NILE BASIN INITIATIVE
Initiative du Bassin du Nil

NILE BASIN DECISION SUPPORT SYSTEM

CONCEPTUAL DESIGN AND DEVELOPMENT PLAN

PART I DSS Development Plan
PART II DSS Conceptual Design

hydrOphil
consulting & knowledge development GmbH

ITAD

CEDARE
سيداري

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Including Implementation Terms of Reference and Training Plan

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Table of Content

Acronyms

AVHRR	Advanced Very High Resolution Radiometer
BOD	Biochemical Oxygen Demand
CBA	Cost-Benefit Analysis
CC	Climate Change
COM	Council of Ministers
CSV	Character Separated Values
CU	Coordinating Unit
DEM	Digital Elevation Model
DM	Decision Making
DNV	Det Norske Veritas (Certification)
DO	Dissolved Oxygen
DSS	Decision Support System
EIA	Environmental Impact Assessment
EN	Eastern Nile (Sub-Region)
ENPM	Eastern Nile Planning Model
ENSAP	Eastern Nile Subsidiary Action Programme
ENTRO	Eastern Nile Technical Regional Office
GCM	Global Climate Change Model
GERB	Geostationary Earth Radiation Budget
GFS	Global Forecast System
GIS	Geographic Information System
GML	Geography Markup Language
GUI	Graphical User Interface
HTML	Hypertext Markup Language
IMS	Information Management System
IS	Information System
ISO	International Standards Organization
IWRM	Integrated Water Resource Management
JMP	Joint Multipurpose Program
LAN	Local Area Network
MCA	Multi-Criteria Analysis
MM5	Meteorology Model 5
NB	Nile Basin
NBI	Nile Basin Initiative
NEL	Nile Equatorial Lakes (Sub-Region)
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme
Nile-IS	Nile Information System
NGO	Non Governmental Organization
OOD	Object Oriented Design
OLAP	On-line Analytical Processing

ORNL	Oak Ridge National Laboratory
OS	Operating System
PHP	Hypertext Pre-Processor
PMU	Project Management Unit
PSC	Project Steering Committee
RBMS	River Basin Modelling System
RDBMS	Relational Data Base Management System
SAP	Subsidiary Action Program
SIA	Strategic Impact Assessment
SQL	Structured Query Language
SVP	Shared Vision Programme
ToR	Terms of Reference
UPS	Uninterruptible Power Supply
WRF	Weather Research and Forecasting (Model)
WRPM	Water Resource Planning and Management (Project)
XML	Extensible Markup Language

1 Introduction

1.1 Context and Structure of the Consultancy Assignment

The Nile Basin Initiative (NBI), under the aegis of its Water Resources Planning and Management (WRPM) Project, commissioned the consultancy services: "Needs Assessment and Conceptual Design for the Nile Basin Decision Support System" as the first step in the development of a decision support system (DSS) for the Nile Basin.

The proposed DSS is one of four components of the WRPM under the Shared Vision Program (SVP). Its scope includes the Nile Basin DSS itself (comprising an information management system, a regional river basin planning model, and a suite of analytical tools to support multi-objective analysis of investment alternatives) as well as the development of core national capabilities to assist in the design and evaluation of alternative development paths and the identification of joint investment projects at the sub-regional and regional level.

The Consultancy has been divided into three distinct phases, namely the Inception Phase, the Analysis Phase and the Synthesis Phase.

During the **Inception Phase** the Consultant assessed the present situation within the Nile Basin in terms of hydrology, water availability and use patterns, environmental and socio-economic and other issues pertinent to the use of the shared Nile water resources, and produced a situation assessment report.

The conceptual design of the Nile Basin DSS was developed during the **Analysis Phase**, and was based on the results of a needs assessments and stakeholder consultations carried out through 9 national and 2 sub-regional workshops during which training needs were also assessed. In addition, prior to the consultation workshops in each location, Training and Awareness Workshops were held in order to enhance the understanding and general awareness of IWRM and the use of DSS among riparian experts. At the same time, an information system (the Nile Information System - Nile-IS) was developed, to be used as a common knowledge base and to promote communication and information exchange among the Nile Basin countries. The Nile-IS has been populated with documents and other information compiled during this consultancy.

The present report concerns the final, **Synthesis Phase** (until mid-April 2008) and describes the DSS Development Plan for the Nile Basin DSS including i) Implementation Terms of Reference and ii) a Training Plan. For the DSS conceptual design it refers to the previous report, in particular Annex B where the system requirements and the functionality design were specified.

1.2 Purpose and Scope of the Nile Basin DSS

The basic purpose of the Nile Basin DSS is to provide a transboundary framework for sharing knowledge, understanding river system behaviour, designing and evaluating alternative development scenarios, investment projects, and management strategies; and to support informed, scientifically based rational decision making. As such its primary objective is to create *"... a shared knowledge base, analytical capacity, and supporting stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin"*. It is intended to improve the overall net benefit from harnessing the Nile, and develop economically efficient, equitable, environmentally compatible and sustainable strategies for sharing the benefits. In doing

so, the DSS should help to *"enhance the capacity to support basin wide communication, information exchange, and identifying trans-boundary opportunities for cooperative development of the Nile Basin water resources"*.

The range of decisions that the DSS will support has been specified on the basis of an initial situation assessment followed by a detailed analysis of specific concerns emerging from a comprehensive stakeholder consultation exercise. The concerns raised at the different workshops – in the nine riparian countries as well as two at the sub-regional level – were grouped and prioritized (see Requirements Analysis and DSS Design Report, Annex A, for details), and finally the following priority areas of concern were agreed at a regional workshop (Entebbe, January 2008):

- Water resources development
- Optimal utilization of water resources
- Coping with floods
- Coping with droughts
- Energy development (hydropower)
- Rainfed and irrigated agriculture
- Watershed and Sediment Management
- Navigation

Water quality and climate change have been identified as cross-cutting issues to be considered in addressing the above eight priority areas of concern.

The above areas of concern guided the identification of key functionalities and model components to be included in the core system in its initial phase of development. Its modular and open architecture will allow for future expansion of the range of decisions to be supported as needs emerge or are re-prioritised.

The DSS and its central river basin model system will directly support an open and participatory multi-criteria decision making process, considering simultaneously hydrological, socio-economic criteria and environmental criteria and objectives.

The Nile Basin DSS design is based on three major functional components:

- An information system that provides a common and shared information basis for the planning and decision making processes, locally, sub-regionally, and basin wide, directly accessible for all stakeholders;
- A modular river basin modeling system built around a dynamic water budget and allocation model including economic evaluation, that helps to design and evaluate possible interventions, strategies and projects in response to the problems and challenges identified and prioritized in the stakeholder consultations;
- Tools for a participatory multi-criteria analysis to rank and select alternative solutions for win-win strategies.

These DSS components will be integrated in an open, hierarchical, modular and very flexible structure that *inter alia* will facilitate information exchange with other models and tools used or developed within the basin. A key concept is the support of the analysis of local, national issues and specific projects, yet always to evaluate their overall downstream effects and basin wide impacts.

The institutional structure of the implementation foresees one common set of software tools and shared, standardized common data sets that can be extended locally with data for individual scenarios, and optional problem specific add-on software, exploiting the modular architecture.

These common tools and data are implemented at a central (NBI) location, two sub-regional locations (covering the NEL and the Eastern Nile sub-regions, respectively) and at the country level, together with the hierarchical data sharing, update, and access control mechanisms to ensure efficient yet safe and reliable use of the system.

The implementation process will use a rapid prototyping approach within an object oriented design paradigm that aims at an early operational prototype to ensure sufficient time for user feedback and extensive and independent testing, calibration and validation. The direct involvement of the end users and future operators and managers of the system in the development, implementation and testing is an important principle here. This implementation process will also include a set of directly relevant pilot applications (including data compilation and an associated training program) as well as a quality assurance task, all intended to ensure control, responsibility, interest and ownership as the basis for trust and acceptance by all riparian countries.

1.3 Brief Introduction of this Report

The present report is structured in a main text and three annexes

The main text provides

- an overview of the **scope of work** related to DSS development, including the presentation of the proposed Work Packages and the specification of the levels of expertise required for performing the required services (at the end of each Work Package description);
- the **implementation schedule** intended for the DSS in terms of work sequencing and phasing;
- a description of the **IT hardware / infrastructure requirements**
- an **initial cost estimate** as a reference and benchmark for the evaluation of proposals;
- the proposed **evaluation strategy** for Work Package 1 (Software Development); and finally
- a discussion of **sustainability issues** and implications from an institutional, financial and technical point of view.

Annex A provides a draft **results framework** for the DSS development.

Annexes B.1 and B.2 contain the **draft Terms of Reference** for the procurement of consultants for Work Packages 1 (Software development and system implementation) and 2 (Data compilation, processing and pilot test applications), respectively.

Annex C is a concise **Training Plan** which is based on the Training Needs Assessment carried out during the Analysis Phase of the Consultancy.

Wherever the term **Core Team** is used in this report it is meant to include:

- regional DSS staff
- national DSS specialists
- national IT/GIS/DB experts
- national counterpart staff (2 per country).

2 Scope of Work / Work Packages

2.1 Proposed DSS Development Approach

In parallel to the primary DSS software development, adaptation, and system implementation (Work Package 1), a number of auxiliary tasks need to be performed in a coordinated manner. These activities include data compilation and quality assurance, pilot application building, calibration and validation exercises, core staff training, the monitoring of the development process and a final evaluation and certification of the system, all designed to enhance the quality and usability of the results. The proposed approach is to define parallel work packages for separate (yet parallel, synchronized) execution, with implementation following the concept of concurrent engineering, in order to accelerate the implementation process and meet the tight time schedule allocated for the DSS development.

In addition to the developer's own software testing, an independent monitoring and testing procedure should be foreseen to ensure an independent, critical appraisal, constructive technical feedback and thus enhanced quality and reliability of the software product. These activities can be combined with other, major auxiliary components such as

- data compilation; including populating the information management system; and
- building of selected pilot/test applications as parallel test cases and usability studies.

The software prototypes (as they get developed and become ready for testing) will be brought together with the data (as they are compiled) in a series of continuing test applications to provide early feedback for the system development and installation (Work Package 2). By starting with realistic applications as early as possible (in fact, even before the first prototype gets formally released), a realistic test bed for the system and for the communication and feedback channels between users and developers will be available.

These parallel activities would benefit from a parallel supervision, monitoring and coordination task for the implementation phase as well as a final (external) certification of the system by an appropriate outside organization. These tasks constitute Work Package 3.

2.2 Structure of Tasks / Work Packages

As stated above, the development and implementation of the Nile Basin DSS should be structured into several parallel tasks, grouped into three independent work packages:

Work Package 1: Software Development and System Implementation
Work Package 2: Data Compilation, Processing and Pilot Test Applications
Work Package 3: Supervision and Monitoring

These tasks are designed to run in parallel over a period of 30 months with continuous involvement of the NBI core team, with regular overlapping 12 months prototyping cycles that each include a major milestone, deliverables and presentation and training workshops every six months (see the proposed time table below, section 3.2, implementation schedule).

The proposed work packages are:

Work Package 1 – Software Development consists of detailed design update and technical specification including a systems ontology and the definition of model specific

data requirements, basic software development and adaptation, testing, initial calibration subject to data availability, installation, documentation, software related training and user support for the core system (Information Management System, core models, and MCA decision support tools); Annex B.1 lists the required and desirable features for the IMS, DSS and model software system, and provides both a structured checklist and a questionnaire for the evaluation of proposals (proposed attachments for the ToR).

The output of Work package 1 is an operational DSS with its three main components, documentation, manuals, and associated training conducted, implemented at the NBI PMU, sub-regional and national DSS units.

The work package also includes the development of a user support and maintenance plan, as well as a series of Deliverables that are described with their nature and due dates in the attached ToR.

Work Package 2 – Data Compilation, Processing and Pilot Test Applications will be executed in parallel but independently, involving end users and the NBI DSS core and national teams.
The **objectives** of this work package include both a support function and a test function:

- providing quality assured data for software testing and applications;
- usability testing of the IMS and data analysis functions;
- pilot test applications (system usability);
- model calibration and validation.

The **tasks** of Work Package 2 are designed to test the operation and usability of the integrated system and its components together with the data in realistic applications of immediate basin wide interest, including specifically

a. Preparatory phase, data catalog and meta data, pilot study definitions;
b. Data compilation, processing and import
c. Usability testing of all components
d. Pilot test cases, model calibration and validation
e. Stakeholder/core team training (data analysis, application building).

Work Package 3 – Supervision and Monitoring coordinates/synchronizes these parallel activities and organizes quality assurance processes; it includes:

a. Compilation and coordination of all test protocols and procedures, reporting and documentation requirements and guidelines;
b. Monitoring of project progress, milestones, deliverables, testing and documentation processes (in WP 1 and WP 2), document management, problem report logging and tracking;
c. Coordination and synchronization between WP 1 and WP 2, conflict resolution, including follow-up on problem reports
d. Facilitation of communication between all teams, maintenance of project web site, mailing lists, discussion fora
e. Coordination of an external peer review and advisory process as well as of all presentation and training workshops;
f. Final system certification (by external auditors, subcontracted).

2.3 Communication and Coordination between the Work Packages

The primary responsibility for communication and coordination rests with WP3; during a kick-off meeting in the first project month, details of the coordination will be discussed and agreed upon, in particular the data and information exchange and associated scheduling, as well as mechanisms for conflict resolution, with the client as ultimate arbiter.

2.3.1 Task Monitoring and Management

A major element in the co-ordination of the work packages is the monitoring of progress and budget against planned schedules (assistance to the client to avoid cost overruns), with due consideration for the interdependency of tasks and work packages, and including an efficient early warning system to detect deviation in time for corrective measures. For this somewhat complex task management, which requires continuous adaptations, an on-line task data base and tracking system (including PERT-CPM tools) for the efficient management of the interdependent work packages and tasks shall be developed and implemented under WP 3.

2.3.2 Communication Management

Communications between the work packages during the prototyping cycles will rely heavily on electronic media (e-mail, ftp, WWW) to ensure a fast and efficient exchange of comments, documents and data and code including problem reports. However, collaboration for the individual work packages will also rely on site visits and face-to-face discussions (minimally six joint meetings on-site (PMU) are foreseen), in particular with the client and the DSS core team, in addition to any electronic communication.

To facilitate communication and coordination, and at the same time maintain a record of feedback, comments, suggestions, and problem reports, WP 3 will maintain an on-line (web enabled) discussion forum that offers features such as notification of new postings, direct partner communication, etc.

In addition to the e-mail through mailing lists a dedicated ftp server (also accessible through a WP 3 project home page on the web) will be maintained as a common and generally accessible repository for project related information; relevant project documents, documentation, and data format and interface examples can be made generally available at this ftp site and through a project WWW server and home page, to be maintained by WP 3. This allows direct access to the latest versions of all project documents including the individual pilot test cases and related multi-media documents (stored in the Nile-IS), with multiple indexing, full text search, and easy-to-use hypermedia structures.

2.3.3 Quality Control

For quality management, and in particular for the software development components (WP 1) of the project, the ISO 9001 and 9000-3 guidelines shall be adopted to prepare a project specific quality management procedure (by WP 2). In addition, and independent technical peer review by external experts in connection with the regular prototype implementation meetings shall be used.

For all project data and documents, a document tracking system with a data base server and web accessible clients (PHP and HTML) shall be used. All Project Deliverables (more than 60 including the 3 monthly mail based progress reports by WP 1 and WP 2) will have to be reviewed and edited/consolidated by WP 3 before submission to the client. External peer review, wherever feasible within the time constraints of the project schedule (feedback on all Deliverables within one month), will be organized where appropriate.

2.3.4 Risk Management

By careful monitoring of project progress against the individual work package milestones, and regular (3 and six months) project internal progress reports, an early warning framework shall be implemented by WP 3 (based on the task monitoring and management system described above) to minimize risks to the project progress and success. The lead consultant of WP 3 shall call for ad hoc meetings of the technical steering committee (to be defined at the initial kick-off meeting) if and when problems arise. For the main foreseeable risks (lack, or delay in availability, of adequate data due to technical or institutional problems, delays in software implementation, problem corrections), a series of contingency plans in terms of a sufficiently flexible approach shall be implemented, supported by the on-line PERT-CPM tools.

2.3.5 Conflict Resolution

The cooperation between the work packages' partners and their respective rights and obligations within the consortium will be defined in detail at the kick-off meeting based on a proposal to be prepared by WP 3.

In case of dispute or difference between the partners, arising out of concern of or in connection with project implementation and the interdependencies between work packages, the work package teams shall always first and foremost endeavor to settle it amicably. Conflicts between project participants will be addressed by the technical steering committee, which will aim to reach a unanimous decision; if no satisfactory agreement in good faith can be reached the client, or any representative appointed by the client, will be involved as arbiter, in accordance with the rules of conciliation and arbitration of the International Chamber of Commerce. The place of arbitration and the applicable law shall be the country of the client and its law.

2.4 Work Package 1

2.4.1 System Development (IMS, RBMS, MCA)

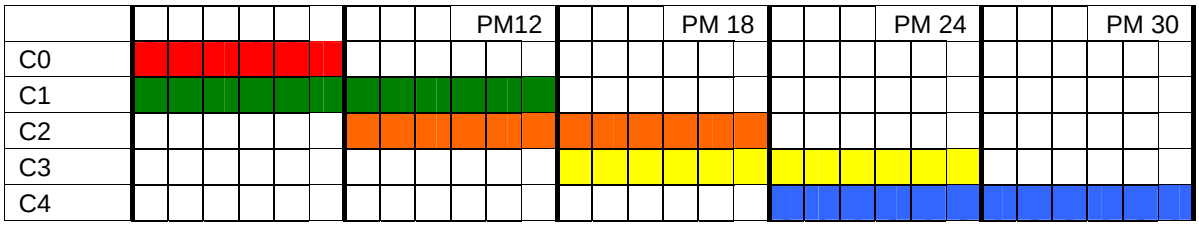
This task includes the adaptation and/or development of the basic software components, the information system and data bases, the core models, and the MCS tools in four prototyping cycles of 12 months, and three times 6 months, respectively.

