NAWABS for Better River Basin Management


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Our country is blessed with one of the most abundant sources of water on the planet. Lying just north of the equator, its tropical climate delivers an average annual precipitation of 2,940mm.

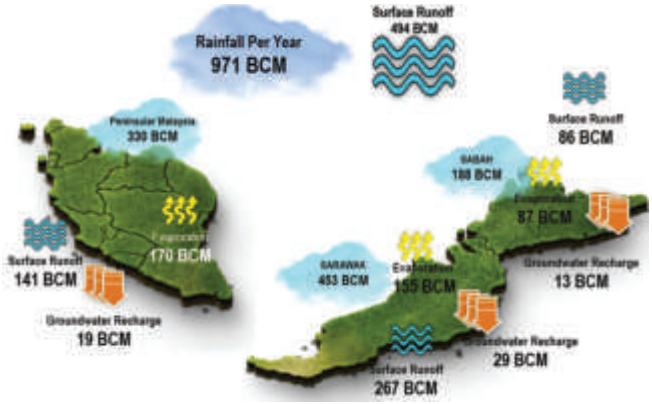

Figure 1: National water balance for Malaysia [Source: Review of National Water Resources Study (2011)]

The annual average rainfall varies between Peninsular Malaysia (2,490mm) and the states of Sarawak (3,640mm) and Sabah (2,560mm). Rainfall is concentrated around the two monsoon periods, North-East Monsoon from November to March and South-West Monsoon from May to September.

As shown in Figure 1, the total annual runoff is estimated at 494 billion m^3, compared to an existing water demand of 14.7 billion m^3 and the projected total demand of 18.2 billion m^3 by 2050 (*Source: National Water Resource Study, 2011*). The total available water storage is 12 billion m^3, with the net supplied by direct river abstractions.

But despite this apparent abundance of water, the supply is not evenly distributed, neither spatially nor temporally. In recent years, due to development pressures, water mismanagement and climate change, the water supply situation has changed "from one of relative abundance to one of relative scarcity" (Zakaria 2013: p.123). In response the Malaysian Government, in February 2012, formulated and endorsed the National Water Resources Policy (NWRP).

The National Water Balance System (NAWABS) is born directly from the vision of the NWRP. It is proposed as a comprehensive river basin management instrument that will facilitate a coordinated planning approach to water resources development as well as provide river basin management with a means to more effectively operate the river basin in the short- to medium-term. The Malaysia Drainage and Irrigation Department is the implementing agency for NAWABS and has selected the water-stressed Muda River basin in Kedah as the first to be incorporated into the new system.

MALAYSIA NATIONAL WATER BALANCE SYSTEM

NAWABS provides a framework for sharing knowledge, understanding river system behaviour, evaluating alternative developments and operational management schemes. It will also support informed decision-making from a river basin and inter-state planning perspective with the shared objective of developing water resources in a cooperative manner, sharing socio-economic benefits, and promoting efficient water utilisation.

The system will be built around a comprehensive Decision Support System framework that will be customised specifically to support the NAWABS operational objectives, with further local customisations for each river basin, as needed.

The developed models and NAWABS DSS will be used to assess existing water balance and future scenarios, as well as an operational system for real time decision making and water accounting.

Real time inputs will include rainfall, river levels and flows, pumped extractions and structure operations. Short-term forecasts will be based on available weather forecast data from the Malaysian Meteorological Department, while longer-term assessments, including uncertainty, will be based on ensemble climate forecasts from NOAA's NCEP datasets.

Model results will be processed and aggregated to provide information on 9 key outputs:

1. Water accounting – river basin inflows and outflows.
2. Water availability – flows and river levels at key demand points.
3. Water quality – key water quality parameters.
4. Water storages – available dam storages and timing and volume of dam releases.

5. Water and drought resources index – calculation of indices to gauge the current and forecast state of the river basin.
6. Water audits – accounts of all water movements in the river basin.
7. Water allocation.
8. Alternative demand options.
9. Water priorities.

MUDA RIVER BASIN

Sungai Muda is the largest river in Kedah (Figure 2). The water resources in the basin have been developed over the past several decades and are used for irrigation and as potable water for Kedah and Penang. Sungai Muda has a catchment area of 4,210 sq. km. The upper tributaries drain mountainous areas where elevations reach a maximum of 1,860m asl. The lower reach of Sg. Muda catchment, comprising about 45% of the total area, is generally flat with an elevation ranging from a minimum 2.5m at the river mouth to about 70m in hilly areas to the east.

