Research Article **AJGRR (2020) 3:17**

American Journal of Geographical Research and Reviews (ISSN:2577-4433)

A Preliminary Study on Constructing the Bed Sounding Data from DEM

Wang Yan

College of Ocean Science and Engineering, Shanghai Maritime University, Shanghai 201306, China.

ABSTRACT

Accurate riverbed information, including riverbed shape, sounding data and elevation data, is needed to simulate the process of flooding in flooded areas by using two-dimensional hydrodynamic model. DEM data is an important feature reflecting topographic changes and plays an important role in hydrological model analysis.However, in the plain area where DEM elevation changes are very small, the extraction and simulation of river network are of low accuracy in the process of hydrologic analysis, and there are great errors in watershed division. Taking the Mihe river basin, shouguang city, shandong province as the research object, based on WMS to abnormal proofreading is smoothing the center line of the river, get in line with the physical meaning of vector river network, the inversion to the original elevation data (DEM), and on this basis, with the river elevation information center line interpolation, construct a sounding data of river model, provide technical support for the two-dimensional hydrodynamic model.

Keywords: River center line; DEM; Riverbed construction; WMS; Mihe river basin; Abnormal point correction

***Correspondence to Author:**
Wang Yan
College of Ocean Science and Engineering, Shanghai Maritime University, Shanghai 201306, China.

How to cite this article:
Wang Yan. A Preliminary Study on Constructing the Bed Sounding Data from DEM. American Journal of Geographical Research and Reviews, 2020; 3:17

eSciPub LLC, Houston, TX USA.
Website: https://escipub.com/

1. Introduction

From "flood control" to "flood risk management" (2002)[1] is an inevitable requirement of the development of flood control and disaster reduction situation at home and abroad (2009)[2]. Establishing hydrodynamic model for flood management area, simulating the whole process of flood evolution and obtaining flood risk information such as submergence depth, flood velocity, submergence duration and arrival time, has become an essential part of non-engineering measures for flood control and disaster reduction. In the absence of measured sectional data, the original DEM was modified to obtain accurate river network information and the riverbed model was constructed as the basis for hydrodynamic simulation.

With the development of computer technology and spatial information, remote sensing and geographic information system (GIS) have become effective geospatial tools for assessment. Since 1990s, scholars at home and abroad have well combined GIS with flood process simulation. Tith (1999)[3] used hec-ras and GIS to study the flood plain determination in Austin, USA, and found that the combination of these two geometric simulation techniques has a strong ability. Taking Ma 'abar Town as the research object, dama university (2012)[4] used remote sensing and GIS to draw the flood map of the Town and its surrounding areas. Using ArcGIS 10.2 software, Rahmati (2016)[5] used weighted linear combination method to synthesize the criterion set and generate flood disaster prediction map.

In China, Xiang Suyu[6] combined DTM data with hydrological data to simulate the spreading process of flood in geographical space and determined the inundation range. On the basis of digital elevation model (DEM), Ge Xiaoping[7] simulated the inundation range of the lower reaches of fenghua river basin with the method of zonal plane simulation. Among them, the difference value of irregular triangulation network was adopted for discrete elevation points and contour lines in the digital elevation model. Ding Zhixiong[8] established triangular grid model and arbitrary polygon grid respectively for DEM in the study area by using remote sensing and GIS technology, and simulated flood inundation range and water depth distribution under certain flood water level and flow rate. In recent years, Jiangling[9] repaired the distortion problem by feature embedded DEM (f-dem) digital terrain modeling technology. Then, based on the monitoring data of flood level, the Kriging interpolation model was used to construct the flooded surface. Wang Xiaojun[10] introduced in detail the application of Arc Hydro Tools to extract water system from raster DEM and simulate the inundation range by seed spreading algorithm, but no methods and measures were proposed for DEM restoration.