- Design update and detailed technical specification (cycle zero);
- Cycle one will result in the implementation of an operational prototype of the core water resources model and associated data bases at PM 12.
- Cycle two will add the associated models and functional extensions of the core system and perform initial calibration based on data provided by WP2, implemented at PM 18; additional functionality for the second prototype includes
    - rainfall-runoff models (lumped, semi-distributed),
    - meteorological pre-processor(s)
    - irrigation water demand,
    - hydropower production,
    - economic evaluation (CBA),
    - water quality, sediment transport, watershed erosion,
    - other associated models (groundwater interaction, 1D hydraulics)
    - model calibration tools.

- Cycle three will implement the necessary extensions of the core models for
    - o sensitivity analysis, stochastic modeling,
    - o automatic generation of feasible alternatives,
    - o export of feasible alternatives to the MCA/DSS,
    - o basic MCA tools (decision matrix, reference point method);

  available at PM 24 for a final six months of testing and evaluation leading to the system's certification;
- Cycle four will be dedicated to adaptation and customization tasks based on user feedback and peer review of components and the overall implementation.

Second and third prototyping cycles will build on the user feedback from the previous prototype installation that should be combined with a parallel training workshop in each case.



Tentative schedule for the four main prototyping cycles, including a preparatory detailed design phase (C0)

Detailed system requirements and technical specifications are provided in Annex B of the DSS Design Report.

2.4.2 Testing Procedures (Developer Level) and Initial Calibration

For each structural or functional component (see Appendix B.1) a detailed test protocol should be developed. For this first level of testing, very simple synthetic data should be used, so that the expected results and performance are easy to predict (e.g., constant inputs or simple - triangular or rectangular - pulse or sinusoidal inputs, simple topologies are geographies with basic geometrical basin shapes, constant slopes, constant temperatures, etc.). The test protocols should be checked and verified (signed or initialed) by a second person (4 eyes principle); preferably, while designed with the cooperation of the developer, the test should be conducted by an independent person or team outside the immediate development team.

Initial calibration of the core models (cycle 1 and 2) will be based on selected quality assured data sets provided by WP 2 not later than PM 15 (see the Table of Deliverables). This will primarily aim at testing the embedded calibration support tools.

2.4.3 System Documentation

Three levels of documentation are required:

1. A **user manual** of tutorial character; this must be structured for a "context sensitive" implementation, so that every major page/function of the system has a corresponding manual page or entry point that can be linked to that page/screen/function.
2. A **reference manual** that describes the implementation, algorithms, and underlying theory in all necessary scientific and technical detail;

3. An **implementation and programmers manual** that defines all configuration options, interfaces, data formats, data base structure, data models and entity-relationships, communication protocols to enable the users to link additional components and develop the system beyond the initial implementation.

The user manuals should be available in an on-line (hypermedia) version embedded in the systems user interface for contact sensitive access. The on-line user manual should provide full-text search capabilities beyond a context (screen and function) specific linkage.

All manuals should also be available in electronic, yet printable (PDF) versions, structured for easy (partial) upgrades as new releases and functionality become available.

All components must clearly and unambiguously indicate the release level of the software they refer to facilitate keeping the manuals up to date.

2.4.4 Core Team Training

The development approach envisages intensive involvement of the DSS core team. Software related user training shall consist of a series of at least four one-week training workshops in conjunction with the installation of each of the four successive prototyping cycle results. The primary objective of this set of trainings is to provide the riparian DSS core team an in-depth training on the system so that the former would be able, at a minimum, to run the system, provide training to other riparians, and maintain the system. These trainings should be held at the location of the software installation to be able to directly use the newly installed systems or updates for the training and at the same time subject it to user testing. Training must cover the background, algorithms and theory of the software, as well as hands on exercises with didactic synthetic test cases to familiarize selected users with the system.

The software training shall be synchronized with the release of the corresponding user manuals to be used as course material in the training to compile user feedback for the improvement of the manuals.

2.4.5 Maintenance and User Support Plan

As part of any bid for the provision (licensing, adaptation or development of new components) of any software solutions, a system maintenance and user support plan is mandatory. The system maintenance and user support plan must include:

- A mechanism for error reporting and the tracing of corrective actions;
- An on-line user help desk based on e-Mail or any appropriate web based discussion forum software;
- A proposal for continuing refresher training courses;
- A mechanism for intermediate systems upgrades (minor bug fix releases) and associated documentation and release notes;
- A proposal for continuing user support and system maintenance beyond the basic project duration including an extended warranty of more than 12 months;
- The maintenance plan must also include specific strategies and tools for regular system backups, and the distribution of any updates of software and data base content by the user at the NBI central installation.

2.4.6 Level of expertise required

The primary requirement is demonstrated experience in developing and deploying water resources models and DSS systems in large river basins, with preference to applications in developing countries.

The consultant should be able to demonstrate a sufficiently experienced software development team (MS or engineering degrees, IT specialists and experienced programmers, domain experience in hydrology, economy, several years of professional experience, international reference projects).

More detailed requirements for core team member qualifications are given in Annex B.1 (Draft ToR for Work Package 1).

2.5 Work Package 2

The tasks and activities of Work Package 2 include:

a) Preparatory phase: Test protocols, identification of data sources; definition of meta data standards and reporting standards; identification of pilot test cases; definition of calibration and validation methods and criteria.

b) Data compilation, processing and import, meta data compilation; data quality assurance, patching, outlier detection and consistency checking. As these tasks require both data processing skills, domain knowledge, and access to local (national) data sources, the direct and prominent involvement of the national NBI/DSS specialists is essential. This will also provide the data basis for the application testing described above and therefore needs an early start and tight synchronization. The task includes remote sensing image processing (e.g., land use, land cover), and compilation / import of model generated hydro-meteorological data sets based on prognostic meteorological models (e.g., WRF).

c) Usability testing (technical, ergonomic, logical and substantive) of all components as they become available and get implemented in the prototyping cycles, based on the test protocols and standard defined under (a).

d) Detailed definition / selection of a set of pilot test cases (identified in (a)) for system calibration, validation, and associated training. Pilot cases will be select in coordination with the client; a set of criteria for the definition and selection of appropriate pilot cases is provided below.

e) Model calibration and validation, which can include benchmark cases (from literature) and model inter-comparison with alternative tools, using the methods and criteria from (a).

f) Stakeholder / core team training in terms of concrete early applications of common interest, back-to back with the software training; minimally six weeks.

2.5.1 Data Compilation, Processing, Analysis and QA

This task should clearly be bundled into Work Package 2 for independent, parallel execution, as it includes critical usability testing of the IMS. The data compilation tasks involve the compilation, consolidation, validation (quality assurance) of all data sets needed for the operation and testing of the Nile Basin DSS, including populating the IMS. This should include:

- any and all data sets from public domain sources (to be compiled by the consultant);
- model generated synoptic dynamic hydro-meteorological data sets for a sufficient number of years, minimally covering a period that spans over average, wet, and dry years;
- all data sets and GIS layers / coverages provided by the client.

Data consolidation involves patching of missing data where possible, outlier detection and correction, eventually resulting in consolidated data sets to be used for testing the DSS. The consolidated data sets must indicate any modification of the raw data with a key linked to a description of the methodology used.

Specific data sets to be compiled and uploaded in the initial data base include:

- Complete DEM coverage at 1 km (and 90 m) resolution;
- Remote sensing / satellite imagery and processing: Land use, land cover and hydro-meteorological and energy budget parameters as satellite background maps derived from LANDSAT TM, AVHRR, Meteosat/GERB, in several resolution layers down to 15 meters for specific locations, wetlands, lakes and the river channel;
- Long-term reference climate data (stations and spatial interpolation to regular grid, e.g. ORNL, Cramer and Leemans 2000);
- Hydro-meteorological data fields (temperature, precipitation, radiation, humidity, wind data) for one or more complete reference (water) years derived from MM5 or WRF GFS data sets at 1-3 km resolution, original hourly data aggregated to daily averages or totals;
- Existing historical data at country level, to be compiled in collaboration with the DSS core team;
- All other data required for the calibration, validation and testing of the DSS.

It is important to note that this is not only an exercise in the (necessary) data compilation resulting in an operational information system, but at the same time it is a very practical usability test for the Information Management System, data bases and GIS in a realistic application context.

2.5.2 Pilot Test Applications, Calibration and Validation

A set of at least three directly relevant application projects with different scope and hydrological regime will be defined, including the effects on the overall basin (using a baseline scenario of the entire basin dynamic water budget based on the main river basin model).

The baseline scenario comprises a dynamic water budget for the entire basin for either typical years (average, wet, dry) or a sequence of several years, as well as any of the years for which the individual pilot cases are run to evaluate their impact on the overall water budget.

The proposed **selection criteria for the definition of the test cases** require that these initial pilot cases:

- have immediate relevance on the overall basin water budget and therefore provide inputs to an overall, basin wide water budget and economic evaluation model (one of the baselines applications and first mandatory test case);
- therefore be of relevance to more than one country (trans-boundary interest, ongoing NBI-SAP projects) but also address at least one country's specific local interests to demonstrate the local version regional applicability of the system;
- include more than one sectoral aspect or address more than one of the main stakeholder concerns;
- relate to ongoing or planned major projects in the basin where possible (and use existing pre-feasibility or feasibility study data where available);
- include a reasonable set of test data for calibration and validation that should be imported to the IMS (data bases and GIS);

- cover (together) a broad geographical and thus hydrographical spectrum to demonstrate the system's applicability of the entire range of conditions in the Nile basin;
- exercise as many of the functional components and features (models) of the consecutives prototypes as possible.

An additional desirable feature of the test cases is

- demonstrated linkage (data exchange, comparison of results) with any existing (legacy) components, data bases or models (e.g., the Lake Victoria Water Quality Model, modeling activities in the Kagera and Mara basins, the ENPM, etc.).

The test procedure and protocols will be developed by WP2 with support from WP3. They will be discussed with WP 1 for technical feasibility (PM 6), and with WP3 for procedure and documentation requirements as the basis of eventual external system certification.

2.5.3 Outputs

The main outputs of work package 2 include:

- a complete, quality assured data set for the initial operation of the DSS, imported into the IMS available from Work Package 1;
- data descriptions (catalog), meta data, QA methods and results;
- data sets derived and compiled from:
  - any public domain sources available
  - basin wide and local (sub-basin level) data sets provided by the client
  - remote sensing (satellite) image processing
  - model generated hydro-meteorological data for at least reference years (normal, dry, wet) and/or a sequence of more than 5 years;
- pilot test cases (at least three plus the overall basin wide water budget modeling framework, i.e. baseline scenario) with calibrated/validated model applications;
- core staff and stakeholder training workshops and training material on data compilation, processing, quality assurance, and the pilot cases (model applications, calibration, validation);
- detailed documentation of the work done (methods, procedures, results, etc).

A list of required deliverables is integrated with the ToR for Work Package 2 (Appendix B.2).

2.5.4 Level of Expertise Required

The primary requirement is demonstrated experience and reference applications in large scale water resources model applications, including the associated data processing (hydro-meteorological time series, satellite image processing, meteorological modeling and downscaling of synoptic weather models), calibration and validation experience. The consultant should be able to demonstrate a proven multi-disciplinary team that covers hydrology, environmental sciences, economics, and computer sciences or and engineering, post-graduate levels of academic background, several years (>10) of professional experience, and again large scale international reference project/applications with preference for experience in the Nile basin and/or other developing countries.

A more detailed specification for the core staff member profiles and qualifications is given in Annex B.2, Draft ToR for Work Package 2.

2.6 Work Package 3

2.6.1 Supervision and Monitoring

This main task includes:

- Definition of a detailed time schedule, milestones, and measurable performance metrics agreed between the consultant and the client;
- Compilation and coordination (consistency checking) of all test protocols and procedures, reporting and documentation requirements and guidelines;
- Monitoring of project schedule, milestones, deliverables (PERT/CPM), test and documentation standards; identification of any deviations and emerging problems as well as mechanisms for their remediation;
- Document management; coordination and facilitation of communication between all teams, maintenance of project web site, mailing lists, discussion fora, problem report logging and tracking;
- Organizing the review and feedback process including external peer review synchronized which each major prototyping cycle's results, coordination of all presentation and training workshops;
- Final system certification (by external auditors, subcontracted).

2.6.2 Peer Review and Validation

The peer review procedure (separately organized by the PMU but synchronized with the presentations and trainings of the four prototyping cycles) will be based on at least four one week workshops involving several international IWRM modelling experts that should be informed through the supervision and monitoring team (WP3) and have access to all reports and documentation on a continuous basis.

The workshops will include

- Presentations from the development team on the current implementation status and the components involved;
- Presentations from the monitoring team and the pilot/test applications;
- Presentation and discussion of the pilot applications and their computational experiments comparing the model validation results for the selected pilot test cases (including data availability in the IMS), i.e. model performance tested with independent data sets not used for calibration;
- Optional model inter-comparison exercises in support of the expert assessment, at the very least based on literature studies (published model application results) or available operational systems such as the Nile DST.

2.6.3 System Certification

Based on the test protocols, the pilot applications, calibration and validation results, an independent entity (such as DNV) will be invited to re-assess the development procedure, documentation, testing and validation, and certify compliance with a set of defined standards (ISO 9000 or derived).

2.6.4 Level of Expertise Required

The primary requirements include a broad interdisciplinary team with strong demonstrated management and IT project implementation experience in very large scale international project management; senior scientists and managers that can credibly provide (authoritative) supervision and coordination of multi-disciplinary and distributed development teams, with advanced academic background (MS or Doctorate level) in all domains covered (water resources/hydrology, socio-economics, information technology and IT management, management sciences) a minimum of 10 years of individual professional experience, several large-scale international reference projects including experience in working in Africa.

For the independent certification, and appropriate (e.g., certified for ISO 9000/14000 certification) international auditor should be sub-contracted.

3 Implementation Schedule

3.1 General Implementation Approach

The proposed NB DSS will be implemented in phases, primarily subject to constraints in time and funding. However, there is also an important aspect of learning and institutional change: The implementation is designed as a participatory process that requires the direct involvement of the riparian experts (DSS core team) and future users to continually provide feedback, build common understanding, responsibility and operational control over the final product, and thus build trust and acceptance as the basis of sustainable applications and use.

It is important to realize that a system as big and complex as a DSS for the entire Nile basin that is also of direct interest and useful for all its riparian countries is a very demanding task. The number of problems such a system should eventually address is nearly endless, and will require not only careful scoping and selection, but mainly a long-term commitment and sustained efforts.

This DSS Implementation Plan will therefore focus on a **first implementation phase of 30 months**, which will be based on a core set of components, tools, and functionality (required and desirable) described in terms of detailed functional requirements and architectural features in a structured checklists for quantitative comparative analysis.

Any available system is unlikely to meet all the features given in the checklist, and their classification as R(equired) and D(esirable) is tentative. There is a potential risk of not being able to include all the required features due to budget and time limitations. Consequently, the NBI has to be pragmatic in identifying what is feasible in the first phase. This requires NBI to keep the final choice of required features relatively flexible, to be decided based on available systems and proposals by potential DSS developers.

Future extensions in subsequent phases will be addressed through the required architecture and implementation strategy that must foresee such extensions (numerous examples of external model components for future linkage or integration are enumerated in the DSS Design Report and its Annex B). The main precondition is to keep the system flexible and open and ready for these future extensions under a developing set of user requirements and emerging opportunities, time and funding.

The basic implementation strategy is **rapid prototyping** to maximize the involvement of local staff and accelerate user feedback during the implementation and test phase. Prospective users are expected to be exposed to the operational prototypes as they become available in the framework of software oriented training courses that will prepare them to explore the systems and provide feedback for adaptations and improvements.

Implementation schedule for the NB-DSS software, data compilation, initial application building and associated training is foreseen for a 30 months period. This includes **several prototyping cycles** with a concurrent engineering approach together with sufficient time for testing as well as associated involvement and training of local (NBI) staff members.

3.2 Work Sequencing and Phasing

The overall project must be scheduled over a 30 months period. A detailed work plan and scheduling is proposed below; however, as part of any offer, the potential contractor is invited to provide any alternative plan, explaining the proposed deviations.

A **first operational prototype** must be installed **by PM 12** ready for application building, calibration and validation.

The **final system** with revisions based on initial prototype feedback and evaluation (external peer review) and experience from pilot applications, ready for the certification tasks, must be installed **by PM 24**.

The implementation phases are related to the following breakdown of components, corresponding to the individual overlapping prototyping cycles, each over a 12 months period, with a 6 months shift and overlap:

1. **River Basin Model**: The core water budget, resources and allocation model and associated data bases (information system) operational prototype implemented at **PM 12.**

   The IMS and its data bases, software as well as first data content as the communication backbone and common data repository of the system will have to be developed in parallel over all cycles (see the task descriptions below).

