Improve the Flood Control and Water Management by Using Hydrological Monitoring Stations Network in Iraq

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Introduction:
The Euphrates basin is a shared resource among Turkey, Syria and Iraq. The river originates in the mountains of southeastern Turkey, and gathers most of its runoff volume before crossing the border with Syria. The main tributaries to the Euphrates are the Balikh and Khabour Rivers in Syria.

The watershed of the Tigris River and its tributaries mostly occupies areas in Turkey, Iraq, and Iran. The Tigris rises in the mountains of Turkey immediately south of the headwaters of the Euphrates. The Tigris only runs a short distance along the extreme northeast tip of Syria. Unlike the Euphrates, the Tigris receives contributions from tributary rivers all along its path to the Gulf.

Major water development has taken place in the Tigris and Euphrates since the 1960s, with the current basin highly developed with storage reservoirs having an aggregate capacity exceeding twice the annual flow and many significant irrigation diversions, with more planned by all states in the near future.

Tigris-Euphrates Water Management System Model T-E WMSM of the effect of projects developments on Turkey and Syria to water that will come to Iraq. The document focuses on the specialized and advanced reservoir system operation rules implemented in the T-E WMSM. The T-E WMSM was developed within the context of a reservoir simulation tool, HECResSim to support the Strategy for Water and Land Resources in Iraq (SWLRI).

Water Management System Model (WMSM)
From the onset of the SWLRI project, two main WMSM scenarios were decided on for Phase I. The first scenario was to model Iraq’s existing water management infrastructure with inputs of upstream Tigris and Euphrates flows adjusted to reflect the impairment effects of present water resources development projects in Turkey and Syria. While the second scenario was to also model the existing system in Iraq, but with adjusted inflow data sets based on estimated effects of the full implementation of Turkish and Syrian project in the foreseeable future.

Hydrological Stations Network
Given the importance of monitoring stations, measurement hydrological basins of the Tigris and Euphrates and the importance of establishing a system to monitor and receive data in real (Real Time Data) and the benefits of big that can be reflected in the operational policy of the tanks in Iraq and to study the water balance through direct access to data from the monitoring sites, measurement and transferred directly to decision-making positions at the right time, especially in cases of flooding and shortages. In order to keep pace with scientific progress and technological world in the field of
monitoring and hydrological measurements and the introduction of the latest scientific achievements of the sophisticated equipment in the field of rehabilitation of hydrological stations in Iraq, has our ministry through the National Center for Water Resources Department in coordination with the Advisory (HEC), (USGS), (IMET), and (New Eden Group), which took it upon themselves to provide the processing and the Ministry of Water Resources and a number of modern equipment and training cadre and raise their technical capabilities and competencies to ensure the installation of the stations up and running efficiently.

The numbers of hydrological stations are as follows:

1. (105) station to measure the levels and early warning for flood control

2. (55) device for measuring the quality of water linking the hydrological station referred to in paragraph (1) above

   • The amount of sediment
   • Salinity
   • The pH level
   • dissolved oxygen

3. (5) stations to measure the speed of the river water

The hydrological station is a means or tool placed near the river to monitor water level, velocity and discharge in addition to water quality sensors. Either way the work is linked with all parts of the station and the settings for the program operating its own (Satlink2) is then directed antenna the station towards the satellite Meteosat07 to the station to send data to the satellite and received at the central station located in the building of the National Centre for the management of water resources where they are indexed by and analyzed by the department to control the water, as shown in figure (2).

![Figure 2: How to transfer data from the hydrological station and received at the central station](image-url)
HEC-ResSim Model of the Tigris-Euphrates

HEC-ResSim Software

The model water resources management system for the basins of the Tigris and Euphrates in Iraq, has been developed using the HEC-ResSim. The program in question represents the physical properties and operational control system for projects on water and ducts to form a network of connections and the representation of the flow behavior of the system in terms of reservoir management and control of the flow in the backside and Withdrawals of water. The program is designed to assist in the planning and daily operation of management systems, reservoirs, where the program aims to meet the target levels for storage in the reservoirs when making decisions releases from reservoirs built on the basis of the constraints specified by the user and needs to be secured back of those reservoirs. This program is currently being used "in the projects managed by the Corps of Engineers U.S. It includes elements of the representation system of reservoirs is that he does not exist in the program algorithms to water quality unless it can be introduced functions are defined by the user take into account some of the factors relating to water quality when you run the tanks. The program also represents power generation hydropower as well as his ability to balance the storage in the system and the coordination of releases from reservoirs parallel or successive (Tandem) to meet the water requirements to be secured in the backside.

