

**PAKISTAN**

**WATER AND POWER DEVELOPMENT AUTHORITY**



**BRIEF ON**

**SUB COMPONENT B1 OF COMPONENT B  
UNDER WCAP**

**“UPGRADING OF TOOLS, WATER RESOURCES  
DATABASE, MANAGEMENT SYSTEMS  
AND MODELS”**

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# **UPGRADING OF TOOLS, WATER RESOURCES DATABASE MANAGEMENT SYSTEMS AND MODELS**

## **1. INTRODUCTION**

The Planning & Design Division of WAPDA has been assigned with this technical study under sub component B1 of component B of Indus 21, Water Sector Capacity Building and Advisory Services Project (WCAP), being financed by the World Bank. The sub component B1 of WCAP includes the upgrading of existing tools, databases, models and management systems, seasonal, monthly and 10-daily planning and operational models and IBMR; development of additional systems-client interfaces, operation of these tools for water/power planning and operation and their linkage or transfer to IRSA and to the provincial institutions. The study has been proposed to be carried out over a period of three years.

The water resources data has fundamental importance for planning of any development project. It is an acknowledged fact that planning without data is an absurdity. It may be emphasized here that validity of data is very important and much depends on the dedication, experience of the people who collect and maintain the data. The usefulness and credibility of any planning and designing exercise depend directly on the quality of the data.

The primary aim of the computerized database is to collect and manage most of the data related to the water resources at one place to facilitate planning, designing and research in the field of water resources. The latest developments in the computer hardware and software have made data management easier. Powerful database software is now available to handle very large datasets without much difficulty. The built-in programming tools can help in generating queries for the users.

The User-interface enables the users to utilize the database effectively and to analyze the datasets. The back-end database generates results for the queries used for data processing. The computerized database provides a user-friendly environment for data handling, checking quality of data & provides efficient data entry and retrieval system.

A Geographical Information System (GIS) handles spatial distribution of data, interrelationships between different types of data, and layering of the different types of data. It is especially useful for establishing the exact location and its mapping. A major advantage is its ability to assimilate spatial information and reproduce and indicate it in visual form. It thus maximizes the value of spatial products such as maps, aerial photographs and especially satellite data and imagery. GIS is, therefore, closely linked to Remote Sensing (RS) technology to exploit its advantages adequately.

The modification in the Indus Basin Model Revised (IBMR) is to be carried out so that it can be used for Water Resources Planning, optimization of Hydro Power, Environmental impact assessment as well as by Indus River System Authority (IRSA) for operation and management of Indus Basin Irrigation System. The detail Terms of Reference (TOR) for adaptation of IBMR and desired modifications will be prepared during the Inception Phase. The existing water resources database has been established in ORACLE computer software which will be upgraded and linked with GIS through interface. Similarly, system-client interfaces will be established to integrate and disseminate the information/data among the stakeholders through web based Wide Area Networking system (WAN).

The upgradation of existing River Flow Forecasting System of WAPDA, will be carried out by the Hydrology and Water Management Organization of WAPDA.

## **2. NEED OF THE STUDY**

The proposal is based on the World Bank Aid Memoire for proposed Indus 21 Water Sector Capacity Building and Advisory Services Project (Indus 21 WCAP). The component B of this Indus 21 WCAP relates to improvement in water resources management and development in WAPDA which includes 4 sub components B1 to B4. The sub component B1 includes the upgrading of existing tools, databases, models and management systems, seasonal, monthly and 10-daily planning and operational models and IBMR; development of additional systems-client interfaces, operationalization of these tools for water/power planning and operation and their linkage or transfer to IRSA and to the provincial institutions.

According to the requirement of sub component B1, this proposal have been prepared to cover the following functional areas :-

- i) Establishment of computer infrastructure
- ii) Agro-economic Farm Survey of Indus Basin
- iii) Upgradation of Water Resources Database
- iv) Upgradation and modernization of IBMR, development of linkages with water resources planning, operation of the Indus System, design and analysis to support water development in the Basin
- v) Development of a System-Client Interface for information sharing among stakeholders
- vi) Strengthening Flow Forecasting System
- vii) Training

## **3. OBJECTIVES**

The major objectives of the study are as under :-

- i) To update the existing data storage, retrieval and processing system for hydro-meteorological, hydro-geological, agro-economic and environmental data needed for planning of water resource development and drainage projects and for management of water resources.
- ii) Upgrading and application of computer models/programs in areas of studies relating to management and operation of Indus River System.
- iii) To conduct system analysis studies for operation and management of water resources of Indus Basin.
- iv) Development of system-client interfaces for information/data sharing among stakeholders.
- v) Strengthening the River Flow Forecasting System of WAPDA to study the change in River Inflows due to global warming or climate change impacts on the upper catchments.
- vi) Upgradation of IBMR to optimize hydropower generation and assessment of environmental impacts.

- vii) Estimation of hydropower from the storage projects in conjunction with down stream irrigation water requirements as indicated by IRSA on Indus River system.

