BUILDING A FLOOD WARNING AND FORECAST SYSTEM IN THE SOUTH CENTRAL VIET NAM

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Abstract: *To raise the efficiency of warning and flood forecasting of forecasters at the Meteorological and Hydrological Station in the South Central region, Viet Nam. A system of meteorological, hydrological and oceanographic measurement stations has been installed throughout the studied area including 10 basins in 5 provinces with more than 114 stations. Data from these stations are automatically transmitted to the server associated with a model system for calculating flood levels and flood maps, then be uploaded to WebGIS. The combination of online data and WebGIS can provide immediated flood warning information; while the WRF weather forecast model system combines the MIKE FLOOD forecasting model to create flood forecast maps for river basins in the South Central region updated on the WebGIS. Users can, thus, refer to flood spots, flood statistics and download updated data from this website. The system has also helped forecasters entering data in advance and creating faster outputs. Results have helped departments and agencies make timely decisions in disaster prevention.*

Keywords: *Forecast and warning system, WRF, MIKE models, WebGIS, South Central of Viet Nam.*

1. Introduction

1.1. Overview

In fact, there are many research subjects related to flood warning and forecasting, such as: the main river system, the reservoir, managing and planning for river system and downstream.

Currently, hydraulic models is a tool for research and application widely applied, that for simulating and solving hydrodynamic problems in order to sever flood forecasting is very popular and applied in many ways. Combining the Bayesian Network model to estimate flood peaks from the forecast of atmospheric populations (AEFs) and the WRF weather forecasting reseach model of Leila (2019) [7]. K.Pennelly (2014) applied WRF model with cumulative parameter maps for flood events in Canada and demonstrated the accuracy of the model in precipitation simulation [9]. Li et al (2017) combined WRF model with a distributed hydrological model that predicted floods in a large basin in Southern China, the results showed that simulated flooding is reasonable and can be brought early flood prevention for the community [8]. Jinyin Ye et al (2016) used TIGGE software (observaiton system reseach and forecast testing) integrating precipitation products from all major forecast centers in the world and supplying evaluation of the multi-model system, rainfall is intergrated by TIGGE model that can provide flood probability prediction [6].

With the flood warning forecasts studies in the country, Tri (2019) applied the MIKE SHE - MIKE 11 - MIKE 11 GIS model combined with IFS rain forecast for downstream Vu Gia River - Thu Bon [2]. MIKE NAM model is selected to simulate, calculate and forecast the flow to the lake for the construction of the lake regulation tool [3].

This research paper focuses on the ability to predict flood flows, research and apply some common hydro-hydraulic forecasting methods

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in flood prediction. A new point in the study is to integrate weather factors such as rainfall to calculate runoff data and flood maps for advanced forecasting for a large basin system in the South Central Coast. In addition, for the convenience of managing the database: forecast data, real measurement data, flooded data, maps,... WebGIS supports to improve the ability to manage, query, update information, news quickly and instantly.

1.2. Introduction of study area

The South Central Coast region is a coastal area with a narrow territory with many types such as coastal plains, low mountains, criss-crossed by river system but short and steep, deep shorelines and narrow continental shelves. This area consists of 5 provinces Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan adjacent to the East Sea, the North to the Middle Central, the South to the Southeast and the West to the Central Highlands. There are large rivers such as Kon River - Binh Dinh, Ba River - Phu Yen, Cai River - Khanh Hoa, Cai Phan Rang River - Ninh Thuan, Luy - Ca Ty, La Nga - Binh Thuan but most of them have very steep slopes.

Downstream areas in the South Central region are prone to floods, on average, there are 2-4 floods a year. Major flooding, the flood retention time last from 2-3 days, causing flooding floor more popular of 0.5-1.0m. Due to short and sloping terrain conditions, small river basins, combined with no transition zone, when heavy rains happen, water control capacity of the buffer-surface is poor, floods focusing on the delta are primary reason causing prolonged inundation in coastal areas and downstream area. Meanwhile, the upstream area is at risk of causing flash floods, pipe floods; small and narrow plains, large extent of changing in topography cause great flooding depth [1, 4, 5, 10, 11, 12, 13].

2. Methodology

2.1. Modeling methods

The main task is to establish a regional flood forecasting model, which requires a model such as a flood model MIKE 11 (RR & HD), MIKE21 and MIKE FLOOD. Observed data used to calculate statistics, analyze, and run models.

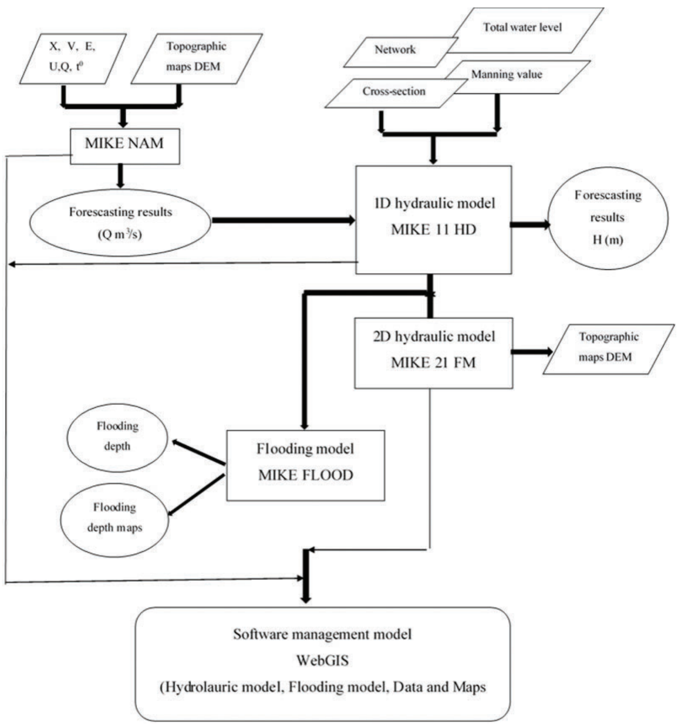


Figure 1. Diagram of steps to implement flood forecasting model

• NAM Hydrological Model (Rainfall - Runoff) is a rainfall-runoff simulation model, which is established to describe the volumetric flow rate approximate hourly or daily rainfall data.

• MIKE 11 modeling with the hydrodynamic modules (HD) is a one-direction flow hydraulic model used for the simulation of flow in rivers. The model is executed basing on data of river network, cross-section, river roughness and volumetric flow rate values from upstream to downstream.

• MIKE FLOOD is an integrated model package that simulates inundation for rivers floodplains, flooding in urban, drainage networks, coastal area, or any combination of these. Combination of this model's products with a GIS helps to present the results of the place which are likely to flood on map.

For ease of use and unity, the inputs and outputs from the model are managed by flood management software via WEBGIS with an intuitive graphical interface for users. The operation of WEBGIS has a property of a dynamic website, which divided into 2 parts including Client and Server. Client activities mainly interact with the map on the server via a web browser.

