Nile Basin Initiative

Eastern Nile Technical Regional Office (ENTRO)

Nile Cooperation for Results (NCORE)

Climate Risk Assessment Study

Consultancy Service

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Assessment of Current Situation

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Summary

The overall objective of this study is to develop and operationalize an analytical framework for integrating climate risks into the process of investment planning and management of the EN water resources. The first task towards this objective, described in this report, is system assessment of the current situation in the Eastern Nile basin, including assessment of information, institutions, and infrastructure.

The investment of Renaissance dam and hydropower project is the most significant development project in the Nile basin since construction of the High Aswan Dam in the 1960s. Hence for this study to remain relevant to current developments in the basin, this project is an obvious choice to include in our analysis. We chose to focus on the Blue Nile sub-basin defined by the total area draining through Khartoum. The system performance indicators will include: (i) Rain-fed agriculture in Ethiopia, (ii) Hydropower generation in Renaissance, (iii) Irrigation agriculture in Sudan, (iv)Hydropower generation in Rosaries, and (v) Contribution of the flow in Khartoum to the water supplied to Egypt. These selections were presented and discussed in the regional workshop organized in Ethiopia in February 2014.

Little is known regarding the future of the climate and hydrology in this basin. In particular, the 4th assessment report presents an uncertain picture about the future levels of rainfall and river flow in the Blue Nile. Models disagree even in the sign of the projected change. The more recent 5th assessment report updates the projections about climate change, however; still the level of uncertainty about the future levels of rainfall and river flow in this region remains high.

The collection of system models available at ENTRO are reviewed and assessed. We conclude that these models represent a adequate and suitable set of tools for conducting a range studies on climate impacts and water resources planning. The only suggestion for complementing this system of models is to add a regional climate model that can be used for dynamical downscaling of global projections from Global Climate Models (GCMs) to produce specific regional impacts relevant to the Eastern Nile.

The assessment of the current state of the institutional capacity in the Eastern Nile countries is carried based on the consultation in February 2014 workshop. Stakeholders, existing capacity, gaps in capacity, coordination level, and future strategies are identified and assessed based on responses to a questionnaire distributed to water resources and climate experts from the region.

The key input for any serious assessment of the current and future demands in the countries of the Eastern Nile are population statistics, their growth rates, economic activity and the associated growth rate. Based on considerations of these statistics, we assess the current level of water-related demands in the Blue Nile sub-basin as they relate to the five system indicators outlined above. Such analysis is necessarily approximate since projections of future demands are uncertain and hard to make with any confidence, especially at long-range climatic time scales.

In the past ENTRO has been a leader in addressing the issues of climate variability and climate change as they relate to the water sector in the Eastern Nile basin. There seems to be an urgent need and ripe opportunity for ENTRO to develop a major program on capacity building and coordination of efforts on issues of water and climate between key stakeholders in the countries of the Eastern Nile, at national and regional levels

1. Introduction & Background

The overall objective of the study is to develop and operationalize an analytical framework for integrating climate risks into the process of investment planning and management of the EN water resources. Such analytical framework for Climate Risk Assessment (CRA) could be used to guide water related investment in the EN and form the basis for climate screening for investment project and provide guidance to the development of climate smart strategies.

The specific objectives of the consultancy are:

(i) Customize the proposed Climate Risk Assessment (CRA) Methodology for the EN, with a set of Adaptation and Mitigation measures integrated as part of the show case to illustrate the effectiveness of the proposed methodology in promoting climate smart planning and climate resilient growth.

(ii) Address challenges facing the operationalization of the proposed framework, identify and prioritize future strategic directions for designing climate smart measures in the EN.

(iii) Strengthen the capacities of the EN national & regional institutions and their abilities to use the proposed analytical framework for climate risk assessment, as means for integrating adaptation and mitigation measures as part of the planning process.

(iv)Develop climate smart development strategies incorporating, interventions, impacts on indicators and prioritized options. This will be undertaken through assessment of current situation (information, institutions, infrastructure), identification of system sensitivity to historic conditions, establishing planning framework and carrying out capacity building and regional consultations at key stages of the study.

