Use Cases

Appendix B

- **Appendix B.1 4+1 Use Cases**
- **Appendix B.2 Priority Concern Tables**
- **Appendix B.3 Original Use Cases**

Appendix B.1

4+1 Use Cases

During the launching workshop, which was held in May 2009, the Consultant worked closely with the DSS Core Team to establish nineteen NB DSS use cases. These 19 use cases are enclosed in Appendix B.3.

Further, during the launching workshop some use cases were mapped into a tabular format containing:

- Objectives: what are the NB DSS relevant objectives related to the use case?
- Alternatives/Interventions: what are the options that are available for addressing the specific objective?
- Decisions: what decisions needs to be taken in relation to the possible alternatives/interventions?
- DSS Questions: what questions can the NB DSS help answering in order to support the decision?
- DSS Outputs: what outputs must the NB DSS produce in order to answer the DSS Questions?

Objectives, alternatives/interventions, decisions, DSS questions and DSS outputs were finally mapped against the 8 priority concerns and the two cross-cutting issues as well as to the ToR functional requirements. The purpose of this mapping exercise was to elaborate the 8 priority concern tables that have previously been produced by the NBI. Appendix B.2 contains tables for those use cases that were used for this mapping.

As such the contents of Appendix B.2 and B.3 are direct outputs of the launching workshop.

Following the Inception Workshop, the original 19 use cases were synthesized into 5 (4+1) use cases by the NBI PMU. The 4+1 use cases represent the broad usage of the NB DSS and have been carefully designed to address all functionalities of the NB DSS as well as the NB DSS usage (activities) represented by the original 19 use cases. The 4+1 use cases were subsequently UML formatted and analysed in detail by the Consultant. The purpose of the use case analysis was to identify additional (generalised) use cases and create logical groups of use cases to form functional components. These functional components have then been used to identify software components. As such the 19 use cases (represented by the 4+1 use cases) constitute important information which has informed the design of the NB DSS. Further, the 19 original use cases may be used for testing purposes later during the project (e.g. by WP2). The 4+1 use cases are included in Appendix B.1. The 19 original use cases are enclosed in Appendix B.3.

Version	Use case ID	Changed By	Date
0.2	**NB-DSS UC-01: Determine Causes for Declining of Lake Victoria Water Level**		9/9/09

Brief Description:	**Background**: There is public concern regarding the falling levels of the Lake Victoria. The drop in lake levels has affected the socio-economic activities in the three east African countries of Uganda, Kenya and Tanzania that directly depend on the Lake's water resources notably, through the prevailing power cuts, fall in fish supplies, unsafe docking of lake transport vessels, hanging domestic water supply intakes, etc. It has also caused environmental effects such as the drying of wetlands on the lakeshore line which are breeding grounds for fish. **Key questions**: the following questions are expected to answered after implementing this use case: - Does the net basin supply show significant downward trend? - Is the departure from the release curve agreed by countries concerned (commonly known as 'agreed curve') the primary cause of decline in Lake water level? - Can Lake Victoria sustain the releases as determined by the agreed curve?
Business Trigger:	Decision by the ministers of water affairs to identify main causes for declining of lake water level
Preconditions:	- Minimum set of data required for the analysis available (rainfall, evaporation, downstream release, stream flow)
Selected information products to be generated (Key indicators)	- Time series of key climatic and hydrologic variables - Trends in lake rainfall, evaporation, stream flow, lake water level and downstream release and their significance levels - Proportional contributions of trends in net basin supply (rainfall + stream flow – evaporation), and downstream release to lake water level decline (in average m/year) - Water balance model for lake Victoria
Actors	Hydrologist - Prepare all data required for the study GIS specialist - processing of spatial map layers Modeller - Setup rainfall-runoff model - Setup lake water balance model - Conduct trend analysis, - Simulate lake water balance - Generate reports Decision makers - Review study results - Decide on follow on studies if required

Actor	Workflow	Reference to User Requirements
Normal flow: To be used under circumstances: - main purpose is to determine initial identification of possible causes to propose follow on studies, - limited/expertise time available for more thorough investigation,		
Hydrologist	**1. Prepare hydrologic time series** a) Import Time Series (such as lake water level, rainfall, total catchment inflow) b) Pre-process data: gap filling, quality assurance, etc c) Generate an annual TS of index lake level: such as, average of daily water levels for the first month of each hydrologic year d) Plot annual index lake water level time series	2.1.3.1/2.1.3.3
Modeller/ hydrologist	2. **Determine trends** in time series a) Determine the trend in lake water level b) Determine the trend in downstream release c) Determine trends in net basin supply (rainfall over lake - evaporation + total inflow into the lake);	2.1.3.1/2.1.3.2
Modeller/ Hydrologist	3. **Determine key factor for lake level decline** a) Determine the proportion (percentage) of total average water level decline (m/year) explained by each of net basin supply and downstream release. b) Summarize results into a table showing the percentage contribution c) Determine unexplained proportion of the decline in water level (due to unaccounted for inflows/outflows)	2.1.3.1/2.1.3.2
Modeller	4. **Generate report** comprising a) Plots of all time series, b) Table summarizing average trends and proportion of lake level decline explained by trend in each time series, and unexplained trend	2.1.2.4
Alternate flow: To be used under circumstances: main purpose is to determine if downstream project release is main cause of the decline in lake water level		
GIS Specialist/ Hydrologist	**1. Identify data availability** a) Delineate sub-basins draining into lake Victoria, b) Display spatial map of study area (lake and its catchments) c) Overlay map of locations of hydrometric and meteorological stations d) Identify un-gauged catchments and determine their characteristics (area, land use/cover, soil characteristics, etc) e) Identify data availability (what data, at what time step, for how long, etc)	2.1.2.1; 2.1.4.3; 2.1.4.4;
Hydrologist	**2. Prepare input data** a) Import hydrologic time series for catchments draining into lake Victoria (rainfall, runoff, etc., daily time step) and link to catchment features b) Quality assure catchment hydrologic time series (gap-filing, remove 'suspicious' data, etc) c) Determine quality assured, gap filled, monthly time series of observed lake rainfall, evaporation, and lake water level	2.1.2.1;

	d) Determine the natural lake outflow vs lake level relationship	
Modeller	**3. Determine net basin supply to lake Victoria** a) Using statistical techniques and data prepared under 2 for unguaged catchments, estimate stream flow in unguaged catchments b) Determine total surface water inflow to the lake c) Compute TS of areal rainfall over the lake surface using gauged values d) Spatially interpolate monthly evaporation from available measurements e) Estimate time series of monthly net basin supply	2.1.3.1; 2.1.3.3; 2.1.4.3; 2.1.4.4; 2.1.7.1
Modeller	**4. Model setup – lake Victoria (monthly time step)** a) Configure a reservoir water balance model setup for lake Victoria b) Calibrate model with observed inflow and outflow time series	2.1.5.1; 2.1.5.2; 2.1.5.4; 2.1.5.6; 2.1.5.13
Modeller	**5. Define scenarios:** a) Scenario 1: Lake outflow governed by agreed curve b) Scenario 2: Lake outflow governed by natural outflow	2.1.6.1
Modeller	**6. Simulate scenarios 1 and 2**	2.1.6.1
Modeller	**7. Post-process scenario run results** a) Determine the trends in lake water level series of observed lake water level and the two scenarios b) Determine estimated lake level decline for scenarios 1 and 2 and compare with observed decline	2.1.3.1 2.1.3.2 2.1.3.3;
Water resources planner/modeller	**8. Compare scenarios** c) Graphically display observed and simulated lake water levels (for scenarios 1 and 2) d) Prepare tabular summary of trends in lake water level: observed, scenarios 1 and 2 e) Determine most important contributing factor for lake level decline (based on the comparison given in (b))	2.1.3.1 2.1.3.2 2.1.3.3; 2.1.6.3;
Modeller	9. **Generate Reports**: with TS plot and summary table of trends	2.1.2.4

Version	Use case ID and title	Changed By	Date
0.2	**NB-DSS UC-02: Select best option for Jonglei Canal**		9/9/09

Brief Description:	**Background:** The primary objective of the Jonglie canal Project was to conserve around 4.7 billion meter cube of water that is lost in the Sudd swamp mainly through evaporation and make it available for downstream use. The project was terminated in 1983 after completion of 260 km out of the total 360km. The EN-COM has realized the benefits of gaining additional water for various uses downstream and agreed to investigate the consequences, both positive and negative, that might occur due to the completion of the canal. **Key questions:** the following questions are expected to be answered through the implementation of this use case: - How much water can be conserved if the Jonglei canal project is completed? - What would be the total changes in the inundation patterns of the Sudd wetland (spatial extent, depth, etc)? - What are the estimated impacts in community livelihoods? - What would be the approximate volume of water to be conserved to keep environmental and socio-economic impacts to acceptable limits?
Business Trigger:	Decision of EN-COM to analyze the consequence of completion of the Jonglie canal.
Preconditions:	a) Minimum required dataset are available (hydro-meteorological, Swamp extent and depth, environmental, socio-economic data, and canal main features) b) Agreed set of criteria and indicators to analyze the consequences

Workflow

Actor	Activity	TOR Reference
Modeler & Decision maker	I Create and Configure Study	
Hydrologist	II Data Preparation and Preprocessing for the Baseline Scenario	

& GIS Specialist	1. Prepare geo-spatial data using the GIS functionalities of the DSS A Import and quality assure any relevant spatial data (such as land use, land cover, soils) B Delineate hydrologic response units (HRU) using digital elevation models (DEM) C Determine relevant properties of HRUs through overlay of different spatial layers and through application of heuristic functions (e.g. soil hydraulic conductivity as a function of soil type and root zone depth) D Through analysis of remote sensing images (1) Determine spatial and temporal distribution of evapo-transpiration (2) Analyze extents of permanent and seasonal swamps (3) Determine river reaches and their properties (and in addition using DEMs and data sets from studies and reports)	2.1.4.1 / 2.1.4.3 / 2.1.4.4
	2. Prepare input time series for daily and monthly time steps A Import historic time series (such as rainfall, flow, temperature) B Quality assure time series (e.g. through gap-filling)	2.1.3.1 / 2.1.3.2 / 2.1.3.3 / 2.1.5.5
Modeler	III Model Configuration for the Baseline Scenario	

	1. Set-up model A Set-up and configure semi-distributed rainfall-runoff models for specific parts of the sub-basin (1) Discretize system according to the HRUs as defined in previous steps (2) Link hydro-objects to each other (set-up topology) and define types of linkages (e.g. reaches) (3) Link input time series (e.g. rainfall and evaporation) to specific hydro-objects B Set-up conceptual water-spine model for the wetlands (1) Model permanent and seasonal swamps as shallow lakes (2) Define evapo-transpiration (ET) and seepage properties of swamps (3) Link swamps to each other and with reaches and define flow properties and rules (e.g. using threshold functions – as necessary use scripting to define specific functional relationships) (4) Define conceptual GW hydro-objects and link these to the shallow lakes and the reaches (through their seepage properties) (5) Link input time series (e.g. rainfall and evaporation) to specific hydro-objects (6) Define virtual nodes to aggregate "losses" (ET & seepage) from swamps and link these to selected hydro-objects C Link the sub-models (1) Check the sub-models in the DSS GUI (2) Link selected hydro-objects in the rainfall-runoff models with selected hydro-objects in water-spine model to define flow/linkage between the models – for automatic data exchange between the sub-models (3) Define the modeling sequence of the sub-models (rainfall-runoff and water spine models)	2.1.5.1 / 2.1.5.2 / 2.1.5.3 / 2.1.5.4 / 2.1.5.7 / 2.1.5 9 / 2.1.5.10 / 2.1.5.13 / 2.1.7.1 / 2.1.7.6
	2. Calibrate and validate each sub-model A Experiment with different (1) evapo-transpiration approaches/methods (2) routing functions in reaches B Analyze sensitivity of results with regard to different input data - such as (1) evapo-transpiration methods (2) resolution and topology of schematic C Change parameterization and topology as necessary (re-setup model) and test the model(s) iteratively	2.1.5.6 / 2.1.6.2 / 2.1.6.5 / 2.1.7.5
System	3. Simulate for baseline scenario; run set of models (model tools will automatically execute according to user-defined sequences and model linkages)	2.1.2.7
Modeler	IV Scenario Configuration and Run	

		1. Copy and modify water spine model of baseline scenario and define different sets of parameters for inlet node of Jonglei Canal, such as: A Water abstraction rules for flows (e.g. as diversion flow as a function of another state variable of another hydro-object) B Water abstraction flows/levels (e.g. as time series)	2.1.5.1 / 2.1.7.6
		2. Set-up and configure hydraulic model of Jonglei-Canal; use DEM and other data sets to determine cross-sections and longitudinal profile	2.1.5.15
		3. For each set of parameters define a scenario and link the set of models (rainfall-runoff and water spine) with the hydraulic model of Jonglei Canal (including definition of modeling sequence) – new linkage between water spine and hydraulic model through inlet and outlet node of Jonglei Canal	2.1.5.10 / 2.1.6.1
System		4. Simulate each Jonglei-Canal scenario; run set of models (according to defined modeling sequences)	2.1.6.1 / 2.1.2.7
Modeler & Decision Maker	V	Indicator Definition (and Calculation)	
		1. Review all information that was made available through the data preprocessing phase using the DSS GUI	2.1.1.1 / 2.1.1.4
		2. Define relevant indicators for scenario comparison and MCA, such as A Total area reclaimed for agriculture B Extent of change in swamp area (permanent and seasonal) and its impacts on the livelihood of the community (such as decrease in livestock, grazing area, fishery production) C Impacts on the flora and fauna that exist in the swamp D Total benefit from conserved water (in this case through assessment in other use cases of the DSS)	2.1.8.2
		3. Define relationships between model data/properties and the above indicators A Import and/or edit tables that represent relationships (in this case these relationships are derived outside the scope of the DSS) B Write scripts to formulate functional relationships and/or aggregations as appropriate	2.1.5.12
System		4. Calculate indicators for all scenarios including baseline scenario (convert model outputs to indicators as defined in indicator definition phase) 5. Populate MCA with indicators as specified and defined in the indicator definition phase	2.1.8.3 / 2.1.5.12
Modeler &	VI	Scenario Analyses	

Decision Maker	1. Compare for each Jonglei-Canal scenario results with each other and with results of baseline scenario: Examples for criteria to be compared are: A Extents of wetlands (including surface areas, water volumes, water elevation) – maxima and minima B Evapo-transpiration (average yearly values, temporal distribution, minima, maxima and other aggregated values) C Outflows from the Sudd (average yearly values, temporal distribution, minima, maxima and other aggregated values) D All the indicators that were determined in the indicator definition (and calculation) section	2.1.6.3 / 2.1.6.5
Decision Maker	VII MCA	
	1. Run MCA tool for the criteria used in the scenario analyses 2. Select the “best” option	2.1.8.1 / 2.1.83

Version	Use case ID	Changed By	Date
0.2	**NB-DSS UC-03**		9/9/09

Use Case 3: Identify the Preferred Cascade of Power Development and first investment for the Eastern Nile Joint Multipurpose Program (JMP)

Background:	Under the Nile Basin Initiative (NBI), the Eastern Nile Technical Regional Office (ENTRO) is currently planning a major investment program under the title: 'Join Multipurpose Program (JMP)'. The JMP shall include major regulation dams in the Eastern Nile (Blue-Nile – Main Nile sub-basins) with power development, irrigation, flood damage mitigation, improving rural livelihoods and other benefits to the three countries, Egypt, Ethiopia and Sudan. The JMP shall be one of the key application cases for the Nile Basin Decision Support System. This use case focuses on the identification of a preferred cascade for hydropower development and selection of the investment sequencing of the regulation works in the cascade. The exercise shall depend on assessment of potential benefits and impacts under conditions of hydrologic variability to arrive at preferred choice. Being a joint undertaking of three countries, technical experts and decision makers from all three countries and ENTRO shall closely collaborate using the DSS to identify the preferred cascade and the investment sequencing of the dams in the cascade.
Questions:	1. What is the most preferred cascade hydropower development (set of generation plants)? 2. In what sequence should the dams be constructed to maximize benefits and minimize adverse impacts downstream? 3. What are the trade-offs (sectoral, country-wise, upstream-down-stream) if hydropower dams are developed in the Blue Nile Basin in Ethiopia accordingly?
Pre-conditions:	- Minimum set of data required for the analysis available - The DSS is installed in all three ministries of water resources and ENTRO
Key indicators (information outputs) to be generated	1. Hydropower energy produced: frequency distribution and spatial aggregation 2. Agricultural yields for irrigated agriculture 3. Flood damages reduced 4. Costs and benefits of interventions 5. Secondary effects of the interventions (with reference to baseline scenario) on a) Environment: frequency distribution of flows at key locations b) Hydropower: frequency distribution of energy c) Irrigation: supply reliability, agricultural yield d) Floods damages reduced: frequency distribution and spatial distribution
Actors	Hydrologists (in all three counties and ENTRO) - Prepare all data required for the study GIS specialists - processing of spatial map layers Modellers - Setup models - Conduct trend analysis, - Simulate lake water balance - Generate reports Water resources planners - define indicators - define scenarios - analyze results - produce report for decision makers Decision makers - Define indicators - Review study results