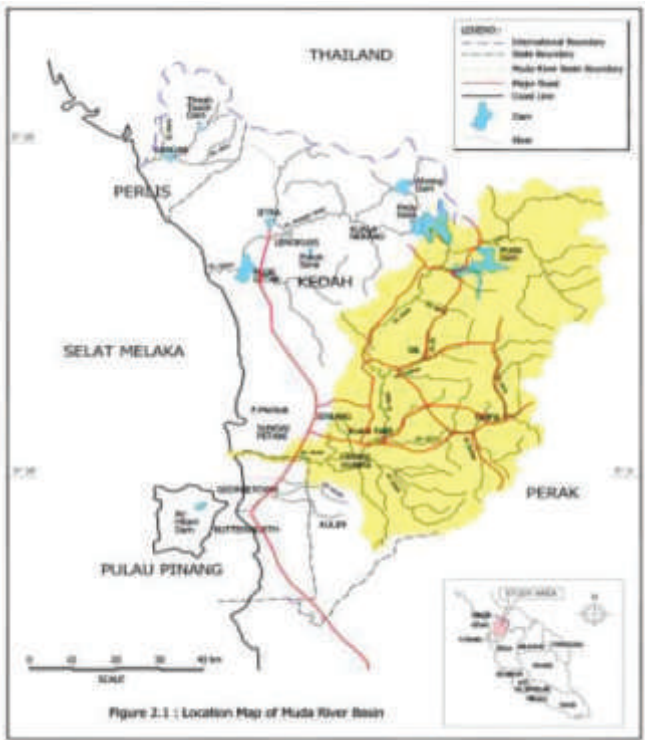

Figure 2: Sungai Muda basin

Management of water resources in the catchment has multiple stakeholders, including DID Kedah, MADA, SADA, PBA and others. Both the long-term sustainability of water resources in the basin, as well as short-term operational considerations are important to ensure the equitable distribution of water to all users during periods of excess as well as water stress.

Key considerations include:

- Multiple stakeholders have different priorities.
- Water resources in the basin are now deemed to be limited.
- Key hydraulic infrastructure in the basin is managed by different authorities, and their operations need to be coordinated.
- Future changes in land use and climate will affect the supply and demand for water.
- The groundwater resource potential has yet to be fully explored.

The uncertainty of the total water resource in the basin and the lack of modern river management tools hinder fully-informed decision making. This, combined with the water shortages commonly experienced in the basin, has resulted in DID proposing the Muda Basin as the first to be implemented with the NAWABS system.

The NAWABS implementation in the Sungai Muda Basin will comprise two main stages:

a) An initial water balance study where the main modelling will be developed to quantify the overall resource availability and assess existing and future demands, including environmental demands.
b) Incorporation of the developed models with a MIKE Customised DSS framework and linking to real time and forecast data sources, to provide an operational water management tool for the river basin managers.

A. Water Balance Study

The National Water Resource study provides a solid foundation for the current project to build on. The Water Balance Study will be based on a validation and update of the previous work and provide a quantitative assessment of:

- Existing and future sources of supply, including surface water, groundwater, dams and inter-basin transfers.
- Existing and future demands, including surface water and groundwater abstractions as well as environmental flows.
- An examination of the priorities for water delivery and how demands can be managed in times of water stress.
- Potential surplus/deficits, now and in the future, under different development and demand management scenario, allowing for climate change impacts.
- Infrastructure operations, now and in the future, to meet all needs, including necessary additional development of water resources.

The Water Balance Study will be supported by a number of sub-studies such as:

- Demand Management Study – investigating current water use efficiencies and how demands are influenced by economic, climate and other factors (should include comprehensive assessment of all water demands).
- Water Resources Conservation Plan – investigating how land use and water supply/demand are linked. Recommend land use map (with catchment protected areas).
- Environmental flow study – to determine environmental flow requirements.

