AWCI Phase 2 Implementation Plan – country inputs compiled
March 2012

1. Bangladesh

1. Issues and Needs

At present the issues related to climate change, water cycle and water use have drawn tremendous attention globally. It has become urgent for the most vulnerable countries like Bangladesh to study in more details the weather forecast, climate change impacts on regional hydrology aiming to reduce the economic losses caused by natural hazards and to plan the adaption strategy to encounter climate change impact more efficiently. This kind of study prevailing in our country at Meteorological Department and Water Management Organizations is very weak and needs significant support for improvement.

1.1 Current Needs and Challenges

- Improvement of Climate and Flood Modeling.
  Currently Meghna does not use computational modeling to understand flood hazard.
- Tools for impact modeling
- Vulnerability and Risk assessment tools to various sectors:
  - Water resources (Flood, Drought, River Bank Erosion, Sea Level Rise, Depletion of Ground Water, Hydropower, Trans-boundary and international coordination, Salinity Intrusion, Cyclones; Shifting of snow residency, melting period and snow-line and their impact on biodiversity)
  - Agriculture
  - Coastal
- Analytical tools to describe the weather extremes and climate variability
- Application of remotely sensed data in monitoring drought and floods
- Decision support systems as risk management tools especially for the water and agricultural sectors
- Forecasts at different time scales (daily, ten-daily, monthly and seasonal) particularly for rainfall
- Areas susceptible to flooding have changed and flood maps developed with past climate data lack enough precision to be useful for disaster management under current climate

1.2 Available Resources/Capability

a. Network of observing stations

1. 133 non-tidal and 14 tidal discharge measuring stations throughout the country
2. 293 non-tidal and 190 tidal water level measuring stations
3. 1256 groundwater level measuring stations
4. 6 Satellite Ground Stations for receiving weather satellite images by SPARSSO
5. Temperature, Rainfall, Radar images, Satellite images, Weather forecast, Marine forecast, Eclipse information are collected and maintained by Bangladesh Meteorological Department
6. More than 60 Automatic Rain-gauges

b. Modeling and monitoring system

1. Flood Forecasting Model: One dimensional fully hydrodynamic model (MIKE 11 HD) incorporating all major rivers and floodplains. This is linked to a lumped conceptual rainfall-runoff model (MIKE 11 RR) which generates inflows from catchments within the country
2. Monitoring system for cloud & depression movements, precipitation estimation from cloud temperature analysis
3. System for cyclone monitoring

c. Human resource

1. Well trained personnel in climate, weather and flood forecasting
2. Expertise and linkages with national, regional and international funding organizations
3. In-house training programs for continuous capability building of personnel

d. Infrastructure for climate modeling

1. Cluster Computing system

2. Issues Related to the Climate System

<u>Current Climate Trends in the Bangladesh</u>

A. Temperature

In Bangladesh Winter (December to February) is cooler and drier with the average temperature ranging from a minimum of 7.2 to 12.8° C to a maximum of 23.9 to 31.1° C, Pre-monsoon (March to May) is hot with an average maximum of 36.7℃ which occasionally rises up to 40.6℃ or more, Monsoon (June to early October) is both hot and humid and Post-monsoon (late October to November) is observed with gradual lowering of night-time minimum temperature. All climate models considered in different past studies estimate a steady increase in temperature in Bangladesh like most other parts of the world as depicted in the table given below. Somewhat more warming is estimated for winter than for summer in all cases where projected temperature would rise 1.0℃ by 2030, 1.4℃ by 2050 and 2.4℃ by 2100 with respect to the base year 1990.

Table 1: GCM estimates of temperature changes in Bangladesh

Year	Temperature change (°C) mean (standard deviation)		
	Annual	**DJF**	**JJA**
2030	1.0 (0.11)	1.1 (0.18)	0.8 (0.16)
2050	1.4 (0.26)	1.6 (0.26)	1.1 (0.23)
2100	2.4 (0.28)	2.7 (0.46)	1.9 (0.40)

B. Precipitation and Projected Rainfall

The mean annual rainfall in Bangladesh is about 2300mm, but there exists a wide spatial and temporal distribution. Annual rainfall ranges from 1200mm in the extreme west to over 5000mm in the east and north-east. Monsoon brings heavy torrential rainfall throughout the season in Bangladesh. The key factor regarding climate change impact in Bangladesh is what happens during the monsoon since more than 80% of annual precipitation that falls on Bangladesh comes during the monsoon period. Most of the climate models estimated that precipitation will increase during the summer monsoon as shown in Table 2.

Table 2: GCM estimates of precipitation changes in

Year	Precipitation change (%) mean (standard deviation)		
	Annual	**DJF**	**JJA**
Baseline average	2278 mm	33.7 mm	1343.7 mm
2030	+3.8 (2.30)	-1.2 (12.56)	+4.7 (3.17)
2050	+5.6 (3.33)	-1.7 (18.15)	+6.8 (4.58)
2100	+9.7 (5.80)	-3.0 (31.60)	+11.8 (7.97)

The climate models also tend to show small decreases in the winter months of December through February. The increase is not statistically significant, and winter precipitation is just over 1% of annual precipitation. However, with higher temperatures increasing evapotranspiration combined with a small decrease in precipitation, dry winter conditions, even drought, are likely to be made worse. The estimation in previous studies shows a little change in winter precipitation and an increase in precipitation during the monsoon.

C. Flood

Flooding is a recurrent phenomenon each year in Bangladesh and has numerous adverse effects, including loss of life through drowning, increased prevalence of disease, and destruction of property. The effects of increased flooding resulting from climate change will be the greatest problem faced by Bangladesh in the coming years. Both coastal flooding (from sea and river water), and inland flooding (river/rain water) are expected to increase. About 20% of the country is flooded every year, and in extreme years, about 70% of the country can be inundated. This vulnerability to flooding is exacerbated by the fact that Bangladesh is also a low-lying deltaic nation exposed to storm surges from the Bay of Bengal. With regard to extremes at the upper end such as the 1988 and 1998 flooding events (Figure 1 & 2), climatic variability (including events such as the El Nino Southern Oscillation) as well as long term climatic change could certainly be contributing factors causing increased glacier melt, increased precipitation, sea level rise; and increased cyclone winds and precipitation.

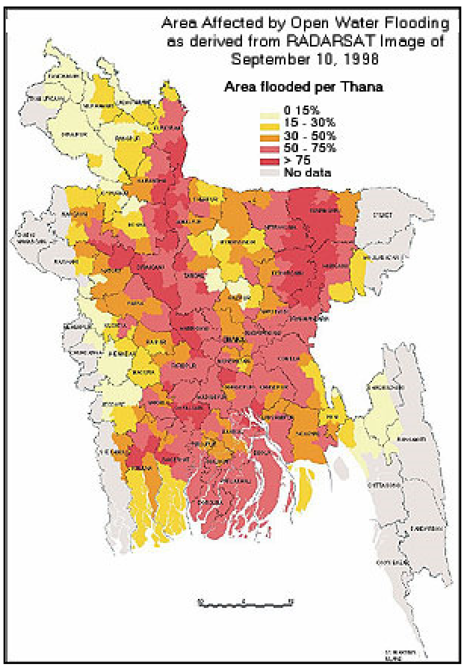

Figure 1: Areal coverage of the 1998 flood

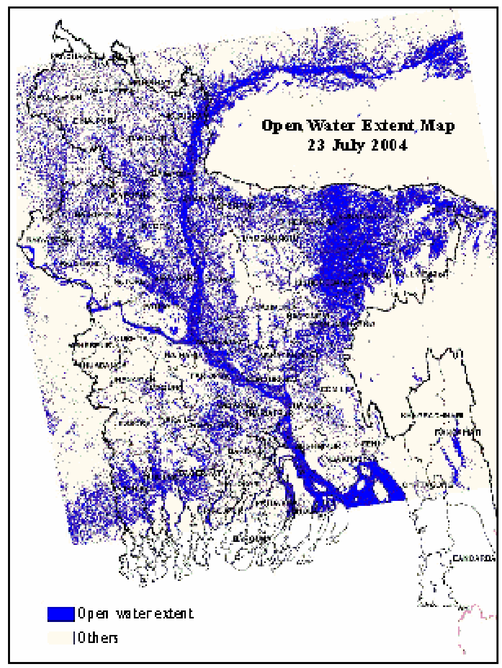

Figure 2: Open Water Extent Map on 23 July 2004

D. Drought

Under climate change drought could increase in Bangladesh though it's a matter of uncertainty. Drought is also a recurring problem in Bangladesh since 19 occurred between 1960 and 1991. The southwest and northwest regions of the country are most vulnerable to drought. Most of the climate models though do not give a clear picture of drought change in Bangladesh, but a number of climate models estimate decreased annual precipitation and reduced precipitation in winter indicates that the possibility of increased drought in future cannot be neglected.

E. River Bank Erosion

Land degradation in the upland areas, deforestation and landslides in the hilly areas contributes to increased soil erosion and changes the river system which creates drainage congestion and makes navigation difficult during the dry season. River bank erosion has become a matter of great concern in Bangladesh during the last few decades which annually consumes several thousand hectares of floodplain making thousands of people landless and homeless every year (Figure 3). A number of cities and towns such as Chandpur, Rajshahi and Faridpur are threatened by river bank erosion.

Figure 3: River Bank Erosion Problem in Bangladesh

F. Sea Level Rise

Another critical variable that determines the vulnerability of Bangladesh to climate change impacts is the magnitude of sea level rise. There is no specific regional scenario for net sea level rise, in part because the Ganges-Brahmaputra-Meghna delta is still active and the morphology highly dynamic. Over the 1961 to 2003 period, the average rate of global mean sea level rise was estimated from tide gauge data to be 1.8 ± 0.5 mm yr^{-1}, while the Bangladesh country study put the range at 30-100 cm by 2100, while the IPCC Third Assessment gives a global average range with slightly lower values of 9 to 88 cm. Sea level rise may have severe implications on livelihood and productivity of coastal area through inundation and salinity. In any event the increases in mean sea level need to be viewed in conjunction with the discussion on cyclones in the preceding section. Higher mean sea levels are likely to compound the enhanced storm surges expected to result from cyclones with higher intensity. Even in non cyclone situations, higher mean sea levels are going to increase problems of coastal inundation and salinization in the low lying deltaic coast.

G. More Frequent and Intensive Cyclones

Bangladesh currently has extreme vulnerability to cyclones, both on account of its somewhat unique location and topography (that creates an inverted funnel effect), and because of the low (though growing) capacity of its society and institutions to cope with such extreme events. Cyclones originate in the deep Indian Ocean and track through the Bay of Bengal where the shallow waters contribute to huge tidal surges when cyclones make landfall. Existing literature records storm surges in the range of 1.5 to 9 meters, and some sources even cite particular cyclones as having resulted in surges almost 15 m in height. A partial listing of major cyclones and accompanying surge heights is given in Table 2. Given that over two-thirds of the country is less than 5 m above sea-level and densely populated, storm surges contribute to flooding and loss of life and livelihoods far beyond the coast. The intense precipitation that usually accompanies the cyclone only adds to the damage through inland and riverine flooding. A cyclone ‘SIDR’ named the strongest cyclone in the Bay of Bengal in 2007, and another named ‘AILA’ in 2009 left thousands of people homeless, many infrastructures totally damaged and thousands of people unemployed.

H. Trans-boundary and International Coordination

Bangladesh is the lower riparian of three major river systems, the Ganges-Padma, the Brahmaputra-Jamuna and the Meghna (GBM), and constitutes about 8 per cent of the combined catchment area. Over 92 per cent of the annual runoff generated in the GBM catchment areas flows through Bangladesh. But Bangladesh, since its independence, has been watching with grave concern, the gradual reduction of the dry season flows of the Ganges, Teesta and many other trans-boundary rivers due to upstream diversions across the borders. A diversion of up to 60% of the Ganges water over 25 yr has caused reduction of water in surface water resources, increased dependence on ground water and destruction of the breeding and raising grounds for 109 species of Gangetic fishes and other aquatic species and amphibians. By this time, when Bangladesh has been badly suffering from acute scarcity of water during dry season due to cross-border upstream diversions, it has received alarming news of upstream country proposed project for interlinking its rivers to resolve country's water crisis within next 10 years. Under this project, it has been proposed to divert waters of the Manas and Sankosh, Dharla, Dudhkumar etc.-the tributaries of the Brahmaputra for transferring to West Bengal first and from there to Godavari-Krishna in South India. The effect of such diversion of water would be disastrous for the river eco-system of Bangladesh and needs urgent attention for the development of an effective river basin management system especially in Meghna River Basin. The aquatic environment for living organisms can be affected and bioaccumulation of harmful substances in the water dependent food chain can occur. A variation of inland surface water quality is noticed due to seasonal variation of river flow. At present, there is no efficient initiative of regional cooperation in terms of sustainable eco-efficient water infrastructures have been found between Bangladesh and India. But still there exist some water sharing and water withdrawing infrastructures (e.g. The Farakka Barrage).

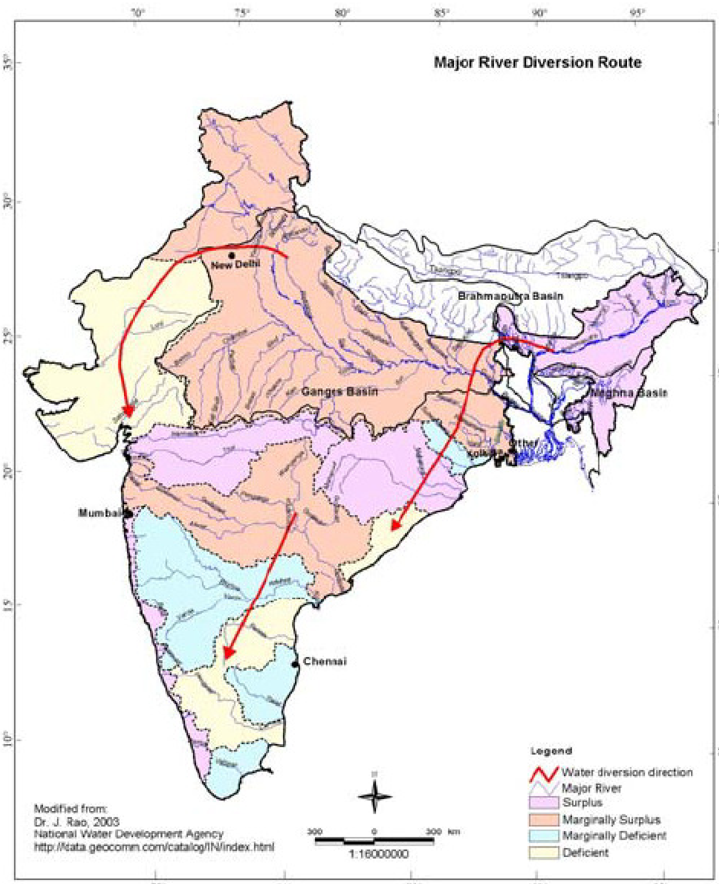

Figure 4: Major Diversion Route of Proposed Indian River Link Project

I. Salinity Intrusion

In addition to the altered hydrology due to climate change and withdrawal of water in Indian part, sea level rise will also have adverse impacts on the world largest mangrove forest, directly through enhanced inundation and indirectly by enhancing saline intrusion in river systems. The reduction in freshwater flows becomes deteriorated with time and the lowest water levels are observed in March. As a response to reduced flow regime the salinity front might penetrate inland both inside the forest areas and in the entire south-western areas of the country (Figure 5). Similar ingress of salinity is also expected on the Indian side of the Sundarbans.

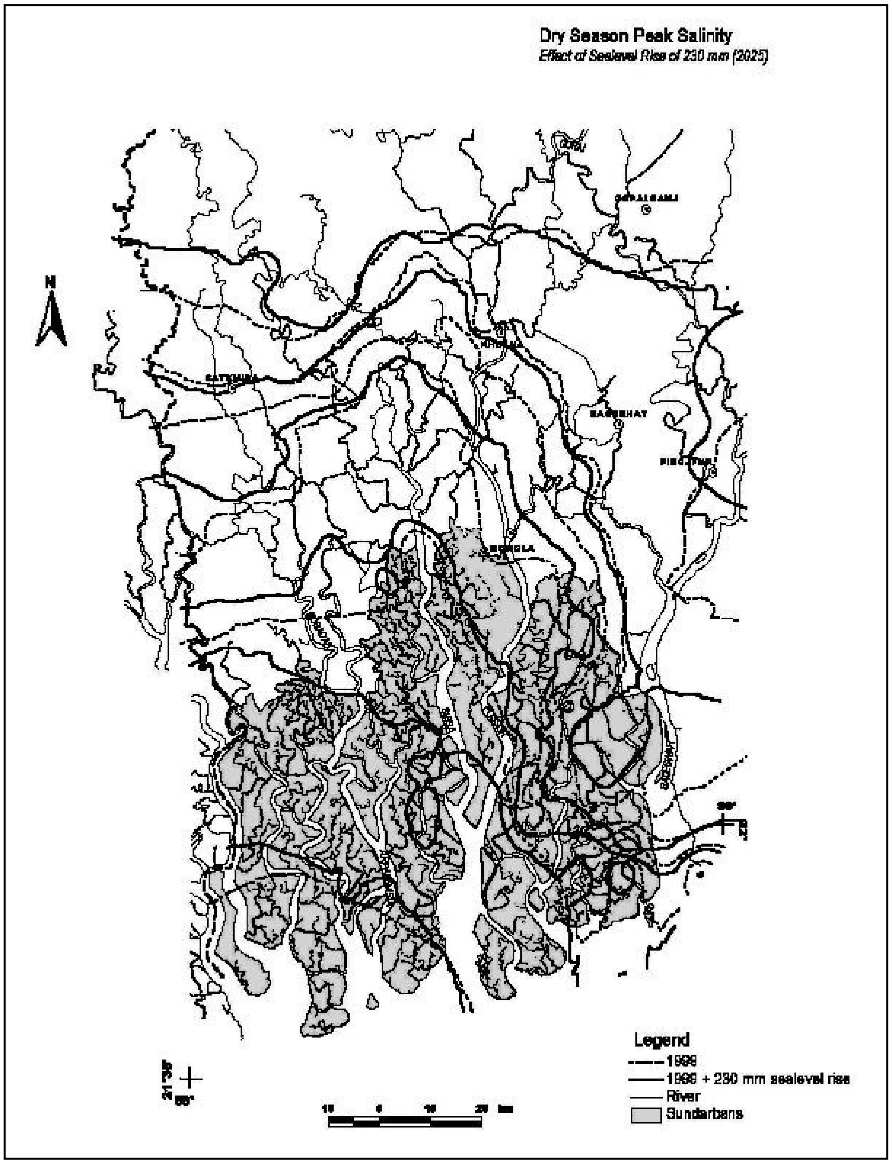

Figure 5: Salinity ingress in the Sundarbans under 23 cm sea level rise

J. Seasonal Climate Pattern

There are six seasons in Bangladesh, which are disappearing due to impact of climate change. Summer & rainy seasons are becoming prolonged, whereas winter season is becoming shortened.

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2. Bhutan

1. 0 Climate change scenarios, impacts, vulnerability

1.1 Climate patterns and climate variability

The country may be broadly divided into three geographic areas and corresponding climatic zones: the southern foothills, inner Himalayas and higher Himalayas. The climate is hot and humid in the southern foothills, with temperatures ranging from 15 to 30oC throughout the year and precipitation between 2,500 and 5,550 mm. The inner Himalayas, which rise to 3,000 m, constitute, with their broad valleys, the economic and cultural heartland of the Kingdom. The inner Himalayas are characterised by a cool temperate climate with annual average precipitation of 1,000 mm. The higher Himalayas constitute the northernmost and highest mountain ranges with elevations up to 7,550 m. These northern regions, under perpetual snow, are sparsely populated and have an alpine climate with average annual precipitation of 400 mm. Bhutan's climate is determined by the summer southwest monsoon from the Indian Ocean (late June through late September), and variations in topography and elevation. The monsoon accounts for 60% to 90% of the country's total precipitation. There are substantial disparities in temperatures and precipitations from one valley to another. The south-western and southern valleys are the warmest zones. Below freezing temperatures in the winter occur in the central, west-central and northern mountains. The southern valley of Bhutan receives the highest annual precipitation, while low precipitation occurs in central and northern Bhutan. The monsoon precipitation of Bhutan occurs more or less in opposite phase with that of India: when the monsoon is strong over Bhutan, it is weak over India and *vice-versa* (Quadir *et al.*, 2006).

1.3 Observed climatic trends in Bhutan

Temperature and precipitation data for the 14-20 years are available and so the period is considered too short for any meaningful analysis. However, an attempt has been made to look at trends with the available data. The Department of Energy is responsible for meteorological and hydrological observations and data measurement, as well as flood warning. Hydro-Met was established to support Bhutan's hydropower development. There are 84 meteorological stations throughout Bhutan. Most require manual observations. Automatic weather stations with data loggers are operational in some areas and real time data is collected for the purpose of weather forecasting.

1.4 Maximum temperature

The maximum temperature data from 18 stations were analyzed for trends. The stations selected represent the altitudinal range. Fig. 1 chart shows the change of maximum temperature with data from the 18 stations. It is observed that there is an increase in the maximum temperature. The increase is higher at higher altitudes. There is no increase at lower altitudes. In fact a cooling trend has been observed. The trend from 18 stations with 14 years of data show an increase of 0.027°C.

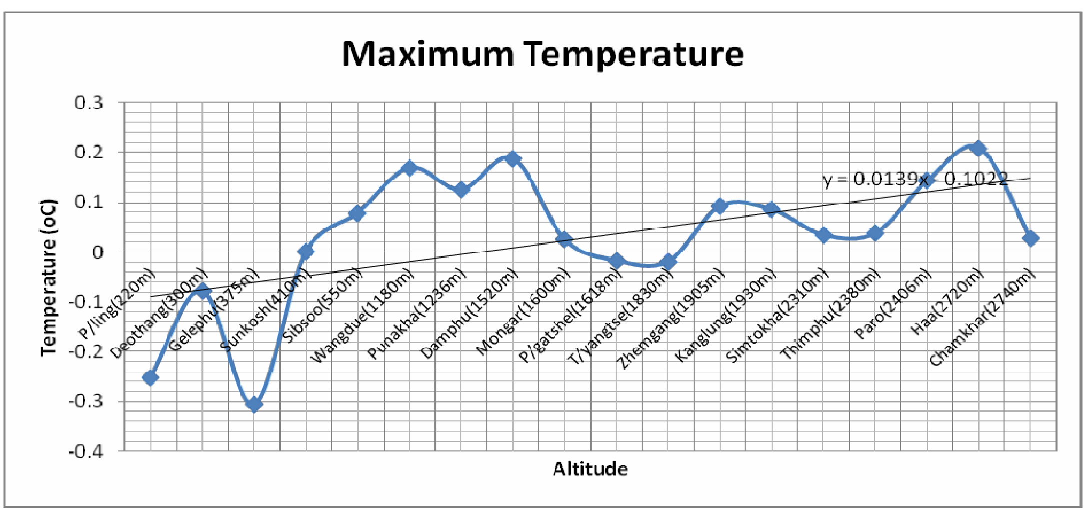


Figure 1: The increase of mean maximum temperature at analyzed stations.

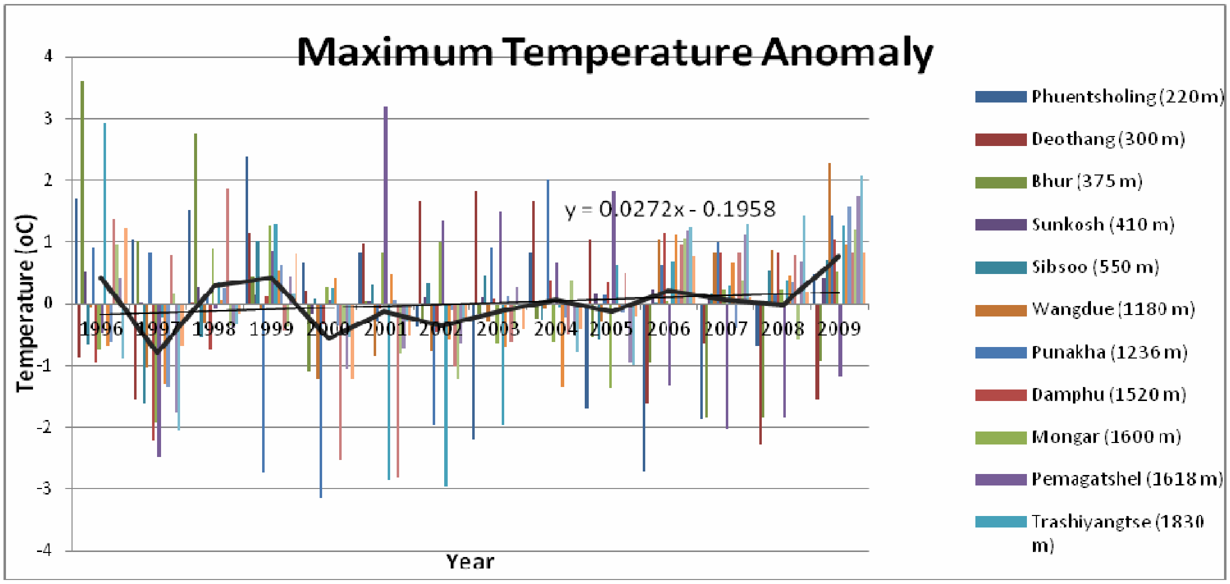


Figure 2: The temperature anomaly from the mean of 1996-2009.

Figure 2 shows the temperature anomaly from the mean of 1996-2009 and Figure 3 shows winter and summer trends. Winter maximum temperature increases are more at higher altitudes. The range between the winter (DJF) and summer (JJA) is highest in Paro. Figure 4 shows maximum temperature increase. The highest increase is in Haa for the period on record and decrease in Phuentsholing.

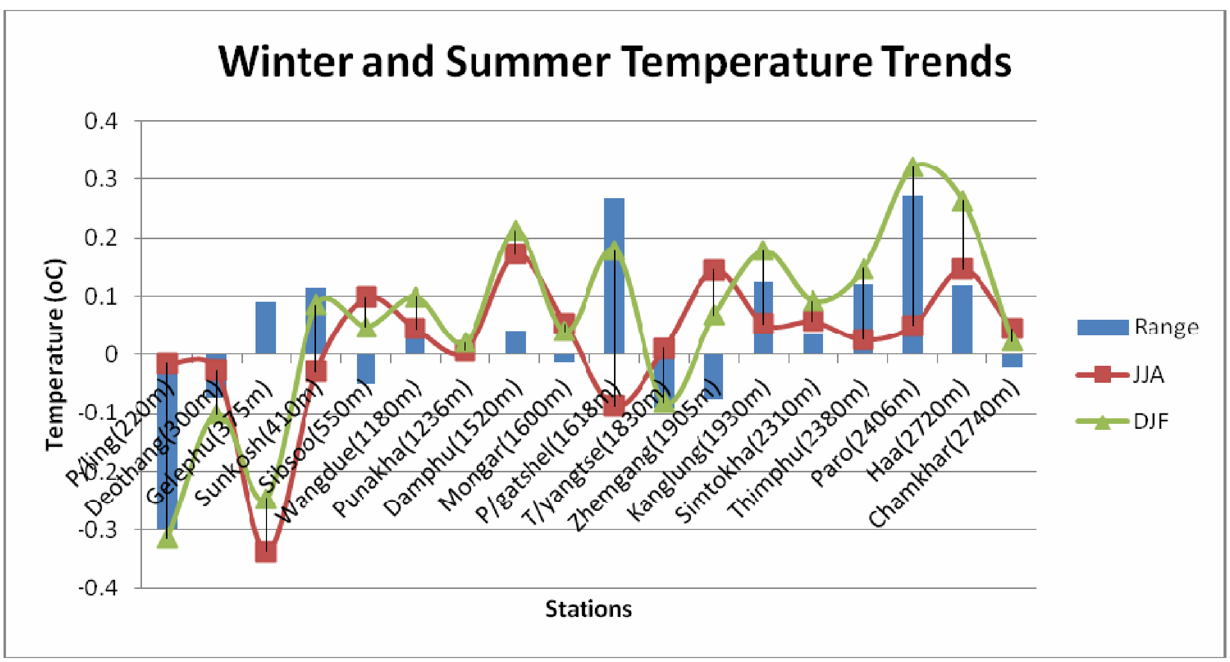


Figure 3: Winter and summer temperature trends.

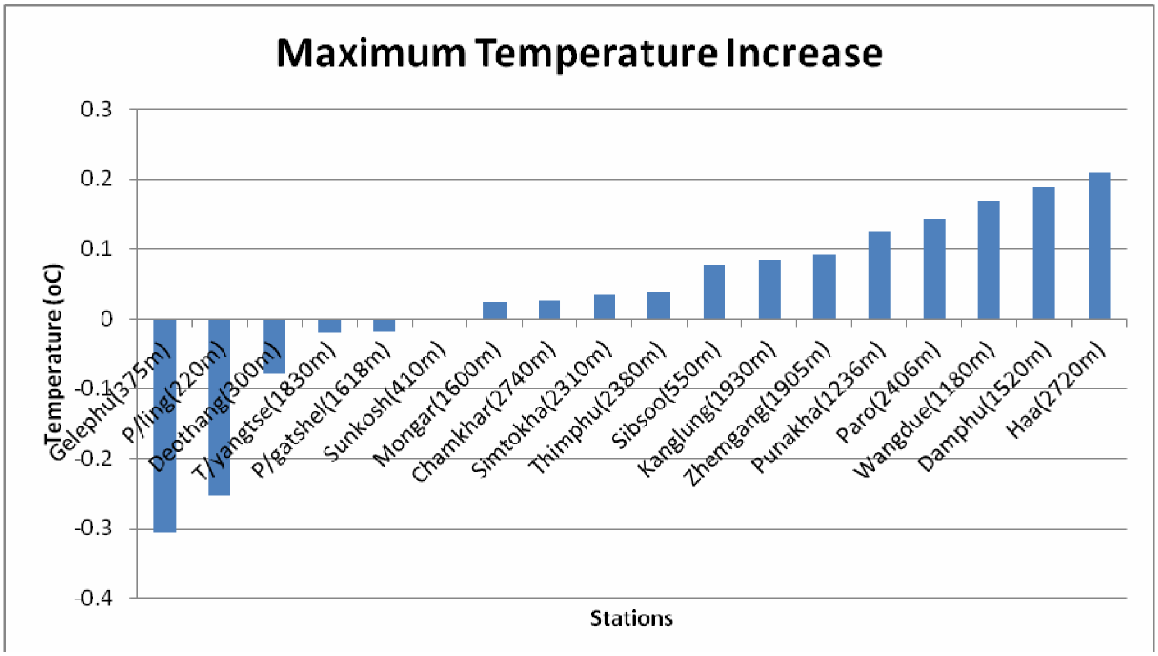


Figure 4: Maximum temperature increase.

The table shows the trend for all the 18 stations.

Stations	Gelephu	P/ling	Deothang	T/yangtse	P/gatshel	Sunkosh	Mongar	Chamkhar	Simtokha
Trend (°C)	-0.306	-0.252	-0.078	-0.019	-0.0173	0	0.025	0.027	0.034
Altitude (m)	375	220	300	1830	1618	410	1600	2740	2310

Stations	Thimphu	Sibsoo	Kanglung	Zhemgang	Punakha	Paro	Wangdue	Damphu	Haa
Trend (°C)	0.038	0.078	0.085	0.092	0.125	0.143	0.169	0.188	0.209
Altitude (m)	2380	550	1930	1905	1236	2406	1180	1520	2720

A study done by ICIMOD indicates that the eastern Himalayan region is an undergoing warming trend. Annual mean temperature is increasing at the rate of 0.01℃/yr or more. There is a diagonal zone from south west to north east regarding annual and seasonal temperatures. The warming in the winter (December, January and February) is higher, about 0.015℃/yr more than the annual trends The temperature trends in the three elevation zones are provided in Table below. The analysis suggests that:

i) the Eastern Himalayan region is experiencing widespread warming and the warming is generally greater than 0.01℃/yr;

ii) ii) the highest rates of warming are occurring in the winter December, January, February (DJF) and the lowest or even cooling trends are observed in the summer (June, July and August; JJA) season; and

iii) iii) Warming increases progressively with elevation, with areas >4,000 m experiencing the highest warming rates. The results suggest that seasonal temperature variability is increasing and the altitudinal lapse rate in temperature is decreasing. Unlike temperature, precipitation does not demonstrate any consistent trends.

