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Model uncertainty in flood modelling. Case study at Vu Gia Thu Bon catchment - Vietnam.

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Abstract

Flood map nowadays is seen as an indispensable tool in urbanism, flood prevention and mitigation. For this reason, establishing flood map is mighty necessary for developing the socio economy of a river catchment. In recent years, creating this kind of map based on hydraulic models has been applied and proved good efficiencies in mitigating the consequences of flood catastrophes to human at many regions on the world. However, because of the lack of observed data in large catchments as well as developing countries, applying this work for these regions becomes a huge challenge for hydrologists. The insufficiency of meteo hydrological data, coarse resolution of topography, land cover data …brings many difficulties to choose a suitable model or decide a reasonable model structure for flood modelling in these catchments. This study via the flood modelling process at downstream of Vu Gia Thu Bon catchment, a coastal region in Viet Nam central will compare the differences between 1D model, 2D model, Quasi 2D model and 1D/2D coupling model for flood simulation. The study also presents the uncertainties of input data such as topography, land use, rainfall, and boundary condition when modelling flood events. These simulations are carried out on the modules of Mike by DHI software: Mike 11, Mike 21, Mike Flood. The results might show strong and weak points of each model. These could help modelers to get several judgments when selecting the model to build the flood map. This study is expected to give some usefulnesses for flood modeling in the coastal part of a big catchment.

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1. Introduction

The climate change is predicted to occur more severely and with more complexity. Under the impact of the variation of weather factors, especially precipitation, extreme flood event is expected to increase not only in intensity but also in frequency. It is thought to have an influence on all aspects of human society in the next few years [1]. Hence, responding actively with these changes is an urgent requirement today. EXCIMAP [2] that a prerequisite for effective and efficient flood risk management, is the in-depth knowledge of the prevailing hazards and risks throughout a river basin and areas of coastal flood risk. This includes information about the types of floods (river, coastal, lake and groundwater), the probability of a particular flood event, the flood magnitude expressed as flood extent, water depth or flow velocity, and finally, the probable magnitude of damage (life, property, economic activity). This basic information about the flood event can be gained through flood modelling and exhibited via flood map. Therefore, flood map is an effective tool in responding proactively to flood disaster in the period of preparation and planning of disaster prevention as well as in the emergency response phase [3]. Constructing the flood map together with taking into account the impact of climate change are seen as useful and indispensable process to respond to this natural phenomenon. It might help the local authority to have scientific evidences to suggest suitable policies and measures to reduce the impact of climate change.

As above mention, the flood hazard map is an essential document for assessing the impact of a flood event to society, flood risk mitigation, flood management as well. Due to its important, up to date, many mapping methods have been developed with different theories such as hydrologic, meteorological and geomorphologic approaches representing the hazard or risk of flood in scale of a catchment [4]. These methods are probably classified into four different types: Flood tracking, image processing, GIS topography combination and flood modeling. There are many pros and cons with each method. Although first three methods have good advantages with workload, there is a common weak point which concerns about their flexibility and their accuracy. It means that their produces do not take into account the effect of hydrological and hydraulic factors. Hence, they could not provide information related to stream flow such as speed or flood direction. These restrictions cause difficulties while forecasting the future scenario as well as assessing scale variability of inundation area under the impact of climate change. Conversely, the last method is realized by using a model which operates based on a mathematical relation between input and output hydrological variables[3]. The link between input and output variables are represented via different kinds of mathematical function which are able to consider on different aspects due to the viewpoint of developers, such as space, time, mathematical structure... So flood mapping using the hydraulic model is expected to translate more accurately the happening of flood event including distribution due to time and space, as well as providing hydraulic information. Especially, this method allows simulating with different scenarios which help to forecast change tendency of flood map under the impact of catchment's factor variations such as the construction, land use, or climate change.

Within hydraulic model, they are divided into several types depending on their dimensionality, capabilities and assumption in modelling water movement [5], [6]. The cornerstone of these models is the fundamental governing equations of fluid dynamics—the continuity, momentum and energy equations [7]. This equation is in fact known as the Navier-Stokes equations, which can be applied to solve complex fluid flows in the form of three dimensional (3D) hydraulic model [8]. However, this model is still so complicated to use for real case at this moment, so Navier-Stokes equations have been simplified into the form of St Venant equations [9], generally known as shallow water equations [10] that have been applied to build one dimensional and two dimensional hydraulic models reliable at a simplified level. With each kind of model, they have different advantages and disadvantages. To construct flood mapping for a region, the model selection depends on many factors, not least on the actual condition of catchment.

In order to choose the most suitable model for representing the flood event of Vu Gia Thu Bon catchment – a large catchment in central Vietnam, this study is realized by comparing the pros and cons of each kind of model: 1D model, Quasi 2D model, 2D model, 1D/2D coupling model. The result is also expected to supply a review for selecting model for flood simulation.