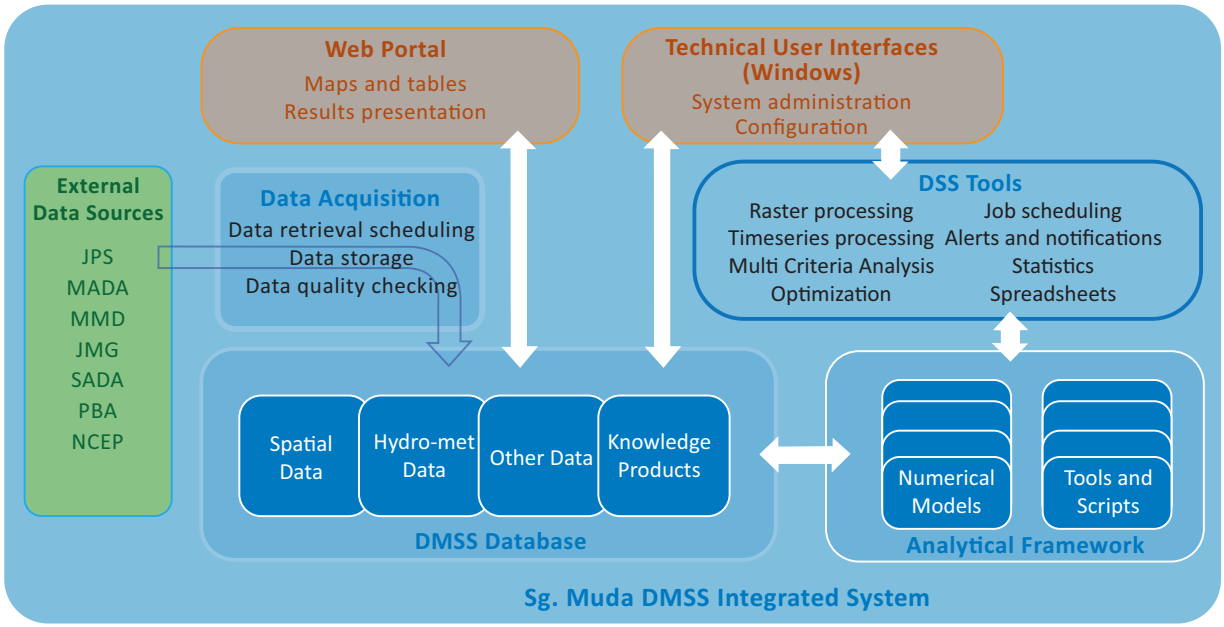

Figure 3: Sg. Muda NAWABS DMSS Components

- Water, energy, food nexus study – to determine the relationships between food, energy and water in the basin and to determine the water footprint.

The Water Balance Study requires a whole catchment approach, one that considers not just surface water resources but also groundwater resources. The MIKE SHE model specified in the TOR, provides a suitable platform on which to undertake this assessment. While there is sufficient information for surface water modelling, hydrogeological data is sparse and additional data is likely to be required.

Water allocation and prioritising various water users, as well as an assessment of the potential for shortages and surpluses, will be investigated using the MIKE HYDRO BASIN model. Once established, the model can be run using long-term rainfall or runoff time series to assess water availability and to fine tune allocations and priority of use.

Water quality is also an issue. The quantification of non-point and point source pollution loads to the river system and movement of these in the river channels will be handled through the water quality extension of the MIKE HYDRO BASIN model.

The models will underpin the overall water balance assessment which will include recommendations for managing existing operations as well as future water developments, including possible groundwater exploitation, if this option is viable.

Models require good quality data with adequate spatial coverage. It is envisaged that substantial relevant data exists within JPS and the stakeholder organisations. Early stakeholder consultations are important to initiate awareness of the project and to determine what relevant data may be available. It is understood that JPS will initiate these workshops.

B. Decision Management Support System (DMSS)

The DMSS will provide water managers with the ability to undertake long-term planning investigations, as well as support short-term and medium-term operations. The developed MIKE SHE and MIKE HYDRO BASIN models will be incorporated into the DMSS and will form the basis for decision making. The outputs from the operational models will be used to generate a set of indicators which will be used in a multi-criteria analysis tool to aid in decision-making. The Sungai Muda NAWABS DMSS will be designed to operate on a range of timescales, utilising different spatial and temporal inputs appropriate to each subject scenario. The overall workflows of the DMSS are shown in Figure 3.

CONCLUSION

The National Water Balance System for Malaysia is the implementation of an Integrated Water Resource Management (IWRM) framework that supports the objectives of the national water resources policy.

Embedded in a solid scientific foundation and understanding of basin scale processes, it will provide decision makers with an improved understanding of the overall water availability within the target river basin and allow for the formulation of improved plans and policies for water resource developments and allocations.

The operational system will enable river basin managers to better balance supply and demands, through an improved assessment of the future flow conditions and the ability to assess the risk of various operational strategies.

The Sungai Muda river basin has been selected as the first basin to be incorporated in NAWABS. The developed system will have the ability to be scaled and expanded to other river basins in the future. ■