

Note / Memo

HaskoningDHV Vietnam Co. Ltd.
Water

To: Quang Nam PPMU; TEDIPORT Consultant
From: Huy Hoang
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Subject: Review of Hydrology and Hydraulic Modelling Report (2019)

1 Introduction

The 'Integrated Development Project- Quang Nam Province Sub-Project' aims among other aspects to develop climate resilient and future proof road and navigation infrastructure in the coastal zone of Quang Nam Province, in the basin of the Truong Giang. The project is implemented by TEDIPORT Consultant under supervision of the PPMU. The World Bank is the financing the project. The project is currently in the Pre-Feasibility phase.

The "Strategic advice to the Quang Nam Provincial People Committee on the integrated management and technical solutions for Truong Giang River Subcatchment" project financed by the Netherlands Enterprise Agency (RVO). This project provides (i) technical assistance to the abovementioned World Bank financed project, and (ii) supports Quang Nam Province with the development of an integrated river basin management approach.

In the framework of project goals (i) a review has been carried out of Hydrology and Hydraulic Modelling Report (dated 2019) prepared by TEDIPORT Consultant. The results of the review is discussed hereafter.

2 General comments

The hydrological and hydraulic models developed for the analysis of the current situation and design of interventions in the Truong Giang Basin consists of the following components:

- MIKE NAM model. This model is used to calculate the rainfall – runoff in the Vu Gia – Thu Bon (VGTB) and Truong Giang River basin. NAM model is coupled with MIKE 11 for the simulation of runoff flow to the main river. The input data is the rainfall from 16 stations in the basin.
- MIKE 11 model. This model is used to calculate the hydrodynamic in the main rivers and tributaries in VGTB and Truong Giang river basin. Upstream boundaries consist of Nong Son Hydrological Station (Thu Bon River) and Thanh My Hydrological Station (Cai River). Downstream boundaries are Han, Dai, Lo river mouths. The cross-section data for all rivers are measured in the year 2018.
- MIKE Flood model, which is a coupling model of MIKE 11 and MIKE 21FM. This model is used for the simulation of the flood in the basin.

- MIKE 21 model. This models simulate the hydrodynamic, sediment transport and salinity intrusion on the Truong Giang River.

The developed models are a very complete set. They are not only suitable for the design of dredging and embankment works on Truong Giang but also for the planning and flood management of VGTB and Truong Giang river basins. The calibrated results of these models are quite good with some remarks (see below). These models have been applied to simulate several scenarios for the dry and flood seasons to derive design parameters.

3 Specific comments on models

Based on the review of the modelling report, we propose to discuss the following aspects with TEDIPORT Consultant to further improve the quality of the model:

1. Modelling of dams and reservoirs

Several hydropower reservoirs in the upstream of VGTB rivers and the Phu Ninh irrigation reservoir were not taken into account in the simulation of the hydraulic model MIKE 11. The current flows in Nong Son and Thanh My stations are not natural flows. These flows are influenced by the upstream reservoirs such as Song Tranh 2, 3, 4 (from 2010) and Dak Mi 4 reservoirs (from 2012). Therefore, the model simulations for high flow conditions, based on the historical data of Nong Son and Thanh My, do not provide realistic flood levels, extents and frequencies. They are most likely overestimated. These means that the current results of the simulations of flood levels and extents should be considered with great care, as they are likely overestimations.