Temperature trends (oC/yr) by elevation zones

	Annual	DJF	MAM	JJA	SON
Level 1 (< 1 km)	0.01	0.03	0.00	-0.01	0.02
Level 2 (1km-4km)	0.02	0.03	0.02	-0.01	0.02
Level 3 (>4 km)	0.04	0.06	0.04	0.02	0.03

1.5 Climate change projections

The Hydro-Met Services Division of the Department of Energy is responsible for meteorological and hydrological observations and data measurement, as well as flood warning. Hydro-Met was established to support Bhutan's hydropower development. There are 84 meteorological stations throughout Bhutan. Most require manual observations. Automatic weather stations with data loggers have been not been operated on a continued basis due to mechanical failures and maintenance issues. Three automatic stations are located in Thimphu. There are 24 gauging stations that have measured water levels and discharge, as well as sediment loads since 1987. Most meteorological and hydrological stations are located in inner and southern Bhutan. Thus data is not available for the higher mountains ranges. Given Bhutan's complex topography, the existing network of meteorological and hydrological stations does not sufficiently reflect variations in temperatures, precipitations, and river flows across the country. Weather forecast for Bhutan is therefore carried out by Hydro-Met staff with the assistance of an advisor sponsored by Japan International Cooperation Agency (JICA). The Second National Communication will again attempt to conduct climate change projections as part of a V&A assessment. However, with less than 15 years of local data available, modelling climate change in Bhutan will remain an arduous task. Mountain regions are characterised by complex topography and rapid changes in temperature and precipitation over short distances. There have been few attempts at modelling future climatic change conditions in mountain areas because of the costly computing requirements for fine spatial resolution to accurately reflect topography and climatic parameters (IPCC, 2007). Regional Circulation Models (RCM), such as PRECIS, has a 50-km horizontal resolution and preferably run a 30-year simulation. Inner valley projections over mountainous regions would require much higher resolution (Met Office, 2004). Bhutan falls within IPCC's South Asia sub-continental region which stretches to latitude 50°N. Averaged temperature and precipitation changes are derived from a dataset of 21 global models. For the A1B scenario6, the models show a median increase of 3.3°C by 2100, with increases in daily minimum and maximum temperatures. The largest warming will take place at higher altitudes, for example over the Himalayas, as surface albedo will decrease with the melting of snow and ice. A 5% decrease in precipitation is projected in the dry season, and an 11% increase for the rest of the year. In summary, the IPCC climate change projections to 2100 for the South Asia sub-continental region, including Bhutan, consist of the following:

- Increase in average temperatures with relatively warmer weather at higher altitudes and during the dry season;
- Increase in average annual precipitation and with a higher relative increase in the wet season and a decrease in the dry season;
- No conclusive indication of changes in climate variability and occurrence of extreme weather events;
- Continued spatial variation in temperatures and precipitation due to complex local topography.

The IPCC A1B scenario shows balance across all sources, where 'balanced' is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies.

1.6 Potential climate change impacts and vulnerability

The most important climate change impacts presented in Bhutan's INC and NAPA are discussed in this section, with supplementary information from the IPCC's Fourth Assessment Report (IPCC, 2007). Adaptation opportunities recommended in the INC consist of '*no regret*' strategies that focus on increasing the ability of ecosystems and communities to cope with on-going environmental stresses and climate variability

Table: Energy sector vulnerability to climate change

Sector	Vulnerabilities
Natural Hazard & Infrastructure	Debris-covered glaciers forming huge moraine dam lakes that ultimately lead to GLOFs (i.e. flash floods and landslides, heavy siltation of the rivers, and other geotechnical hazards). A GLOF will affect vital infrastructure: - Hydropower systems (generation plants, transmission and distribution infrastructure) as the main export product
Water Resources (& Energy)	production/exports due to disruption of average flows for optimum hydropower generation - Increased sedimentation of rivers, water reservoirs and distribution network, affecting notably irrigation schemes' productivity/ agricultural crop yields - Reduced ability of catchment areas to retain water/increased runoffs with enhanced soil erosion (deterioration of environment)

2.0 Manifestations

2.1 Glacier retreat

A study carried out by ICIMOD, UNEP and the Asia Pacific Network (APN) for Global Change Research between 1999 and 2003 documented15,000 glaciers and 9000 glacial lakes in Bhutan, Nepal, Pakistan and selected basins in China and India (Mool. et al. 2005). These glaciers feed the major river systems in the region and are considered lifelines for 10% of the world's population. The glacier retreat rates in these regions are shown in the table below:

Bhutan	• Tarina Glacier retreat rate was 35 m per year from 1967 to 1988 (Ageta et. al. 2000); • Retreat rates as high as 26.6 m per year were reported for 103 debris free glaciers in the Bhutan Himalaya over a period of 30 years from 1963 to 1993 (Karma et; al., 2003); • Jichu Dramo Glacier retreated by 12 m from 1998 to 1999 (Naito et. al., 2000); • The retreat rates are higher for glaciers in Bhutan Himalaya than in eastern Nepal (Karma et. al., 2003); • 8% shrinkage estimated using 66 glaciers in 30 years from 1963 to 1993 (Karma et. al., 2003); • Luggye Glacier retreated by 68.5 m per year from 1967 to 1994; and • Raphstreng Glacier retreated on an average 35.5 m per year from 1957 to 1987, and rate increased to 60 m per year from 1998 to 1993.

(*Yeshey Dorji, Specialist, DGM, MoEA*)

2.2 Flow fluctuations

The Hydro-met Services Division under the Department of Energy operates and maintains a network of river gauging stations. The network is divided into principal and secondary stations. The principal stations are equipped with cableways, current meters and staff gauges. Discharge measurements in secondary stations are computed by the float method. In the Wangchu basin, gauging stations are operated in Chukha, Tamchu, Paro, Thimphu and Haa. The average annual discharge data from these stations for the period 1992-2009 have been analyzed as shown in Figure 5 below. The data from Paro shows yearly fluctuation. A decreasing trend of 2.051 m3/s per year is noticed in the case of Paro and 0.295 m3/s per year in the case of Thimphu. Even in Haa, there is a decreasing trend.

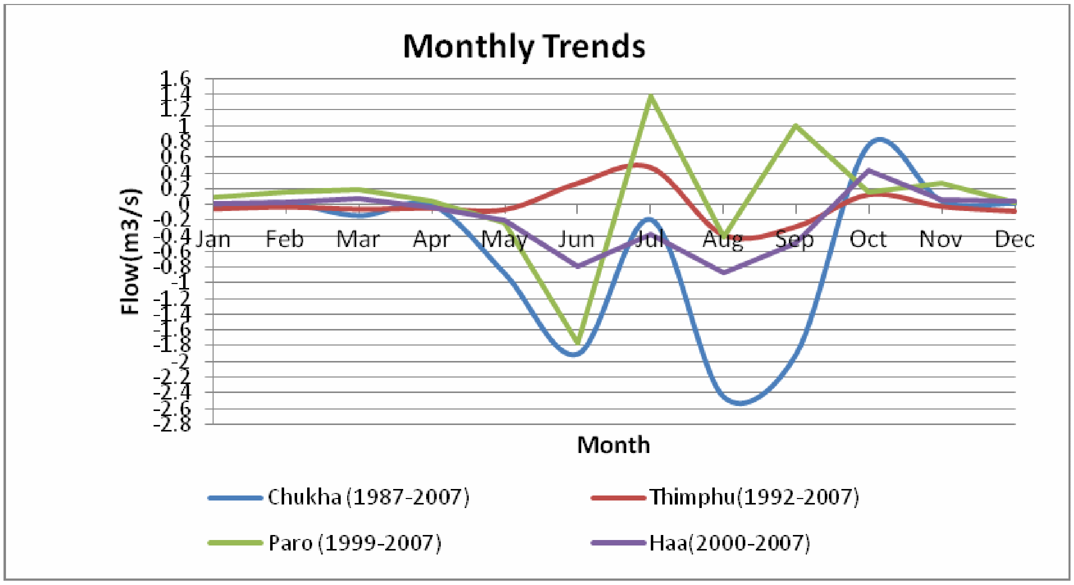


Figure 5: Monthly trends of streamflow.

The Figure 6 below shows the monthly flow trends in the four stations. The summer months show a decreasing trend indicating decrease in rainfall during these months. Winter flows in Paro, Haa and Chukha show an increasing trend. The increase is highest in April and May, indicating more glacial contribution.

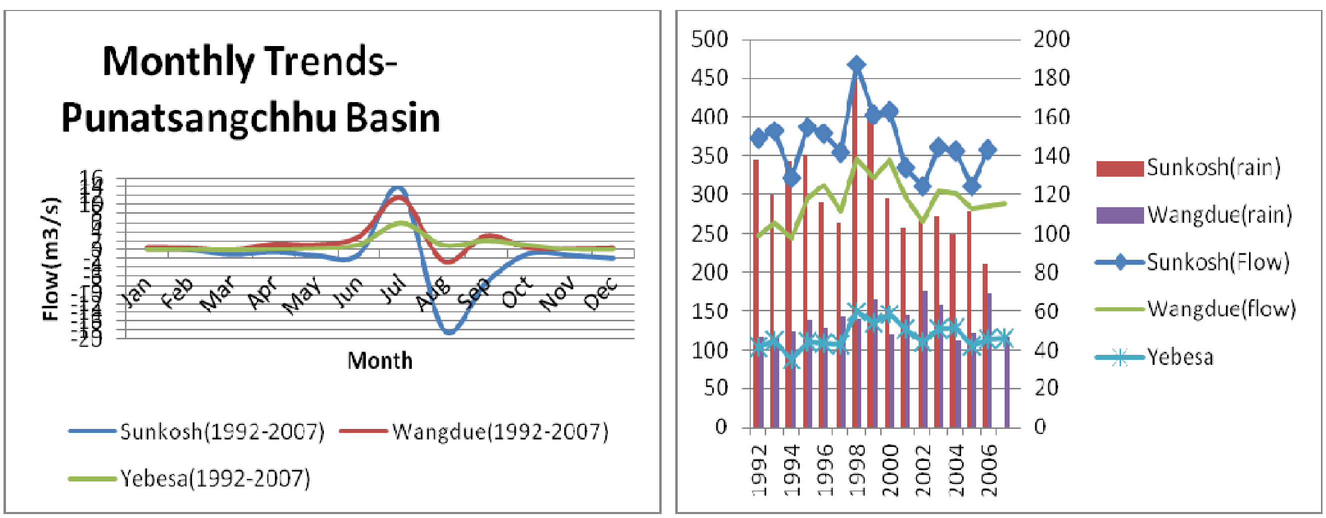


Figure 6: Monthly trends in Punatsangchhu Basin.

3. Issues

3.1 GLOF

Climate change impacts in Bhutan are noticeable in the formation of glacial lakes due to accelerated retreat of glaciers with increasing temperatures. The risk of GLOFs is increasing now as water levels in various glacial lakes reach their thresholds. GLOFs pose a serious threats to lives, properties and infrastructure in downstream areas. The current level of disaster preparedness in Bhutan may not be able adequate to deal with GLOFs apparently caused by climate change.

3.2 Variation of flow over time and space

It is said that as a result of climate change induced glacial melt, about half a billion people in the Himalayan region may be impacted. Millions of people in the plains of India and Bangladesh depend on flows originating from the Himalayas. The glacier melt rate indicates a high probability of reduced low flows in the river systems. This may impact food production and thereby, economic growth. Some of the most populated areas of the world may run out of water during the dry season if the current warming and glacial melt trends continue for several more decades (Barnet et al. 2005).

3.3 Decline in hydropower generation

The critical impacts on water resources in Bhutan would be on hydropower. The following are the likely impacts:

- Increased vulnerability to Glacial Lake Outburst Floods (GLOFs);
- Increased sediment loads as a result of frequent and erratic heavy rainfall events;
- Increased evaporation losses from reservoirs as a result of increased temperatures;
- Increased run-off variability's of glacier retreat;
- Increased precipitation in monsoon and less precipitation in winter.

3.4 Reduced water source yields and deterioration in quality

The main impacts of climate change on water, sanitation and hygiene would be:

- Possible drying up of stream sources. Water sources have already dried up in some areas;
- Damages to water supply infrastructures and sanitation infrastructures due to flooding caused by landslide dam bursts or GLOFs;
- Water borne diseases caused by droughts and degradation in water quality in ponds and marshes; and
- Increase in cost of operation and cost of water treatment systems due to deterioration in quality.

3.5 Landslide Dam Bursts

There have been instances of slides blocking the path of a stream/river and creating a lake, which after a while burst due to the increased pressure of the water on the impounding landslide dam. The most recent was that of the Tsatichhu landslide dam in a district in eastern Bhutan. Such occurrences are likely to increase due to increase in frequency of heavy rainfall events.

3.6 Water induced health hazards

Climate change has a more subtle and sustained impacts on human health by affecting the three basic elements of life which are air, water and food. Endemic morbidity and mortality due to diarrhoeal disease associated with floods and droughts are expected to rise in east, South and Southeast Asia due to projected changes in the hydrological cycle (IPCC 2007a). Heavy rainfall can lead to flooding which has the possibility of increasing incidences of water borne diseases.

3.7 Reduction in agricultural productivity

In recent years, the visible impacts on agricultural productivity probably due to the impacts of climate change have been the loss of arable lands mainly due to floods. Windstorm damages have been frequent. The areas in the east and south of Bhutan are more vulnerable to increased soil erosion as these receive more rains. Due to changing weather patterns, humidity and temperature, there has been a dramatic rise in pest and diseases outbreaks in many crops.

4.0 Food, Water and Energy

4.1 Food

Various studies suggest that Bhutan has a low level of food security and the reasons can be attributed as under:

- The vast majority of the population is engaged in subsistence farming and animal husbandry;
- Between 25-50% of the population suffer from food insecurity;
- Bhutan imports between 30-35% of the cereal needs;
- There is potential for some regions such as the subtropical plains and the central temperate highlands to become self sufficient in food, while it is difficult for people living in the higher Himalayas of Bhutan;
- Due to a rugged and unstable terrain, landslides due to monsoon rains and other disasters disrupt supply of both local and imported foods; and
- Loss in fertility of soils is a major concern and attempts are made to reverse this declining trend.

4.2 Energy
The country is blessed with a huge hydropower potential and has so far developed about 1500 MW. Another 3000 MW is in various stages of construction. In terms of energy, the energy security level is high.

- The country is self sufficient in electricity, but imports fossil fuel to power industries and vehicles;
- Electricity is exported to India and the export will increase as more hydropower projects come on line;
- The country has a vast hydropower potential totaling to 30,000 MW;
- The drive to provide electricity for all by 2013 has so far resulted in reaching electricity to about 80% of the population. However, most rural areas still depend on biomass for cooking and heating;
- The strict environmental laws ensures that forests are properly conserved; and
- Wind and solar potentials are being explored.

4.3 Water
The water security level has been determined as moderate due to the following:

- The main rivers have their origins in the Himalayan glaciers and subject to the impacts of warming temperatures;
- The majority of the Bhutanese population live along these river valleys and are dependent for irrigation and drinking water supplies;
- The rural water supply initiatives have ensured that about 90% of the population have access to safe drinking water supply, but these schemes are beset with maintenance problems; and
- Cultivated lands are located on hill slopes, and construction and maintenance of irrigation schemes are costly.

4.4 Food, energy and water interrelations
The positive food water, energy interrelations include the following:

- Vast areas are still available to permit food , energy and water production; and
- The cost of increasing food, water and energy security is low due to the small population.

The negative aspects of food, water and energy interrelations include:

- Rapid melting of glaciers may result in less water being available for food and energy production;
- Dependence on monsoon rains will increase, and hence the uncertainty in the timing and quantities of these rains; and
- Large areas may be lost as a result of hydropower development.

5. Contribution of GEOSS/AWCI

The National Action Plan of Bhutan was framed through a series of consultative meetings with the primary purpose of recommending realistic, practical and far sighted measures and actions to adapt to the impacts of climate change. The key goals which are expected to guide the realization of the action plan are given below with the objectives and activities. While the list given below has numerous activities and from a country's perspective has equal priority, prioritization may be necessary with regard to the contribution that can be requested from GEOSS.

Goal 1 – To improve understanding and increase awareness of the impacts of climate change on water resources.

Objective 1.1 – Detailed water resources inventory
Activities:

- Mapping and assessment of water sources for different uses;
- Development of a database of water resources including availability, demand and changes;
- Monitoring of snow cover changes and glaciers to assess their contribution to river flows;

Objective 1.2 – Capacity building to improve knowledge on climate change impacts on water resources.
Activities:

- Creation of a platform to share research and data on climate change on water resources among educational institutes and other organizations involved in climate change issues;
- Development of a basis for quantifying and valuing the services provided by forests a a source of water;
- Identification of gaps in human resources and devise means to address these gaps.

Goal 2 – To increase resilience to respond to the impacts of climate change on water resources.

Objective 2.1 – Readiness to cope with water related disasters.

- Vulnerability assessment to design effective risk minimization measures;
- Determination of minimum flows required for habitat survival in downstream reaches of water courses;
- Installation of automated early warning system for floods originating from glacial lake outbursts;
- Revitalization of degraded catchment/watersheds;
- Improve exchange of flood information across physical boundaries.

Objective 2.2 – Strengthening local communities in preparedness on the impacts of climate change.

- Awareness creation on water resource management at the local level;
- Involvement of the communities in restoration of watersheds/catchments;
- Incorporation of traditional knowledge and local perspectives in adapting to climate change;
- Inclusion in curriculum of educational institutes the preparedness aspects fo water induced disasters;

Objective 2.3 – Design and implementation of projects.

- Water storage schemes for ensuring drinking water supply in both urban and rural areas;
- Development of storage hydropower schemes;
- Rain water harvesting system for small communities and households to capture and store water during the monsoon season.

Goal 3 – Water Resources Management through adoption and implementation of IWRM and eco-efficiency.

Objective 3.1 – Harmonization of functions of various stakeholders in the water sector.

- Creation of a national authority for coordination and management of water resources;
- Promotion of integrated water resources management and use of river basin as the framework for planning;
- Harmonization of policies and legislations dealing with water issues; and
- Strengthen coordination among NGOs, CSOs and other agencies dealing with water issues;

Objective 3.2 – Eco-efficiency of effective water resources management.

- Ensure adequacy and safety of water supply systems through formulation of a water safety plan;
- Prevention of water loss in water conveyance systems through monitoring and maintenance;
- Improving on farm management to enhance productivity of water;
- Promotion of the rational use of water for industrial purposes; and
- Promotion of the use of water efficient fittings and fixtures.

Objective 3.3 – Enhancement of ecological management practices.

- Development and management of rules and regulations to protect watersheds and catchment areas;
- Implement the requirement of maintaining a buffer zone on the banks of rivers;
- Encourage the spread of green belt to increase local resilience to sediment; and related disasters, recharging of ground water and create aesthetic green landscapes.

Goal 4 – Mainstream Climate Change and Water Resources into national plans and programmes.

Objective 4.1 – Develop water and climate change mainstreaming tools and guidelines

- Integrate existing and emerging knowledge on water and climate change into water management plans;
- Develop appropriate tools to address water and climate change issues at all levels;
- Strengthen the capacity of local communities and increase their engagement potential in implementing water and climate change adaptation activities; and
- Plan for incremental adaptation actions together with improved climate change projections.

6.0 Summary

While broad areas where GEOSS/AWCI can make a contribution have been detailed above, the following are some of the activities that can be initiated under the auspices of GEOSS/AWCI as early as possible:

- Review of the adequacy of the existing hydro-meteorological network and data processing processes;
- Review of existing climate models and selection of appropriate modeling tools;
- Introduction of modern methods of water conservation techniques and water use efficiency; and
- Capacity building in terms of hydro-meteorological modeling and analysis of climate data.

3. Cambodia

1. Issues

1. <u>*Issues related climate system - water cycle - water use*</u>

- *Regionally common issues issue relevant to the country of Cambodia:*
  - changes in climate and consequences as:
    - ✓ intensification of variability heavy rain and dry spells and some years influence from cyclones
    - ✓ frequency of extremes as flash in flood localized and drought
    - ✓ the change of seasonal climate pattern precipitation, dry and wet, maxima globally and locally
  - *Available capability/resources*
    - ✧ only center governments
  - *Lack of capability*
    - ✧ Missing monitoring networks as data managements' system and observing, Modeling and inventory of water resources managements (E.G they using modeling but the data is not enough , missing net work, observation, therefore the data for analysis for water resources also Hydrology and meteorology data networks)
    - ✧ missing understanding project planning & management

- *Critical and issues in country:*
  - Erosion (deforestations on the river catchment and,)
  - Sea level rise (not information)
  - Temperature rise
  - Depletion of ground water more farmer using water for support for agriculture activities due to lack water surface and also more hydropower have been developed in the upstream that can be effected on downstream for ground water and more effected on biodiversity
  - Hydropower more upstream have been constructed and ongoing that will affect the downstream environment (river flow, biodiversity, sediment, nutrient)
  - Trans-boundary and international coordination missing understanding between riparian country for managements' river basin (MRC)

2. <u>*Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem*</u>

   A. *Issues related to Water Nexus in the country as:*
      1. *Water and Climate Change affect each Socio-Benefit Area (SBA)*
         a. Flooded and Drought
      2. *Each SBA affects water and environment*
         a. Water using for agriculture and industry as water supply for domestic use

B. Introduce on-going projects and programs related to Water Nexus in country

SBA	**CC, Water, and Environment**
• Agriculture: (JICA, ADB,MRC,JAXA, SAFE…)	←water scarcity and surplus, crop failures → quality of surface and ground water (fertilizer, pesticide)
• Energy: ?	←hydropower
• Urban: (JICA,MRC, ADB…..)	→water quality, ground water depletion, increase of municipal water demand, inefficient municipal water management (low tariff, unplanned conjunctive), decrease of flood plains,
• Ecosystem and Biodiversity:	←change in flow pattern, water diversion
• Health	←water bone diseases (dry and wet spells: Malaria, Dengue, flood: Diarrhea)
• Infrastructure:	←design and management

C. Respond to each of the following questions by considering water and climate change specifically in country:

- We can address on seasonal variability at national and regional level
- For the manage water resources way between upstream and downstream and among different sector uses as hydropower, irrigation, water supply is not yet fully functions (understood from each other)

  The data information is the right information to these different sectors to give them for analysis and managements.
- To adapt of the design criteria to changing characteristics and magnitude of water hazards, the study is important and analysis training among of relevance agencies for the structure designing
- Each department or ministry they has own database they can share the data to the different sectors beyond laboratories

3. *Needs for functions and/or tools of WCI to address the identified issues*

Specify needs for country:

- *Observations:*
  - in-situ telemetric network also included the mountain areas
  - remote sensing (satellite, radar) currently and in future
  - DEM, Land use currently height resolution
- *Data Access*
  - satellite data access (operationally coupled with in-situ near real-time data)
  - global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)
  - remote sensing (satellite, radar) currently and in future
  - DEM, Land use currently height resolution
- *Models*
- *Management systems*
  - Forecasting
  - Water resources management model
  - Early Warning
  - Decision support
  - Climate Change Model for regional and to downscale
    - ✓ National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)
    - ✓ community-based
- *Platform for sharing data and knowledge and exchanging ideas and experiences*
- *Capacity building*
  - ➢ *describe in other section (Part 2: Implementation Proposal)*

4. *Needs for collaboration framework at the national level: inter-agency, interdisciplinary*

The activities and kind of activities/framework is needed for country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*
- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.*
- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*
- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:

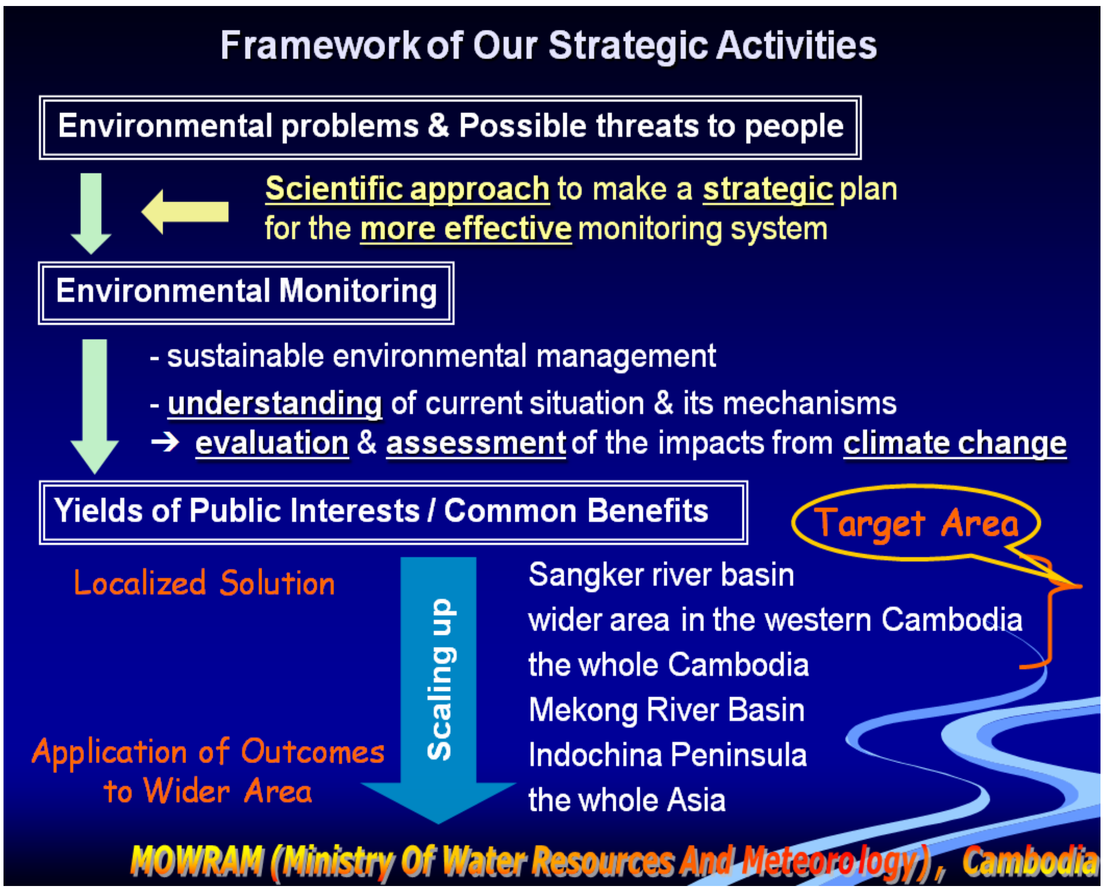
Framework development approach – describe desirable framework in your country

- Demonstration design ←→ infrastructure integrity
- Introducing legislation→high level coordination body among Ministry of Water Resources and Meteorology, Ministry of Agriculture, Forestry and Fishery, Ministry of Environment, and Tonle Sap Authority →research promotion to the decision makers to assign funding

→Improvement of awareness to both decision makers and local people → involvement of private sector, farmer water use, and local people

Strategic approach

- Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)
- Demonstrations → regional and general commonality
- Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.



Technical approach – propose a technical approach considering your target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction, Process understanding of the current water cycle mechanisms →detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge

2. *Additional resources – suggestion of potential collaborators*

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ---------- Field	Local	National	Regional	Worldwide
Research	University of Tokyo			
Operation			MRC	
Administration				
Financial res.	University of Tokyo			
Human res.	University of Tokyo	MRC, University of Tokyo	MRC	

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

  Coordination among ministries: Ministry of Water Resources and Meteorology (MORAM), Ministry of Environment (MoE), and Ministry of Agriculture Forestry and Fishery (MAFF).

3. *Specific request to GEOSS and to international community for the data/tools accessibility for country needed*

- free domain for keeping data and can access or download for free for each country
- the data function is should be simplify as climate data the format can be excel, ASII…… file and also the time step is daily and for spatial (GIS) data as grid, shape file format, and both Degree and UTM, WGS84
- Models and Tools analysis
  - for analysis ,flood , drought , water resources, and river basin managements
  - for prediction, early warning, risk assessment, decision support – for stakesholder, farmer, and decisionmaker levels
- Regional office and/or data center
  - Regional and national data center is both together working is more reliable
    - Regional analysis decision as data quality and standard checking data base keeping for free domain access for sharing data with member the country.
    - National collection, analysis, monitoring system observed data, storing data base keeping

4. Coordination between water cycle integration and capacity development strategy

- The existing and on-going activities and the needs and support related to these five items:
We are cooperation within fully and free for regional and international levels an also included the five items

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*
- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*
- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*
- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

5. Schedule

Apr. 2012 5th GEOSS AP Symposium: Preparation for Implementation Plan
Oct. 2012 4th AWCI Symposium: Approval of the 2nd stage implementation plan

2013-2015: Step 1 - demonstration project (feasible study) at each basin

1) Installation of water level recorder
2) Simulation and prediction of flood inundation, storm ➔ evacuation alarming
3) Simulation and prediction of inundation and available water resources ➔ information for agricultural water use
4) Provide information (2) and 3)) to local people by using mobile phone etc., in the demonstration basin.
5) The items 1)-4) would be operated by the supports from the University of Tokyo

2016-2018: Step 2 - project implementation at national and/or regional scale

The items above would be operationally carried out by the Cambodian Ministry of Water Resources and Meteorology.

4. India – by NIH

1. Issues and Needs

1. Issues related climate system - water cycle - water use

- Regionally common issues - identify which of the common issues are relevant to your country:
  - changes in climate and consequences – quantitative assessment
    - ✓ intensification of variability (heavy rainfall and dry spells), cyclones
    - ✓ frequency of extremes: flood (localized + social)and drought
    - ✓ seasonal climate pattern (precipitation, dry and wet, maxima,)
  - Identify available capability/resources in your country – specify clearly
  - Identify lack of capability – specify clearly, including more details, which capability out of the following ones is missing: monitoring, modeling, inventory of water resources, understanding planning & management

India receives annual precipitation of about 4000 km^3. The rainfall in India shows very high spatial and temporal variability and paradox of the situation is that Mousinram near Cherrapunji, which receives the highest rainfall in the world, also suffers from shortage of water during the non-rainy season, almost every year. The total average annual flow per year for the Indian rivers is estimated as 1953 km^3. The total annual replenishable ground water resources are assessed as 432 km^3. The annual utilizable surface water and ground water resources of India are estimated as 690 km^3 and 396 km^3 per year, respectively. With rapid growing population and improving living standards the pressure on our water resources is increasing and per capita availability of water resources is reducing day by day. Due to spatial and temporal variability in precipitation the country faces the problem of flood and drought syndrome. Over exploitation of groundwater is leading to reduction of low flows in the rivers, declining of the groundwater resources, and salt water intrusion in aquifers of the coastal areas. Over canal irrigation in some of the command areas has resulted in waterlogging and salinity. The quality of surface and groundwater resources is also deteriorating because of increasing pollutant loads from point and non-point sources. The climate change is expected to affect precipitation and water availability. So far, the data collection, processing, storage and dissemination have not received adequate attention. The efforts initiated under Hydrology Project Phase-I and the development of the Decision Support System proposed under Hydrology Project Phase-II are expected to bridge some of the gaps between the developed advanced technologies of water resources planning, designing and management and their field applications. The paper presents availability and demands of water resources in India as well as describes the various issues and strategies for developing a holistic approach for sustainable development and management of the water resources of the country. It also highlights integration of the blue and green flows and concepts of virtual water transfer for sustainable management of the water resources for meeting the demands of the present, without compromising the needs of future generations.

Climate change is a human-induced stress (at least in part) that is generally not yet taken into account. An annual mean global warming of 0.4 to 0.8^0 C has been reported since the late 19^{th} century. In India, the analysis of seasonal and annual air temperatures, using the data for 1881 to 1997 has shown a warming trend of 0.57^0 C per hundred years[28]. Substantial increases in greenhouse gases are likely in the future as a consequence of which global mean surface temperature is expected to increase by between 1.4^0 and 3^0 C for low emission scenarios and between 2.5^0 C and 5.8^0 C for high emission scenarios by 2100 with respect to 1990. Lal states that globally averaged precipitation is projected to increase, but at the regional scale both increases and decreases are projected. Global mean sea level is likely to rise by 0.14 to 0.80 meters from 1990 to 2100.