The first task towards these objectives is system assessment of the current situation in the Eastern Nile basin, including assessment of information, institutions, and infrastructure.

2. Information Assessment

2.1 System Definition, and Performance Indicators

In assessing information, we first define the system to be considered. This issue was discussed during the first visit of the consultant to ENTRO, and further discussed during the consultation workshop in February 2014. Our initial considerations of the current state of the Eastern Nile system suggests a focus on the Blue Nile sub-basin defined by the total area draining through Khartoum. The investment of Renaissance dam and hydropower project is deemed to be a reasonable candidate for analysis compared to any other option. This is the most significant development project in the Nile basin since construction of the High Aswan Dam in the 1960s. Hence for this study to remain relevant to current developments in the basin, this project is an obvious choice. The system performance indicators will include:

(1) Rain-fed agriculture in Ethiopia,
(2) Hydropower generation in Renaissance,
(3) Irrigation agriculture in Sudan,
(4) Hydropower generation in Rosaries, and
(5) Contribution of the flow in Khartoum to the water supplied to Egypt.

All five indicators will be considered within the system defined above. As part of this assessment exercise we will focus on historical climate variability as characterized by (rainfall, river flow and temperature), as well as future conditions of the same variables predicted by the current generation of climate models.

The selections of the system/investment/performance indicators define a specific case study that can be used to illustrate and operationalize the CRA methodology. This illustration and operationalization are important aspects called for by the objectives of the study. Following this step, extensions of the application of the methodology to other sub-basins, to other investments, and to other performance indicators should be feasible, using in-house resources available to ENTRO and regional institutional capacity. The stated selections were presented and discussed in the regional workshop organized in Ethiopia in February 2014.

2.2 Existing Knowledge base about Climate in the Blue Nile Basin

In this section, we would like to examine the status of the existing knowledge base and identify obvious knowledge gaps and strategies to address them; in particular, relative future climate projection data. The Blue Nile basin is one of the best-studied hydrologic systems.

Historically, sufficient knowledge has been gained about river flow and the associated runoff processes based on flow-gauge observations. Limited knowledge is available about rainfall from rain-gauge network, and more recently from satellites. In general, evapotranspiration is the least know variable in the hydrologic cycle of the Blue Nile basin.

Little is known regarding the future of the climate and hydrology in this basin. In particular, the 4th assessment report presents an uncertain picture about the future levels of rainfall and river flow in the Blue Nile. Models disagree even in the sign of the projected change. The more recent 5th assessment report updates the projections about

Model	Description
(1) RIBASIM (River Basin Simulation Model)	RIBASIM (River Basin Simulation Model) is a generic modelling package for simulating the behaviour of river basins under various hydrological conditions.
(2) RiverareW	RiverWare contains a flexible modelling environment that uses both an object-oriented workspace environment and rule-based policy language that allows a robust simulation of complex operational decisions and policies that govern the management of reservoir systems.
(3) Eastern Nile Multi-Purpose Optimization System (ENMOS)	This modelling tool is developed in house by ENTRO professionals, with the support of World Bank and University College of London specialists, uses GAMS optimization software linked to an Excel Interface for inputs and outputs.
(4) SWAT (The Soil and Water Assessment Tool)	SWAT is a semi distributed hydrological model which is simple, flexible and robust enough to be applied for different scale basins. It is an open source model and has been widely applied worldwide to develop water balance models.
(5) Hec-ResSim (Reservoir simulation model)	Hec-ResSim is used to model reservoir operations at one or more reservoirs for a variety of operational goals and constraints. It simulates reservoir operations for flood management, low flow augmentation and water supply for planning studies, detailed reservoir regulation plan investigations, and real-time decision support.
(6) HEC HMS (Hydrologic Modelling System)	HEC-HMS is designed to simulate the complete hydrologic processes of dendritic watershed systems. It includes many traditional hydrologic analysis procedures such as event infiltration, unit hydrographs, and hydrologic routing as well as procedures necessary for continuous simulation.