The WMSM for the Tigris and Euphrates in Iraq has been developed using the HECResSim software. ResSim represents the physical and operational characteristics of Water control system projects with conveyance elements forming flow network connectivity, and simulates system behavior in terms of reservoir storage management, downstream flow control and withdrawals. The software is designed to assist in planning and real-time applications for reservoir management systems. ResSim operates on the premise of aiming to meet seasonal target levels for reservoir storage, while making release decisions based on user-specified constraints and objectives for at-site, downstream, and system operation.

Tigris-Euphrates WMSM Framework

The general HEC-ResSim structure of Tigris-Euphrates WMSM is made up of two networks, an upper basin and a lower basin. This division was necessary due to the large extent of the entire system and different roles of projects in the upstream versus downstream. The upper basin model (Figure 4) encompasses projects along the Tigris, including its tributaries, from Mosul Reservoir to just upstream of Kut Barrage. Along the Euphrates, projects from Haditha reservoir to just upstream of Hindiyah Barrage are also part of the upper basin model. The lower basin model (Figure 5) extends from Kut Barrage along the Tigris and from Hindiyah Barrage along the Euphrates to the downstream confluence of the two rivers at Qurna.
Figure 4: Upper Basin Network (2004 Conditions Model Configuration)

Figure 5: Lower Basin Network (2004 Conditions Model Configuration)

Model rules of the water management system:
Been developed operating rules of the operating rules adopted by the Ministry of Water Resources of Iraq but the model HEC-ResSim allows the use of multiple types of operating rules for the various reservoirs has been given priority to the operating rules as follows:
- Avoid the flow of water over the top of the dam in cases of exceptional floods.
- Identify all of the reservoir so that the maximum does not exceed the maximum capacity of the river back of the dam.
- Providing minimum releases from the reservoir, which provides the required minimum rear discharge of the dam.
- Providing minimum releases from the reservoir which provides water requirements nape of the dam.
- Ensuring a balance between the reservoirs Stockpile to run consistent.
- Followers of the operating curve of the tank solo and as permitted under the regulations set for the discharge of the back of the dam and reservoir system as a whole.

Main model elements:
- Reservoirs for storage
- Release decision making
- River reaches for flow conveyance
- Diversions for irrigation withdrawals or flood escape Junctions for establishing network connectivity and representing system control points.

WMSM Alternatives Modeling Alternatives
The WMSM was developed to portray the data, physical features, and operating functions of water control projects in Iraq for the purpose of evaluating water balance in the system for a given set of inflows, operating schemes, system constraints, and withdrawal requirements, while considering existing and future basin development conditions. So far, preliminary inflow data sets and reservoir system operation schemes have been developed. Example scenarios have been established to demonstrate water balance analysis by simulation. The example scenarios are formulated as model alternatives summarized below.

Model Alternative 0:
This model alternative was generated to establish baseline conditions relative to the state of basin development that existed in 1930. It was simply intended to show an estimated pre-existing picture of the Tigris and Euphrates river network and flow regime excluding the effects and presence of modern water resources development projects. The 1930 model network was confined to the upper and central sections of Iraq, and it depicted the Euphrates River, Tigris River and its tributaries without any reservoirs or major diversions. The 1930 flow dataset, developed from an extended and adjusted historic record to reflect a complete 74-year sequence of unimpaired flows, was fed at the upstream boundary locations along the main rivers and tributaries. In the case of the Tigris
basin, the unimpaired time-series of flows were routed along the main stem and combined with the unimpaired tributary basin flows. Output from this base model alternative was meant for a revealing comparison against other model alternatives that demonstrate the impact of water control and abstraction, under existing and future conditions, that alter the natural flow regime.

