22nd International Congress on Irrigation and Drainage

14-20 September 2014, Gwangju, Korea

9th N D Gulhati Memorial Lecture for International Cooperation in Irrigation and Drainage on

"Climate Variability and Change: Impacts on Water Availability"

Jeremiah R.D. Lengoasa
Deputy Secretary-General, WMO

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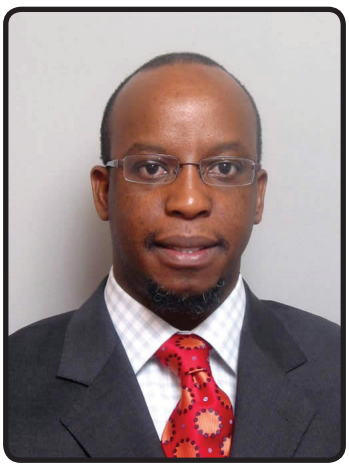

Jeremiah R.D. Lengoasa

Deputy Secretary-General, WMO

Mr. Jeremiah R.D. Lengoasa took up his duties as Deputy Secretary-General of World Meteorological Organization (WMO) on 1 March 2010. Earlier he held the position of Assistant Secretary-General of WMO from 2005.

Prior to his joining WMO, Mr Lengoasa served as the Chief Executive Officer of the South African Weather Service and Permanent Representative of South Africa with WMO and served as member of the WMO Executive Council, during the period 2003 to 2005. He served in the South African public service in Environment, Environmental Regulations, and Environmental Quality and Protection, followed by a period in financial sector as Senior Manager. He was for several years a teacher and a university senior lecturer in Geography, environmental studies and atmospheric sciences.

Mr Lengoasa holds an Honours degree in Geography from Fort Hare University and Master's Degrees in Geography (Climatology) and in Public and Development Management both from Witwatersrand University, Johannesburg.

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Jeremiah R.D. Lengoasa
Deputy Secretary-General
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Switzerland

Presented at

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14 September 2014, Gwangju, Republic of Korea

ICID•CIID

INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (ICID)

Dr. Charles M. Burt

THE N.D. GULHATI MEMORIAL LECTURE
for International Cooperation in Irrigation and Drainage

Preserving the memory of the visionary Water Resource Engineer, ICID, in collaboration with Gulhati Trust has been organizing the 'N.D. Gulhati Memorial Lecture for International Cooperation in Irrigation and Drainage' at the time of its triennial Congresses. The memorial lecture aims at encouraging exchange of significant global developments relevant to irrigation and drainage engineering including all allied aspects like environment, sociology, economics etc. and fostering and enhancing international cooperation to meet ICID objectives. The lecture is delivered by an invited eminent person in a field related to ICID's mission. An honorarium of US $ 1000 is presented to the invited distinguished Lecturer as a token of appreciation.

N.D. Gulhati Memorial International Lectures held so far:

	**Dr. Charles M. Burt** Professor of Irrigation and Chairman of the Irrigation Training and Research Center (ITRC), USA Delivered the eighth lecture in 2011 at Tehran, Iran on **"The Irrigation Sector Shift from Construction to Modernization: What is Required for Success?"**
	**Prof. Dr. Chandra A. Madramootoo** Dean, Agricultural and Environmental Sciences McGill Unviersity, Canada Delivered the seventh lecture in 2008 at Lahore, Pakistan on **"Irrigation in Context of Today's Global Food Crisis"**
	**Er. Albert J. Clemmens** Founding Member and Director American Academy of Water Resources Engineers, USA Delivered the sixth lecture in 2005 at Beijing, China on **"A Process-Based Approach to Improving the Performance of Irrigated Agriculture"**
	**Dr. Marvin E. Jensen** National Program Leader Water Management and Salinity Research Agricultural Research Service, USDA, USA Delivered the fifth lecture in 1993 at The Hague, Netherlands on **"The Impacts of Irrigation and Drainage on the Environment"**

Late W.R. Rangeley OBE
Independent Consultant
Water Resources Development, World Bank, UK

Delivered the fourth lecture in 1990 at Rio de Janeiro, Brazil on ''**Irrigation at a Crossroads''**

Late Adriaan Volker
Professor Extra-Ordinarius in Hydrology
Delft University of Technology, The Netherlands

Delivered the third lecture in 1987 at Casablanca, Morocco on **''Role of Failures and Negative Secondary effects in the Development of Irrigation, Drainage and Flood Control''**