Table I: System Models available at ENTRO climate change, however, still the level of uncertainty about the future levels of rainfall and river flow in this region remains high.

2.3 Existing System Models

In this section, we would like to examine existing systems models at ENTRO developed to analyze the system - such as water simulation models & rainfall runoff models, etc. Initial work on this study regarding assessment of knowledge was carried in November 2013 through direct interactions between the consultant and ENTRO staff. The sets of models, climate information and tools, available at ENTRO were presented and discussed. These are summarized in the following table. This collection of models represents an adequate and suitable set of tools for conducting a range studies on climate impacts and water resources planning.

The only suggestion for complementing this system of models is to add a regional climate model that can be used for dynamical downscaling of global projections from Global Climate Models (GCMs) to produce specific regional impacts relevant to the Eastern Nile.

2.4 Climate Information Portal

In this section, we would like to examine the climate information and tools available in the ENTRO portal. The following figures describe the Nile climate analysis tool and one application example. Upon user request the result of the selections made in the window displayed in Figure 1 is displayed on the map and on a separate graph, as shown in Figure 2.

The only suggestion for improving this system is the extension of the system to provide the same information broadly to all stakeholders in all countries of the Eastern Nile, through the use of modern information technology and the Internet.

3. Institutional Assessment

3.1 Stake Holders, their Capacity, and their level of Coordination

The assessment of the current state of the institutional capacity in the Eastern Nile countries is carried based on the consultation and questionnaire distributed in February 2014 workshop (See Appendix), and of close examination of the draft documents produced by the Joint Multipurpose Project (SSEA, WP1, WP2). The objective of this institutional assessment is to define:

(1) Key stakeholders in each country who are commissioned or expected to carry CRA in the context of water resources planning and management,

The Nile climate Analysis tool provides information related to climate offered by the Climate Wizard (Washington) specifically for the NBI. The Climate variables, Measurement types, Emission scenarios, GCMs and Ensembles, provided are shown below.

