and Contingency Plans

Md. Shadekul Alam, Assistant Director, Bangladesh Meteorological Department

Mr Alam gave a brief introduction to the topography of Bangladesh. Land elevation; 50 per cent of the country is within five metres from mean sea level (MSL) and approximately 68 per cent of the country is vulnerable to floods. Nearly 20 to 25 per cent of the area is inundated during a normal flood event.

Floods in Bangladesh vary, they occur as river flood, flash flood, rain-fed flood and tidal flood due to storm surges. South Eastern, Eastern and North Eastern areas of Bangladesh receive heavy rainfall whereas Western part receives relatively less but not less than 1400mm.

Mr Alam showed the historical drought occurrences in Bangladesh; severe droughts occurred in 1966, 1969, 1972, 1978, 1979, 1982, 1989, 1992, 1994, 1995 and 1998 and moderate in 1961, 1962, 1967, 1968, 1970, 1977 and latest is in 2002. He said that the calculation of severity is still not very clear.

There is no continuous Drought Monitoring System in Bangladesh therefore BMD is planning to start issuing SPI in different scales, monthly, three months and six months immediately.

There is a common misunderstanding about drought related terms in country are; aridity, scarcity of water and usability and/or availability of water. BMD is in the process of defining drought and various terms.

BMD is the information generating organisation but decision making and dissemination is not in their mandate and sharing of information and coordination with other stakeholders is the mandate of the Directorate of Disaster Management. Other organisations in Bangladesh that support in producing data and information are Space Research Organization and Institute of Water Modelling (IWM).

SESSION 3: BREAKOUT GROUPS TO DISCUSS THE IMPLEMENTATION OF THE SADMS

Session chair: Angela Klauschen, Senior Network Officer – China and South Asia
Focal point for Energy and Water Security, GWP

The participants were divided into three groups to discuss about the three sets of questions given below. Thirty minutes were allocated for discussions and there were five minute presentations by each group.

The three sets of questions were;

1) How would you like to see the drought monitoring system and its product usability?
- What are the spatial and temporal details required and why?
- How will you be using the system in early warning and impact assessment?

2) What alerts on drought progression you may need to receive from the system and what action can be associated with them?
- Who needs to receive the alerts –Ministries, Agencies and others?
- What actions may they need to be undertaken on receiving the alerts and how information best communicated to wide range of stakeholders and general public?

3) What should be the implementation strategy, business model for drought monitoring system sustainability?
- Does the system needs recite at some original points to SAARC?

- What facilities required and do they already exists?
- How the system to be financed for regular updating and disseminating information?

First Group:

The group consisted of six participants representing Maldives, Sri Lanka and Bangladesh. The group suggested receiving information in ten days interval with the spatial resolution of 250 to 500 metres. These are mostly important for agriculture sector and also other sectors in the countries. The early warning can be used in sectors including crop management. Quality of information in Agromet bulletin which is already producing and advisory services to the farmers can be enhanced with this information and data can be used as sources for crop insurance schemes. In Maldives where rain water harvesting is practicing, people can take extra precautions until the emergency water arrives to the island.

Second Group presented by Mr Phuntsho Wangdi:

As per the group's observation the drought alerts should be directed to Ministries of Water, Agriculture, Disaster Management, Economic Affairs and Wildlife and Forestry. The Ministry of Information and Communication needs to be informed for dissemination of the information. The Extension services should receive the alerts to transform the information to the grassroots especially the farmers.

Possible actions that need to be taken would include; if it is a severe drought the information should be directly shared with public – a drought certainly affects to the agriculture sector. The Health Department should be informed as there will be related health and sanitation issues.

Television, internet and social media and National Broadcasting Services can be used to communicate the message to the public. Schools are another place where the message could be communicated effectively and the extension officers can play a significant role as they work at the grassroots level.

Third Group presentation was conducted by Dr Tarun Pratap Singh, Director and Professor of Symbiosis Institute of Geo-informatics in India.