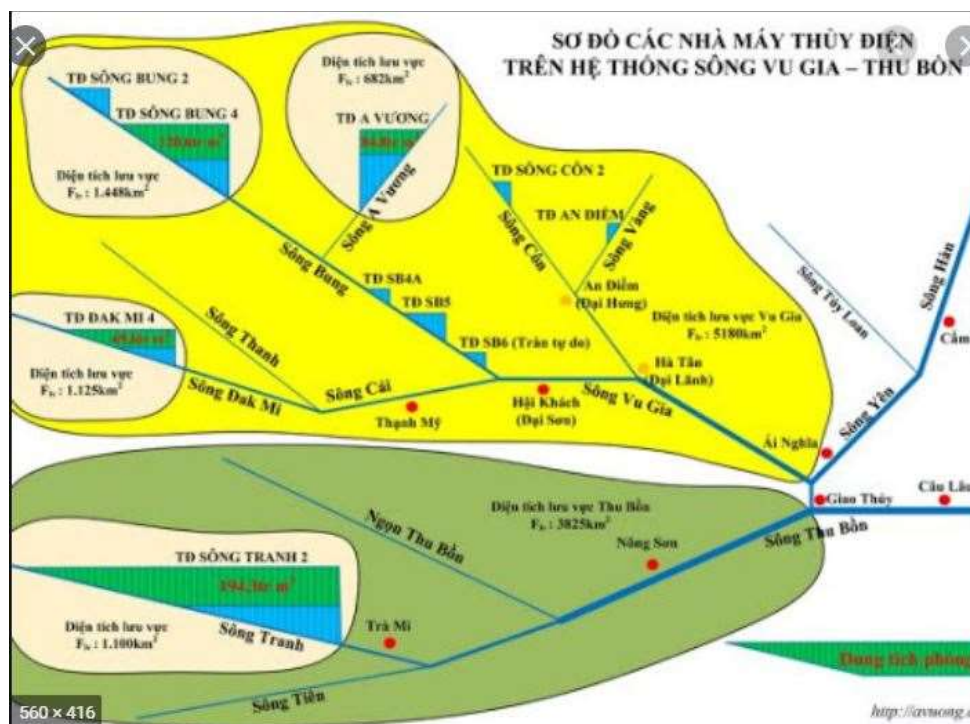


Figure 1: Hydropower dams on VGTB river basin (Source: <http://avuong.com>)

Suggestions for improvement:

- The upstream model boundaries should be extended to Song Tranh 4 and Dak Mi 4, and Song Bung tributary (from Song Bung 5 or Song Bung 6 reservoir) should be added to the schematisation
- The operation procedures of the VGTB hydropower dams and Phu Ninh reservoirs should be considered in the MIKE 11 model. Moreover, the water diversion (Ex. Dak Mi 4) should be also included in the simulation in the dry season.

2. NAM rainfall-runoff model

The NAM model should be calibrated with all downstream hydrological stations for which discharge data is available. Currently, the model is only calibrated with discharge data from Nong Son and Thanh My stations. This will raise the question on the simulation accuracy of other sub-basins further downstream. Moreover, if the modelling tool set will be transferred to Quang Nam Province to use for the water resources planning and management, it is necessary to calibrate the NAM model in full year(s), including low and high flow periods.

3. MIKE 11 model

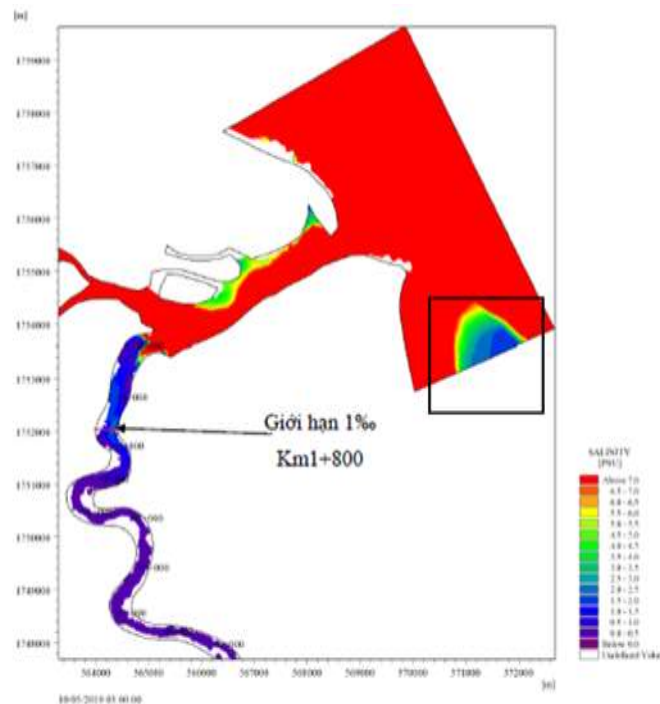
- *Upstream boundaries.* It is recommended to use the boundaries at downstream locations of Song Tranh 4, Dak Mi 4, Song Bung 6 and Phu Ninh reservoirs. The observed outflows of these reservoirs could be used for the inputs of model calibration process. The operation procedures of the upstream reservoirs should be used in the scenario simulations.
- *Number stations used for calibration.* Currently, the model is calibrated and validated with water level and discharge data at 3 monitoring stations (Hoi Khach, Ai Nghia, Giao Thuy). It is suggested to also calibrate with other stations such as Cau Lau, Vinh Dien, Hoi An, Cam Le, Tam Ky (and Nong Son, Thanh My if the model is extended). The observed discharge data for these stations should then be collected and used for further model calibration and validation.
- *Calibration and validation periods.* The model is calibrated and validated with the flood events in the years 1996, 1998, 1999, 2004 and 2007. It is suggested to calibrate and validate some flood events in the last 5 years when almost hydropower dams have operated.