2. **Associated models** and functional extensions of the core system, including
   - Rainfall-runoff models
   - Meteorological pre-processor(s)
   - Irrigation water demand
   - Hydropower production
   - Basic economic evaluation (CBA)
   - Water quality and sediment transport
   - Watershed erosion
   - Groundwater interaction
   - 1D hydraulic model

   together with basic scenario management and comparison functions;
   implemented at **PM 18,** installed together with updated manuals and including a core staff training workshop;

3. **MCA tools and extensions of the core models** for:
   - Sensitivity analysis
   - Stochastic modeling
   - Calibration and validation
   - Automatic generation of (feasible) alternatives
   - Export of alternatives to the MCA/DSS; including
   - Implementation of the basic MCA tools;

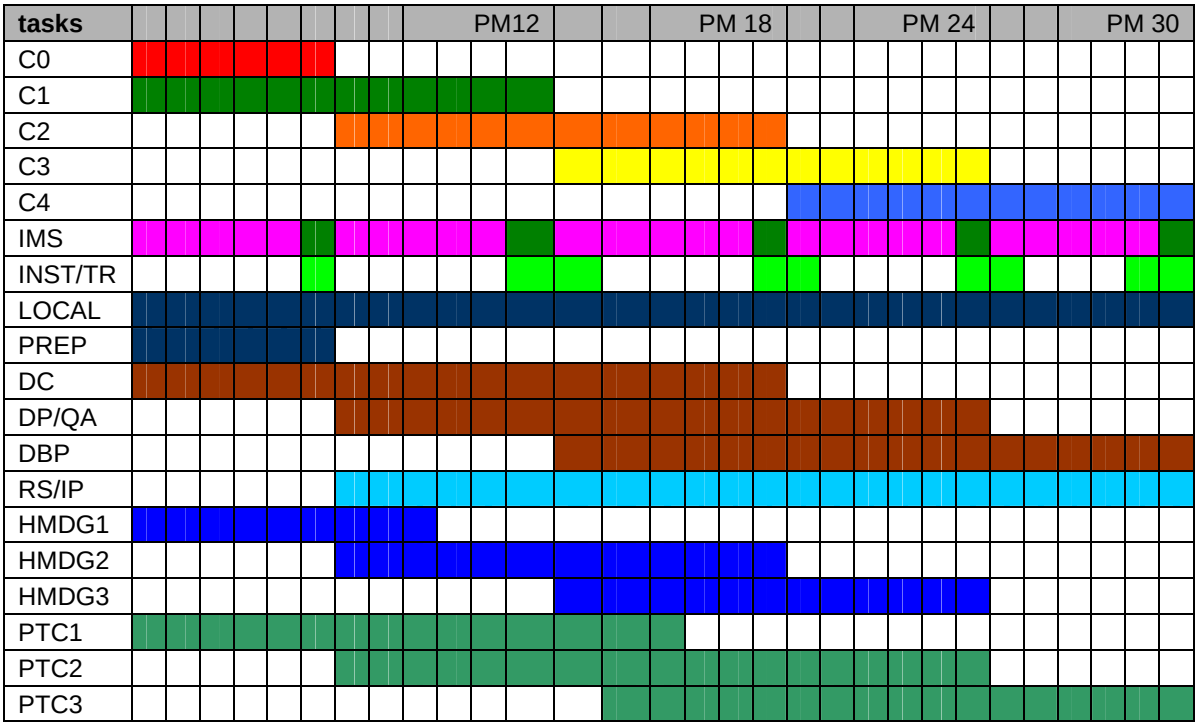
   available at **PM 24**, installed together with updated manuals and including core staff training workshop, ready for a final six months of testing and evaluation leading to the system's certification.

4. **Integrated system**, including adaptation and customization based on user feedback and peer review of components and the overall implementation, to be completed by the end of **PM 30**; including final installation, manuals release, and training workshop.

The Table below indicates the sequencing and relationship of the major groups of tasks defined as follows:

Task Acronym	Description of the Component or Task Group	PM	
WP 1		**from**	**to**
C0	Detailed design and implementation plan	1	6
C1	River Basin Model (dynamic water budget model)	1	12
C2	Component models of the core system	7	18
C3	Multi-criteria analysis tools (MCA)	13	24
C4	Integrated system, interfaces, general utilities	19	30
IMS	Information management system, data bases and GIS	1	30
INST/TR	Installation, testing and training (intermittent)	1	30
LOCAL	Local NBI team/user involvement (continuous)	1	30
WP 2		**from**	**to**
PREP	Definition of test protocols and meta data, detailed work plan and methodology	1	6
DC	Data compilation (with NBI core team and national DSS specialists)	1	18
DP/QA	Data processing, analysis, quality assurance	7	24
DBP	Data import, populating the IMS, DB and GIS	13	30
RS/IP	RS image processing	7	30
HMDG1	Model setup, compilation of boundary conditions	1	9
HMDG2	Simulation runs (3-10 years, 1 km/hourly resolution)	7	18
HMDG3	Post-processing, DB import	13	24
PTC1	Pilot test cases: definition and setup	1	15
PTC2	Model exercises, usability testing	7	24
PTC3	Calibration and validation	14	30

Sequencing of overlapping prototyping cycles and associated major components to be installed over a period of 30 months:



4 IT Hardware / Infrastructure Requirements

The necessary hardware and infrastructure must be available for the installation of the first operational prototype **by PM 12**. Central purchasing under the assumption that there are no export and customs problems with the distribution of centrally purchased hardware would seem to be of advantage.

1. **Servers** (NBI, 2 sub-regional, 9 country level, including local consoles or networked clients to support at least three simultaneous users.).
    a. Servers should be based on the latest state-of-the-art dual or quad core Intel or AMD processors.
    b. Must be capable of running an open source OS such as Ubuntu (all necessary drivers available).
    c. Must be designed to operate all interactive tasks within response times of less than 10 seconds (target performance metrics to be specified as part of the detailed technical specifications provided by the developer).
    d. One laser printer per server, including consumables (toner, paper) for at least one year of operation).
    e. Backup system (USB disk, DAT tape, or LTO tape) for automated, scheduled daily backup.
2. **Clients:** 2 additional networked clients for each of nine country installations (18) for a maximum of five simultaneous users at the country level.
    a. Client hardware: standard PC (desktop or laptop) with sufficient graphical screen resolution (minimally 1024*768) to support a standard web browser. Target resolution is 1280*1024 or better, true color.
    b. Must have sufficient memory (min. 2GB) and local disk capacity (120 GB) to support local processing of exported data with PC based utilities (GIS, statistical software, MS Office/OpenOffice).
3. Associated infrastructure requirements include:
    a. Air conditioned computer rooms (with acoustically separated server enclosure) with UPS (minimal support period of up to one hour battery operation), furniture for five work places for two persons each.
    b. Local area network (cabling and switch) for 100 Mb Ethernet.
    c. Internet connectivity: 100 Mb switched LAN; external connection: ADSL/XDSL with a **minimum** of 128/512 kb bandwidth; target bandwidth is 1 Mb/s or better.

5 Initial Cost Estimates

The cost estimate primarily address the estimated manpower for the main task groups listed below, to be provided in detail in the proposals; they only provide a very rough initial estimate, rounded to the nearest 1,000; a detailed budget has to be provided by any proposer. The estimated total costs over the proposed 30 months of development are in the order of US$ 5M.

WP	Task	Description	Cost US$	Total US$
1	1	**Total SW development:** Software development, basic software testing, documentation, software related training and installation, user support tasks; Assumes a minimal team of 5 developers over the 30 months period, i.e., 150 PM of efforts; at an average 18,000 US$ per PM for 150 PM of effort, this would amount to US$ 2,700,000.-; Involvement of the local staff and training will involve at least 36 international trips (at US$ 1,200 each) and 480 field days (either way) with an estimated total costs of US$ 523,000.-	3,223,000	
	2	**Software licenses, maintenance, support** 12 licenses	240,000	
	SUBTOTAL WP1			3,472,000
2	3	**Data compilation, quality assurance, populating the data bases:** Assumes the main data compilation efforts to be done by NBI / national DSS specialists (see TOR inputs, 4.3) and a support team (part time) amounting to one full time person over the 30 months period, 8 international trips and 60 field days for direct collaboration and related training; including satellite imagery (LANDSAT and SPOT scenes)	384,000	
	4	**Pilot test applications involving end users, system calibration and validation, stakeholder and peer review process:** Assumes two consultants involved for 15 months, four workshops (8 international trips) with 18 (two per riparian country) participants four times for five days each, and four peer review meetings with 5 external participants each.	552,000	
	SUBTOTAL WP2			936,000
3	5	**Supervision, monitoring and coordination of the implementation phase:** Assumes 15 PM (2 – 4 consultants, part time) over the entire period, attending all workshops and meetings, or a total effort of 30 Person Month	440,000	
	6	**Final testing and system certification with 6 person months** 4 trips	125,000	
	SUBTOTAL WP3			556,000
TOTAL COST FRAMEWORK, INITIAL ESTIMATE				**4,964,000**

6 DSS Sustainability

This section is intended to make clear the challenges and opportunities that must be acknowledged and – where necessary – faced if the Nile Basin DSS is to be sustainable in terms of its ability to provide a relevant service to the riparian stakeholders. In this context sustainable refers not only to continuity, reliability and serviceability, but also to the flexibility and adaptability needed to provide support to decision makers as the water socio-economy and other factors or priorities change over time in the Nile basin.

Sustainability in this context mainly depends on three factors:

- Institutions
- Finances and
- Technology.

Each is discussed in the sub-sections below which identify the sustainability issues and include, to the greatest extent possible at this stage, recommendations regarding ways by which sustainability can be ensured.

6.1 Institutional Sustainability

Institutional sustainability of the DSS will depend on the capacity, adequacy and continuity of the operational structures, institutional arrangements, and human resources, on the one hand; and on the long-term commitment of the main stakeholders, on the other hand. Both aspects will be discussed in this section.

Ensuring the institutional sustainability of a complex multi-national and multi-sectoral DSS within the socio-economic environment given in the Nile basin is a major challenge. A **stable, permanent institutional structure** with clear responsibilities and a certain degree of technical and operational autonomy is desirable to create an appropriate framework for DSS operations. This includes clear authorities and agreements with respect to data exchange and reconciliation modalities, consultative processes, etc.

The procedures of **data collection, processing and dissemination** (conditions of use) should be defined not only at a general basin-wide level, but also – through individual Memoranda of Understanding (MoU) – at a very concrete level, between national data providers, National DSS Units and the Regional DSS Centre.

The institutional structure of the DSS foresees a central installation and several (at least nine national and two sub-regional) decentralised installations, with hierarchical data sharing, update, and access control mechanisms to ensure efficient, safe and reliable use of the system. The **Regional DSS Centre** will hence be responsible for the overall integrity and consistency of the system as well as for the quality assurance of the common data sets, software tools and parameter sets. This requires a sufficient number of highly qualified core staff and a high degree of continuity and reliability of the services.

At the national level the current approach with **National DSS Units** liaising with national line Ministry counterparts seems to be appropriate. Dedicated national teams with appropriate qualifications and, as a pre-requisite for this, appropriate remuneration are needed and will work under the supervision of the Regional DSS Centre. The required staff numbers will vary according to the type and scope of applications being developed (initially, these will be the selected pilot test

applications) and the qualifications within the team should cover all the required fields of expertise.

These National DSS Units reporting to the Regional DSS Centre are indispensable for reliable system operations and maintenance and for **continuity**: The DSS, including its national installations, should be situated in and maintained, operated and upgraded by a long term institution established at the basin level rather than in say, a local ministry where it could be neglected during inevitable reform and restructuring cycles or changes of Government.

However, it is also essential to aim at **maximum involvement of national institutions** and stakeholders. Formal appointment of national counterparts is not sufficient in this context. To keep physical distance small it is strongly recommended to install the National DSS Units within the premises of national institutions (normally the line ministry for water resources management). Technical staff of national institutions should be closely involved in activities such as application development and data validation. Specific efforts will be needed to involve national decision makers and create ownership and trust of the system (more details on these aspects see below). This includes the generation of information products according to national requirements and responding to requests from national stakeholders. Handling of national data, the development of specific applications and the generation of specific scenarios are technically possible and should be encouraged to enhance ownership. For the same reasons it is desirable to encourage replications of the system in national institutions, including higher learning institutions.

Developing national capacities in modelling and DSS application will be an important aspect for the medium-term to long-term sustainability of the system, and it will generate awareness and capacities in (Transboundary) IWRM. It is particularly important, to this end, to collaborate with **national research and educational institutions** active in relevant fields. National universities and institutes can either provide or benefit from training activities; students can contribute to and benefit from application development through thesis, dissertations, etc. It is recommended to make dedicated funds available to promote this type of cooperation and networking.

It is recommended to undertake a **comprehensive assessment** of the specific institutional structures and capacities that are required for the NB DSS at the various levels (regional, sub-regional, national), including the detailed conceptualisation of **capacity building** measures.

The **sustained availability of trained personnel** and related issues (staff turn over, adequate remuneration levels) are obviously crucial for the medium to long term success of the DSS. As described above a stable core team should be provided by and report to a long term institution to be established at the basin (regional) level. Assuming that long-term donor commitment will be available this would ensure the continuity of basic DSS operations but not necessarily the full linkage and benefits of the system at the national and sub-regional level.

The success of the DSS will therefore also depend on factors such as awareness, demand, trust and ownership within the region:

1. Potential users must be aware of the DSS and what it could do for them. A first round of **awareness** raising has already been carried out to this end during the execution of this consultancy. Although these workshops were well received by the stakeholders there were indications that considerable follow-up would be useful. In particular, although there seemed to be general understanding about what a generic DSS could do, there remained a degree of confusion regarding a specific Nile Basin DSS as a sub-regional or regional tool rather than a national tool. Also, when participants at the stakeholder workshops were asked to brainstorm relevant stakeholders, criteria and DSS questions, there was a tendency to suggest a range of institutions to be involved and questions to be answered that is as comprehensive and inclusive as possible. While this was understandable in this initial phase more guidance on focussing and on keeping expectations realistic will be needed in the future. These problems could not always be properly addressed due to the

highly structured nature of both the sensitization and consultation workshops, which was unavoidable due to time pressure. As a consequence it is recommended that future workshops provide greater time for spontaneous discussions, in the hope that these would reveal more questions or misunderstandings than has been possible at the structured workshops to date.

2. There must be **demand** for the DSS, among the riparian stakeholders. In other words, stakeholder commitment (in terms of both interest and possibly resources) will depend on perceptions with respect to the usefulness that the Nile Basin DSS represents to them, their "constituencies" and the specific transboundary water management challenges and opportunities. That there is demand for DSS services was clearly confirmed by the results of the stakeholder consultations carried out during the consultancy, but ongoing commitment will require focusing on concerns of high mutual interest. Already the first working version of DSS will support a wide range of decisions that are of high priority in all member countries, including agriculture/irrigation and energy development. Ongoing commitment on the part of the NBI (or its successor) will be required to maintain a high level of awareness raising and consultation.
3. **Trust** in the DSS is an essential condition for its successful regional use. The main elements of building trust are transparency and close involvement of national stakeholders, both at the technical and decision making level, throughout system development and implementation. The development and implementation process has been designed to build trust by (i) participatory development of pilot applications and (b) an independent peer review and certification process. During the operational phase any new model, data set or parameter set should pass a transparent consultation, testing and approval process before its application.
4. There must be **ownership** among the member countries. The NBI is highly committed to a fully participatory approach to river basin management and makes serious efforts to engender a sense of local ownership in all its initiatives. High levels of participation are intended not only to provide much needed information, but also to bring stakeholder representatives closer to the action, and hence to a closer sense of ownership. In addition, the establishment of local DSS cells close to the decision makers in the member countries will compound the sense of ownership. In a venture such as this, ownership is easy to engender at the beginning, but longer term ownership will depend highly, or even fundamentally on the extent to which the DSS actually supports stakeholders real decisions as they have to be made and that it does so in a convincing fashion. The DSS is designed to ensure a high degree of adaptability, including the possibility to add and edit local data sets and run specific model scenarios.

6.2 Financial Sustainability

It is understood that DSS development and operations will be funded from existing resources until 2012, but thereafter alternative funding modalities will be required. It is obviously desirable that these must be sustainable and to the greatest extent possible, independent of direct development partner support. It is also desirable that the funding should be sufficient to cover the following basics:

- Staff (staff requirements have been discussed in the previous section; a detailed assessment of staffing adequacy and requirements would need more in-depth studies)
- Establishment (office space, office equipment etc)
- Utilities (power, telecommunications, internet connections etc)
- Equipment (including servicing, repair, replacement)
- Ongoing development (consultants and other external service providers).

- Ongoing expenditures related to data acquisition and quality assurance.

At some stage before the first generation DSS is commissioned it will therefore be necessary to formulate a business plan thereby establishing the scale and timing of funding needed. So far, three kinds of funding streams have been identified and discussed with representatives of the WRPM:

- **First** is the possibility of funding the DSS as core business of the NBI, and to do so by means of fixed transfers and special allocations from the overall NBI operating budget;
- **Second** would be to levy a small percentage from the development budgets of water sector investment projects in the Basin;
- **Third** is the possibility of charging third party (ie neither NBI nor member governments) for using the DSS. Possible such users could include researchers, NGOs and Development Partners).

6.3 Technical Sustainability

To ensure technical sustainability, all hardware purchase should include the longest possible support and **extended warranty periods** (all inclusive care for 3-5 years). The Consultant must prepare a detailed plan for the **operational maintenance** of the systems, regular backup, off-site storage of backup media, and a disaster recovery strategy.

Elements of technical sustainability also include:

- **Open architecture** with well defined interfaces and protocols and, as a minimum requirement, well documented re-linkable object code, to facilitate adapting or adding **new components**;
- A high degree of (user**) configurable options** to adapt and customize the system with growing experience and changing requirements;
- **Access to the source code**, at least in part and under some confidentiality agreement to protect the provider's IPR. The objective is to provide **detailed documentation** and/or the basis for continuing development (possibility to recompile modified components of the system), use of open, interpreted languages (e.g., PHP, Java Serveletts); as a minimal measure, source code could be put in escrow.
- **Direct and extensive involvement** of the NBI DSS specialists and dedicated system managers/operators beyond the prototype presentation workshops in joint development at NBI offices or on-the-job-training (ownership, operational control, responsibility).