#### **4. THE INDUS BASIN MODEL REVISED (IBMR)**

The computer model used by WAPDA and consultants in the Master Planning Studies (1975-79) essentially routed surface water under different simulations. In order to convert the water inputs to agriculture outputs, a more versatile and powerful tool was needed. In 1976, soon after starting work on Revised Action Programme (RAP), the World Bank initiated work on the development of a large scale linear programming model for the Indus Basin. WAPDA provided the necessary data to be used in the process of model development. The resulting Irrigation Basin Model-I (IBM-1) was based on 53 irrigated regions or "polygons", covering the entire Indus Basin with more than 20,000 constraints. Later on, some structural simplifications were made such that the entire model contained approximately 8000 constraints which could be solved using a large machine and commercial software. The resulting model, referred to as Indus Basin Model (IBM) was completed in 1981-82 that could combine the standard agricultural modeling techniques with the surface water reservoirs and canal distribution network of the Indus Basin Irrigation System. The model also incorporated the conjunctive use of surface and ground water in the areas underlain by fresh groundwater.

The IBM was a valuable research tool investigating and analyzing water related projects and agricultural policies where important factors with respect to ground water quality and depth to water table were involved. However, the size of the model prevented the researchers from obtaining solutions beyond a limited number of alternatives. It was also recognized that partial analytical techniques adopted for the IBM did not prove adequate for modeling the large water resources projects like Kalabagh Dam Project

Because of the interdependence of the entire Indus Basin Irrigation System (IBIS) accomplished through re-routing of surface waters, the need for a model was realized which could simultaneously evaluate the benefits of additional water throughout the Agro-Climatic Zones and among the major crops. Consequently, in 1985, a team from the World Bank, in association with consultants, undertook the assignment of updating the IBM. It included updating of the model's input data, structural modifications to the programme through rewriting the model in General Algebraic Modeling System (GAMS) language, reduction of the 53 ground water homogeneous sub-areas (polygons) to nine Agro-Climatic Zones (ACZ), deletion of a large number of constraints imposing groundwater equilibrium in favor of an accounting system, and replacing the farm level linear expenditure system, originally based on consumption functions, with a price endogenous structure which could simulate the material equilibrium of demand and supply. The resulting model, called the Indus Basin Model Revised (IBMR) contained about 2500 equations and was extensively used in 1986 by the World Bank for the analysis of the proposed Kalabagh Dam Project. The World Bank further updated and streamlined the model in 1989 during the Water Sector Investment Planning Study (WSIPS) using the agro-economic field survey data collected by WAPDA in 1988. The model was eventually transferred to WAPDA in August 1989 and was extensively used for evaluation of alternative 10-years (1990-2000) water resources development plans presented in WSIPS. The IBMR has been further upgraded and modified by increasing the ACZ from 9 to 12 for a distinct-ACZ-Province delineation, during the study "Reactivation of

IBMR” in the context of National Drainage Programme (NDP) and the model has been updated for 2000-01 datasets.

## **5. Upgradation of Water Resource Database**

The objectives of Water Sector Database are: i) to upgrade the existing water resource database and to provide capability for the wide range of management functions for water resources data and information; ii) to develop technical capability in the areas of database through GIS, Remote Sensing (RS) and the other aspects of data management; iii) to support water resources data needs for various project planning studies under Water Sector.

The major steps involved in the implementation of proposed Computerized Database will be (i) design of the Database i.e. identification of the database; (ii) structure and data sets (iii) installation of GIS/RS System; (iv) data collection (v) programming for user interface; (vi) preparation of data entry formats/procedures; (vii) processing of data and format of data sets; (viii) development of standard queries; (ix) programming of the database; (x) preparation of manuals for training to operate and maintain the database; and (xi) training of staff to operate and maintain the database.

## **6. Strengthening Flow Forecasting System**

The purpose of this project is to build the capacity of Pakistan Snow and Ice Hydrology Project in the use of advanced Remote Sensing and GIS techniques to measure and monitor the snow and ice in the Mangla catchment. Later on this capacity will be utilized for short and long-term inflow forecasting of River Jhelum at Mangla. This will especially give important information on early Kharif snow melt for River Jhelum above Mangla and will also be helpful in the study of Climate Change impact on River Jhelum flows by analyzing the time series satellite imagery and other information to quantitatively analyze the changes in the physical dimensions and volumes of snow cover and its effect on river Jhelum and its tributaries Kunhar, Neelum and Poonch flows. The capacity building effort under this 24 months project will concentrate on building the understanding and capability of Pakistan Snow and Ice Hydrology Project (PSIHP) staff on the usage of time series satellite imagery based on different spectral resolutions and different spectral bands to estimate the area coverage of snow and amount of water held in it using the data from the high altitude network.

## **7. Local and Wide Area Networking (LAN/WAN)**

At present, the computer infrastructure in Computer Application Directorate (CAD) is connected through LAN System in its own periphery which has to be upgraded to include other formations of WAPDA. Similarly, the System-client interfaces will be established for sharing of informations/data as well as results of simulation models, among the stakeholders through a web based Wide Area Networking System (WAN).