The mechanism of water inundation is that the water source and the flooded area have channels and the difference of water level. Flood inundation is a dynamic process, which is affected by many factors, among which flood characteristics and landform in flooded area are the main factors. DEM can well reflect the change of elevation. River network extracted based on DEM is an indispensable data for hydrologic and hydrodynamic simulation analysis, and the technology is becoming increasingly mature[11-12]. Therefore, DEM[13-14] is modified according to the measured topographic data, and riverbed construction is crucial for flood process simulation in flooded areas. Based on the "river basin as the research object, according to the map world drainage figure revised original DEM extraction of river network, and the smoothing with the WMS, use Arcgis will handle good river into grid embedded into the original DEM, finally using the map world in riverbed shape to TIN, difference of the center line of the river, with river plate information of DEM data, to facilitate the process of flood routing simulation, to provide important for flood control plan and the relevant system.

2. Problems solved

Theoretically, the position of the center line must be the position of the riverbed, so the vector river network must be accurate, so we need to test the vector river network. However, the currently available Shared data cannot meet this requirement, while the water system map is available. We can check and correct the extracted river network through the actual water system map. An important function of Arc Hydro tool abroad is to use known dem grids to burn a vector river network, which is also a rough repair, but limited to an artificially set depth without smoothing.

If the flood simulation is carried out, the construction of riverbed and the extraction of sounding data are required. Currently, due to the limitation of 30mdem, the information of riverbed is not perfect, and the relevant sounding data cannot be extracted. Therefore, we should not only carry out line restoration, but also carry out surface restoration to meet the needs of flood research.

3. Study area and data source

Mihe river is located in the southwest of Laizhou bay, originated from the northern foot of Qinyi mountain, mainly composed of more than 150 rivers, such as Shihe river, Dan river and shigou river. After three counties (cities) of Linqu, Qingzhou and Shouguang, the main branch flows to the northeast and joins the Danhe river to enter the sea at Yangzigang, hanting district, Weifang city. The other two branches all flow into the sea to the north. Mi river is 206 kilometers long with a drainage area of 3847.5 square kilometers. With the formation of the alluvial diluvial fan of mi river, mi river has changed its course for many times [15], with a large slope in the upper reaches and a slow slope in the middle and lower reaches into the alluvial plain. Due to the process of the valley is different, resulting in a wide gap in the river body width, the widest 750 meters, the narrowest place is only 25 meters, affected by the atmospheric precipitation space-time, the river flow seasonal changes are large, the flood season maximum flow 4950 cubic meters/second, the minimum flow in the dry season 0.32 cubic meters/second.

The underlying data source in the study area are: SRTM (Shuttle Radar Topography Mission) data is mainly by the us space agency (NASA) and the department of defense the state bureau of surveying and mapping (NIMA) joint measurement of[16], including access to 60 degrees north latitude to 56 degrees south latitude between, covering more than 80% of the world's land surface precision of 30 m and 90 m digital elevation model. DEM data of mi river basin were obtained by GIS data import, projection conversion and edge cutting. See figure 1 on the left.

"Tianditu" is a comprehensive geographic information service website built by the national administration of surveying, mapping and geographic information. It is the public version of the national geographic information public service platform, which is presented in three modes: vector, image and three-dimensional. See figure 1 on the right.