Under changed climatic scenarios a number of chain events, like melting of glaciers, sea level rise, submergence of islands/coastal areas and deviant rainfall patterns, are likely to occur. Likely impacts would include a greater annual variability in the monsoon's precipitation levels, leading to more intense floods and droughts. Thus, climate change in future is expected to have implications on river flows in South Asia including India. Global climate change is likely to result in severe droughts and floods in India, with major impacts on human health and food supplies.

Developing countries of temperate and tropical Asia already are highly vulnerable to the extreme climate events such as floods, droughts and cyclones. Climate change and variability would exacerbate these vulnerabilities. Annual and seasonal changes in climate would alter the frequency and severity of major droughts. Changing temperature and evaporation rates would alter soil moisture conditions and the amount of runoff from the catchments into reservoirs. There are some evidences of increases in the intensity or frequency of some of these extreme events on regional scales throughout the 20^{th} century. The abnormalities generated due to climate change are likely to trigger shifts in existing biodiversity patterns and demands for totally new set of land uses. The growing frequency and magnitude of extreme environmental events worldwide has intensified research interest in natural disasters as well as regional vulnerability and response capabilities.

Water resources assessment and planning assumes that the past records of variability are reflections of what will happen in the future. Climate change is likely to result in hydrologic conditions and extremes of a nature that will be different than those for which the existing projects were designed. The approaches for effectively dealing with climate change will have to be different than those that have been employed to manage variability in the past. It is also likely that the variability due to climate change may be beyond the range for which current projects have been designed and are being operated. A review of current coping strategies of populations already affected by climate variability is needed. The likely impacts of increased climate variability and climate change on the water resources are required to be assessed. The coping strategies need to be evolved considering major factors viz. social, economic, institutional etc. to reduce vulnerability and enhance adaptation to climate related developments and events. Some part of the country facing the frequent drought are adopting the dry land farming practices to grow the crops which require less amount of water. However, there is a need to take up such studies for assessment of available water resource for different agro-climatic regions of India and various adaptation practices under the changing climatic scenarios.

Some recommendations to cope up with the problems in a systematic and a planned manner are: (i) a nation wide climate monitoring programme should be developed; (ii) while formulating new projects that influence climate, it should be ensured that no action is taken which causes irreversible harmful impact on the climate; (iii) improved methods for accounting of climate related uncertainty should be developed and made part of decision making process; (iv) existing systems should be examined to determine how they will perform under the climate situations that are likely to arise; (v) water availability and demands in all regions, particularly in water scarce regions should be reassessed in the new climate scenario; (vi) a re-examination of the water allocation policies and operating rules should be taken up to see how these need to be updated to handle extremes that are likely to arise; and (vii) there should be proper coordination amongst concerned organizations so as to freely share technology and experience for capacity building.

Capability/Resources – The meteorological data is available for long duration in most of the river basins. The runoff data is also available for major river basins in India.

Lack of capability – More intensive monitoring network is required for the alpine basins and there is need for capacity building in the modeling techniques.

- *Describe critical and specific issues in your country, include more details:*
  - *landslides / erosion*
  - *Sea level rise*
  - *Temperature rise→GLOF*
  - *Depletion of ground water*
  - *Hydropower*
  - *Trans-boundary and international coordination (MRC)*
  - *Shifting snow residency, melting period, snow-line→biodiversity*

Landslides / erosion: The problem of soil erosion is prevalent over about 53 % of the total land area of India. Landslides are the other dominant cause of soil erosion and related problems in the Himalayas.

Sea level rise: Length of coastline of India including the coastlines of Andaman and Nicobar Islands in the Bay of Bengal and Lakshwadweep Islands in the Arabian Sea is 7517 km. The published studies depict that the rate of Sea level rise in the Indian Ocean is much larger than the global average.

Temperature rise → GLOF: The climatic change/variability in recent decades has made considerable impacts on the glacier lifecycle in the Himalayan region. As a result, many big glaciers melted rapidly, forming a large number of glacial lakes.

Depletion of ground water: Highly intensive development of ground water in certain areas in the country has resulted in over exploitation leading to decline in the levels of groundwater and sea water intrusion in coastal areas. There is a continuous growth in 'dark' and 'overexploited' areas in the country.

Hydropower: There are a large number of large and small size hydropower plants in India. During the non-rainy season inflows for these plants are based on snow and glacier melt contributions and base flows. Due to reduction in snow and melt contribution possibly due to climate change, the inflow to the power plants are likely to get reduced and hydropower production may get reduced.

Shifting snow residency, melting period, snow-line → biodiversity: In Himalayas there is upward shift in snow line causing decrease in snow cover area and excessive built up of moist snow cover on slopes. The moist snow cover on slopes melts faster.

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):
1. Water and Climate Change affect each Socio-Benefit Area (SBA)
2. Each SBA affects water and environment

Total annual requirement of water for various sectors of India has been estimated and its break up is given Table 1.

Table 1. Annual water requirement for different uses[9] (in km^3)

Uses	Year 1997-98	Year 2010			Year 2025			Year 2050		
		Low	High	%	Low	High	%	Low	High	%
Surface Water										
Irrigation	318	330	339	48	325	366	43	375	463	39
Domestic	17	23	24	3	30	36	5	48	65	6
Industries	21	26	26	4	47	47	6	57	57	5
Power	7	14	15	2	25	26	3	50	56	5
Inland Navigation		7	7	1	10	10	1	15	15	1
Environment – Ecology		5	5	1	10	10	1	20	20	2
Evaporation Losses	36	42	42	6	50	50	6	76	76	6
Total	399	447	458	65	497	545	65	641	752	64
Ground Water										
Irrigation	206	213	218	31	236	245	29	253	344	29
Domestic	13	19	19	2	25	26	3	42	46	4

Industries	9	11	11	1	20	20	2	24	24	2
Power	2	4	4	1	6	7	1	13	14	1
Total	230	247	252	35	287	298	35	332	428	36
Grand total	629	694	710	100	784	843	100	973	1180	100
Total Water Use										
Irrigation	524	543	557	78	561	611	72	628	807	68
Domestic	30	42	43	6	55	62	7	90	111	9
Industries	30	37	37	5	67	67	8	81	81	7
Power	9	18	19	3	31	33	4	63	70	6
Inland Navigation	0	7	7	1	10	10	1	15	15	1
Environment – Ecology	0	5	5	1	10	10	1	20	20	2
Evaporation Losses	36	42	42	6	50	50	6	76	76	7
Total	629	694	710	100	784	843	100	973	1180	100

With the increasing population as well as all round development in the country, the utilization of water has also been increasing at a fast pace. In 1951, the actual utilization of surface water was about 20% and 10% in the case of ground water. The utilizable water in river basins is highly uneven. For example in the Brahmaputra basin, which contributes 629 billion m^3 of surface water of the country's total flow, only 24 billion m^3 is utilizable.

Energy-irrigation nexus: Throughout South Asia, the 'groundwater boom' was fired during the 1970's and 90's by government support to tubewells and subsidies to electricity supplied by state-owned electricity utilities to farmers. The invidious energy-irrigation nexus that emerged as a result and wrecked the electricity utilities and encouraged waste of groundwater are widely criticized. However, hidden in this nexus is a unique opportunity for groundwater managers to influence the working of the colossal anarchy that is India's groundwater socio-ecology. Even while subsidizing electricity, many state governments have begun restricting power supply to agriculture to cut their losses. International Water Management Institute research has shown that with intelligent management of power supply to agriculture, energy-irrigation nexus can be powerful tool for groundwater demand management in livelihood supporting socio-ecologies to create tradable poverty rights in groundwater. Some workable solutions for management of groundwater resources are mentioned below.

i. Banning private wells is futile; crowd them out by improving public water supply.
ii. Regulating final users is impossible; facilitate mediating agencies to emerge, and regulate them.
iii. Pricing agricultural groundwater use is infeasible; instead, use energy pricing and supply to manage agricultural groundwater draft.
iv. No alternative to improved supply side management: better rain-water capture and recharge, imported surface water in lieu of groundwater pumping.
v. Grow the economy, take pressure off land, and formalize the water sector.

B. Introduce on-going projects and programs related to Water Nexus in your country

SBA — CC, Water, and Environment

- Agriculture: ←water scarcity and surplus, crop failures → quality of surface and ground water (fertilizer, pesticide)
- Energy: ←hydropower
- Urban: →water quality, ground water depletion, increase of municipal water demand, inefficient municipal water management (low tariff, unplanned conjunctive), decrease of flood plains,
- Ecosystem and Biodiversity: ←change in flow pattern, water diversion
- Health ←water bone diseases (dry and wet spells: Malaria, Dengue, flood: Diarrhea)
- Infrastructure: ←design and management

The irrigated area in the country was only 22.6 million hectare (M-ha) in 1950-51. Since the food production was much below the requirement of the country, due attention was paid for expansion of irrigation. The ultimate irrigation potential of India has been estimated as 140 M-ha. Out of this, 76 M-ha would come from surface water and 64 M-ha from ground water sources. The quantum of water used for irrigation by the last century was of the order of 300 km^3 of surface water and 128 km^3 of ground water, total 428 km^3. The estimates indicate that by the year 2025, the water requirement for irrigation would be 561 km^3 for low demand scenario and 611 km^3 for high demand scenario. These requirements are likely to further increase to 628 km^3 for low demand scenario and 807 km^3 for high demand scenario by the year 2050.

Implementation of water pollution prevention strategies and restoration of ecological systems are integral components of all development plans. To preserve our water and environment, we need to make systematic changes in the way we grow our food, manufacture the goods, and dispose of the waste. In India, agriculture is the biggest user and polluter of water. If pollution by agriculture is reduced, it would improve water quality and would also eliminate cost incurred for treatment of diseases. Like all other inputs, there is an optimal quantity of fertilizer for given conditions and excess application does not improve the crop yield. Pricing of fertilizers and pesticides as well as appropriate legislation to regulate their use will also go a long way in stopping indiscriminate use. Industries need to carefully treat their waste discharges. Manufacturers may reduce water pollution by reusing materials and chemicals and switching over to less toxic alternatives. Industrial symbiosis, in which the unusable wastes from one product/firm become the input for another, is an attractive solution. Also, there is a need to encourage reductions or replacement of toxic chemicals, possibly through fiscal measures. Pollution taxes in the Netherlands, for example, have helped the country slash discharges of heavy metals such as mercury and arsenic into waterways by up to 99% between 1976 and the mid-1990s. Many countries discourage use of equipment, such as thermometers that contain mercury. Such measures in India would also be helpful. For this purpose, society and individuals should have a greater knowledge and ability to bring about the required changes. Widely and readily available technical help about ‘how to do this’ will accelerate the process.

The hydropower potential of India has been estimated at 84044 MW at 60% load factor. At the time of independence (1947), the installed capacity of hydropower projects was 508 MW. By the end of 1998, the installed hydropower capacity was about 22000 MW. The status of hydropower development in major basins is highly uneven. According to an estimate, India has plans to develop 60,000 MW, additional hydropower by the twelfth five year plan. It includes 14,393 MW during tenth five year plan (2002-2007); 20,000 MW during eleventh (2007-2012) and 26,000 MW during twelfth (2012-2017) five year plans. A potential of the order of 10,000 MW is available for development of small hydropower projects in the Himalayan and sub-Himalayan regions of the country. Therefore, it is not only desirable but also a pressing need of time to draw a master plan for development of small, medium and large hydro-schemes for power generation.

Demand Management for Urban Areas and Industries is another strategy which could be adopted to reduce demands in urban water supply or households and industries. However, before taking such measures it is necessary to study the actual savings the measures will result in based on practical data. Such information will help in planning curtailment of household demand during drought periods. Similarly, another strategy is to go for demand reduction approaches in the industry during periods of scarcity. Apart from ensuring leakage control, water technology to ensure efficient use of cooling and process water and necessary pollution control mechanisms. A sound water budgeting in industry can reduce the water demand to a considerable extent. The water conservation and reuse strategies should be planned at the time of setting up of a new industry so as to build in the conservation and reuse requirements from the beginning. Studies are required to develop production functions relating industrial policies to (i) availability of resource inputs like water, energy etc. (ii) technology of production, (iii) waste water discharge constraint etc. for devising measures of reducing water demands in the industry.

An environmental flow is the water regime provided within a river, wetland or coastal zone to maintain ecosystem and their benefits where there are competing water uses and where flows are regulated. Environmental flows provide critical contributions to river health, economic development and poverty alleviation. They ensure the continued availability of many benefits that healthy river and groundwater systems bring to society. Environmental flows normally include the flow requirements in rivers and estuaries for maintenance of riverine ecology. Some people view EF as wastage of water but clearly this is a narrow view.

Most Indian rivers have monsoon-driven hydrological regimes where 70 to 80% of the annual flow occurs in 3 to 4 months. Such rivers fall into the category of highly variable flow regimes. The total EFR for most of Indian rivers range between 20 to 27% of the renewable water resources. But these EFR estimates may be considered as preliminary. These need verification through detailed, basin-specific assessments of the EFR. At the same time, it is important to appreciate that EFR allocations of less then about 20% of the mean annual flow are likely to degrade any river beyond the limits of possible re-habilitation. An additional factor, not yet considered in the assessment, is that a reduction in river flows decreases the ability of a river to cope with pollution loads. These loads are known to be massive in many Indian basins. Unutilizable portion of surface runoff in most Indian basins is adequate to meet the EFR. Only in a few basins, namely Pennar, West flowing rivers in Kutch, Saurastra and Luni, Cauvery and east flowing rivers between Pennar and Kanyakumari, the EFR exceeds the unutilizable runoff. In these basins, a part of the potentially utilizable water resources has to be earmarked for EFR. Sometimes, during the period of water scarcity it may be difficult to meet out the EFR considering the importance of the demands from the other water sectors such as drinking water supply, irrigation, hydropower etc. In such a situation, an optimum allocation policy may be evolved considering the potential demands and available supply. Efforts must be made to restrict the pollution loads to the rivers and other water bodies from the point and non-point sources of pollution in order to minimize the EFR.

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*

The future rainfall scenarios can be generated from GCM output and an estimate of seasonal availability of water can be assessed. In the Himalayan catchment the impact of global warming on the river flows can be assessed and the seasonal variability can be determined.

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*

Most of the hydropower schemes on the upstream are run of the river schemes which require temporary storage and the water is flows through the river. More storages may be created to cater the water supply and irrigation requirements.

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*

Once the projections of climatic variables are obtained they can be used in the determination of impact on the river flows and change in the seasonality of the flow pattern. This can be given to the hydropower companies to get sustainable water supply.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*

Due to climate change extreme events floods and droughts are likely to get increased and there is a need for evolving/ modifying the hydrological design criteria for hydraulic structures and drought management indices.

To address the problems of droughts and floods triggered by extreme weather events, it is essential to both augment storage capacity and improve drainage systems. Effective drainage is also essential to reclaim waterlogged and saline-alkali lands and to prevent the degradation of fertile lands. Key areas are listed below:

- Prioritizing watersheds vulnerable to flow changes and developing decision support systems to facilitate quick and appropriate responses
- Restoration of old water tanks
- Developing models of urban storm water flows and estimating drainage capacities for storm-water and for sewers based on the simulations
- Strengthen links with forestation programmes and wetland conservation

Enhancing storage capacities in multipurpose hydro projects, and integration of drainage with irrigation infrastructure

The flow volumes under changing climate will indicate the requirement of changes in the design of structures and need for new drainage.

3. Needs for functions and/or tools of WCI to address the identified issues

Specify needs for your country:

- *Observations:*
  - *in-situ telemetric network (mountain areas)*

- *Data Access*
  - *satellite data access (operationally coupled with in-situ near real-time data)*

The satellite data is available but the coupling with near real-time data is missing.

  - *global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)*

The global data access is very much required for the ongoing studies and planning of adaptation strategies.

- *Models*

Access to state of art distributed models is required. This model may be used for the climate change impact on the river flows and other hydrological variables.

- *Management systems*
  - *Forecasting*

The forecasting of floods and droughts is required for most of the river basins in India. GLOF is another major concern in the Himalayan region.

  - *Early Warning*

Early warning of cloudburst and extreme events will be beneficial for disaster management authorities.

- *Platform for sharing data and knowledge and exchanging ideas and experiences*

A common platform for exchange of ideas will be useful.

Needs for collaboration framework at the national level: inter-agency, interdisciplinary

Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*
- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.*
- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*
- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

We need training and capacity building in downscaling techniques and its coupling with the distributed hydrologic model (s) for simulation and forecasting of hydrologic response.

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:
Framework development approach – describe desirable framework in your country

- *Demonstration design ←→ infrastructure integrity*
- *Introducing legislation→high level coordination body→research promotion→Improvement of awareness→private sector involvement*

Under the forthcoming National Water Mission of Ministry of Water Resources, Govt. of India in which NIH is also participating, the framework development is under evolution.

Strategic approach

- *Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)*
- *Demonstrations → regional and general commonality*
- *Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.*

Strategic approach will be adopted in accordance with the R&D and capacity building activities of AWCI and R&D activities of NIH as well as forthcoming National Water Mission of Ministry of Water Resources, Govt. of India in which NIH is also participating.

Technical approach – propose a technical approach considering your target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction→detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge

We would like to apply the downscaling and catchment modeling software/ models as well as other software to be developed by AWCI to the demonstration basin for simulation and forecasting of hydrological variables for IWRM.

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

The collaborators with approval/ consent will be engaged as and when these would be required.

Collaborators ----------- Field	*Local*	*National*	*Regional*	*Worldwide*

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

The water demand in most of the basins in India is already high and is growing. Available water resources is generally fully allocated and often over exploited. In many locations increasing water quality degradation is exacerbating water shortage problems. The projected changes in climate could further decrease water streamflow and ground water recharge in the basin, while increasing irrigation water demand and withdrawal due to higher temperatures and consequent higher ET and evaporation from soil.

The main streaming strategy would be assessment of water availability, hydrologic design practices, demands and allocation including optimal operation and reliability of water resources projects under present and future conditions for IWRM as well adaptation strategies for sustainability of water resources management under climate change.

3. Specific request to GEOSS and to international community (data/tools accessibility)

Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case*

An inventory of glaciers in the Indian Himalayas using Remote Sensing technique. This should be supported by sufficient numbers of ground truth verification.

- *Data request function responding to new needs – what kind of function*

The future scenarios from GCM/ RCM output for the Indian River basins will be helpful in the climate impact assessment.

- *Data access and information exchange*
- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose*

Distributed hydrological model for the purpose of impact studies is need of the time. This model should have the capability of coupling with GCM outputs.

- *Regional office and/or data center – what kind of function you expect for the office*

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country
- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*

NIH, Roorkee organizes about 15 Training Programs in a year for various organizations of the country. It may coordinate with the AWCI and national organizations in organization of training and capacity building activities.

- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*

NIH, Roorkee organizes about 15 Training Programs including training programs for international practitioners in a year for various organizations of the country including for practitioners. It may coordinate with the AWCI and national organizations in organization of training and capacity building activities.

- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*

Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers may be organized by NIH with the support of AWCI.

- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*

Coordination with national and regional centers of excellence may be carried out by NIH.

- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

NIH, IITs and other R&D and academic institutions would be requested from time to time as per requirement.

India – by IMD

1. Issues and Needs

Water is the Elixir of Life. In the 21[th] century water crisis will be more vulnerable as in the coming years due to the increasing demand of usable water. Scientists in their studies recommended that there should be proper techniques to be developed for the water management and detail studies has to be carried out to find the impact of climate change on water resources of the basins. There are some studies which show increasing extreme events may be due to climate change. It has become urgent need to look into on climate change impacts on water resources to plan the adaption strategy to encounter it more efficiently.

Water Availability in India

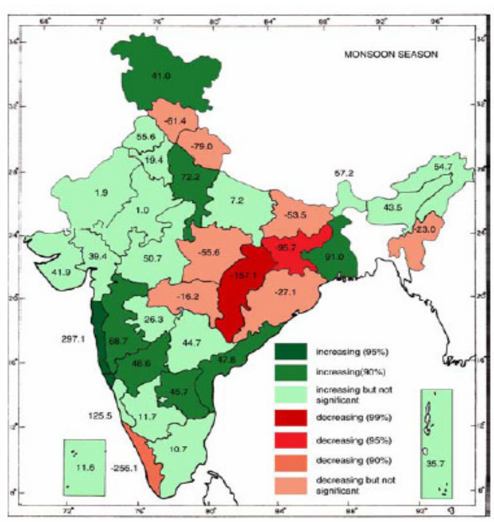
- Area of The Country 3287263 SQ. KMs
- Rainfall 4000 KM^3

Water requirement is increasing day by day in all the fields viz irrigation, domestic industry etc.. In the year 2000, it was 629Cu Kms and it is expected to increased to850 Cu Kms and 1180Cu Kms in the years 2025 and 2050 respectively.

2. Issues related climate system

2.1. Trend in Precipitation

There are four main seasons in India which are Winter (Jan-Feb), Pre-monsoon(Mar-May), South-West Monsoon (Jun-Sept) and Post-Monsoon (Oct-Dec). 74.2% of annual rainfall occurred during monsoon season only and heavy rainfall events eventually occurred in this season. The annual rainfall country as a whole is 1182.8 mm. The mean south-west monsoon rainfall (877.2 mm) contributes 74.2 % of annual rainfall (1182.8 mm). Contribution of pre-monsoon rainfall and post-monsoon rainfall in annual rainfall is mostly the same (11%). India is divided into 36 meteorologically homogenious Met sub divisions. In the following figure shows the rainfall trends during the South-West Monsoon rainfall.



Increase/Decrease in rainfall in mm in 100 year for each of 36 subdivisions for the south-west monsoon season. Different levels of significance are shaded with colors

Also the seasonal rainfall trends for the other seasons are depicted in the following figure below:

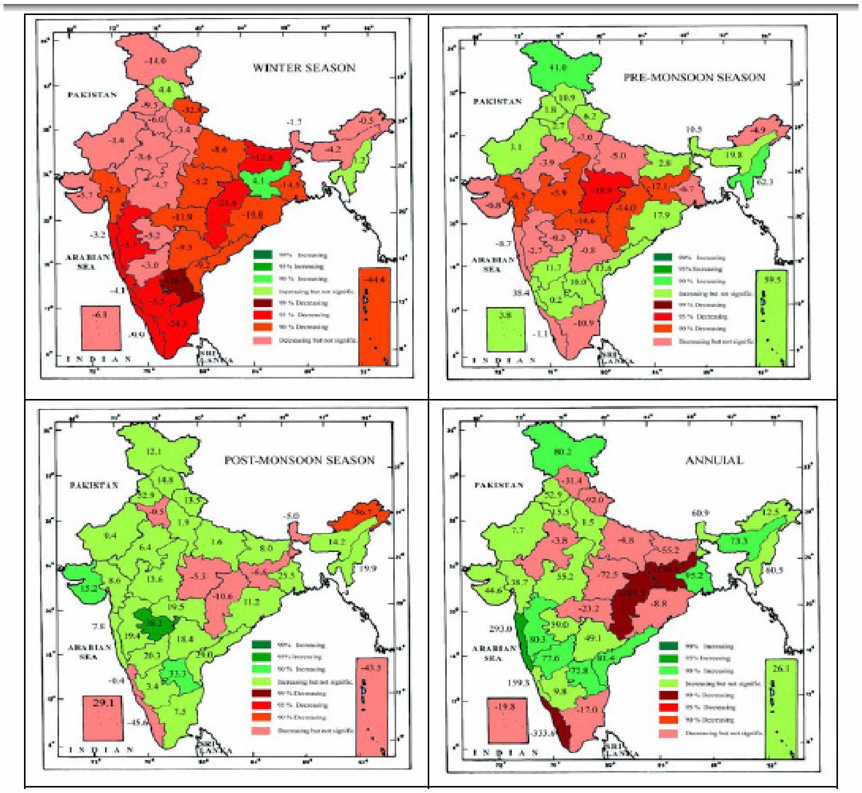


Fig.12. Increase/Decrease in rainfall in mm in 100 year in each of 36 subdivisions for the winter, pre-monsoon, post-monsoon seasons and annual. Different levels of significance are shaded with colors

2.2. Available Capability/Resources

There is a rapid development in context of NWP modeling and computing facility in IMD in the last few years. Global as well Mesoscale NWP models are operational. But the models have a limited capability in heavy rainfall forecasting. The heavy rainfall events which cause disaster like floods are mainly under estimates and also there is a problem of dislocation of the system.

Challenges in Quantitative Precipitation Forecast for Flood Forecast

- The forecast should be time and space specific.
- It should not be an underestimate otherwise there will be an avoidable loss of life and property.
- It should not be also an over estimate as same may result in unnecessary displacement of population resulting in diminishing confidence in forecasts and warnings.

2.3. Trends in cyclones

Cyclones generally occurred during Pre monsoon and post monsoon seasons in India. Data from 1890-1999 shows decreasing trends in cyclonic disturbances and also cyclonic storms.

2.4. Trends in Temperature

Analysis of data for the period 1901-2009 suggests that annual mean temperature for the country as a whole has risen by 0.56°C over the period. It may be mentioned that annual mean temperature has been generally above normal (normal based on period, 1961-1990) since 1990.

This warming is primarily due to rise in maximum temperature across the country, over larger parts of the data set. However, since 1990, minimum temperature is steadily rising and rate of its rise is slightly more than that of maximum temperature. Warming trend over globe of the order of 0.74°C has been reported by IPCC (2007) Spatial pattern of trends in the mean annual temperature shows significant positive (increasing) trend over most parts of the country except over parts of Rajasthan, Gujarat and Bihar, where significant negative (decreasing) trends were observed. Season wise, maximum rise in mean temperature was observed during the Post-monsoon season (0.77°C) followed by winter season (0.70°C), Pre-monsoon season (0.64°C) and Monsoon season (0.33°C). During the winter season, since 1991, rise in minimum temperature is appreciably higher than that of maximum temperature over northern plains. This may be due to pollution leading to frequent occurrences of fog. Upper air temperatures have shown an increasing trend in the lower troposphere and this trend is significant at 850 hPa level, while decreasing trend (not significant) was observed in the upper troposphere. As the temperature is rising, evaporation is also increasing.

2.5 Trans-boundary and international coordination (MRC)

India is having a very good relationship with the neighbouring countries. Bilateral MOU were signed between the neighbouring countries for sharing of meteorological forecast and data. Also there is a close coordination between meteorological communities of the neighbouring countries in respect of knowledge sharing by conducting workshops/seminars, trainings, joint projects etc.

2.6 Project Basin

Seonath Basin may be taken as the project basin for AWCI Phase 2 Implementation Plan.

5. Indonesia

<u>1. Issues and Needs</u>

<u>1. Issues related climate system - water cycle - water use</u>

- *Regionally common issues:*
  - *Changes in climate and consequences – quantitative assessment*
    - ✓ *difficulty in quantifying the correlation of climate change to hydrologic parameters*
    - ✓ *intensification of variability (heavy rainfall and dry spells), cyclones*
      - heavy rainfall: increment in non-uniformity, intensity, and frequency
      - dry spell: data not available
      - small tornado (puting beliung): increasing occurrence on land (where originally it occurs on the sea).
    - ✓ *frequency of extremes: flood (localized + social) and drought*
      - Increasing frequency and risk observed in flood prone area, eg Ciliwung River (Jakarta), Bengawan Solo River (Central Java) and Bandung Basin (Citarum River, West Java). Scattered flood event occur in other area.
      - drought: longer period in arid area and scattered extreme occurrence found in other areas
    - ✓ *seasonal climate pattern (precipitation, dry and wet, maxima)*
      - wet and dry season period are shifting
      - difficulty in distinguishing the impacts of La Nina and El Nino from the impact of climate change
  - *Available capability/resources:*
    - ✧ In the last five years, researches have been conducted by government research institutions and universities to study the impact of climate change to water resources management (flood disaster, agricultural and fresh water supply management).
    - ✧ These research outputs will provide data and analysis of current climate change issues in Indonesia regarding water resources problems, such as flood and drought.
  - *Lack of capability:*
    - ✧ Monitoring
      - Available only for strategic-major rivers (such as Citarum, Bengawan Solo, Brantas, etc.) under River Authority (Balai Besar Wilayah Sungai)
      - Difficulty for automatic monitoring due to social problem in maintaining instruments
    - ✧ Modeling
      - Limited access to the available computer modeling regarding climate change
      - Limited resources to perform climate model.
    - ✧ Inventory of water resources
      - Identifications of water resources issues in Indonesia have been done thoroughly, yet the database available to support problem-solving study is very limited.
      - This limited database problem is related to lack of monitoring and prioritization to create a sufficient water resources database.
    - ✧ understanding planning & management
      - Updated efforts in building code not yet available
      - Lack of knowledge of decision maker in climate change

- *Critical and specific issues:*
  - *Sea level rise*
    - Several big cities in Java Island have suffered seawater flooding due to the rising sea level. Sea level in Semarang has risen 20 cm over the past 23 years, while in Jakarta the rate of sea level rise is 0.57 mm/year.
  - *Temperature rise*
    - Regional temperature is mainly rising in big cities where there are more activities which trigger the greenhouse effect such as transportation usage and industrial manufacture.
  - *Depletion of ground water*
    - Ground water level is mainly falling in big cities where there are more water consumptions from housing and industrial activities which are taken from ground water supply.
  - *Trans-boundary and international coordination (MRC)*
    - The trans-boundary and international coordination activities regarding climate change study is still in beginner level, which is still in need of improvement to advance the study and understand the climate change impact better regionally.
  - *Shifting snow residency, melting period, snow-line*
    - The snow-line in Jayawijaya mountain tops has been degrading due to the effect of global warming. Until present, 90% of the snow volume has melted as it was discovered that the original snow area which covers 20 km^2 has now degraded to only 2 km^2.

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Issues related to Water Nexus:

1. There are a total of 390,000 ha of irrigated paddy fields, with 240,000 ha served by the Jatiluhur reservoir and canal system in the lower part of Citarum River Basin.
2. The combined effects of untreated domestic sewage, solid waste disposal and industrial effluents have significantly increased pollution loads in the Citarum River system.
3. Villager activities in the upper watersheds are a major threat to both the quantity and quality of water available to down-stream users.

B. On-going projects and programs related to Water Nexus:

SBA	***CC, Water, and Environment***
• *Agriculture:*	*←water scarcity and surplus* ➢ Citarum River (irrigation water supply) ➢ Bengawan Solo River (irrigation water supply)
• *Energy:*	*←hydropower* ➢ Citarum River (cascade dam: Saguling, Cirata, and Jatiluhur) ➢ Cimanuk River (Jatigede multipurpose dam)
• *Urban:*	*→water quality, ground water depletion, increase of municipal water demand, inefficient municipal water management (low tariff, unplanned conjunctive), decrease of flood plains* ➢ Ciliwung River (flood disaster management, PROKASIH – improving water quality) ➢ Citarum River (flood disaster management)
• *Infrastructure:*	*←design and management* ➢ Ciliwung River (river improvement) ➢ Citarum River (river improvement) ➢ Polder system (flood management) in Jakarta North Coast ➢ East & West Flood Canal in Jakarta

- *Big rivers which are potential for projects related to Water Nexus:*
  - ➢ Inside Java Island : Brantas River, Serayu River, Opak River
  - ➢ Outside Java Island : Musi River, Mahakam River, Kapuas River

C. Respond to questions about water and climate change:

- *How can we address seasonal variability at national level?*
  - ➢ Socialize the information and updated related regulation through national board of climate change

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply? (incentive and disincentive, optimize water use in line with its priority)*
  - ➢ An integrated water system development and management by using concept of incentive and disincentive for optimizing water use based on its priority is needed so that development in upstream area will not be disadvantageous to downstream area and vice versa.
  - ➢ Another crucial step is to identify each area's potential and need for water resources. For example an area which has big and steep river is potential for hydropower, where an area with agriculture potential will need supply of irrigation water.