2.2. Research content

The South Central Coast region is a coastal area, a narrow territory. The terrain here includes coastal plains and low mountains, horizontal direction of East-West (averaging of 40-50km), narrow compared to the North Central and Central Highlands. There is a system of short and steep rivers, deep coast with many bends and narrow continental shelves. The plains are not large due to the western mountain range along the southern direction towards the sea and gradually narrowing in area. The delta is mainly formed due to the accretion of rivers and seas, often close to the foothills when forming.

The study area is bordered by the North to the North Central, the West to the Central Highlands, to the South by the Southeast, to the South and to the East by the East Sea. The South Central Coast consists of 5 provinces: Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, and Binh Thuan (Figure 1). Because majority of this area belongs to the coastal areas with steep slopes, the short river is combined with heavy rains so there is usually the phenomenon of surge creating flash floods.

Our study focuses on the main river basins of 5 provinces in the South Central Coast including Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, and Binh Thuan. Due to the topographic distribution and rainfall, the river systems are complicated. Its main rivers are Lai Giang, Kon - Ha Thanh (Binh Dinh); Ky Lo, Ba (Phu Yen); Dinh, Cai (Khanh Hoa), Cai Phan Rang (Ninh Thuan); Luy, Ca Ty and La Nga (Binh Thuan) Rivers, as well as other tributaries. The river has a steep slope, heavy rains causing sudden flash floods concentrate here.

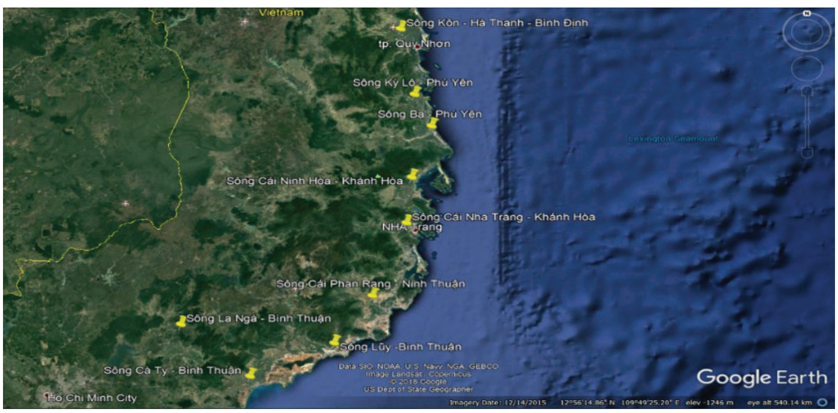


Figure 2. Map of the South Central Coast region
(Source: Sub-Institute of Hydrometeorology and Climate Change)

2.3. Data collection

2.3.1. Rainfall data

Observed rainfall data in the study area of 10 river basins is hourly rainfall data used as input data for the MIKE NAM model. This data set is covered by South Central Regional Hydrometeorological Center. Plans of calibration-test the model parameters in the flood season in 2013 and 2016.

- Binh Nghi, Thanh Hoa, An Hoa, Hoai An, Vinh Kim, Dinh Binh, Phu Cat, An Nhon, Van Canh, Quy Nhon, Vinh Son, Hoai Nhon and Bong Son stations: Binh Dinh province;
- Cung Son, Tuy Hoa, Son Hoa, An Khe, Ayun Pa, MaDrak, Ha Bang, Xuan Quang, Song Cau stations: Phu Yen province;
- Da Ban station, Ninh Hoa, Khanh Vinh, Dong Trang: Khanh Hoa province;
- Phuoc Binh, Song Pha, Tan My, Nha Ho, Phan Rang, Phuoc Ha, Nhi Ha stations: Ninh Thuan province;
- Song Luy, Phan Ri, Phan Tien, Phan Son, Song Mao, Bau Trang stations: Binh Thuan province.

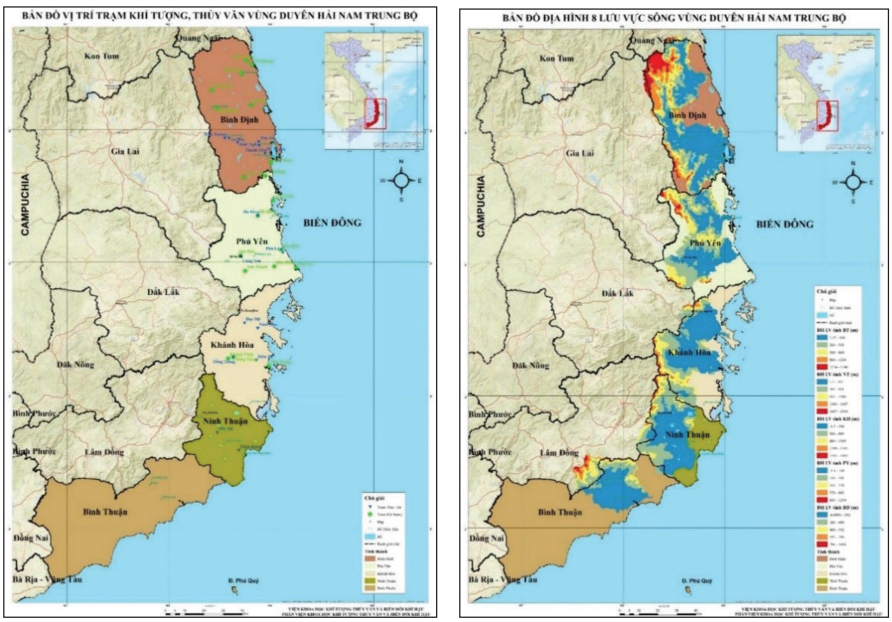
2.3.2. Flow rate and water level data

Hourly water level and flow rate data is collected over 2 periods of 2 years (2013 and 2016). Data set is used to calculate the changing of water levels as well as to simulate flooding problems for 10 river basins. It is also used for calculating in NAM models, flooding models, and supporting checking the calculation results of models, calibration and tests.

- Binh Tuong, Thanh Hoa, Bong Son stations: Binh Dinh province;
- Cung Son, Phu Lam, Ha Bang stations: Phu Yen province;
- Dong Trang station, Ninh Hoa: Cai River basin - Khanh Hoa province.
- Tan My station: Ninh Thuan province;
- Song Luy, Ta Pao, Vo Xu stations: Binh Thuan province.