Two possible models were identified to maintain the sustainability of SADMS. First model would be – identifying nodes and sub nodes/mirror images of nodes at the country level and second model would be developing a regional level node - this approach is used because all the countries do not have similar capacity and the regional node can act and serve equally to the given countries. Another advantage of having nodes is - if there is a data failure, still the programme can operate with the available information with other nodes. Once the information is disseminated to countries a feedback is expected to update the product and re-disseminated the improved version to the countries immediately.

There are centres such as SAARC DMC based in New Delhi and Centennial Asia who are working at the regional level.

Without knowing clearly the nature of the final product, the basic facilities which would be required are; computer facilities with high end computers to manage and disseminate the data and man power to model developing, managing and dissemination of information within a given time frame. Further in this era there is not much need to think about high technology as it can be made accessible easily. With the assumption of SAARC is the agency who is having the capacity to own and run the system, it should be the centre of dissemination.

When funding the programme he said, UNESCAP is one option who can also monitor and evaluate the fund distribution. JICA is another source who fund generously towards natural resource management and agriculture. In addition the companies who are working agriculture sector can also be considered as it is advantageous for them to fund this type of activities.

Closing remarks by Frederik Pischke and Dr Vladimir Smakhtin:

Mr Pischke thanked all the presenters including the country representatives who provided valuable inputs to improve the product. He stressed that it is needed to continue these discussions and work together with relevant authorities and stakeholders to maintain the sustainability of this project and it is the task of the project team to maintain the collaborations. He invited the participants to use the coming two days to compare and contrast what we have discussed within the day and have side meetings with each other – as all the participants will remain in Bangladesh for the 6th South Asian Climate Outlook Forum.

Mr Pischke thanked the BMD for hosting the workshop and GWP SAS for organizing the event.

Dr Smakhtin representing IWMI thanked everyone for their time and interesting information shared with the forum. He also thanked the organisers for bringing the experts together for the discussion. He said that he felt a sense of a “community of drought” by the end of the day after all these interactions with the group which is also having different skills sets.

Though executing of these types of projects takes time our region does not have much time to waste – it needs to be started swiftly - and once it started implementing it will start bringing regular benefits to the region.

CONCLUSIONS/RECOMMENDATIONS AND FOLLOW-UP

The occurrence of drought both in magnitude and frequency is increasing while the knowledge on spatial distribution across South Asia is limited.

The needs assessment survey concluded that;

- No validated system of drought monitoring that could meet the requirement for a high spatial resolution in any of the surveyed countries.
- Challenges that the countries face at present in drought monitoring are;
  - lack of hydrological / meteorological measurement stations
  - missing access to satellite data
  - insufficient rainfall prediction capability
  - shortage of well-trained staff
- Development of an institutional mechanism of functional collaboration across ministries and departments at the sub-national, national and regional/international level is also essential
- There is a need to shift emphasis from disaster response to risk management: to improve drought forecasting; to establish early warning systems and to improve communication flow.

The regional Drought Monitoring is expected to support regionally coordinated drought mitigation efforts that can be further tailored to the national level. Therefore, it is important to look at the existing cooperation mechanisms such as SAARC Disaster Management Centre which has the mandate for disaster management in South Asia. IDM includes horizontal integration, vertical integration, knowledge sharing, demonstration products and capacity building when compared to the traditional approaches.