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*
  - ➢ Information about climate change and water resources management can be given through implementation of the updated building code, workshop and seminar for related government institutions and universities. This is hoped to give better understanding on the critical issues of climate change and water resources management.
  - ➢ Customized climate information is advised to relate to Indonesia's country characteristic and development plan.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*
  - ➢ The design criteria will have to have safety factor which ensure the capability of accommodating changing characteristics and magnitude of water hazards.
  - ➢ Further studies have to be conducted in order to adjust the design criteria with climate change impact. Existing infrastructures have to be evaluated every period of time to avoid failure caused by water hazards.

- *How can we share the data to the different sectors beyond laboratories?*
  - ➢ Data sharing from research laboratories to related government institutions and universities will be visible through integrated online database. This database will contain water resources data and study output from various institutions (government and university) which can be accessed by all related sectors of water resources management. Particularly universities have advantages because of its independency and its human resources to maintain database.
  - ➢ Database server maintenance and management can be organized by an independent institution formed solely for this purpose.

<u>3. Needs for functions and/or tools of WCI to address the identified issues</u>

- *Observations:*
  - *in-situ telemetric network (mountain areas)*
    - ✧ automatic measurement of rainfall and river water level and velocity connected to telemetric observation station
  - *remote sensing (satellite, radar) currently and in future*
    - ✧ to identify and assess land slide or flood risk in the upstream area as part of disaster mitigation plan
- *Data Access*
  - *satellite data access (operationally coupled with in-situ near real-time data)*

- *global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)*
- *integrated database*

- *Models*
  - computer models of surface water flow and weather prediction to model observed area and data to comprehend the decision support system

- *Management systems*
  - *Forecasting*
  - *Early Warning*
  - *Decision support*
    - ✓ *National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)*
    - ✓ *community-based*

- *Platform for sharing data and knowledge and exchanging ideas and experiences*
  - Annual or biannual workshop and seminar about climate change impact to water resources management and development open for government officers, academic personnel and researchers. Every event will have a specific theme related to current issues and connected to the previous theme. Output and conclusions of the event will be published and informed to the related government sectors and general public.
  - Regular open discussion between government officers, academic personnel and researchers to convey findings and critical issues identified by researches in order to be assessed by government policy and development plan.

- *Capacity building*
  - Capacity building needs and plan are presented in the implementation proposal (Part 2).

4. Needs for collaboration framework at the national level:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*
  - Existing activity: Seminars and workshop held by HATHI (national hydraulic organization) and PUSAIR (government research institution)
  - Needed activity: Regular open discussion between government officers, academic personnel and researchers

- *We need a well-organized interdisciplinary and inter-sectorial body at professional- and/or policy making- levels by involving academia and civil societies.*
  - Existing activity: researches related community development and empowerment in line to water resources research group with study case in Citarum River Basin.
  - Needed activity: aspirations of academia and civil societies experienced in water resources field have to be accommodate by making them part of policy making board in government. This way the current needs and issues in public will be easily identified and assessed by the government.

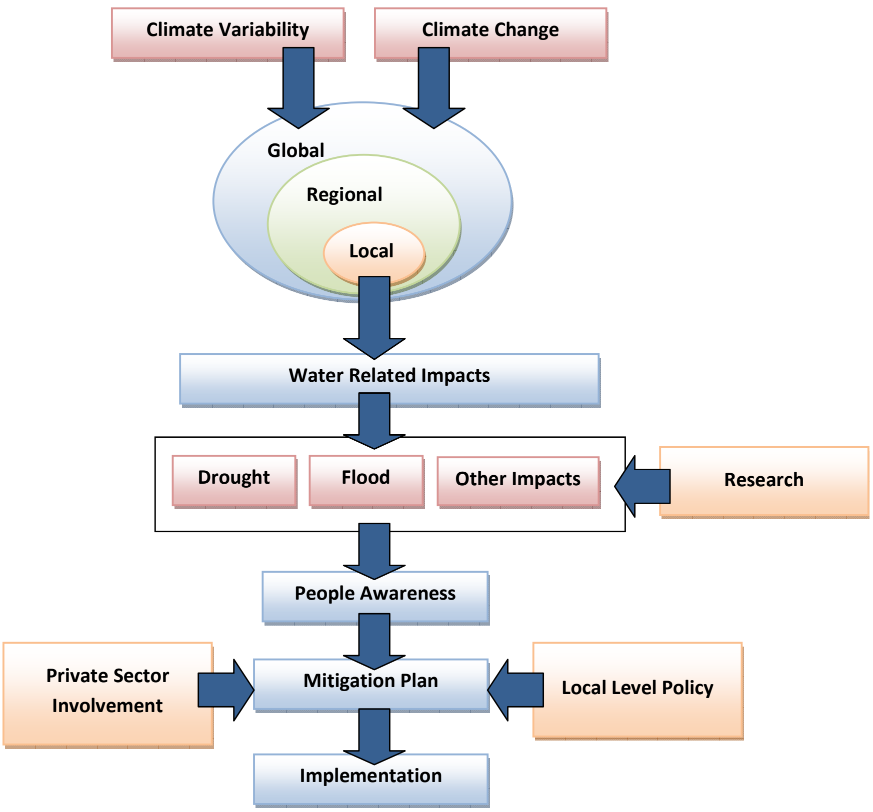
- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*
  - Existing activity: none
  - Needed activity: demonstration on good and failure practices needs to be inserted in seminars and workshop to give knowledge to general public

- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*
  - Existing activity: technical standards are accommodated in SNI (national standard for constructing infrastructures) and other standards published by PU (general work department).
  - Needed activity: criterion to maintain data quality for rainfall, water level and river velocity/discharge as well as the process of data filtering itself.

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:

Framework development approach – describe desirable framework in your country



Strategic approach

Some problems which might occur in policy development and application are:

1. Unreliable information caused by the lack of data concerning the relation of climate information
2. Inappropriate strategy for climate change impact in Bandung Basin.

To cope with those problems, the proposed activities are:

1. The acquirement of technical data of Citarum River Basin, through direct field investigation (primary data) and improving the assessment through:
    - Calibration assessment based on field measurement
    - Improving climate change risk based on future scenario which will be developed
2. Dissemination of the updated information to the local community and decision maker that can be used to improve the strategy to cope climate change impact.

Technical approach – propose a technical approach considering your target basin/country

The aim is to conduct evaluation of climate change impact based on future climate change scenarios. Citarum River Basin is selected as target basin. This basin is one of the strategic Basins in West Java. Citarum River flows from the mountainous area in Bandung, through the three cascade dams: Saguling, Cirata, and Jatiluhur, before finally flows to Java Sea.

Climate change evaluation in a river basin needs good model and appropriate downscaling method. Therefore sufficient observed data is important in model development related to verification process while the selection of downscaling method is important for detail assessment regarding regional scale knowledge. Flowchart of technical approach can be seen in below figure.

In relation to mitigation against the possibility of extreme weather/climate related to climate change, there are two essential conditions to be considered: 1) Flood, 2) Drought. For extreme wet condtition analysis (floods), mathematical model can be developed to estimate flood discharge in a relatively short time scale (daily to hourly) and varied spatial distribution customized to the catchment area. To analyze drought and water conservation efforts, the development of long time scale modeling (annually to decade) is needed. The model is expected to be able to predict long-term effects of climate change on water conservation efforts observed from several aspects such as water availability, vegetation growth trends, and changes in land use. Mathematical model with such characteristics can be found in Dynamic Global Vegetation Model (DGVM).

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	ITB (Research Group on Water Res, Atmospher Sci,GIS, Financ and Industrial Math and Center for Disaster Mitigation)	PJT II (Jatiluhur Reservoir in Citarum River)	Tohoku, Kochi, Tokyo Univ	
Operation	BBWS Citarum, NGO	BMKG, LAPAN, BAKOSURTANAL, Ministry of Public Work, Environment		
Administration	ITB, DPSDA	National board of Climate Change, Public Works, MInistry of Env.	AWCI	
Financial res.	ITB	DIKTI, RISTEK, NGO	ASAHI Glass Found., AWCI	USAID, ADB-K-Water
Human res.	Local Gov and NGO	Ministry of Public Work, Environment	Tokyo, Hiroshima Tohoku, Kochi	

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*
  - Strong basic environmental management in government agencies to improve decision making process.
  - Develop plan for sustainable water and wastewater management
  - Knowledge for raising awareness of climate change mitigation and adaptation

3. Specific request to GEOSS and to international community (data/tools accessibility)

Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case*
  - Hydro-climatology data
  - Hydraulic structure
  - Operation and maintenance

- *Data request function responding to new needs – what kind of function*
  - Early warning
  - Risk assessment

- *Data access and information exchange*
  - Online based accessibility

- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose*
  - Mitigation (structural and non structural)
  - Planning and evaluation (monitoring and long term river basin development planning)
  - Operation (water supply-demand and reservoir system)
  - Management (water resources and water quality)

- *Regional office and/or data center – what kind of function you expect for the office*
  - Center for data base management for sharing and exchanging

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country

- awareness to adapt issue related water and climate information
- knowledge improvement to analyze data and information
- risk assessment and adaptation effort of climate change

- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation program coordinated by the regional program*
  - Data Base Development : need support for related atmospheric data, land use change and instrumentation for ground observation
  - Risk assessment: need support for bias modeling and rain.

- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*
  - Updating existing method of assessment for flood hydrograph and dependable flow
  - Updating flood control (including ews) and drainage system
  - Capacity building of local people of the flood prone area to live with flood

- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
  - Developing risk map, evacuation map for local people of the flood prone area
- *Coordinate with national and regional centers of excellence (ex. WMO center in Hanoi on WR)*

- ADPC, AWCI

- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*
    - PROMISE Project, USAID for Jakarta City in collaboration with ADPC and Jakarta Province.

6. Japan

7. Korea

8. Lao PDR

1. Issues and Needs

1. *Issues related climate system - water cycle - water use*

- Common issues relevant to Lao PDR:

- Lao PDR has a typical monsoon climate with two distinct seasons: Rainy season from May to October and Dry season from November to April. The southwest monsoon prevails from mid May to early October, while the northeast monsoon dominates from early November to mid March. Generally, the average annual rainfall ranges between 1400 mm and 2500 mm and exceeds 3500 mm over the central and southwest region. Except in the northern part of the country, temperatures remain high throughout the year, with an average highest temperature range between 35-38^{0}C and lowest temperature of about 16-18 ^{0}C. In the subtropical regions of the north, the temperature range is much wider, cold air from China and Siberia occasionally penetrates during the dry season, lowering air temperature to near zero. The maximum temperature is 40°C (March-April, over low land) and minimum temperature is 0°C (high land).
- Lao PDR as one of the Least Developed Country, has very limited capability in coping with implementing activities of AWCI. Even though there is a small National Meteorological and Hydrological Service (NMHS), a government Department under Ministry of Natural Resources and Environment (MoNRE), with small hydro-meteorological monitoring network, it is still lack of capacities in various fields, such as human resources with scientific or research skills, modeling development, climate change assessment and adaptation as well as lack of understanding planning.

- Critical and specific issues in Lao PDR:

- Flood and drought are the main hazards in Lao PDR and both are dependent on the amount of rainfall. If the annual rainfall is less than 2000 mm, drought sensitive areas will be affected. When more than 200 mm of rainfall accumulate in 2 days, certainly this will lead to floods along low-lying areas of the Mekong plain and tributaries. Tropical cyclones are not direct hazard, since their force is normally diminished once they have bestracked and reached Lao PDR from the South China Sea, but they can produce flood as a consequence of heavy rainfall. Up to three or four cyclones hit the country annually, while **flood, drought and landslides** occur irregularly. Flash floods are also huge destructive disasters along rivers over high hills' valleys and mountainous provinces.
- Trans-boundary and regional coordination: Department of meteorology and Hydrology (DMH), as a line-agency of the Lao National Mekong Committee (LNMC), plays important roles in Climate and Water data collection and sharing amongst member countries namely Vietnam, Cambodia, Thailand and Lao PDR, contributing to the implementation of the Flood Mitigation and Management Programme (FMMP) and Information and Knowledge Management Programme (IKMP) as well as the Drought Mangement Programme (DMP). In this connection, Line-Agencies of LNMC including DMH utilized relevant MRC's developed Models in to local applications, such as flood forecasting models, etc ….

  Besides, Line-agencies of LNMC also play as key implementing organizations taking actions of the MRC's Climate Change Adaptation Initiative (CCAI).

2. *Issues related to Water Nexus:*

A. Introduction:

1. Water and Climate Change affect Socio-Benefit Area (SBA) :

In Lao PDR water and climate change affect many sectors, but the most critical ones are agriculture (including villagers) and hydro-power.

- The majority of Lao villagers are agricultural dependent farming. They are mostly inhabitant along low-lying Mekong plain and main tributaries. While some ethnic groups are settling along high hills' valleys and are dependent on high land rain fed cropping farming. Either river over-Floods (inundations), flash floods or drought cause damages to their agricultural production and loss of their properties.

- Energy/Electricity from hydro-power dams throughout the country is one of main exports for Lao PDR. The shortage of water will impact the country's income, while the surplus of water will threaten the dam's security and will lead to severe floods.

2. Each SBA affects water and environment:

In Lao PDR, most critical sectors which affect water and environment are hydro-power, mining and industry (factories).

- Current situations have shown that all dam reservoirs devastated huge forest, ecosystems and water quality issues.
- The mining site exploration as well as factories' production are of potential risks of polluted water through the drainage down to rivers.

B. On-going projects and programs related to Water Nexus in Lao PDR

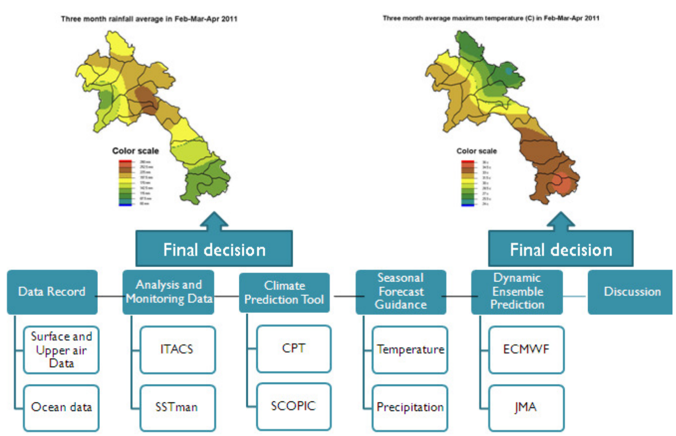
SBA	CC, Water, and Environment
• Agriculture	Irrigation for rice fields; Water control gates and Pumping Stations; Climate Change Adaptation Initiative.
• Energy	Hydropower dams construction and operation at central and southern provinces
• Urban	Integrated Water Resources Management (IWRM) over Prioritized River Basins .

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*

(i). Long-range data analysis, Statistical methods.

(ii). Application of climate prediction tool (e.g. CPT, SCOPIC), as a trial , learning by doing,



(iii). Downscaling of Weather Research and Forecasting (WRF) Model, as a trial application.

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*

Lao PDR applied the legislative tools:

1. National Water Resources Law
2. The National Water Resources Management Policy and Strategy
3. River Basin Organization/Committee (RBO/RBC) manage individual Basin.
4. Department of Water Resources (DWR) and Line-Departments under MoNRE

play roles of proper implementation

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*

  Department of Meteorology and Hydrology (DMH) is a sole government Agency to provide services of hydro-met data & climate information. While the Natural Resources and Environment Research Institute of MoNRE provide the model's output of Climate Change Assessment Scenario.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*

  Up to present time, this issue relied on the design of individual project (international/national consultants) utilizing local raw data provided by DMH

- *How can we share the data to the different sectors beyond laboratories?*

  Laboratories are about to be established from this year, so far available data are shared on demands basis to requested agencies.

<u>3. Needs for functions and/or tools of WCI to address the identified issues:</u>

Specify needs for your country:

• *Observations:*

a). Automated Hydro-meteorological stations including rain gauges over river basins areas with in-situ data communication network. For the proposed Demonstration Basin, there are following needs:

- 4 land surface climatic stations
- 10 hydrological stations
- 30 rain gauges

b). Remote sensing: Currently there is only one weather Radar at the headquarters, which can not cover demonstration site. Also only one Geostationary Satellite of Weather Images Reception site locating at Headquarters in Capital city.

For capacity improvement, there are needs of at least two more Doppler Weather Radars for data composite. While Satellite, it is required to upgrade the existing system with latest version and more advanced applications functions/tools.

• *Data Access*

- Besides Geostationary Meteorological Satellite , Lao PDR also needs to access GEOSS network satellite , such as JAXA or others.
- NWP products, Lao PDR has access to WMO members' centers , such as JMA, ECWMF, KMA, Hongkong Observatory, ASMC Singapore, Vietnam (as WMO designated Support Center for Severe Weather Forecast Demonstration Project)
- There is a need to strengthening capacity on Downscaling of Climate Regional or global models into local specific demonstration basin areas.

• *Models*

Currently, Lao PDR does not have capacity in running Climate or NWP models. While in Flood forecasting, currently trial and testing the MRC's developed models, such as URBS and FEWS. These are to be adopted for operational use in future.

In this regard, Lao PDR urgently needs recommended appropriate Climate projection model as well as NWP Model for national use. While hydrological forecasting model, also needs for application and testing over individual river basins approaches.

• *Management systems*

- Forecasting and Early warning are mandated as core roles and functions of Department Meteorology and Hydrology. DMH has plan (2012-2014) to establish and operate

National Early Warning Center (NEWC) for Flood, Drought as well as severe disastrous phenomena.

- National Climate Change Adaptation Strategy has been mandated to Department of Disaster Management and Climate Change (MoNRE), while DMH is one of Line-Implementing Agency
- Decision Support System (DSS) has been mandated as Cross-Sectored function, which key implementing agencies are DMH and National Disaster Management Office.
- Community-based systems for disasters and Climate change impacts have been planned and to start the mock-Drill exercises at piloted community risk level.

These management systems urgently need assistance on both human resources capacity building and technical expertise as well as financial support from potential development partners.

- *Platform for sharing data and knowledge and exchanging ideas and experiences*

  - Lao PDR , as a LDC, has to rely on activities of AWCI Workbenches. On the other hand, Lao PDR actively involves in implementation of regional programmes , such as ASEAN + Dialogue partners, MRC's and World Meteorological Organization (WMO)'s Programmes.

4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary

- **Existing status and activities :**

  In Lao PDR all Departments / Agencies which manage or related mandates on Water, Climate Change, Weather, Environment, Land use, Forestry, geology and Lao National Mekong Committee Secretariat are under the umbrella of Ministry of Natural Resources and Environment (MoNRE). While other ministries are prime users, such as Agriculture, Energy and Mine, Public Health, etc….

  All of these are Line-Agencies of National Mekong Committee which are inter-collaborated in implementing the MRC's Programmes and frameworks.

  Current main activities are:

- Improvement and Applications of National Water Resources Policy and Strategy in to Action Plans.
- Implementation of the National Integrated Water Resources Management (N-IWRM) Programmes and the regional Mekong-IWRM programmes.

  These include Flood and Drought Management, strengthening Early Warning Systems, Climate Change Adaptation Initiatives, Information and Knowledge Management.

In regard to the Climate Change Assessment and Adaptation as well as AWCI activities implementation, there is a need of collaboration amongst Departments of MoNRE and River Basin Committee (RBC), such as DMH, Natural Resources and Environment Research Institute, Dept. of Water Resources, etc… which are under the same Ministry.

In terms of maintaining data quality, such as rainfall, water level and river discharge, this is the mandate of DMH to act as service provider, while technical standards to design infrastructures in terms of water, it is interdisciplinary issue amongst Department of Water Resources, Natural Resources and Environment Research Institute, Hydropower, Irrigation, water supply, Navigation etc…

2. Implementation proposal

1. Steps and Strategy following the three approaches:

Framework development approach:

- National Disaster Management Committee (NDMC) is the high level decision making body which composing of ministerial members and chaired by Vice-Prime Minister.
- Existing developed framework and legislation tools are:
  - National Water Resources Policy and Strategy
  - National Strategy on Disaster Management
  - National Climate Change Adaptation Plan of Action (NAPA)

It is proposed to Develop :

(1). National Policy or Decree on Meteorology and Hydrology

(2). Strategy and SOP on National Early Warning Systems

(3). Guidelines and Procedures on Applications of AWCI over Demonstration Basin and Replication to Nationwide.

Strategic approach

Intention.

Lao PDR is willing to Input to the AWCI Phase 2 Implementation Plan

Background.

- In Lao PDR , the implementation of the Integrated Water Resources Management strategy involved the collaboration of various sectors, especially government Departments and River Basin Committee. According to geographical features of the country, AWCI activities implementation need to be conducted at selected river basins approach which benefits to local people living over the basin, their agricultural production, national economic infrastructure, i.e. Hydropower Reservoir for management and operation of dams.
- The selected Demonstration site is Sebangfai River Basin. The Study and analysis of impacts of Climate Change for adaptation planning as well as the study and modeling of flood and drought monitoring , forecasting and early warning will respond to local and national urgent needs on disaster risk reduction and poverty alleviation. Outputs of AWCI implementation over this selected demonstration site is actually also contribute to the Mekong Regional Flood Management and Mitigation Programme and Drought Management Programme (FMMP and DMP of MRC).
- Experiences and best practices learnt from this demonstration will firstly expanded to adjacent upper basin which is the reservoir of Nam Theun, biggest hydropower of the country. Furthermore the outcomes of this AWCI demonstration studies will be replicated to other prioritized river basins over the country, i.e. first five basins during the implementation phase of 7^{th} National Development Plan (up to 2015).

Technical approach

It is proposed that the AWCI expert mission to visit Lao PDR for inspection demonstration site, conducting detail design of activities and convene the meeting on awareness and consultation with collaborated agencies. Requirements on technical issues for AWCI activities on demonstration target of Lao PDR should include followings:

1. Detail design to fit AWCI activities and also match national and regional programs;
2. Consultation & Inception Workshop for awareness and transparency
3. Establish adequate automated & telemetry observation station network for rainfall, climate, water level, streamflow and weather.
4. Data collection and Bias correction, through specific trainings
5. Climate Change Assessment and Model testing, downscaling to national and basin's area
6. Flood and drought Modeling, testing and operational application, consistency with relevant MRC's key tools
7. Mainstreaming in to National Early Warning Systems, Disaster Management and Climate change Adaptation Plans of Actions

2. Additional resources – suggestion of potential collaborators

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	None	None	None	None
Operation	Provincial authorities	Departments under MoNRE and concerned stakesholders	MRC RIMES	WMO UN-ESCAP GEOSS/AWCI
Administration	Provincial Departments of Natural Resources and Environment	MoNRE and concerned Departments		
Financial res.	None	National Counterpart Contribution	ADB World Bank MRC's Programmes	GEOSS/AWCI JICA
Human res.	Provincial Staff Hydro-Met Division	Staff of Departments under MoNRE	Experts from AWCI	

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

There existed the National Strategy of mainstreaming Disaster Management and Risk Reduction strategy into the National 7th Five Year Economic Development Planning collaborating with Ministry of Planning and Investment (MPI). Also the National Strategy on Early Warning System has been under adoption and endorsement process.
It is proposed to merge and mainstream the Demonstration Outputs to the existing national strategies and action plans.

3. Specific request to GEOSS and to international community (data/tools accessibility)
Describe in a concrete way and specifically for your country needs:

- Need assistance to establish an Office as centralized national GEOSS/AWCI database on climate, water, weather including metadata with the service dissemination network accessible to all national agencies and requested users. This center is the hub to link with regional GEOSS/AWCI Data servers.
- Need authorization to access data server of GEOSS/AWCI, real time satellite imagery receiving systems, satellite data in concerned portals.
- Need provision and training of following Models for operational application:
  Climate Prediction downscaling Model, Climate Analysis and Risk assessment Models, Flood forecasting models, Flash Flood Guiding Systems Model, Drought Analysis and Prediction Model.

4. Coordination between water cycle integration and capacity development strategy
- Identify contents of capacity development needs in your country

The urgent and essential needs for capacity development in Lao PDR are both levels of practitioners and researchers.

- Related to these five items, prioritized needs are as follows:

- Short term capacity development workshops on specific observation and modeling skills and medium to long term supports from regional resource centers:
    - Climate
    - Water
    - Weather
- Synchronize capacity development with national implementation programme coordinated by the regional programme.
    - AWCI to match National Integrated Water Resources Management Programme and coordinated with MRC's FMMP, IKMP, DMP programmes
- Coordinate with national and regional centers of excellence , such as Natural Resources and Environment Research Institute of MoNRE, WMO's SWFDP Center in Hanoi, Vietnam, MRC's RFMMC in Pnompenh, Cambodia, and Regional Integrated Multihazard Early Warning Systems (RIMES)'s Center for Asia and Africa
- Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with Universities in Japan, such as Tokyo University, JAXA, JMA, ect…, as well as education institutes of neighboring countries, such as Thailand, Vietnam and other ASEAN member countries.

9. Malaysia

1. ISSUES AND NEEDS

1. Issues related climate system - water cycle - water use

- Main issue - problem of floods, river sedimentation, siltation of reservoir and degradation of river water quality due to:
  - ✓ intensification of variability (heavy rainfall and dry spells) & frequency of extremes due to heavy rainfall (monsoon and convective);
  - ✓ large concentration of runoff – exceeds river capacity;
  - ✓ rapid development within the river corridor resulted in higher runoff & deteriorated river capacity;
  - ✓ 60% of population residing in urban areas – flash flooding perceived the most critical flood type (surpassing monsoon flood);
  - ✓ Inadequate drainage capacity, uncontrolled development, earth works for land development, soil erosion and sedimentation;
  - ✓ Coastal areas - flooding could be attributed to high tides and occasionally aggravated by heavy rains or strong wind;

1.2. Available capability/resources:

- Network of Hydrological Information

Table 1: National Network of Hydrological Stations in Malaysia

National Network of Hydrological Stations					
	Rainfall	Evaporation	Streamflow	River Water Quality	River Suspended sediment
Peninsula	633	18	92	70	70
Sabah	83	4	37	32	-
Sarawak	297	25	39	5	-
Total	986	47	168	107	70

Table 2: Source of Hydrological Information in Malaysia

	Dept. of Irrigation & Drainage	Malaysia Meteorological Dept	Dept. of Environment	Ministry of Health	Others	Total
Rainfall	1038	271			49	1358
Evaporation	55	60			115	230
Discharge	195	-			24	219
Suspended Sediment	108	-			-	108
Water Quality	70	-	800	458	-	1328
Groundwater	-	-			115	115

- Rainfall and Flood Forecasting Modeling

    1. Rainfall Forecasting provided by Malaysia Meteorology Department
    2. Floods Forecasting provided by Dept. of Irrigation and Drainage Malaysia
        a. Atmospheric model-based Rainfall and Floods Forecasting System (AMRFF) at Pahang, Kelantan and Johor River Basin;
        b. Tank Model for Kelantan River Basin
        c. Infowork Model for Kelang River Basin
        d. AWBM-Hydrodynamic Model for SMART Tunnel cum Klang-Ampang River System

- Human resources
    1. Well-trained rainfall and flood forecasting officers are available but integrated forecasting system is needed;
    2. In-house capacity building also required in order the improvement of rainfall and flood forecasting can be done

1.3. The lack of capability:

Assessment and adaptation of climate change impacts at local scale, integrated sustainable water resources management in urban and basin level

➢ *Describe critical and specific issues in your country, include more details:*

✧ *Floods and drought*

Floods have been the most occurred disaster in Malaysia. In the first decade of 21st century, flood events especially flash floods with greater magnitudes are becoming more frequent. It is estimated that some 29,000 km² or 9% of the total land area are flood prone, affecting more than 15% of the total population. At the same time, dry periods become even drier where water crisis often occurred and affected thousands of citizens and crop irrigation systems.

✧ *Landslides/slope failure*

The increase of surface runoff volume and bare lands including indiscriminate developments in the building and agriculture sectors in the highlands have exposed the environments to landslides and ground erosion resulted in the increased of landslide incidents for the past 20 years. Failures at cut slopes and embankments mainly due to erosions, underground water movements and insufficient earth/soil treatment are frequently reported.

✧ *Sea level rise*

Sea level rise and salinity intrusion and inundation are one of the critical issues as most of human settlement and urbanization are developed along the coastlines. Our study has shown that the sea level rise along Malaysian coastline varying in the range of 2.73-7.0mm/year. By assessing the impact of climate change, it is expected that sea level will rise 0.25-0.52m for Peninsular Malaysia (NAHRIM, 2006) and 0.43-1.06m for East Malaysia by 2100 (NAHRIM, 2010).

✧ *Temperature rise*

The rate of warming mean surface temperature for the country as a whole based on 40 years record (1969-2009) increases from 0.6℃ to 1.2℃ per 50 years. The projected annual mean surface temperature for future period is higher where it is expected to be warmer by 1℃ to 1.5℃ in the next 50 years (NAHRIM, 2006).

✧ *Trans-boundary and international coordination*

Trans-boundary and international coordination issues of Golok River between Malaysia and Thailand particularly on the matter related to flood protection system should be coordinated and provided by both countries.

2. ISSUES RELATED TO WATER NEXUS: AGRICULTURE, ENERGY, HEALTH – WATER QUALITY, BIODIVERSITY, AND ECOSYSTEM

2.1. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):
1. Water and Climate Change affect each Socio-Benefit Area (SBA)
2. Each SBA affects water and environment

2.2. Introduce on-going projects and programs related to Water Nexus in your country

SBA	CC, Water and Environment
Agriculture	• Aerobic rice production • Research on producing variations of rice, rubber, coca and palm oil with optimum tolerant level to drought and flood • Crop zoning based on climate, soil and government policy • Long term project of selecting and producing oil palm genes which have high drought resistance • Programs to encourage water conservation in oil palm plantation • Raising the height or elevation of dam level for Bekok and Sembrong dam
Energy	• Small Renewable Energy Power (SREP) Program which includes small hydropower electric by means of river run-off generation; • Sustainability Achieved Via Energy Efficiency (SAVE) Program to improve energy efficiency through collaboration between ministry, utility companies, appliance/equipment manufacturers, retailers & consumer • Biogas Entrapment at Oil Palm Mill Project under the National Key Economic Areas where all palm mill shall build a facility to capture biogas by year 2020
Transportation	• MRT project to enhance public transportation problem in urban and city areas and to minimize green house gases and climate change impact
Urban & Landuse	• Flood Mitigation Programs in the Tenth Malaysian Plan (2011-2015) • Second National Physical Plan (2011-2015) • National Slope Master Plan (2009-2023) • Redevelopment Plan of Brownfield Area
Ecosystem &Biodiversity	• Logging impact management by implementing Reduced Impact Logging System • Conserving Marine Biodiversity through Enhanced Marine Park Management and Inclusive Sustainable Island Development under UNDP • Borneo Biodiversity & Ecosystems Conservation Programme Phase II (BBEC II) in Sabah (2007-2012)
Health	• Malaria control program in an integrated manner through vector control (i.e. Insecticide Treated Mosquito Nets (ITN), and Indoor Residual Spray (IRS)) and new diagnostic tests (i.e. Rapid Test for quick detection and treatment, and drug resistance monitoring) and health education and promotion which aims for zero local transmission in the year 2020.

2.3. Respond to each of the following questions by considering water and climate change specifically for your country:

2.3.1. How can we address seasonal variability at national level?

By the analysis of historical observed data coupled with future projections of rainfall, temperature and river flow characteristics so that it will make known to the relevant authority

2.3.2. How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?

As the issue of water and land are under the state matter, an integrated and coordination, management and data sharing at planning and implementation should be discussed and agreed by federal and state government

2.3.3. How can we give the right information to these different sectors? They are demanding for more customized climate information?

Well-designed climate change database and web-based application of future hydroclimate database need to be established for the common data required, however for specific data and information required it can be obtained upon request to the related agency;

2.3.4. How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?

a. To review design standard which is to include the element of climate change in new standards such as to introduce “climate change load factor” in rainfall-runoff modeling for drainage design of river system, open and closed channel network, sewerage system and reservoir capacity;
b. To introduce “wind load factor” for building standard and “temperature load factor” for road construction;
c. To include “sea level rise load factor” for coastal protection system and coastal infrastructure; and also to use “green infrastructure technology” such as rainwater harvesting, construction materials, landuse planning and to enforce the Urban Storm water Management Manual for Malaysia as a mandatory practices;
d. Other words, to integrate disaster risk management and climate change adaptation at planning and implementation stage so that it can minimize the impacts of water hazards.