2.3.3. Topographic data

DEM digital elevation map of research area used with resolution of 30×30m. The river network is digitized by using ArcGIS 10.1 on a 1:10,000 scale terrain. Topographic data has the resolution of 10×10m in the UTM zone 48N coordinate system, there is a diagram of hydrographic network, suitable topography with a closed network at the boundary values. Data of river networks and cross-sectional data are also collected and inherited from other projects that conducted by the Sub-Institute of Hydrometeorology and Climate Change.



a) Meteorology - Hydrology Station *b) Topographic data*

Figure 3. The input database of the flood forecast modeling system

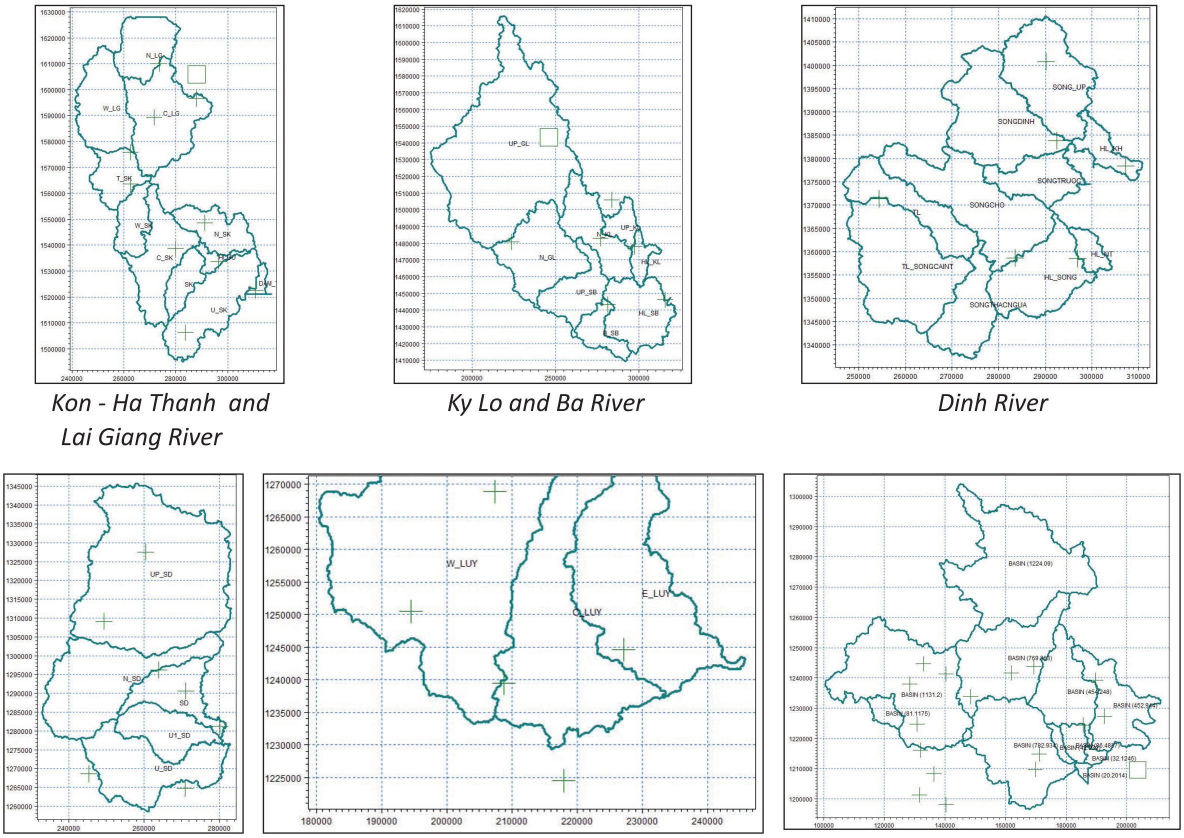
3. Results

We will put observed hydrometeorological data into the model for analysis, calibrating and testing results of flow rate over time (hours, days, months). After that, flooding simulation and inundated time in each small area and synthesized into flood maps. By combining with online data and actual results, the results are published on the WEBGIS flood warning system.

3.1. Results of rainfall-runoff model

3.1.1. Calibration of NAM model

Calibration parameters of the NAM model aims to find out the most appropriate parameters for the research area. Parameters for sub-basins found basing on a test method of measured flow rates and calculated values at monitoring stations. When calibration results are quite close to the measured data at the sites, these found parameters is good and can be used in the simulating of the next plan. The errors between the calculated and measured values during calibration were assessed according to the Nash-Sutcliffe efficiency index.



Kon - Ha Thanh and Lai Giang River *Ky Lo and Ba River* *Dinh River*

Cai Phan Rang River *Luy River* *La Nga, Ca Ty River*

Figure 4. Diagram of sub-basins division in South Central Viet Nam region

After testing the model, we conduct tests and determine the model parameters for the basins. Then, comparing the simulated values with the measured values (at the monitoring station), the results show that the flow rates from rainfall is quite similar. The effectiveness of the model is assessed by the correlation coefficient R^2 (if $R^2 \geq 0.8$ - it means satisfactory).

