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Malaysia's National Water Balance Management System: Tool for Water Resources Manager

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Abstract. A comprehensive water resources management system, the c (NAWABS) was developed by Department of Irrigation and Drainage, Malaysia based on the Sustainable Water Resource Management (SWRM) framework to supports the objectives of the National Water Resources Policy (NWRP). The NAWABS system provides a framework for sharing engineering approach on river system behaviour, evaluating alternative developments and operational management schemes. It supports decision-management for river basins and inter-state planning for developing water resources in a cooperative manner, sharing socio-economic benefits, and promoting efficient water utilisation. The NAWABS comprises of comprehensive Decision Management Support System (DMSS) framework customised specifically to support the operational objectives for each river basin. The operational NAWABS DMSS will enable river basin managers to better balance supply and demands, through an improved assessment of the future low conditions and the ability to assess the risk of various operational strategies.

Keywords: Water resources management, NAWABS, Decision Management Support System, water basin manager, water security.

1 Introduction

Water balance from the hydrological cycle perspective is defined as the amount of water entering and leaving a control space during a specific time period. It also accounts for major hydrological inputs, outputs and delayed components over specific spatial and temporal scale. The development of water balance model has been established for many river basins of various catchment sizes in the world and some of the example includes Nile Basin in Egypt (3,254,555 km^2), Tarim River in China (557,000 km^2), 11 River Bains in Nepal (147,181 km^2) and Murrumbidgee Basin in Australia (84,000 km^2) (Butts et al., 2016; Yu et al. 2015; GON, 2018 and Department of Primary Industries Water, 2015). The main reason for the development of a water balance modelling which

typically includes a modeling tool is to provide a comprehensive solution to water resources management issues such as providing updated information on water availability, water demand, and options for water transfer, water storing and allocation and integration of surface water and groundwater. The water balance model has now become a useful management tools to be developed under the Integrated Water Resources Management in Malaysia.

In Malaysia, as elsewhere, water is considered as the core of sustainable development and a critical element for its socio-economic development. Water is the driver of the key sectors of its economy and will remain as a crucial element to sustain its healthy ecosystem which eventually affects the well-being of its population. Water is a finite resource and it is only renewable if it is well managed. Water can pose serious challenges to sustainable development but if managed efficiently and equitably, water would play a key enabling role in strengthening the resilience of socio-economic and environmental systems in the light of rapid and unpredictable changes. The implementation of integrated water resources management was done via National Water Balance Management System (NAWABS). It is particularly important for key river basins involving inter-basin sharing or transferring of water resources, among the states in Malaysia.

2 National Water Balance Management System (NAWABS)

The NAWABS is a comprehensive Decision Management Support System (DMSS) framework customised specifically to support the operational objectives for each river basin. The operational NAWABS DMSS enable river basin managers to better balance supply and demands, through an improved assessment of the future weather conditions and the ability to assess the risk of various operational strategies. It is developed using MIKE modelling platform. The system requires real time inputs such as rainfall, river levels and flows, pumped extractions and structure rule operations. Short-term forecasts are generated 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 National Oceanic and Atmospheric Administration National Centers for Environmental Prediction (NOAA's NCEP) datasets (Saha et al. 2010 and Saha et al. 2014). The structure of NAWABS is shown in Fig. 1.

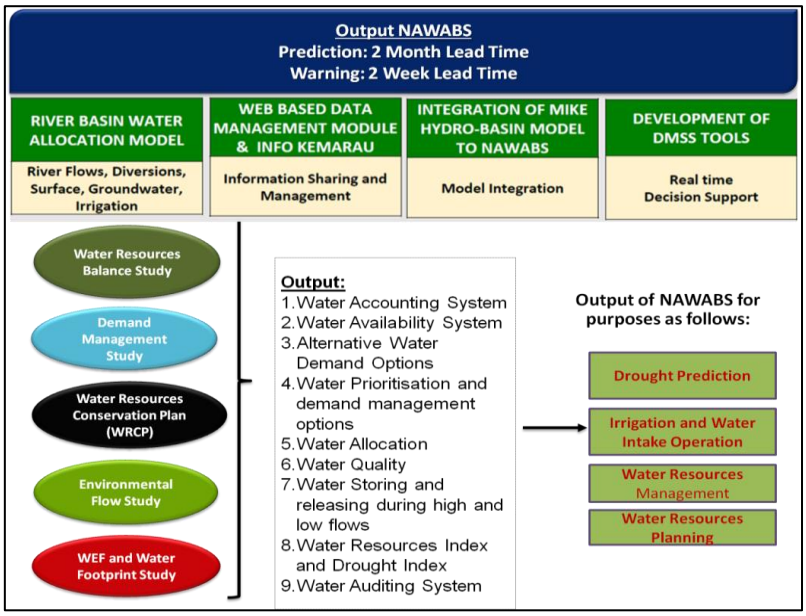

Fig. 1. Structure of NAWABS

NAWABS is a comprehensive modelling tools and decision management support to ensure the following targets are achieved:

(a) Water Accounting

The analysis and modelling shall account for all water entry and exit/loss within the river basin and key sub-basins and shall be updated on a daily basis, and the accounting process shall be updated on a weekly/monthly basis and aggregated on a yearly basis.

(b) Water Availability

The analysis and modelling shall account for water availability both in terms of volume and river stage (m) at all key demand points and be designed to incorporate and take into account future demand points;

(c) Water Allocation

The analysis and modelling shall assist the water resources manager to determine how water shall be allocated depending on demand and priorities.