	- Decide on follow on studies if required	
Normal Flow		
Actor	**Workflow**	**Requirements From TOR**
	1. **Define Study**	
Study lead	**1.1 Create a study:** a) Title, ID, objective, b) Geographic area, etc c) Study period d) Configure study-specific report template(s) e) Study team (access privileges) **1.2** Store all study definition to be linked with study data and results	[2.1.2.1 2.1.2.8]
	1. **Prepare all necessary data**	
Group of *Hydrologists, GIS experts* collaborating (including across country) on the study (including synchronization)	**2.1 Prepare spatial map layers of key study features and their characteristics:** a) Import/delineate basins/sub-basins of the study area b) Prepare geo-referenced map layers of: a. Flow gauging and climatic stations, b. Access roads, towns, airports, c. Locations of proposed dams for the study, d. Land use/cover maps, soil map, etc e. Major existing and planned irrigation development sites and their characteristics f. Locations of flow control points (such as in-stream flow requirement points) g. Degraded watersheds, intervention hotspots h. Flood damage zones and their characteristics (such as extent, land use) i. Recession agriculture zones and their characteristics (such as areal extents, crops) c) Delineate ungauged catchments and determine their key characteristics needed for flow estimation, such as: a. Area, slope, b. Land use/cover classification with relevant hydrologic properties (related to interception, rooting depth, etc) c. Soil types and their hydrologic characteristics (such as hydraulic conductivity, water holding capacity, etc)	2.1.2.1 2.1.2.3 2.1.2.6 2.1.4.3 2.1.4.4
	2.2 Identify data gaps (spatial, temporal, thematic)	[2.1.2.1 2.1.4.3]
	2.3 Prepare data for study a) Import all data not available within database (from spreadsheet, asci files, manual entry, etc) b) Quality assure hydro-meteorological data c) Generate/prepare in-stream flow requirements at key control points d) Estimate/generate flow series for unguaged catchments e) Generate inflow Time Series (TS) at dam sites f) Prepare rainfall TS at dam sites and irrigation development sites g) Prepare TS of temperature, evaporation, etc at irrigation development sites h) Import/Determine flood damage zones characteristics (damage curves/tables) i) Import population distribution and density data j) Compile operation rules of existing reservoirs k) Generate/import sediment yields at key dam sites (could involve catchment erosion estimation) l) Prepare characteristics of dams (area-capacity curve, spillway	[2.1.2.1 2.1.2.3 2.1.2.6 2.1.2.7 2.1.3.1 2.1.3.2 2.1.3.3 2.1.4.3 2.1.4.4 2.1.7.1 2.1.7.2 2.1.7.6 2.1.7.4 2.1.2.8]

	rating curves, etc) m) Estimate water demands (such as irrigation sites, major urban centres) n) Generate ensemble of flow time series (daily time step)	
	2.4 Store all prepared data in the database for later use (linked with study)	[2.1.2.1 2.1.2.3 2.1.2.8]
	2. Determine the preferred cascade development scenario	
Modeller/water resources planner	**3.1 Define baseline (reference) scenario – Sc00, using** data prepared in step 1,configure a) Model B1: Water Spine for Blue-Nile – Main Nile system, including Atabra sub-basin (with white Nile input flow series) b) Model B2: Hydrodynamic – for lower reaches of Blue Nile (around Khartoum) – for flood damage analysis c) Link all input time series generated in step 1 to models of the baseline scenario d) Link Models B1 and B2 (sequential flow of data from B1 to B2; linking nodes of the models determined by user) e) Identify all model run outputs that shall be needed for selection of preferred scenarios, i.e. should be stored in the database explicitly	[2.1.5.12.1.5.3 2.1.5.4 2.1.5.5 2.1.5.7 2.1.5.8 2.1.5.9 2.1.5.10 2.1.5.13 2.1.5.14 2.1.5.16 2.1.5.15 2.1.6.1 2.1.2.8]
Modeller/decision makers	**3.2 Define performance indicators (linked with selected outputs of the model runs; via script/macro)** a) Extent of flow regulation by all dams in a scenario (dead and live storage) b) Extent of flood alleviation in Sudan for each scenario (under varying flood storage zone) c) Change in energy production downstream (Egypt and Sudan) due to reservoir filling upstream d) Increase in energy production in Sudan on the long-term (annual and firm energy) e) Increase in reliability of water supply for domestic and irrigation purposes downstream at key control points (Sudan and Egypt) f) Potential impact of sediment management downstream (could be an 'offline' activity with results imported into the MCA) g) Evaporation losses from reservoirs (basin-wide) h) Savings in evaporation losses from reservoirs downstream i) Economic indicators (IRR, BC ratio, etc)	[2.1.2.8 2.1.5.12]
	3.3 Calibrate Model B1 of the baseline scenario	2.1.6.2
Modeller	**3.4 Calibrate the hydrodynamic model (Model B2) of baseline scenario** (with inflow from the water spine model)	2.1.6.2 2.1.6.2
	3.5 Update baseline scenario with planned irrigation schemes in Sudan and Ethiopia	2.1.6.1
Modeller/water resources planner	3.6 **Define cascade development scenarios** (about 10), *for each scenario*, using data prepared in step 1: a) Configure model (water spine) for Blue – Main Nile system, including Atbara sub-basin, with data from the database (prepared in step 1), with White Nile inputs flow series; model setup includes different storage dams b) Link input time series to model features c) Configure model (hydrodynamic) – lower reaches of Blue Nile in Sudan where flood damages assessment shall be conducted in the study (use data prepared in step 1) d) Link input time series to model features	[2.1.6.1 2.1.5.1 2.1.5.15]

	e) Create additional scenarios by varying characteristics of the models (operating rules for reservoirs, power generation capacities, etc) f) Identify all model run outputs that shall be needed for selection of preferred scenarios, i.e. should be stored in the database explicitly	
Modeller/decision makers	**3.7 Update definition of performance indicators (given under 3.2) and link to outputs from each of the cascade scenarios**	[2.1.2.8 2.1.5.12]
Modeller/Water resources planner	**3.8 Configure MCA tool – decision matrix with stakeholder preferences (weights on criteria)**	[2.1.8.1 2.1.8.3]
System	**3.9 Run updated baseline scenario**	2.1.6.1
	3.10 Determine relevant indictors for updated baseline scenario (using user-defined relationships/functions between model outputs and indicator values)	[2.1.5.12 2.1.2.8]
	3.11 Automatically populate MCA tool (decision matrix) with indicator values for the updated baseline scenario	[2.1.8.3]
Modeller	**3.12 Run all scenarios, for each scenario:** a) Simulate scenario b) Estimate extent of flood alleviation: a. Using the hydrographs generated by hydrodynamic model, estimate spatial extent and depth of flooding b. Determine flood damages using the damage curve in the compiled/defined under step 1 c) Run benefit - cost analysis (power, irrigation, flood control, etc) d) Generate indicator values (including economic indicators) e) Populate MCA tool with indicator values for all scenarios	[2.1.6.1 2.1.5.11 2.1.5.12 2.1.8.3]
Water Resources Planner/Decision makers	**3.13 Use MCA to rank scenarios**	[2.1.6.1 2.1.6.2]
Modeller, Water resources planner	**3.14 Conduct trade-off analysis between the cascade scenarios, each cascade vs updated baseline, using tradeoff curves. Use the performance indictors:** a) Hydropower generation (by country (upstream vs. downstream)); b) Hydropower generation vs irrigation water supply reliability (by country, by sector – power vs irrigation) c) Flood damage benefits vs hydropower generation	[2.1.3.1 2.1.3.2 2.1.8.1 2.1.8.2]
Decision Makers	**3.15 Select preferred cascade scenario**	[2.1.6.1]
Water resources Planner	**3.16 Generate reports**	[2.1.2.4]
	4. Determine sequencing of JMP power development dams and select first project	
Water resources planner/Modeller	**4.1 Using the preferred scenario, define sequencing scenarios** using: a) Different construction sequencing of the dams in the preferred cascade scenario and b) A set of filling strategy for the first dam c) Identify all model run outputs that shall be needed for selection of investment sequence, i.e. should be stored in the database explicitly	[2.1.2.8 2.1.6.1]
Modeller	**4.2 Link generated ensemble with model setup of each scenario**	[2.1.2.8 2.1.6.1]

Modeller/decision makers	**4.3 Update indicator definition for evaluating sequencing scenarios** (see 3.2 for sample indicators) with: a) Probabilistic indicators: a. Probability of minimum flow falling below required levels and variation of the probability over study period, b. Probability of reservoir reliability meeting target and variation over study period, c. Reliability of producing firm power and its variation over study period. d. Probability of the economic indicator (such as B/C) falling below a pre-defined threshold value	[2.1.5.12 2.1.6.1]
Modeller/Water resources planner	**4.4 Configure MCA tool using the scenario identification and performance indicators**	[2.1.6.1 2.1.6.3]
Modeller	**4.5 Simulate the sequencing scenarios** using the ensemble of input series	[2.1.6.1 2.1.5.4 2.1.5.6 2.1.5.7]
Modeller	**4.6 Analyse ensemble simulation run results and synthesize statistical outputs (mainly indicator values given under 4.3)**	[2.1.3.1 2.1.3.2]
Modeller	**4.7 Determine indicator** (including economic indicators) values (including their probabilities)	[2.1.5.11 2.1.5.12 2.1.6.1]
System – Scenario Manager	**4.8 Populate MCA tool** with indicator values	[2.1.8.3]
Water resources planner	**4.9 Introduce stakeholder preferences (weights) and minimum criteria for evaluation**	[2.1.8.1 2.1.8.2]
Water resources planner	**4.10 Run MCA and rank sequencing scenarios**	[2.1.8.1 2.1.8.2]
Modeller/water resources planner	**4.11 Evaluate sensitivity of rank to stake**holder preferences to evaluation criteria (indicators)	[2.1.6.5]
Water resources planner	**4.12 Compare scenarios using various charts and plots (include tradeoffs)**	[2.1.6.1 2.1.6.3]
Water resources planner/decision makers	**4.13 Select preferred sequence of development**	[2.1.6.1 2.1.6.3]
Water resources planner	**4.14 Generate report for decision makers**	[2.1.2.4]
Modeller	**4.15 Store study data (inputs, scenario definitions, model run results, indicators values, MCA outputs and reports) for use by a study team in other riparian countries**	[2.1.2.1 2.1.2.3]

Version	Use case ID and title	Changed By	Date
0.2	**NB-DSS UC-04: Select best investment option for Nile Equatorial Lakes region**		9/9/09

Brief Description:	The Nile equatorial region is facing problems of shortage of hydropower, food security and transportation. The region would like to exploit the hydropower potential within the region, use the available lakes as source of water for irrigation, and also as means of transport. This use case focuses on selection of best investment option to address that power and food shortages in the region.
Business Trigger:	The available water may not be enough to cater all planned activities at once. Therefore there was a need to see different scenarios in which the effect of planned development activities on the existing water uses.
Preconditions:	a) Agreed scenarios to be investigated (with the availability of the relevant data) • Base Case – existing situation • Alternative 1: one multiple reservoir on R. Kagera • Alternative 2: Two medium dams on R. Nzoia • Alternative 3: Water abstraction from lake Victoria for irrigation • Alternative 4: Four new hydropower dams (Lake Victoria- lake Albert stretch) b) Agreed set of analysis: • Planned hydropower development on existing water fall. • Irrigation water abstraction from Lake Victoria on the water level • Multipurpose reservoirs on flood protection and fishery. c) Spatial, hydro-meteorological and system data in the Lake Victoria area exist.

Actor	Work Flow	Reference to user requirements
Normal flow		
GIS Specialist Hydrologist	1. Prepare Input Data A. Geo Spatial Data • Import and quality assure relevant spatial data (e.g., Irrigation sites, Hydropower sites, flood prone areas, tourist attraction site etc.) • Determine HRUS (Catchment, sub catchment) and relevant characteristics	2.1.4.1 2.1.4.3 2.1.4.4
	B. Time Series Data • Import and quality assure Historic time series (River flow, sediment, temperature, evaporation etc) • Import time series from other external tools(e.g. from RR Models for un gauged catchment) • Generate Ensembles or as necessary Import Ensembles from external tools. • Lake water level TS	2.1.3.1 2.1.3.2 2.1.3.3 2.1.6.6 2.1.7.1
Modeler	2. Model Setup A. Setup the models (Water spine and Hydraulic), link them and determine modeling sequence. B. Map TS data and ensembles to selected nodes in the model. C. Identify additional data requirement(Here some data may be required from other countries) D. If the available data is sufficient go to Step 3 E. Else go to step 7	2.1.5.1 2.1.5.2 2.1.5.3 2.1.5.15 2.1.8.3

	3. Model Calibration and validation A. Run each of the models B. Examine the time series of each model out put with respect to the existing record (river flow, water quality parameters, flood areas etc) C. Calibrate and validate each model.	2.1.5.4 2.1.5.5 2.1.5.6 2.1.6.2
	4. Define scenarios A. Scenario Group 1: Base case + Irrigation Development (Here a number of diversion sites for irrigation can be considered) B. Scenario Group 2: Hydropower Development (Different Dam locations and Heights) C. Scenario Group 3: a combination of the two scenarios	2.1.6.1
	5. Model set up for the new scenarios A. Setup the models for the new scenario; Data include the following I. Physical Properties II. Socio economic indicators for CBA (Such as Cost and benefit functions) B. Identify additional data required for the new model configuration. C. If the available data is sufficient go to step 8 D. else go to step 7	2.1.5.4 2.1.5.5 2.1.5.6 2.1.5.8 2.1.5.14
Decision Maker/Modeler	6. Determine user defined indicators A. irrigation area and crop production B. power production C. water quality including sediment transport D. flood prone areas E. Environmental impact on flora and fauna F. Amount of fish catch etc.	2.1.8.2 2.1.5.12
Modeler and System Administrator	7. Information sharing and exchange : *(Within the equatorial lakes region, there are quite a number of countries that would like to share information for the completeness of this exercise)* A. Share the partially populated scenarios (Base case + new Scenarios) to the relevant countries B. Updated model setups C. Update the data on the relevant user defined indicator. D. Verify the suitability of the available data E. If the available information is sufficient, go to step 8/ as appropriate go to step 3 or 5, else repeat	2.1.2.3
Water resources economist /Modeler	8. Determine parameters for simulation based optimization including Objective functions and Constraints A. Define objectives I. Define objective function to Maximize revenue from Power production or Irrigation crop production. II. Define objective function to minimize cost. (the cost can be investment, environmental mitigation) B. Define constraints I. Minimum Lake Water level (Time series) II. Minimum downstream water release (Ecological Flow) (Time series) III. Acceptable water quality (In terms of water quality parameters like Nutrient level, BOD, sediment load etc.) IV. Minimum Economic and financial parameters (such as: IRR, B/C ratio, NPV) V. Maximum cost C. Determine/define method of optimizer.	2.1.6.4

System	9. Optimization Maximize benefits/Minimize cost (impacts) with respect to pre defined objective functions and constraints. A. Run simulation for the selected scenario a number of times by varying the sizes of reservoirs and/or scales of irrigation developments and determine i TS of Water quality parameters including sediment load ii TS of Lake Victoria water level iii Flood Prone areas: extent of economic damage iv Power generation v Irrigated areas & consumptive use of water vi Affected tourist attraction sites. B. Determine costs and benefits for each of the simulation runs: (using specs of step 5) i Determine costs: Investment and running costs, economic losses due to flooding etc. ii Determine benefits: Revenue from power generation, irrigation development fisheries etc. C. Calculate economic and financial parameters (B/C, EIRR, FIRR, NPV) for every simulation	2.1.5.11 2.1.5.16 2.1.7.2 2.1.7.3 2.1.7.4 2.1.5.8 2.1.5.14 2.1.6.4 2.1.6.7
Water resources economist /Modeler	10. Alternative selection. A. Select optimum alternative of the scenario under consideration. B. Sensitivity analysis with respect to discount rate and other parameters like delay in construction and change in cost of construction etc.	 2.1.6.5
System	11. Convert Model outputs into user defined indicators for the optimum alternatives of each scenario. (using specs of step 6)	2.1.5.12
Decision Maker	12. Run the MCA tools and Select the best option	2.1.8.1
Decision Maker and Modeler	13. Generate Report	2.1.2.4

Version	Use case ID	Changed By	Date
0.1	**NB-DSS UC-05: Integrate a New Model Tool in DSS**		9/9/09

Background:	One of the requirements of the Nile Basin DSS is that is shall be flexible enough to enable advanced users integrate model tools to solve diverse types of problems in the operational application of the DSS. This use case focuses on integrating a Groundwater model tool into the DSS.
Questions:	Does the DSS platform enable plugging-in of external models?
Pre-conditions:	- Model tool available with required level of technical documentation - Re-linkable object codes and/or dynamic link libraries of the DSS components with accompanying technical documentation
Key indicators of performance	1. Users are able to access model tool from within DSS 2. New model tool can be linked to other model tools of the DSS from within the DSS for sequential and real-time model linkage 3. Necessary data is available to the new model tool at initialization 4. Outputs of the new model tool are available to the IMS at completion of model tool run
Actors	Software engineer - develop interfaces between model tool and DSS - test functionalities of interface Modeler - identify relevant information/data that need to be communicated between model tool and DSS under at various stages - test functionalities of interface (domain perspective) - test integrated system on real-life applications