Model Alternative 1A:
Alternative 1A was based on the existing conditions (2004) network configuration of the system. The water supply operating policy was dedicated to primarily meet irrigation demand. Only overflow situations constituted any flow allocations to the Marshes. Upstream boundary condition inflows were associated as the 2004 flow dataset, which represents the adjustments made to the 1930 dataset to reflect impairment effects of upstream current water resources utilization beyond Iraq’s borders.

The major reservoirs, Mosul, Haditha, Tharthar, and Habbaniyah, in the Upper Basin (UB) model were instructed to guarantee minimum downstream deliveries, arriving above Kut and Hindiyah Barrages. At the handoff points above Kut and Hindiyah Barrages, flow deliveries from the UB to the Lower Basin (LB) model are meant to meet irrigation demand in the LB while reproducing impairment effects due to upstream regulation projects and withdrawals within Iraq. In the LB model, irrigation diversions further depleted upstream deliveries. Water control projects such as Ammara were obliged to first satisfy minimum downstream flows before residual flows, observing higher magnitudes during flood seasons, could be supplied to the Marshes. In essence, specific Marsh requirements were not considered in this alternative. The intent here was to assess the minimum quantity available to the Marshes under existing development and operating policy disposed for irrigation.

Model Alternative 1B:
Alternative 1B was also based on the existing conditions (2004) network configuration and depended on the 2004 dataset for inflows to the system. Except in this alternative, Marsh demands conceived for demonstration were specified as additional release criteria for the top reservoirs to cover minimum downstream flow requirements in the LB model.

Model Alternative 2A:
For Phase I of SWLRI, model alternative 2A was defined as the existing conditions (2004) configuration in Iraq coupled with the 2030 flow dataset as the upstream boundary condition. This alternative was established to appraise the performance of existing water control projects in Iraq operating to meet existing project demands given a future scenario of impaired upstream flows, due to greater scale water utilization in Turkey and Syria. Similar to the approach used in Alternative 1A, Alternative 2A did not consider specific Marsh requirements and concentrated on irrigation water supply operation.

Model Alternative 2B:
Alternative 2B was a modified version of Alternative 2A. Alternative 2B included regulation criteria influencing additional releases from the UB to the LB model to meet specified Marsh demand.

Results:
Below some of simulated results from the model:

<table>
<thead>
<tr>
<th>Model</th>
<th>Upstream Boundary inflow</th>
<th>Iraq Water Management System Configuration</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1930 Dataset</td>
<td>2004 Dataset</td>
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<tr>
<td>Alt. 0</td>
<td></td>
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<td>Alt. 1A - UB</td>
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<td>Alt. 1A - LB</td>
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<tr>
<td>Alt. 1B - UB</td>
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<td>Alt. 1B - LB</td>
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<tr>
<td>Alt. 2A - UB</td>
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<td>Alt. 2A - LB</td>
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<tr>
<td>Alt. 2B - UB</td>
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<td>Alt. 2B - LB</td>
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* Includes regulation criteria to meet specified Marsh demand.
Figure 6: Effect of upstream developments on the Tigris inflow to Iraq

Figure 7: Effect of upstream developments on the Euphrates inflow to Iraq

Figure 8: Shortage water on the Tigris and Euphrates rivers due to project developments on the Turkey and Syria

Conclusions:
By Using the hydrological gauging station network can be control and management the flood better and also how distribution the extra water.

There are vast possibilities of the program HEC-ResSim to identify the system behavior of reservoir management and control of runoff and withdrawals in the backside and the various alternatives that can provide valuable information for the daily operation and planning of water resources management.

The substitutes for time series of imports of water next to Iraq, especially the "River Euphrates was extracted through a simple and requires extraction on the basis of the default operating the reservoirs in the Upper Basin Nutrition (Turkey, Syria, Iran) for a series of time and more reliable."

References

- Droogers, P., 2000, Estimating actual evapotranspiration using a detailed agro-

1. Figures 6 and 7 shows that inflow will reduce approximately 6.5 BCM and 24 BCM annually for Tigris and Euphrates if the project developments completed on Turkey and Syria.
2. As a result of shortages as shown in the (figure 6):
   • The cultivated area will reduce in Iraq.
   • Reduce hydropower generation in Iraq.
   • Poor water quality
hydrological model. J. Hydrol. 229 (1/2), 50-58.