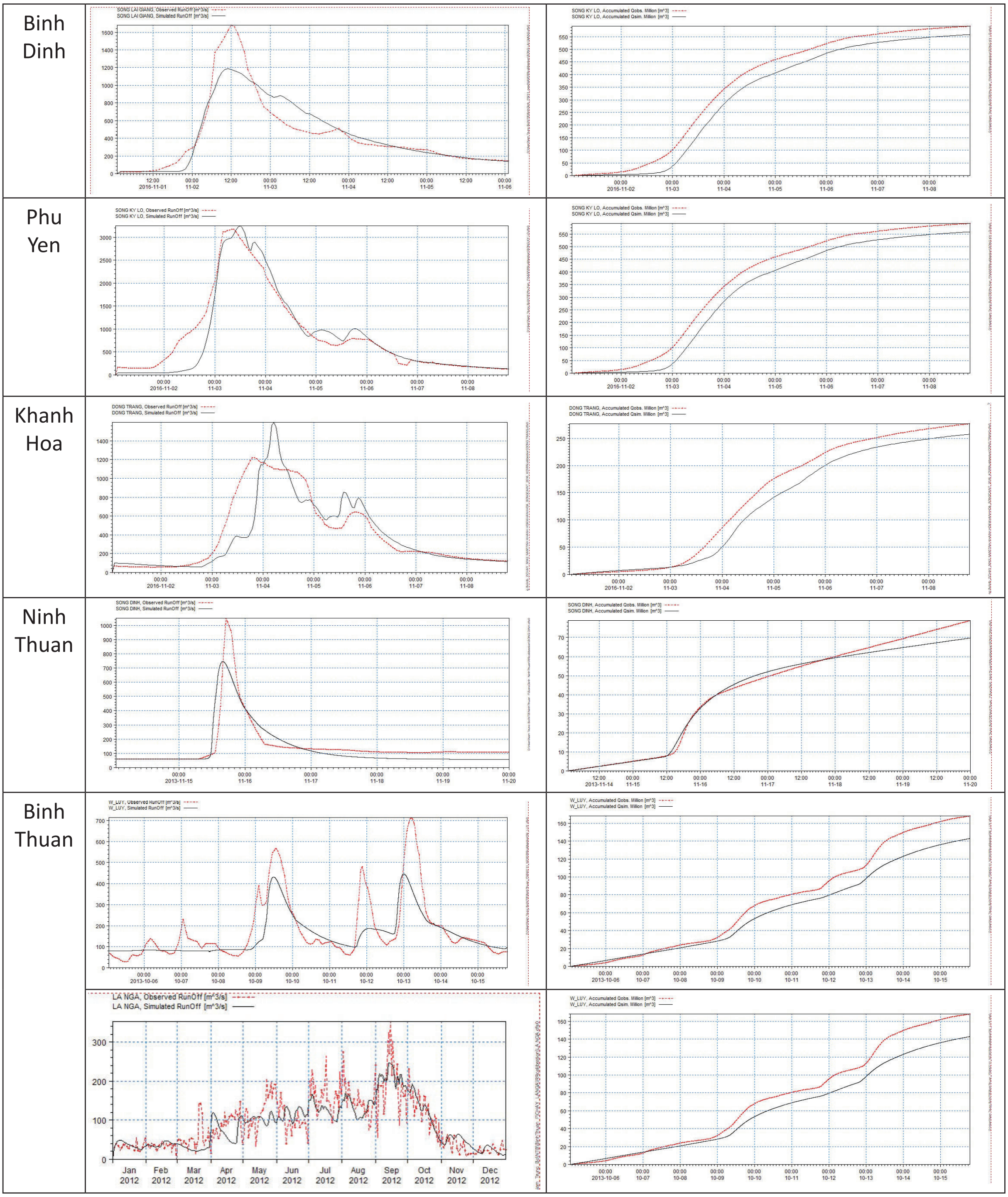


Figure 5. Calibration of rainfall-runoff model in the river basins

3.1.2. Testing of model parameters

After calibrating the actual floods for each province, we obtained the appropriate parameters to put into the model to assess the reliability when applied to the floods in the past corresponding to different time series. Calculated results of hydrological models for the sub-basins show that the highest flow-rates and peak floods are same phase during the flood season at the upstream. It can be seen that topographic conditions, fertility as well as natural conditions that make the difference from meteorological characteristics of each region. Heavy rainfall in the upstream causes large flow-rates in the s rivers and streams, affecting the water level of this area.

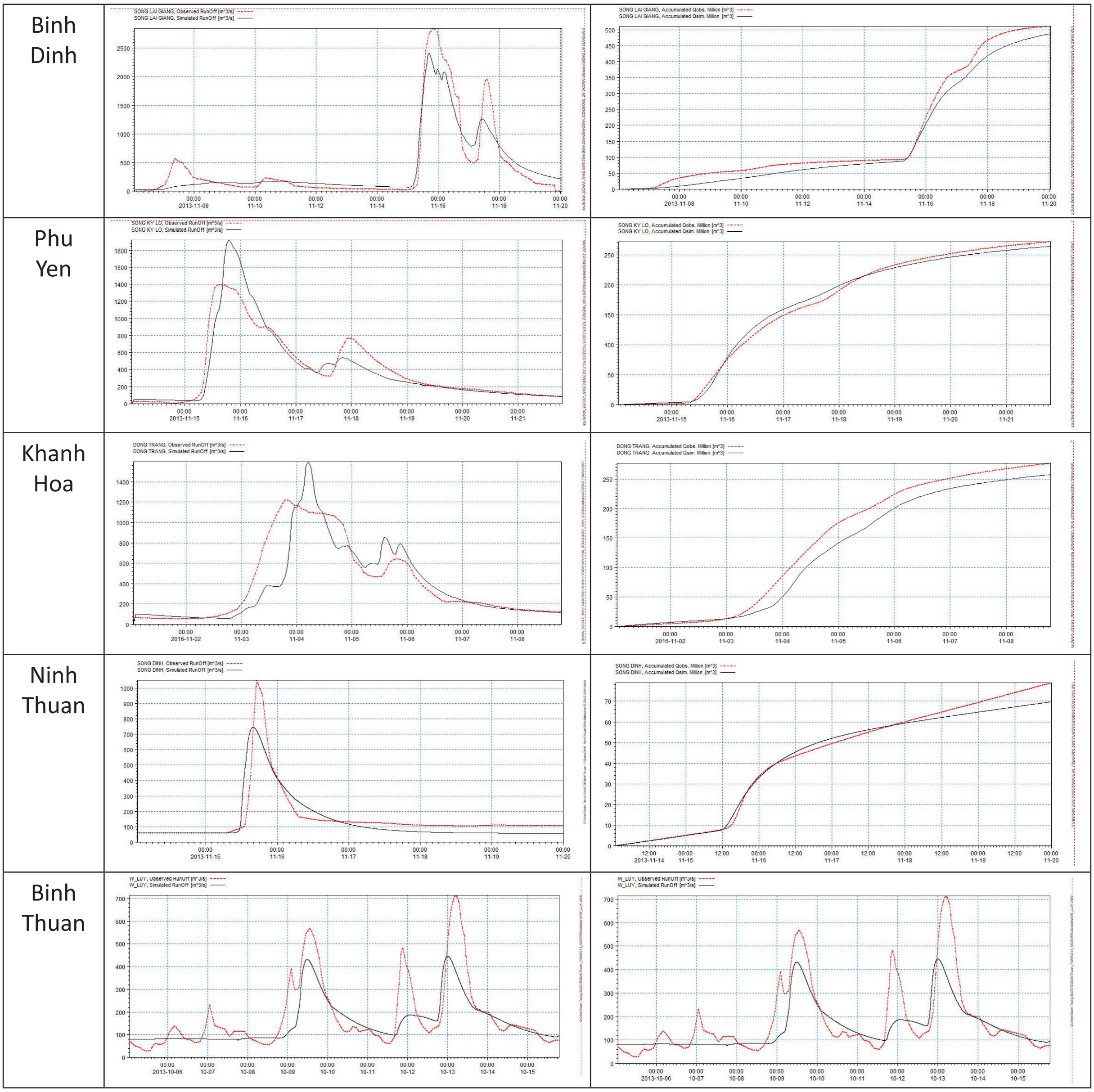


Figure 6. Testing of rainfall-runoff model in the river basins

Table 1. Correlation coefficient correction in the hydraulic model in the South Central region

Province	Basin river	Station	Correlation coefficient correction R^2	
			Correction	Accreditation
Binh Dinh	Kon - Ha Thanh	Binh Tuong	0.898	0.806
	Lai Giang	Bong Son	0.842	0.898

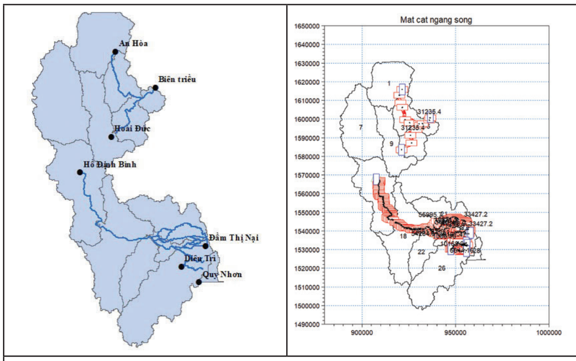
Province	Basin river	Station	Correlation coefficient correction R^2	
			Correction	Accreditation
Phu Yen	Ky Lo	Ha Bang	0.903	0.827
	Ba	Cung Son	0.83	0.82
Khanh Hoa	Dinh - Cai	Dong Trang	0.777	0.708
Ninh Thuan	Cai Phan Rang	Tan My	0.772	0.824
Binh Thuan	Luy - Ca Ty	Luy River	0.636	0.75
	La Nga	Ta Pao	0.649	0.784