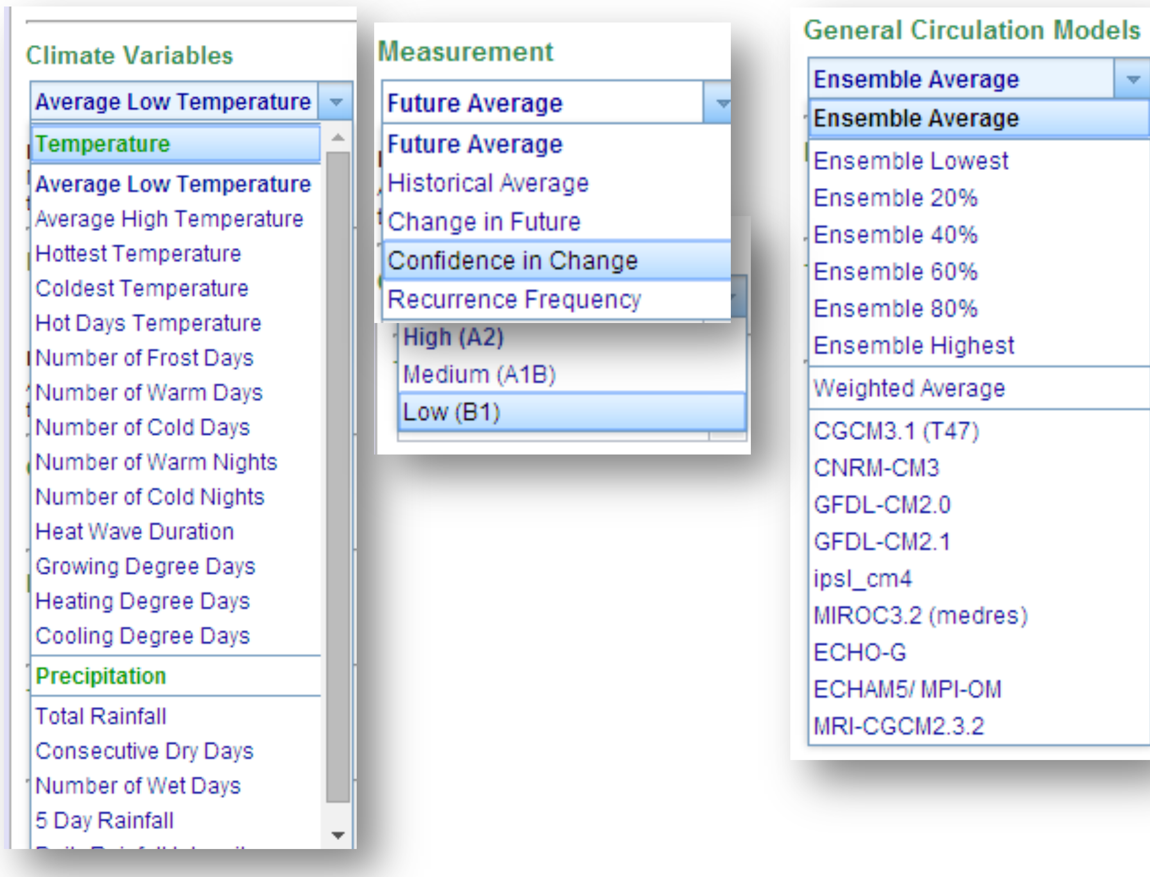

Figure 1: Nile Climate Analysis Tool.