NAWABS DMSS provides data management and model-based forecast results for operational control of river systems, water collection systems, water distribution systems, and tools for acquiring and combining online data sources in preparation for real-time modelling (A. M. Ishak et al, 2017; DID, 2011 and M. R. Husain, 2017). The components of NAWABS DMSS is shown in Fig. 2.

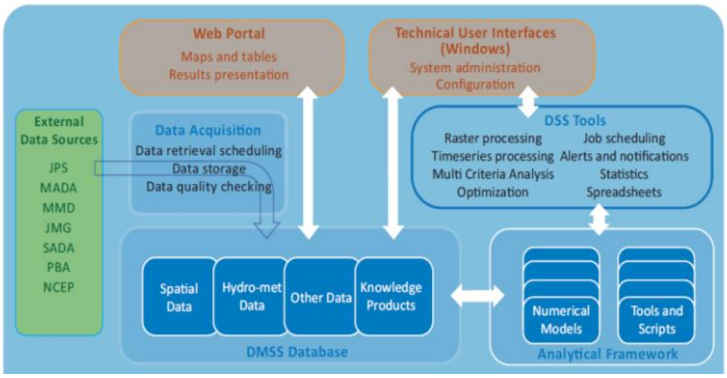

Fig. 2. NAWABS DMSS Components

Currently, 5 river basins undergoing the development of NAWABS which area Muda River Basin, Kedah River Basin, Bernam, River Basin, Melaka River Basin and Klang River Basin, while few more is in the pipeline. Among factors being considered for development of NAWABS is based on complexity of the river basin and potential of transferring water to adjacent river basin. For example, Sg Perak river basin, which is considered as complex system which comprise of 4 cascading hydropower reservoirs and 16 water intakes. It is crucial to manage this type of rivers basin to ensure sufficient supply while maintaining economic value through energy production at the hydropower plant. (DID, 2011)

3 Management of Water Demands through NAWABS

The water availability for the inter-basin transfer of raw water will be assessed to provide rules of water allocation, priority and options for decision makers during extreme drought and future climate conditions. The NAWABS for the Perak river basin will be developed to manage the water resources for all development needs. This section discussed on water transfer opportunity and management for the state of Perak and Penang.

The water supply services in Perak is managed by a state government institution, Perak Water Board, known as LAP. The water demand of Perak state is estimated to 1,276 MLD by year 2020, 1,422 MLD by year 2040 and 1,566 MLD by year 2050. It is

expected that there should not be water shortage if the catchment conditions are well maintained in Perak state. Fig. 3 shows the projected water demand for Perak state.

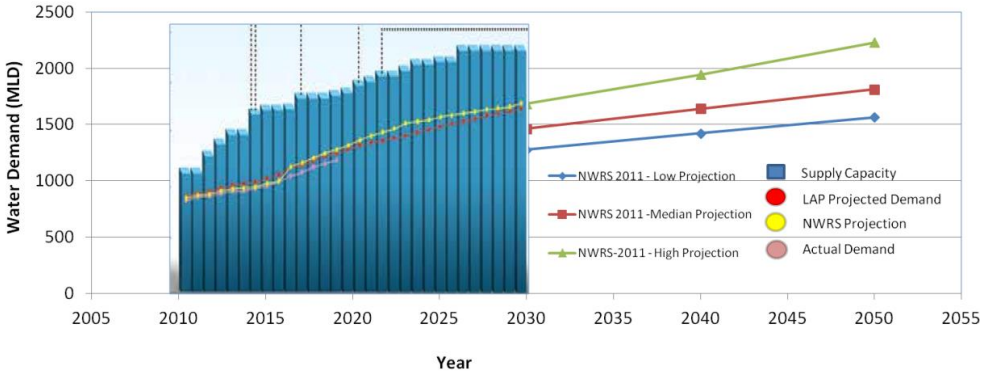

Fig. 6. Water Supply and Demand in Perak State
(DID, 2011 and LAP, 2016)

Meanwhile, the water supply services in Penang is managed by a state government linked company, Penang Water Supply Corporation, known as PBAPP. The water demand of Penang state is estimated to continue escalating in tandem with population growth as well as increasing economic activities. Penang's water demand was 840 million litres per day (MLD) in 2018. It is projected to reach 1,483 MLD by 2030 and 1,884 MLD by 2050. Due to its inherent geographic limitations, the related issue of limited water resources, PBAPP will face challenges to produce sufficient treated water to meet Penang's future demand.

Thus, NAWABS will be able to evaluate the needs of supply and demand between the two states and respective river basin. The NAWABS for the Perak river basin will be developed to manage the water resources for all development needs. The results from the Study will be used for the management and long-term sustainability of water resources in the Perak river basin.

4 Conclusion

The Integrated Water Resource Management (IWRM) framework through NAWABS supports the objectives of the national water resources policy. The NAWABS DMSS focus point is to evaluate the potential of supplying raw water for the water demand consumption as well as supplying raw water for inter-basin transfer to the adjacent water shortage state and applicable for Perak and Penang state. NAWABS DMSS enable basin managers to access existing water balance, short- and long-term scenarios, as well as an operational system for real time decision management, water accounting and water availability. NAWABS provides coherent framework to cross-evaluate the information on supply, demands and impacts on water availability for river basin.

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