3.2. Hydraulic model for South Central Region

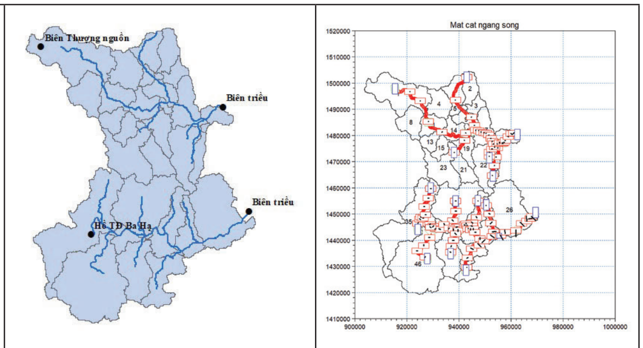
To determine the Manning's roughness coefficients, we conducted the data testing put into the model and comparing to the measured data. The hydraulic diagram for the river basins is shown in Figure 5. The results of the Nash coefficients and the correlation coefficient R^2 are shown in Table 1. In general, correlation coefficients are higher than 0.8, it means good correlation between two dataset.

Table 2. Nash coefficients and correlation coefficient correction in the hydraulic model in the South Central region

Provinces	Stations	Nash coefficients	R^2
Binh Dinh	Bong Son	0.73	0.96
	Binh Tuong	0.88	0.97
	Binh Nghi	0.74	0.97
	Thanh Hoa	0.7	0.93
Phu Yen	Ha Bang	0.61	0.96
	Cung Son	0.82	0.92
	Phu Lam	0.7	0.89
Khanh Hoa	Dong Trang	0.87	0.95
	Ninh Hoa	0.858	0.98
Ninh Thuan	Tan My	0.86	0.94
Binh Thuan	Luy River	0.74	0.86
	Vo Xu	0.98	0.81

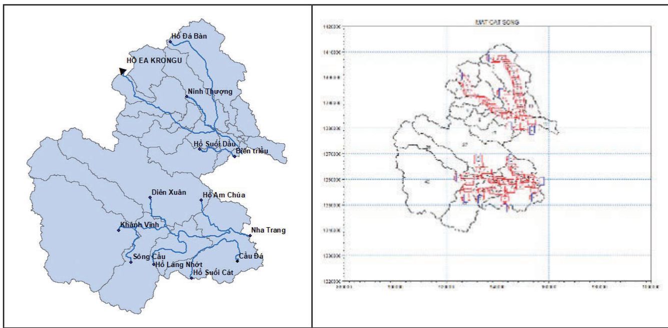


Hydraulic diagram of river basins in Binh Dinh

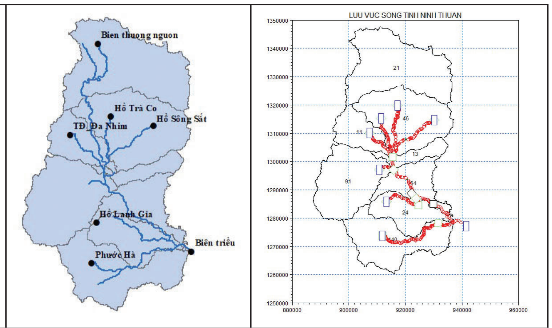


Hydraulic diagram of river basins in Phu Yen

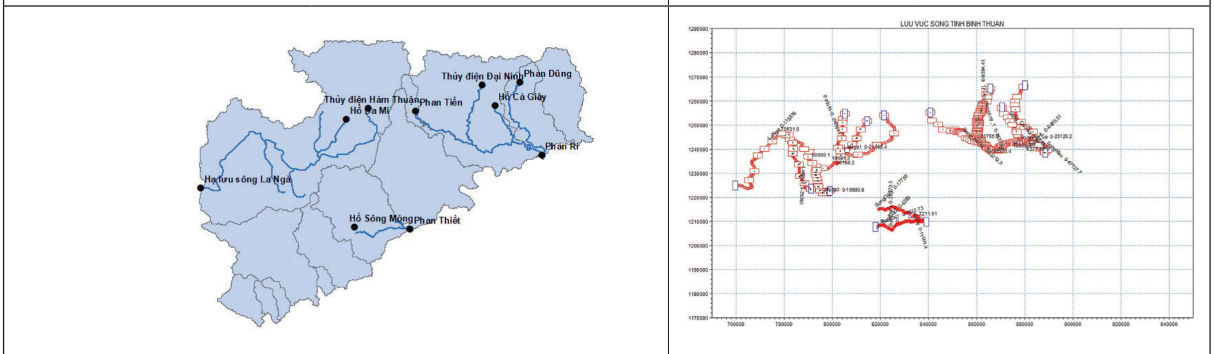
Figure 7. Hydraulic diagram of river basins of provinces in the South Central region



Hydraulic diagram of river basins in Khanh Hoa



Hydraulic diagram of river basins in Ninh Thuan

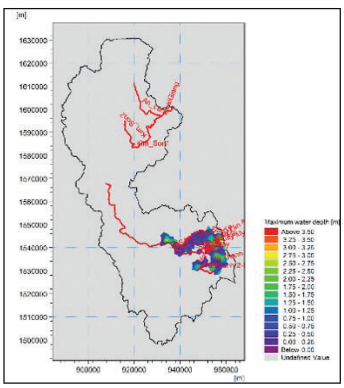


Hydraulic diagram of river basins in Binh Thuan

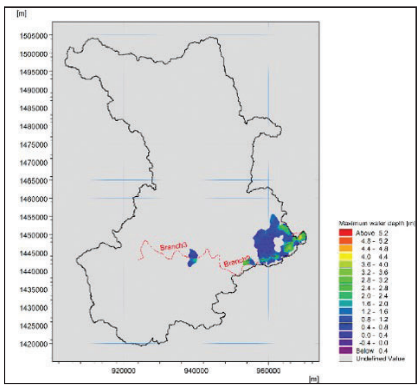
Figure 7. Hydraulic diagram of river basins of provinces in the South Central region

3.3. MIKE FLOOD model

The MIKE FLOOD model was set up to simulate past flood for 10 river basins in 5 provinces belonging to the South Central region. 1-D hydraulic model, MIKE 11 RR + HD model are shown above and digitized terrain (DEM) are digitized to put into 2-D model (MIKE 21 FM). When setting up a 2-D model, it is necessary to set up the topographic terrain, which is the basis for simulating the direction of flow movements as well as the hydraulic interactions in the whole system. Results of interpolated topography and MIKE FLOOD modeling for 10 river basins of South Central region will be presented following Figure 8.