Late K.K. Framji
Chief Engineer and Joint Secretary
Ministry of Irrigation and Power
Government of India

Delivered the second lecture in 1984 at Fort Collins, USA on **''Past and Likely Future Developments in Irrigation and Drainage and Flood Control Measures in Developing Countries''**

Prof. Dr. M. Holy
Dean of Civil Engineering
Prague Technical University, Czechoslovakia

Delivered the first lecture in 1981 at Grenoble, France on **''Irrigation Systems and their Role in the Food Crisis''**

Prize winning papers of Young Professionals

Er. R. Rajkumar
Lecturer, Civil Engineering
Centre for Water Resouces Anna University, India

Winner of the Second N.D. Gulhati International Award in 1999 for the Best Paper contributed to an ICID Congress titled at Granada, Spain on **"Controlled Water Saving Method for Paddy Cultivation - A Case Study"**

Ms. Margreet Z. Zwarteveen
Gender Specialist, IWMI, Sri Lanka

Winner of the First N.D. Gulhati International Award in 1996 for the Best Paper contributed to an ICID Congress titled **"A Plot of One's Own: Gender Relations and Irrigated Land Allocation Policies in Burkina Faso"**

Er. N.D. Gulhati
A Visionary Water Resources Engineer

(1904-1978)

Er. Niranjan Das Gulhati, popularly known as N.D. Gulhati, a visionary, was one of the forces behind India's march towards food self-sufficiency through Green Revolution. As the Chief of the Natural Resources Division in the Planning Commission, Government of India, he laid its foundation by initiating proposals relating to the development of irrigation and power, soil conservation and mineral development in the First Five-Year Plan. The notable positions he held in Government of India service includes Secretary, Central Board of Irrigation and Power (CBIP) from August 1945 to March 1949; Chief Engineer and Joint Secretary in 1953 and Additional Secretary to Government of India in 1958. While serving on these positions, he championed the cause of irrigation and drainage at national and global level.

As the Chief Representative of Government of India on the Indus Water Negotiations under the aegis of International Bank for Reconstruction and Development (IBRD), he played a key role in the successful conclusion of the historical Indus Water Treaty between India and Pakistan in 1960 (ratified in 1961). He represented India in many international engineering conferences and made immense contributions to India's agricultural, water and power sectors.

In recognition of his ''distinguished services of a high order'', Er. Gulhati was bestowed with one of India's highest civilian honours "PADMA BHUSHAN" by the President of India in 1961.

Late N.D. Gulhati dedicated his entire professional life to the development of irrigation engineering and conceived and implemented the concept of an 'International Commission' for ensuring international cooperation on advancing the world knowledge in the fields of irrigation, drainage, flood management and river training by pioneering the idea of setting up an International Commission to the Government of India in 1946. The Commission was set up in the year 1950 and Er. Gulhati was befittingly selected as its first Secretary General to lead its operations in its budding period. Later he led the Commission from the forefront holding positions of Vice President (1957-1960), and President (1960-1963) of ICID.

President Honoraire Gulhati was a globally renowned Water Resources Consultant, whose services were utilized by many State Governments in India and global organizations like IBRD (1963), International Development Association (1963-1973), and United Nations (ESCAP) in 1969.

Born on 15 November 1904 in Lahore, Pakistan, Er Gulhati completed his technical education from the Thomson Civil Engineering College, Roorkee in 1926 (later University of Roorkee and now IIT Roorkee) where he achieved honours. He was appointed to the Indian Service of Engineers in October 1927 and posted to the Irrigation Branch of the Public Works Department, Punjab. Er N.D. Gulhati passed away in December 1978.

Er. Gulhati was amongst the foremost supporters of ICID and did everything possible to promote the objects of ICID. His mature leadership, dynamic personality and diplomatic and adroit handling of all matters won him universal respect and endearment with all the members of the ICID fraternity. As the architect of the "International Commission" who laid a strong foundation for Commission's growth during its nascent years, Er. Gulhati has been aptly called the 'Father' of ICID.