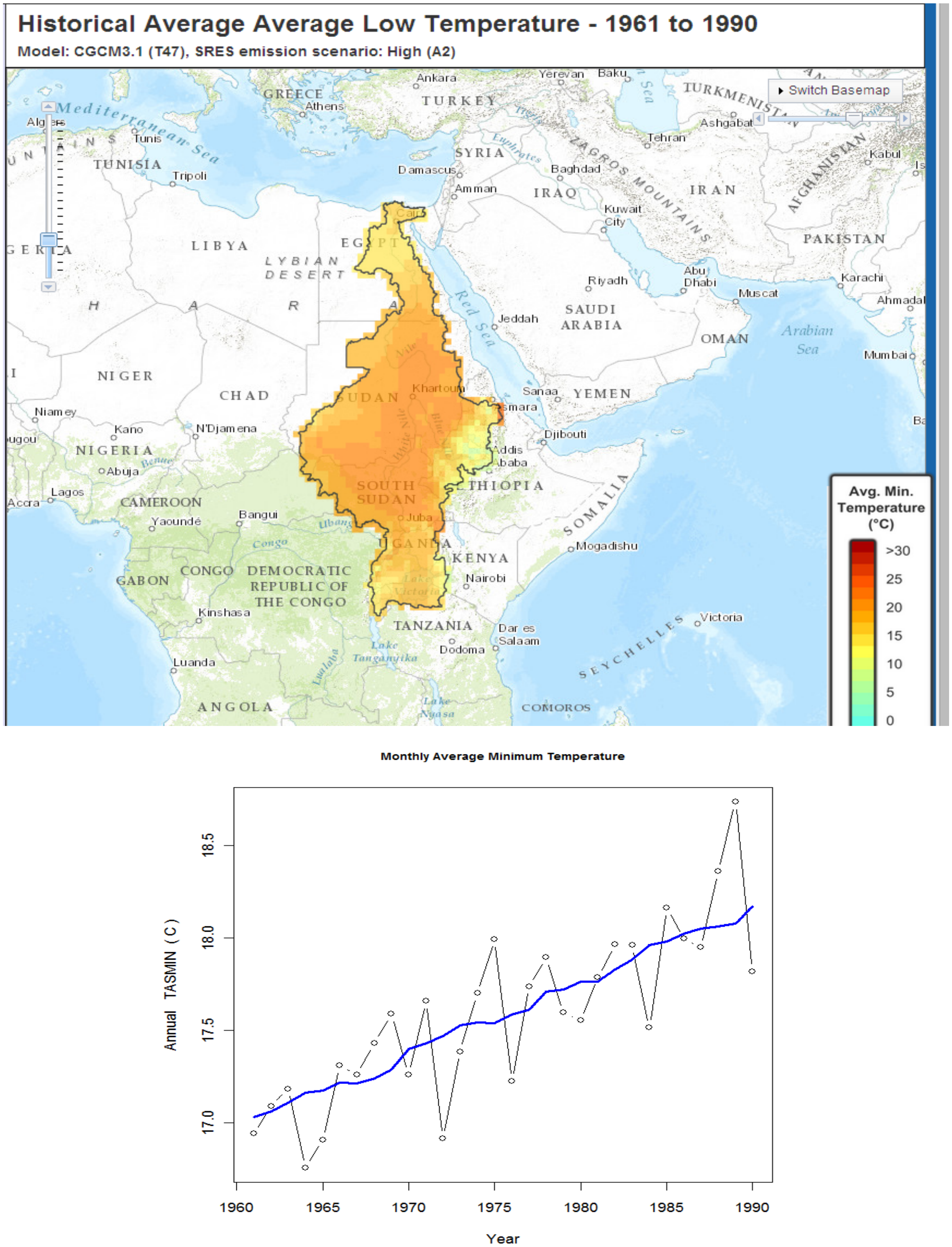

Figure 2: Example outputs from Climate Information System at ENTRO

Country	Key stakeholders who are commissioned or expected to carry CRA in the context of water resources planning and management	The capacity of these stakeholders (human, and technology) to carry or interpret CRA analysis in this context	Gaps in capacity between needed and available resources	Existing level of coordination between stakeholders at different sectors within the same country, and at the regional level	Strategies to enhance institutional capacity for CRA in the context of water resources planning and management
Egypt	Ministry of water resources; Ministry of State for Environmental Affairs	Limited Good	Significant	Unknown	Needed coordination at regional levels
Ethiopia	MOWIE, NBI, Environmental protection Agency, MOA, Higher Education	Limited to Good	Huge	Medium, to not well coordinated	Some training, higher education
South Sudan	Ministry of water Resources, Ministry of Environment, Ministry of Agriculture, Ministry of Animal Resources and Fishery, National Universities	Fair, but no technology	Large	Very good, high	Attempts are ongoing to enhance capacity in a new country
Sudan	Ministry of Irrigation, Ministry of Agriculture, National Universities, Ministry of Environment	Adequate to weak	Huge	Not good, isolated islands, inadequate, weak, poor	Educational courses, seminars, public lectures, no national strategy

Table II: Stakeholders, Existing Capacity, Gaps in Capacity, Coordination, and Strategies based on responses to questionnaire distributed to water resources and climate experts from the region.

(2) The capacity of these stakeholders (human, and technology) to carry or interpret CRA analysis in this context,
(3) Gaps in capacity between needed and available resources,
(4) Existing level of coordination between stakeholders at different sectors within the same country, and at the regional level, and
(5) Strategies to enhance institutional capacity for CRA in the context of water resources planning and management.

In this section, we attempt to identify key stakeholders for climate-related analyses, and assess current institutional framework and capacity for "bottom-up" CRA in water resources planning and management. Based on the questionnaire, the key stakeholders seem to be ministries of Irrigation, agriculture, water resources, electricity, and environment.

The capacity of these stakeholders to carry and interpret CRA seems to vary between the different countries of the Eastern Nile, from adequate to limited, and even weak. Significant gaps exist between needed and existing capacity. The level of coordination between stakeholders at national and regional levels seem to vary greatly too. There is an urgent need for significant capacity building efforts at different levels, from single institutions to national and international. Significant efforts are also needed to achieve adequate and uniform levels of coordination at the national and regional levels.

In the past ENTRO has been a leader in addressing the issues of climate variability and climate change as they relate to the water sector in the Eastern Nile basin. There seems to be an urgent need and ripe opportunity for ENTRO to develop a major program on capacity building and coordination of efforts on issues of water and climate between key stakeholders in the countries of the Eastern Nile, at national and regional levels.

4. Infrastructure Assessment

The key input for any serious assessment of the current and future demands in the countries of the Eastern Nile are population statistics, their growth rates, economic activity and the associated growth rate.