The expected outputs of the SADMS;

- Enhanced understanding and quantification of drought's magnitude, spatial extent, and potential impact to capture the complexity of drought onset, progression, and extent;
- Produce historical to current high spatial and temporal drought risk maps to provide current view of drought propagation on a regular basis;
- Identify drought hotspots, support preparedness and drought mitigation and provide early warning at regional, national, state and community level
- Operational drought monitoring system(s) installed in national centre(s) and regional hub
- National capacity in drought monitoring to be built in all participating countries to address the gaps identified through the needs assessment
- Regional sharing and dissemination of operational drought information users can be downloaded at country level for subsequent analysis

The involvement of users and relevant government agencies from the beginning and throughout the project is the key to the drought monitor's success. Particularly to transfer ownership of the system to national and/or regional which would ensure the sustainability of the system. The key recommendations given by institutions to be addressed during the SADMS development and implementation are; keep the input data simple and ensure that there is an understanding on what basis drought risks are being generated for SADMS to gain acceptance by users, include ground verification of the results, uncertainty to be communicated clearly to users, make efforts to include the outputs of the SASCOF as well as any National Climate Outlook Forums, involving and gaining the ownership of government agencies and the users from the beginning in SADMS development –and the product has the potential to be evolved into a SADEWS.

The workshop was an interim consultation with national agencies (users of the system) to validate the system at the end of Phase I of the SADMS. The final product should aim at how it can be contributed to proactive drought management instead of reactive approaches. The targeted audience for SADMS is not the farmers but the decision makers who are working directly on drought mitigation/compensations. Field level officers who provide compensation to households want to know information to calculate the compensation for household who were affected by drought. Make all the relevant authorities such as water resources, irrigation and agriculture aware that the tool is available and it can be used to give the answers. The gathered information (level of severity no of total people affected) can be fed into planning commission and Ministry of Finance where the funds are allocated for interventions or compensation. The farmers will be supported by the relevant local authority.

Real time drought monitoring and early warning based on composite indicator is required as a single indicator alone is unable to monitor the droughts precisely. The India Agriculture Research Institute (IARI) indicated that the monitoring should provide quantitative estimation of drought impact on agriculture as agriculture is the most vulnerable sector. There is no common criteria used in the drought declaration process in India and drought is a state subject. In Pakistan the National Drought Monitoring Centre of Pakistan Meteorological Department (PMD) share the mandate to monitor and advise the government on drought related matters. The National Drought Monitoring Centre issue fortnightly/monthly drought monitor and advisories in different regions of the country based on various drought indices and advising government agencies on drought related matters including drought declaration. NDMC Emphasized that reporting, monitoring and prediction of drought events are important and the limitation of rain gauges is a problem and PMD overcome the issue by having community managed rain gauge stations. Maldives Meteorological services is the responsible agency for monitoring drought and National Disaster Management Centre (NDMC) is responsible for coordinating all disasters in Maldives and supplies desalinated water to the island in the dry season. Nearly Ruffia 12-13 million is spent for supplying water each year. Droughts are not prominent in Bhutan but water scarcity exist as a result of the topography. In Sri Lanka the cultivated crop area is an indication for the prevailing drought situation. Department of Meteorology maintains about 400 rain gauge stations whereas Irrigation Department maintains about 100 rain gauge stations. Comparison of the observed rainfall situation with average conditions results in identifying the dry, normal or wet conditions. BMD is in the process of defining drought and various terms as there is a common misunderstanding about drought related terms in Bangladesh.

There is no continuous Drought Monitoring System in Bangladesh therefore BMD is planning to start issuing SPI in different scales, monthly, three months and six months immediately. Decision making and dissemination of drought related matters is the mandate of the Directorate of Disaster Management. Nepal is developing an agricultural management information system services to help framers to mitigate climate-related production risks.

The spatial and temporal details required is suggested as receiving information in ten days interval with the spatial resolution of 250 to 500 metres. These are mostly important for agriculture sector and also other sectors in the countries. The drought alerts should be directed to Ministries of Water, Agriculture, Disaster Management, Economic Affairs and Wildlife and Forestry. The Ministry of Information and Communication needs to be informed for dissemination of the information. The Extension services should receive the alerts to transform the information to the grassroots especially the farmers.

Two possible models were identified to maintain the sustainability of SADMS. First model would be – identifying nodes and sub nodes/mirror images of nodes at the country level and second model would be developing a regional level node - this approached is used because all the countries do not have similar capacity and the regional node can act and serve equally to the given countries.