9th N.D. Gulhati Memorial Lecture for International Cooperation in Irrigation and Drainage

"Climate Variability and Change: Impacts on Water Availability"

Jeremiah R.D. Lengoasa*

Dr. Gao Zhanyi, President of the International Commission on Irrigation and Drainage
Dr. Avinash C. Tyagi, Secretary General, Office Bearers of ICID, Distinguished Delegates, Ladies and Gentlemen,

It is an honour and a pleasure for me to be with you here today on the occasion of the opening of the twenty-second Congress of the International Commission on Irrigation and Drainage. On behalf of Mr. Michel Jarraud, Secretary-General of the World Meteorological Organization, I extend a warm welcome to all participants. I also take this opportunity to express our appreciation to the Government of the Republic of Korea for hosting this Congress.

It is my privilege to be delivering the N.D. Gulhati Memorial Lecture on International Cooperation in Irrigation and Drainage at this 22nd ICID Congress deliberating on the theme "Securing water for food and rural community under climate change" which has many issues that are directly relevant to the services provided by the World Meteorological Organization (WMO) through its network of National Hydrological and Meteorological Services in the countries, which is based on cooperation and collaboration.

WMO, through its predecessor International Meteorological Organization established in 1873, was one of the first international platforms for cooperation in the field of meteorology. The World Meteorological Organization (WMO) is a specialized agency of the United Nations since 1950. It is the UN system's authoritative voice 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. Working in close cooperation with UN-Water and FAO and to some extent with ICID, WMO realizes the importance of International Cooperation for ensuring food safety and addresses these issues in the spirit of "Working Together". 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.

* Deputy Secretary-General, World Meteorological Organization

Climate change adaptation in the water, as well as the agricultural sector, is not only key to water and food security but also to sustainable development in future. Irrigation, which falls at the intersection of adaptation in water and agriculture domains and serves as a tool to mitigate the adverse impacts of droughts, has contributed to the Green Revolution and continues to stabilize food production against variable weather and water availability. The need for the application of irrigation water depends largely on the timely availability of water in the form of soil moisture for the healthy growth of plants. It is therefore important to understand the variability of weather, which determines the soil-moisture, evaporation and the availability of rain to determine the irrigation requirement. How these weather and, and in the longer term, climate elements will change in future under climate change conditions will determine the long-term sustainability of food production in many areas. I will therefore address the issue of "Climate Variability and Change: Impacts on Water Availability".

I will focus my lecture on:

(i) the latest scientific understanding on climate change,
(ii) the efforts being made by WMO in delivering science based services through its various programmes,
(iii) the new initiative that has been taken by the WMO in collaboration with other international agencies to provide climate information and services through the Global Framework for Climate Services (GFCS), and
(iv) the need for broader collaboration and cooperation among different development sectors at global as well as regional and national levels.

If we can ensure that the needs of the agricultural sector for targeted and relevant climate services will be met through closer cooperation between the institutions in your countries and the respective National Meteorological and Hydrological institutions, we will have moved a long way towards adaptation to climate change. Through this new initiative WMO is spearheading closer collaboration between users and providers of weather and climate information and services. In order to seek your attention, I propose to you the possibility of establishing such collaborations at the national level among the water, agriculture and climate communities of your countries and offer WMO's support to such initiatives.

WMO has played a unique and powerful role in contributing to the safety and welfare of humanity within the framework of WMO programmes, through National Meteorological and Hydrological Services, and contributes substantially to the protection of life and property against natural disasters. WMO initiatives are aimed at safeguarding the environment and enhancing the economic and social wellbeing of all sectors of society including in areas such as food security and water resources management. In the specific case of weather-, climate- and water-related hazards, which account for nearly 90% of all natural disasters, WMO's programmes provide vital information for the advance warnings that save lives and reduce damage to property and the environment.

ICID is dedicated to enhance the world wide supply of food and fibre for all people and believes that food security at various levels: global, national, local and household, and provision of assured livelihood starts with stable agriculture production. The Commission, with active support from its members, provides an international forum and network in which the technical, agronomic, socio-economic, environmental and managerial complexities involved in the development, management and operation of irrigation, drainage and flood management works are discussed.

Mr. President

The need for these two great institutions to work closely together is thus obvious and hence WMO and ICID have signed a Memorandum of Understanding between the two organizations identifying areas for future cooperation. Adaptation to climate change is one of these areas.

I Scientific understanding on climate change

The Fifth Assessment Report of the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC) stressed that the warming of the climate system is unequivocal and that since the 1950s many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

Human activities—primarily burning of fossil fuels and changes in land cover—are modifying the concentration of atmospheric constituents or properties of the Earth's surface that absorb or scatter radiant energy. Global atmospheric concentrations of carbon dioxide have increased 41% as a result of human activities since 1750 and now far exceed pre-industrial values. According to the IPCC report, concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) now substantially exceed the highest concentrations recorded in ice cores during the past 800,000 years.