2.3.5. How can we share the data to the different sectors beyond laboratories?

Data sharing with different sectors are done through local networks, meetings, workshops, seminars and project collaborations

3. NEEDS FOR FUNCTIONS AND/OR TOOLS OF WCI TO ADDRESS THE IDENTIFIED ISSUES

- *Observations:*

3.1.1. In-situ telemetric network (mountain areas)

a. Network coverage and density of in-situ telemetry system require to be improved in order to enhance ground data observation;
b. National hydrological stations network may need to be upgraded and migrate to telemetric system network but with cost implication.

3.1.2. remote sensing (satellite, radar) currently and in future

a. remote sensing observation system by means of satellite and weather (precipitation) radar should be improved as for improving real-time quantitative rainfall estimate (QPE);
b. Radar density and coverage has to be enhanced particularly to cover medium to large river basin.

- *Data Access*
  - *Satellite data access (operationally coupled with in-situ near real-time data):* Calibrated gridded satellite rainfall data and coding application is required so that it can be coupled with ground data observation network (telemetric) in order to produce QPE, and thus quantitative precipitation forecast can be produced;
  - *Global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)*

    a. Numerical weather prediction : method of information dissemination should be improve and ready to share the data
    b. Reanalysis data: accessibility to download it from climate data centre or regional centre

c. Climate change projection: able to produce climate change project through RCM and Regional Hydroclimate Model (RegHCM);

- *Models*
  - ✧ Lumped/semi/fully distributed land surface hydrologic model
  - ✧ Fine resolution of Digital Terrain /Elevation model (DTM/DEM)
  - ✧ Landslide prediction model
  - ✧ Water quality model
  - ✧ Watershed inflow model

- *Management systems*
  - Forecasting
  - Early Warning
  - Decision support
    - ✓National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)
    - ✓community-based

- *Platform for sharing data and knowledge and exchanging ideas and experiences :*
  - Regional Data Centre

- *Capacity building – describe in other section (Part 2: Implementation Proposal)*

4. NEEDS FOR COLLABORATION FRAMEWORK AT THE NATIONAL LEVEL: INTER-AGENCY, INTERDISCIPLINARY

Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

4.1. We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together;
Task force, technical and working committees involving all stakeholders are established to work together in addressing water, environment and climate change issues

4.2. We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies:
It is critically essential as to incorporate and facilitate implementation of climate-friendly measures and technologies by strengthening the laws and regulations, human resource development, finance and incentives, research and development and transfer of technologies

4.3. We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops
Studies and discussions on impacts and climate change adaptation to water resources, agriculture, energy, health etc are aggressively ongoing at national and international symposiums and workshops

4.4. We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water:

a. Database and data quality control is needed such as developed for DIAS AWCI system is required but also to provide “digital” library so that it can accommodate potential users;
b. Technical standards is paramount important as it will assist and guide potential user to use the data and information.

2. IMPLEMENTATION PROPOSAL

1. Please describe Steps and Strategy following the three approaches:

Figure 1 shows the steps and strategy to conduct the proposed extension study AWCI project.

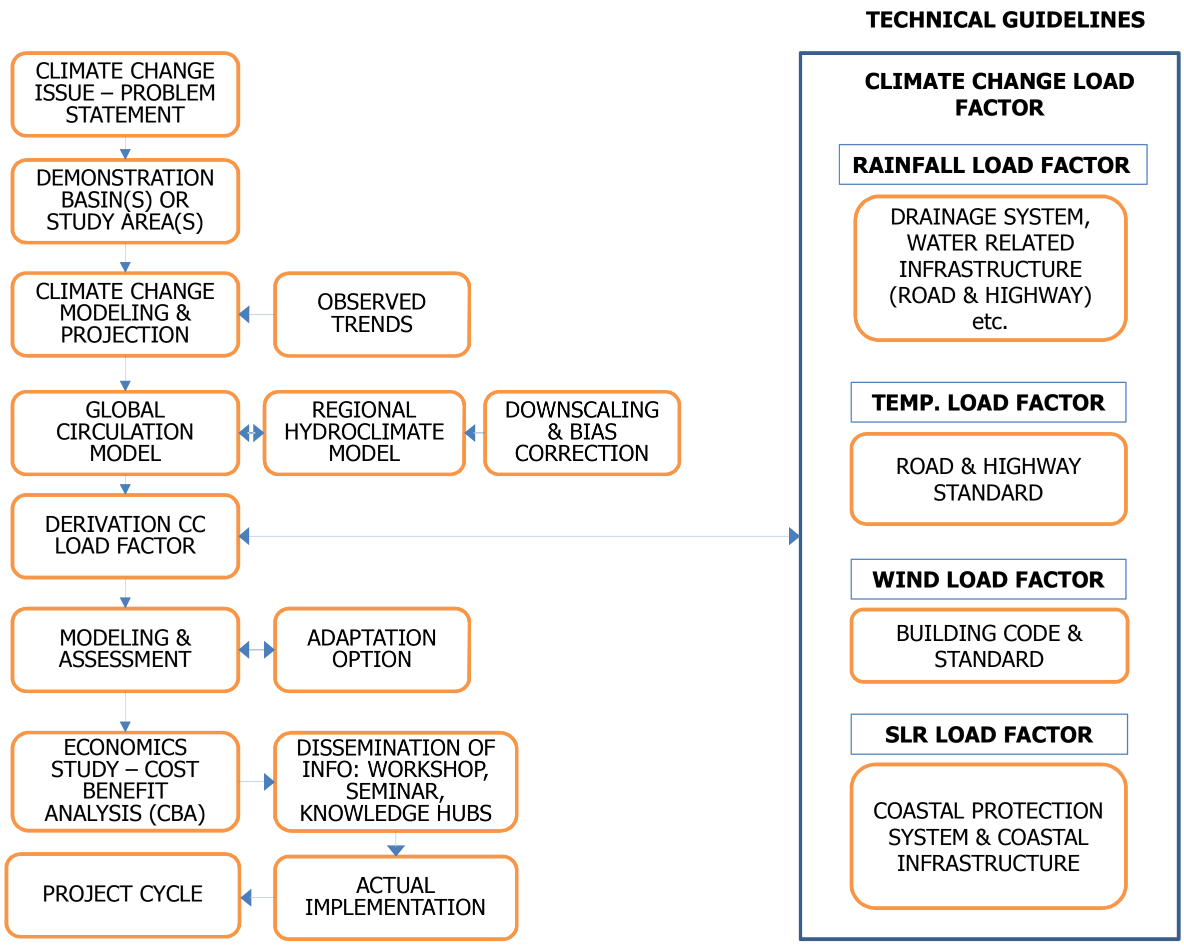


Figure 1: Proposed Technical Approach for conducting the extension of AWCI project

2. Additional resources – suggestion of potential collaborators

- Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	MMD, UKM, DOA, MARDI	MMD, UKM, Agency Remote Sensing, TNB R&D, MARDI	Univ. of Tokyo, Institute Water Management (IWM), JICA, RHIMES, Regional Water Knowledge Hubs	Univ. of California (Davis), NCAR, MRI, CSIRO
Operation	DID, MMD, PWD, DOE, DOA,	DID, PWD, MMD, DOE, DOA, MOGTWE, NRE, National Security Council	JAXA, Regional Water Knowledge Hubs	UNFCCC
Administration	NAHRIM District & state authorities	National Water Services Commission, NAHRIM,	Regional Water Knowledge Hubs other relevant organizations	WMO UN other relevant organizations
Financial res.	State Government	Federal Government - MOF, NRE, MOGTWE, MOSTI, JICA	JICA, APN, ADB	ADB World Bank IDB UNDP-GEF UNFCCC
Human res.	DID, local authority	DID, UKM, Universities, NGO	Regional Water Knowledge Hubs, RHIMES, IWM, UN-CECAR	University of California, Davis

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

  Wise management of resources and enhanced environmental conservation in strengthening economic competitiveness and improving quality of life through the integration of policies, plans, programs and cooperation from stakeholders, research institutes, government agencies, non-governmental organizations and the key players in all related sectors. The focus is to strengthen the resilience of development from arising and potential climate change impacts.This strategy should be empowered with adequate resource allocation, educational, training and research.

3. Specific request to GEOSS and to international community (data/tools accessibility)

Describe in a concrete way and specifically for your country needs:

3.1. Inventory and summary directory – what kind is needed in your specific case

- Geospatial data – fine resolution of DEM/DTN
- Satellite imagery data – flood areas/ burning area hot spot
- Satellite based rainfall, temp data etc.
- Altimetry data
- Global climate model
- Global forecast data from Global Forecast System (GFS)
- Upper sounding data and information

3.2. Data request function responding to new needs – what kind of function

- More than emission scenario (only SRES A1B available) such as A2, A1F1, B1, etc.
- GCM data – full scenario period is needed (2010-2100) instead 2046-2065 only
- Possible to obtain sub-daily data
- CMIP3 and CMIP5 data set

3.3. Data access and information exchange

An appropriate accessibility to information and data exchange through a systematic and centralized database

3.4. Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose

- GCM downscaling to local level - models of precipitation and temperature for hydrological and hydraulic modeling
- Climate change analysis models/tools which integrating/ensemble all/critical parameters: temperature, precipitation, altimetry sea level, landuse change etc.
- Main purposed - analysis, prediction, early warning, risk assessment, decision support as to accommodate the project approach as shown in Figure 1.

3.5. Regional office and/or data center – what kind of function you expect for the office

Access for data, knowledge and technology sharing/transfers, especially real time and forecasted hydro-meteorological monitoring and modeling

<u>4. Coordination between water cycle integration and capacity development strategy</u>

- Identify contents of capacity development needs in your country
- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*
- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*
- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*
- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

10. Mongolia

1. Issues and Needs

1. Issues related climate system - water cycle - water use

- *Regionally common issues - identify which of the common issues are relevant to your country:*
  - *changes in climate and consequences – quantitative assessment*
    - ✓ *intensification of variability (heavy rainfall and dry spells), cyclones*
    - ✓ *frequency of extremes: flood (localized + social) and drought*
    - ✓ *seasonal climate pattern (precipitation, dry and wet, maxima,)*
  - *Identify available capability/resources in your country – specify clearly*
  - *Identify lack of capability – specify clearly, including more details, which capability out of the following ones is missing: monitoring, modeling, inventory of water resources, understanding planning & management*

Climate extreme variability is changing over Mongolia. According to extreme indices estimation of daily variability from 1961- 2008 (MARCC, 2009), the number of days, when daily maximum temperature is higher than its 90^{th} percentile, has increased by 7-12 days. The number of days, when daily minimum temperature is lower than its 10th percentile, has decreased by 3-6 days in the country. Similarly, their duration (higher than consecutive 6 days) increased and decreased, respectively. It indicates that dry spell is becoming more severe in the country.

There is no significant change in precipitation, however during last decade it tends to decrease in summer and increase in winter. More intensive decrease in precipitation has been observed in central region of Mongolia, where more intensive increase in temperature has also been observed. Precipitation type tends to change from large scale to more convective precipitation. Accordingly, number of flash flood events increases and causes significant flood damage in urban areas coupled with desertification, urbanization and climate change adverse effects.

Generally, climate is changing, coldness weakens, however, it becomes snowy and hotter and dry conditions prevail in summer.

Available capability/resources: monitoring network consists of 134 hydrological, 130 meteorological stations and 200 agro-meteorological posts, 2 satellite receiving stations, 1 Doppler radar, 3 Lidars, super computer system and trained personnel capacity in climate, weather, hydrology and water resources, expertise and linkages with national, regional and international funding organizations.

Lack of capability: network extension in terms of space (at high altitude) and time (automated continuous measurement), application of distributed hydrological model to apply for climate change assessment and adaptation at river basin scale (within closed system) and flood and drought early warning systems. Lack real integration and coordination in holistic sense of Integrated water resources management at national, basin scales.

- *Describe critical and specific issues in your country, include more details:*

Depletion of ground water: Climate change leads to change in rainfall pattern, land cover, consequently, it is observed clear depletion of groundwater in Mongolia and loss of hydraulic connection between surface water and groundwater. As consequences during the low flow period cutting surface runoff, exhausting groundwater reservoirs in bigger settlement area etc. causing seasonal shortage of water use.

Hydropower: Nowadays, 13 small and medium sized hydropower stations are operating in Mongolia and impacts of the power station to downstream natural regime, water availability and safety and efficient operation of the power stations, establishing monitoring network of the hydropower system and research studies on water balance of the reservoir are becoming critical and specific issues in our country.

Trans-boundary and international coordination (MRC): trans-boundary water resources management plans are implemented in agreement with two neighboring countries.

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):

1. Water and Climate Change affect each Socio-Benefit Area (SBA)
Natural disasters such as drought, heavy snow fall, flood, windstorms and extreme cold and hot temperature events are recurrent all the year round and the prediction suggest higher temperatures and less rain in summer and more snow in winter (frequent droughts or harsh winter). Depending on the specific geographical and climatic conditions, Mongolia might be more heavily influenced by the global climate change. The impacts of climate change on the ecological system and the natural resources would be dramatic affecting directly almost all sectors of the national economy and all spheres of social life, such as livestock, agriculture, human mechanical migration and poverty.

2. Each SBA affects water and environment
Mining, urbanization, agricultural cultivation, pasture use lead to desertification and land cover changes that results in decrease in rainfall, decline natural water resources.

B. Introduce on-going projects and programs related to Water Nexus in your country

SBA	CC, Water, and Environment
All SBA in selected river basins:	"Ecosystem based adaptation approach to maintaining water security in critical river catchments in Mongolia" (5.425 million USD)
All SBA in selected river basins:	"Strengthening integrated water resources management in Mongolia" (6.0 million USD)

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*
  Using National Target Programme on Climate change to address seasonal variability at national level.

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*
  We need national coordination body at Prime minister cabinet level which will be able to coordinate all water related issues in terms of IWRM based on Law on Water, National Program on water, IWRM plans, River basin council focuses**.**

- *How can we give the right information to these different sectors?*
  National Agency for Hydrology, Meteorology and Environment and National Water Agency are responsible for provision of information on water resources and climate change to different sectors.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*
  It is needed to develop new or redesign criteria to changing characteristics and magnitude of water hazards, based on climate change scenarios and hydrology modeling results. Regionally, it is encouraged to develop baselines to develop new or redesign criteria to changing characteristics and magnitude of water hazards.

- *How can we share the data to the different sectors beyond laboratories?*
  There is National law on hydrometeorology and environment monitoring that regulates routine data sharing and special data collection and sharing among providers and users. WMO standard for data sharing and exchange is also used.

3. Needs for functions and/or tools of WCI to address the identified issues

Specify needs for your country:
- *Observations:*
  - *in-situ telemetric network (mountain areas)*
  - *remote sensing (satellite, radar) currently and in future*

Currently, the National Hydrometeorological Service, NHMS in Mongolia receives NOAA, MODIS and FY2D satellites data and processes their raw data as operationally and mainly for weather and environment monitoring purposes such as cloud image, snow cover, biomass, forest fire and dust storm. It is needed to establish ASTER and Aqua/AMSR-E satellite data receiving stations and tools for data processing in the Agency for hydrology, meteorology and environment monitoring in Mongolia for environment and water resources monitoring and research.

Doppler radar is operating in Ulaanbaatar for now-casting of heavy rainfall and potential flooding. In future, it is necessary to create Doppler radar's network including at least 3 radars over central region of the country.

Network extension with in-situ telemetric and automated stations at high altitude for water cycle monitoring is important task for the country.

- *Data Acce*

  - *satellite data access (operationally coupled with in-situ near real-time data)*

  The Institute of meteorology, hydrology and environment is needed to have access to historical data of ASTER and Aqua/AMSR-E satellites for environment and water resources monitoring and research.

  - *global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)*

  NHMS obtains global model output from ECMWF, NCEP, JMA, KMA and CMA with 6 hourly, daily, monthly and seasonal time slices. However, regional models (MM5 and WRF) are performed as operationally up to 10 km resolution based on NCEP and KMA global model output as creating initial and boundary conditions.

  NCEP I, II and final reanalysis, ERA40, JRA25 reanalysis are mostly used in research study of simulating of regional climate and land surface models. It is needed capacity building to create national reanalysis data

  Global climate model output in IPCC, DDC and CMIP4/5 are mainly used for climate projection of Mongolia as simply interpolating and statistical downscaling. Only ECHAM5 model output is dynamically downscaled by regional climate model under A1B GHG scenarios, AR4. Other GCMs 6 hourly 3D data need to access in terms of ensemble prediction and model uncertainty.

- *Models*

  NHMS does not perform global model, however, regional weather (MM5/WRF) and climate model (RegCM3/4) run coupling with land surface modeling such as Noah, BATS and CLM in the country.

  Statistic guidance method MOS technique (Kalman filter and Neuron network) is linked these model output to exclude system error and produce user oriented point data in city and settlement. Distributed hydrological model and water and energy budget models are needed.

- *Management systems*
  - *Forecasting*

  Real time data processing and analysis system is needed in weather forecast operational activity.

- *Early Warning*

Flood and drought early warning systems will be adaptive and decision making tools are highly preferable to be implemented in the country.

- *Decision support*

Decision support system tools for IWRM is needed.

- *Platform for sharing data and knowledge and exchanging ideas and experiences*

WMO standard is applicable for data sharing and exchange.

4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary

Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*

  We need to enhance inter-sectoral coordination and reorganizing existing data information centers.

- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.*

  We need national coordination body at Prime minister cabinet level which will be able to coordinate all water related issues in terms of IWRM based on Law on Water, National Program on water, IWRM plans, River basin council focuses**.**

- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*

  We need to implement demonstrations and exchange good (failure) practices through conferences/workshops organized in national level and river basin councils and shear good practices from countries in the region.

- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

  Data are exchanged between Mongolia and Russia, China in trans-boundary river basins; data will be exchanged through DIAS system for AWCI, University of Tokyo, Japan (desired to be user-friendly).

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:

There are 2 possible proposals:

1. Mongol AMSR/AMSR-E/ ALOS validation experiment (MAVEX),Lead Prof. I. Kaihotsu, University of Hiroshima, and prof. T. Koike, University of Tokyo, Japan
2. Water and energy budgets and modeling in Tuul and Ulaan-Am river basins, Mongolia to support IWRM in these basins

Framework development approach – describe desirable framework in your country

- *Demonstration design ←→ infrastructure integrity*
- *Introducing legislation→high level coordination body→research promotion→Improvement of awareness→private sector involvement*

Second proposal has been submitted to Ministry of Nature, Environment and Tourism for approval.

Strategic approach

- *Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)*
- *Demonstrations → regional and general commonality*

- *Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.*

Detailed regional project covering showcase, demonstrations within region and expansion of the AWCI demonstration studies, enabling sharing experiences, understanding water cycle and climate change related issues and technology transfer is most relevant approach for Mongolia.

Technical approach – propose a technical approach considering your target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction→detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge
"Water and energy budgets and modeling in Tuul and Ulaan-Am river basins, Mongolia to support IWRM in these basins" proposal focuses on extension of existing water cycle observation network, climate change assessment including downscaling, modeling, demonstration and contribution to IWRM in these basins.

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	Center of Hydrometeorology in province	Institute of Meteorology and Hydrology, Mongolian Academy of Sciences	JMA, CMA, KMA , ICHARM Tokyo University, Research institute of hydrometeorology of Russia (Obininsk)	UNDP, AWCI, IAEA, WMO, IHP
Operation	Center of Hydrometeorology in province	Institute of Meteorology and Hydrology	KMA, CMA, JMA	WMO,
Administration	Regional Hydrometeorological centers	Ministry of Environment and Tourism, National Agency for Hydrology, Meteorology and Environment monitoring	WMO RA II	WMO
Financial res.	Local government, private companies	Ministry of Environment and Tourism, NAMHEM, Science and technological Foundation	JMA, CMA, KMA , ICHARM Tokyo University, JAXA, Tsukuba University, Hiroshima University, IORCG, JAMSTEC	WMO, IAEA, NOAA, UNDP WB, JICA, KOIKA, WWF, IHP
Human res.	Local observers, engineers in regional hydrometeorological centers, Darkhan and Khovd province agriculture University	Ministry of Environment and Tourism, National University of Mongolia, Water authority, Academy of Sciences	Tsukuba University, Hiroshima University, KMA, CMA, JMA, AIT, Roorkee India	UNDP, WMO, IHP, IAEA, JICA, NOAA, WWF, DHI

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

The Government of Mongolia has established an interagency and intersectoral National Climate Committee (NCC) led by the Minister for Nature, Environment and Tourism to coordinate and guide national activities and measures aimed to adapt to climate change and to mitigate GHG emissions. The NCC approves the country's climate policies and programmes, evaluates projects and contributes to the guidance to these activities. It is directly responsible for implementing the commitments under the UNFCCC and Kyoto Protocol and for managing the nationwide activities to integrate all climate-change-related problems in various sectors.

3. Specific request to GEOSS and to international community (data/tools accessibility)

Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case:*
  - ASTER and Aqua/AMSR-E satellite data receiving
  - In-situ telemetric and automated stations at selected high altitude basins for water cycle monitoring
  - Access to historical data of ASTER and Aqua/AMSR-E satellites for environment and water resources monitoring and research

- *Data request function responding to new needs – what kind of function:*
  - Real-time reporting of hydrological data from networks including from remote stations

- *Data access and information exchange:*
  - Promotion and strengthening of the principle of free and unrestricted international exchange of data, information and products

- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose:*
  - For drought and flood
  - Models/tools for flood routing prediction, water balance
  - GCM –MOLTs for hydrological models

- *Regional office and/or data center – what kind of function you expect for the office:*
  - Data sharing and exchange
  - Access and use of e-learning materials

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country

- Distributed hydrological modeling
- Remote sensing and satellite application
- Downscaling technique in river basin scale

- Introduce existing and on-going activities and the needs and support related to these five items:

- Synchronize capacity development with national implementation programme coordinated by the regional programme.
  - National Program on Climate change and National Program on water

- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g.* UNU, UN-CECAR).
  - Training for engineers, technicians, practitioners and operators are needed.

- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
  - Ensemble prediction and its application

- Data assimilation satellite data
- GCM –models temperature/precipitation for hydrological models
- Statistical techniques
- Distributed hydrological modeling
- Operational hydrological forecasting
- National reanalysis data development

• *Coordinate with national and regional centers of excellence*
  UNU, UN-CECAR, ICHARM, AIT

• *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*
  Regular workshops are organized by Institute of Hydrology, Meteorology and Environment (IHME), workshops organized within River basin councils to strengthen IWRM with participation of National Agency for Meteorology, Hydrology and Environment monitoring, Institute of Meteorology, Hydrology and Environment (IHME), Water Agency, Regional hydrometeo centers, WWF, USA- Asia foundation and etc.

11. Myanmar

<u>1. Issues and Needs</u>

<u>1. Issues related climate system - water cycle - water use</u>

- *Regionally common issues*

The following common issues are relevant to our country (Myanmar):

- changes in climate and consequences – quantitative assessment
  - ✓ intensification of variability (heavy rainfall and dry spells), cyclones
  - ✓ frequency of extremes: flood (localized)and drought
  - ✓ seasonal climate pattern (precipitation, dry and wet, maxima,)
- <u>Available capability/resources</u> in our country are some hydrologists and Meteorologists for human resources
- <u>Lacks of capability</u> in our country are specifically monitoring and modeling in impact of climate changes on water resources, and understanding planning & management.

- *Critical and specific issues*:
  - Flood/ Drought
  - Flash flood
  - landslides / erosion
  - Depletion of ground water

<u>2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem</u>

A. *Issues related to Water Nexus in our country are as follow:*
1. Water and Climate Change affect each Socio-Benefit Area (SBA) (such as agriculture, Energy, Urban, Ecosystem and Biodiversity, Health, Infrastructure)
2. Each SBA affects water and environment

B. *On-going projects and programs related to Water Nexus in our country are as follow:*
- To reduce the crop failure due to CC and to control the flood, some dams are constructing for monitoring the water scarcity and surplus by the concerning departments
- To get more electric energy, hydropower plants are constructing by concerning department.
- To monitor the water quality, the relevant departments are measuring water quality parameters
- Myanmar National Adaptation Plan of Action (NAPA) is commencing for Vulnerability Assessment and Measured for reduction of impact and strategy for adaptation.

C. *Respond to each of the following questions by considering water and climate change specifically for our country:*
- *How can we address seasonal variability at national level?*
  We can address seasonal variability at national level by the analysis of past historical observation data.

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*
  We can manage water resources in proper way between upstream and downstream by installing observation stations (if need to install stations in upstream and downstream) and sharing data and also cooperate among different sectors (hydropower, irrigation, water supply).

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*
  We can give the right information to these different sectors through fax, phone, radio and TV, holding meetings and workshops.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*
  We can adapt the design criteria to changing characteristics and magnitude of water hazards as follows:

- Development of a new generation of risk-based design standards for infrastructure; responding to extreme events (floods and droughts);
- Increased research and development oriented towards climate change and variability;
- Develop improved forecasting methods for improved reservoir and emergency operations;
- Strengthen interagency collaboration for developing joint procedures and applied research for adapting to climate change;
- Strengthen emergency management and preparedness plans for all Corps projects and assist local communities in upgrading their plans and participation.

- *How can we share the data to the different sectors beyond laboratories?*

  We can share the data to the different sectors by holding meetings and workshops.

3. Needs for functions and/or tools of WCI to address the identified issues

- *Observations:*
  - in-situ telemetric network (upstream remote areas and mountain area)
  - remote sensing (satellite, radar) currently and in future

- *Data Access*
  - satellite data access (operationally coupled with in-situ near real-time data)
  - global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)

- *Models*

  Rainfall Downscaling models, Climate scenario models such as PRECIS and SWAT, WEB-DHM model, Flood Forecasting Models for wide catchment area

- *Management systems*
  - Forecasting
  - Early Warning
  - Decision support
    - ✓ National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)
    - ✓ community-based

- *Platform for sharing data and knowledge and exchanging ideas and experiences*

4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary

The following activities/frameworks are needed in our country:

- We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.
- We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.
- We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.
- We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:

Framework development approach – desirable framework in our country

- *Demonstration design ←→ infrastructure integrity*
- *Introducing legislation→high level coordination body→research promotion→Improvement of awareness→private sector involvement*

Strategic approach

- *Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)*
- *Demonstrations → regional and general commonality*
- *Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.*

Technical approach – propose a technical approach considering our target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction→detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	DMH	DMH	DMH(Myanmar),AWCI, GEOSS, other relevant organizations	AWCI, GEOSS, other relevant organizations
Operation	DMH	DMH	DMH(Myanmar),AWCI, GEOSS, other relevant organizations	AWCI, GEOSS, other relevant organizations
Administration	DMH	DMH	DMH(Myanmar),AWCI, GEOSS, other relevant organizations	AWCI, GEOSS, other relevant organizations
Financial resources	-	-	APN and other financial support organizations	APN and other financial support organizations
Human resources	DMH	DMH	DMH(Myanmar),AWCI, GEOSS, other relevant organizations	AWCI, GEOSS, other relevant organizations

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

3. Specific request to GEOSS and to international community (data/tools accessibility)

Describe in a concrete way and specifically for our country needs:

- *Inventory and summary directory – what kind is needed in your specific case*

  In our specific case, we need to analyze the climate change, its impacts on water resources and to predict the climate scenarios and flood forecasts, flood hazard map for the D.P basin.

- *Data request function responding to new needs – what kind of function*
  - Soil Information for flood forecasts
  - Satellite image of Flood period for Flood Hazard Map
  - Digital Elevation Model with high resolution for Flood Hazard Map

- *Data access and information exchange*
  By DVD or CD

- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose*
  Analysis (such as PRECIS climate model), prediction (rainfall downscaling model, Climate projection rainfall bias correction method, WEB-DHM model, Global Climate Model (GCM) with downscaling and Hydrologic model), risk assessment.
  The objectives of above mention are to reduce the loss of live and properties, to analyze the impact of climate change on river flow and flood and to simulate the runoff based on certain parameter: observed daily climatic data, topography, soil and land cover.

- *Regional office and/or data center – what kind of function you expect for the office*
  To improve the issuance of the accurate and timely flood forecast for early warning system and to develop the flood hazard map in order to improve the systematic flood management system

4. Coordination between water cycle integration and capacity development strategy

- The contents of capacity development needs in our country are as follow:
  (a) Technical developments for rainfall downscaling model, rainfall-runoff model and flood forecasting model
  (b) Human resources developments for the trainings of above models

- Our country needs the following items:
  - Synchronize capacity development with national implementation programme coordinated by the regional programme.
  - Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).
  - Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.
  - Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)
  - Organize capacity development workshops in our country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.

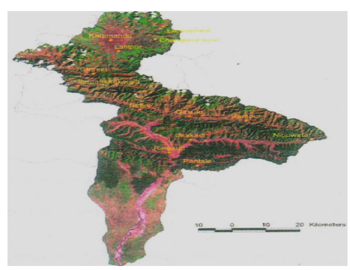
12. Nepal

Water, the most precious gift of the nature, is the prime natural resource and source of life. Water as a resource is under relentless pressure due to population explosion with rise in living standard, rapid urbanization, large-scale industrialization; environmental demands and climate change. Water is also a key component of hydrological cycle which makes a bridge between the socio benefits areas including agriculture and forestry; health; energy; human settlement and geophysical and bio-geochemical water cycle process in atmosphere, oceans, and land. Climate change is continuously triggering significant and harmful impact in water cycle. Nepal is also experiencing the harmful impacts of climate change on water resources and water related hazards viz. flash floods; GLOF; retreat of glaciers lakes and shift of hydrological regime of rivers. Impact of climate change in Nepal is critically high and severe compared to other developed countries due to its fragile mountain ecosystem; rugged and high mountain terrain; and its poor economy. Climate change is a global phenomena and its impact can be minimized in coordinated and sustained way.

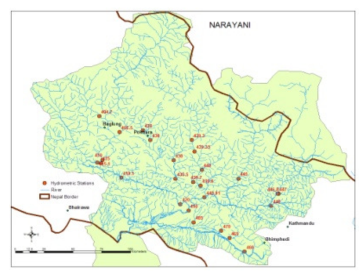
In this context, AWCI is becoming a common platform among Asia – Pacific countries to share data; information; exchange of knowledge and experiences; deepen mutual understanding and work together effectively. Nepal is a member country of AWCI since its beginning and taking part actively in each its activities. Nepal has proposed two river basins namely Bagmati River Basin as demonstration basin and Narayani River Basin as CCAA study basin.

River Basins of Nepal

Bagmati River Basin



Narayani River Basin



Bagmati River is a medium type of river of Nepal with drainage area of 3700 Km^2. It originates from Shivapuri Hill (2731 m) and flows down to south through Kathmandu valley up to Indo – Nepal boarder. Nakhhu, Kulekhani, Kokhajor, Marin and Chandi rivers are its major tributaries. Flood damages; landslides, bank erosion and water pollution are acute problems in the river basin. There are 21 numbers of meteorological stations and two hydrometric stations within and around the basin.

Narayani River Basin is a major river basin of Nepal. It has total drainage area of 34960 Km^2 out of which 29626 Km^2 lies in Nepal and 5334 km^2 lies in Tibet, China. The basin contains 1025 no. glaciers and 338 no glaciers lakes out of which 4 no. are potentially dangerous for GLOF. It has 2030 Km^2 area under ice and snow cover. Budhi Gandaki, Trishuli, Marsayndi, Kali Gandaki and Seti are major tributaries of the Narayani River. GLOF, landslides, flash flood and flood inundation are severe problems in the river basin. There are 58 no of metrological and 26 no of hydrometric station in and around the basin.

<u>Nepal Involvement in AWCI Phase 2 (in line with GEOSS/WCI)</u>

1. Issues and Needs

The climate in Nepal varies from the tropical to the arctic within 200 km span south to north. Much of Nepal falls within monsoon region, with regional climate variation largely being a function of elevation. National mean temperature hover around 15 ^{0} C, and increase from north to south with exception of mountain valleys. Average rainfall is 1875 mm, with rain fall increasing from west to east. Although rainfall is abundant, its distribution is of great concern: flooding is frequent in the monsoon season during the summer, while droughts are not common in Nepal.