PART I DSS DEVELOPMENT PLAN

ANNEX A: Results Framework

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The results framework below refers to the DSS development and implementation, as covered by the Work Packages 1 to 3 described in this DSS Development Plan. Sustainability of the DSS, and achievement of its broader development objectives, assume that in parallel

- the institutional and physical framework for DSS operations will be created; in particular, 2 sub-regional DSS Centres and 9 national DSS Units will be operational (physically established and equipped with the necessary hardware) and adequately staffed with technical experts, modellers and operators;
- riparian stakeholders agree on the modalities of data exchange and of using common, agreed datasets and model parameters in DSS based decision making;
- the monitoring and data collection systems in the Nile Basin will be strengthened;
- appropriate funding sources and modalities will be identified to cover staff and other recurrent expenditures, as well as the further development and adaptation of the system;
- commitment and demand for DSS services will be created among riparian stakeholders through building awareness, trust, and ownership.

Goal		
To achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin Water Resources		
Outcome	**Project Outcome Indicators**	**Means of Verification**
Nile Basin DSS developed, tested and deployed	1. Nile Basin DSS software (Information Management System, modular river basin modelling system with a core set of models, MCA decision support tools) operational, installed, tested and certified within 3 years 2. At least 3 pilot applications, including a baseline scenario representing the effects on the entire basin, developed; related datasets available, models calibrated and validated, ready for use in decision making 3. DSS core team and senior experts from Nile Basin countries trained to run and maintain the system and provide training to other riparians	o Approved final project report o M&E reporting system (WP 3) o Nile Basin Initiative annual reporting
Intermediate Outcomes	**Intermediate Outcome Indicators**	
Work Package 1: Software Development		
o River Basin Model (dynamic water budget model) and associated databases implemented	o Operational prototype of the core water resources model and associated data bases ready by PM 12	o M&E reporting system (WP 3)
o Embedded models of the core system implemented as per functionality requirements	o Associated models and functional extensions of the core system (including rainfall-runoff, irrigation water demand, hydropower production, economic evaluation, water quality, erosion), implemented by PM 18	o M&E reporting system (WP 3)
o MCA decision support tools implemented	o Necessary drivers of the core models for automatic generation of alternatives, their export to the MCA/DSS, and the basic MCA tools available by PM 24	o M&E reporting system (WP 3)

o Integrated system including user interfaces, GIS functionalities and external interfaces implemented, tested and certified	Four levels of testing and validation successfully accomplished: o Developer level testing o Application level testing o Peer review o System certification	o M&E reporting system (WP 3) o Test protocols o Peer review workshop minutes o Certification documents
o System fully documented	o User manual, reference manual and implementation/programmers manual available	o M&E reporting system (WP 3) o System manuals
o System users trained	o At least four one-week training workshops held in conjunction with the installation of each of the four successive prototyping cycle results	o M&E reporting system (WP 3) o End-of-course evaluation sheets
o System maintenance and support assured for sustainability	o Maintenance and user support plan available and followed o Strategy for regular system backups defined and implemented	o M&E reporting system (WP 3) o Maintenance and user support plan
Work Package 2: Pilot Applications and Data Compilations		
o Baseline scenario of the entire basin water budget established	o Baseline scenario (including network representation of a basic set of objects in the entire basin) implemented and tested	o M&E reporting system (WP 3)
o Directly relevant pilot applications developed	o At least 3 pilot applications defined o Relevant data compiled, checked and imported o Relevant models calibrated o Feedback from usability testing provided to software developers	o M&E reporting system (WP 3)
o Available datasets compiled and IMS populated with the data	o Data sets from international sources (DEM, satellite imagery, long-term reference hydro-meteorological data) compiled and uploaded o National data sets made available checked/corrected and uploaded	o M&E reporting system (WP 3)
o Stakeholders/users trained	o Training workshops and on-the-job training held according to Training Plan	o M&E reporting system (WP 3) o End-of-course evaluation sheets
o Synchronization between installations achieved	o Initial set of common data and model parameters agreed and installed at all system locations	o M&E reporting system (WP 3)
o MCA criteria defined and agreed	o Workflow and master list of criteria defined and agreed	o M&E reporting system (WP 3)
Work Package 3: Supervision and Monitoring		
o Time schedule, milestones, and measurable performance metrics defined and agreed	o Monitoring framework in place, by end of Year 1	o Annual report
o Review and feedback process including external peer review established	o 4 workshops involving at least 5 international IWRM modeling experts carried out	o Annual report
o Quality control of the system established and certified	o Appropriate certification achieved by PM 30	o Quality assessment report / certification documents

Training		
o Training implementation plan established	o Training implementation plan approved, by year 1	o Annual report o Training Plan
o Training modules delivered according to plan	o Modules prepared and delivered according to plan	o Annual report o Training Plan o End-of-course evaluation sheets

NILE BASIN INITIATIVE
Initiative du Bassin du Nil

PART I DSS DEVELOPMENT PLAN

ANNEX B1: Terms of Reference / Software Development and System Implementation

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Table of Content

1 Introduction

This document provides the (DRAFT) Terms of Reference (ToR) for Work Package 1 of the development and implementation of the Nile Basin Decision Support System, a model and simulation based multi-criteria Decision Support System (DSS) for water resources planning and strategic management.

Work Package 1 refers to the development and implementation of the software system, with its main components:

- Information Management System (IMS) including data bases and GIS;
- A core set of simulation models around a basic dynamic water budget model, including tools for sensitivity analysis and automatic generation of alternatives;
- Multi-criteria decision support tools.

This river basin decision support system should be implemented within a 30 months period, together with the appropriate documentation, testing, and user training as detailed below.

The basic design characteristics of the system are described in the DSS Design Report (Requirements Analysis and DSS Design Report, Annex B), while a checklist of required and desirable features and functionality is attached to these ToR (Appendix B1-1).

1.1 Background

The riparian countries of the Nile – Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda; Eritrea participates as observer – have embarked on the Nile Basin Initiative. The NBI is governed by the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM) and seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. The shared vision is: to *"achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources,"* leading to a Strategic Action Program (SAP) to translate this vision into concrete activities and projects.

Under the aegis of its Water Resources Planning and Management (WRPM) Project, the NBI is in the process of establishing a Decision Support System to support water resources planning and investment decisions in the Nile Basin, especially those with cross-border or basin level ramifications. Its scope includes not only the Nile Basin DSS itself (comprising an information management system, a regional river basin planning model, and a suite of analytical tools to support multi-objective analysis of investment alternatives) but also the development of core national capabilities to assist in the evaluation of alternative development paths and the identification of joint investment projects at the sub-regional and regional level.

The basic purpose of the Nile Basin DSS is to provide a framework for sharing knowledge, understanding river system behavior, designing and evaluating alternative development, investment projects, and management strategies. The main goal is to support informed, scientifically based rational cooperative decision making. The objective is to improve the overall net benefit from harnessing the Nile, and develop economically efficient, equitable, environmentally compatible and sustainable strategies for sharing the benefits. The DSS should help to *"enhance the capacity to support basin wide communication, information exchange, and identifying trans-boundary opportunities for cooperative development of the Nile Basin water resources"*.

1.1.1 The Nile Basin DSS Development Process

The DSS development process is based on a comprehensive needs assessment and the subsequent conceptual design of the system which form the basis of these ToR.

After an initial assessment of the present situation within the Nile Basin (in terms of hydrology, water availability and use patterns, environmental and socio-economic issues) extensive stakeholder consultations were carried out through 9 national and 2 sub-regional workshops during which training needs were also assessed. In addition, Training and Awareness Workshops were held in order to enhance the understanding and general awareness of IWRM and the use of DSS among riparian experts.

The consultancy engaged for this preparatory phase produced four main deliverables, three reports (Situation Assessment Report, Requirement Analysis and DSS Design Report, DSS Development Plan) and a web-based information system (Nile-IS).

DSS development and implementation will be structured in three work packages:

- Work Package 1 – Software Development and System Implementation
- Work Package 2 – Data Compilation, Processing and Pilot Test Applications
- Work Package 3 – Supervision and Monitoring (Including independent certification).

All three work packages will be synchronized and should be completed within 30 months from commencement of Work Package 1.

1.1.2 Institutional Context

The functional requirements of the DSS depend on institutional interaction at different levels; directly relevant for the development and implementation process are the:

- Regional level with the **Regional Nile Basin DSS Centre** at the WRPM Project Management Unit, which has the responsibility for providing the technical core team and modeling tools to support transboundary water management. The Regional center shall also be responsible for continuous maintenance, further development, user training and operational use of the DSS from basin-wide perspectives, which shall be conducted with the involvement of all riparian countries.

- Sub-regional level (Eastern Nile, Nile Equatorial Lakes), represented by the **Sub-regional DSS Units**. The primary role of these two units shall be to support the development of cooperative projects at subsidiary level, i.e. provide necessary technical support for planning of cooperative projects.

- National level (9 riparian countries) with the **National DSS Units**, which are being engaged in DSS development and will be responsible for the operational use of the DSS at the national level for planning and management of cooperative projects, as well as for collating and analyzing technical, environmental and economic information / data. Such National DSS Units, including National DSS Specialists and riparian experts, also facilitate the use of the DSS in the planning and management of cooperative projects. During the development of the DSS, the National DSS staff shall contribute as appropriate to activities, such as selection of consultants, review of development progress, training and selection of case studies.

In addition there are DSS Counterpart Staff in all member countries, whose offices are generally situated in the line Ministry for Water Resources Management.

The Consultant engaged for Software Development and System Implementation will be expected to work closely with the Regional Nile Basin-DSS Centre, to the extent that substantial portions of the work are expected to be carried out in its regional office in Addis Ababa.

Member countries are currently developing agreement on data and information sharing. The agreement shall, among others, lay down the roles/responsibilities of relevant NBI institutions and riparian countries with respect to provision of data and maintenance of databases. The complete establishment and roles of the institutional framework will evolve as the agreement on data and information sharing is prepared and an institutional strengthening project takes place.

1.2 Objectives

1.2.1 Objectives of the Nile Basin DSS

The primary objective of the Nile Basin DSS is *"…a shared knowledge base, analytical capacity, and supporting stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin… As such the Nile Basin DSS is expected to be an "agreed upon tool that will be accepted and used by all riparians in the management of the shared Nile water resources"*.

The situation assessment and stakeholder consultations confirmed that the range of requirements for such a tool proved to be complex. As a result, to be realistic, the DSS development will have to evolve gradually over time in an adaptive, phased approach. The immediate target of the first DSS development exercise shall be ***"an operational water balance and allocation model, linked to a set of core models relevant to the priority areas of concern in the Nile Basin, and integrated with an information system and decision support tools for multi-criteria analysis (MCA)"***.

1.2.2 Objectives of the Present Work Package

The objective of Work Package 1 is to develop/adapt, test and install the software for an integrated Nile Basin DSS, consisting of the main dynamic water budget, resources management and allocation model, associated data bases (information system - IMS) and a core set of the embedded, integrated models as well as MCA decision support tools. It includes software related documentation, basic calibration, training and continuing user support.

1.3 Interfaces with Related Work Packages

The inputs to the TOR listed below refer to **Work Package 1 – Software Development and System Implementation**. WP 1, however, will run in parallel and has interfaces with Work Packages 2 and 3, introduced below:

Work Package 2 – Data Compilation, Processing and Pilot Test Applications will be executed in parallel but independently, involving end users; it will test the operation and usability of the integrated system and its components together with the data in realistic applications, including specifically

a. Preparatory phase: Preparation of data catalog, definition of meta data, pilot test cases, test protocols and procedures;

b. Data compilation, processing, quality assurance and import to the IMS;
c. Pilot test cases and model calibration/validation;
d. Usability testing (technical and substantive) of all components;
e. Stakeholders/core team training (data analysis, application building) for technical staff and policy makers;
f. Obtain and analyze feedback from policy and decision makers (stakeholders), maintain problem reports.

Work Package 2 will provide basic test protocol templates (substantive parts) and quality assured test data sets to WP 1 for basic calibration exercises by the software developers not later than PM 9.

Work Package 3 – Supervision and Monitoring coordinates/synchronizes these activities and organizes quality assurance processes; it includes,

a. Compilation and coordination of all test protocols and procedures, reporting and documentation requirements and guidelines;
b. Monitoring of project progress, milestones, deliverables, testing and documentation processes (in WP 1 and WP 2), document management, problem report logging and tracking;
c. Coordination and synchronization between WP 1 and WP 2, conflict resolution, including follow-up on problem reports
d. Facilitation of communication between all teams, maintenance of project web site, mailing lists, discussion fora
e. Coordination of an external peer review and advisory process as well as of all presentation and training workshops;
f. Final system certification (by external auditors, subcontracted).

All these tasks are designed to run in parallel with continuous end user involvement over the 30 months of proposed duration, with regular overlapping 12 months prototyping cycles that include a major milestone, deliverables and presentation and training workshop every six months (see the proposed time table below).

WP 1 will provide the models and software prototypes to WP 2 for testing as they become available; WP 2 provides to WP 1 the initial (quality assured) calibration data sets and any and all user feedback and the results of the calibration/validation runs as they become available. In the preparatory six months initial phase the two groups closely cooperate in the definition of the initial detailed design, model data requirements, detailed work plan scheduling, implementation of documentation requirements and test protocols and procedures.

WP3 will be responsible for the communication and exchange of data and tools between WP1 and WP2.

2 Scope of Work

The tasks in work package 1 will include:

- Preparation of a detailed initial design / technical specification document (see below);
- Development and adaptation of the software system according to the required components and features (Appendix B1.1);
- System documentation, including :
  - detailed documentation of the implementation process including system testing and initial calibration (report to be submitted together with the prototype)
  - user, reference, and programmers manuals, tutorial and training material;
- System deployment
- User training coordinated with the implementation steps;
- Development of a Maintenance and User Support Plan.
- Submission of the associated Deliverables as defined in the Table below.

2.1 Detailed Technical Specification (Basis for Implementation)

In the preparatory initial (six months) phase of the first prototyping cycle, detailed technical and functional specifications for the system should be prepared. These include:

- Functional design of the system, including all components and models, their functionality (scope, range of applicability in the Nile basin, temporal and spatial resolution, data requirements, parameters), data formats, interfaces, communication protocols, user interface and implementation details, as well as requirements for methods used for the various process models and all pre- and postprocessors, utilities, auxiliary programs and tools, data base design and content with meta data formats and standards, linkage of the components, etc.;
- Detailed software design and implementation plan;
- Definition of all model specific data requirements (for WP2);
- Comments on the technical feasibility of test protocols (templates designed in WP2 and WP3).

2.2 System Development (IMS, RBMS, MCA)

This task includes the adaptation and/or development of the basic software components, the information system and data bases, the core models, and the MCA tools in four prototyping cycles of 12 months each, with a lag and overlap of 6 months each, for a total duration of 30 project months.

- **Preparatory phase** (parallel with the initial six months of cycle one): includes the update of detailed work plan, schedule, and design specifications, see above;
- **Cycle one** will result in the implementation of an operational (full functionality) prototype of the core water resources model (dynamic water budget model) and associated parts of the IMS (data bases and GIS) at PM 12;
- **Cycle two** will address all feedback provided on cycle 1, add the associated models and functional extensions of the core system (rainfall-runoff, irrigation water demand,

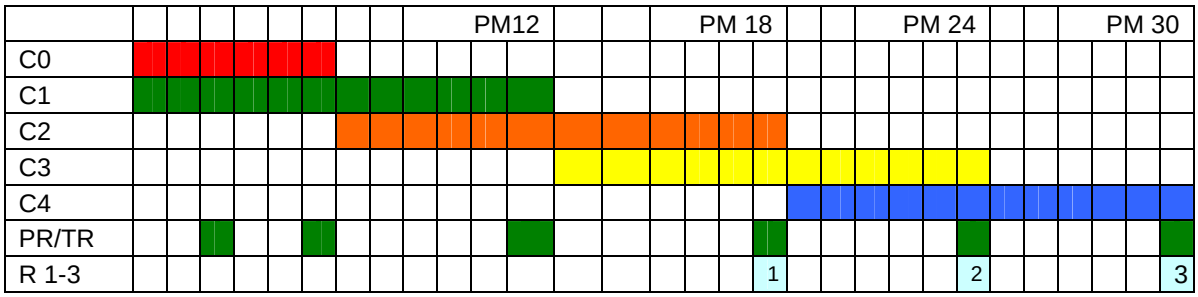
economic evaluation, water quality, basic sediment budget) including associated IMS functionality, and commence detailed software testing and initial calibration based on the data sets provided by WP 2; the second prototype will be implemented at PM 18;

- **Cycle three** will again address all issues, problem and bug reports compiled on the previous prototypes, implement the necessary drivers of the core models for automatic generation of alternatives (simulation based optimization, satisficing, any other mathematical programming methods), their export to the MCA/DSS, and the basic MCA tools, available at PM 24 for a final six months of testing and evaluation leading to the system's certification.
- **Cycle four** will be dedicated to adaptation and customization tasks based on user feedback on the previous prototypes and the results of the parallel calibration and validation exercises in the pilot applications (WP 2).

The IMS will be developed in parallel, over all prototyping cycles, to match and directly support the data requirements of each of the cycles.

The detailed tasks within the prototyping cycles are governed by the required features in the checklist (Appendix B1-1 below).