And what is alarming is that, for the first time, in April this year the monthly concentrations of CO_2 in the atmosphere topped 400 parts per million (ppm) averaged over the northern hemisphere. This threshold is of symbolic and scientific significance and reinforces evidence that the burning of fossil fuels and other human activities are responsible for the continuing increase in heat-trapping greenhouse gases warming our planet. CO_2 lingers in the atmosphere for hundreds if not thousands of years and so will determine global mean surface warming by the late 21st century and beyond. Most aspects of climate change will persist for centuries even if emissions of CO_2 are stopped immediately.

Mr. President, Distinguished Delegates,

According to the latest WMO Statement on the status of the global climate, the year 2013 tied with 2007 as the sixth warmest since global records began in 1850. Although the climate varies naturally from year to year, it is clear that the planet is experiencing

an overall warming trend. Thirteen of the fourteen warmest years on record have all occurred in the 21st century, and each of the past three decades has been warmer than the last, culminating with 2001–2010 as the warmest decade on record. As highlighted by the Fifth Assessment Report of the IPCC, this steady warming is caused by rising levels of anthropogenic greenhouse gases in the atmosphere.

The global average surface temperature in 2013 was 0.50°C above the 1961–1990 average and 2013 was also warmer than both 2011 and 2012, which, though marked by cooling La Niña conditions, were 0.43°C and 0.46°C above average, respectively. The globally averaged combined land and ocean surface temperature data as calculated by a linear trend, show a warming of 0.85°C over the period 1880 to 2012.

The Fifth IPCC Assessment Report noted that changes in many extreme weather and climate events have been observed since about 1950. It is very likely that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. It is also likely that the frequency of heat waves has increased in large parts of Europe, Asia and Australia. There are likely more land regions where the number of heavy precipitation events has increased than where it has decreased. The frequency or intensity of heavy precipitation events has likely increased in North America and Europe.

Looking ahead with regards to future global and regional climate change, the IPCC report concludes that continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions, starting now.

Global surface temperature change for the end of the 21st century is likely to exceed 1.5°C relative to 1850 to 1900 for most future climate scenarios. Warming will continue to exhibit interannual-to-decadal variability and will not be regionally uniform. It is virtually certain that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales as global mean temperatures increase. It is very likely that heat waves will occur with a higher frequency and duration. Occasional cold winter extremes will continue to occur.

Changes in the global water cycle in response to the warming over the 21st century will not be uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions. The high latitudes and the equatorial Pacific Ocean are likely to experience an increase in annual mean precipitation by the end of this century under the very high-emission scenario. In many mid-latitude and subtropical dry regions, mean precipitation will likely decrease, while in many mid-latitude wet regions, mean precipitation will likely increase by the end of this century under the very high-emission scenario.

Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will very likely become more intense and more frequent by the end of this century, as global mean surface temperature increases. Globally, it is likely that the area encompassed by monsoon systems will increase over the 21st century. While

monsoon winds are likely to weaken, monsoon precipitation is likely to intensify due to the increase in atmospheric moisture. Monsoon onset dates are likely to become earlier or not to change much. Monsoon retreat dates will likely be delayed, resulting in lengthening of the monsoon season in many regions.

Distinguished Delegates,

According to the IPCC report, freshwater-related risks of climate change increase significantly with increasing greenhouse gas emissions. Each degree of warming is projected to decrease renewable water resources by at least 20% for an additional 7% of the global population. By the end of the 21st century, the number of people exposed annually to a 20th century 100-year flood is projected to be three times greater for very high emissions scenario than for very low emissions. Climate change is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions. We just add that as a result of sea level rise and overutilization of water resources salt water intrusion into coastal aquifers is expected to increase.

So far there are no widespread observations of changes in flood magnitude and frequency due to anthropogenic climate change, but projections imply variations in the frequency of floods. Flood hazards are projected to increase in parts of south, southeast and northeast Asia, tropical Africa, and South America. Since the mid-20th century, socio-economic losses from flooding have increased mainly due to greater exposure and vulnerability. Global flood risk will increase in the future partly due to climate change.