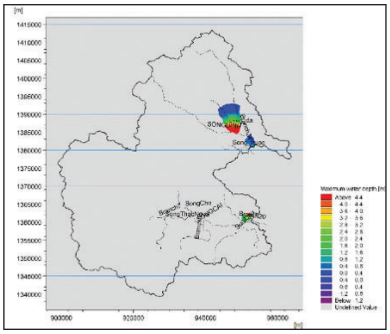


a) Binh Dinh

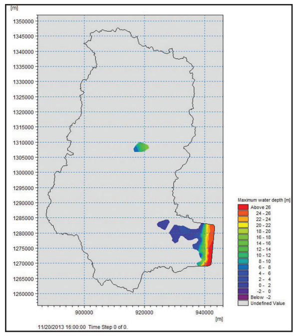


b) Phu Yen

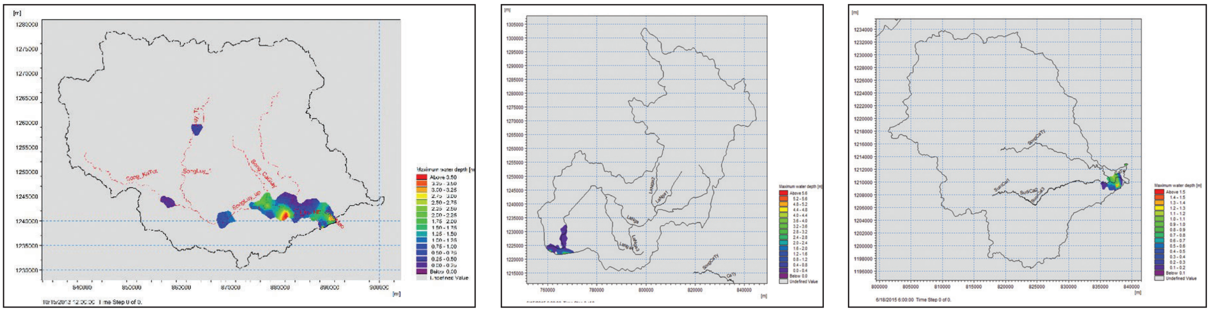
Figure 8. Results of simulation of flooding of South Central region



c) Khanh Hoa



d) Ninh Thuan



e) Binh Thuan

Figure 8. Results of simulation of flooding of South Central region

Accreditation of flooding model

Table 3. Results of flood water level simulation at the flood spot investigation locations in the Kon River basin, Binh Dinh province in 2007

Numberical order	Flood spot comparison location	Longitude	Latitude	Z Flood marks 2007 (m)	Z max (m)	ΔZ (m)
1	Song Kon	109°00'30	13°54'26	15.826	16.881	1.055
2	Song Kon	109°02'00	13°54'76	14.543	16.253	1.71
3	Dap Da	109°02'04	13°54'60	14.523	15.23	0.707
4	Dap Da	109°05'59	13°55'16	13.686	14.058	0.3686
5	Song Kon	109°05'49	13°54'98	14.052	14.114	0.062
6	Dap Da	109°09'08	13°57'17	7.189	8.563	1.374
7	Song Kon	109°06'40	13°54'05	10.891	11.542	0.651
8	Song Kon	109°07'07	13°54'30	9.101	10.21	1.109
9	Dap Da	109°06'46	13°52'82	10.297	10.377	0.08
10	Song Say	109°08'25	13°52'41	8.043	9.34	1.297

Table 4. Results of flood water level simulation at the flood spot investigation locations in the Cai River basin, Nha Trang province in 2009

Numberical order	Flood spot comparison location	Longitude	Latitude	Z Flood marks 2007 (m)	Z max (m)	ΔZ (m)
1	Suoi Cai	109°8'13	12°16'29	4.66	5.078	0.418
2	Suoi Cai	109°8'22	12°16'38	4.77	5.078	0.308
3	Suoi Cai	109°10'48	12°15'55	1.93	0.734	1.196

Numberical order	Flood spot comparison location	Longitude	Latitude	Z Flood marks 2007 (m)	Z max (m)	ΔZ (m)
4	Suoi Cai	109°11'4	12°15'56	1.74	0.734	1.006
5	Suoi Cai	109°6'8	12°16'3	6.39	6.041	0.349
6	Suoi Cai	109°6'19	12°16'18	6.14	5.135	1.005
7	Suoi Cai	109°5'25	12°16'44	5.73	5.135	0.595
8	Suoi Cai	109°5'59	12°16'15	6.86	6.783	0.077
9	Suoi Cai	109°1'33	12°15'33	10.43	9.798	0.632
10	Branch7	108°59'43	12°17'37	14.03	13.54	0.49

Table 5. Results of flood water level simulation at the flood spot investigation locations in the Dinh River basin, Ninh Thuan province in 2016

Numberical order	Flood spot comparison location	Longitude	Latitude	Z Flood marks 2007 (m)	Z max (m)	ΔZ (m)
1	Song Dinh	108°58'34	11°34'01	6.941	6.463	0.478
2	Song Dinh	108°58'32	11°34'01	6.963	6.463	0.5
3	Song Dinh	108°59'03	11°34'12	6.688	5.463	1.225
4	Song Dinh	108°58'57	11°34'18	7.127	6.463	0.664
5	Song Dinh	108°59'48	11°32'31	4.521	4.65	0.129
6	Song Dinh	108°59'50	11°32'34	4.876	4	0.876
7	Song Dinh	109°01'37	11°32'43	2.336	2.544	0.208
8	Song Dinh	109°01'37	11°32'44	2.370	2.544	0.174
9	Suoi Gia	108°55'05	11°29'45	17.490	16.077	1.413

3.3. Assessment the flood forecasting model

3.3.1. Results of the process of observed and predicted water level

Result of the test forecast with expected time (Tdk = 12h) is presented in the graph of comparing the measured and forecast water level at hydrological stations shown in Figure 11.

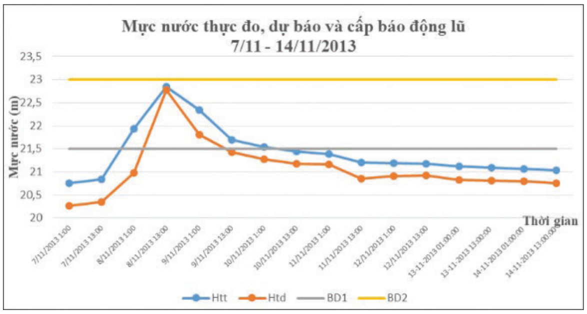
3.3.2. Results of quality forecast assessment

From the results of each prediction for the plan with forecast rainfall data from the weather model, we can give a general assessment for the stations as follows (Table 2). Assessment of flood prediction’s capacity of the model corresponds to flood alert at stations according to National Standards in Table 3.

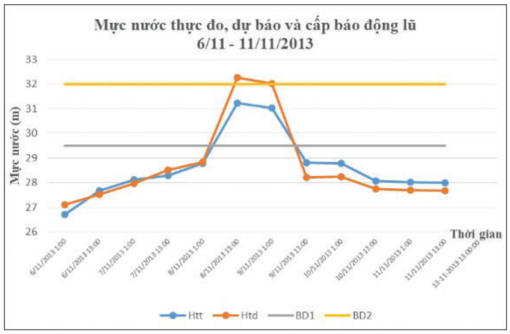
Basing on the overall evaluation of forecast results at Binh Tuong, Cung Son, Dong Trang, Tan My and Song Luy stations, the total number of correct forecasts are P = 93.33%, 90.91%, 93.33%, 54.54% and 71.43% respectively. The level of forecast quality from time to time has errors following to the extent possible.