Based on considerations of these statistics, we describe the current level of water-related demands in the Blue Nile sub-basin as they relate to the five system indicators outlined above. Such analysis is necessarily approximate since projections of future demands are uncertain and hard to make with any confidence, especially at long-range climatic time scales.

Country	Population (M)	Population Growth 2014	GDP per capita, 2013	GDP Growth, Last 3 years
Ethiopia	96.6	2.89%	$1300	9.0%
Egypt	86.9	1.84%	$6600	1.9%
South Sudan	11.6	4.12%	$1400	10%
Sudan	35.5	1.78%	$2600	0.3%

Table III: Summary Statistics on Population and Economy in the Eastern Nile Countries.

Indicator	Current Assessed Demand	Future Projected Demand
(1) Rain-fed agriculture in Ethiopia;	High	Likely to double ~20 years
(2) Hydropower generation in Renaissance,	Non existent	Likely to be fully developed in ~10 years or less
(3) Irrigation agriculture in Sudan,	High	Likely to double ~30 years
(4) Hydropower generation in Rosaries, and	Operating	Likely to remain essential
(5) Contribution of the flow in Khartoum to the water supplied to Egypt.	About 56 cubic Kilometer	Likely to become even more critical for Egypt

Table IV: Current and Future Demands

The demand on suitable land for rain-fed agriculture in Ethiopia is indeed high, specially given limitations of arable land due to constraints imposed by topography and soil conditions. However, given the rapid increase in population of Ethiopia and the recently fast economic growth, we project that the current demand levels could double in a few decades, as short as in 20 years.

The new project in Ethiopia (Renaissance) introduces additional new demands for using water in hydropower generation. Although hydropower generation is not a consumptive use of water, it requires significant regulation in the flow levels with impacts likely downstream.

The demand on irrigated agriculture in Sudan is relatively high; however since demand is projected to increase significantly though with a lower rate compared to Ethiopia give the differences in population growth and economic growth between Sudan and Ethiopia.
The demand for hydropower in Rosaeris, Sudan is likely to remain stable.

Finally, the demand on the Nile water in Egypt is relatively high. This demand is likely to become higher, and of even more critical importance for Egypt given the projected increases in population and economic activity.

Appendix

<u>Questionnaire</u>

Name: ………………… ……. Country: ……… ………………….

(A) **ASSESSMENT OF CURRENT INSTITUTIONAL CAPACITY IN THE EASTERN NILE COUNTRIES:**

(1) Key stakeholders in each country who are commissioned or expected to carry CRA in the context of water resources planning and management:

…………………………………………………………………………………………

(2) The capacity of these stakeholders (human, and technology) to carry or interpret CRA analysis in this context:

……………………………………………………………………………………….

(3) Gaps in capacity between needed and available resources,

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(4) Existing level of coordination between stakeholders at different sectors within the same country, and at the regional level:

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(5) Strategies to enhance institutional capacity for CRA in the context of water resources planning and management:

………………………………………………………………………………………

<u>(B) RANGE OF THRESHOLDS FOR SYSTEMS PERFORMANCE INDICATORS:</u>

describing limits between 3 states (High, Normal, Low; or in other words hydrologic conditions of Flood, Normal, and Drought, or describing economic conditions of Plenty, Sufficient, and Deficient). We propose these thresholds correspond to conditions that are experienced historically 1/3, 1/3, and 1/3 of the time.

Reaction (………) Agree (………..) Disagree (………………….) Alternative

<u>(C) STRATEGIES TO COPE WITH HISTORICAL VARIABILITY:</u>

What strategies, if any, do the stakeholders responsible for CRA within the water sector use to cope with significant historical events of climate variability (major droughts e.g 1983-84; major floods such as 1998, and 2008)?.

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Are these strategies evolving with time to adapt to the likelihood of climate change?

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<u>(D) TRENDS IN INFRASTRUCTURE DEVELOPMENT</u>:

Are there any trends in infrastructure development & management in the system defined above?

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What are the most significant investments in the last 10 years?

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And in the coming 10 years?

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