There is no evidence that surface water and groundwater drought frequency has changed over the last few decades, although impacts of drought have increased mostly due to increased water demand. Climate change is likely to increase the frequency of meteorological droughts (less rainfall) and agricultural droughts (less soil moisture) in presently dry regions by the end of this century under the very high-emission scenario. This is likely to increase the frequency of short hydrological droughts (less surface water and groundwater) in these regions. Projected changes in the frequency of droughts longer than 12 months are more uncertain, because these depend on accumulated precipitation over long periods.

Climate change negatively impacts freshwater ecosystems by changing streamflow and water quality. Proportional changes are typically one to three times greater for runoff than for precipitation. However, quantitative responses are known in only a few cases. Except in areas with intensive irrigation, the streamflow-mediated ecological impacts of climate change are expected to be stronger than historical impacts due to anthropogenic alteration of flow regimes by water withdrawals and the construction of reservoirs.

All this will exacerbate competition for water among agriculture, ecosystems, settlements, industry and energy production, affecting regional water, energy and food security. In contrast, water resources are projected to increase at high latitudes. The effects on water resources and irrigation requirements of changes in vegetation due to increasing greenhouse-gas concentrations and climate change remain uncertain.

The IPCC report also states that an adaptive approach to water management can address uncertainty due to climate change. Adaptive techniques include scenario planning, experimental approaches that involve learning from experience, and the development of flexible and low-regret solutions that are resilient to uncertainty. Barriers to progress include lack of human and institutional capacity, financial resources, awareness, and communication.

Distinguished Delegates,

II Contributions to adaptations by various WMO Programs

There are several WMO activities and projects that are relevant to promoting weather and climate solutions for water resource management. One of these is the Associated Programme on Flood Management (APFM), established in 2001 and co-sponsored by WMO and Global Water Partnership (GWP). The APFM is aimed at supporting countries in the application of the concept of Integrated Flood Management (IFM) as an alternative approach in dealing and living with floods. To this aim, it facilitates dialogue and provides governmental agencies (in particular National Meteorological and Hydrological Services) with multi-disciplinary guidance on flood management for the implementation of IFM national strategies.

The APFM activities can be easily summarized through the structure and functioning of its IFM HelpDesk, a facility that provides guidance on flood management policy, strategy, and institutional development for countries that want to adopt the IFM concept. Users have the possibility either to request custom-made technical support through the Get Help function or to find flood management solutions by themselves using the literature in the Help Yourself section. Over its 13 years of activity APFM has implemented various field demonstration projects, developing strategies for flood management either at the national level (e.g. Kenya, Zambia, and Thailand) or at the local scale (e.g. India, Bangladesh) through community based flood management approaches.

Droughts are one of the most common hazards around the world, and yet only a few countries around the world have comprehensive drought mitigation policies. Most countries have reactive policies to deal with the after effects of droughts. In order to address the issue of national drought policy, WMO, the Secretariat of the United Nations Convention to Combat Desertification (UNCCD) and the Food and Agriculture Organization of the United Nations (FAO), in collaboration with a number of UN agencies, international and regional organizations and key national agencies, organized the High Level Meeting on Drought Policies (HMNDP) in Geneva in March 2013.

The HMNDP provided practical insight into useful, science-based actions to address the key drought issues being considered by governments and the private sector under the UNCCD and the various strategies to cope with drought. National governments must adopt policies that engender cooperation and coordination at all levels of government in order to increase their capacity to cope with extended periods of water scarcity in the event of a drought. The ultimate goal is to create societies that are more drought resilient.

Based on the APFM experience in service delivery, during the HMNDP, WMO and GWP launched the Integrated Drought Management Programme (IDMP). The scope of the Programme is to contribute to national efforts for poverty alleviation in drought-affected regions of the world through an integrated approach to drought management cutting across sectoral, disciplinary, and institutional jurisdictions. IDMP is currently working on the set up of an HelpDesk on Drought Management, while in the meantime various projects have been launched at the regional level through the GWP network (e.g. the IDMP Central and Eastern Europe, the IDMP West African and the IDMP Horn of Africa), or in support to National Meteorological or Hydrological Services for the development of national strategies through the WMO network (e.g. in Mexico, supporting the CONAGUA PRONACOSE – national programme against droughts; or in Turkey, supporting the establishment of a national drought policy and providing international expertise).

An integrated approach to managing climate extremes, such as floods and droughts, is crucial to stepping out of our silos and to making the right connections. Both APFM and IDMP aim to link practitioners with the science for improved forecasting and better planning. They contribute to the GFCS, which bridges the gap between climate information developed by scientists and the practical needs of policy makers and planners, aiming to facilitate climate-smart decisions.