Temperature observation in Nepal from 1977 – 1994 show a general warming trend (Shrestha et al. 1999) with an annual increase of 0.06^0C/year. Later study (Practical Action 2009) on the temperature trend of 45 stations from 1976 to 2005 also shows a consistent and continuous warming at an annual rate of 0.04^0 C/year. The temperature differences are most pronounced during dry winter season, and least during the height of monsoon. There is also significantly greater warming at the higher elevation in the northern part of the country than at lower elevation in south. Significant glacier retreat as well as significant areal expansion of several glacial lakes, and shifting of snow line upward to the higher elevation have been documented in the recent decades, with extremely likelihood that such impacts are linked to the rising of temperature.

There are no definitive trends in aggregate precipitation, although there is some evidence of more intense precipitation events. The annual precipitation trends based on the analysis of 166 station all over Nepal from 1976 to 2005 reveals positive trend in annual rainfall in Eastern, Central, Western and Far-western Nepal. The overall trend in the country is increasing by 3.6 mm/year. Analysis reveals that number of rainy days is in decreasing trends whereas the amount of average annual precipitation remains almost same. It leads to come up with the conclusion that the intensity of the rainfall is increasing. A somewhat clear picture emerges in the stream flow patterns of certain rivers where there has been an increase in the number of flood days. Some rivers are also exhibiting a trend towards a reduction in dependable flows in the dry season, which has implications both in irrigation and hydropower. Glacial retreats also contribute significantly to stream flows variability in the spring and summer, while glacial lake outbursts which are becoming more likely with rising temperature, are an additional source of flooding risk.
Variability in the monsoon rainfall is likely to change in the flooding process resulting in river floods, flash floods, urban floods, sewer floods, glacial lake outburst floods. The flood-producing processes include intense and/or long-lasting precipitation, snowmelt, dam break, landslides, or by storm which cause landslides and bank erosion in hilly areas and inundation problem in plain area of the country. The variability in the precipitation is likely to bring changes in river annual flows. The impact is on the water availability (irrigation and water supply infrastructures) and power output of hydropower projects.

Warming trends have already had significant impacts in the Nepal Himalayas – mostly significant in terms of glacier retreat and significantly increases in the size and volume of glacier lakes, making them more prone to GLOF. Continued glacier retreat can also reduce dry season flow fed by the glacier melt. The enhanced melting, as well as the increased length of the melt seasons of Himalayan glaciers, first leading to increased downstream river runoff and discharge peaks, while in the longer time-frame (decadal to century scale), glacier runoff is expected to decrease. The impact is on the downstream water availability for irrigation and water supply and power generation of the run of the river hydropower projects. Snow residency period is observed shortened in recent past a decade due to which the process of metamorphism in the Cryosphere is severely affected. Shifting of snowline in the Nepal Himalayas upward to the higher altitude is being observed.

Variability in the rainfall in the summer and winter is likely to increase the frequency of draught. Decreased land precipitation and increased temperatures, is likely to enhance evapotranspiration and reduce soil moisture. The impact is on the rain fed agriculture, water supply systems (due to drying out or reduction in the spring discharges), and production of terrestrial ecosystem (forest production and availability of fuel wood, fodder and grass)

Being poor country, Nepal is facing tremendous difficulties to cope with the rising adverse impacts associated with climate change. There is no single focal institution within governmental setup which can address the issues and problems related to the climate change. Government is trying to set up a focal point under the Ministry of Science and Technology. Recently Government of Nepal has focused to mainstreaming climate change issues into the government policies and actions. Government has recently formulated National Adaptation Programme of Action (NAPA) to climate change.

There are different departments like Department of Irrigation (DOI); Nepal electricity Authority (NEA); Department of Water Supply and Sanitation; and Department of Water Induced Disaster Prevention (DWIDP) who take sectoral water related decision in the basin individually. Efforts are being made to set up a single institution within the basin which can take water related decision based on IWRM principles.

Review of the existing government organizations in the water resources sector indicates the absence of an appropriate institutional framework for integrated management. Problems relating to institutional framework and mechanism are:

- Absence of an effective central planning organization (despite mandating WECS as the central water planning body);
- Blurred responsibilities between policy, implementation, operational and regulatory institutions;
- Absence of an institutional framework for coordinated and integrated development;
- Jurisdictional overlaps and challenges of maintaining coordination between public and local bodies; and
- Absence of an effective mechanism for institutional cooperation for the development of international watercourses.

2. Issues related to Water Nexus: Agriculture; Energy; Health-Water quality; biodiversity; and Ecosystem

- Untimely rainfall and decrease in the river/rivulet discharges in the winter and summer months (Hill, Mountain and Terai ecological zones) resulting to closer of water mills (Hill and Mountain ecological zones), inadequate or no water in the irrigation systems (Hill, Mountain and Terai ecological zones), low energy output of the hydropower plants including micro-hydro plants (Hill and Mountain ecological zones);
- Decrease in longer and milder precipitation and increase in shorter and intense precipitation resulting to high run off, increased soil erosion (Hill, Mountain and Terai ecological zones), increased mass wasting such as debris flows and landslides (Hill and Mountain ecological zones) and increased floods in the monsoon (Terai ecological zone);
- Decrease in soil moisture (Hill, Mountain and Terai ecological zones) in the winter and summer (due to high evapotranspiration, and decline in rainfall) resulting to reduced agricultural productivity and forest productivity with implications on food security and energy security;
- Decline in the rivulet and spring discharges (Hill and Mountain ecological zones) often going dry resulting to water scarcity even for domestic consumption making the water supply infrastructure inadequate and redundant;
- Decline in recharge of groundwater (Terai ecological zone) due to intense precipitation and high runoff resulting to lowering of the shallow groundwater levels;
- Shift in the precipitation forms from snow to rain (Mountain ecological zone) resulting reduced groundwater recharge and increased soil erosion;
- Increased water pollution particularly pathogens due to increased rainfall intensity and long period of low flows (Hill and Mountain ecological zones) resulting into epidemic outbreak;
- Increased forest fires (Hill and Mountain ecological zones) due to long spell of no precipitation in the winter resulting into scarcity in the fuel wood (primary household energy for cooking) and loss of biodiversity;
- Increased water induced disaster due to frequent and intense precipitation in monsoon resulting to flash floods (Terai ecological zone) and landslides (Hill and mountain ecological zones) with implications on human life and property, road and communication infrastructures, irrigation and water supply infrastructures, and hydropower plants (including micro-hydro);

- Increased long periods of no rain or little rain in the winter, pre-monsoon and delayed monsoon season resulting into draught (Hill, Mountain and Terai ecological zones);
- Increased sediment loads in the rivers due to frequent and intense precipitation in the monsoon resulting into river bed and bank erosion (Hill and Mountain ecological zones) and river bed level rise and bank erosion (Terai ecological zone) with implications on the life and property of communities residing close to rivers and road, communication, irrigation and water supply infrastructures

Understanding the dynamics of current variability and future climate change as they affect water and energy supply and demand across all water and energy using sectors, and enhanced capacity to respond to these dynamics enables better water and energy resources management. This strengthens resilience to current climate challenges, while building capacity to adapt to future climate change

We can manage water resources between upstream and downstream and among the sectors in proper way on IWRM principle. Optimization of water uses and proper water allocation can also minimize the conflict among sector uses. Special effort should be required in conflict resolution of water right among upstream and downstream users as well as sectoral users. Nepal has set the priorities among the sectoral uses in Water Resources Act and Regulations.

3. Needs for functions and/or tools of WCI to address the identified issues

Nepal has started taking hydro meteorological data since 1962. Generally, in-situ observation data like precipitation & temperature, wind velocity, RH are observed. Department of Hydrology and Meteorology has recently established few in-situ observation stations in high altitude for snow. In-situ observation stations in mountains area are few in operation. In- situ telemetric network is yet to be established. Remotely sensed data (Satellite, radar) is used in special case for decision making. Real time data of few river gauge stations are recently started to be taken. Department of Hydrology & Meteorology (DHM) is a sole government agency responsible for hydro metrological data. Regional and Global data centers for satellite data, reanalysis data, climate projection data etc should be established for easy access to data.

Understanding for using physical based hydrological models is comparatively very less. Distributed hydrological models are rarely used in decision making process. HEC series model like HEC-HMS, HEC RAS is used in some cases. Data availability & data length, poor resolution & accuracy; less observation frequency and less coverage are the gaps in using data & model. Flood is frequent extreme event in the river basin of Nepal. Flood fore casting and early warning system is not yet established. It is very difficult to identify the single impediment to successful management of the basin. Lack of basin wise single institution, lack of enough in-situ data & remotely sensed data and lack of consorted effort from line agencies are the impediments.

Common platform like AWCI will be very effective for sharing data and knowledge and exchanging ideas and experiences in water related issues for country like Nepal.

4. Needs for collaboration framework at the national level; inter-agency; interdisciplinary

Climate change is a global phenomena and its impact can be locally and globally as well. Its impact can be minimized if we work together in coordinated and sustained way. There should be a common platform at national as well as regional level where we show holistic view of water and climate change and their impacts on water nexus to all stakeholders through sharing data and information, exchanging ideas and experiences. Enhanced water-related information systems and appropriate legal frameworks should be made functional. Regional cooperation for substantial mutual benefits is achieved. Appropriate institutional mechanisms for water sector management are essential.

5. Implementation Proposal

5.1 Steps and Strategies

Framework Development Approach

- Demonstration design
- Introducing legislation – high level coordination body – research promotion – improvement of awareness – private sector involvement

Strategic Approach

- Demonstrations – regional and general commonalities
- Expansion of AWCI demonstration studies to a whole a region – sharing experiences – a holistic understanding and technology

Technical approach

- Monitoring – understanding – climate change assessment including downscaling, bias correction – detail assessment – model – demonstration – mainstreaming – creation of regional knowledge

5.2 Additional Resources

Collaborators .... Field	Local	National	Regional	Worlwide
Research	Local level Offices of GoN (line agencies), NGOs/INGOs, Universities Students	Universities, Engineering Institutes, Research Institutions, National level GoN Offices (DoI, DHM etc)	AWCI, Regional Universities, SARC, ICIMOD, IWMI	UNU, UT, JAXA, NASA
Operation	District / Regional level Offices of GoN, NGOs/INGOs	Related Ministries of GoN	AWCI, SARC, Regional Universities, ICIMOD, IWMI	UN, UT
Administration	District / Regional level Offices of GoN, NGOs/INGOs	Related Ministries of GoN	AWCI, SARC, Regional Universities, ICIMOD, IWMI	UN
Financial Resources	Private Sectors, Government	Government, Donor Agencies,	UNDP, DFID JICA, ADB	WB, IMF, IFC
Human Resources	Government Officers, Consultants, NGO/INGOs, Universities Students	Government Officers, Consultants, Researchers	Human resources from collaborating countries	Human resources from collaborating countries

5.3 Specific request to GEOSS and to International Community (data/tools accessibility)

- Accurate water resources inventory of the country
- Enhancement and capacity building
- Enhancement of telemetric data network systems
- Easy access to the satellite and radar data; reanalysis data and climate projection models & tools
- Establishment of Regional data center office

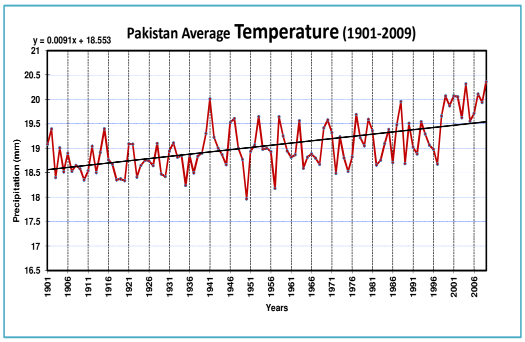
5.4 Coordination between water cycle integration and capacity development strategy

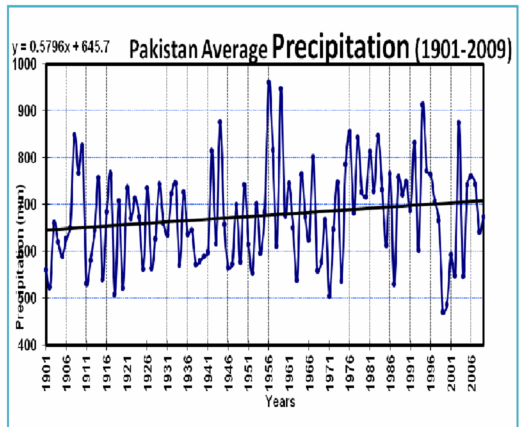
- Need training not only for researchers but also practitioners from top level to operation/technician's level
- Need postgraduate program in collaboration with international educational framework
- Need short term capacity development workshops on specific observation and modeling skills and medium to long term support to regional resource centers

13. Pakistan

Pakistan' Climate Profile

Pakistan covers land mass elevated at sea level to very high mountains of Himalaya, Karakoram and Hindukush experiencing all types of climatic characteristics. Climate change has posed serious challenges to water, energy, food and socio-economic security due to the highly anomalous climatic pattern embedded by extremes. Following two graphs present the trends of thermal and precipitation regimes over Pakistan. It is quite clear that temperature has risen sharply during the last 10 years and precipitation has suffered well marked inter-annual variation.

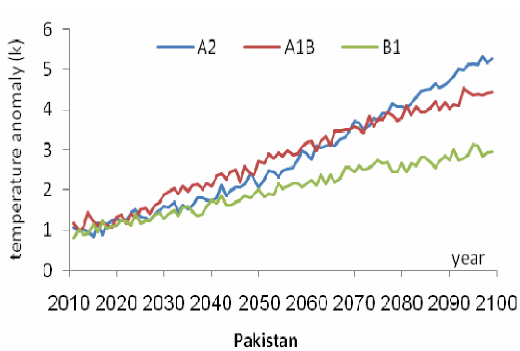


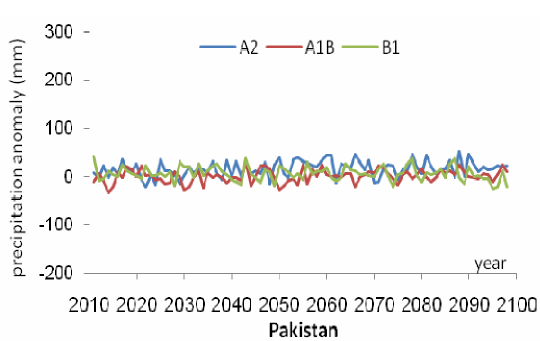


Summary of Extreme Events experienced in Pakistan during the First Decade of 21st Century is given below to understand the gravity of situation and impacts of climate change.

- Cloudburst Events 2001, 2003, 2007, 2008,2009, 2010, 2011
- Prolonged Drought 1999-2002
- Historic River Flooding 2010 and 2011
- Tropical Cyclones 1999,2007,2009
- Severe Urban Flooding 2001, 2003, 2007, 2008, 2009, 2010, 2011
- Heat Waves in Spring 2006, 2007, 2010, 2011 (Reduced wheat yield)
- Snowmelt flooding 2005, 2007 and 2010
- Drought at sowing stage 1999-2002, 2005, 2007, 2008, 2009, 2012
- Sea water intrusion affected 6200 hectares land since 2003.

Future projections of temperature indicate that under optimal climate scenarios more than 4C increase is expected by the end of 21st century. Precipitation amount is not likely to be altered much but increased inter-annual and inter as well as intra-seasonal variability is foreseen.





1. Issues and Needs

1. Issues related climate system - water cycle - water use

- *Regionally common issues - identify which of the common issues are relevant to your country:*
  - *changes in climate and consequences – quantitative assessment*
    - ✓ *intensification of variability (heavy rainfall and dry spells), cyclones*
    - ✓ *frequency of extremes: flood (localized + social)and drought*
    - ✓ *seasonal climate pattern (precipitation, dry and wet, maxima,)*
  - *Identify available capability/resources in your country – specify clearly*
    A well designed network of climate and water cycle monitoring is in place. Efforts on improvement of water use efficiency are in progress considering structural and non-structural measures.
  - *Identify lack of capability – specify clearly, including more details, which capability out of the following ones is missing: monitoring, modeling, inventory of water resources, understanding planning & management*

- *Describe critical and specific issues in your country, include more details:*
  - *landslides / erosion*
    Land slide hazards are common in winter and summer precipitation seasons especially in mountainous areas hampering road transport for a couple weeks depending upon weather conditions. Ata Abad dammed lake which blocked Hunza River (a tributary of the Indus) formed in Jan 2010 due to a massive landslide. It has casted huge loss to trade, tourism, economy on national scale and socio-economic conditions of the divided population on both ends. There are more than 50 potentially dangerous land slide nodes identified in HKH region.

  - *Sea level rise*
    Although sea level rise is not that serious problem like island's submergence for Pakistan, but due to increasing level, the saline sea water intrusion to the coastal fertile land is threat to the livelihood of that marginal farming community.

  - *Temperature rise→GLOF*
    Pakistan is at the highest risk of GLOFs. Recently such events have been recorded due to both accelerated melting of glaciers as well as occurrence of liquid precipitation (rainfall) not only in summer but also in winter.

  - *Depletion of ground water*
    Optimum surface water availability was the limiting factor which has now further aggegerated due to increased water requirement of agriculture, domestic and industrial sectors under global warming. It resulted into shift of pressure on ground water which has been depleting at an alarming rate in the absence of sufficient recharging.

  - *Hydropower*
    Power generation is mainly dependent on hydro resources. New water reservoirs have not been built and capacity of existing two major reservoirs has depleted by about 30% in last 35 years.

  - *Trans-boundary and international coordination (MRC)*
    Such issues are there with neighbours as all the Pakistani rivers come from their territory.

  - *Shifting snow residency, melting period, snow-line→biodiversity*
    It has been noticed during the last 10 years that snow occurs towards the end of winter season which melts immediately due to rise in temperature. This reduced snow residency period does not allow snow to go through metamorphic process for conversion in ice to become the part of glacier ice. Further, studies have shown that warming trend is creeping up to higher elevations, shifting the snowline upward and simultaneously animals and plant species of vital importance in local ecosystem.

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):

1. Water and Climate Change affect each Socio-Benefit Area (SBA)
2. Each SBA affects water and environment

B. Introduce on-going projects and programs related to Water Nexus in your country

SBA	CC, Water, and Environment
• *Agriculture:*	*←water scarcity and surplus, crop failures → quality of surface and ground water (fertilizer, pesticide)* UNDP Climate Change Adaptation Program + Many small programs on Food Security
• *Energy:*	*←hydropower* Construction of Bash-Diamer Dam started 2011
• *Urban:*	*→water quality, ground water depletion, increase of municipal water demand, inefficient municipal water management (low tariff, unplanned conjunctive), decrease of flood plains,* None
• *Ecosystem and Biodiversity:*	*←change in flow pattern, water diversion* None
• *Health*	*←water bone diseases (dry and wet spells: Malaria, Dengue, flood: Diarrhea)* Control measures are taken in case of outbreak but no steps underway to cope with challenges of CC
• *Infrastructure:*	*←design and management* None

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*

• Through improved seasonal precipitation predictions + Construction of additional reservoirs for control on surplus flows and release during dry season

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*

• By proper legislation and water pricing

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*

• A focal agency at national/provincial/local level such as National Meteorological and Hydrological Services should be given responsibility where relevant experts may translate Climate information according to the requirements of each user.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*

• Keeping in view the ground realities of occurring extremes which have been setting new records and future projections, the design criteria should be determined

- *How can we share the data to the different sectors beyond laboratories?*

• Through inter-organizational cooperation and exchange

3. Needs for functions and/or tools of WCI to address the identified issues

Specify needs for your country:

• *Observations:*
  - *in-situ telemetric network (mountain areas)*

PMD being NMHS operates 105 hydromet and met (manned and automatic) stations throughout the country. Still at low elevation 15% area is not monitored and 75% are the data gaps in mountainous areas including glaciers and river basins.

- *remote sensing (satellite, radar) currently and in future*

  Data gaps are filled with satellite information which is not freely available at finer resolution. Most of the river catchments do not come under radar coverage, at least 5 radars may serve the purpose of flood warning up to some extent.

- *Data Access*
  - *satellite data access (operationally coupled with in-situ near real-time data)*

    Satellite imageries are accessible coupled with met observations but they are coarse resolution. There is no software available for satellite data processing and its integration to Numerical Models.
  - *global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)*

- *Models*

  Only data are accessible for the models available at IPCC website and pseudo free Regional Models are being used for climate modeling studies. Capacity building in NWP and Climate Projections is highly desirable.

- *Management systems*
  - *Forecasting*
  - *Early Warning*
  - *Decision support*
    - ✓ *National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)*
    - ✓ *community-based*

All the above management systems are in place but their effectiveness can be optimized through enhancing their capacity by technological input and training of manpower.

<u>4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary</u>

Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*
- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.*
- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*
- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

These are just the recommendations to step forward, we strongly support them. Establishment of the Task Force on Climate Change un Prime Minister of Pakistan is a solid step toward the inter-agency and inter-disciplinary approach. To achieve the objectives, a lot of expert input and moral boasting mechanism is required from international community such as AWCI and WCI following the success story approach and sharing experiences. Frequent visits of leading scientists like Prof. Toshio Koike have high impact on the minds of planners and policy makers to urg them in translation of likely impacts in national policies.

2. Implementation proposal

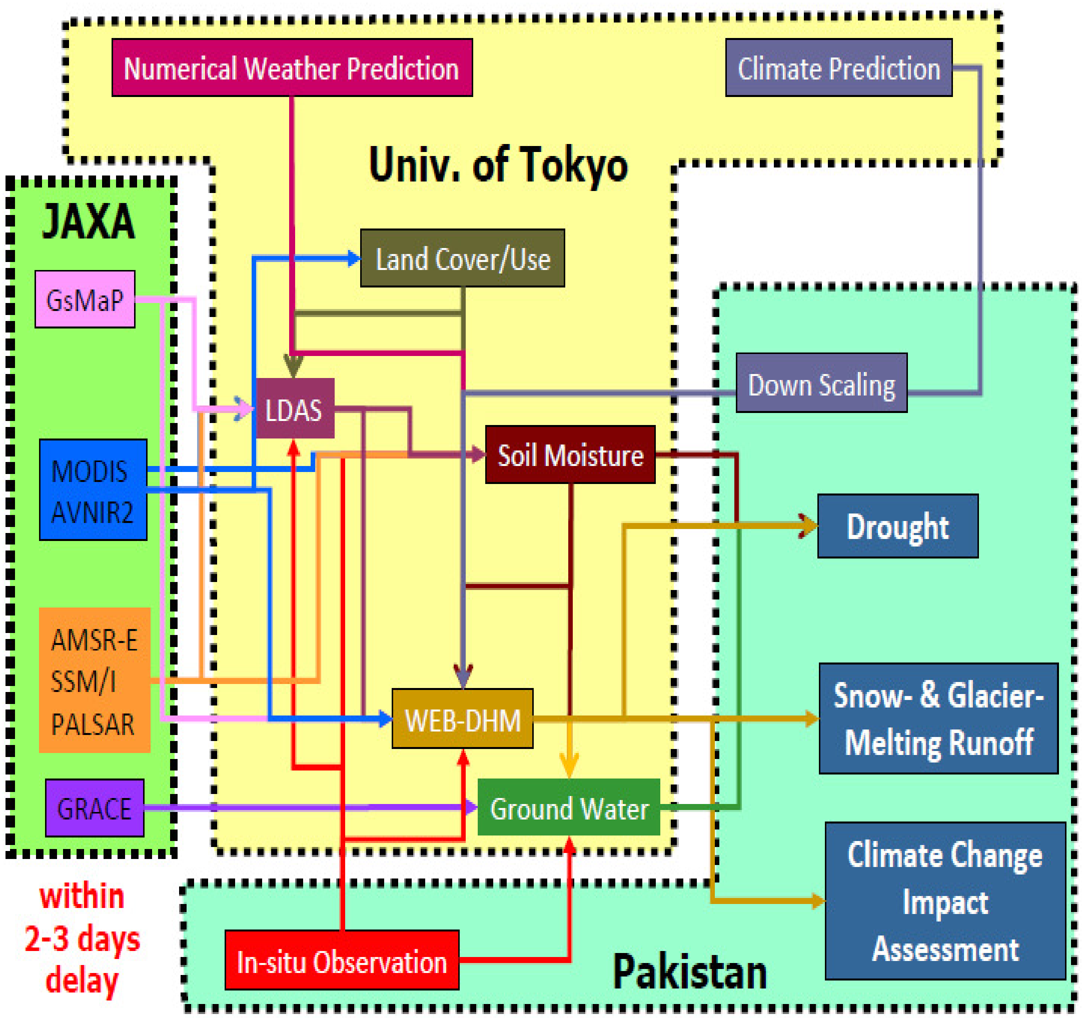
<u>Challenges</u>

- Extreme Climate Variability
- Winter and summer monsoon variability
- Lack of technical and human capacity in NWP and Seasonal Forecast
- Flood Forecasting and Warning
- Climate Impact Modeling
- Reliable and fine Resolution Climate Projections

Needs
As mentioned in opening paragraphs, Pakistan is vulnerable to all sort of climatic problems and it has been struggling with limited technical and human resources. Immediately water cycle variability has become a serious concern which has been threatening water, food, energy and socio-economic security. There is a dire need to address these challenges with an integrated approach in collaboration with an experienced and competent partner who have already have already achieved sufficient success in adaptation. Hardware, software and training requirements are given as under:

- High speed cluster computing system
- Denser AWS network in glacier zone
- Capacity building in weather and climate modeling
- Improved seasonal forecasting techniques
- Impact Assessment and modeling
- Access to remote sensing data and processing software
- International collaboration

Project Proposal
Impact of Climate Change on Water Cycle Variability in Pakistan



Brief Introduction
Global warming resulting in accelerated melting of HKH glaciers and enhanced monsoon precipitation variability over time and space coupled to generate highly variable river flows. Upper Indus Basin comprises 10 sub-basins and fed by more than 5000 glaciers in addition to summer monsoon at lower reaches of the Indus River System. Surplus amounts of water associated with extreme events caused urban, riverine and flash flooding. Deficient rains promoted prolonged social, hydrological and agricultural droughts. Sustainable crop production and power generation have become a challenge due to lack of capacity of prediction with sufficient lead time and accuracy. Above schematic diagram covers intended framework.

<u>Pakistani Collaborators</u>
Project PI: Dr. Ghulam Rasul
Project Coordinator: Dr. Bashir Ahmad
Participating Scientists: Furrukh Bashir, Waheed Iqbal, S. Ahsan Bukhari, Muhammad Arshad

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local KIU, FOCUS, PMD	National PMD, WRRI	Regional ICIMOD, CAREERI	Worldwide UT, EDH, EV-K2-CNR
Research	PMD, WRRI, GCISC	PMD, WRRI, GCISC	ICIMOD, CAREERI	UT, EDH, Ev-K2-CNR
Operation	PMD, WAPDA	PMD, WAPDA	-	UT,EDH, Ev-K2-CNR
Administration	PMD	PMD	-	-
Financial res.	PMD, WRRI	PMD, WRRI	ICIMOD	UT, UNDP, JICA, GEOSS, EDH, SDC, EV-K2-CNR
Human res.	PMD, WRRI	PMD, WRRI	-	UT, EDH, Ev-K2-CNR

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*
  - By organizing workshops to disseminate research findings to key stakeholders for sensitization on emerging issue
  - Arranging meetings/briefings of International experts with members of Prime Minister's Task Force on Climate Change
  - Mass awareness campaign on climate change translating results in local language and delivery through radio, print and electronic media.
  - Short video messages by national heroes, athletes, showbiz icons.

3. Specific request to GEOSS and to international community (data/tools accessibility)
Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case*
- *Data request function responding to new needs – what kind of function*
- *Data access and information exchange*
- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose*
- *Regional office and/or data center – what kind of function you expect for the office*

After conceiving the project, above requirements will be given in detail

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country
- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*
- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*
- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*
- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

14. Philippines

1. Issues and Needs

There is an increasing need for a more detailed weather, climate and hydrological information to minimize growing economic losses from natural hazards and the need to adapt to climate change. These information and services are delivered by the National Meteorological and Hydrological Services (NMHSs), which in many countries are weak and need considerable support.

A. Current Needs and Challenges

- Improvement in Climate and Flood Modeling.
  Currently PAGASA does not use computational modeling to understand flood hazard.
- Tools for impact modeling
- Vulnerability and Risk assessment tools to various sectors:
  - Water resources
  - Agriculture
  - Health
  - Coastal
- Analytical tools to describe the weather extremes and climate variability
- Application of remotely sensed data in monitoring drought and floods
- Decision support systems as risk management tools especially for the water and agricultural sectors
- Forecasts at different time scales (daily, ten-daily, monthly and seasonal) particularly on rainfall
- Areas susceptible to flooding have changed and floods maps developed with past climate data lack enough precision to be useful for disaster management under current climate.

B. **Available Resources/Capability**

a. Network of observing stations
   - ✓ 58 synoptic
   - ✓ 24 agromet
   - ✓ 5 Doppler radars (with 5 other existing Conventional radars upgrade to Doppler capability)
   - ✓ More than 100 AWS (several other being installed through several projects)
   - ✓ 2 Marine Meteorological Bouys
   - ✓ 1 Wind Profilers
   - ✓ More than 100 Automatic Raingauges

b. Human resource
   - ✓ Well trained personnel in climate, weather and flood forecasting
   - ✓ Expertise and linkages with national, regional and international funding organizations
   - ✓ In-house training programs for continuous capability building of personnel

c. Infrastructure for climate modeling
   - ✓ Cluster Computing system

<u>1. Issues Related to the Climate System</u>

Current Climate Trends in the Philippines
A. Temperature

The Philippines, like most parts of the globe, has also exhibited increasing temperatures as shown in Fig.1 below. The graph of observed mean temperature anomalies (or departures from the 1971-2000 normal values) during the period 1951 to 2010 indicates an increase of 0.65 ℃ or an average of 0.0108 ℃ per year-increase.

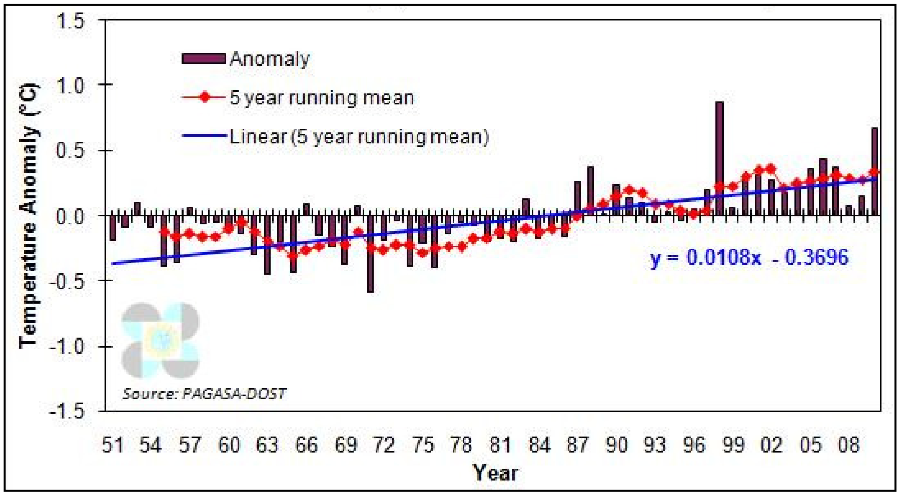


Fig.1: Observed annual mean temperature anomalies (1951-2010) in the Philippines based on 1971-2000 normal values.

In the Philippines, there already are trends of increasing number of hot days and warm nights, but decreasing number of cold days and cool nights as shown in Figures 2 & 3. Both maximum and minimum temperatures are generally getting warmer. Study done by IRRI indicate that a 1 °C rise in minimum temperature will result to a 10% decrease in rice production.