Actor	Activity	Reference to user requirements
Normal Flow		
Modeler & Software Engineer	I Requirements Analysis and System Analysis	
	1. Analysis of modeling tool A Analyze input- and output-file formats of modeling tool B Determine hydro-objects and their properties to be availed for other modules in the DSS C Determine variables to be exchanged with the modeling interface of the DSS at simulation time D Determine the object types to be used for sequential model linkage	
	2. Analysis of DSS plug-in specifications for modeling tools, for A Interface for data exchange and configuration (including GUI) B Interface for model-model-communication during simulation time	2.2.3
Software Engineer	II Develop model interfaces to DSS	
	1. Program modeling tool interface for data exchange and configuration (including GUI)	2.2.4.5
	2. Program modeling tool interface for model-model-communication during simulation time	2.2.4.5
Modeler	III Test model integration according to the following key questions and give feedback to software engineer	
	1. Does the IMS of the DSS provide the necessary data of the study focused on when the modeling tool (e.g. GW-model) is initialized?	2.1.1 / 2.1.5
	2. Does the IMS of the DSS populate the modeling tool (e.g. GW-model) with the right data when the model is selected and modeling tool is launched?	2.1.1 / 2.1.5
	3. Does the GUI of the DSS represent all hydro-objects of the modeling tool (e.g. GW-model) and their properties adequately?	2.1.1.4
	4. Does the GUI of the DSS support model linkage for sequential modeling cases correctly? E.g. GW-model with MIKE-Basin	2.1.1.1 / 2.1.2.7 / 2.1.2.8 / 2.1.5.10 / 2.1.7.6
	5. Does the layer of the DSS to support model-model-communication during simulation time function correctly (e.g. for different time-steps)? E.g. GW-model with MIKE-11	2.1.2.8 / 2.1.7.6

Appendix B.2

Priority Concern Tables

Use Case: No 1 lake Victoria water level

Objective	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria)	TOR Requirements
[WRD] Domestic water supply [WRD] Water resources development. [OWR] Optimal water utilisation [CF] Flood control [ED] Energy development [RFA] Improved Food security [NAV] Improved navigation	[OWR] Change in release policy from the lake [OWR] Regulation of lakes downstream of Lk. Vic [ED] Runoff river hpp schemes [RFA] Changed cropping patterns	[WRD] Determine the sequencing of dams. [OWR] Define the operation water levels max min [OWR] Determine rule curves [OWR] Determine minimum releases (environment , navigation) [ED] Determine the number and capacity of runoff river hpp schemes. .	[WRD] What is the optimal release from the lake with and without Jonglei canal. [all] What is the optimal operation rules (constraints docking level, water supply inlets, hpp, water quality and fisheries) [all] What is the environmental and socio economic impacts as a consequence of the lake operation rules. [all] What is the climate change impacts on all the above questions.	[WRD] Downstream minimum flow with and without the Jonglei canal. [WRD] Impacts on the fishery production [OWR] Optimal release policy (rule curves) [OWR] Water inflows to the Sudd wetlands and impacts to wetland extent (wetland water balance) [ED] Unit cost of energy production and total energy production. [RFA] agricultural production (crop yield). [RFA] amount of water available for agricultural production, water supply. [all] costs and benefits associated with the different operation rules. [all] Salinity levels of lk albert (salt balance simple mass balance approach) [all] Water quality conditions in the lake (concentrations).	2.1.5 Dynamic Water Budget and Allocation model 2.1.8.1 MCA 2.1.6.4 Simulation based optimisation 2.1.6.2 Calibration (support in building the model) 2.1.5.14 Hydropower production 2.1.5.11 CBA 2.1.5.12 tools for converting model outputs to criteria. 2.1.7.3 Water Quality model 2.1.3.1 Statistical tool 2.1.3.2 time-series analysis tools 2.1.7.2 crop production model 2.1.4.4 Spatial Analysis tools.

Actors:
Eastern Africa Commission (EAC0 – Head of States
Council of Ministers (NELCOM) – Senior Decision Makers
Nile Equatorial Lakes Advisory Committee (NELTAC) – Senior Decision Makers
Nile Equatorial Lakes Coordination Unit (NEL-CU) – Modellers and Data Analyst

- Senior Program Officer - Modellers
- Researchers – Modellers and Data Analyst

Lake Victoria Basin Commission (LVBC) - stakeholders
Regional and National Working groups – stakeholders
Relevant strategic/planning Commission at National Level - stakeholders

Use Case: No 3 Deterioration of Lake Victoria Water Quality

Objective	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria)	TOR Requirements
[WS] Reduce sediment loads to the lake [NAV] Improve navigation (limit water hyacinth) [all] Improve the wq of the lake [all] Reduce nutrient loads to the lake.	[WS] Sediment traps [WS] Watershed management: ▪ Contour bands (terrases) to capture sediments on the / close to fields. ▪ aforestation. [all] More efficient usage of nutrients in the ag. Production. [all] Improved wastewater treatment. [all] Cleaner production / reduce pollution loads from production/industry.	[OWR] Determine the management options of the lake (water level management / rule curves) [OWR, WS] Determine land use changes. [WS] Watershed management decisions: ▪ Location of sediment traps, countour bands, aforestation planning. [all] Determine whether to construct / improve waste water treatment plants. [all] Determine dredging planns (timing etc.) for the lake (external / out of scope)	[all] what is the potential improvement of the water quality considering all measures (interventions). [all] which intervention is most efficient (cost/effective)? And the related capital investments (perhaps to be considered as an input for the DSS) [all] what is the impact on bio-diversity in the lake.	[OWR] Change of fish population in the lake. [WS] Sediment loads to the lake. [all] Nutrient concentrations in the lake.	2.1.7.1 Rainfall Runoff model 2.1.7.3 WQ model 2.1.5 Water Allocation model 2.1.7.4 Catchment erosion 2.1.7.7 (D) river bank erosion. 2.1.3.1 Stat tools 2.1.3.2 TS Analysis tools 2.1.4 GIS functionality 2.1.2.4 Report generation 2.1.6.1 Scenario management 2.1.6.2 calibration tools 2.1.6.3 direct scenario comparison Ability to add external models.

Actors:

Eastern Africa Commission (EAC0 – Head of States
Council of Ministers (NELCOM) – Senior Decision Makers
Nile Equatorial Lakes Advisory Committee (NELTAC) – Senior Decision Makers
Nile Equatorial Lakes Coordination Unit (NEL-CU) – Modellers and Data Analyst

- Senior Program Officer - Modellers
- Researchers – Modellers and Data Analyst

Lake Victoria Basin Commission (LVBC) - stakeholders
Regional and National Working groups – stakeholders
Relevant strategic/planning Commission at National Level - stakeholders

4 - Use Case Description: Consequences of Completion of Jonglie Canal

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
Assess/evaluate the costs and benefits (impacts) of completion of the canal [WRD, OWR, CF, ED, NAV, CC, WQ, CD] Determine the increase in the flow of the White Nile (and maybe the value of that increase)[WRD, OWR, CF, ED, NAV, CC, WQ, CD] Determine the reduction in water losses in the Sudd area [WRD, OWR, CF, CC, WQ, CD, RFA] Determine the socio-economic and environmental impacts in the Sudd region due to development [WRD, OWR, CC, WQ, RFA, CF, WS] Determine the impact on navigation along the White Nile [WRD, OWR, CF, CC, NAV, ED, CD]	Complete the canal as designed [WRD, OWR, CF, CA, NAV, CC, WQ, RFA]	Information developed will support a decision about completing the canal [WRD, OWR, CF, CD, NAV, CC, WQ, RFA, WS]	1. What will be the impact of the canal on groundwater? [WRD, OWR, WQ] 2. What are the socio-economic impacts? [WRD, OWR, CF, ED, RFA, WS, NAV, WQ, CC] 3. How will the nomadic populations be affected? [WRD, OWR, CF, WQ] 4. How will the variable/seasonal swamp area change? [WRD, CF, RFA, WQ] 5. what are the environmental impacts? Change in salinity/water quality? [WRD, CF, WQ, RFA, CC] 6. What is the change in sediment discharge/accumulation in the swamp and downstream reaches of the White Nile? [WS] 7. How much flow will there be in the river as a result? [WRD, OWR, NAV] 8. What is the area of permanent reduction of the swamp? [WRD, CF, RFA, WQ] 9. What is the change in habitat – for fish, birds, other wildlife? [WRD, CF, WQ, CC] 10. How will the net evapotranspiration change? (what is the impact the microclimate) [WRA, OWR, CD, RFA, CC, WQ] 11. What is the impact on health due to waterborne disease, malaria? [WRD, CF, RFA, WS] 12. How will navigation be impacted? [NAV, WRD]	Long term change in discharge of the White Nile (7) [2.1.3.1-4] Change in groundwater recharge/levels/quality (1) [2.1.5.7; 2.1.7.3; 2.1.3.1-4] Population displaced (number of people) (3) [2.1.5.12] Change in revenue due to displacement (2) [2.1.5.12] Change in fish habitat (2) [2.1.5.12] Change in swamp area – permanent, variable (4, 8) [2.1.5.13; 2.1.4.1-4] Change in revenue from reduction in available area for recession agriculture (2) [2.1.5.12] Maps of the area that is subject to seasonal inundation [2.1.4.1-4] Maps of area suitable for habitat (medicinal plants, papyrus, mosquitoes, fish, etc) (9, 11) [2.1.4.1-4] Change in sediment load in the White Nile (6) [2.1.5.16] Change in water quality in the White Nile (5) [2.1.7.3; 2.1.5.15 check] Change in ET at various locations (10) [2.1.7.1; 2.1.7.5] Water depth in the canal over time with respect to navigation criteria (12) [2.1.5.9; 2.1.5.2(2f)]

Use Case: No 5 Water Conservation in the Baro-Akobo Catchment.

Objective	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria)	TOR Requirements
[WRD] Water Resources Development(increase water yield from Baro-Akobo river) [ED] Hydro power generation. [OWR] More efficient water utilisation in upper Baro catchment. [RFA] Improve rain fed and irrigated agriculture. [WS] Wetland management in upper Baro and the Mashar marshes. [CF] Improve flood management. [ALL] Improve socio-economic and environmental development.	[ALL] Construction of multi purpose reservoir(s) for hydropower and irrigation. [WRD,OWR] Construction of diversion canals at Marshar marhes (removing water from the marsh). [WRD,CF,RFA,WS] Cultivation of swamps and ponds in the upper Baro Akobo catchment. [RFA] Irrigation development in the upper Baro.	[WRD,OWR] Determine the reservoir characteristics and location. [WRD,ED] Determine the number and capacity of HPP. [RFA] Determine the identify cultivated areas (to be supplied) [WRD,OWR] Determine the capacity of drainage canal from the swamp.t [ALL] Determine the environmental releases / wetland conservation / acceptable change of bio-diversity.	[all] What is the change of bio diversity (loss of habitat / i.e. area wetland) [ED] What is the hpp potential of the projected dams? [WRD,RFA] What is the increased yield resulting from cultivation of swamp and ponds. [WRD,OWR] What is the change of water yield from Marshar marshes area? [all] What are the socio-economic and environmental impacts from these projects.	[CF,RFA] Change in area of wetland. [ED] Total energy production. [ED] Unit cost of energy production. [RFA] Agricultural production (crop yield). [OWR] Change of yield (water budget) [all] Resettlement/displacement of people. [WRD,OWR,RFA] Change in evapotranspiration. [WS] Change in sediment loads.	2.1.4 GIS functionality 2.1.5 Water Allocation model 2.1.3.1 Statistical analysis 2.1.3.2 TS analysis 2.1.7.1 Rainfall-Runoff 2.1.7.2 Irrigation demand calculator 2.1.7.3 WQ 2.1.7.5 Evaporation. 2.1.6.1 Scenario management 2.1.6.2 Calibration tools 2.1.6.3 Direct scenario comparison 2.1.6.4 Optimization 2.1.2.4 User Defined Reporting

<u>Actors:</u>
Council of Ministers (ENCOM) – Senior Decision Makers
Eastern Nile subsidiary Action Program Team (ENSAPT) – Senior Decision Makers
Eastern Nile Technical Regional Office (ENTRO) – Modellers and Data Analyst

- Senior Program Officer - Modellers
- Researchers – Modellers and Data Analyst

Baro-Akobo Coordination unit - Modellers and data Analyst
Regional and National Working groups – stakeholders
Relevant Commission on National Scale - stakeholders

8 - Use Case Description: Evaluating trade offs of the dams planned in the Eastern Nile Power trade program

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
To develop the hydroelectric potential of the basin [WRD, ED, CC, OWR] To share the benefits of the development among the member countries [WRD, OWR] Reducing downstream flooding [WRD, CF] To Improve Navigation [NAV, WS] Irrigation [RFA, WQ, CC, WS, CD, OWR] Reduction of downstream sedimentation [WS, WQ] Notes: Actors: Council of Ministers (ENCOM) Nile subsidiary action program team (ENSAPT) Eastern Nile Technical Regional Office (ENTRO) Senior Program Officer Researchers Steering Committee Technical Committee Do we have an indicator for resiliency?	Construct reservoirs and dams [WRD, ED, OWR] Systems of Reservoirs [WS, WRD, OWR, ED, RFA, CC, CF, CD, NAV]	Determine the number of reservoirs [WRD, OWR, CF, CD, ED, RFA, WS, CC] Determine the capacity of the reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV] Determine the best location of reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV] Determine the operating rules of the reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC, WQ] Determine the initial filling plan/operating rules [WRD, OWR, CF, CD, ED, RFA, NAV] Determine the secondary benefits [WRD, OWR, NAV, WQ] Determine the proper sequencing of construction/development of multiple projects [WRD, OWR, ED, RFA]	1. What are the environmental impacts? [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC, WQ] 2. What are the socio-economic impacts? [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC, WQ] 3. What is the life of the dam in relation to sediment? [WRD, WS] 4. What is the projected power demand? [WRD, ED, WS, CC] 5. What are the secondary benefits of the project? (related to all of the secondary objectives) [NAV, WQ, OWR, WRD] 6. What are risks to projected benefits resulting from potential upstream development? [WRD, OWR] 7. What is the impact of climate change on the viability of the project (resilience/robustness and sensitivity – how sensitive is the decision to climate change)? [WRD, OWR, CC] 8. What project/system scheme gets me closest to my goal? [WRD, OWR, CF, ED, RFA] 9. What is the impact on navigation? [NAV, WRD, OWR, CF, ED, RFA] 10. What is the energy production for various scenarios? [WRD, OWR, ED, CC, WS] 11. how does the hydropower alternative compare with a Thermal power alternative? 12. What is the impact on downstream users?	With and without project discharge time series, minimum and maximum flows at all locations in the basin. (1, 2, 5, 7, 9,) [2.1.5.8; 2.1.5.15; 2.1.5.16; 2.1.3.1] Energy production by site, by country, aggregate (10) [2.1.5.8; 2.1.3.1; 2.1.5.14] Change in hydropower production downstream of project (10) [2.1.5.8; 2.1.5.14] Change in irrigation production (5) [2.1.7.2] Change in evaporative losses (system wide/other scales) (1) [2.1.7.5] Change in sediment transport (5) [2.1.5.16] Population displaced (2) [2.1.5.12; 2.1.4.3]* Map of habitat change for wildlife and birds (1) [2.1.4] Groundwater recharge (1) [2.1.7.1] Estimated fishery production by alternative (2) [2.1.5.12]* Unit cost of energy production (10) [2.1.5.11] Water quality parameters at various locations in the system (1) [2.1.7.3] HAD release (10) [2.1.5.8] MCA table (8) [2.1.8.1] Point data/spatial data (1, 2, 4, 10) [2.1.4] Comparison table of costs of alternatives (8) [2.1.8; 2.1.5.22] Comparison of thermal and hydropower alternative [2.1.8.1; 2.1.5.22]

9 – Use Case Description: What are the Impacts of afforestation plans for Watershed on Water Resources

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
Determine the Impacts of afforestation on Water Resources [CF CD WS CC RFA WQ] Ultimately, to compare and select among alternative plans Stated purposes of afforestation are: decrease erosion, increasing fuel availability, increasing timber for construction, decreases flood peaks, increasing infiltration and associated groundwater recharge	A specific plan for afforestation [CF CD WS CC RFA WQ]		1. What is the change in land cover? [RFA CD CF CC WS] 2. What is the change in water infiltration in groundwater? [CD CF WQ WS] 3. What will be the change in groundwater storage and/or the groundwater table? 4. What will be the change in soil moisture over time? [RFA CD] 5. What is the change in atmospheric humidity* [RFA, CD] 6. Will there be Increased discharge from springs during dry seasons? [RFA, CD] 7. What will be the change in stream flow? [CD CF] 8. What will be the change in soil erosion? [WS] 9. How will the peak flows change? [CF] 10. What will be the change in river and reservoir sedimentation? [WS WQ] 11. how much of the observed decline in lake levels is due to loss of forest, and how much is due to climate change? [CD CC] 12. Will water quality change as a result? [WQ] 13. how will the net evapotranspiration change? (what is the impact the microclimate) [CD, CC] 14. What effect will population/demographic changes have on water demand and water quality? [WQ, CD]	Maps of land cover (1) [2.1.4.3] Hydrologic outputs, summaries, and comparisons including runoff, infiltration, evapotranspiration, seasonal volumes, peak flows, lake levels, soil moisture (2, 4, 7, 9, 11, 13, 14) [2.1.7.1; 2.1.5.2; 2.1.7.5] Groundwater levels and groundwater pressure (3, 6) [2.1.5.7; Pressure not included]* Maps of land use [2.1.4.3] Sediment load at various locations in the watershed (8, 10) 2.1.7.4; 2.1.5.16] Universal Soil Loss Equation model output (8) [2.1.7.4] Water quality model outputs resulting from land use change, including nitrates, pesticides, phosphorus, etc. (12, 14) [2.1.7.3]

* useful information, not critical to DSS, not necessarily available through the DSS

Use Case: No 10 Flood Mitigation on the Blue Nile / Main Nile stretch.

