

## **Response to 1<sup>st</sup> Referee's Comments on**

### **Has dyke development in the Vietnamese Mekong Delta shifted flood hazard downstream?**

**by Nguyen Van Khanh Triet**

The paper presents the interesting case of the flooding in the Vietnamese delta and the consequences of dyke construction on the flooding pattern. The subject well-presented and the approach is detailed. Though as authors are mentioning there should be further studies about the possible causes for the new flooding patterns, the paper presents in depth analysis of the different flooded areas in the downstream of the catchment where large-scale high-dyke development were performed.

- 1. I did miss however details of the quasi-2D model used. Can you please give more explanations on the model, not to repeat what is in the reference, but to explain the underlying equations and the solution of them?**

**AUTHORS' REPOSE:** Thank you for the comment. We include the following lines on the model being used and its underlying equation and solution. The 1<sup>st</sup> paragraph of Sect. 2.4 Hydrodynamic modelling (p.6 – line 18) will be revised as following.

To quantify the impact of the high-dyke development on flood hazard, a hydrodynamic model for the simulation of flood propagation in the MD was used. The model is a quasi-2D model based on the 1D hydrodynamic modelling suite MIKE 11. The MIKE 11 hydrodynamic (HD) module solves the vertically integrated equations of conservation of continuity and momentum (the ‘Saint Venant’ equations). The solution of the equations of continuity (1) and momentum (2) is based on an implicit finite difference scheme developed by Abbott and Ionescu (1967). The model domain includes the CFP, the Tonle Sap Lake as well as the majority of the channels and hydraulic structures in the VMD. The model was initially developed by Dung et al. (2011) and refined by Manh et al. (2014). It explicitly takes the complex hydraulic system with intersecting channels and dyked floodplains of the VMD into account. A typical flood compartment, i.e. part of the floodplain encircled by channels and protected by dykes, is described by “virtual” channels with wide cross-sections connected to the channels by sluice gate model structures. These cross-sections were extracted from the available DEM (originally SRTM, now LiDAR DEM). The cross-section width is defined in such a way to preserve the flood compartment area. Dyke-lines of each flood compartment are described by four control structures right after the points where virtual and real channels are linked. These structures are introduced in the model as broad crest weirs. The crest levels of dyke-lines are presented as sill levels of these control structures (see Fig. 2). A comprehensive description of how floodplain compartments are introduced by the “virtual” channels and wide cross-sections can be found in Dung et al. (2011). The model has been calibrated by Dung et al. (2011) and Manh et al. (2014) with recent flood events in the VMD, encompassing the high floods of 2011, the medium floods in 2008 and 2009, and the extraordinary low flood in 2010.

$$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = q \quad (1)$$

$$\frac{\partial Q}{\partial t} + \frac{\partial(\alpha \frac{Q^2}{A})}{\partial x} + gA \frac{\partial h}{\partial x} + \frac{gQ|Q|}{C^2AR} = 0 \quad (2)$$

where:

$Q$	discharge
$A$	flow area
$q$	lateral inflow
$h$	stage above datum
$C$	Chezy resistance coefficient
$R$	hydraulic or resistance radius
$\alpha$	momentum distribution coefficient

- 2. Given the fact that there are many models of the Vietnamese delta available to be used, mentioned in the literature (i.e. Mike 11 model, TELEMAC, etc.) can you justify why this quasi-2D model was chosen, and what is this model giving different as result as compared with the other available models.**

**AUTHORS' REPOSE:** Thank you for the comment. We agree there are many hydrodynamic models available either open source e.g. TELEMAC, SOBEK or commercial e.g. MIKE. Despite the fact that MIKE model is commercial, the software is widely applied in many scientific studies on the Vietnamese Mekong Delta not limited to hydrodynamics but also to water quality, salinity intrusion and sediment transport. Because the authors' institutes, i.e. GFZ and SIWRR, have purchased licenses for MIKE 11 package, and because the model has been proven to be appropriate for the simulation of the inundation dynamics in the Mekong Delta, this model was chosen for this study. Another benefit of the quasi-2D approach is the fast simulation time which is much faster than for fully 2D models. This enables the simulation of a number of scenarios within a reasonable time frame.

- 3. The authors are stating that the research is carried out triggered by the recent discussions in the Vietnamese public and the media. However being a research paper which will not be read by the general public how would such results be conveyed/ made available to the public, or authorities in charge of the system. What is the concern of the public, just that flood pattern is changed? or are there consequences of such a change?**

**AUTHORS' REPOSE:** Thank you for the comment. This was one of our concerns when selecting a journal for our publication, which should be open-access. Once our paper is accepted for publication in Hydrology and Earth System Science (HESS), freely access is granted to anyone who interested in this issue including scientific communities and decision makers in Vietnam. We do agree that scientific publication is hardly read by the general public. Therefore, we plan and hope that we might be able to present our findings in a conference/symposium in Vietnam where public press are invited. By doing this our study

might reach a wider reader via public media e.g. TV, newspaper. Moreover, the results of the study will be transferred to decision makers, i.e. the relevant authorities in Vietnam through the close contacts between the home institute of the lead author, SIWRR, with these authorities. These contacts are established over a large number of national and international applied and research projects over the last decades. Therefore the “ears of the decision makers” are open to the results and implications of the study.

The main public concerns are (i) how the flood regime downstream of high-dyke areas has changed due to the construction of fully flood protection measures in the northern part of the VMD e.g. at An Giang and Dong Thap. And (ii) should these high-dyke construction to be continued for expansion of triple rice cropping areas. The findings of our study will provide the numerical quantification for the first question and can be taken as the basis for decision makers to develop a holistic water and flood risk management plan in the VMD.

## **References**

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