Ladies and Gentlemen,

III Global Framework for Climate Services: the new initiative

In many countries, the National Meteorological and Hydrological Services (NMHSs), in partnership with academic and private sector service providers, have initiated innovative information and advisory services that have significant impact on water management. In order to meet the water needs of rapidly growing populations, especially in developing countries, information generated by the NMHSs is a vital element for ensuring the sustainable use of natural resources. Thus, new emphasis must be placed on improving awareness in the water resources community, especially in developing countries, of the available and relevant weather and climate information resources and their potential value to water resources management.

Many developing countries lack the capacities and specialized competencies to deliver timely and relevant information services to meet the needs of the water resources community. The growing sense of urgency for continued but closer collaboration between the water community and NMHSs has been highlighted. This collaborative process must move forward more aggressively, with effective risk coping strategies, to maximize the benefits of weather, climate and water information in the water sector.

In 2009 when world leaders from 155 countries agreed to establish a Global Framework for Climate Services (GFCS), a challenge was launched to both the scientific community and the users of climate services to galvanize collaborative efforts to develop effective climate services in support of decision-making. A High Level Taskforce of eminent personalities from scientific and political spheres produced a blue print to provide

guidance on the focus of the Framework. Based on their report, the World Meteorological Congress, in an extraordinary session held in 2012 for the first time in the history of WMO, established an Intergovernmental Board on Climate Services (IBCS) and provided it with an Implementation Plan containing Annexes, detailing the essential elements needed for its operation, and Exemplars, providing details on what needs to be done to enable better application of climate services in the four initial priority areas (agriculture and food security, disaster risk reduction, health and water resources management). The IBCS met for the first time in July 2013 and adopted the Implementation Plan.

One of our main goals is to ensure that WMO activities in various application programmes such as agricultural meteorology and operational hydrology provide a strong interaction with the development and implementation of the GFCS in close cooperation with other International Organizations such as ICID.

The vision of the GFCS is "To enable better management of the risks of climate variability and change and adaptation to climate change, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale."

Climate services offer science-based information and forecasts that empower decision-makers to manage the risks and opportunities of climate variability and climate change. Providers of climate services consult with users to determine what kind of information they need, when and how often, and in what format. They then deliver the information and assist their clients to interpret and apply it. Sophisticated climate services combine climate forecasts with information from other sectors to inform decisions on public health, agriculture, water management, disaster risk and other priorities. For example, forecasts of drier-than-average periods in the Sahel can be integrated with information about a population's health and maps of available health facilities to support the timely roll-out of vaccines ahead of a meningitis outbreak. A monsoon forecast with information on past cropping decisions and market trends can support decisions on food security. Scenarios of future sea-level rise combined with population trends can shape long-term investments in coastal housing and infrastructure.

The GFCS is composed of the following five components: User Interface Platform – where users can make their voices heard through the Platform and make sure climate services are relevant to their needs; Climate Services Information System – the production and distribution system for climate data and information products that address user needs; Observations and Monitoring – the essential infrastructure for generating the necessary climate data; Research, Modeling and Prediction – needed to advance the science needed for improved climate services that meet user needs and most importantly, and Capacity Development – which will support the systematic development of the institutions, infrastructure and human resources needed for effective climate services.

The second meeting of the Intergovernmental Board on Climate Services will be held in Geneva in November and I would urge the ICID to consider becoming a Partner to the GFCS and joining the Partners Advisory Committee.

IV Road map for a broader cooperation

During the development and approval of the GFCS by the WMO Congress and leading up to the establishment of the IBCS, all of the priority areas (agriculture and food security, disaster risk reduction, health and water resources management), developed examples (Exemplars) of how they would potentially work within each of these areas. I will only focus on the agriculture and food security and water resources areas.

The objective of the Agriculture and Food Security Priority Area is to identify needs of the agriculture and food security sectors, characterize abilities in climate services, and suggest ways to improve performance and management of agriculture and food security systems from global to local levels using climate information.

Broadly speaking, agriculture includes crops, animal husbandry, and fisheries, but necessarily encompasses plants, horticulture, harvesting wild products, both capture fisheries and aquaculture, grazing, forage, some forestry including agro-forestry, timber fuel as well as bio fuels.