Objective	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria)	TOR Requirements
[CF]Improved flood control [WRD]Water resources development [OWR]Optimal water utilisation [All]Improved water quality. [WRD]Improve groundwater recharge.	[All]Flood protection structures (dams, dikes, embankments) [OWR,CF,CD]Change operation policies in dams.	[All] Determine Size, capacity, location of structures incl. dams. [OWR,CF,CD] Determine the operation rules for the structures.	[CF] What is the flood risk? [CF] What is the most cost/effective flood protection alternative? [All] What is the benefit (costs and benefits) [CF] What is the flood damage related to the different interventions? [CF] What are the environmental and socio-economic impacts? [WS] What is the amount of sediments that are trapped in reservoirs and structures?	[All] Inflows to dams and at structures. [All] Water levels [CF] Flood risk maps Extent of flooded area, flood frequency, flood duration, flood depth. How will the flood event affect deceases (decease indicators can be developed based on model outputs) [CF,RFA] Number of persons affected, number of households affects, Agricultural areas affected. [WS] Sediment concentrations.	2.1.3.1 Stat tools 2.1.3.2 Time series tools 2.1.5.15 1D Hydraulic model 2.1.5.13 Lateral inflows/catchments 2.1.5.16 Sediment transport 2.1.7.1 Rainfall Runoff 2.1.7.8 (D) Fully Distributed RR 2.1.7.3 WQ model 2.1.5.3 Geo reference network 2.1.5.11 CBA 2.1.5.12 Tools for making criteria 2.1.6.2 Calibration tools 2.1.6.3 Direct scenario comparison 2.1.4 GIS functionality 2.1.2.4 User Defined Reports

<u>Actors:</u>
Council of Ministers (ENCOM) – Senior Decision Makers
Eastern Nile subsidiary Action Program Team (ENSAPT) – Senior Decision Makers
Eastern Nile Technical Regional Office (ENTRO) – Modellers and Data Analyst

- Senior Program Officer - Modellers
- Researchers – Modellers and Data Analyst

Eastern Nile Flood Preparedness and Early Warning Unit – Modellers and data Analyst
Regional and National Working groups – stakeholders
Relevant Commission on National Scale - stakeholders

Use Case: No 12 Drought Management Planning (NEL regions)

Objective	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria)	TOR Requirements
[OWR] Optimal water resources utilisation. [RFA] Increased agricultural production. [CD] Reduce drought impact. [CD] Coping with droughts and drought management planning.	[CD,OWR] Drought management planning [WRD,OWR] Inter basin transfers [WRD,OWR] Groundwater utilisation. [WRD,OWR] Artificial groundwater recharge (ASR) [WRD,OWR,CF,CD] Construction of reservoirs. [OWR,CD] Operation of reservoirs to sustain droughts (better). [WRD,OWR,CD,WS] Rainwater harvesting. [OWR,CD] Water demand management. [OWR,CD,RFA] Water pricing. [OWR,CF,RFA] Supplemental irrigation.	[WRD,CD] Determine Reservoir characteristics and location. [OWR,RFA] Determine the areas to receive supplemental irrigation. [WRD,OWR,CD] Determine the design of groundwater abstraction schemes. [WRD,CD] Determine location and type of rainwater harvesting installations. [OWR,CD] Determine the water services pricing strategy	[WRD] What is the suitable drought indicators (accounting for current water storage, past rainfall, projected future rainfall) [RFA] What is the crop losses assuming certain drought triggers and drought management strategy (e.g. supply reduction levels). [OWR,CD] What is the drought response triggers (e.g. water levels)	[OWR,CD] CBA for different Drought Management Plans [PWR,CD,WS] Trend of past rainfall and projected rainfall patterns [WRD,OWR] Optimal reservoir(s) capacity, operation rules. [OWR] Maps of affected areas. [WRD,PWR,CD] Optimum/possible GW abstractions. [All] Minimum flows for environment. [PWR,CD,RFA] Amount of crop loss for each drought management strategy	2.1.5 Water allocation model 2.1.4 GIS functionality 2.1.3.1 statistical tools 2.1.3.2 TS tools 2.1.7.2 Irrigation demand calculator 2.1.7.1 Rainfall Runoff 2.1.7.5 Evaporation 2.1.6.4 Optimization 2.1.2.4 User defined reports

<u>Actors:</u>
Eastern Africa Commission (EAC0 – Head of States
Council of Ministers (NELCOM) – Senior Decision Makers
Nile Equatorial Lakes Advisory Committee (NELTAC) – Senior Decision Makers
Nile Equatorial Lakes Coordination Unit (NEL-CU) – Modellers and Data Analyst

- Senior Program Officer - Modellers
- Researchers – Modellers and Data Analyst

Lake Victoria Basin Commission (LVBC) - stakeholders
Regional and National Working groups – stakeholders
Relevant strategic/planning Commission at National Level - stakeholders

14 - Use Case Description: Reduce impacts of sea level rise on morphology of the northern coast and salinisation of groundwater in the delta

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
Protect the national wetland in the coastal zone [WRD, OWR, CF, CC, WQ, WS] Integrated management for the coastal zone [WRD, OWR, CC, WQ] Improve the water quality in groundwater aquifer in the coastal zone as a result of saltwater intrusion [WRD, OWR, WQ, CC] Improve the water quality and drainage system to protect the wetland in the coastal zone [WRD, OWR, WQ, CC, CF] Asses the current and future vulnerability of sea level rise and other climate change variability [WRD, CF, CC, WQ]	Changes in the operation of HAD. [OWR, WRD, CF, CD, CC, WQ, ED] Tradeoff among treatment technologies in the runoff system [WRD, OWR, WQ, CC] Tradeoff among unconventional water resources: Desalinization of brackish groundwater, recycling, artificial wetland, instream wetland [WRD, OWR, WQ, CC] Improved irrigation techniques [WRD, OWR, CC, WQ, RFA] Change the cropping patterns to use crops with higher tolerance to salinity [WRD, OWR, WQ, CC] Infrastructure measures [WRD, OWR, CC] Channel improvements on the delta branch [WRD, OWR, WQ] Improvements of sewer network and drainage canal [WRD, OWR, WQ]	Determine the best combination of interventions (investments) to most effectively reduce impacts and achieve the objectives [WRD, OWR, WQ, CC]	1. What is the situation for current and proposed alternatives regarding: - How much water is being extracted from the groundwater aquifer? [WRD, OWR, WQ, CC] - How much water is in the groundwater aquifer? [WRD, OWR, WQ, CC] - What is the current area under cultivation with various crops [WRD, OWR, WQ, CC, RFA] - What is the current area of wetlands that can be supported by the current water quality? [WRD, OWR, WQ, CC] - What are the consumptive demands for current water uses? [OWR, WQ, CC, RFA] - What is the current level of salinity? [WQ, OWR, WRD] 2. How much water can be extracted without experiencing saltwater intrusion? [WRD, OWR, WQ, CC] 3. what is the spatial extent of saltwater intrusion? [WRD, OWR, WQ, CC] 4. What are the costs associated with each of the development alternatives? [WRD, OWR] 5. What are the impacts of various additional releases from the HAD to reduce impacts.[WRD, OWR, WQ, CC, NAV, CF, CD] 6. What is the best schedule for investment? (not reflected in DSS outputs) ? 7. What is the potential pollution in coastal area resulting from water quality degradation in the drainage system [WRD, OWR, WQ, CC]	Many of the following items are provided for each alternative, which can then be compared against the others: Demand time series for agricultural production (1) [2.1.7.2; 2.1.3.2; 2.1.8; 2.2.6; 2.2.5; 2.2.3] Groundwater levels and groundwater pressure [2.1.5.7; 2.1.8; 2.2.6; 2.2.5; 2.2.3] Supplementary release from HAD (difference between available water in the delta and the current demand) [2.1.5.19; 2.1.5.6; 2.1.6.1; 2.1.8; 2.2.6; 2.2.5; 2.2.3] Maps of areal extent of land suitable for wetlands (1) [2.1.4] Maps of land use (1) [2.1.4] Current water demand/predicted water demand (5) [2.1.5.1-3, 5, 6; 2.1.3; 2.1.8; 2.2.6; 2.2.5; 2.2.3] economic yield from various areas/nodes in the system (5) [2.1.5.11; 2.1.5.2-3; 2.1.3.1; 2.1.5.12; 2.1.4; 2.1.8; 2.2.6; 2.2.5; 2.2.3] Maps showing the extent of seawater intrusion into the groundwater; groundwater quality maps; water quality/salinity profile map. (2, 3) [2.1.4; 2.1.7.3; 2.1.5.7] Net economic benefits from each alternative (4, 5) [2.1.5.11; 2.1.5.2-3; 2.1.3.1; 2.1.5.12; 2.1.8; 2.2.6; 2.2.5; 2.2.3] Biological, physical, and chemical water quality parameters (7) [2.1.6.1; 2.1.6.2; 2.1.6.4; 2.1.6.7; 2.1.7.3; 2.1.7.2; 2.1.7.4; 2.1.8; 2.1.4; 2.2.1.3; 2.2.6; 2.2.5; 2.2.3]

15 - Use Case Description: Development Plan for HPP, Irrigation and Navigation in the Nile Equatorial Lakes region

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
Determine if : The water available will be sufficient to cater for all the planned activities at once. [WRD, OWR, CF, CD, ED, RFA, NAV] Abstraction of water from the lakes will alter the fish breading grounds and hence affect the fisheries industry immensely. [OWR, WQ] Submerging of the rapids would adversely affect the tourism industry in the region and the aesthetics of the area. [WRD] Converting of the swamps into irrigated land will clear the breeding grounds of birds and hence affect the tourism industry. [RFA, WRD, OWR] Development of the proposed infrastructure would interrupt the fisheries industry by destroying the fisheries breeding grounds. [WRD, RFA, OWR, CF] Proposed Irrigation schemes in the Kyoga area will be destroyed by floods during rainy seasons. [RFA, CF, WRD]	Construct dams [WRD, OWR, RFA, NAV, WS, ED, CC, WQ, CF, CD] Irrigate from Lake Victoria [WRD, OWR, RFA, CD] Change operations of Lake Victoria and Albert to improve navigation [NAV] Construct Run-of River hydropower plants [WRD, ED]		1. How much electricity can be generated from the various alternatives [ED] 2. What are the negative consequences of the various alternatives (increased evaporation, displacement of people) [WRD, ED, CD, RFA, WQ, CC] 3. Will a given alternative submerge the rapids, and what impact might that have? [WRD, ED] 4. How much water can be taken out of Lake Victoria for any purpose without having an impact on fishery breeding ground? What about for navigation? [OWR, NAV, RFA, WRD] 5. Does the proposed irrigation area in the Kyoga region flood enough to be destroyed by floods during the rainy seasons? [CF, RFA, WRD] 6. How much of the wetland can be converted into irrigated agriculture? [WRD, RFA] 7. What is the economic cost of lost tourism revenue from converting wetland to agriculture? [RFA] 8. What are the environmental or other impacts? [WS, WQ] 9. What is the increased crop production compared with rainfed irrigation? [RFA] 10. What sedimentation impacts will be found in lakes and reservoirs? [WS, WQ]	Hydropower production time-series and summaries (1) [2.1.5.14; 2.1.5.8] Population displaced by proposed reservoirs (2) [2.1.5.12; 2.1.4.3]* Evaporation loss from reservoirs (2) [2.1.5.8] Consumptive water demand from irrigated agriculture [2.1.7.2] Maps of inundated area from dam construction (3, 8) [2.1.4.3] Water available for abstraction [2.1.5.19] Hydrologic outputs, summaries, and comparisons including runoff, infiltration, evapotranspiration, seasonal volumes, peak flows, lake levels, soil moisture (4, 5, 8) [2.1.5.2; 2.1.7.1; 2.1.7.5; 2.1.5.8] Frequency of flood impacts to crops during the rainy season, associated economic impacts [2.1.5.11; 2.1.5.2(h); 2.1.5.13] Frequency of violating breeding or navigation criteria (4, 8) [2.1.5.2(2)] Tradeoff curves between agricultural benefits of irrigation and downstream power generation benefits (9) [2.1.6.3; 2.1.5.1] Sedimentation rate in existing and proposed lakes/reservoirs (10) [2.1.5.16] Land use and land cover maps (6, 7) [2.1.5.3] Soil maps (6) [2.1.4.3] Alternative cost comparison tables (7) [2.1.5.11] Tables of crop production (9) [2.1.7.2]

19 - Use Case Description: Eastern Nile Joint Multi-Purpose Project

Objective (including secondary benefits)	Possible Alternatives /Interventions	Sample Decisions	DSS Questions	DSS Outputs (Criteria) and related TOR Requirements
Develop untapped hydropower potential in the Blue Nile Basin in Ethiopia [ED, WRD, CC] Mitigate for reduced effectiveness of existing reservoirs on the Blue Nile in Sudan and Main Nile in Sudan and Ethiopia due to sedimentation [WRD, WS, CF, WQ, CC] Develop untapped irrigation potential on the Blue Nile in Sudan [RFA, CD, WQ, CC]	Hydropower dams in Ethiopia [EP, WRD, CC] Irrigation and flood control dams/projects on Blue Nile in Sudan [RFA, CD, WQ, CC, CF]	Determine the number of reservoirs [WRD, OWR, CF, CD, ED, RFA, WS, CC] Determine the capacity of the reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC] Determine the best location of reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC, WQ] Determine the operating rules of the reservoirs [WRD, OWR, CF, CD, ED, RFA, NAV, WS, CC, WQ] Determine the initial filling plan/operating rules [OWR, CD, ED, RFA, NAV, WS, WQ] Determine the secondary benefits (instream flows, navigation, fishery production, etc) [WRD, OWR, NAV, WQ] Determine the proper sequencing of construction/development of multiple projects [WRD, OWR, ED, RFA] Determine number, size, location, of irrigation schemes [WRD, OWR, CD, RFA, WS, CC, WQ] Determine type of crops to be grown, and cropping patterns [CD, RFA, OWR, CC]	1. What is the best strategy to develop hydropower potentials on the Blue Nile in Ethiopia? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 2. What are the positive and negative impacts of proposed alternatives downstream of the hydropower dams on the Blue Nile in Ethiopia? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 3. What is the Irrigation and flood control (and possibly hydropower) development and management potential downstream of the Ethiopian dams on the Blue Nile? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 4. What are the trade-offs (sectoral, country-wise, upstream-down-stream) if hydropower dams are developed in the Blue Nile Basin in Ethiopia for each alternative? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 5. What are the trade-offs between irrigated and rain-fed agriculture? [RFA, WQ] 6. What are environmental impacts of developments? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 7. What are the other socio-economic impacts? [WRD, OWR, ED, CF, CD, NAV, RFA, WS, CC, WQ] 8. How would potential climate change affect the decisions that would be made? CC	With and without project discharge time series, minimum and maximum flows at all locations in the basin. (1-4) [2.1.3.1-4] Minimum river water levels for navigation (4) [2.1.5.2(2f); 2.1.5.9] Energy production by site, by country, aggregate (1-4); Change in hydropower production downstream of projects (4) [2.1.5.14; 2.1.5.8] Impact on irrigation production (5) [2.1.7.2; 2.1.5.2(2b); 2.1.6.3] Additional and total water available for irrigation purposes (3) [2.1.7.2; 2.1.5.2(2b)] Reduction in peak discharges (2, 3) [2.1.3.1-4; 2.1.5.4; 2.1.6.1-5; 2.1.5.8] Maps of inundation frequency (2, 3) [2.1.4.1-4; 2.1.3.1-4] Change in evaporative losses (system wide/other scales) (2) [2.1.7.5; 2.1.7.1(2c); 2.1.5.8(8)] Evaluation of instream flow compared to minimum flows at specific locations for each alternative (6) [2.1.3.1-4; 2.1.5.2(2f); 2.1.5.9; 2.1.5.4] Change in sediment transport [2.1.5.16; 2.1.7.3(3)] Resettlement impacts (7) [2.1.5.12] Map of habitat change for wildlife and birds (6) [2.1.4.1-4; 2.1.5.12] Groundwater impacts – water level and quality [2.1.7.3; 2.1.5.7] Estimated fishery production by alternative (7) [2.1.5.12; 2.1.6.1] Unit cost of energy production (1,2) [2.1.5.11(3); 2.1.6.1] Change in water quality parameters at various locations in the system (6) [2.1.7.3; 2.1.6.1; 2.1.5.2; 2.1.5.3; 2.1.5.4; 2.1.3.1-4] Change in reservoir storage and release at downstream locations (4) 2.1.5.4; 2.1.3.1-4; 2.1.6.1-4; 2.5.1.8] MCA tables comparing alternatives (1) [2.1.8.1-6] Tradeoffs between hydropower and irrigation among alternatives (5) [2.1.5.2; 2.1.5.8; 2.1.5.11; 2.1.5.13; 2.1.5.14; 2.1.7.2; 2.1.6.1-4]