The proposed sequencing is illustrated below:



C0: preparatory phase
C1 – C4: prototyping cycles
PR/TR: presentation and training workshops associated with each prototype
R: developer's response: end of review/corrections cycle of the previous prototype, presented with the following prototype release.

After the implementation of each prototype, its presentation, submission of the documentation, and related training sessions, the client will provide written comments and feedback within one month. WP 3 will compile all technical comments and user requests for modification in a data base supported problem reporting and tracking system. The comments and problem reports will be addressed and the solutions/corrections presented at the next following prototype implementation.

Detailed system requirements and technical specifications are provided in Annex B of the Requirements Analysis and DSS Design Report (Chapter 4), and are summarized in Appendix B1-1 of these ToR in the form of a feature checklist.

2.3 System Documentation

The following levels of documentation are required:

1. A **user manual** of tutorial character; this must be structured for a "context sensitive" implementation, so that every major page/function of the system has a corresponding manual page or entry point that can be linked to that page/screen/function.
2. A **reference manual** that describes the implementation, algorithms, and underlying theory in all necessary scientific and technical detail;
3. An **implementation and programmers manual** that defines all configuration options, interfaces, data formats, data base structure, data models and entity-relationships, communication protocols to enable the users to link additional components and develop the system beyond the initial implementation.
4. **Tutorial material** in support of the training workshops and suitable for self-study.

The user manuals should be available in an on-line (hypermedia) version embedded in the systems user interface for contact sensitive access. The on-line user manual should provide full-text search capabilities beyond a context (screen and function) specific linkage.

All three manuals should also be available in electronic, yet printable (PDF) versions, structured for easy (partial) upgrades as new releases and functionality become available.

All components must clearly and unambiguously indicate the release level of the software they refer to facilitate keeping the manuals up to date.

Implementation details (preliminary outlines, level of details etc.) will be discussed at the kick-off meeting.

2.4 System Deployment / Implementation

The work package includes system installation at all locations (1 regional, 2 sub-regional and 9 national installations) and collaboration with work package 2 (pilot test cases, population of IMS, model calibration/validation, usability testing) to achieve fully functional system implementation.

The work package includes responsibility to address all issues and feedback on aspects related to software, system installation and interfaces, system integration, usability and user support as well as model functionality, but excluding any issues related to data quality and availability, hardware installation or infrastructure facilities (e.g. rooms, energy supply, internet connectivity).

2.5 Core Team Training

Software related user training (core team) shall consists of a series of at least four one-week training workshops in conjunction with the installation of each of the four successive prototyping cycle results. These trainings should be held at the location of the primary software installation (PMU) to be able to directly use the newly installed systems or updates for the training and at the same time subject it to user testing. Training must cover the background, algorithms and theory of the software, as well as hands on exercises with didactic synthetic test cases to familiarize selected users with the system.

The software training shall be synchronized with the release of the corresponding user manuals, to be used as course material in the training and to compile user feedback for the improvement of

the manuals. At least four one-week training workshops shall be conducted in conjunction with the prototype implementation. These four workshops will address the functionality but also the theoretical background and operation of the prototypes as installed.

In addition, a period of at least 120 working days (corresponding to six calendar months) is to be planned for either or both:

- On-site work of members of the development team at the NBI PMU (Addis Ababa) with direct involvement and on-the job training for selected NBI staff;
- On-the job training for selected NBI staff member at the consultant's premises.

2.6 Maintenance and User Support Plan

As part of any bid for the provision (licensing, adaptation or development of new components) of any software solutions, a system maintenance and user support plan is mandatory. The system maintenance and user support plan must include:

- A mechanism for error reporting and the tracing of corrective actions;
- An on-line user help desk based on e-Mail or any appropriate web based discussion forum software.
- A proposal for continuing refresher training courses.
- A mechanism for intermediate systems upgrades (minor bug fix releases) and associated documentation and release notes.
- A proposal for continuing user support and system maintenance beyond the basic project duration including an extended warranty of more than 12 months.
- The maintenance plan must also include specific strategies and tools for regular system backups, and the distribution of any updates of software and data base content by the user at the NBI central installation.

2.7 Deliverables

Deliverables include the software in the consecutive prototype installations (see the time table below), associated manuals and documentation of the implementation process, and at least six monthly progress reports that also provide inputs to the proposed parallel supervision, monitoring and coordination tasks, addressing any comments, suggestions, and requests from the client and the DSS team members.

Required Deliverables

No	Description of the Deliverable	type	due
1	Project kick-off meeting, initial work plan	WS	1
2	Detailed design report, systems ontology, initial draft	RE	3
3	First joint coordination meeting, detailed work plan	WS	3
4	Model data requirement report (input to WP 2)	RE	3
5	Detailed design report, systems ontology, final draft	RE	6
6	Second joint coordination meeting	WS	6
7	First six-monthly progress report	RE	6
8	First operational prototype implementation (IMS and water budget model)	PR	12
9	Associated systems manuals	RE	12
10	First user training (and material)	WS	12

11	Second six-monthly quarterly progress report	RE	12
12	Second operational prototype (IMS upgrades, embedded core models)	PR	18
13	Systems manuals (updates)	RE	18
14	Second user training (and materials)	WS	18
15	Third six-monthly progress report	RE	18
16	Initial calibration report	RE	18
17	Third operational prototype (IMS upgrades and MCA tools)	PR	24
18	System manuals (updates)	RE	24
19	Third user training (and materials)	WS	24
20	User support and maintenance plan	RE	24
21	Final system implementation	PR	30
22	System manuals (updates)	RE	30
23	Final user training (and materials)	WS	30
24	Final progress report	RE	30

RE: report; PR: software prototype; WS: workshop, including presentations and training material and coordination meetings

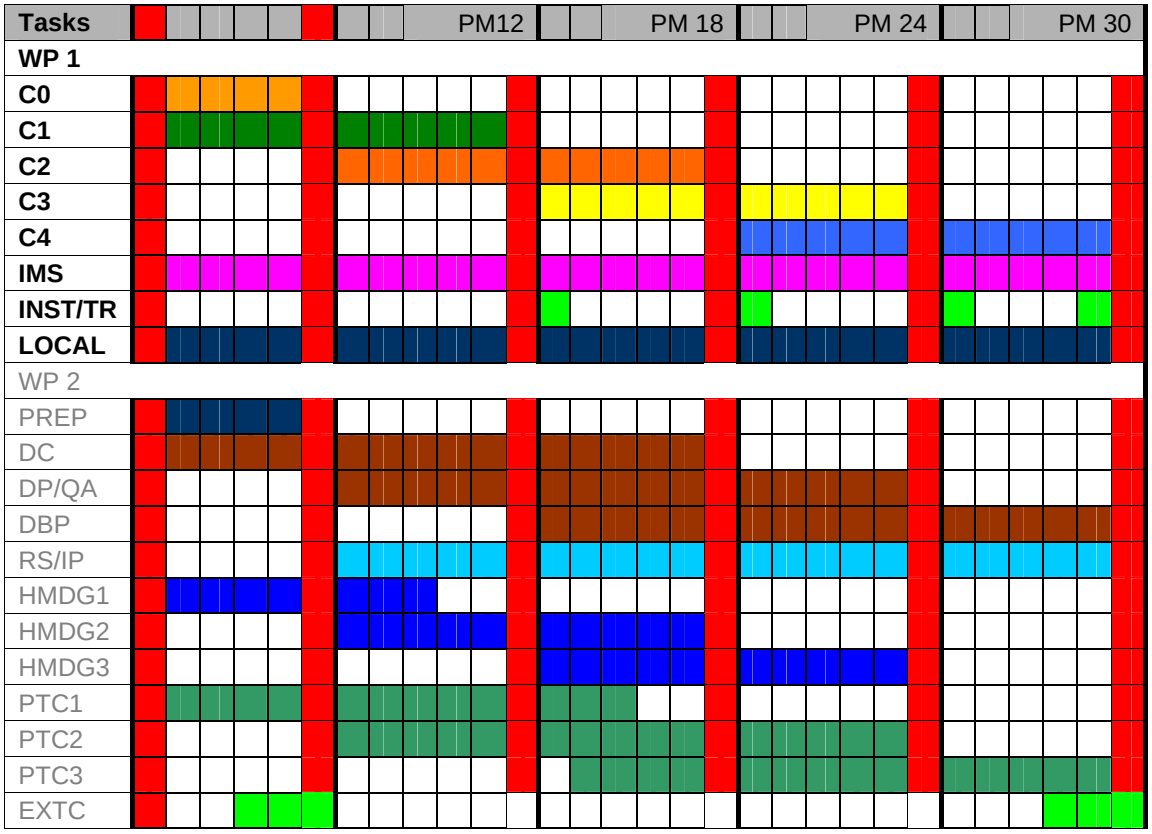
3 Time Schedule and Milestones

Implementation of WP 1 is scheduled over a 30 months period: Initial software adaptation within 12 months, first operational prototype installed for user testing at PM 12, ready for application building, testing, and parallel review and validation exercises in WP 2.

The table below indicates the sequencing and relationship of the major groups of tasks defined as follows:

Tasks Code	Description of the Component or Task Group	PM	
	WP 1	**from**	**to**
C0	**Detailed design and implementation plan**	**1**	**6**
C1	**River Basin Model (dynamic water budget model)**	**1**	**12**
C2	**Component models of the core system**	**7**	**18**
C3	**Multi-criteria analysis tools (MCA)**	**13**	**24**
C4	**Integrated system, interfaces, general utilities**	**19**	**30**
IMS	**Information management system, data bases and GIS**	**1**	**30**
INST/TR	**Installation, testing and training (intermittent)**	**1**	**30**
LOCAL	**Local NBI team/user involvement (continuous)**	**1**	**30**
	WP 2 *(for reference only)*	from	to
PREP	Meta data definition, detailed work plan and methodology	1	6
DC	Data compilation (with NBI core team and national DSS specialists)	1	18
DP/QA	Data processing, analysis, quality assurance	7	24
DBP	Data import, populating the IMS, DB and GIS	13	30
RS/IP	RS image processing	7	30
HMDG1	Model setup, compilation of boundary conditions	1	9
HMDG2	Simulation runs (3-10 years, 1 km/hourly resolution)	7	18
HMDG3	Post-processing, DB import	13	24
PTC1	Pilot test cases: definition and setup	1	15
PTC2	Model exercises, usability testing	7	24
PTC3	Calibration and validation	14	30
EXTC	External certification	28	30

The sequencing of the overlapping prototyping cycles and associated major components to be installed over a period of 30 months is shown in the chart below. Joint coordination meetings (starting with a project kickoff meeting in PM 1) and milestones for which detailed implementation reports are proposed are indicated in RED. The proposed time table for WP 2 is provided for reference only.



The following Milestones are foreseen to be used for monitoring the implementation progress:

Milestone	Description	Date
M 0	Joint project kick-off meeting	PM 1
M 1	Detailed Design report; in parallel with the test protocols from WP2	PM 6
M 2	First operational prototype, with associated training, initial calibration	PM 12
M 3	Second operational prototype with associated training	PM 18
M 4	Third operational prototype with associated training	PM 24
M 5	Fourth and final installation, final training, testing (calibration and validation, WP2) completed, external certification (WP 3)	PM 30

4 Data, Personnel and Facilities Provided by the Client

The Client will provide

- Technical staff to be involved in user training;
- Assistance in organizing training workshop (selection of participants, locations and infrastructure) and review meetings;
- Access to all computer/server rooms once established (remote and physical) for software installation, remote or local upgrades, and remote support and maintenance during the project period;
- All relevant data at its disposal, to be used for system population, calibration and testing in collaboration with the consultant engaged for Work Package 2;
- For each Deliverable, the client will provide consolidated comments within a period of one month.

5 DSS System Specifications: Required and Desirable Features

Please refer to Annex B (DSS Design) of the "Requirements Analysis and DSS Design Report" for a full description of system design and requirements.

Appendix B1-1 provides a checklist of functional requirements (technical and administrative features) classified in

- **R**: required features
- **D**: desirable features.

6 Expertise Required

The primary requirement is demonstrated experience in developing and deploying water resources models and DSS systems in large river basins, with preference to applications in developing countries. A template for the description of reference projects is attached as Appendix B1-4.

The consultant should be able to demonstrate a sufficiently experienced software development team (MS or engineering degrees, IT specialists and experienced programmers, domain experience in hydrology, economy, several years of professional experience, international reference projects). Specifically the consultant team should include:

- Team leader (doctoral degree in one of the applicable fields of research - software engineering, information technology, environmental sciences, hydrology, or similar), with a minimum of 15 years of professional experience including management of large software development projects, international experience including developing countries
- Senior software engineer (MSc, engineering or doctoral degree), with a minimum of 10 years of experience in systems analysis, design and development of complex software development projects, covering, at a minimum, the following areas: GIS, RDBMS, web applications; experience in developing water resources applications software (such as simulation and optimization modeling, DSS/MCA) is an advantage
- Software developers/programmers (BSc, MSc of engineering degree or equivalent), with a minimum of five years of software development experience
- Senior domain specialists (water resources systems/modeling, hydrology, environment, economics), MSc or doctoral degrees, minimum of ten years of professional experience including experience in developing countries.

As the DSS is to be developed based on an existing water resources modeling system, key staff need to have in-depth knowledge and experience on working with the system.

Proposers are required to provide a list of staff members proposed with standard format CVs, including the expected involvement in person months throughout the project.

Appendix B1-1

DRAFT Topics for Functional Requirements

This is a checklist of features extracted from the DSS Design document.

	Requirements and Feature Description (R: required; D: desirable**)**
	General, administrative Requirements
R	Guarantee (>= 12 months)
R	Continuing support for >= 12 months
R	Maintenance options (alternatives to be offered by the bidder, minimally covering the warrantee period with help desk, updates, application building support.
R	Help desk (mail/web based) and error logging
R	Re-linkable object code, dynamic linking/compilation with adequate documentation
D	Licensing scheme: unlimited institutional license within NBI
D	Source code access
	Implementation, Architecture
R	Implementation platform (platform independent),
R	Client-server implementation
R	Web-based access (http, ftp, ssh, scp …)
R	Modular implementation (easy exchange through standard interfaces)
R	Multi-level user access control, loging/monitoring
D	Operating system support (Open source)
D	Backup tools (embedded) and backup strategy (disaster recovery plan)
D	Modern coding style and languages (OOD, structured programming, C++)
	Documentation
R	User manuals (English; hypermedia and hardcopy): user, reference, Programmer's,
R	Embedded, context sensitive, full text search
D	All manuals and documentation also in French
D	Tutorial material, test data sets and example results
	User Interface
R	Interactive (hyperlinked), menu driven graphical
R	Web browser support (standard browser clients)
R	Multi-language support (English, French)
	General Utilities and Tools
R	Model scenario management (common META data, search, retrieval)
R	Embedded calibration methods, error statistics
R	Direct scenario comparison
R	Simulation based optimization (automatic scenario – feasible alternative - generation) or alternative mathematical programming tools for optimization
D	Sensitivity analysis
D	Stochastic modelling, error analysis
	Information Management System, RDBMS
R	Database protocol/interface: SQL
R	Datamodel and Entity-Relationship and all data tables description explicit
R	Standard META data model (e.g., Dublin core)
R	User defined report generation
D	OLAP support
	Data Analysis
R	Embedded statistical methods (basic descriptive statistics, correlation, interpolation, non-parametric methods) and tools, external link/compatibility
R	Time series analysis tools (graphical display, descriptive statistics, aggregation and interpolation, autocorrelation,, synthetic TS generation
R	Data quality assurance tools (outlier detection, tests for completeness, consistency and plausibility, patching, interpolation, etc. for raw monitoring data set)

	Requirements and Feature Description (R: required; D: desirable**)**
D	Spatial analysis, interpolation (GIS links)
D	Advanced statistical methods (multi-variate analysis/regressions, cluster analysis.spectral analysis)
	Embedded GIS Functionality
R	Support of industry standard formats
R	Data exchange, compatibility, OpenGIS compatibility
R	Support of spatial data pre-processing for all model input requirements (lumped, semi-distributed, regular grids) , display of georeferenced results (topical maps)
	Dynamic Water Budget Model
R	Data driven, user specified, interactive network configuration
R	Basic set of pre-defined NODE TYPES (minimal list NODE types below) • Start or input nodes, representing o Sub-catchments (One more linked Hydrological Response Units, defined by time series of runoff which can in turn be generated by the linked rainfall-runoff model o Springs, wells and well fields o Other inputs (e.g. desalination, water harvesting) • Demand nodes, representing areas of water use: o Settlements o Agricultural use (irrigation districts, livestock farming) o Commercial and industrial uses o Wetlands o Associated (waste)water treatment plants o Navigation reaches • Structural components: o Confluences o Abstractions or bifurcations o Dams and reservoirs (with multiple abstractions/outflow for multi-purpose use including hydropower production) or natural lakes; o Falls and cataracts (relevant for navigation and water quality) o Geometry node (for geo-referencing and diagram design) • Control nodes for monitoring, compliance, calibration • Aquifers (underlying any number of nodes and reaches that can interact by seepage, extraction, infiltration and exfiltration). • Groundwater recharge (artificial) • End nodes (outflow from the basin simulated) • Reaches (open channel) and associated lateral catchments, floodplains, pipelines (supporting pumped flow and negative slopes).
R	Geo-referenced network geometry
R	Explicit routing of flow
R	Temporal scope and time step: hourly to monthly, multiple years
R	Explicit mass budget, error statistics
R	Explicit groundwater representation, coupling (groundwater mass budget model)
R	Multiple reservoirs (single and multi-purpose) with multiple independent outlets/abstractions, including hydropower generation
R	Variable reach geometry, support for rating curve/ flow data conversion
R	Model nesting, hierarchical linkage of networks
R	Economic analysis of scenarios (CBA): such as cost of structures and services, benefits of irrigation, water supply and energy production
R	Lateral inflow, lateral catchments, floodplain representation
D	Open (user defined) list of node types
D	User defined reports, data export (CSV)
D	Yield/reliability analysis for reservoirs and catchments
	Hydrological Processes
R	Multiple ET estimation methods (data dependent)
D	Multiple routing methods (data dependent)

	Requirements and Feature Description (R: required; D: desirable**)**
D	Support for user defined process representation/algorithms
	Core Process Models (linked to the Water Budget Model)
R	Meteorological pre-processor: statistical (e.g., Thiessen polygons, simple spatial interpolation
R	Rainfall-runoff models (lumped, semi-distributed)
R	Irrigation water demand estimation, crop production model
R	Hydropower production
R	Water quality model (DO/BOD, conservative, first order decay
R	Erosion modelling: catchment, transport/siltation
R	Hydraulic model (1D)
D	River bank and bed erosion
D	Rainfall-runoff model: fully distributed
D	Meteorological pre-processor: diagnostic
D	Meteorological pre-processor: prognostic
D	Meteorological modelling: GCM downscaling, CC scenarios
	MCA, DSS Tools
R	Multiple MCA methods (minimally: Pugh and Reference Point)
R	User defined open list of criteria
R	Automatic model linkage (alternative and criteria export)
D	Support for participatory decision making
D	Support for group decision making
D	Preference structure sensitivity analysis

NILE BASIN INITIATIVE
Initiative du Bassin du Nil

PART I DSS DEVELOPMENT PLAN

ANNEX B2: Terms of Reference / Data Compilation, Processing and Pilot Test Applications

hydrOphil
consulting & knowledge development GmbH

ITAD

CEDARE
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Table of Content

1 Introduction

This document provides the (DRAFT) Terms of Reference (ToR) for Work Package 2 – Data Compilation, Processing and Pilot Test Applications – of the development and implementation of the Nile Basin Decision Support System, a model and simulation based multi-criteria Decision Support System (DSS) for water resources planning and strategic management.