At Binh Tuong, Cung Son and Dong Trang stations, flood peak values as well as flood alarm levels at the evaluation locations provide reliable results. At Tan My station, at the time of peak floods appeared exceeding alarm level I and II, these data values were accurately calibrated,... At Song Luy station, although the water level fluctuations limited in the flood and ebb trend, the water-level’s phase both prediction and observation had similar. So, we regconized that it is suitable for flood alarm. At the time of flood peak appear exceeding alarms level II, these two datasets are calibrated accurately. Therefore, the reliability of the weather model needs to be revised to increase the level of flood simulation most accurate in flood forecasting for the Luy River basin in

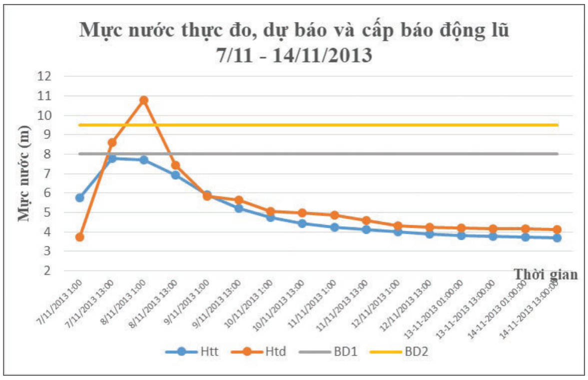
Binh Thuan province. Therefore, the reliability of the weather model needed to be revised to increase the most accurate flood simulation level in predicting for Dinh River in Ninh Thuan province and Luy River in Binh Thuan province.



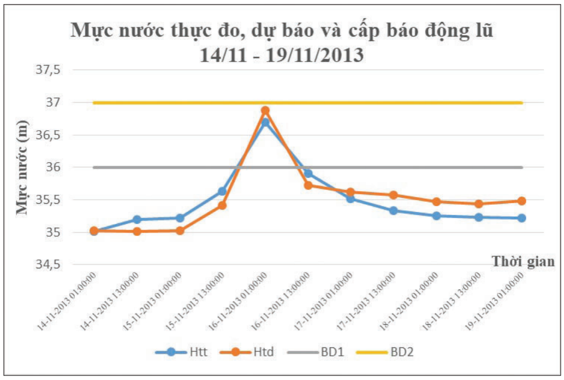
Binh Tuong station



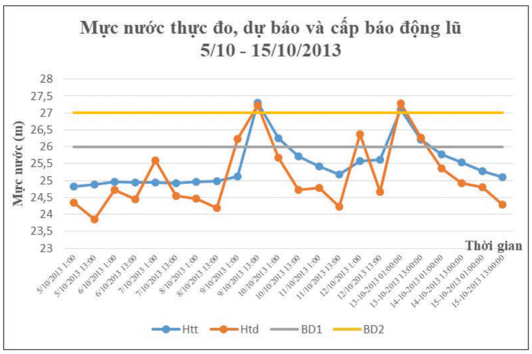
Cung Son station



Dong Trang station



Tan My station



Luy River station

Figure 9. Comparing of measured and predicted water level at the hydrological stations

Table 6. Assessing the quality of flood forecasting models

Assessment (%)	Stations				
	Binh Tuong	**Cung Son**	**Đong Trang**	**Tan My**	**Song Luy**
Excellent	1	4	2	1	5
Good	10	5	4	0	1
Mediate	3	1	8	5	9
Poor	1	1	1	5	6
P%	***93.33***	***90.91***	***93.33***	***54.54***	***71.43***

Table 7. Water level at stations correspond flood alarm levels
(according to QĐ 46/2014/QĐ-TTg)

Stations	Alarm level I	Alarm level II	Alarm level III
	m	m	M
Binh Tuong	21.5	23	24.5
Cung Son	29.5	32	34.5
Dong Trang	8	9.5	11
Tan My	36	37	38
Luy	26	27	28

3.3.3. Assessing the quality of general forecast in the South Central region

Result of the test forecast with flood event (Nov, 2013) in expected time Tdk = 12h basing on permissible errors according to Circular No. 722 (Table 4).

The results of the trial forecasts show that the use of the parameters of the past floods (in Nov, 2013) has a guaranteed level of over 50% for whole river basins with an expected time of 12 hours at qualified level. Flood prediction in locations with each prediction gives good results, consistent with the observed data. The time of occurrence of flood peaks is within the errors and the difference is small. The error depends on many objective factors, so it will need better calibration-test when additional automatic measurement stations are updated. This thing aims to calculate the flow generated from the precipitation over the basin, and then results will take higher accuracy.

Table 8. Assessment the number of accurate forecast
(according to Circular No. 722)

Provinces	Stations	Number of prediction	Number of accurate prediction	Guaranteed levels (%)	Assessment
Binh Dinh	Binh Tuong	16	14	87.5	Qualified
Phu Yen	Cung Son	11	10	90.91	Qualified
Khanh Hoa	Dong Trang	15	14	93.33	Qualified
Ninh Thuan	Tan My	11	6	54.54	Qualified
Binh Thuan	Luy River	21	15	71.43	Qualified

Table 9. Assessment the errors of forecast time of flood peaks's occurrence

Provinces	Stations	Hmax td (m)	H max db (m)	$\vert\Delta H\vert$ (m)	$\vert\Delta t\vert$ (hrs)	Difference error
Binh Dinh	Binh Tuong	22.77	22.854	0.084	1	Under the allowed tolerance, qualify
Phu Yen	Cung Son	32.28	31.232	1.048	4	Under the allowed tolerance, qualify
Khanh Hoa	Dong Trang	11.2	9.52	1.68	4	Difference 0.9m
Ninh Thuan	Tan My	38.37	37.364	1.006	3	Difference about 0.13m
Bình Thuan	Luy River	27.293	27.22	0.087	1	Under the allowed tolerance, qualify

3.4. Model management tool and WEBGIS map

WebGIS system uses statistical methods, analyzing to determine the necessary information for the flood forecasting database; collect and process information to construct map layers with both spatial and attribute information; WebGIS programming provides information on flood forecasts. Specifically, the research and implementation process is conducted as follows:

The process of implementing WebGIS system includes the following main steps:

- Step 1: Collect data and information related to the basemap of 5 provinces in the South Central region: administrative data, river network, traffic layer, residential area, self-measuring monitoring stations dynamic data,...

- Step 2: Editing spatial and attribute data.

- Step 3: Analyze the system and build the Database model.

- Step 4: Set up interfaces for WebGIS website and build functions for users and managers including accessing, searching information and updating data.

- Step 5: Build WebGIS website, conduct test functions. Finally, WebGIS products support management of professional flood forecasting and warning.