Appendix B.3

Original Use Cases

Use Case Document

Title: Use Case 01: Determine causes for declining of lake Victoria water level

Version	Use case ID	Changed By	Date

Brief Description:	**Background:** There is public concern regarding the falling levels of the Lake Victoria. The drop in lake levels has affected the socio-economic activities in the three east African countries of Uganda, Kenya and Tanzania that directly depend on the Lake's water resources notably, through the prevailing power cuts, fall in fish supplies, unsafe docking of lake transport vessels, hanging domestic water supply intakes, etc. It has also caused environmental effects such as the drying of wetlands on the lakeshore line which are breeding grounds for fish. **Key questions:** the following questions are expected to answered after implementing this use case: - Does the net basin supply show significant downward trend? - Is the departure from the agreed curve the primary cause of decline in lake water level? - Can Lake Victoria sustain the releases as determined by the agreed curve?
Business Trigger:	Decision by the ministers of water affairs to identify main causes for declining of lake water level
Preconditions:	- Minimum set of data required for the analysis available (rainfall, evaporation, downstream release, stream flow)
Selected information products to be generated (Key indicators)	- Time series of key climatic and hydrologic variables - Trends in lake rainfall, evaporation, stream flow, lake water level and downstream release and their significance levels - Proportional contributions of trends in net basin supply (rainfall + stream flow – evaporation), and downstream release to lake water level decline (in average m/year) - Water balance model for lake Victoria
Actors	Technician - Prepare all data required for the study Modeller - Examine data prepared for study and make adjustments, if required - Setup lake water balance model - Conduct trend analysis, simulate lake water balance - Generate reports Communications expert - Prepare communications material for decision makers, media and other stakeholders Decision makers - Review study results - Decide on follow on studies if required

Use Case Document

Title: Use Case 01: Determine causes for declining of lake Victoria water level

Normal flow: To be used under circumstances: - main purpose is to determine initial identification of possible causes to propose follow on studies, - limited/expertise time available for more thorough investigation,	• Generate annual time series of lake water level (example, average of daily water levels for the first month of each hydrologic year) • Plot annual lake water level time series • Determine (from visual inspection) the breaking point of the annual water level series (year at which the downward trend commenced) • Determine the trend in lake water level (average decline in meters per year) • Determine the trend (including significance levels) in downstream release • Determine trends in net basin supply (rainfall over lake - evaporation + total inflow into the lake); • For all significant trends determine average increase/decrease in MCM per year • Convert the average increase/decrease (in net basin supply and release) into depth of water over lake surface area (taking the average water level of the first month of the hydrologic year for entire time series) • Determine the proportion (percentage) of total average water level decline (m/year) explained by each of net basin supply and downstream release. • Summarize results into a table showing the percentage contribution • Determine unexplained proportion of the decline in water level (due to unaccounted for inflows/outflows) • Generate report showing plots of all time series, table summarizing average trends and proportion explained by trend in each time series, and unexplained trend • If unexplained part of the downward trend is significant (more than the average percentage exhibited by the time series of rainfall, evaporation, stream flow and downstream release), provide recommendation on follow on studies
Alternate flows: To be used under circumstances: - main purpose is to determine if downstream project release is main cause of the decline in lake water level	• Determine annual time series of observed lake rainfall, evaporation, stream flow, and lake water level (average of daily values for the first month of each hydrologic year, designated as lake water level series 0) • Plot annual lake water level time series • Determine the breaking point (year at which the downward trend commenced) of the annual water level series • Set up an annual water balance model of the lake (using measured/estimated values of inflow and outflow) • Using the water balance model, generate time series of annual lake water levels with the release based on agreed curve (this series designated as lake water level series 1) • Using the water balance model, generate annual lake water level time series with the release determined from lake level vs. natural lake outflow relationship (water level series 2) • Determine the trends in lake water level of series 1, and 2 and their significance levels • Prepare time series plot of lake water level 0, 1, and 2 • Generate report with plots of the time series, summary table on trends of the time series, and the conclusions: a. If trend of water level series 2 is not significant, then i. If trend of water level series 1 is not significant then the increase in downstream release from the agree curved is main cause for declining water level b. Else, the main cause of the downward trend in lake water level is reduced net basin supply, which makes the lake unable to support water abstraction levels under the agreed curve
Frequency of use	As per request (not frequent)
Notes and issues	

Use Case Document

Use case 02: Sequencing of investments for HPP on the Victoria Nile

Version	Description	Changed By	Date

Brief Description:	The Victoria Nile countries wish to maintain and expand an affordable, reliable and sustainable electric supply to promote economic and social development. A number of plans and studies exist for hydropower development in the Victoria Nile region. All the planned HPP schemes are run-of-the-river therefore their operation is directly controlled by the releases at the Owen falls. The actual sequencing of hydropower development will depend on a number of factors that include economic, power demand, environmental and social considerations.
Business Trigger:	Decision of sequencing of Hydropower development schemes
Preconditions:	a) Agreed scenarios to be investigated as part of the investment sequencing study (with relevant data) • Base case – existing situation • Base case + two hydropower dams • Base Case + Three Hydropower dams • Base case + Four Hydropower dams. • Different operational release rules of L. Victoria with Alternate sequencing of HP development b) Agreed set of issues for sequencing study (attributes using which the performance of each scenario is to be determined): • Generation capacity to meet the demand • Unit cost of generation • Impacts to the low flows into the Sudd • Reservoir filling times c) Set of agreed conditions under which sequencing of development shall be evaluated • Short term: reservoir filling time • Long term: reservoir sedimentation during operation

This analysis explores the sequence of new hydropower plants that ensures that firm energy meets the energy demand targets and maintains water levels of L. Victoria at levels that don't impact on fisheries, navigation and other ecosystems around the lake. The sequencing may not alter significantly the river flows to the sudd during dry periods. The analysis also considers cost of production per unit kwh for each site.
1. Pre-Condition: spatial, hydro-meteorological and HPP system data on proposed schemes available, reservoir locations with optimum reservoir sizes are identified, Developed hydropower demand time series.
Indicators to be used for decision - minimum flows to the Sudd

- Dependable power capacity and firm energy generation or Energy Demand target deficit
- L. Victoria minimum observed water levels
- Unit generation cost

Setting up the baseline model

2. Setup a model for the base case
3. Run the water allocation and hydropower model
4. Verify the outputs of the model with real data.
5. Calibrate the model where necessary
6. Save the model

Alternative 1

1. Determine a combination of two dams
2. select two hydropower dams randomly from combinations
3. Update the baseline model with one Hydropower dam among the selected dams of step 2
4. Run the model with the new setup
5. Determine the energy generation
6. Modify the lake Victoria operation rule for reservoir filling and operation
7. Determine observed minimum lake levels and its impact on Navigation.
8. Determine the minimum flows to the Sudd
9. Determine the cost of production per unit Kwh.
10. Repeat steps 2-8 with additional one dam.
11. Repeat all the above steps with reverse order of the two dams
12. From model outputs, Establish relationships in such a way that indicators are addressed.
13. Run the model for all combinations
14. Prioritize and rank the options.
15. Select the “best” sequence

Alternative 2

1. Update the Model with one additional dam taking the selected sequence(two dams) from alternative 1
2. Do the same as alternative 1 from steps 4-15

Alternative 3

3. Update the Model with one additional dam taking the selected sequence(three dams) from alternative 1
4. Do the same as alternative 1 from steps 4-15

Use Case Document

Title: Use case 03: Analyzing Water Quality: Deterioration of Lake Victoria Water Quality

Version	Description	Changed By	Date

Brief Description:	The NELSAP/East African Council of Ministers has decided to investigate the state of Lake Victoria water quality and reasons for the alleged deterioration of the quality of water. The study is also expected to recommend appropriate measures to improve water quality in the lake and prevent/reverse the deterioration of the same. One of the most visible sign of degrading lake environment is the proliferation of water hyacinth in the 1990's and re-emergence of the same lately.
Business Trigger:	Decision by NEL/EAC COM to investigate the state of Lake Victoria water quality.
Preconditions:	• Investigate the state of lake eutrophication which in caused by increased nutrients loading into the lake. Nutrients come from different sources, i.e. agricultural activities, erosion and transport of soil containing nutrients, untreated sewage and solid waste discharge and direct deposition of nitrogen and phosphorus form the atmosphere. • Investigate if proliferation of water hyacinth is linked to eutrophication of the lake.

This investigation examines if increased nutrients loading into Lake Victoria has caused the lake, partly or wholly, to reach eutrophic levels and consequently the deterioration of its water quality. Lake trophic classification in order of increasing severity start with ultra-oligotrophic, oligotrophic (ordinary), mesotrophic (moderate), eutrophic (strong) and hypertrophic (high/severe). Each classification represents certain water quality state and has linkage to state of fish's production and/or proliferation of water hyacinth.

Pre-Condition: spatial, hydro-meteorological and water quality data in the lake and rivers, and other systems that feed into the lake exist.

Indicators to be used for decision

A number of criteria can be used but in terms of the lake trophic classification given above the following are required

- Nutrients concentration particularly mean total phosphorus
- Algae biomass concentration, Chlorophyll-a both annual mean and maximum and/or total Particulate Organic Carbon (POC)
- Transparency both annual mean and maximum
- Degree of dissolved oxygen

Use Case Document

Title: Use case 03: Analyzing Water Quality: Deterioration of Lake Victoria Water Quality

Setting up the baseline model

To identify the long-term impact of land use on non point sources pollution, a water quality model need to be set-up to determine the actual nutrients load trend into the Lake for correlation purposes

1. Setup a model for the base case
2. Run the rainfall-runoff model
3. Run the sediment yield/erosion model
4. Run the water allocation model
5. Run the sediment transport/water quality model
6. Verify the outputs of the model with real data.
7. Calibrate the model when necessary
8. Save the model

Because the water quality of Lake is the sum of all the inputs and outputs to and from the lake, together with the reaction of the ecosystem to these inputs and outputs a lake water quality model need to be set-up to determine the state of lake water quality in relation to nutrients loading (eutrophication)

1. Setup the lake Water quality model
2. Run the hydrodynamic/water quality model
3. Verify outputs with real data
4. Save the model

From the results determine the state of Lake Eutrophication and its consequences and determine mitigation measures if need be.

Confirm the deterioration of the lake ecosystem, through correlation analyses as the lake is generally considered eutrophicating as algal blooms and invasive water weeds, particularly water hyacinth, proliferate.

Use Case Document

Title: Use case 04: Consequences of Completion of Jonglie canal

Version	Description	Changed By	Date

Brief Description:	**Background:** The primary objective of the Jonglie canal Project was to conserve around 4.7 billion meter cube of water that is lost in the Sudd swamp mainly through evaporation and make it available for downstream use. The project was terminated in 1983 after completion of 260 km out of the total 360km. The EN-COM has realized the benefits of gaining additional water for various uses downstream and agreed to investigate the consequences, both positive and negative, that might occur due to the completion of the canal. **Key questions:** the following questions are expected to be answered through the implementation of this use case: - How much water can be conserved if the Jonglei canal project is completed? - What would be the total changes in the inundation patterns of the Sudd wetland (spatial extent, depth, etc)? - What are the estimated impacts in community livelihoods? - What would be the approximate volume of water to be conserved to keep environmental and socio-economic impacts to acceptable limits?
Business Trigger:	Decision of EN-COM to analyze the consequence of completion of the Jonglie canal.
Preconditions:	a) Minimum required dataset are available (hydro-meteorological, Swamp extent and depth, environmental, socio-economic data, and canal main features) b) Agreed set of criteria and indicators to analyze the consequences

Selected information products to be generated (Indicators)	- Volume of water conserved (total volume and time series), - Total area reclaimed for agriculture - Extent of change in swamp area (permanent and seasonal) and its impacts on the livelihood of the community (decrease in livestock grazing area, fishery production etc.) - Impacts on the flora and fauna that exist in the swamp. - Total benefit from conserved water (by economic sectors, irrigation, hydropower, navigation)
Normal flow	**Setting up the baseline model** 1. Setup a model for the base case (from Inlet to outlet of the swamp without canal) 2. Run water allocation and reservoir simulation models 3. Determine the water lost and outflow from the swamp 4. Verify the outputs of the model with real data.

	5. Calibrate the model when necessary 6. Save the model **Analyse the consequences** 1. Update the baseline model with completion of the Jonglie canal. 2. Run the model with the new setup for a few pre-set levels of water abstraction levels (levels of abstraction as input), for each level: a. Determine the amount of water that can be conserved b. Determine the benefit gained from the water conserved for irrigation and hydropower in downstream. c. Determine area reclaimed for agriculture and its benefits d. Use the user defined function to convert model outputs to selected (agreed) indicators (impact (loss) on livestock, fishery production, impact on flora and fauna) e. Populate the MCA with indicator values for the current level of abstraction 3. Run the MCA tool under agreed set of criteria. 4. Select the “best” option

Use Case Document

Title: Use case 05: Integrated Water Resources Development of the Baro-Akobo Basin

Version	Description	Changed By	Date
D-02	The second draft of the Use Case of the integrated water resources development of the Baro-Akobo Basin	Yasser Elwan	14 June 2009

Brief Description:	Background: The Eastern Nile Council of Ministers agreed to develop the Baro-Akobo Basin for integrated water resources purposes that consider increase the energy in the region by developing a series of Hydropower dams in the Baro-Akobo Basin, and to develop irrigation projects through supplementary irrigation and water harvesting in the upper Baro-Akobo Basin as well as increase the yield by the upper Baro-Akobo through the development of drainage system. Moreover, to investigate the water conservation options in Mashar Marches in Lower Baro-Akobo taking into account the impacts on the wetlands and wildlife in the Mashar Marches as well as the socio-economic and environmental impacts on the Eastern Nile Countries. analysis. The following key questions will be answered by this use case. • To what extent irrigation can be developed? • How much water can be conserved from mashar marches? • What will be the energy generation? • What are the socioeconomic impacts?
Business Trigger:	Decision of EN-COM for the integrated water resources development of the Baro-Akobo Basin.
Preconditions:	a) Agreed scenarios to be investigated as part of the Integrated Water resources development (with the availability of the relevant data) • Base case – existing situation • Alternative 1: Base case + Hydropower Dams Upstream and downstream of Mashar marshess • Alternative 2: Base case + Construction of Canal in Mashar Marches • Alternative 3: Base case + Agriculture Development of upper Baro-Akobo with construction of Drainage system and rainfall harvesting b) Agreed set of Water Resources interventions (attributes using which the performance of each scenario is to be determined): upstream power/energy production vs. • Upper Baro-Akobo irrigation • Upper Baro-Akobo Conservation • Mashar Marches water conservation • Water level of HAD; its impact on energy generation and operation of the reservoir. • Downstream Irrigation. c) Set of agreed conditions under which impacts of planned developments shall be evaluated • Minimal environmental impacts on the Mashar Marches wetlands.

	• Socio-economic development for the Eastern Nile Countries.

Selected information products to be generated **(Indicators)**	- Maximum energy production from hydro power - Maximum and minimum reservoir outflows. - Reduced area of the wetland - Increased agricultural production in the upper baro – Akobo - Increased water availability at HAD
Normal flow	**Setting up the baseline model** 1. Setup a model for the base case 2. Run the water allocation model 3. Verify the outputs of the model with real data. 4. Calibrate the model when necessary **5. Save the model** **Alternative 1** 1. Determine locations and optimum sizes of reservoirs – Separate use case 2. Determine sequencing of investment/development –Separate use case 3. Update the baseline model with Hydropower dams identified in steps 1 4. Run the model with the new setup 5. Determine the energy production 6. Determine reservoir filling times 7. Determine the change in wetland area in Mashar marches. 8. Determine the impacts on irrigation, navigation, flood, operating levels of HAD (reduced water for irrigation, reduced water level for navigation, area protected from flooding, impacts on energy generation from HAD) 9. Analyse the increased benefits downstream with respect to dams 10. Optimize operation rules of hydropower dams to reduce losses of evaporation in masher marches area. 11. establish relationships between reservoir inflows and outflows (according to sequencing of development) and change in area of masher marches with time step. 12. establish relationship between reservoir outflows and change in river flows downstream 13. establish relationship between the regulated flow and the natural flow of the river. 14. establish relationship between changes in area of mashar marches and affected people. 15. repeat the above steps with upstream irrigation development. 16. CBA 17. develop criteris for the best option selection – User defined 18. Prioritize and rand options 19. Select the best option

	20.
	Alternative 2 1. Setup the model with diversion canal at mashar marches 2. Determine the change of the Bar-Akobo yield through the construction of diverting canal at Mashar Marches. 3. Determine the environmental impacts on the wetlands and wildlife. 4. Determine energy production 5. Analyse the trade-off – separate use case 6. establish relationships between the diverted (drained) water and socio environmental impacts 7. repeat steps 2-6 with different canal capacities 8. CBA 9. establish criteria for selection 10. Prioritize and rank the different canal capacities 11. Select the best option **Alternative 3** 1. Determine the scale of Agriculture production in Upper Baro-Akobo. 2. Setup the model with the new irrigation land 3. Determine the Water conserved from the agriculture drainage and rainfall harvesting 4. Determine the environmental impacts on the wetlands and wildlife in Mashar Marches. 5. Determine energy production. 6. Determine socio-economic benefits 7. Analyse the trade-off – separate use case 8. repeat steps 2-7 with different irrigation areas 9. CBA 10. establish selection criteria – user defined 11. Prioritize and rank options in accordance with the agreed criteria 12. Select the “Best” Option

Use Case Document

Title: Use case 06: Catchment management plan for Lake Kyoga and Albert

Version	Description	Changed By	Date

Brief Description:	Government of Uganda has established a water resources management framework that is hinged on decentralized water resources management. Lake Kyoga and Lake Albert catchments have been designated as two of the four Catchment Management Zones (CMZ) of the Country. Catchment Management Committees will be set up that will be tasked to develop Catchment Management plans in consultation with stakeholder groups. The key objectives of the plan are • Reduce suspended solids due to erosion and mining • Reduce nitrate pollution due to urban domestic waste and agriculture • Reduce floods that lead to loss of crops and damage to infrastructure • Provide adequate water for hydropower and irrigation
Business Trigger:	Implementing government policy which draws on other national and international strategies to managing water resources at the most appropriate geographical unit - which is the Catchment
Preconditions:	a) Agreed scenarios to be investigated as part of the CMP development process. (with relevant data) • Base case – maintain status quo • Scenario 1: Base case + afforestation • Scenario 2: Base case + good practises w.r.t Crop mgt, grazing mgt, vegetation mgt., • Scenario 3: Base case + levies • Scenario 4: Scenario 2 + envisaged land use changes b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): Catchment management vs. • Agricultural production • Flood protection downstream • Energy production c) Set of agreed conditions under which tradeoffs shall be evaluated • During the long term implementation of the management plan.