1.1 Background

The riparian countries of the Nile – Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda; Eritrea participates as observer – have embarked on the Nile Basin Initiative. The NBI is governed by the Council of Ministers of Water Affairs of the Nile Basin states (Nile Council of Ministers, or Nile-COM) and seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security. The shared vision is: to *"achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources,"* leading to a Strategic Action Program (SAP) to translate this vision into concrete activities and projects.

Under the aegis of its Water Resources Planning and Management (WRPM) Project, the NBI is in the process of establishing a Decision Support System to support water resources planning and investment decisions in the Nile Basin, especially those with cross-border or basin level ramifications. Its scope includes not only the Nile Basin DSS itself (comprising an information management system, a regional river basin planning model, and a suite of analytical tools to support multi-objective analysis of investment alternatives) but also the development of core national capabilities to assist in the evaluation of alternative development paths and the identification of joint investment projects at the sub-regional and regional level.

The basic purpose of the Nile Basin DSS is to provide a framework for sharing knowledge, understanding river system behavior, designing and evaluating alternative development, investment projects, and management strategies. The main goal is to support informed, scientifically based rational cooperative decision making. The objective is to improve the overall net benefit from harnessing the Nile, and develop economically efficient, equitable, environmentally compatible and sustainable strategies for sharing the benefits. The DSS should help to *"enhance the capacity to support basin wide communication, information exchange, and identifying trans-boundary opportunities for cooperative development of the Nile Basin water resources"*.

1.1.1 The Nile Basin DSS Development Process

The DSS development process is based on a comprehensive needs assessment and the subsequent conceptual design of the system which form the basis of these ToR.

After an initial assessment of the present situation within the Nile Basin (in terms of hydrology, water availability and use patterns, environmental and socio-economic issues) extensive stakeholder consultations were carried out through 9 national and 2 sub-regional workshops during which training needs were also assessed. In addition, Training and Awareness Workshops were held in order to enhance the understanding and general awareness of IWRM and the use of DSS among riparian experts.

The consultancy engaged for this preparatory phase produced four main deliverables, three reports (Situation Assessment Report, Requirement Analysis and DSS Design Report, DSS Development Plan) and a web-based information system (Nile-IS).

DSS development and implementation will be structured in three work packages:

- Work Package 1 – Software Development and System Implementation
- Work Package 2 – Data Compilation, Processing and Pilot Test Applications
- Work Package 3 – Supervision and Monitoring (Including independent certification).

All three work packages will be synchronized and should be completed within 30 months from commencement of Work Package 1.

1.1.2 Institutional Context

The functional requirements of the DSS depend on institutional interaction at different levels; directly relevant for the development and implementation process are the:

- Regional level with the **Regional Nile Basin DSS Centre** at the WRPM Project Management Unit, which has the responsibility for providing the technical core team and modeling tools to support transboundary water management. The Regional Center shall also be responsible for continuous maintenance, further development, user training and operational use of the DSS from basin-wide perspectives, which shall be conducted with the involvement of all riparian countries.

- Sub-regional level (Eastern Nile, Nile Equatorial Lakes), represented by the **Sub-regional DSS Units**. The primary role of these two units shall be to support the development of cooperative projects at subsidiary level, i.e. provide necessary technical support for planning of cooperative projects.

- National level (9 riparian countries) with the **National DSS Units**, which are being engaged in DSS development and will be responsible for the operational use of the DSS at the national level for planning and management of cooperative projects, as well as for collating and analyzing technical, environmental and economic information / data. Such National DSS Units, including National DSS Specialists and riparian experts, also facilitate the use of the DSS in the planning and management of cooperative projects. During the development of the DSS, the National DSS staff shall contribute as appropriate to activities, such as selection of consultants, review of development progress, training and selection of case studies.

In addition there are DSS Counterpart Staff in all member countries, whose offices are generally situated in the line Ministry for Water Resources Management.

The Consultant engaged for Software Development and System Implementation will be expected to work closely with the Regional Nile Basin-DSS Centre, to the extent that substantial portions of the work are expected to be carried out in its regional office in Addis Ababa.

Member countries are currently developing agreement on data and information sharing. The agreement shall, among others, lay down the roles/responsibilities of relevant NBI institutions and riparian countries with respect to provision of data and maintenance of databases. The complete establishment and roles of the institutional framework will evolve as the agreement on data and information sharing is prepared and an institutional strengthening project takes place.

1.2 Objectives

1.2.1 Objectives of the Nile Basin DSS

The primary objective of the Nile Basin DSS is *"…a shared knowledge base, analytical capacity, and supporting stakeholder interaction, for cooperative planning and management decision making for the Nile River Basin… As such the Nile Basin DSS is expected to be an "agreed upon tool that will be accepted and used by all riparians in the management of the shared Nile water resources"*.

The situation assessment and stakeholder consultations confirmed that the range of requirements for such a tool proved to be complex. As a result, to be realistic, the DSS development will have to evolve gradually over time in an adaptive, phased approach. The immediate target of the first DSS development exercise shall be ***"an operational water balance and allocation model, linked to a set of core models relevant to the priority areas of concern in the Nile Basin, and integrated with an information system and decision support tools for multi-criteria analysis (MCA)"***.

1.2.2 Objectives of the Present Work Package

The objectives of Work Package 2 include both a support function and a test function:

- Providing quality assured data for software testing and applications;
- Usability testing of the IMS and data analysis functions (technical and substantive);
- Pilot test applications (system usability);
- Model calibration and validation (core system).

The Work Package will provide QA of the DSS developed by WP 1, to certify that it satisfies the minimum requirements of the client, for all development cycles (detailed design, development and testing of all prototypes). The outcomes (results) of the Work Package are essential for the acceptability of the DSS: Successful completion of all tests (usability, calibrating, validation, pilot, etc) is a requirement for the final acceptance of the DSS, where "successful completion" implies that there are no more pending (unresolved) problem reports.

The consultant will advise the client on main areas of improvement for enhancing data coverage, resolution, and quality. Where the DSS (core models) do not show good 'fit' in the calibration/validation (and subsequent expert assessment and peer review), the consultant will support the client in identifying possible causes such as insufficient/erroneous data, i.e. assist with diagnostic analysis and suggest strategies for improvement.

1.3 Interfaces with Related Work Packages

The present draft ToR refer to **Work Package 2 – Data Compilation, Processing and Pilot Test Applications.** WP 2, however, will run in parallel and has interfaces with Work Packages 1 and 3, introduced below; synchronization will be ensure through joint project meetings (see project schedule).

> **Work Package 1 – Software Development and System Implementation** consists of detailed design update including a systems ontology, basic software development and adaptation, testing, initial calibration subject to data availability, installation, documentation, software related training and user support for the core system (Information Management System, core models, and MCA decision support tools); Appendix B1-1 of the DSS Development Plan lists the required and desirable features for

the IMS, DSS and model software system, and provides both a structured checklist and a questionnaire for the evaluation of proposals.

The output of Work package 1 is an operational DSS with its three main components, documentation, manuals, and associated training conducted, implemented at the NBI PMU, sub-regional and national DSS units.

The work package also includes the development of a user support and maintenance plan, as well as a series of Deliverables that are described with their nature and due dates in a separate ToR.

Work Package 3 – Supervision and Monitoring coordinates/synchronizes these parallel activities and organizes quality assurance processes; it includes,

a. Compilation and coordination of all test protocols and procedures, reporting and documentation requirements and guidelines;
b. Monitoring of project progress, milestones, deliverables, testing and documentation processes (in WP 1 and WP 2), document management, problem report logging and tracking;
c. Coordination and synchronization between WP 1 and WP 2, conflict resolution, including follow-up on problem reports
d. Facilitation of communication between all teams, maintenance of project web site, mailing lists, discussion fora
e. Coordination of an external peer review and advisory process as well as of all presentation and training workshops;
f. Final system certification (by external auditors, subcontracted).

All these tasks are designed to run in parallel with continuous end user involvement over the 30 months of proposed duration, with regular overlapping 12 months prototyping cycles that include a major milestone, deliverables and presentation and training workshop every six months (see the proposed time table below).

WP 1 will provide the models and software prototypes to WP 2 for testing as they become available; WP 2 provides to WP 1 the initial (quality assured) calibration data sets and any and all user feedback and the results of the calibration/validation runs as they become available. In the preparatory six months initial phase the two groups closely cooperate in the definition of the initial detailed design, model data requirements, detailed work plan scheduling, implementation of documentation requirements and test protocols and procedures.

WP3 will be responsible for the communication and exchange of data and tools between WP1 and WP2.

2 Scope of Work

The tasks and activities of Work Package 2 include:

a) Preparatory phase: Test protocols, identification of data sources; definition of meta data standards and reporting standards; identification of pilot test cases; definition, development and adoption of calibration and validation methods and criteria (parameters and error statistics); identification of appropriate 'benchmark' cases (published, peer reviewed data sets and applications for comparison) and alternative modeling tools (model cross-calibration and comparison) to be used in the process; for the test protocols, definition of criteria of acceptance, levels of accuracy, data types, time windows, etc.

b) Data compilation, processing and import, meta data compilation; data quality assurance, patching, outlier detection, consistency checking. As these tasks require both data processing skills, domain knowledge, and access to local (national) data sources, the direct and prominent involvement of the national NBI/DSS specialists is essential. This will also provide the data basis for the application testing described above and therefore needs an early start and tight synchronization. The task includes remote sensing image processing (e.g., land use, land cover) as well as model generated hydro-meteorological data sets based on prognostic meteorological models (e.g., WRF).

c) Usability testing of all components as they become available and get implemented in the prototyping cycles, based on the test protocols and standard defined under (a); usability testing should include both technical (interface, performance, ergonomics) and substantive (calibration / validation, appropriate decision relevant results, criteria, presentation for stakeholders) aspects; the use of formal test protocols will provide an important input for the eventual final system certification (to be defined at the first joint coordination meetings, see time table).

d) Detailed definition / selection of a set of pilot test cases (identified in (a)) for the calibration, validation, and associated training; pilot cases will be selected in coordination with and approval by the client; A set of criteria for the definition and selection of appropriate pilot cases is provided below. Pilot cases will be select in consultation with the client.

e) Model calibration and validation, which can include benchmark cases (from literature) and model inter-comparison with alternative tools, using the methods and criteria from (a); minimum requirements for calibration methods include: Use of several alternative (including non-parametric) error statistics as well as derived properties of the observation data sets (Gestalt), and support for automatic (optimizing) calibration that goes beyond manual trial and error.

f) Stakeholder / core team training in terms of concrete early applications of common interest, back-to back with the software training, minimally one week for each prototyping cycle.

The scope of work includes regular visits to Addis (core team interaction), including four one-week core-team training workshops, four subsequent stakeholder workshops (3 days each), kick-off and coordination meetings (expected: 4 meetings of 3 days each).

WP2 will contribute a detailed draft plan for QA and test protocols, as well as a structure and format of user feedback at the first/second coordination meeting (PM 3/6), thus contributing to the detailed design stage (joint meetings with WP1).

Stakeholders to be trained will be selected by the client; these should be from the group of most likely initial system users. Their training will concentrate on the DSS aspects of the system and provide feedback on the relevance of criteria, scenarios, DSS options, etc. The consultant will be required to provide the training material in advance (but within the same project month) of the training to the client for distribution to the trainees.

2.1 Data Compilation, Processing, Analysis and QA

This task involves the compilation, consolidation and validation (quality assurance) of all data sets needed for the initial operation and testing of the core model system, including populating the IMS. This should include:

- any and all data sets from the public domain and commercial sources (to be compiled by the consultant including remote sensing data (satellite imagery) for landuse and landcover analysis (the cost of satellite data (e.g., LANDSAT, SPOT) to be purchased by the consultant should be included in the offer explicitly);
- model generated synoptic dynamic hydro-meteorological data sets for a sufficient number of years, minimally for a typical average, a wet, and a dry year;
- all data sets and GIS layers/coverages provided by the client.

Data consolidation involves patching of missing data where possible (short gaps, strong autocorrelation, or well correlated related data sets), outlier detection and correction. The resulting consolidated data sets must indicate any modification of the raw data with a key linked to a description of the methodology used. The primary objective of this task is to generate complete, consistent data set to be used with the models from any and all raw data sets compiled. Consultant should provide the client with the complete (in triplicate) documentation of all methods used (for instance for patching), results obtained, and all necessary explanations, assumptions, theory, etc.

Specific data sets to be compiled and uploaded in the initial data base include:

- Complete DEM coverage at 1 km (and 90 m) resolution;
- RS/satellite imagery and processing: Land use, land cover and hydro-meteorological and energy budget parameters as satellite background maps derived from LANDSAT TM, AVHRR, Meteosat/GERB, in several resolution layers down to 15 meters for specific locations, wetlands, lakes and the river channel; the objective is to generate up to date high-resolution landuse and landcover (vegetation) data.
- Long-term reference climate data (stations and spatial interpolation to regular grid, ORNL, Cramer and Leemans 2000);
- Hydro-meteorological data fields (temperature, precipitation, radiation, humidity, wind data) for one or more complete reference (water) years derived with MM5 or WRF from GFS data sets at 1-3 km resolution, original hourly data and aggregated to daily averages or totals or derived parameters (e.g., rainfall intensity);
- Existing historical data at country level, to be compiled in collaboration with national DSS specialists;
- Relevant socio-economic data;
- All other data required for the calibration, validation and testing of the DSS.

It is important to note that this is not only an exercise in the (necessary) data compilation resulting in an operational information system and input data for the pilot applications, but at the same time it is a very practical usability test for the Information Management System, data bases and GIS in a realistic application context.^

2.2 Pilot Test Applications, Calibration and Validation

A set of at least three directly relevant application projects with different scope and hydrological regime will be defined, including the effects on the overall basin (using an additional baseline scenario of the entire basin dynamic water budget based on the main river basin model). The final acceptance of the pilot studies rests with the client. The DSS core team will be involved in the selection and implementation of the pilot test cases.

The proposed **selection criteria for the definition of the test cases** require that these initial pilot cases:

- have immediate socio-economic and political relevance on the overall basin water budget and therefore provide inputs to an overall, basin wide water budget and economic evaluation model (one of the baselines applications and first mandatory test case);
- therefore be of relevance to more than one country (trans-boundary interest, ongoing NBI-SAP projects) but also address at least one country's specific local interests to demonstrate the local version regional applicability of the system;
- include more than one sectoral aspect or address more than one of the main stakeholder concerns;
- relate to ongoing or planned major projects in the basin where possible (and use existing pre-feasibility or feasibility study data where available);
- include a reasonable set of test data for calibration and validation that should be imported to the IMS (data bases and GIS);
- cover (together) a broad geographical and thus hydrographical spectrum to demonstrate the system's applicability of the entire range of conditions in the Nile basin;
- exercise as many of the functional components and features (models) of the consecutives prototypes as possible.

An additional desirable feature of the test cases is

- demonstrated linkage (data exchange, comparison of results) with any existing (legacy) components, data bases or models (e.g., the Lake Victoria Water Quality Model, modeling activities in the Kagera and Mara basins, the ENPM, etc.).

2.3 Data Documentation and Meta Data

All data sets and processing steps need to be documented and extensively described using a standard META data system such as the Dublin Core. Standard statistical methods including non-parametric methods shall be used for data analysis and quality assurance, error correction and patching where required. An appropriate document management system shall be used to maintain the data prior to their implementation in the NB-DSS IMS.