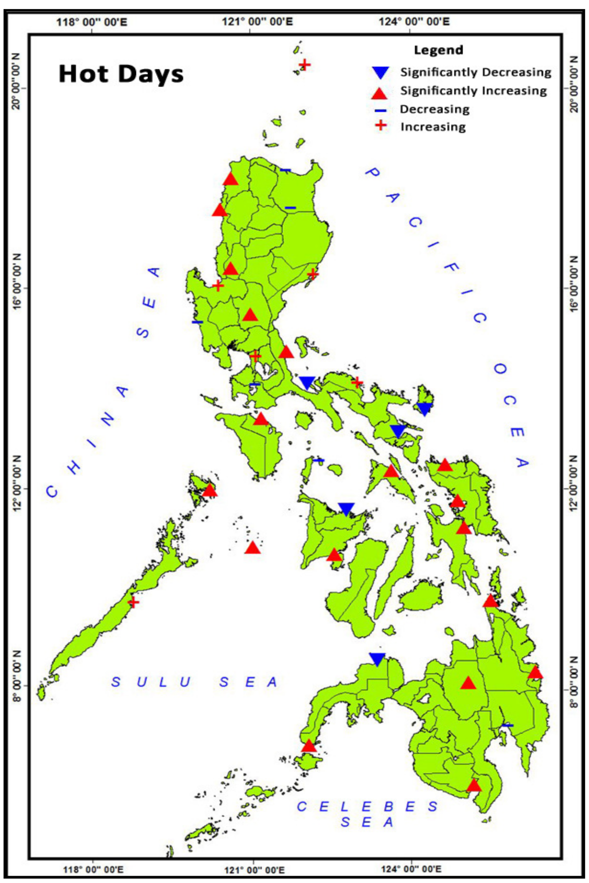


Fig.2: Trends in the frequency of days with minimum temperature below the 1971-2000 mean 1st percentile.

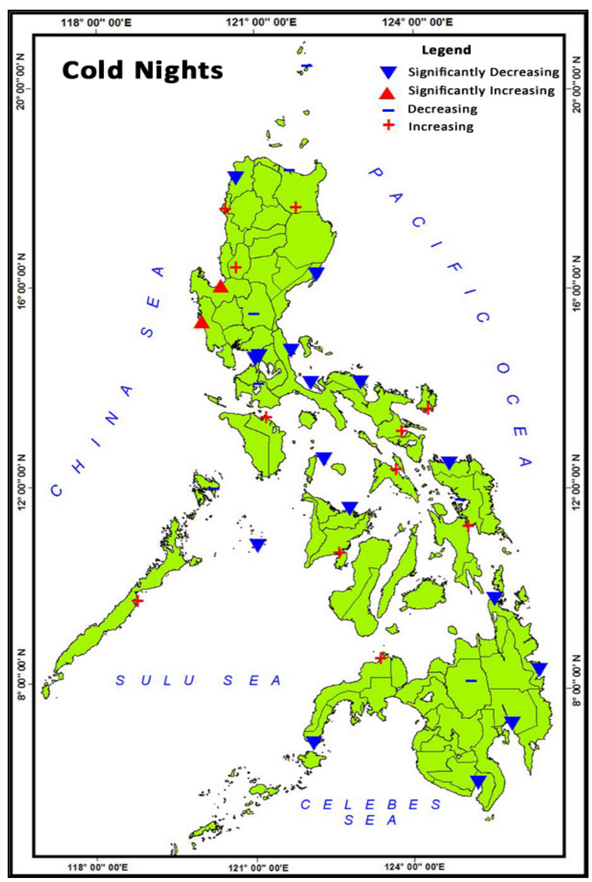


Fig.3: Trends in the frequency of days with maximum temperature above the 1971-2000 mean 99th percentile.

B. Rainfall

Analysis of extreme rainfall shows increasing trend in terms of frequency and intensity in most parts of the country as shown in Fig 4 & 5. Only three stations show statistically significant trend. Increases in rainfall particularly during the rainy season could cause flooding and landslide especially in areas vulnerable to hydrometeorological hazards.

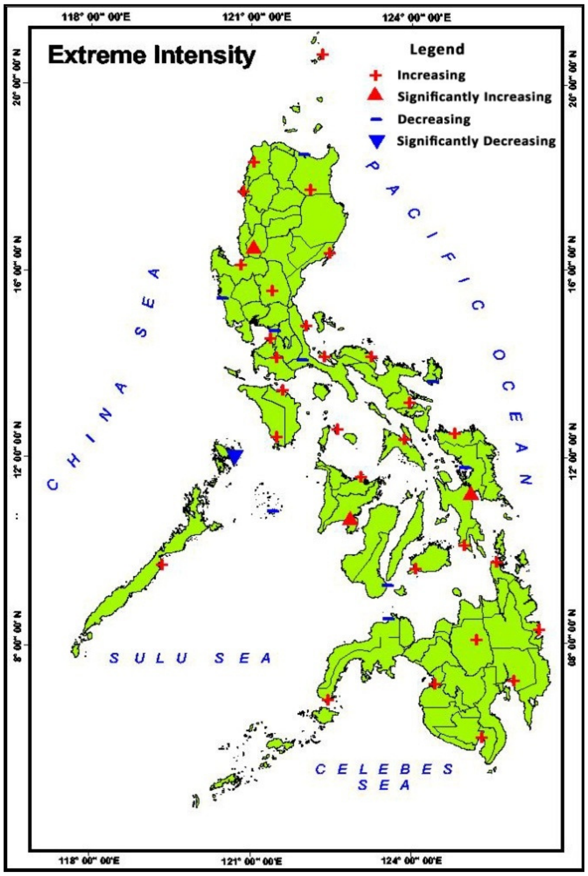


Fig. 4: Trends in extreme daily rainfall intensity in the Philippines (1951-2008) compared with the 1971-2000 mean values. Index used is the amount of rainfall exceeding the top four events during the year.

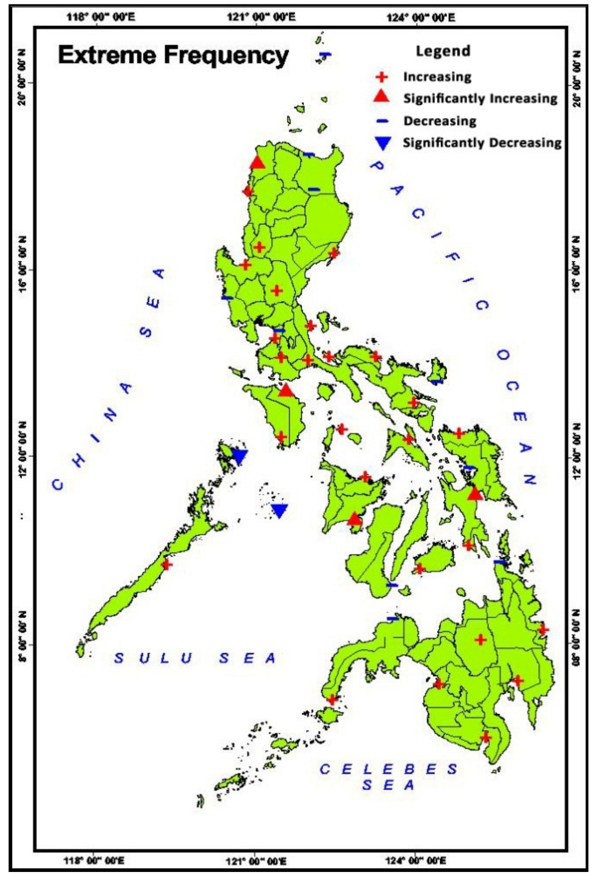


Fig.5: Trends of extreme daily rainfall frequency in the Philippines (1951-2008) compared with the 1971-2000 mean value. Index used is the number of days with rainfall exceeding the top four events during the year.

Projected Rainfall Change

In areas/regions where rainfall is projected to decrease, there will be water stress (both in quantity and quality), which in turn, will most likely cascade into more adverse impacts, particularly on forestry, agriculture and livelihood, health, and human settlement.

Large decreases in rainfall and longer drier periods will affect the amount of water in watersheds and dams which provide irrigation services to farmers, especially those in rain fed areas, thereby, limiting agricultural production. Likewise, energy production from dams could also be rendered insufficient in those areas where rainfall is projected to decrease, and thus, could largely affect the energy sufficiency program of the country. Design of infrastructure, particularly of dams, will need to be re-visited to ensure that these will not be severely affected by the projected longer drier periods.

- In terms of seasonal rainfall change, generally, there is a substantial spatial difference in the projected changes in rainfall in 2020 and 2050 in most parts of the Philippines, with reduction in rainfall in most provinces during the summer season (MAM) making the usually dry season drier , while rainfall increases are likely in most areas of Luzon and Visayas during the southwest monsoon (JJA) and the SON seasons, making these seasons still wetter, and thus with likelihood of both droughts and floods in areas where these are projected;
- The northeast monsoon (DJF) season rainfall is projected to increase, particularly for areas characterized by Type II climate with potential for flooding enhanced;
- During the southwest monsoon season (JJA), larger increases in rainfall is expected in provinces in Luzon (0.9% to 63%) and Visayas (2% to 22%) but generally decreasing trends in most of the provinces in Mindanao in 2050;

C. Seasonal climate Pattern

ENSO is one of the major drivers of the climate system. Based on climatological studies, the manifestations of ENSO event in Philippine climate are shown in Table 1. During El Niño, drier than normal weather condition could last for one or more seasons causing dry spells or even drought in many parts of the country.

Table 1. Initial results of diagnostic and statistical studies on general influences of ENSO on Philippine climate.

El Niño	La Niña
• Extended dry season • Early end of rainy season • Weak monsoon activity • Less number of tropical cyclone • Above normal sea level pressure • Above normal air temperatures	• Short dry season • Early onset of rainy season • Strong monsoon activity • More number of tropical cyclone • Below normal sea level pressure
• Drier weather conditions	• Wetter weather conditions

In a recent study on the impacts of extreme climate events in major reservoirs in the Philippines particularly during occurrences of El Niño and La Niña for Angat reservoir for example, water inflow exhibited peak responses from October to March rather than during the southwest monsoon months from April to September. This is consistent with the peak response of rainfall to El Niño / La Niña events during the northeast monsoon months. As indicated in Table 2, reduction during El Niño and increase during La Niña to the inflow, amounts to about 20 % of their historical average values. In extreme cases seasonal inflow reduction could even reach to more than 50 % of the historical average inflow causing disastrous impacts on the urban water supply for Metro Manila due to the water shortages in the Angat reservoir (Table 3).

Table 2. Departure (%) of Angat seasonal inflow from the normal during El Niño and La Niña events

Season	El Niño		La Niña		Normal Inflow
	Inflow (mcm)	Departure	Inflow (mcm)	Departure	
Southwest Monsoon (April-September)	802.33	.5 %	777.47	-3.58%	806.35
Northeast Monsoon (October-March)	866.35	-19.85%	1334.89	+19.99%	1087.1

Table 3. Actual monthly inflows compared with the normal values (1968-1998) for Angat reservoir in Luzon during selected El Niño years (million cubic meters).

Month	1991-1992			1997-1998		
	Actual	Normal	% of Normal	Actual	Normal	% of Normal
October	68.0	304	22	90.2	304	30
November	181.0	291	62	43.4	291	15
December	113.0	211	53	86.9	211	41
January	62.0	101	61	52.0	101	51
February	29.0	57	51	28.0	57	49
March	15.0	51	29	20.9	51	41
Total	**468.0**	**1015**	**46**	**321.4**	**1015**	**31.6**

15. Sri Lanka

1. Issues and Needs

1. Issues related climate system - water cycle - water use

- *Regionally common issues - identify which of the common issues are relevant to your country:*
  - *changes in climate and consequences – quantitative assessment*
    - ✓ *intensification of variability (heavy rainfall and dry spells), cyclones*
    - ✓ *frequency of extremes: flood (localized + social) and drought*
    - ✓ *seasonal climate pattern (precipitation, dry and wet, maxima,)*
  - *Identify available capability/resources in your country –*

    Water resources rainfall-runoff modeling, limited capability of climate change data downscaling, availability of rainfall records for more than a century

  - *Identify lack of capability –*

    Climate change impact monitoring, modeling
    Planning of adaptation strategies

- *Describe critical and specific issues in your country, include more details:*
  - *landslides / erosion*

    Central part of the island which is mountainous receives high intensity rainfalls, annual rainfall spatially ranges from 2500-6000 mm. Landslides, slope failures floods are experienced.

  - *Hydropower*

    Hydropower contributes to more than 50% of the power requirement. Run-of-the river hydropower stations are specially affected by the rainfall variations and prolonged droughts have increased the low flow periods.

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):
1. Water and Climate Change affect each Socio-Benefit Area (SBA)
2. Each SBA affects water and environment

B. Introduce on-going projects and programs related to Water Nexus in your country

SBA	CC, Water, and Environment
• Agriculture:	Number of irrigation projects are carried out including the small scale village reservoir centered irrigation projects. Use of pesticides has caused ground water pollution.
• Energy:	hydropower development projects are encouraged by the government. A large number of mini hydropower schemes are being developed.
• Urban:	Water supply development, sewage systems developments are being carried out. Urban drainage systems are upgraded to convey the storm water generated by intense rainfalls.
• Health	dry and wet spells have increase waterborne deceases such as Dengue fewer
• Infrastructure:	the development of flood mitigation structures, water supply schemes are carried out

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*

  Seasonal variability of water resources is faced by strengthening of the storage systems. Sri Lanka has a large number of small reservoirs, improvement of scattered storages is required. Variation of crops considering seasonal variations of rainfall need to be adopted

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*

  The central committee representing each of the sector require to prepare guidelines for sharing water. Decisions need to be take at regular meetings assessing the requirement at each sector

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*

  A central secretariat capable of providing such climate information need to be strengthened, established with necessary resources.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*

  Designs based on historic records are not correct/sufficient due to climate change. New guidelines need to be introduced based on climate change impact predictions

- *How can we share the data to the different sectors beyond laboratories?*

  Sharing data through agreements for mutual benefits

<u>3. Needs for functions and/or tools of WCI to address the identified issues</u>

Specify needs for your country:

- *Observations:*
  - *in-situ telemetric network (mountain areas)*

    expanding and modernizing the data acquisition systems is required, this include setting up of new stations for recording high resolution data, wireless transfer to central locations, etc.

  - *remote sensing (satellite, radar) currently and in future*

    remote sensing data acquisition systems are not available

- *Data Access*
  - *satellite data access (operationally coupled with in-situ near real-time data)*

    Access to real time data is required

  - *global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)* Limited to access available through internet sources

- *Models*

  Availability of models, Training / development of capability of using new models that use available data

- *Management systems*
  - *Forecasting & Early Warning -*

    modern tools for rainfall forecasting and training for interpretation of available information

  - *Decision support*
    - ✓ *National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)*
    - ✓ *community-based*
- *Platform for sharing data and knowledge and exchanging ideas and experiences*
- *Capacity building – describe in other section (Part 2: Implementation Proposal)*

<u>4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary</u>

Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together.*

  The government agencies responsible for hydrological/ meteorological data , make the data available to any party for a payment. Some data are published at the end of the year and made available to line agencies. A system for real time sharing of data would be useful.

- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies.*

  The recent advancements in technologies, use of data effectively, for social benefits can be brought to implementation only if researchers/academia also involved in decision making process. Establishment of advisory panels/ consultative committees with representations from experts in relevant areas at national level would be helpful

- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*

  The dissemination of knowledge is done through annual seminars/sessions of various professional organizations. These activities need to be strengthen through keynote lectures by experts local/international.

- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

  Regular verification of data acquisition centers is done by responsible agencies. Improvement to quality of data through calibrations of equipments, introducing of modern equipment, training the data recorders/processors need to be done. Data providing institution need to be accredited.

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:
Framework development approach – describe desirable framework in your country

- *Demonstration design ←→ infrastructure integrity*
- *Introducing legislation→high level coordination body→research promotion→Improvement of awareness→private sector involvement*

Establishment of high level of an apex body with the permanent Secretaries of the ministries of water resources and water nexus, higher education and research, experts in water resources including researchers, international experts to identify country needs and develop project proposals with a mission. WCI/AWCI can arrange advisory panels as appropriate. Appropriate panel to be formed for each project including private sector as appropriate. The apex body will be responsible to the ministerial panel .

The above issues and needs to be addressed by different project developed by the ministries and submitted to the panel.

Strategic approach

- Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)
- Demonstrations → regional and general commonality
- Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.

There must be public awareness and promotion for the positive side and short-term and long-term gain from the projects through success stories from Sri Lanka and other countries. AWCI could assist in this through its demonstration projects.
The benefits of the activities of various government and private organizations through the apex body and its identified projects have to be showcased.

Technical approach – propose a technical approach considering your target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction→detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge

Technical support for the projects to be arranged through training and providing models and data by the WCI/AWCI, GEOSS and other international organizations.

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	University of Peradeniya, Institute of Fundamental Studies	National Science Foundation	AIT, UNU, ICHARM, Univ of Tokyo	IWMI UNESCHO-IHE
Operation		Department of Irrigation Dept of Meteorology Dept of Agriculture		
Administration	Disaster Management Centre	Apex body to be formed Ministry of Water Resources		
Financial res.		Ministry of Water Resources National Science Foundation, National research Council	FAO	WB, ADB
Human res.	Universities	Ministry of Water Resources	AIT	AIT, UNU, ICHARM

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*
  The ministries dealing with water nexus to identify the issues related to water sources and the impact of climate change on the nexus. Present the importance of addressing the issues to convince the government on the importance.

  Identify ways to overcome the negative impacts and prioritize the projects at each ministry. Submit strategies to secure funds and cooperation.

3. Specific request to GEOSS and to international community (data/tools accessibility)
Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case*
- *Data request function responding to new needs – what kind of function*
- *Data access and information exchange*
- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose*
- *Regional office and/or data center – what kind of function you expect for the office*

The availability of real time remote sensing data available with developed nations has to be accessible at a minimum cost for researchers in developing countries at through regional centres. To popularize the data usage, regular updates of available data and demonstration of use of such data for specific purposes need to be publicized through bulletins accessible to university students researchers.

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country

Training of a large number of research officers in government agencies on climate change impact interpretation and adaptation, conjunctive use of water is important

- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*

Government trains the officers through trainings provided by various international programmes carried out by international donor agencies

- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*

University of Peradeniya, Sri Lanka is a member in UN_CECAR programme and capacity development in climate change adaptation through workshops, postgraduate training are carried out. Staff and students carry out joint research in climate change adaptation with UNU researchers. These activities need to be expanded.

- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*

Training workshops on climate data downscaling and the use for prediction on future water nexus areas through models, long term support through follow up seminars

- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*

International links to research centres and universities would help to sustain the knowledge. Postgraduate programmes on related areas and research in related topics should be supported by the regional centres

- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

Sustainable development of expertise in countries through collaborative research with universities, research organizations.
Universities (University of Peradeniya), Department of Irrigation, Meteorology, Central Engineering Consultancy Bureau(CECB)

16. Thailand

1. Issues and need

- Water-related disasters are currently the extreme issues that trend to increase in terms of areal extension, frequency and severity in global regions. These disasters seriously affect on water resource, environment and livelihood issues and losses in most countries including Thailand.
    - ✓ intensification of variability (heavy rainfall and dry spells), cyclones
    - ✓ frequency of extremes: flood (localized + social)and drought
    - ✓ seasonal climate pattern (precipitation, dry and wet, maxima,)

Each year Thailand has to face with the natural disasters that cause economic losses and casualties so far while the natural hazards still have trend to increase higher in severity and scale since the climate change.

<u>The lack of capability</u>: climate change assessment and adaptation at river basin scale/ regional scale.

Late of the year 2011 Thailand confronted with the immense inundation that covered the area of 63 provinces (from all 77 provinces of the country) with 12.8 million sufferers, 698 casualties and 3 losts. More than 60 million acres of agricultural areas were damaged, most of industrial estates in central part of the country were flooded and stopped with the whole economic losses estimated as 45,300 million $.

At the critical situation, flood monitoring, forecasting and early warning systems were all failed, the administration and management systems were disabled and 2,000,000 workers of labor sector immediately became unemployed and lose the hope for their future because the industrial sector had been paralysed for almost 6 months.

Researching for sustainable disaster management could be one of the way out of this disasters and their results. We have to study and learn first to understand all behaviors and changes of natural sources and phenomena through appropriate approaches and tools, globally for climate change and regionally and locally for rainfall, runoff and groundwater in both upstream and downstream areas …to be able to create the models for flood or drought predicting, forecasting and early warning systems. However the study needs to classify physical and biological characteristics of each basin in each region with the public participation as the main mechanical process to move forward to strategic management about disasters particularly flash flood and landslide in Thailand.

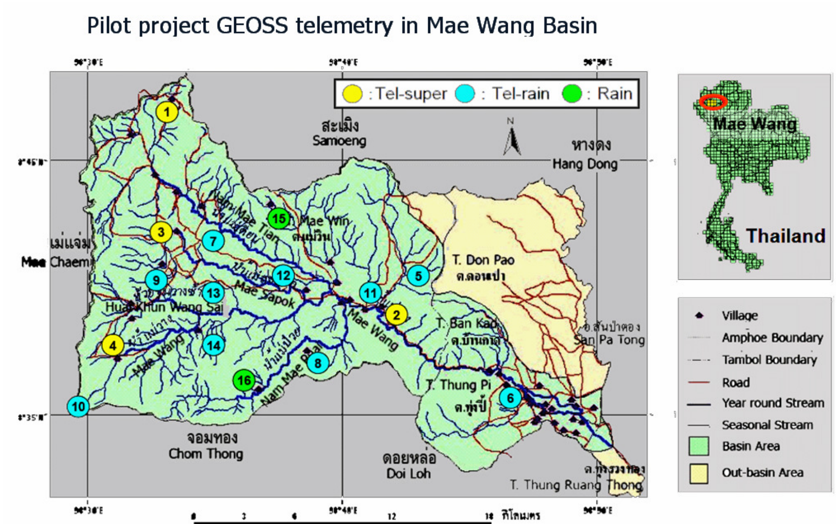


Figure 1 : Mae Wang River Basin Project by GEOSS in Chiang Mai province, northern Thailand.

Mae Wang River (Figure 1) in Chiang Mai province is one of the tributaries of Ping River, The Mae Wang Basin regarded as the high potential basin for meteo-hydrological research and demonstration model of upstream flood and landslide disasters management project of the northern region. It has been studied for flood monitoring system with water levels correlation between 2 station in GAME-T research and the first phase of GEOSS research (Figure 2), besides there are available network of 4 automatic raingauges and water level survey stations already installed. So this basin is suitable for carry on and implement the project for the best appropriate and efficient model designed for flash flood and landslide early warning system.

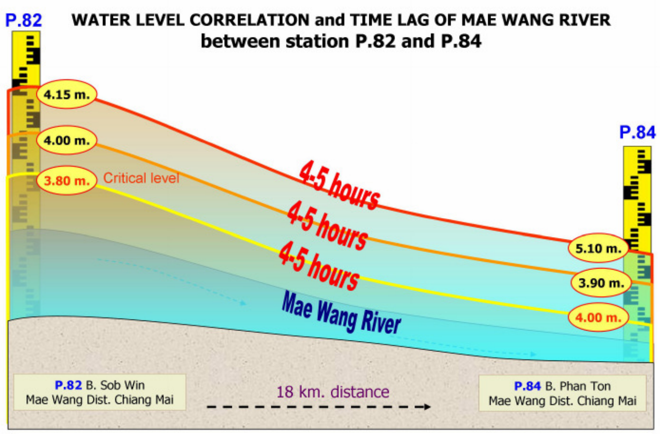


Figure 2 : flood monitoring system with water levels corelation between 2 station in GAME-T research and the first phase of GEOSS research

2. implementation proposal :

By the reasons above we propose the research project of Mae Wang Basin as “Flood and Landslide Disaster Management System with Public Participation Model” as 4 activities designed as follow:

<u>Activity 1</u> : Finding the appropriate type of observation stations, data survey- collection and report methods with geoinformatic and disaster management system preparing for communities.
<u>Activity 2</u> : Rainfall analysis and runoff yield assess by satellite images model.
<u>Activity 3</u> : Real-time flood and landslide assessment model for upstream area
<u>Activity 4</u> : Symbolic disaster warning system, technics and steps of warning for public sector.

Details
Activity 1: Method
Finding the appropriate type of observation stations, data survey- collection and report methods with geoinformatic and disaster management system preparing for communities.

1. Finding the appropriate locations for raingauge and runoff stations which suitable for physical characteristic of basin and region and consistent with the need of communities.
2. Finding the appropriate data survey technique or tools and the data transfering and dissemination system among basins or organizations.
3. Prepare geoinformatic system by define the real altitude reference, data account of vulnerable area residents such as names, addresses, status of family membership, phone numbers, idenity details such as aged people, disables, chronic illness etc.
4. Personnel training and workshop about system application skill for public sector especially local administrators.

Activity 2: Method
Rainfall analysis and runoff yield assess by satellite images model.

1. Study and try available models both in the country and international for rainfall upstream and runoff yield assessment.
2. Study and analyse rainfall and its distribution by satellite images

Activity 3: Method
Real-time flood and landslide estimate model for upstream area

1. Develop the most appropriate and accurate model for real-time estimating the possibility of upstream flood and landslide.
2. Test and adjust the model to be applied for another basins.

Activity 4: Method
Symbolic disaster warning system, techniques and steps of warning for public sector.

1. Study to manage symbolic warning materials, communication and dissemination procedure, technique and pattern of public relations, prepare daily report and simplified warning massage for local people.
2. Disaster prediction, forecast and warning training for public sector by using technology and geoinformatic system.

3. Available Resources/Capability

1. Available automatic meteo-hydrological observation stations installed by GEOSS-1 project.
2. Previous collected meteo-hydrological data of Mae Wang Basin by involved authorities.
3. Data collected by GAME-T and GAME-C research projects
4. General data of physical, socio-economic of the flooded area of Mae Wang Basin.

<u>Additional resources-suggestion of potential collaborators</u>

Collaborators Field	Local	National	Regional	Worldwide
Research				
Operation				
Administration				
Financial res.		NRCT/		
Human res.		Thada Sukhapunnaphan Sutep Junkhiaw		

<u>Need of research group (Thailand)</u>

1. Efficient early warning system consists of data system, prediction and forecast system obtained from accurate rainfall data of the highland or mountainous upstream area.
2. Flood and landslide predicting and forecasting model for local area not for general area or for the whole major basin.
3. Data access, data interpretation and data dissemination systems for public sector particularly for local administrations which could be able to access and manage the system by themselves.

17. Uzbekistan

1. Issues and Needs

A characteristic feature of mountain areas of Central Asia and neighbouring countries is the increasing number of floods and water-related risks, particularly in a global climate change phenomena. Every year floods enormous economic and social damage, often leading to massive loss of human life. Extreme weather events in Asia this is the most common causes of floods and other water-related risks (mudslides, landslides, and glacial advances dammed lakes). The combination of extreme weather events is particularly dangerous. The sharp rise in the melting snow and glaciers, combined with intense rainfall.

The vast majority of floods and water-related risks are of a transboundary nature. Floods, mudslides, breakthroughs dammed lakes are often formed on the territory of one country, but damage are done to neighbouring countries. In this case, the transboundary nature of the impact is difficult to predict, control and management, as countries have different systems for monitoring hazardous hydrological phenomena. This disagreement is especially evident in varying degrees of technical and technological equipment and control systems of hazardous hydrological phenomena. Not all countries have access to operational satellite data, which is the most modern and responsive source of information for timely monitoring and early warning systems.

Hazardous Climatic Phenomena and Risk Management Opportunities in Uzbekistan

Global warming facilitates increase of periodicity of extreme and hazardous hydrometeorological phenomena. Uzbekistan is the most vulnerable to such phenomena as droughts, high temperatures, heavy precipitation, mudflows, floods and avalanche.

High country's vulnerability to the hazardous hydrometeorological phenomena causes governmental response on population protection from extreme situations associated with mudflows, floods, landslides and their effects mitigation. The National hydrometeorological service (NHMS) of Uzbekistan provides forecasts and warnings; Ministry for Extreme Situations is operating in close coordination with local authorities.

Practice shows that extreme natural phenomena regularly take place, but their effects degree entirely depends on extent of country or certain region preparedness for countering the natural disasters. In this context, the change of natural risks on the territory of Uzbekistan associated with ongoing Climate Change has to be evaluated.

Hazardous Hydrometeorological Phenomena

Mudflows and floods. All rivers in Uzbekistan, including temporal water streams within the mountains and foothills are hazardous in terms of mudflows. The territories potentially vulnerable to the risk amount about 12% of the country space, with population at least 4 million people. While development of the piedmont and low mountain territories this share of population is increasing. The lower areas of the river valleys where the mudflow mass deposits occur are the high risk areas of mudflows and floods.

On the average for Uzbekistan rivers, 22 mudflows a year arc, they frequently cause the tragic consequences. Intensive rains as well as inrush of the highland and moraine lakes, frequently due to intensive snowmelt are responsible for the mudflow formation. Period of the highest mudflow risk is March-July (96% of total mudflow). Frequently, mud How formation has transboundary nature, and mudflow origin takes place on the territory of the cross-border countries, and adverse effects appear on the territory of Uzbekistan.

Key factors of mudflow activity intensification in line with the Climate Scenarios:

- rainfall increase and their variability enhancement;
- increase of the daily rainfall peaks;
- increase of the rain precipitation share;

- snowmelt intensification;
- rain flood overlapping over the melting one.

For the Climate Change impact assessment statistical approach was applied. Analysis shows that around 90% of the mudflows arc formed with the shower involvement. The daily peak of precipitation, mean annual number of rains, quintiles of daily precipitation and mudflow periodicity were selected as the key indicators. Assessment of the changes of the rain-related mudflow periodicity for 29 rivers with the longest observation periods was made on the basis of statistical dependences among selected indicators.

Assessment demonstrated that change of the mudflow risk extent for various altitudinal zones will occur in line with the values of the rainfall change. Numeric evaluations of the rain flood peak (lows 1%-occurrence were made with application the methods developed for the Central Asian region. Calculations illustrated increase of the peak flows of the rain and caused by them the mudflow floods. Small rivers of the low mountain area of Uzbekistan are the most vulnerable ones, where the mudflow formation occurs due to the rare but very intensive rains.

In entire Uzbekistan increase of the mudflow number can be expected by 2030-2050 to 19-24% compared to the current situation, along with the lower increase by 2080 (12-13%). Increase of me mudflow risk period is also expected.

Therefore, the future risks from the mudflow activity on Uzbekistan rivers will increase. Specific danger represent the river plain floods and low river terraces, with potential bank destruction, stream-way deformation, mudflow mass deposit, block appearance and increase of the flood level. *Outburst risk lakes.* Particular catastrophic mud flows are originated when the highland lakes outburst. Territory of Uzbekistan is threatened with 271 lakes of various origins, and their majority is located outside Republic. The largest one - Sarez Lake located in Tajikistan, in the central part of Murgab River (Amudarya River Basin).

In increased water availability years the monitoring of the highland periglacial and rock-dammed lakes is being conducted. Aerial visual observations are carried out in the period of the maximal water mass accumulation in the lakes, and the field ones (Ikhnach and Shovurkul lakes) - in the outburst risky period. Data on the lakes condition are delivered to the MES of Uzbekistan and the other concerned organizations. However, currently, the possibility of aerial visual observations of the outburst risky lakes located outside the Republic depends on the cross-border states (Kyrgyzstan and Tajikistan).

Climate Change impact assessment on the outburst risky lakes showed that increase of the air temperatures in the mountainous area and intensification of the rainfall variability would cause increase of altitudinal limit of the lakes existence, probability of the new lakes formation in the area of the glacial recession will increase along with their outburst danger. In general, the mudflow risk from the lake outburst in the upper mountains will grow.

Measures on mitigation the adverse effects of the floods, mudflows and avalanche arc split into three types:

1. **Organizational measures:**

- Ensuring protection measures when construction the sites in the mudflow and avalanche hazardous areas;
- development of monitoring of the avalanche, mudflows and outburst risky lakes;
- improvement of information warning system, including interstate one, on potential mudflow and avalanche hazard.

2. **Technical measures:**

- protection of the residence and sites from the mudflows and avalanche with the help of hydro technical and avalanche-protection constructions (debris basins, mudflow flumes, tunnels, avalanche-protection galleries, etc.) in the most risky regions;

- preventive avalanche reliese;
- warning systems introduction.