This analysis explores the tradeoffs associated with various catchment management strategies
Pre-Condition: spatial, hydro-meteorological and economic data in Lake Albert and Lake Kyoga catchments exist
Indicators to be used for decision - Hydrology –flow volume and timing same or close to the pre 90s hydrology. - Water quality – reduction in nutrient enrichment, turbidity, salinity etc of water resources

- Groundwater – improvement in aquifer recharge.
- Damage reduced at designated flood prone areas
- Improved availability of water for irrigation and domestic use. change in energy production at existing power plants downstream

Setting up the baseline model

1. Setup a model for the base case
2. Run the water allocation model
3. Verify the outputs of the model with real data.
4. Calibrate the model when necessary
5. Save the model

Trade-off analysis (scenario 1)

1. Change baseline model to incorporate afforestation in appropriate areas
2. Run the model with the new setup
3. Determine changes in flow volumes and timing
4. Determine changes in nutrient enrichment, turbidity, salinity etc of water resources reservoir minimum filling time
5. Determine flood impacts within the catchment.
6. Determine available water for irrigation
7. Determine impact on hydropower production
8. Undertake a cost-benefit analysis of various catchment management strategies visa vie the social, economic and environmental benefits.

Trade-off analysis (scenario 2,3 and 4)

1. Update baseline model for scenario 2, 3 and 4.
2. Repeat steps 2 though 8 in the above trade-off analysis
3. Run the MCA tool under agreed set of criteria and select the pest option best on the social, economic and environmental scales.

Automatically generate a catchment management guideline with;

Tables showing the recommended land use areas, agronomical practices, water allocation schedules, and surface - groundwater conjunctive use.

Maps showing recommended land use and agronomical practices, location of water users and demands.

Graphs showing variation of water demand by the various water users and how the demand is satisfied.

Use Case Document

Title: Use case 07: Optimizing the use of reservoirs in the Blue and main Nile stretch

Version	Description	Changed By	Date

Brief Description:	**Background:** The Eastern Nile Council of Ministers agreed to increase the availability of energy in the region by developing a series of four Hydropower dams in the Blue Nile. When one or more of these dams constructed, the flow characteristics of the Blue Nile and the main Nile will be changed which in turn affects the use of the existing reservoirs in the Blue and main Nile. The impact on the existing reservoir will be higher if the reservoirs are operated independently. However, if the operations of these reservoirs are optimized through a coordinated reservoir operation the negative impacts will be minimized and benefit (increased energy production) will be maximized. To achieve this, optimization of multiple reservoir operation is required to increase the energy production; by individual plant, by country and by the system as a whole. This coordinated operation will influence the scale of energy production to be decided by MCA analysis taking the impacts and benefits into consideration. Key questions: - What would be the optimum joint operation strategy (rules) for reservoirs in the Eastern Nile? - What would be the gain in system performance when compared to currently practiced operation strategy (measured in terms of agreed indicator values)? -
Business Trigger:	Decision of EN-COM to optimize the use of reservoirs to increase energy production in the Eastern Nile
Preconditions:	a) Agreed minimum release from each reservoir at different time period. • Base case – existing situation • Alternative 1: Base case + one hydropower dam • Alternative 2: Base case + Two hydropower dams • Alternative 3: Base case + Three hydropower dams • Alternative 4: Base case + Four hydropower dams b) Near real time data on inflow to each reservoir, reservoir levels are available. c) Operation rule exists for each reservoir

This analysis explores how to optimize the use of reservoirs in the Blue and main Nile stretch.
Pre-Condition: hydro-meteorological, reservoir and turbine characteristics data exist

Indicators to be used for decision

- Energy production (minimum, maximum and average) if operated independently; by individual plant, by country and basin wide,
- Change in energy production if the use of reservoirs are optimized through coordinated operation; by individual plant, country and basin wide,

Setting up the baseline model

1. Setup a model for the base case (existing reservoirs operated independently)
2. Run the multiple reservoir simulation and hydropower generation model
3. Verify the outputs of the model with real data.
4. Calibrate the model when necessary
5. Save the model

Optimization (Alternative 1)

1. Update the baseline model with the additional hydropower dam.(Alternative 1)
2. Run the model with the new setup (reservoirs operated independently)
3. Determine the energy production; by each plant, by country, basin wide
4. Run the simulation based optimization model and choose set of operations that gives maximum energy production by;
   A. country
   B. basin (system wide)
5. Determine the change in energy production; by each plant, by country, basin wide
6. Analyze the increased benefit with respect to different reservoir operation rule
7. Use the user defined function to convert model outputs to selected (agreed) indicators
8. Run the MCA tool under agreed set of criteria.
9. Select the “best” option

Optimization (Alternatives 2-4)

1. Update the model for two to four additional hydropower dams (from previous alternative)
2. Repeat the procedure as done in Alternative 1

Use Case Document

Title: Use case 08: Evaluating tradeoffs - Hydropower Dams planned in the Eastern Nile Power trade program

Version	Description	Changed By	Date

Brief Description:	**Background:** The Eastern Nile Council of Ministers agreed to increase the availability of energy in the region by developing a series of Hydropower dams in the Blue Nile. Development of large dams will have impacts on the downstream water uses and will be impacted by upstream water abstraction. These impacts will influence the scale of energy production to be decided by MCA analysis taking the impacts and benefits into consideration. Key questions to be addressed in this use case: • What will be the minimum reservoir filling time for the proposed dams? • What should be their operation strategy to minimize negative impacts in the system? • Which scale of development and combinations of development has least impacts?
Business Trigger:	Decision of EN-COM to develop hydropower potentials in the Eastern Nile
Preconditions:	a) Agreed scenarios to be investigated as part of the tradeoffs analysis (with relevant data) • Base case – existing situation • Alternative 1: Base case + one hydropower dam • Alternative 2: Base case + Two hydropower dams • Alternative 3: Base case + Three hydropower dams • Alternative 4: Base case + Four hydropower dams b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): upstream power/energy production vs. • Upstream irrigation • Downstream irrigation • Flood protection downstream • Reduced water level of HAD; its impact on energy generation and operation of the reservoir c) Set of agreed conditions under which tradeoffs shall be evaluated • Short term: during reservoir filling time • Long term: during the economic life of the infrastructure under consideration • Flood peak season analyses

This analysis explores the tradeoffs associated with the development of hydropower in the Blue Nile.

Use Case Document

Title: Use case 08: Evaluating tradeoffs - Hydropower Dams planned in the Eastern Nile Power trade program

Pre-Condition: spatial, hydro-meteorological and system data on the Blue Nile-Main Nile reach exist	
Selected information products (Indicators)	- minimum flow at irrigation diversion sites downstream and its reliability - change in energy production at existing power plants downstream - total system wide energy production - damage reduced at designated flood prone area downstream
Normal Flow	**Setting up the baseline model** 1. Setup a model for the base case 2. Run the water allocation model 3. Verify the outputs of the model with real data. 4. Calibrate the model when necessary 5. Save the model **Trade-off analysis (Alternative 1)** 1. Update the baseline model with the additional hydropower dam.(Alternative 1) 2. Run the model with the new setup 3. Determine the energy production 4. Determine reservoir minimum filling time 5. Determine the impacts downstream on irrigation, navigation, flood, operating levels of HAD (reduced water for irrigation, reduced water level for navigation, area protected from flooding, impacts on energy generation from HAD) 6. Determine the energy that can be generated from the corresponding filling time. 7. Analyse the cost of losing energy with respect to different reservoir filling times. 8. Analyse the increased benefits downstream with respect to different filling times. 9. Run the model for different dam filling times (repeat steps 2 – 8). 10. Use the user defined function to convert model outputs to selected (agreed) indicators 11. Run the MCA tool under agreed set of criteria. 12. Select the “best” option **Trade-off analysis (Alternatives 2-4)** 1. Update the model for two to four additional hydropower dams (from previous alternative) 2. Analyse the energy production, filling times downstream impacts, increased benefits and loses of energy for trade-off analysis as done for “alternative 1” 3. Investment sequencing study- **Separate use case**

Use Case Document

Title: Use case 08: Evaluating tradeoffs - Hydropower Dams planned in the Eastern Nile Power trade program

	Trade-off analysis with upstream water abstraction 1. Determine upstream water abstraction for irrigation. 2. Determine the reduced flow to the planned hydropower dam. 3. Determine energy production 4. Analyse the trade-off 5. Select the “best” option **Automatically populate the MCA table and determine best option (this shall be a separate use case)**

Use Case Document

Title: Use case 09: Impacts of Afforrestation Plans for Watersheds

Version	Description	Changed By	Date

Brief Description:	Due to population pressure and increased energy demand the Nile countries have experienced high level of deforestation. The Nile council of ministers decided that an extensive programme of afforestation is a possible remedial action, but such a programme may have both positive and negative impacts on the economy, river/water bodies' regime, availability and quality of water downstream. The Nile council of ministers therefore instituted an impact assessment of the afforestation program before making a final decision.
Business Trigger:	Decision of Nile-COM to assess the impacts of afforestation plans for the Nile watershed
Preconditions:	a) Agreed scenarios to be investigated as part of the tradeoffs analysis (with relevant data) • Base case – existing situation (current forest cover) • Alternative 1: Base case + afforested area 25% of each watershed (Lake Victoria basin (Atbara, Baro-Akobo, Kagera, Nzoia, Mara, SMM,..), • Alternative 2: Base case + afforested area 25% of each watershed • Alternative 3: Base case + afforested area 50% of each watershed • Alternative 4: Base case + afforested area 75% of each watershed(or maximum possible area) b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): % area forested vs. • Total Watershed ET • Downstream flow • Groundwater levels/recharge • Water level of Lakes; its impact on energy generation and operation of the reservoir • Economic CBA (with food production (area) foregone, wood production, displaced population) • Changes in water quality parameters (Nitrates, sediments) c) Set of agreed conditions under which tradeoffs shall be evaluated • Short term: during reservoir filling time • Long term: Changes in water Balance components

This analysis explores the Impacts of Afforestation Plans for Watersheds.

Use Case Document

Title: Use case 09: Impacts of Afforrestation Plans for Watersheds

Pre-Condition: spatial, hydro-meteorological and system data on the White, Blue Nile-Main Nile reach exist

Indicators to be used for decision

- minimum flow at sites downstream and its reliability
- change in energy production at existing power plants downstream
- Nitrate/sediments level in stream at downstream selected points
- Groundwater levels
- Lakes water level

Setting up the baseline model

1. Setup a(semi-distributed hydrological & water quality) models for the base case (current land cover)
2. Calibrate and validate model (best fit parameters values for various land cover classes determined)
3. Run the water allocation & water quality models (streamflow input from hydrological model)
4. Verify the outputs of the model with real data/calibrate and validate water quality model.
5. Save the model

Trade-off analysis (Alternative 1-4)

1. Update the baseline model with the additional area of forest cover-change parameters for newly forested areas-.(from previous alternative)
2. Run the model (hydrological as well as water quality) with the new setup
3. Determine the water balance changes for these scenario
4. Determine the new water quality indicator values at selected points
5. Determine the impacts downstream on irrigation, navigation, flood, biodiversity, operating levels of lakes/dams (reduced water for irrigation, reduced water level for navigation, area protected from flooding, impacts on energy generation)
6. Use the user defined function to convert model outputs to selected (agreed) indicators
7. Run the MCA tool under agreed set of criteria.
8. Select the “best” option

Trade-off analysis with upstream/downstream agricultural production/hydropower generation

1. Determine upstream water ‘lost’ through ET.
2. Determine the reduced flow to the irrigation projects, hydropower dam.
3. Determine energy, food production
4. Analyse the trade-off
5. Select the “best” option

Multi-criteria analysis based on the outputs from the Trade-off analysis

Use Case Document

Title: Use case 10: Flood Mitigation in the Blue Nile – Main Nile stretch

Version	Use case ID	Changed By	Date
1.0	10: Flood Mitigation in the Blue Nile – Main Nile stretch	Mekuria Beyene	16/06/09

Background:	1. Regular flood damages on irrigation sites and in urban settlements the Blue Nile and Main Nile stretch 2. These flood damages can be reduced through structural and non-structural measures.
Questions:	1. What are the present potential flood damages (yearly expected values and probabilities of exceedance) on irrigation sites and in urban settlements? 2. What are possible structural and non-structural interventions to mitigate flood impacts? 3. What is the reduced damage (yearly expected values and probabilities of exceedance) through the different interventions? 4. What are the costs of the flood damage mitigation interventions? 5. Which flood damage mitigation measure has the best economic performance? 6. What are the environmental and social impacts of the flood mitigation interventions? 7. What are the trade-offs between economic performance and the other impacts of the flood damage mitigation interventions?
Business Trigger:	
Preconditions:	1. All relevant time series available in NB-DSS 2. Relevant GIS themes (vector and raster) available in NB-DSS 3. Relevant characteristics of existing and planned system components (such as reservoirs, diversion infrastructure or irrigation sites) known and available
Key indicators (information outputs) to be generated	1. Flood inundation parameters for baseline and intervention scenarios such as a) frequency distribution, b) location and spatial extent, c) depth, d) duration, and e) velocity 2. Flood damages for baseline and intervention scenarios a) frequency distribution, b) spatial distribution, and c) sectoral differentiation 3. Costs and benefits of interventions 4. Effects of the interventions (with reference to baseline scenario) on a) Environment: frequency distribution of flows at key locations b) Hydropower: frequency distribution of energy

	c) Irrigation: supply reliability, agricultural yield
Actors	1. Senior decision makers a) Analyze inputs and outputs in charts and maps b) Configure templates reports of inputs and outputs c) Analyze trade-offs in charts and tables 2. Modelers a) Input data (import and interactively) b) Validate (QA) data c) Configure models d) Supervise and monitor external activities to enable the definition user-defined functional relationships regarding flood vulnerability e) Run simulation f) Analyze model inputs and outputs in charts and maps 3. Data Analysts a) Import and export (1) Time series (2) Remote sensing data b) Prepare model inputs through geo-processing and statistics
Workflow	1. Baseline scenario a) Identify flood prone urban and agricultural areas (through GIS operations) b) Determine reaches for flood routing and for 1D hydraulic modeling c) Set-up model with the relevant nodes and links and define their properties/characteristics (such as reservoirs, diversions and reaches) d) Generate ensembles of flow time series under different assumptions (including different climate change scenarios) e) Map time series to nodes in the system f) Determine characteristics of flood prone areas in terms of flood vulnerability (<u>external activity</u> to determine flood damage as function of hydrological parameters such as inundation depth, duration and/or velocity as well as land use characteristics) g) Define flood vulnerability (indicator: flood damage) of the flood prone areas as user-defined functions of model inputs and outputs h) Run the model and calculate the flood damage for all time series ensembles i) Determine and analyze the flood damage exceedances and yearly expected values for all flood prone areas and aggregate as appropriate (by region, by land use category) 2. Identify and determine possible interventions (as appropriate through consultations) a) Change of existing reservoir operation rules b) Adaptation of operation rules for planned reservoirs

	c) Dikes and levees in selected river reaches d) Cross-sectional and lateral changes in selected river reaches (geometry and texture) e) Land use change and adaptation for selected flood prone areas 3. Intervention scenarios (for each identified intervention) a) Change model set-up according for the intervention under consideration b) Determine flood damage characteristics (<u>external activity</u> to determine flood damage as function of hydrological parameters such as inundation depth, duration and/or velocity as well as land use characteristics) for the scenario that considers land use change and adaptation c) Define flood vulnerability (indicator: flood damage) of the flood prone areas as user-defined functions of model inputs and outputs for the scenario that considers land use change and adaptation d) Determine environmental and social impacts of interventions (<u>external activity</u>) e) Define environmental and social impacts as user-defined functions of model inputs and outputs for each intervention f) Run the model and calculate the flood vulnerability as well as the environmental and social impacts for all time series ensembles g) Determine and analyze the flood damage exceedances and yearly expected values for all flood prone areas for each intervention and aggregate as appropriate (by region, by land use category) h) Determine the reduced damages (yearly expected values and probabilities of exceedance) through the different interventions and aggregate as appropriate (by region, by land use category); reference is the baseline scenario i) Determine and analyze environmental and social impacts (probabilities and yearly expected values?) for each intervention 4. Cost benefit analyses a) Determine costs of interventions: investment costs and running costs b) Compare costs and benefits (benefits = reduced yearly expected damage) c) Analyze sensitivity of costs and benefits for different discount rates d) Rank the interventions according to economic performance, taking into account, costs, reduced damages and sensitivities 5. Trade-off analyses a) Combine results of cost benefit analyses with analyses of environmental and social impacts for each intervention b) Process and prepare results for decision making (trade-off curves and tables)
Frequency of use	