2.4 Core Team Training

Software related user (core team) training shall consists of a series of at least four one-week training workshops in conjunction with the installations of each of the four successive prototyping cycle results. These trainings should be held at the location of the primary software installation to be able to directly use the newly installed systems or updates for the training and at the same time subject it to user testing. Training must cover the background, algorithms and theory of the software, as well as hands on exercises with didactic synthetic test cases to familiarize selected users with the system.

Core team training shall be synchronized with the software training (WP 1) and the release of the corresponding user manuals to be used as course material in the training, in order to compile user feedback for the improvement of the manuals. At least four one week training workshops shall be conducted in conjunction with the prototype implementation. These four workshops will address the functionality but also theoretical background and operation of the prototypes as installed.

In addition, a period of at least 120 working days (corresponding to six calendar months) is to be planned for project specific on-the-job training, to include either or both:

- On-site work of members of the development team at the NBI PMU (Addis Ababa) with direct involvement and on-the job training for selected NBI staff;
- On-the job training for selected NBI staff member at the consultant's premises.

2.5 Deliverables

Deliverables include the data sets as they become available for the consecutive prototype installations (see the time table below), associated documentation of the pilot test cases, and at least six monthly progress reports (short interim 3 monthly reports will be delivered by e-mail) that also provide inputs to the parallel supervision, monitoring and coordination tasks (WP 3), as well as compiling and documenting any comments, suggestions and requests from the client and the DSS team members through the problem reporting system.

Required Deliverables

No	Description of the Deliverable	type	due
1	Kick-off meeting	WS	1
2	Detailed work program	RE	3
3	Data catalog and description of methods	RE	3
4	First joint coordination meeting (draft test protocols)	WS	3
5	Pilot cases selection and initial description	RE	6
6	Calibration and validation methodology, detailed test protocols	RE	6
7	First six-monthly progress report	RE	6
8	First quality assured data sets for calibration (also for WP 1)	PR	9
9	Associated data description	RE	12
10	First user training (and material)	WS	12
11	Second six-monthly quarterly progress report (??)	RE	12
12	Pilot cases: detailed description and documentation	RE	18
13	Data catalog and meta data (updates)	RE	18
14	Second user training (and materials)	WS	18
15	Third six-monthly progress report	RE	18
16	Initial calibration and validation report (methodology, data)	RE	18
17	Pilot case results (updates)	RE	24
18	Third user training (and materials)	WS	24
19	Final data catalog and IMS implementation	RE	30
20	Final pilot case descriptions, validation results report	RE	30
21	Final user training (and materials)	WS	30
22	Final progress report	RE	30

Abbreviations used:
RE: report
PR: prototype/data sets
WS: workshops and coordination meetings, including presentations and training materials

2.6 Implementation Arrangements

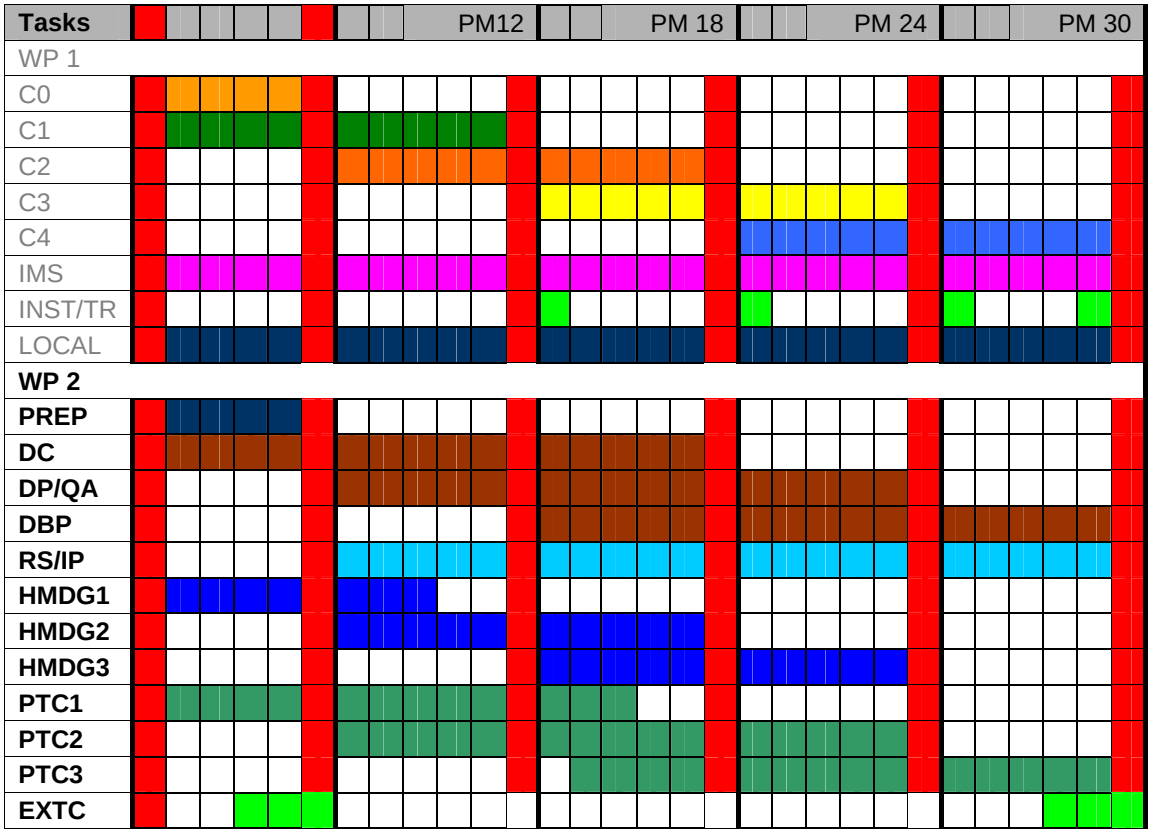
All data sets (including the pilot test cases) will eventually be implemented on the IMS installed at the PMU in Addis Ababa. The consultant will assist in their replication and installation (by the NBI DSS core team) at any other implementation (sub-regional, national) within the NBI. In addition to their implementation on NBI servers, the consultant will provide copies on DVD or CD together with the complete documentation of all data sets, as described above.

3 Time Schedule and Milestones

The Implementation of WP 2 is scheduled over a 30 months period, running parallel with WP1 and the coordination tasks of WP3. The Table below indicates the sequencing and relationship of the major groups of tasks defined as follows:

Tasks Code	Description of the Component or Task Group	PM	
WP 1 *(for reference only)*		from	to
C0	Detailed design and implementation plan	1	6
C1	River Basin Model (dynamic water budget model)	1	12
C2	Component models of the core system	7	18
C3	Multi-criteria analysis tools (MCA)	13	24
C4	Integrated system, interfaces, general utilities	19	30
IMS	Information management system, data bases and GIS	1	30
INST/TR	Installation, testing and training (intermittent)	1	30
LOCAL	Local NBI team/user involvement (continuous)	1	30
WP 2		**from**	**to**
PREP	**Meta data definition, detailed work plan and methodology**	**1**	**6**
DC	**Data compilation (with NBI core team, national DSS specialists)**	**1**	**18**
DP/QA	**Data processing, analysis, quality assurance**	**7**	**24**
DBP	**Data import, populating the IMS, DB and GIS**	**13**	**30**
RS/IP	**RS image processing**	**7**	**30**
HMDG1	**Model setup, compilation of boundary conditions**	**1**	**9**
HMDG2	**Simulation runs (3-10 years, 3-1 km/hourly resolution)**	**7**	**18**
HMDG3	**Post-processing, DB import**	**13**	**24**
PTC1	**Pilot test cases: definition and setup**	**1**	**15**
PTC2	**Model exercises, usability testing**	**7**	**24**
PTC3	**Calibration and validation**	**14**	**30**

The sequencing of the overlapping prototyping cycles and associated major components to be installed over a period of 30 months is shown in the chart below. Joint coordination meetings (starting with a project kickoff meeting in PM 1) and milestones for which detailed implementation reports are proposed are indicated in RED. The proposed time table for WP 1 is provided for reference only.



The following Milestones are foreseen to be used for monitoring the implementation progress:

Milestone	Description	Date
M 0	Joint project kick-off meeting	PM 1
M 1	Detailed work program, proposed data catalog, methods, pilot cases identified	PM 6
M 2	First quality assured data sets available for calibration	PM 9
M3	Calibration data available, first IMS implementation started, first training WS	PM 12
M 4	All pilot cases defined und underway, second training	PM 18
M 5	First results of calibration and validation in the pilot cases, third training	PM 24
M 6	Pilot cases completed and documented, validation completed, last training	PM 30

4 Data, Personnel and Facilities Provided by the Client

The Client will provide

- Technical staff to be involved in user training, identification of stakeholders to participate in training;
- Assistance in organizing training workshop (selection of participants, locations and infrastructure) and (peer) review meetings;
- All relevant data at its disposal; to be used for system population, calibration and testing;
- Access to all computer/server rooms once established (remote and physical) for software installation, remote or local upgrades, and remote support and maintenance during the project period, as well as access to the NB-DSS prototypes as they become available;
- For each Deliverable, the client will provide consolidated comments within a period of one month.

5 Expertise Required

The primary requirement is demonstrated experience and reference applications in large scale water resources model applications, including the associated data processing (hydro-meteorological time series, satellite image processing, meteorological modeling and downscaling of synoptic weather models), calibration and validation experience. The consultant should be able to demonstrate a proven multi-disciplinary team that covers hydrology, environmental sciences, economics, and computer sciences or and engineering, post-graduate levels of academic background, several years (>10) of professional experience, and large scale international reference project/applications with preference for experience in the Nile basin and/or other developing countries.

The consultant should be able to demonstrate a sufficiently experienced team for integrated water resources or river basin planning management applications and associated data processing (basic and advanced academic degrees, IT/data processing including specialists and experienced computer users, domain experience in water resources management, economy, statistics, RS and GIS, with several years of professional experience, international reference projects). Specifically the consultant team should include:

- Team leader (doctoral degree in one of the applicable fields of research, minimum of 15 years of professional experience including management of large integrated water resources (river basin) management and development projects, international experience including developing countries; advanced (postgraduate) teaching experience is an advantage.
- Data analysts and data processing, data base and GIS specialists with a minimum of 5 years of experience in at least one of the following domains: water resources planning and management, water resources data analysis, GIS, RDBMS, (BSc, MSc of engineering degree or equivalent), a minimum of five years of demonstrated data processing and model use experience);
- Domain specialists (environment, hydrology, water resources, economics) MSc or doctoral degrees, minimum of ten years of professional experience including experience in developing countries.

Consultants are required to provide a list of staff members proposed with standard format CVs, highlighting IT /modelling experience, models and tools used, including the expected involvement in PM through the project.

NILE BASIN INITIATIVE
Initiative du Bassin du Nil

PART I DSS DEVELOPMENT PLAN

ANNEX C: Training Plan

hydrOphil
consulting & knowledge development GmbH

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Table of Content

1 Introduction

This Training Plan forms part of the DSS Development Plan and is the result of the Training Needs Assessment carried out during the Analysis Phase of this consultancy, and therefore draws its contents, conclusions and recommendations directly from this assessment. The assessment was carried out at the stakeholder consultations in all nine NB countries.

The NBI, through its various donors, will invest considerable amounts of money for the development and the implementation of the NB-DSS and the related structures. For the efficient application and use of the NB-DSS there is a need of considerable capacities, know how and experience. To ensure this, a comprehensive Training Plan has been developed.

The primary objectives of the trainings are aimed to provide the capabilities to the different user categories to use and to operate the NB-DSS. The trainings are not specifically designed to develop management know how and/or general technical and professional capabilities for applications which are not directly related to the NB-DSS specifically.

The primary, overall objectives of the trainings are:

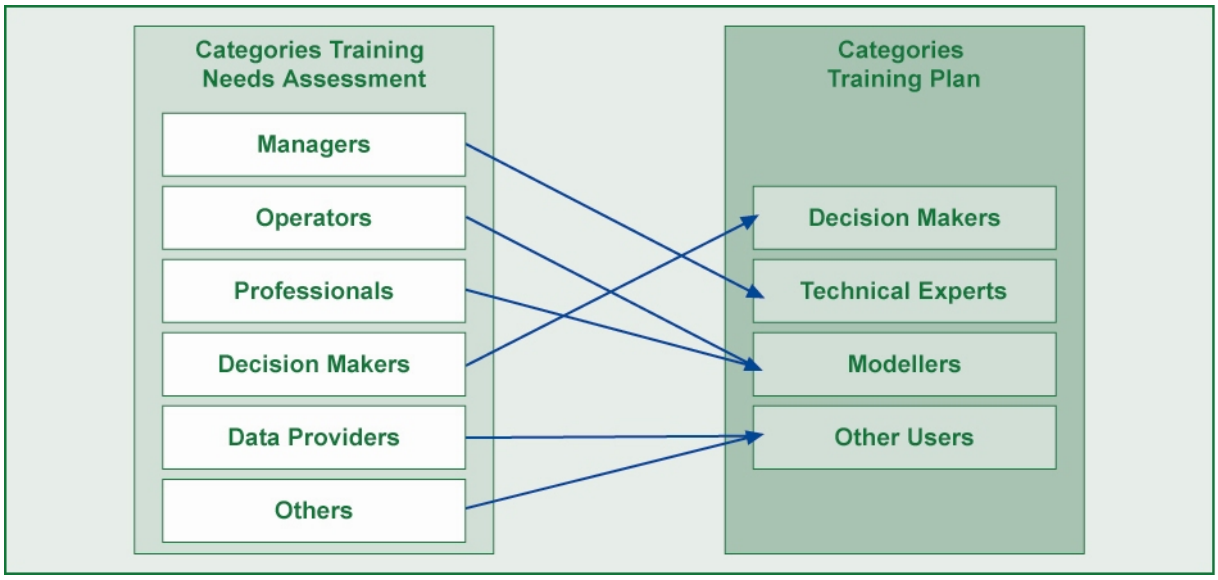
- Transfer of the necessary competencies and know how to operate the specific NB-DSS above an advanced level of technical and professional capabilities that should already be available;
- raise awareness for the application options and advantages of the NB-DSS.

For detailed information regarding the Training Needs Assessment see Annex C of the Requirements Analysis and DSS Design Report.

We have divided the different stakeholders into different categories in order to develop tailor made training modules and concepts according to the different training needs. The Training Needs Assessment has been carried out using the following categories:

- Managers
  are the responsible administrators of the DSS Centres and have direct connection to Decision-Makers. Managers are not Decision-Makers but are responsible for the whole decision-making processes.
- Operators
  are the system administrators and responsible for the administration of the data, database, communication and user administration as well.
- Professionals
  will be hired by NBI to build and manage the models. They can be also involved in the planning processes as well.
- Decision Makers
  are the representatives of certain groups of beneficiaries and are directly involved in the decision-making processes.
- Data Providers
  supply data to the DSS data bases.
- Others
  are persons interested in getting more information on the Nile Basin and can use the IS via Internet portal.

For the development of the Training Plan we have, upon agreement with the Client, reclassified the categories as shown by the figure below:



2 Target Groups

The training needs differ according to which function a specific individual has in dealing with the DSS. Together with the client the following definitions have been agreed:

1. ***Decision Makers*** are the representatives of certain groups of beneficiaries and are directly involved in the decision-making processes at senior level. They include, e.g. (i) Members of councils of ministers; ministers of relevant ministries (energy, environment, etc) (ii) Senior planners involved (directly or indirectly) with cooperative/multi-country projects at subsidiary level; examples are JMP working group, regional PSC for NELSAP projects, etc., (iii) Senior members of NBI programs and projects (e.g. executive directors). They will make use of DSS analysis results for decision making on interventions. They are also expected to continuously support the DSS in order to enhance its maintenance and its further development.

2. ***Technical Experts*** are the responsible managers and administrators of the Regional DSS Centre and Sub-regional as well as National NB-DSS Units such as (i) senior technical staff and planners from hosting ministry or national agency and (ii) NBI programs and projects officers and coordinators and have direct connection to Decision-Makers and Regional DSS Network members. They are not decision-makers but they support the decision making by supplying relevant information, supervision of model runs, synthesising model results, etc. They are responsible for modelling staff (i) of NB-DSS Units in all riparian countries, (ii) of sub-regional NB-DSS Units as well as (iii) of the Regional DSS Centre.
   They will primarily

   - identify information needs for selected interventions to be analyzed by the NB-DSS;
   - provide support in scenario definition and analysis;
   - define model applications, supervise and monitor model runs;
   - synthesize information from NB-DSS applications;
   - present synthesized information to decision makers;
   - be responsible for human resource development, e.g. including definition of staffing requirements, by NBI to build and manage the models and capacity building activities.

3. ***Modellers***
   work under the supervision of managers and administrators of the Regional DSS Centres and Sub-regional as well as National NB-DSS Units.

   a) They make the core of Nile Basin DSS technical expertise in the specific modelling sense. These are core teams (regional, sub-regional and national) directly responsible for NB-DSS applications, e.g.
   - application building for specific project cases;
   - conduct model runs and produced model outputs;
   - parameterize the model, calibration and validation routines and model outputs;
   - maintenance of knowledgebase (administration of the data, data bases, spatial information, visualization of model output for decision making, etc);
   - etc.

   b) The category also includes IT-system administrators (lead by their NB-DSS Centre/Unit managers) responsible for the administration of the NB-DSS soft- and hardware

components incl. system installation and maintenance and continuous upgrading (DSS models and data bases) and user administration. These can be permanent staff of the NB-DSS hosting organization who also serve the NB-DSS Units or could be contracted professionals who has a service contract supporting NB-DSS Units as required and on demand. The same applies for the Regional NB-DSS Centre; the IT system administrator of the NBI also supports the Regional NB-DSS Centre or the centre or performs a contract with an external service provider.