3. **Exploration and plans:**

- development of the large-scale maps of the avalanche and mudflow hazard;
- development/updating of recommendations for the planning institutions and decision makers;
- improvement of the forecast techniques of the hazardous phenomena and warning systems;
- improvement of insurance system.

Existing strategy and specific activities on reducing the risk of the mudflow and avalanche hazard are specified in the Decree by the President of the Republic of Uzbekistan of February 9, 2006 "*On the high priority measures on protection the population and territories from extreme situations associated with the mudflow-flood and landslide phenomena as well as on their consequences liquidation".*

Climate Risk Management

The observations show that in Uzbekistan due to the Climate Change increase of periodicity of the hazardous hydrometeorological phenomena is expected. The Government, state, professional and commercial organizations have to receive the full-scale information on possibility and necessity of mitigation the adverse after-effects of the hazardous phenomena on economy, environment and human health.

The early population warning will reduce vulnerability via implementation of efficient measures on reduction the risk of hazardous phenomena. The National hydrometeorological service of Uzbekistan is responsible for providing the forecast and climatic information, the data on the hazardous phenomena and ensures their prevention and spread**.**

Monitoring of the areas with the high danger of the hydrometeorological phenomena. Currently, NHMS of Uzbekistan is implementing the measures focused on the climate risk management - maintenance and publication of the state cadastres (climatic, water cadastres and hazardous phenomena).

The Annual publication "State cadastre of the areas with the high natural danger". Section: High risk areas in terms of hydrometeorological phenomena" is being issued since 2006 in Uzbekistan for the monitoring of the hazardous hydrometeorological phenomena, assessment of their trends and consequences [6].

This cadastre comprises the data on extreme air temperatures, frosts, heavy precipitation, strong wind, air and hydrological drought, floods, water logging, occurred mudflows and avalanching. This publication comprises also the information on material damage and the other adverse consequences due to the hazardous hydrometeorological phenomena recorded on the territory of Uzbekistan during the recent year. This cadastre maintenance **will** enable making well-grounded decisions when design, construction works implementation, tourism planning and more rational allocation of the agricultural crops cultivation.

Improvement of forecasting and servicing on the basis of the monitoring and scientific research expansion and improvement *is the primary strategy* enabling climate risk management and mitigation of after-effects of the climate-related hazardous phenomena.

More reliable short-term hydrometeorological forecasts for agriculture may assist in on-line water management and improve the efficiency of irrigation water use, and this is one of the key measures of adaptation to the arid climatic conditions.

Agriculture and water management are specifically vulnerable to the Climate Change caprices. In case of the large-scale droughts (combination of abnormal hot weather conditions in vegetation period with the water resource deficiency) - expansive areas are vulnerable to the risk of the crop failure, and this, ultimately, affects the food security of the country.

Early warning system is focused on the early warning on expected drought in order to enable correcting the management of available water resources, including operation mode of the key reservoirs. Local authorities may activate the relevant programs of the effect mitigation. Development and introduction of these systems, including the relevant action plans - *is the second strategy* of the climatic risk management.

Measure enabling improvement of the climatic risk management are associated with capacity building of all NHMS of the region with development of research applying the new forecasting technologies and techniques as well as active exploration of the hydrometeorological processes, with development of information dissemination system.
Specific needs of the capacity building are listed below.

- Development of above-ground system of hydrometeorological surveillance, including the area of the outflow formation located in the cross-border Republics.
- Expansion the network of specialized avalanche stations, establishment of glaciological stations.
- Application and development remote monitoring techniques.
- Renewal of observations over the upper atmosphere in Uzbekistan.
- Improvement of the forecast methods of the weather and hazardous phenomena.
- Active exploration on the hazardous hydrometeorological processes and phenomena.

2. Available Resources/Capability
The Observation Network, functioning on the territory of the Central Asia (Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan) has been developed on the basis of climatic characteristic variability and appeals of economic organizations, ignoring the borders of the country.

Maximum number of hydrometeorological stations and posts were established in 1980-s. Subsequently, number of points and observation extent was decreased (Table 1). However, even in the period of the most intensive development the observation network of Uzbekistan, like those in the Republics of the region, was not enough dense.

Table 1 Change of Number of Hydrometeorological Observation Points

Country / Region	Number of Observation Points			Data % for 1985	
	1985	1995	2005	1995	2005
Hydrological posts					
Uzbekistan	155	128	130	83	84
Central Asia	559	399	277	72	50
Meteorological Stations					
Uzbekistan	93	76	78	82	84
Central Asia	361	282	272	78	75

Owing to establishment of the National hydro-meteorological agencies (NHMA) in the Central Asian states and Kazakhstan, part of hydrological stations and posts, within the jurisdiction of NHMA of Uzbekistan, were transferred to NHMA of Kyrgyzstan, Kazakhstan and Tajikistan. That is why for the period 1991-1998 the observation network of Uzbekistan decreased. Thus, compared to the middle of 1980-s the number of hydrological and meteorological points of observation decreased up to 16%. To the present moment the situation with hydrometeorological points of observation in Uzbekistan has become stable, but is still complicated.

NHMA of Uzbekistan faces difficulties in its efforts to solve tasks on provision of state management organs and branches of economy with the information on the state of natural environment and climate, actual and solicited changes of hydro-meteorological conditions and state of the natural environment, causes of these changes, submitting of extraordinary information in force-majeure circumstances.

Eight posts in Amudarya upper waters and 9 posts in Amudarya upper water, within the jurisdiction of NHMA of Tajikistan and Kyrgyzstan ceased supply of operational hydrological information. Some meteorological stations on the Aral Sea and in the mountainous areas of Tajikistan and Kyrgyzstan were closed. The situation with snow-metering observations in the mountains, essential for assessment of water resources of the region, worsened and is poor now and for the future perspective (Table 2).

Especially disastrous situation occurred regarding the observations on small rivers. Observations over the regime of dried rivers in low mountain zones are not carried out, and such a situation is observed in the majority of small rivers. At the same time, these rivers are good indicators of climatic and anthropogenic changes.

Table 2 Change of Number of Specialized Observation Points in Uzbekistan

Years	Actinometric Stations	Agro-meteorological		Evaporation from water surface	Observation over snow cover		
		stations	posts		on river basins	ground points	aero-visual points
1975	7	68	10	22	13	161	141
1980	7	74	17	22	11	121	244
1985	7	77	28	23	5	41	282
1990	7	66	32	25	3	31	302
1995	6	60	26	20	3	22	233
2000	6	62	26	16	2	12	153
2005	6	61	30	10	2	12	138

NHMA of Uzbekistan does not have enough funds for construction and repairing of post devices on hydrometric posts and for maintaining them in a due working state. Annually only part of posts are repaired, which demand capital or preventive repair. Therefore, in result, there is urgent need in undertaking measures directed to improving the situation, and this is out of power of any state of the Central Asian region. So, it is necessary to unite the efforts and power, supported by the international community aid.

<u>Information needs and gaps</u>

1. Disadvantages ground monitoring network

In Central Asia, is insufficiently developed system of ground observation network of hydrological objects that pose a threat, especially this fact is important to consider the cross-border effects of hazardous hydrological phenomena. As indicated above, the breakthrough of glacial lakes, the occurrences of mudflow occur in one country, but the **effect is manifested in the neighbouring countries** and leads to significant damage. At the same time to monitor the country is not economically profitable, since the observing system expensive.

In this regard, it needs to develop monitoring systems, having a structure of cooperation between the countries. In this regard, regional cooperation under the umbrella of international organizations is of great perspective and desperately needed.

2. Communication links between the countries
In Central Asian countries are now the communication system is based on **telephone transmission lines**. In this case, the system alerts when a hazard is too slow relative to place hazards. There is great risk that the alert system using a telephone connection may be too late for timely action. Moreover, the very phone lines may be disrupted as a result of the impact hazard. In this regard, it is imperative to establish exchange of information through the satellite system of information exchange with the study of technical issues.

Be taken into account **language barriers** between countries. Information exchange system should be a unified system of coding and common symbols to enhance the efficiency in information sharing. For damage assessment and appropriate action is necessary to develop warning systems through the Internet line as a network. In this case, the information will be distributed even when breaking a line.

3. High resolution satellite images with real time access
In Central Asia there are many potentially dangerous and developing objects - glacial lakes and outbreaking lakes, and monitoring are difficult because of inaccessibility. Objects themselves are often small in size but have an enormous potential threat in the event of their destruction. Dammed lakes have a dynamic character in time.

In the single case dammed lake has its own dynamics as changes in volume and corresponding area of the mirror. There are also systems moraine lakes formed by large glaciers. Mode of existence of such a system of lakes depends on the regime of the glacier. In this case, the system of lakes may change dynamically over time. Some lakes can disappear in consequence of the increased filtration through the detrital material, and other Lake melt water can accumulate with the subsequent risk of a breakthrough. System monitoring of glacial lakes to the Central Asian countries need access to **high resolution satellite images for early prediction** of the risk of a dangerous situation. Satellite imagery has the advantage that they can be used to monitor hazards **to neighbouring countries.**

Priority needs at the Subregional level (two or more countries) for addressing common problems.
The main priorities between the countries are the rapid exchange of information on the origin and development of emergency situations using information-switching technology.

Example - the existence of enclaves in the **Fergana Valley**. For example Shakhimardan River - Zone of the formation of glacial lakes located on the territory of Kyrgyzstan, downstream is the territory of Uzbekistan, on the river bed Shakhimardan again passes through the territory of Kyrgyzstan and then re-channels the river runs into the territory of Uzbekistan. Thus the impact of one process is at risk for the two countries simultaneously.

Breakthrough of the slide-rock **Sarez Lake**, located on the territory of Tajikistan is potentially dangerous not only for Tajikistan but also for Afghanistan, Turkmenistan and Uzbekistan.

Installation of the system for exchange of operational information between countries on the basis of new technologies to reduce the risk of exposure to hazardous processes.

Synopsis of priority needs of Uzbekistan national and Sub regional levels
Geterogeneity of huge amount to information and diversity of interrelations between scientific, economic, social and political issues determine challenges and gaps in process of receiving of exact and internationally comparable data.

In Uzbekistan, the basic source of indices is official state statistics, the area facing hindrances as to providing time continuity and stability of key indices statistical data. There occurs an urgent need in improving and expanding of statistical account of such indices as GDP in internationally comparable prices, GPD by the parity of purchasing power; population mortality from deceases, which directly or indirectly relate to climatic factors etc.

It is necessary that statistics register annual data on damage caused to agricultural production by negative effect of extreme weather conditions; statistical reporting should be provided on tourist sector development; access should be granted to data *on* registration of individual vehicles etc.

What would be the affect of Climate Change in the nearest future to the environment and economy, infrastructure, and health in Uzbekistan? What adaptation measures are to be taken first of all upon occurrence of dangerous changes in the environment? This depends on the scale of impact and the adaptation capacity of the environment, socioeconomic sectors and population of the country. Answers to these questions depend on the degree of elaboration of knowledge of all socio-economic sectors.

The basis for examination and scientifically substantiated assessment of Climate Change impact is represented, first of all, by the adequacy of the system of climate observation (correspondence to principles of climate monitoring) and second, by presence of "non-climatic" socio-economic data, upon which any sectoral assessment and analysis of adaptation measures are based. Often impact of Climate Change is not unequivocal, that is why before undertaking an adaptation measure it is necessary to assess potential damage from Climate Change and to correlate it to the cost of development and implementation of such a measure. So, submission of data on the current and future damages from Climate Change in diverse socio-economic sectors is an obligatory condition for approving a strategy of adaptation to Climate Change.

Systematic Climate Observations. To receive authentic data on climate it is necessary to create an adequate system of observation and data collection. In Uzbekistan, there is the basis for performing the Convention obligations related to systematic observation, however, supplementary development of capacity (materials and technical support, improvement of management, in-service training of experts) is needed.

Gaps and Seeds. Economic reasons, that caused shrinking of the observation network, affected provision of the hydro-meteorological network with devices, gauges and equipment while Uzbekistan lacks sufficient funds for re-organization and development of the network. First of all, it is necessary to restore observations in agrologic stations, to improve technologies of information collection and storing, and in separate cases - to save data, and to establish data bases, appropriate to the modern requirements, including easing of access to information.

It is necessary to synchronize diverse international initiatives on strengthening of observation networks and on developing of interrelation between the states of the region. The developed Regional Plan of Action on Global System of Climate Observation (GSCO) for Central Asia regarding restoration of the work of high-mountain stations in the Aral Sea basin actually still remains only written on paper. Efficient forecasting of run-off of Syrdarya and Amudarya rivers lacks hydro-meteorological information from formation zone, as well an adequate long-term assessment of water resources considering Climate Change. Exchange of regional data and historical observation series between the neighboring countries faces some difficulties.

It is necessary to establish regional climatic database, including long-term (not less than 30 years) homogeneous series of observation of different parameters (meteorological, hydrological, and glaciological) for the whole basin of the Aral Sea. The objective for establishment of such database is revealing of climatic changes, profound assessments of impacts for both, the whole region, and for separate stales, provinces, geographic districts, river basins.

Son-climatic Data" (socio-economic data, data on the state of environment). Shortage and inaccessibility of authentic socio-economic data from diverse sectors made it difficult to make an assessment on vulnerability to Climate Change and analysis of adaptation measures.

In process of vulnerability assessment, difficulties were faced relating to the socio-economic data in the following sectors/spheres: development of socioeconomic scenarios, water resources in the zone of run-off distribution, agriculture, eco-systems, population health, dangerous and extreme phenomena related to the climate.

Practically in every sector information was deficient, data on economic damage was actually absent. Moreover, vulnerability indices and criteria have not been sufficiently developed, both, sector based and integrated ones, which did not permit to perform a complete analysis and assessment of adaptation measures.

Examination and assessment of "impact-reaction-damage-selection of measures" sequence should be based upon factual data, differentiated by the sectors, territories, separate natural and anthropogenic objects. In view of this, it is necessary to develop recommendations, schemes and mechanisms of submission of socio-economic data, essential for assessment of Climate Change impact, including information on economic damages from dangerous natural calamities to Uzgidromet, an organization responsible for fulfilling of commitments under the Framework Convention.

Development and introduction of international standards for statistical reports taking into account assessment requirements will allow to assess vulnerability of Uzbek economic sectors to Climate Change in a more reliable and authentic way and to develop more convincing adaptation measures.

In Uzbekistan, internal sources for research funding are insufficient, and implementation of majority of international projects do not imply long-term support of research activities.
However, research works on issues of Climate Change are essential to solve a lot of tasks:

- analysis of social, ecological, and economic consequences of Climate Change; risks assessment;
- distribution of continuously updated information on issues of Climate Change;
- development and implementation of early-warning system to forecast dangerous calamities, related to climate (draughts, thermal waves etc.);
- development of ecological education programs to involve people in solving of the problems of Climate Change, and development of appropriate social behavior;
- maintaining of specialized training on he appropriate level (ecological, hydro-meteorological, agro-climatic etc.);
- determination of costs and benefits of potential measures, development of adaptation projects, and involvement of additional resources through international cooperation.

Droughts. The assessment of vulnerability and analysis of adaptation measures to such increasingly frequent phenomenon in Uzbekistan as drought have demonstrated that the major gap in this area is lack of information on its impact on socio-economic aspect due to the fact that no large-scale and catastrophic drought have been observed in Uzbekistan. Periodical seasonal drought has been mitigated through regional water resources management in the interest of irrigation in the lower reaches of the rivers. However, increasing range of fluctuation of precipitation during the last decades, intensive warming, increased water consumption and change in the functioning regime of water reservoirs in the riverheads of the Syrdarya and Amudarya Rivers (the priority was given to the Energy Sector), have significantly increased the drought risk, especially in the lower reaches of the Amudarya River Basin. The drought of 2000-2001 became an evident example of the phenomenon.

The main conclusion made as a result of vulnerability assessment is that the phenomena such as drought of 2000-2001 will occur more frequently with prolonged duration. In this regards, the following questions come up: what is the size of the territory that the phenomenon could affect; what would the consequences be; what measures arc required for mitigation of consequences? In order to answer these questions, it is required to expand the hydrometeorological monitoring, conduct research in relevant fields and develop organizational measures. The major needs in the capacity building of research that arc directly related to impact assessment and adaptation measures include:

- improving hydrometeorological monitoring;
- improving droughts forecast methods;
- conducting socio-economic consequences assessment with differentiated territory information;
- developing programs and plans of action aimed at drought prevention and risk reduction for agricultural sector (ensuring preparedness for extraordinary situations liquidation, mechanisms of information dissemination on drought warning in the provinces, population and administrative organs preparedness); and
- developing the drought early warning system;
- insuring the drought consequences.

There is a need for institutional strengthening -establishment and functioning of the drought monitoring centre; and political measures -identifying the joint trans bound a ry concept of water use in the conditions of the expected drought on the regional level and improving water resources monitoring.

Freshets and torrents. According to conducted assessment, due to the Climate Change, it is expected thai the number of events will increase while the duration of hazardous periods will extend. The bottom lands of the river and low river terraces are especially dangerous due to the possibility of shores destruction, rivers beds deformation, mudhow mass deposit and occurring of gorge phenomenon.

Outburst risky lakes. Currently. 271 lakes of various origins threaten the territory of Uzbekistan. The largest out of them is the Sarez Lake. Due to warming, the mudflow hazard after lake outburst in the upper mountainous zones increase.

Avalanches. On the average, according to conducted assessments, the avalanche periodicity in Uzbekistan and avalanche risk period duration due to the Climate Change will have the minor decrease by 2050, which means that the avalanche risk remains.

Risks depend on probability of the hazardous phenomena, their demonstration extent, territories where they are observed, available sites and population size in each hazardous region. When development the mountainous areas the natural risks associated with the mudflows and snow-slides increase. Assessment of the location of periodicity and volumes of consequences of the hazardous and extreme phenomena is one of the priority objectives due to the Climate Change.

Since it is not possible to completely avoid the natural risks associated with the floods, mudflows and snow-slides, the needs of capacity building for assessment the vulnerability and adaptation are linked with prevention (non-admission), impact mitigation (protection) and damage division (insurance). The needs of the risk assessment for the floods, mudflows and snow-slides include identification of the hazardous areas, probability of events and duration of the hazardous period. The types of activities requiring the gap filling and capacity building are listed below:

- Analysis of the current variability of extreme hydrometeorological phenomena (probability of occurrence, duration of hazardous period by the territory) and their after-effects for vulnerability assessment.
- Future risk assessment in line with the Climate Scenarios and application of the advanced methods and tools.

- Development of the large-scale maps of the current and future risk for individual phenomena in line with the needs of the sectors (construction, transportation, recreation area, etc.) for identification the high risk areas.
- Assessment of potential of the hazardous phenomena risk reduction via improvement of forecasting and warning.

The goal of vulnerability assessment deepening and adaptation in the sector is to identify potential probability for the risk reduction and elimination; identification of priority activities, implementation of identified measures and mitigation of the natural disaster consequences.

At the national level for countries of Central Asia should be expanded use of information and communication technologies. In some countries have a databases and information systems, but completely lacking operating system with access via the Internet, that in some cases difficult to carry out operational monitoring for eliminating manifestations of dangerous disasters. Developing information systems for water-related disaster prompt access via the Internet will allow the countries of Central Asia

At national level:

- provide timely information to all interested users
- more accurately determine the degree of risk and spatial distribution of hazards
- quickly and accurately identify the needs for emergency response
- determine more accurately the social and economic losses from the manifestation of Emergency

At the sub-regional level:

- raise awareness of the bordering countries on the extent of manifestation of an emergency
- increase the availability of neighboring countries to adopt appropriate preventive measures
- improve the management system in the aftermath and to reduce socio-economic losses

At the national and regional levels need access to operational satellite data. That will more accurately predict the manifestation of water-related disaster and depend on extreme weather events.

For processing satellite data using GIS technology to education and training for personnel of national administrations to improve the reliability and timeliness of services.

Recommendations to address these needs at the national level

At the national level needs

- To develop and improve of information and communication technology on the basis of modern GIS and satellite data
- Creating Web sites with information on floods, mudflows, glacial lakes with a wide access via the Internet
- Creating a satellite monitoring systems on existing practices in the region
- Meetings and conferences with participation of specialists concerned ministries and agencies to share experiences and practical lessons
- Training for young scientists and specialists

18. Vietnam

1. Issues and Needs

1. Issues related climate system - water cycle - water use

- *Regionally common issues - identify which of the common issues are relevant to your country:*
    - Vietnam is the one of most countries affected by climate change. That why, the important issues for Vietnam are:
        - ✓ intensification of variability (heavy rainfall and dry spells), cyclones
        - ✓ frequency of extremes: flood (localized + social)and drought
        - ✓ seasonal climate pattern (precipitation, dry and wet, maxima,)
    - The lack of capability: climate change assessment and adaptation at river basin scale/ regional scale.

- *Describe critical and specific issues in your country, include more details:*
    - Land slides / flash flood often occur in the country with 2/3 total area covered by mountains/hills.
    - Sea level rise, salinity intrusion and urban inundation are crucial problems for Vietnam under climate change affect.
    - Hydropower development affect to hydrological regime and water use in all river basins.
    - Trans-boundary and international coordination (Mekong River and Red River) also need to focus on.
    - Exists national target program to respond to climate change and adaptation, but there are limitations in financial and human resources for this programme implementation

2. Issues related to Water Nexus: agriculture, energy, health – water quality, biodiversity, and ecosystem

A. Introduce issues related to Water Nexus in your country and identify two directions (see the example below):

1. Water and Climate Change affect each Socio-Benefit Area (SBA)

2. Each SBA affects water and environment

B. Introduce on-going projects and programs related to Water Nexus in your country

SBA	CC, Water, and Environment
• Agriculture:	←Sustainable Land and Forest Management, 2010-2013, $2300000, UNDP, Review and formulate policies, policy instruments and procedures for reducing forest degradation through carbon financing. Improve the management of degraded forests to protect and enhance carbon stocks and reduce GHS emissions.
• Energy:	←Barrier Removal to implement cost effective Energy Efficient Standards and labeling (BRESL) (2008-2012), $1000000, UNDP ←Phasing out Incandescent Lamps through Lighting Market Transformation in Vietnam (2008-2014), $10975000, UNEP/GEF ←Energy Efficiency Improvement in the Public Building in VN (2010-2014), $2000000, UNDP/GEF ←Sector Budget Support to NTP: Mitigation Component, (2009-2014), Denmark/ODA , ←Vietnam Renewable Energy (P103238), (2009-2014) $ 239400000, WB
• Urban:	← Megacity Research Project Ho Chi Minh City (2009-2014), funded by Germany/ODA, to derive adaptation options for urban land use planning in HCMC as a response to climate change. ←Hanoi Urban Transport Project (P085393), 2007-2013,

$9800000, WB/GEF

- Disaster Management — ← Disaster Risk Management portfolio (2009-2012)-$4000000, funded by UNDP, Strengthening of Emergency response mechanisms, improving institutional setting for complex emergencies. Capacity building for senior officials and humanitarian workers and volunteers.

- Ecosystem and Biodiversity: — ←Management of Natural Resources in the Coastal Zone of Soc Trang Province (2007-2012), $4500000, funded by Germany/ODA, The coastal wetlands of Soc Trang Province will be protected and sustainably used for the benefit of the local population.

C. Respond to each of the following questions by considering water and climate change specifically for your country:

- *How can we address seasonal variability at national level?*

Using National Target Programme (NTP) to address seasonal variability at national level.

- *How can we manage water resources in proper way between upstream and downstream and among different sector uses: hydropower, irrigation, water supply?*

We need national coordination from government by concrete rules or law for water resources use, management and sharing; establish reservoir operation rules for flood and dry seasons; international or bilateral data cooperation and sharing for trans-boundary river basins.

- *How can we give the right information to these different sectors? They are demanding for more customized climate information?*

Using NTP with standing office providing neccesary information to related sectors.

- *How can we adapt the design criteria to changing characteristics and magnitude of water hazards, e.g. for new drainage?*

We need run or test several scenarios with appropriate modeling tools.

- *How can we share the data to the different sectors beyond laboratories?*

We need data sharing agreement or contract between providers and users, depending on the purpose of data use.

3. Needs for functions and/or tools of WCI to address the identified issues

Specify needs for your country:

- *Observations:*
  - in-situ telemetric network (mountain areas): need equipment, software, database and training for telemetric system
  - remote sensing (satellite, radar) currently and in future: how use satellite, radar data in hydrological modeling or forecasting, water resources management and disaster reduce.

- *Data Access*
  - satellite data access (operationally coupled with in-situ near real-time data): Need not only satellite raw data but also the tools/software for interpreting and using these data sets effectively.
  - global data access (Numerical Weather Prediction, Reanalysis, Climate Projection)

- *Models*

  for flood/inundation forecasting, water quality

- *Management systems*
  - *Forecasting*
  - *Early Warning*

- *Decision support*
  - ✓ *National/local government (climate proofing, urban management, risk reduction measures, adaptation strategies)*
  - ✓ *community-based* at village level for disaster management/prevention/reduction

- *Platform for sharing data and knowledge and exchanging ideas and experiences*

  Based on WMO standard data sharing and exchange

4. Needs for collaboration framework at the national level: inter-agency, interdisciplinary
Please introduce existing activities and what kind of activities/framework is needed in your country with regards to each of the following points:

- *We need to show a holistic view of water and climate change and their impacts on water nexus to all the stakeholders through sharing data and information, exchanging ideas and experiences, and working together*

.-> need establish modern hydro-meteorological data and information center

- *We need a well-organized interdisciplinary and inter-sectoral body at professional- and/or policy making- levels by involving academia and civil societies*

-> improve and strengthen institutional capacity of govermental and sectoral organizations related to water and climate change.

- *We need to implement demonstrations and exchange good (failure) practices through regional conferences/workshops.*

->Implement projects like using satellite data for disaster reduction; Urban flood risk management among TC members with pilot cities (Hanoi, Malina, Hatsai) and good practice in China, Japan, Korea Republic.

- *We need criterion to maintain data quality, at least for rainfall, water level and hopefully river discharge and technical standards to design infrastructures in terms of water.*

->Data exchange between Mekong River Commission Member countries in Mekong basin, between Vietnam and China in the Red river basin; DIAS system of AWCI.

2. Implementation proposal

1. Please describe Steps and Strategy following the three approaches:

For Vietnam, there are 2 proposals (2012-2014):

- Comparative study on monitoring scheme of river water quality taken in consideration of water balance among different watersheds in Asia, lead by Prof. Hiroaki FURUMAI, UT
- Urban Flood Risk Management considering impact of climate change, lead by Typhoon Committee

Framework development approach – describe desirable framework in your country

- Demonstration design ←→ infrastructure integrity
- Introducing legislation→high level coordination body→research promotion→Improvement of awareness→private sector involvement
  - Design, develop and complete proposal project
  - Submit to Ministry for approval
  - Approved from govermental authorities (Middle 2012)
  -

Strategic approach

- *Showcase: intention, background, objectives, collaborations, achievements with accuracy and feasibility, benefits to other sectors, interest → involvement one by one starting with existing inter-agency collaborations)*
- *Demonstrations → regional and general commonality*
- *Expansion of the AWCI demonstration studies to a whole region → sharing experiences →a holistic understanding and technology.*
  - Detail describe project proposal
  - Management matrix for execute proposal

Technical approach – propose a technical approach considering your target basin/country
Monitoring→understanding→Climate change assessment including downscaling, bias correction→detail assessment→model→demonstration→ mainstreaming→ creation of regional knowledge

- Consideration of all necessary and available methods, techniques for proposal implementation

- Applied approriate methods, techniques depending on data availability, financial and human resources
- First proposal applied for Huong river basin from 2012-2014
- Second proposal applied for Hanoi city (2012-2014)

2. Additional resources – suggestion of potential collaborators

- *Please identify local, national, regional, and worldwide (including UN) collaborators in the field of research, operation, administration, financial and human resources supports. Please fill the matrix:*

Collaborators ----------- Field	Local	National	Regional	Worldwide
Research	- Hue University - Hanoi Water Resources Institute	- Institute of Hydrology, Meteorology and Environment - Institute of Water Planing - Research Institute of Water Rerources	- ICHARM - PWRI - Univercity of Tokyo - AIT	- DHI – DELFT
Operation	-Hue Provincial Hydro-Met Centre	- National Hydro - Met Service - National Remote Sensing Centre	- Mekong River Commission Secretariate - JAXA - NASA, NOAA	- WMO - TC - UN IHP - UN ESCAP
Administration	- Provincial Flood andStorm Control Committees	- National Flood and Storm Control Committee - MONRE	- Regional Hydro-Met Centres	- WMO - UN
Financial res.	- Provincial fund	- Ministries funding - National invest	- NDF (Nordic Development Fund) - UN ESCAP	- WMO - UNDP - WB
Human res.	Provincial, institute, university	- National Hydro - Met Service - Institute, University	- AIT - MRCS	- DHI - UT - UNESCO

- *Mainstreaming water and climate change within the national policy by getting supports from water nexus. Please describe mainstreaming strategy suitable for your country.*

  Identify national sources and present requests for technical cooperation, including that related to technology transfer and know-how, with international organizations and donor institutions should formulate requests in the framework of long-term sector or subsector capacity-building strategies. Strategies should, as appropriate, address policy adjustments to be implemented, budgetary issues, cooperation and coordination among institutions, human resource requirements, and technology and scientific equipment requirements. They should cover public and private sector needs and consider strengthening scientific training and educational and research programmes, including such training in the developed countries and the strengthening of centres of excellence in developing countries. Country could designate and strengthen a central unit to organize and coordinate technical cooperation, linking it with the priority-setting and resource allocation process.

3. Specific request to GEOSS and to international community (data/tools accessibility)
Describe in a concrete way and specifically for your country needs:

- *Inventory and summary directory – what kind is needed in your specific case:*
  Establishment of the Regional Climate Centres (RCCs)
  Reliability of quality control procedures applied on collected data
  Automatic data reception, decoding and archival; automatic data visualization; and automatic data processing
  Monitoring and warning systems for drought

- *Data request function responding to new needs – what kind of function:*
  Operational access to NWP products from major centres. 24/7 production and dissemination of basic and specialized NWP products under emergency situations
  Real-time reporting of hydrological data from networks including from remote stations

- *Data access and information exchange:*
  Promotion and strengthening of the principle of free and unrestricted international exchange of data, information and products

- *Models and Tools: analysis, prediction, early warning, risk assessment, decision support – what kind for what purpose:*
  Models/tools for flood/innudation prediction
  GCM –models temperature/precipitation for hydrological models
  Use Ensemble prediction tools (long/short term)
  Statistical tools from seasonal climate predictions to shorter time-scales….need to develop new statistical methods accounting for non-stationary…..

- *Regional office and/or data center – what kind of function you expect for the office:*
  Data sharing and exchange, especially for trans-boundary river basins.
  Access and use of e-learning materials

4. Coordination between water cycle integration and capacity development strategy

- Identify contents of capacity development needs in your country:

- Improved downscaling techniques
- Developed a Strategy Document for Distance Learning

- Introduce existing and on-going activities and the needs and support related to these five items:

- *Synchronize capacity development with national implementation programme coordinated by the regional programme.*
  National Target Program to respond to climate change.

- *Training for not only researchers but also practitioners from top level to operator/technician's level, with appropriate standards depending on the level (various kinds of training) including trainer's training to be followed by practice and identify it as a postgraduate program in collaboration with international educational framework (e.g. UNU, UN-CECAR).*
  Continuous education programmes and refresher courses for staff, as well as management training (including strategic planning) for mid- and high-level personnel

- *Short term capacity development workshops on specific observation and modeling skills and medium to long term supports to regional resource centers.*
  GCM –models temperature/precipitation for hydrological models

- *Coordinate with national and regional centers of excellence (ex. WMO centre in Hanoi on WR)*
  AIT and Water Resources Institute, Institute of Hydrology, Meteorology and Environment (IHME)

- *Organize capacity development workshops in each country for the agencies involved in the project at national level on the WCI implementation. Identify agencies and participating organizations for making such an opportunity.*

Maintenance/implementation of a structured training plan for professional, technical and supporting staff. Continuous education programmes and refresher courses for staff, as well as management training (including strategic planning) for mid- and high-level personnel