Use Case Document

Title: Use case 11. Assessing the consequences of different agricultural development scenarios (Blue Nile)

Version	Description	Changed By	Date

Brief Description:	Background: The Eastern Nile Council of Ministers agreed to improve the food security situation in the upstream of Blue Nile through irrigation. The region is characterized by rainfed agriculture and a high rainfall variability which leads to crop failure, but it also has a huge irrigation potential of over 500,000ha. Agricultural development will have an impact on the water resources availability on downstream user since irrigation is by nature a consumptive use. Question: What are the tradeoffs associated with the different development of irrigation in the Blue Nile
Business Trigger:	Decision of EN-COM to develop Irrigation potentials in the Eastern Nile
Preconditions:	a) Agreed scenarios to be investigated as part of the tradeoffs analysis (with relevant data) • Base case – existing situation (current area & crop under rainfed condition) • Alternative 1: Base case + Supplemental irrigation during Drought season (for crops planted under rain-fed condition/in the rainy season) • Alternative 2: Base case + 100,000ha Surface irrigation (potential crops) + one Reservoir • Alternative 3: Base case + 200,000ha of Surface irrigation scheme (potential crops) + one reservoir • Alternative 4: Base case + 300,000ha of Surface irrigation scheme (potential crops) + two reservoirs • Alternative 5: Base case + 400,000ha of Surface irrigation scheme (potential crops)+ two reservoirs b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): Irrigated area Vs. • (Agricultural) Water productivity (yield/unit volume) • Irrigated area (upstream/downstream by country) • Flood protection downstream • Reduced water level of downstream reservoirs; its impact on energy generation, irrigation and operation of the reservoir • Necessary reservoir capacity • Economic benefits in each scenario c) Set of agreed conditions under which tradeoffs shall be evaluated • Short term: during reservoir filling time • Long term: during the economic life of the infrastructure under consideration d) data: spatial, hydro-meteorological, and system data on the Blue Nile-Main Nile reach; agricultural (soil, crop) data in the project area exist

Use Case Document

Title: Use case 11. Assessing the consequences of different agricultural development scenarios (Blue Nile)

<table>
<tr><td>Key indicators (information outputs) to be generated</td><td>1. Agricultural production (crop yield)
2. minimum flow at irrigation diversion sites downstream and its reliability
3. satisfaction of crop water requirement/extent of reduction of crop loss
4. change in energy production at existing power plants downstream
5. damage reduced at designated flood prone area downstream
6. Net economic benefit</td></tr>
<tr><td>Actors</td><td>1. Senior decision makers
a) Analyze inputs and outputs in charts and maps
b) Configure templates reports of inputs and outputs
c) Analyze trade-offs in charts and tables
2. Modelers
a) Input data (import and interactively)
b) Validate (QA) data
c) Configure models
d) Supervise and monitor external activities to enable the definition user-defined functional relationships regarding flood vulnerability
e) Run simulation
f) Analyze model inputs and outputs in charts and maps
3. Data Analysts
a) Import and export
(1) Time series
(2) Remote sensing data
b) Prepare model inputs through geo-processing and statistics</td></tr>
<tr><td>Workflow</td><td>Setting up the baseline model
1. Setup a model for the base case
2. Generate ensembles of flow and rainfall time series under different assumptions (including different climate change scenarios)
3. Map time series to nodes in the system
4. Run the water allocation model as well as irrigation water demand and crop production model for existing agricultural sites
5. Verify the outputs of the model with real data.
6. Calibrate the model when necessary
7. Save the model
8. Determine and analyze yields
Scenario analysis (Alternative 1)
1. Update the baseline model with the supplemental irrigation water requirement (Alternative 1)
2. Run the model with the new setup
3. Use the user defined function to convert model outputs to selected (agreed) indicators
4. Determine and analyze yields
5. Determine the impacts downstream on irrigation, navigation, flood, operating levels of downstream dams (reduced water for irrigation, reduced water level for navigation, area protected from flooding, impacts on energy generation from reservoirs)</td></tr>
</table>

	6. Analyze the cost of losing energy with respect to reduced downstream flows. **Scenario analysis (Alternatives 2-5)** 1. Update the Irrigation water demand and Crop production model for the irrigation area to derive the seasonal water demand and yields 2. Update the water allocation model with the new irrigation water demand and run it 3. Steps 4 to 6 as done for "Alternative 1" **Trade-off analysis with downstream water abstraction** 1. Run the economic (CBA) analysis of the scenarios model 2. Determine upstream water abstraction for irrigation. 3. Determine the reduced flow to the hydropower dams, irrigation projects. 4. Determine energy production reduction 5. Determine the food production from irrigated area 6. Combine results of cost benefit analyses 7. Process and prepare results for decision making (trade-off curves and tables)

Use Case Document

Title: Use case 12: Develop drought management plan

Version	Description	Changed By	Date

Brief Description:	**Background**: the study region is prone to droughts of varying degree of severity. Most vulnerable economic activities include agriculture and hydropower production. This use cases focuses on developing tactical (short-term) drought management plans (focusing on non-structural measures) to alleviate impacts of drought on irrigated agriculture and hydropower production. **Key Questions**: - What are the historical patterns of drought in the study region (severity, spatially aggregated)? - What were the impacts of drought to different economic activities? - What drought management strategies can be implemented and what are their benefits? - What values of indicators can be used to trigger drought management plans at different levels of drought severity?
Business Trigger:	Decision by senior planners/decision makers to develop drought management plan
Preconditions:	Datasets required for the implementation of the use case available in the system
***Selected Information Products generated* (Indicators)**	- Historical pattern of drought, described using drought indices in the study region (spatially disaggregated) - A water balance model – calibrated/validated - A set of threshold values of drought triggers (indices) - Vulnerability indices of key water uses (based on historical drought information) - Drought management strategies for various drought severity levels - Threshold values of drought indices for triggering each drought management strategy
Actors	Technician - Prepare all data required for the study Modeller - Examine data prepared for study and make adjustments, if required - Setup water budget/allocation model - Conduct simulation runs implementing the different drought management plans - Generate reports Decision makers - Review study results - Select most appropriate drought management plans - Decide on follow on activities

Use Case Document

Title: Use case 12: Develop drought management plan

<table>
<tr><td>Normal flow:</td><td></td></tr>
<tr><td></td><td>

Determine drought characteristics in the study region (using drought-severity indices, spatially disaggregated).
Determine a set of classes of drought severity based on values of drought-indices
Determine current and future water demand patterns (temporal, spatial, by economic sectors)
Determine vulnerability (extent of damage related to actual water allocation/availability to each use) of key water uses to drought (based on types of uses); partly from results of analysis conducted externally.
Determine drought-relevant indicators of system performance (for individual key use and system wide)
Determine minimum acceptable levels of indicator values (can be a separate use case) for each key water use
Generate ensemble of historical climatic and stream flow
Setup the baseline water budget/allocation model of the water resources system in the region
Simulate the status-quo (current drought management plans in place) and validate results with observed patterns
Iterate for each class of drought-relevant index (i.e. drought severity level):

Formulate/alter drought management strategies (as scenarios/alternatives of non-structural interventions) for level of drought severity considered
Conduct multiple runs of the simulation model for the entire ensemble and each drought management strategy (a possible alternate flow is to run the optimizer)
Generate drought-relevant indicators of system performance for each strategy
Stop iteration when acceptable level of system performance is reached, i.e. ‘best’ management strategy is obtained for the drought severity level considered

Generate various plots of indicator values (duration curves, box plots, etc) to capture performance of each drought management strategy for the different drought severity levels
Generate report

</td></tr>
<tr><td>Alternate flows:</td><td></td></tr>
<tr><td>Frequency of use</td><td>Use case to be implemented as per regular time schedule for updating drought management plans, say every 5 years</td></tr>
<tr><td>Assumptions</td><td></td></tr>
</table>

Use Case Document

Title: Use case 12: Develop drought management plan

Notes and issues	

Use Case Document

Title: Use case 13: CONJUNCTIVE USE OF GROUNDWATER / SURFACE WATER ON THE NILE DELTA

Version	Description	Changed By	Date

Brief Description:	The water shortage and inadequacy of the surface water in the Nile delta region especially at western zone, lead to aggressive withdraw from the ground water aquifer. The heavy GW activities resulted water shortage and soil degradation. The crop production decreased and investments in Western Delta subjected to risk. As a prime solution the MWRI of Egypt planned to save more water from different sectors (water recycling), use modern irrigation schemes, and increase the surface water efficiency to supply the western delta part with the utilized water. A new canal will be constructed to feed the area with the surface water. The planning phase of the projects needs a lot of information and data also the alternative scenario to maintain the large investments shall be determined through the preparation phase of the project, for which the DSS will has a main role in providing the data and tool to examine the different scenarios.
Business Trigger:	optimize different water uses from surface and ground water that will stop the degradation of groundwater quality and quantity
Preconditions:	a) Agreed scenarios to be investigated as part of the analysis (with relevant data) • Base case – existing situation with ground water resources • Alternative 1: Base case + surface water resources (surface canal from branches) • Alternative 2: Base case + save more water from different sources (water recycling) • Alternative 3: Base case + save more water from different sources (urbanization in the delta) • Alternative 4: Base case + save more water from different sources (increase the surface water efficiency, efficient water uses and new techniques) • Alternative 5: Base case + save more water from different sources (by using new irrigation techniques) b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): ▪ reliability, ▪ resilience ▪ vulnerability c) Set of agreed conditions under which tradeoffs shall be evaluated

	• Short term: support the small farmer • Long term: stakeholder participation in operating, maintinance and management

The DSS will optimize different water uses from surface and ground water that will stop the degradation of groundwater quality and quantity by using reliability, resilience and vulnerability as the main indicators of the system performance.
Pre-Condition: ▪ **The GIS maps** shall be showing the irrigation network, the drainage network, groundwater well distribution, WQ measurements locations, land use, urban areas, drinking water plants, waste water treatment plants. ▪ **Data related to** ; ground water potentials, water demands, nearby surface water flow, current groundwater salinity, GW aquifer capacity, cropping pattern, evaporation rates, crop production, economic return and area served.
Indicators to be used for decision - reliability : the limit for investments that the stakeholder being in satisfactory state - resilience : protect the excessive use and prevent the depletion in the ground water - vulnerability: maintenance , operate and management the system with sustainable manner
Setting up the baseline model 1. simulate the served area in the model for the base case with data available 2. Run the system model 3. Verify the outputs of the model with real data. 4. Calibrate the model when necessary 5. Save the model 6. Determine the reliability, resilience and vulnerability of the system in relation to the new scenario **scenario analysis (Alternatives)** 1. Update the baseline model with each Alternatives 2. Run the model with the new setup 3. Determine the reliability, resilience and vulnerability of the system in relation to the new scenario **Trade -off analysis between selected Alternatives** 1. Set the objective functions for the optimisation models and variables

2. Run the model with the new setup
3. Determine the reliability, resilience and vulnerability of the system in relation to the selected

Scenario Automatically populate the MCA table and determine best option

Use Case Document

Title: Use case 14: Impact of Atbara-Takeze River Upstream Developments on the Main Nile Downstream

Version	Description	Changed By	Date

Brief Description:	The construction of a large dam mainly for hydropower generation, is currently on going upstream the river in Ethiopia. Sudan is also planning to construct a large dam across the river, upstream the existing Khash El Girba dam. The new planned dam in Sudan, is expected to secure irrigation water supplies to the downstream irrigation schemes, and domestic water supplies for El Gadaref city. Development of large dams will have impacts on the downstream water uses, as well as socioeconomic and environmental impacts on local communities particularly those of Delta Sedon at the lower Atbara, who also depend on groundwater recharged annually by the river flood water. These impacts will influence the scale of energy production, irrigated agriculture, to be decided by MCA analysis taking the impacts and benefits into consideration.
Business Trigger:	Decision of EN-COM to develop hydropower & irrigation potentials in the Atbara-Takaze River.
Preconditions:	a) Agreed scenarios to be investigated as part of the tradeoffs analysis (with relevant data) • Base case – existing situation (existing Khashm El Girba dam) • Alternative 1: Base case + one hydropower dam in Ethiopia • Alternative 2: Base case + one multipurpose dam in Sudan • Alternative 3: Base case + Ethiopia dam + one Sudan dam • Alternative 4: Base case + Ethiopia dam + one Sudan dam +upstream abstraction in Ethiopia b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): upstream power/energy production vs. • Upstream irrigation • Downstream irrigation • Downstream domestic water supplies • Flood areas in Sedon delta • Groundwater recharge rate in lower Atbara area • Reduced water level of HAD; its impact on energy generation and operation of the reservoir c) Set of agreed conditions under which tradeoffs shall be evaluated • Short term: during reservoir filling time • Long term: during the economic life of the infrastructure under consideration

This analysis explores the tradeoffs associated with the development of hydropower in the Blue

Use Case Document

Title: Use case 14: Impact of Atbara-Takeze River Upstream Developments on the Main Nile Downstream

Nile.
Pre-Condition: spatial, hydro-meteorological and system data on the Atbara-Tekeze-Main Nile reach exist.

Indicators to be used for decision

- minimum flow at irrigation diversion sites downstream and its reliability
- minimum water supplies for domestic use
- flooded area for agricultural use at lower Atbara
- minimum groundwater table at lower Atbara area
- Groundwater table changes at lower Atbara
- change in energy production at existing power plants downstream
- total system wide energy production
- Socio economic impacts on local communities at lower Atbara area

Setting up the baseline model

1. Setup a model for the base case
2. Run the water allocation model
3. Verify the outputs of the model with real data.
4. Calibrate the model when necessary
5. Save the model

Trade-off analysis (Alternative 1)

1. Update the baseline model with the additional hydropower dam.(Alternative 1)
2. Run the model with the new setup
3. Determine the energy production
4. Determine reservoir minimum filling time
5. Determine the impacts downstream on irrigation, navigation, flood, operating levels of HAD (reduced water for irrigation, reduced water level for navigation, fooded area, impacts on energy generation from HAD, impact on groundwater levels in lower Atbara – Sedon area)
6. Run the model for different dam filling times (repeat steps 2 – 5).
7. Determine the energy that can be generated from the corresponding filling time.
8. Analyse the cost of losing energy with respect to different reservoir filling times.
9. Analyse the increased benefits downstream with respect to different filling times.
10. Use the user defined function to convert model outputs to selected (agreed) indicators
11. Run the MCA tool under agreed set of criteria.
12. Select the “best” option

Trade-off analysis (Alternatives 2)

1. Update the model for alternative 2. (one multi-purpose dam in Sudan)
2. Analyse the energy production, filling times downstream impacts, change in groundwater table at lower Atbara, increased benefits and loses of energy for trade-off analysis as done for “alternative 1”

Title: Use case 14: Impact of Atbara-Takeze River Upstream Developments on the Main Nile Downstream

Trade-off analysis (Alternatives 3)

1. Update the model for alternative 2. (both reservoirs of Sudan & Ethiopia)
2. Analyse the energy production, filling times downstream impacts, change in groundwater table at lower Atbara, increased benefits and loses of energy for trade-off analysis as done for “alternative 1”

Trade-off analysis with upstream water abstraction (alternative 4)

1. Determine upstream water abstraction for irrigation.
2. Determine the reduced flow to the planned hydropower dam.
3. Determine energy production
4. Analyse the trade-off
5. Select the “best” option

Use Case Document

Title: Use case 15: Development Plan for Hydropower, Irrigation, Navigation in the Nile equatorial lakes region

Version	Description	Changed By	Date

Brief Description:	The Nile equatorial region is facing problems of shortage of hydropower, food security and transportation. The region would like to exploit the hydropower potential within the region, use the available lakes as source of water for irrigation, and also as means of transport. The situation is compounded by the rapid population growth in the area and climate change like phenomena. Fisheries industry in the region is the major export earner and the major source of protein for the riparians, however, silt coming from the rivers of Kagera and Nzoia is threatening the fisheries industry. The countries would like to develop **one multipurpose reservoir on R. Kagera** at the boarder of Tanzania, Burundi and Rwanda. The region is planning to construct **two medium dams on R. Nzoia** that flows in Lake Victoria. There are plans to **abstract water from L. Victoria for irrigation** both in Kenya and Tanzania parts of the basin. On the Ugandan side, there plans to construct **four new dams at Bujagali, Kalagala, karuma and Ayago**. However, at Bujagali and Kalagala construction of dams would mean submerging rapids that are a tourist attraction which is the second largest foreign exchange earner for the country. It would also alter the scenic views of the sites. The countries also would wish to improve navigation on the lakes of Albert and Victoria to improve transportation of goods between the countries. This is considered very relevant because a number of countries within the region are land locked. Land chunks of land around the lakes of Kyoga and Albert are surrounded by swamps that are believed to cause a lot of water loss through evapotranspiration and the remaining areas are semi-arid. However, the swamps are also a breeding ground for various bird species in the region that contribute to the tourism. However, during rainy seasons the crops and property in the area are destroyed by floods. There are plans to convert the swamps into irrigated schemes and also use the lakes to provide water from the lakes for supplementary irrigation of the surrounding area. The region is planning to construct a number of irrigation schemes around the area for rice. The countries would like to combat sediment loading from the catchments to save the fisheries industries.
Business Trigger:	The available water may not be enough to cater all planned activities at once. Therefore there was a need to see different scenarios in which the effect of planned development activities on the existing water uses.
Preconditions:	a) Agreed scenarios to be investigated (with the availability of the relevant data) • Base Case – existing situation • Alternative 1: one multiple reservoir on R. Kagera • Alternative 2: Two medium dams on R. Nzoia • Alternative 3: Water abstraction from lake Victoria for irrigation • Alternative 4: Four new hydropower dams (Lake Victoria- lake Albert stretch) b) Agreed set of analysis: • Planned hydropower development on existing water fall. • Irrigation water abstraction from Lake Victoria on the water level • Multipurpose reservoirs on flood protection and fishery.
	Spatial, hydro-meteorological and system data in the Lake Victoria area exist.