The process of updating information to WebGIS:

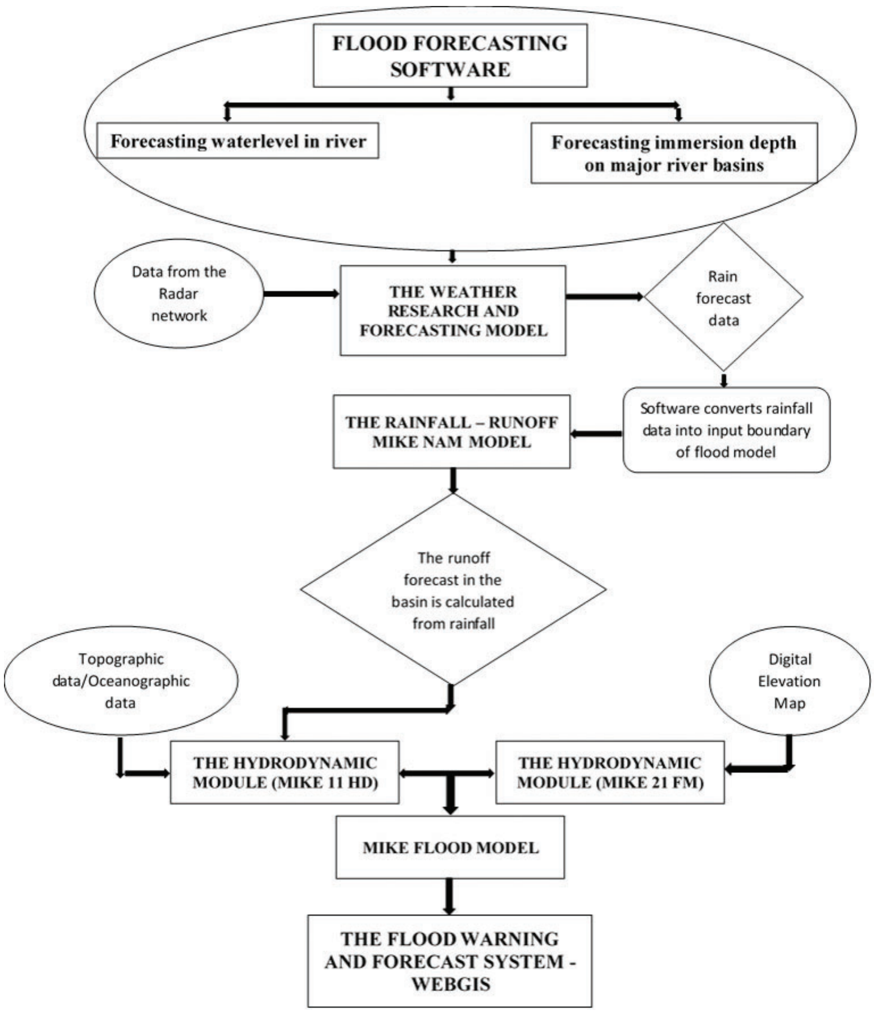


Figure 10. The forecast update process on WebGIS

Data from flood modeling results managed by WebGIS:

- The forecast rainfall data at the rain measurement stations in the main river basins of the 5 South Central provinces includes the following information: rain gauge station, rainfall represented under the column graph, time of appearance.

- Data of forecast water level at alarm stations and positions to display water level information is represented in the form of a line graph, including information: station name, station location, statistics and time forecast.

- Results from the flooding model are handled by WebGIS, converted into flood maps with information about the flooding layer such as: depth of inundation, level of alarm level corresponding to the possibility of flooding. on the basin.

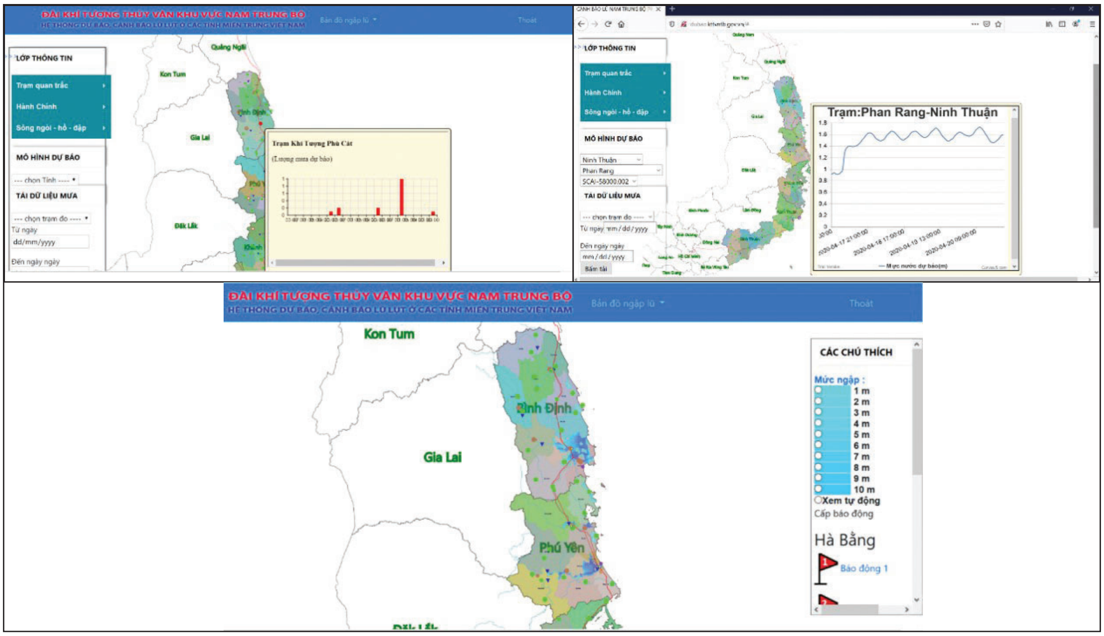


Figure 11. WebGIS data management tool

4. Conclusions

Main reason cause inundating this area is heavy rains and the topography characteristics in the South Central provinces. Low mountains and coastal plains accompanied by the topography of the river basin with high slope resulting, the floods often occur more unpredictable under weather condition changes. A set of flood models (rainfall-runoff model + hydraulic model + flood model) was built to serve the management as well as professional predicting in the future. Process of calibration- test of rainfall - runoff model has errors due to using only data from the presented rain gauge stations applied in a large area. A dataset of parameters for the model has been built with Nash coefficients and R^2 achieving reliability. Simulated results of calculated and observed flood catching up the flooding trend accurately, especially the time of flood peak occurrence. Difference from calculated water level of flood drainage locations and actual flood trace survey locations is not too significant. Thus, the condition of the parameters as well as the quality of the FLOOD model is reliable for applying in the future professional work.

WebGIS technology is popular day by day, applied in many different ways. It is convenient for users who do view attribute and spatial online information layers without installing GIS software. Interact data without requiring processing any specialized data. It is also easy manipulation. WebGIS supports the integration of flood predicted models, displaying and updating rainfall data, calculated water level values and managing maps, which is an effective solution to convey information on flood levels, inundated levels. The results are published on the WEBGIS flood warning system. Results of early flood warning have helped departments and agencies make timely decisions in disaster prevention.

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