4. ***Other users****;* these are mainly data suppliers for the DSS data bases, but this category can also include others, such as interested users from various institutions, including academic/research institutions who might not be involved with the NB-DSS on a continuous basis (as in the other categories) but would be interested to know the NB-DSS.

3 Implementation Options

The training programme in form of a modularised system is intended to be offered to the countries. It allows the countries to choose and to customize the modules to the specific target groups in the riparian countries, who shall be involved in the development and/or the operational use of the DSS. They may propose for their DSS staff a complete itinerary or just to concentrate on single elements, which are indispensable in their respective area of work. Each module is designed to deliver a package of competencies and is at the same time a separate unit of education. The modules themselves consist of specific key points and contents, each one related strictly and closely to the DSS application within the NBI framework.

Some training activities will be carried out by external suppliers in relation to the procurement of the software and the modelling services. In specific these are:

- Training related to software development: Module – DSS Software Training (Chapter 4.1)

  The training on the DSS software will be part of the software development package. Please refer to DSS Development Plan / Annex B.1 – Terms of Reference Software Development and System Implementation, Work Package 1, for further details.

- Technical training related to the application development: Module – Pilot Test Applications (Chapter 4.4)

  The training for, as well as the calibration of, the models and their application, including test runs for specific regions and problems, among them data input will also be procured from third parties. Please refer to DSS Development Plan / Annex B.2 – Terms of Reference for Data Compilation, Processing and Pilot Test Applications, Work Package 2, for further details.

Supplementary trainings can be provided by third party (e.g. other institutions, comprising national and regional institutions and private training institutes and/or consulting companies), hence, a separate arrangement has to be made for their delivery:

- Module – IT System Administration (Chapter 4.2)
- Module – Data Base Management (Chapter 4.3)
- Module – DSS Awareness Training (Chapter 4.5)
- Module – National and International Data Mining and Procurement (Chapter 4.6)
- Module – Data Quality Control (Chapter 4.7)
- Module – Economic Appraisal of Projects (Chapter 4.8)
- Module – GIS and Remote Sensing (Chapter 4.9)

The NBI/WRPM can provide parts of these trainings

- either directly as on-the-job training, e.g.
  Module – DSS Awareness Training (Chapter 4.5);
  Module – National and International Data Mining and Procurement (Chapter 4.6);
  Module – Data Quality Control (Chapter 4.7);

or

- indirectly through setting up partnerships or other agreements with regional or national institutions from the riparian countries.

In any case, the NBI/WRPM as one of the primary users of the DSS should be closely involved in the definition and approval of the standards and contents of all trainings.

The possible synergies resulting from the considerable number of training institutions are important for the NBI. It will be of utmost importance to liaise with national and international institutions for the implementation of parts of the training

Furthermore, experts in curricula development should be involved, when fine tuning the implementation modalities.

4 Content of the Training Modules

4.1 Module – DSS Software Training

Approximate duration and implementation schedule:

- Series of at least 4 one-week training workshops
- A period of at least 120 working days (corresponding to six calendar months) is to be planned for either or both:
  - On-site work of members of the development team at the NBI PMU (Addis Ababa) with direct involvement and on-the job training for selected NBI members of the DSS core team (from all NBI countries) and other riparians, as appropriate;
  - On-the job training for selected members of the DSS core team, from all NBI countries, as appropriate, at the consultant's premises.
- Refresher trainings

Details on the implementation schedule can be derived from Annex B.1 – Terms of Reference for the Software Development and System Implementation, Work Package 1

Type: Training courses and on-the job training for Regional NB-DSS Centre (core team)

Objective: Proficiency on DSS software maintenance and operation.

Key points: The software related user training shall be held in conjunction with the installation of each of the four successive prototyping cycle results. These trainings should be held at the location of the primary software installation (PMU) to be able to directly use the newly installed systems or updates for the training and at the same time subject it to user testing.

Training must cover the background, algorithms and theory of the software, as well as hands on exercises with didactic synthetic test cases to familiarize selected users with the system.

The software training shall be synchronized with the release of the corresponding user manuals, to be used as course material in the training and to compile user feedback for the improvement of the manuals.

At least four one-week training workshops shall be conducted in conjunction with the prototype implementation. These four workshops will address the functionality but also the theoretical background and operation of the prototypes as installed.

Audience: Relevant members of the DSS core team and other selected riparians from all NBI countries.

Assumption: Trainees already have excellent IT and modelling know-how.

This training course needs to be organized by the consultant responsible for the implementation of Work Package 1 – Software Development and System Implementation.

4.2 Module – IT System Administration

Approximate duration and implementation schedule: 3-5 days

Implementation in parallel to or as part of Module – DSS Software Training.

Type: Regional training course

Objective: Interdependencies of IT-system administration of hosting institution and operation of DSS software.

Key points:

- Data base administration, backup strategies, replication via network etc.;
- Management of local settings, printers, plotters etc. used by DSS modelling and visualization devices;
- Hardware maintenance;
- User administration, definition of access rights etc.

Audience: IT-system administrators from the NB-DSS hosting institutions:

- NBI office (Regional NB-DSS Centre);
- Ministries responsible for water resources management (National NB-DSS Units).

Detailed know-how on IT system of hosting organization is a prerequisite.

Assumption: If IT system administrators of the hosting institutions are not available to also administer the NB-DSS, a service contract with an external system administrator (i.e. system admin provided by IT service company) is recommended. In such cases where the system is administrated by contacted service providers it should be ensured that the service provider receives an appropriate introduction to specific aspects of the DSS soft- and hardware administration.

This training course needs to be highly synchronized with the training provided by the consultant responsible for the implementation of Work Package 1 – Software Development and System Implementation.

4.3 Module – Data Base Management

Approximate duration and implementation schedule: 3-5 days

Implementation in parallel to or as part of Module – DSS Software Training.

Type: Regional training course

Objective: To enable the management of data bases those are utilized by DSS runs.

Key points: The course will discuss

- datasets with a special focus on water management, environmental and hydrological modelling;
- requirements, possibilities, restrictions and dependencies of data bases of various DSS components;
- different options of data base structure;
- topology and topology levels, topology rules and errors;

- basic SQL, mapping, data editing, etc.

The course will also feature practical applications and best practice examples from other comparable experiences and data bases. Specific requirements for Nile and DSS application should be emphasized.

Audience: *Modellers* from Regional NB-DSS Centre and National NB-DSS Units. The training should be organized in cooperation with IT system administrators from the Regional NB-DSS Centre and National NB-DSS Units.

Assumption: The participants at this course already have good data base management experience. They are hired by Regional NB-DSS Centre and National NB-DSS Units (permanent staff) into the modelling team partly because of their experience with data base management.

This training course needs to be synchronized with the training provided by the consultant responsible for the implementation of Work Package 1 – Software Development and System Implementation.

4.4 Module – NB DSS Pilot Test Applications

Approximate duration and implementation schedule:
back-to back with the software training, minimally one week for each prototyping cycle: 4 courses every ca. 6 months

Details on the implementation schedule can be derived from Annex B.2 – Terms of Reference for Data Compilation, Processing and Pilot Test Applications, Work Package 2.

Type: Training courses at the premises of the Regional NB-DSS Centre

Objective: To introduce advanced modelling competencies on selected regional NB case study examples.

Key points: *(1)* Introduction to water resources/hydrologic modelling with specific relevance for the Nile basin

(2) Detailed training on a set of pilot test cases (selected in coordination with and approval by the client):

- Training in terms of concrete early applications of common interest;
- Definition of processes to be modelled and algorithm to be used (derived from the decision making demand);
- Scenario building and calibration;
- Multi-criteria analysis;
- Sensitivity analysis;
- Sources of error (modelling and data);
- Pre- and post-processing of data;
- Statistical analysis and visualization of model output.

The training will concentrate on the DSS aspects of the system and provide feedback on the relevance of criteria, scenarios, DSS options, etc.

Audience: *Modellers* from Regional NB-DSS Centre (core team) and National NB-DSS Units. Further participants to be trained will be selected by the client; these should be from the group of most likely initial system users.

Assumption: Participants must have advanced water resources/hydrologic modelling experiences. It is difficult to assume that the NB-DSS can be successfully operated if such background would not be available.

This training will be organized by the consultant responsible for Work Package 2 – Data Compilation, Processing and Pilot Test Applications.

4.5 Module – DSS Awareness Training

Approximate duration and implementation schedule: 1-3 days

This module should be implemented in parallel to Module – Pilot Test Applications when pilot test applications (with a specific relevance for the Nile) can be used for demonstration purposes already.

Type: Regional training course

Objective: To raise awareness about the vision and aims of NB-DSS applications for regional development;
To create awareness for and to encourage the support of the NB-DSS utilization;
To familiarise the participants with the organisational set up of the NBI / NB-DSS;
To introduce the basic concepts of structured decision making in the context of DSS application with special relevance for the Nile basin to understand the main implications of scenario definition and analysis.
To familiarise the participants with NB-DSS and its current as well as potential future modelling and simulation capability;
To reflect on possible regional and sub-regional case studies.

Key points:

- Project introduction: It will give an overview on the NB-DSS project and its vision, the status of progress and future work plan;
- Interfaces and links of NB-DSS to other national and international knowledge development institutions, reflections on potentials for further strengthening;
- General overview on NB-DSS software: modelling / simulation with NB-DSS, work flows for NB-DSS applications and outputs;
- Potential advantages for decision making within the Nile basin, incl. reflections on possible decision-making strategies and potentials for rational decision making with differing stakeholder interests;
- Introduction of NB-DSS applications and discuss its main features: system inputs, results analysis, etc.
- Real live examples from the Nile basin (applying the NB-DSS) and other countries (application of other relevant DSS) and different water resources planning sub-sectors are given: Scope of work of other DSS initiatives in other river basins, concrete and potential advantages of those other DSS applications will be highlighted and illustrated through examples, specific links to Nile basin and NB-DSS applications are emphasized.

Audience: *Decision Makers* and *Technical Experts* from public agencies and institutions involved in decision making and preparation of decision making bases.

Assumption: No special preparatory training is required. It should be considered to give this course for Decision Makers and for Technical Experts separately:

- For Decision Makers with a stronger focus on policy development and decision making processes (approximate duration: 1-2 days);
- For Technical Experts with more concentration on NB-DSS applications (approximate duration: 2-3 days, hence, additional 1-2 days compared to training for decision makers).

4.6 Module – National and International Data Mining and Procurement

Approximate duration and implementation schedule: 2-3 days

Implementation in parallel to or as part of Module – Pilot Test Applications.

Type: Regional training course

Objective: To ensure that

- the DSS Centre/Units are well equipped with nationally and internationally available data, hence, can perform its maximal modelling capacities;
- data of adequate quality, format etc. and appropriate costs are procured.

Key points: The course will discuss the key features of national and international data procurement such as

- general introductions on remote sensing (types of sensors, satellite types, scanning frequencies, etc.);
- overview on international data providers and their services;
- legal provisions for the use of data, e.g.
  - copyrights and data ownership
  - specific restrictions on the special application rights (e.g. restrictions of use in certain countries)
  - etc;
- costs of international data with special considerations on freeware for non commercial use;
- national and international standards and modalities of mutual data exchange, i.e.
  - discussion on the situation in the Nile basin;
  - examples of different standards used in countries outside the Nile basin;
  - delivery period of different international data providers;
  - etc;
- data resolutions, technical formats and geo-referencing standards;
- technical options for transfer of data incl. considerations on data compressing and storage;
- data updating;
- etc.

The specific training content of the regional training should more focus on those items from the above list which are more relevant for international procurement. Sub-regional trainings should more focus on national data procurement rules.

Audience: *Technical Experts*

- who are responsible for the management of a DSS Centre/Unit;
- who define model applications for the support of decision making case studies;

- who supervise and monitor model runs and are specifically responsible for the provision of necessary data to ensure that specific DSS case studies support the demand of decision makers.

In this training *Technical Experts* should be accompanied by *Modeller* from each DSS Centre / Unit who will later apply nationally or internationally procured data sets.

Assumption: The type and number of trainings (e.g. if both regional and sub-regional trainings are necessary) depends on the agreed selection of case studies on the regional, sub-regional levels.

4.7 Module – Data Quality Control

Approximate duration and implementation schedule: 3 – 5 days

Implementation in parallel to or as part of Module – Pilot Test Applications.

Type: Regional training course

Objective: To explain the importance of adequate good quality information on water resources as a basis for planning.
To understand the main issues related to data quality assurance in the context of DSS applications.

Key points: The course will discuss data requirements and key factors concerning data quality assurance in relation to, e.g.

- overview on data requirements for DSS application,
- types of data, e.g. quality vs. quantity, point vs. spatially aggregated data, etc.
- data collection,
- data analysis and aggregation,
- main sources of error,
- consistency checks, e.g. outlier detection,
- methods for filling of gaps and corrections of errors,
- overview on national data collection and processing standards and formats in use,
- data transfer formats (XML and GML), exchange and migration procedures,
- methods for data storage and backup.

Real live examples from other countries and different water resources planning sub-sectors are given. Specific requirements for Nile and DSS application are emphasized.

Audience: *Technical Experts* from public agencies and institutions involved in data collection and procession. *Modellers* from Regional NB-DSS Centre and National NB-DSS Units.

Assumption: Good knowledge on data measurement / acquisition techniques, data processing and storage is assumed (acquainted through day to day working assignments in home institutions). Familiarity with basic statistical techniques is expected.

4.8 Module – Economic Appraisal of Projects

Approximate duration and implementation schedule: 4-8 days

Implementation in parallel to or as part of Module – Pilot Test Applications.

Type: Regional training course

Objective: To introduce the economic analysis of decisions

Key points: The course will discuss the main economic analysis tools and their implications for the DSS, e.g.

- theoretical background of economic models;
- cost -benefit analysis;
- long term return, payback calculations;
- applications of economic modelling;
- financial analysis tools;
- preparation and interpretation of economic reports.

The course will consist of the theoretical framework and selected case studies.

Audience: *Technical Experts* and *Modellers*.

Assumption: It should be provided for *Technical Experts* with a more general focus and for Modellers with a focus on more detailed economic modelling features:

- For *Technical Experts* with more general content relevant for the development and management of case studies (approximate duration: 4 days), knowledge of political economics and financial sciences is desired;
- For *Modellers* with a specific focus on NB-DSS applications (approximate duration: 5-8 days), econometric skills are desired. The training for *Modellers* can be organized - but not necessarily - by the consultant responsible for Work Package 2 – Data Compilation, Processing and Pilot Test Applications.

4.9 Module – GIS and Remote Sensing

Approximate duration and implementation schedule: 6-10 days

Implementation in parallel to or soon after Module – Pilot Test Applications.

Type:

- Regional training courses with a special focus on regional applications
- Sub-regional courses with a special focus on sub-regional case studies

The course could well combine class room teaching with e-learning component.

Objective: To ensure that GIS and remote sensing experts are well acquainted with a wide range of applications for hydrological modelling.

Key points: The course will consist of a GIS and remote sensing applications specifically for RBM, IWRM and hydrological processes, e.g.

- processing of remote sensing data using GIS tools;
- advanced GIS operations with various hydrological data and parameter layers;
- applications of remote sensing and GIS to selected water resources problem solving.

Audience: *Modeller* of DSS core team; members of the National DSS network.

Assumption: Participants of this training need to be *Modeller* with a proven track record on GIS and remote sensing. Even though an experience with environmental or even hydrological modelling is an advantage, participants can also be GIS and remote sensing without specialization in these specific fields of expertises. This course doesn't teach basic GIS / remote sensing knowledge, moreover it ensures that GIS/remote sensing experts either receive a refresher course or learn about the relevant remote sensing and GIS operations in hydrology. Knowledge on procurement of remote sensing data and data base management is a pre-requisite (e.g. through successful conclusion of related training courses).

This training can be organized - but not necessarily - by the consultant responsible for Work Package 2 – Data Compilation, Processing and Pilot Test Applications.

5 Budget

For what concerns the budgeting, it is premature to make any concrete statements as for now because

(i) major parts of the training will be implemented through on the job trainings included in the Software Development and System Implementation consultancy (Work Package 1) and Data Compilation, Processing and Pilot Test Applications consultancy (Work Package 2);
(ii) the role of the PMU of the WRPM (direct and/or involvement trough partnerships with regional and national training institutions) need to be clarified in coordination with the selected consultants for Work Package 1 and 2;
(iii) any precise cost estimate may not be accurate since the involvement of other institutions from the riparian countries is not finally defined at this stage;
(iv) and the exact numbers of participants and modules to implement are not finally identified yet.

6 Evaluation

Effective training evaluation should provide feedback in two areas:

To assess training performance during implementation – to determine the extent to which training objectives were achieved and to identify necessary adjustments to the ongoing programme

To assess training impact – to determine whether trained staff have put into practice what they have learned, and whether this has improved the organisation's performance

It is appropriate to assess ongoing training performance through end-of-course evaluation sheets that ask participants to evaluate each course against:

- Achievement of learning objectives
- Relevance of course contents to participants' own work situations
- Quality of training delivery
- Appropriateness of training materials, including visual aids, training exercises and case studies
- Appropriateness of training resources such as the venue, accommodation and the refreshments provided

To assess training impact a key focus would be on the extent to which trained staff are actually applying training concepts in their work and the extent to which this is leading to improvements in the quality of their work. Such data should be tracked back against the findings of the training needs assessment in order to determine how the training has improved practice.

In addition to this formal end-of-course evaluation, during the delivery of the course the trainers should continuously monitor the response and learning of the participants. This is done through regular oral 'question and answer' reviews to reinforce key points and to check participant understanding. Key indicators areas of difficulty can be identified and addressed through repetition or the use of additional exercises or examples.