Use Case Document

Title: Use case 15: Development Plan for Hydropower, Irrigation, Navigation in the Nile equatorial lakes region

This analysis explores the impacts of planned water resources development on existing major water uses in the NEL region.	
Selected information products (Indicators)	• Minimum flow downstream of planned reservoirs. • The damage reduced in fishery at flood prone area due to reduced sediment. • Maximum irrigation water that can be drawn from Lake Victoria. • Maximum allowable drawdown of Lake Victoria water level for navigation. • Reduced income from tourism industry associated with reduced water fall. • System wide increased benefits from energy production and irrigation development.
Normal flow	**Setting up the Baseline model** 1. Setup a model for the base case 2. Run the water allocation model 3. Verify the outputs of the model with real data. 4. Calibrate the model when necessary 5. Save the Model **Pre-processing of relevant data** 1. Establish relationship between reduced sediment load and increase in fish catch (can also be input). **Alternative 1** 2. Update the base cases with one multiple use reservoir on river Kagera. 3. Run the model with the new setup. 4. Determine energy production 5. Determine minimum downstream water flow. 6. Determine the Lake Victoria water level with respect to the kagera reservoir development. 7. Determine change in energy generation downstream of Lake Victoria. 8. Determine the reduced sediment load downstream of Kagera reservo. 9. Determine the reduced flood area. 10. CBA 11. Convert model outputs into selected indicators 12. Determine impacts (in terms of agreed indicators; navigation, irrigation, power development) 13. Repeat steps 1-12 with different reservoir capacities and filling times 14. Prioritize and rank options (dam height) with agreed set of criteria. 15. Select the best option (dam Height). **Alternative 2** 1. Same as Alternative 1

	2. Additionally cascade development- separate use case. **Alternative 3** 1. Determine irrigable land around the lake Victoria 2. Determine crop water requirement 3. Setup the water allocation model with water abstraction from lake Victoria 4. Determine the Lake Victoria water level. 5. Run the model with different water demand and upstream developments to satisfy the minimum water level for navigation. 6. repeat steps 1-6 with alternatives 1, Alternative 2, both alternatives 1 and 2 7. Tradeoffs analysis between downstream water uses and upstream water abstraction from lake Victoria with and without alternatives 1 and 2 - Separate Use case 8. CBA 9. Convert model outputs into selected indicators 10. Determine impacts (in terms of agreed indicators; navigation, irrigation, power development) 11. Establish agreed criteria for selecting the best option 12. Repeat steps 1-12 with different irrigation demand from Lake victoria. 13. Prioritize and rank options (Water demands) with agreed set of criteria. 14. Select the best option **Alternative 4** 1. Determine Hydropower dam/reservoir locations 2. Setup the Model with four dams. 3. Run the model. 4. Determine the optimum energy production from the dams – separate use case. 5. Determine cascade development of reservoirs- Separate use case 6. Trade-off analysis with downstream and upstream water uses - Separate use case. 7. Analyse impacts of these reservoirs on Lake Albert as described in alternatives 1 and 2 8. Determine changes in areal coverage of the Sudd wetland. 9. Estimate changes in evaporation losses. 10. Estimate the change in water availability in the system. 11. CBA 12. Convert model outputs into user defined indicators. 13. Prioritize and rank options with agreed set of criteria. 14. Select the best option

Use Case Document

Title: Use case 16: Impacts of climate change on water availability in the Nile Basin

Version	Description	Changed By	Date

Brief Description:	The Nile countries have planned various water resources developments, in addition to the already existing ones, that are aimed at poverty reduction, food security, hydropower generation and environmental protection. Climate change has the potential to affect many sectors in which water resources managers play an active role, including water availability, water quality, flood risk reduction, ecosystems, navigation, hydropower and other energy sectors. These changes may have adverse or positive impacts on one or more sectors and any of these changes could occur gradually or abruptly. Because of the importance of climate in system design and operations, it is apparent that climate change could translate into changed design and operational assumptions about resources supplies, system demands or performance requirements, and operational constraints, impacting all sectors of water resources management. The countries would like to investigate the impacts of climate change on the Nile region hydrological structures, irrigation and management options through: (i) development of the climatic change scenarios, (ii) assessing the performance of the basin facilities and plans using reliability, resilience and vulnerability as the main indicators of the system performance. The outcome of the analysis may imply changes to: ▪ System structures, such as added water storage, pumping, or canal capacity; ▪ Reservoir operating rules, such as changing the space requirements for flood control; ▪ Stream control requirements; ▪ Water quality standards and others.
Business Trigger:	Investigating the effectiveness of the planned & existing infrastructure and management plans in changed climatic conditions
Preconditions:	a) Agreed scenarios to be investigated as part of the analysis (with relevant data) • Base case – existing situation with historical data • Alternative 1: Base case + Planned infrastructure & management options • Alternative 2: Climate scenario 1 + Existing, Planned infrastructure & management options • Alternative 3: Climate scenario 2 + Existing, Planned infrastructure & management options • Alternative 4: Climate scenario 1 + Existing adjusted planned infrastructure & adjusted management options through optimisation techniques. • Alternative 4: Climate scenario 2+ Existing adjusted planned infrastructure & adjusted management options through optimisation

	b) Agreed set of tradeoffs (attributes using which the performance of each scenario is to be determined): • reliability, • resilience • vulnerability c) Set of agreed conditions under which tradeoffs shall be evaluated • Short term: • Long term: Selected/ derived climate change scenarios

The countries would like to investigate the impacts of climate change on the Nile region hydrological structures, irrigation and management options through: (i) development of the climatic change scenarios, (ii) assessing the performance of the basin facilities and plans using reliability, resilience and vulnerability as the main indicators of the system performance.

Pre-Condition: spatial, hydro-meteorological and system data on the Nile exist, Information on planned infrastructure & management plans exist.

Indicators to be used for decision

- reliability : the probability of a system being in a satisfactory state
- resilience : the severity of failure
- vulnerability: system's ability to bounce back from the failure sate

Setting up the baseline model

1. Setup a model for the base case with historical data
2. Run the system model
3. Verify the outputs of the model with real data.
4. Calibrate the model when necessary
5. Save the model
6. Determine the reliability, resilience and vulnerability of the system in relation to the intended interventions

Impact analysis (Alternative 1 & 2)

1. Update the baseline model with the climate scenario 1 & 2.
2. Run the model with the new setup
7. Determine the reliability, resilience and vulnerability of the system in relation to the intended interventions

Impact analysis (Alternative 3 & 4)

3. Update the baseline model with the climate scenario 1 & 2.
4. Set the objective functions for the optimisation models and variables
5. Run the model with the new setup
8. Determine the reliability, resilience and vulnerability of the system in relation to the intended interventions

Automatically populate the MCA table and determine best option

Use Case Document

Title: Use case 17: Impact of reducing snow cap on Mt. Ruwenzori

Version	Description	Changed By	Date

Brief Description:	In the wake of climate change, the snow cap of Mt. Ruwenzori has reduced from 217 ha in 1906 to only 18.5 ha in 2006. The glaciers are a source to the mount rivers of Semuliki, Mobuku, Nyamwamba etc with flow into lake George and Lake Edward. The rivers are important for hydropower production, irrigation, and domestic water supply. Besides, they are a source of water to the surrounding wetlands most of which have been designated as RAMSA sites. The object of this use case therefore, is to assess the impact of glacial recession on the hydrology of rivers originating in Mt Rwenzori, hydropower production and available water for irrigation with the aim of developing the best water allocation strategy.
Business Trigger:	Need for information by decision makers on how climate change is likely to impact on the water resources and water uses so as to develop appropriate adaptation measures.
Preconditions:	a) Agreed climate change scenarios to be investigated. (with relevant data downscaled from GCMs) • Base case – existing situation • Scenario 1: low increase in temperature • Scenario 2: moderate increasing in temperature • Scenario 3: high increase in temperature b) Agreed set of tradeoffs (attributes of which the performance of each water allocation strategy is to be determined): • Domestic water supply • Agricultural production • Environmental flows • Energy production

This analysis explores the tradeoffs associated with water allocation strategy for various climate change scenarios.

Pre-Condition: downscaled climate change simulations, spatial, hydro-meteorological and economic data in the relevant river catchments exist

Indicators to be used for decision

- Domestic water supply – all domestic water demand has to be satisfied before any other water use
- Hydrology – appropriate environmental flows in river reaches.
- Agriculture – substance irrigated agriculture receives second priority.
- The rest of uses are allocated water according to economic value

Use Case Document

Title: Use case 17: Impact of reducing snow cap on Mt. Ruwenzori

Setting up the baseline model

1. Setup a model for the base case
2. Run the water allocation model
3. Verify the outputs of the model with real data.
4. Calibrate the model when necessary
5. Save the model

analysis (scenario 1,2 and 3)

1. Change baseline model to incorporate scenario 1
2. Run the model with the new setup up to 2100
3. The precipitation changes,
4. Compute changes in water availability in % of a baseline scenario
5. Project increase in crop water demand and irrigation demand,
6. run water allocation model and distribute water according to set priorities
7. Calculate potential decline in agricultural yields in % if irrigation demand is not met
8. Project potential changes in hydropower production,
9. Project population at risk of increased water stress,
10. Project decline in groundwater recharge

Automatically generate a water strategy indicating demand, supplied quantities and deficit on a spatial and temporal scale ;

Use Case Document

Title: Use case 18: Analyzing Wetlands: Understanding the processes in the Kagera Basin wetlands

Version	Description	Changed By	Date

Brief Description:	The NELSAP/East African Council of Ministers has decided to investigate the processes in the Kagera basin wetlands. Wetlands have important functions which include improving water quality, regulating river flow, biodiversity conservation, special wetland plants that produce special products etc. Wetlands degradation on the other hand results into reduction or loss of wetland services. The degradation of wetlands can be found in many forms; cultivation in the wetland areas, introduction of exotic species which result in loss of biodiversity and decrease in the amount of fresh water supply to wetland. Buffering capacity/retention capacity of a wetland is the term used to describe the cycling of nutrients and the fate of behaviour of pollutants in wetlands. Therefore the retention capacity of wetlands is one of the key properties of a wetland that need to be determined in the investigation.
Business Trigger:	Decision by NEL/EAC COM to investigate the processes of Kagera basin wetlands.
Preconditions:	• Determine the type of wetland as permanent, seasonal, open water system or tree swamps • Investigate the retention capacity of wetlands it terms of suspended solids, nutrients, pollutants and other toxics • Investigate the minimum water flow required to preserve most of the wetland functions. • Investigate the storage capacity of wetlands and change in wetland area versus water inflow amount • Investigate evapotranspiration/infiltration as a function of the amount of water stored in the wetland. • Investigate the social-economic and other ecological benefits of wetlands in the Kagera basin.

This investigation examines the capacity of wetlands in the Kagera basin to purify water in terms of their retention/buffering capacities. The storage capacities of wetlands will also be investigated as well as the minimum amount water required to preserve most of the wetland function. The investigation will also include quantification of other hydrological processes taking place like evapotranspiration and infiltration/percolation to ground water.
Pre-Condition: spatial, hydro-meteorological and water quality data for rivers exist.
Indicators to be used for decision - No particular decision to be made apart from the investigation to understanding the processes/ features of the wetland mentioned previously

Use Case Document

Title: Use case 18: Analyzing Wetlands: Understanding the processes in the Kagera Basin wetlands

Setting up the model

1. Setup the lake model
2. Run the water budget/allocation model
3. Run the wetland/evapotranspiration/infiltration models
4. Verify outputs with real data
5. Save the model

The type of wetland, social-economical values of the wetland and other ecological aspects of wetlands might be determined from literature and other sources and not as part of model results.

Use Case Document

Title: Use case 19: Eastern Nile Joint Multi-Purpose Project

Version	Use case ID	Changed By	Date
1.0	19: Eastern Nile Joint Multi-Purpose Project	Mekuria Beyene	16/06/09

Background:	1. Untapped hydropower potentials in the Blue Nile Basin in Ethiopia 2. Reduced effectiveness of existing reservoirs on the Blue Nile in Sudan and Main Nile in Sudan and Ethiopia due to sedimentation; effects on irrigation and flood control 3. Untapped irrigation potentials on the Blue Nile in Sudan
Questions:	1. What is the best strategy to develop hydropower potentials on the Blue Nile in Ethiopia? 2. What are the positive and negative impacts downstream of the hydropower dams on the Blue Nile in Ethiopia? Irrigation and flood control (and possibly hydropower) 3. What are the development and management potentials downstream of the Ethiopian dams on the Blue Nile? Irrigation and flood control (and possibly hydropower) 4. What are the trade-offs (sectoral, country-wise, upstream-down-stream) if hydropower dams are developed in the Blue Nile Basin in Ethiopia accordingly?
Business Trigger:	
Preconditions:	1. All relevant time series available in NB-DSS 2. Relevant GIS themes (vector and raster) available in NB-DSS 3. Relevant characteristics of existing and planned system components (such as reservoirs, diversion infrastructure or irrigation sites) known and available
Key indicators (information outputs) to be generated	1. Hydropower energy produced: frequency distribution and spatial aggregation 2. Agricultural yields for irrigated agriculture 3. Flood damages reduced 4. Costs and benefits of interventions 5. Secondary effects of the interventions (with reference to baseline scenario) on a) Environment: frequency distribution of flows at key locations b) Hydropower: frequency distribution of energy c) Irrigation: supply reliability, agricultural yield d) Floods damages reduced: frequency distribution and spatial distribution
Actors	1. Senior decision makers a) Analyze inputs and outputs in charts and maps b) Configure templates reports of inputs and outputs c) Analyze trade-offs in charts and tables 2. Modelers

	a) Input data (import and interactively) b) Validate (QA) data c) Configure models d) Supervise and monitor external activities to enable the definition user-defined functional relationships regarding flood vulnerability e) Run simulation f) Analyze model inputs and outputs in charts and maps 3. Data Analysts a) Import and export (1) Time series (2) Remote sensing data b) Prepare model inputs through geo-processing and statistics
Workflow	1. Pre-processing: Generate ensembles of flow time series under different assumptions (including different climate change scenarios) 2. Determine indicators to quantify and evaluate downstream positive and negative impacts a) Flood control (example: yearly expected flood damage for selected areas) b) Irrigation (example: irrigation yield and net benefit) c) Hydropower (example: firm energy and net benefit) d) Instream flow 3. Define scenarios with different number of dams (in Ethiopia and Sudan); each activity to be carried out for each scenario (including baseline) a) Set-up model with the relevant nodes and links and define their properties/characteristics (such as reservoirs, diversions and reaches) b) Map time series to nodes in the system c) Simulate hydropower and determine hydropower capacities of the potential dams with different operation rules and various building sequences d) Analyze downstream impacts according to the indicators determined above; the simulations will comprise the following (1) Reservoir simulation in a river system (2) Evaporation calculation using different approaches (3) Irrigation demand modeling and crop yield analysis (4) Simplified flood inundation simulation for selected locations (5) Flood damage assessment (6) River and reservoir sedimentation modeling (7) Transform model inputs and outputs to required indicators e) Analyze and aggregate model inputs and outputs (1) Simple statistics (2) Duration curves

	(3) Yield curves for different probabilities (4) Expected values (for flood damages) f) Cost benefit analyses (1) Determine costs of interventions: investment costs and running costs of the dams (2) Assess costs and damages of impacts (through heuristics, empirical relationships) (3) Assess benefits of impacts (through heuristics, empirical relationships) (4) Analyze sensitivity of costs and benefits for different discount rates g) Define objectives and constraints and run optimizations under different aspects (1) Basin wide (2) With country perspective (3) With sectoral focuses 4. Show optimization results of each scenario as trade-offs
Frequency of use	