4. MIKE Flood models

- *Calibration.* The model is calibrated in the flood event in year 2009. It is suggested to calibrate and validate some flood events in the last 5 years when almost hydropower dams have operated
- *Scenarios for future conditions.* We suggest to simulate more scenarios related to water level rise due to storm surge, climate change and sea level rise in years 2030 and 2050.

5. MIKE21 models for Truong Giang River

- *Model description.* The description of model schematization and settings is limited. It is suggested to provide more detail to make the reader better understand the potential and limitations of the model.
- *Calibration.* The model shows some strange results of the salinity inside the black box in Figure 8.11; Figure 8.15, Figure 8.16 and Figure 8.20. The model boundary condition along this southern boundary is not correct.



Hình 8.11 Giới hạn độ mặn 1‰ HT khu vực cửa Đại

- *Model scenarios.* The simulated model scenarios are not suitable to quantify salinity intrusion. The worst-case should be the combination of the highest tidal level and low flows from upstream in the dry season.
- *Scenarios for future conditions.* We suggest having more scenarios related to climate change and sea level rise in year 2030 and 2050. As for the salinity intrusion simulation, the scenarios should be also related to the frequency of highest tidal level and low flows from upstream in the dry season.
- *Hydraulic design conditions.* A flood frequency of 1% has been selected to derive flow velocities for the design of the revetments along Truong Giang River. We consider this to be relatively high because of the assumed current over-estimation of the flood levels (see remarks above under 'Modelling of dams and reservoirs'). This will in principle result in higher project costs. We suggest that the flood modelling is reviewed, and the Vietnamese design standards are checked in order to select reasonable design conditions.

6. Simulation of salinity intrusion

- The salinity intrusion can be simulated with MIKE 11 model to show the better view on the impact of combination factors such as river dredging, low flow from upstream, high tidal water level, sea level rise etc. The use of the Mike21 (horizontal 2D) model for the simulation of salinity intrusion simulation does not add much value over simulating with a 1D model. Due the large computations times it restricts the number and extent of simulations for a range of hydrological conditions.
- The simulated salinity levels in the middle part of the Truong Giang are relatively low (fresh water) (see for example Figure 8.1 above). It seems likely that in reality these parts of the river are brackish, especially in the dry season. This may be a consequence of the applied simulation time (too short?). It is suggested to review this aspect, although it is recognized that this is not a main focus of the current Pre-FS.

4 Other comments

In addition to the specific comments regarding the individual models, we would like to make the following additional remarks:

1. Chapter 2, 3 and 4: it is proposed to be combined into one chapter about 'natural conditions'.
2. Section 3.1: we suggest to include a map on the spatial rainfall distribution for the whole basin
3. Section 3.5: the information about storm events should be update with newest information.
4. Chapter 4: Background information about the reservoirs in the basin is missing. The analysis and discussion in the report focus largely on the Vu Gia Thu Bon river. Limited information is provided about the hydrological conditions in Truong Giang River and Tam Ky River. Given the importance of this area for Quang Nam Province, it is suggested to expand the reporting on the latter basins.
5. Sections 5.5.2 and 5.5.3: the calibration results in Tables 5-8 to 5-12 are Correlation Coefficient (R2), not Nash–Sutcliffe coefficient. It is suggested to correct this.
6. Section 6.3.3: please revise the formula to calculate the Nash–Sutcliffe coefficient.
7. Chapter 8: with only one observed salinity measurement date (23/1/2021), it is not necessary to present the Nash–Sutcliffe coefficient results as in Table 8-1. Nash–Sutcliffe coefficient is usually used for the comparison of the time series data (not only one value).
8. Chapter 6, 7 and 8: these chapters include many figures to show the model simulation results but include no discussion and explanation. To improve the understanding of the readers of the report, it is suggested that only the most suitable figures are presented in the main report and discussed. Other figures can be presented in an appendix.
9. Chapter 6 and 7: these chapters present the results of same model, and are therefore preferably merged into a single chapter.