Several partners were involved in developing this area including the WMO, the United Nations Food and Agriculture Organization, the World Food Programme and the International Federation of the Red Cross and Red Crescent National Societies. These partners share this common goal of improving the relevance of and access to climate services.

The partners in this priority area are aware of the climate-sensitive aspects of agriculture and food security and would focus together on: assessing areas where climate information and services are useful to agriculture and food security activities; reviewing successful use of climate services; making an analysis of the gaps; providing a work plan to improve delivery, uptake and use of climate services for agriculture and food security communities; and proposing key activities to foster interactive work across the agencies and organizations.

To facilitate dialogue across disciplines to understand information requirements of the different users and to develop effective climate service applications, the user interface program needs to facilitate an effective flow of information from weather and climate service providers to decision makers in a timely manner for appropriate use. It will differentiate between the different types of decision makers; recognizing that the needs and abilities vary amongst the farming community, research community, governmental bodies, private industry, and international agencies.

Likewise, the Water Resources Management Priority Area noted that water services or agencies and professionals are dealing with the impact of human interventions and climate variability and change on flow regimes. Water is a key driver of economic and social development while it also has a basic function in maintaining the integrity of the natural environment. However water is only one of a number of vital natural resources and it is imperative that water issues are not considered in isolation. Drivers such as demography and climate change further increase the stress on water resources.

As a result, the Integrated Water Resources Management (IWRM) approach, a more holistic approach to water management, has now been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands.

For making climate services useful for better water management, the communities that support this Priority area advocate for: a development-centric approach based on IWRM and meeting user needs; implementation through existing programmes and mechanisms that can be adapted according to requirements and that are flexible; a focus on the climate services required to support IWRM, including the management of extremes (floods and droughts), as well as the day-to-day water resources operational management needs which are influenced by climate, including those of coastal regions; and, well-defined linkages between the five pillars of the GFCS. User-driven services will require robust observation and monitoring systems, sound science, flexible service delivery mechanisms and targeted and deliverable capacity development support.

An essential element in this process for the agriculture, food security and water communities is the user feedback from the beginning of this collaborative partnership at the global, regional and national level. Within the existing WMO scientific communities, there is already progress being made with regards to the GFCS and reaching out to partners. This is main reason of my visit to the ICID: to foster the partner between our two communities and organizations. There is already a strong relationship between WMO, FAO, and WFP with regards to the agriculture and food security communities. I would like to propose as well, a close collaboration between the water communities, which could be composed of the National Committees of ICID, and the climate community represented by WMO and its National Meteorological and Hydrological Services.

Excellencies, Distinguished Delegates, Ladies and Gentlemen,

As water management (both surface water and groundwater) is intrinsically linked to climate variability and change, water managers have a central role to play in the development and implementation of adaptation strategies and on the ground measures. Water resources management is in a difficult transition phase, trying to accommodate large uncertainties associated with climate change while struggling to implement a difficult set of principles and institutional changes associated with integrated water resources management. Existing water management methodologies, including the design of engineering structures, are generally based on the concept of stationarity of historical time series that are extrapolated into the future, a concept that is not valid under conditions of climate change, thus adding an additional substantive uncertainty factor. This problem of non-stationarity is particularly critical in water-related risk management, especially when dealing with the management of and adaptation to hydrometeorological extremes (floods and droughts).

To improve water management through the use of climate services, it is important to identify the tasks and the products of the service. These will include climate predictions products, seasonal climate outlooks, downscaling products at various levels, different downscaling methodologies describing the underlying assumptions and uncertainties.

This requires the establishment of professional interactions between climate service developers and water managers at scientific and operational levels and across the full spectrum of water resources, including surface water, both regulated and non-regulated systems, groundwater and the freshwater-ocean interface.

In the light of the growing concerns of the impact of increased climate variability and future climate change on water resources, it is important that we actively promote hydrological research and applications. I would like to assure you of WMO's continued commitment to the promotion of agricultural meteorology and hydrology and water resources management and to ensuring that WMO continues to assume a leadership role in all relevant global initiatives and activities aimed at addressing these concerns of humanity.

In conclusion, I urge ICID and its members to establish linkages, where appropriate, at global, regional and national levels to ensure that climate information and services reach their intended audiences and are used for the betterment of humanity. Working alone we do things differently, working together, we can make a difference!

I wish all the participants the very best in their deliberations and an enjoyable stay in Gwangju.

Thank you.

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