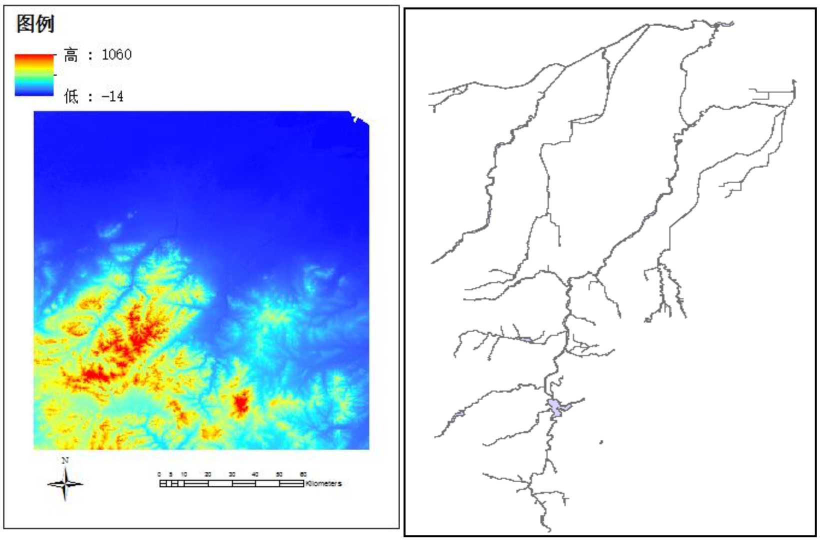

Fig.1 Data Map of Mihe River Basin

4. River network extraction and result analysis

At present, there are many methods and Tools for River network extraction, such as ArcGIS hydrological module[17], ArcSWAT[18], River Tools[19],Arc Hydro Tool[20], etc. Among them, Arc Hydro Tools develops hydrologic data model based on Geo Database data format, embedded in ArcGIS software[21], and inbuilt a rich auxiliary extraction method of watershed features. This method will be used to extract the river network. It is a common method to extract a vector river network by burning a known DEM grid. Stream burning method is based on the transformation of representative vector river network into a raster river network and the fusion with DEM data to improve the accuracy of the location of the virtual river network[22]. Below the step diagram:

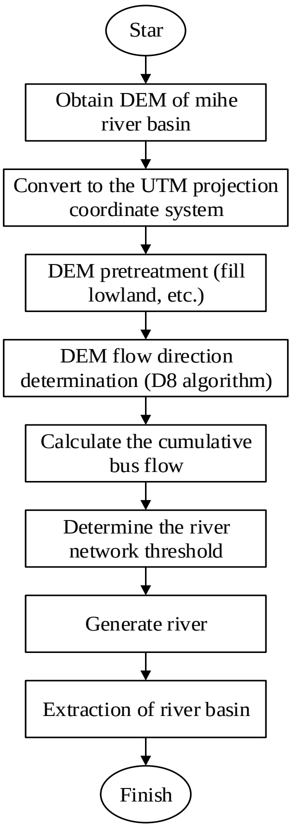

Fig.2 River Network Extraction Flow Chart

Virtual river through the original DEM extraction compared with map world water system in the actual networks can be found that position is difficult to coincide with actual river plains rivers and there will be a virtual parallel[23] obviously, in some of the steep mountain river discontinuous easily, can't divide the correct basin range, more cannot get correct flow path and other terrain parameters in the basin, it is for the hydrological and hydrodynamic simulation to build a lot of obstacles.

The blue part in FIG. 3 is the comparison between the center line of the river network extracted from the original DEM and the Tianditu.

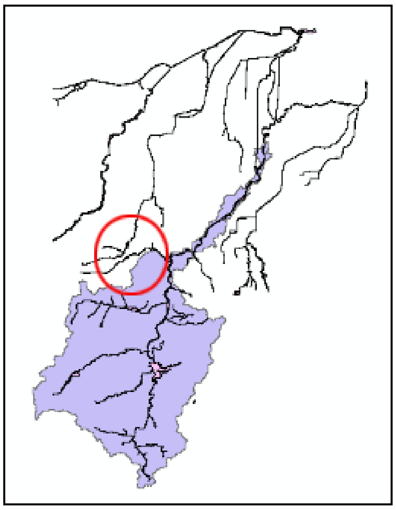

Fig.3 Extract the comparison map of river network and Tianditu

5. Technical route

Get the mihe river system map from the map of heaven and earth, and edit the map from the opposite side in the ArcMap to ensure that the surface is continuous. The flow direction was then determined in WMS and smoothed. Furthermore, neighborhood difference value is calculated according to the elevation of the center line of the river network. ERDAS program is used to carry out 3*3 mesh interpolation on the river channel surface according to the elevation of the center line of the river network and the actual measurement data, and the value outside the riverbed area is assigned to zero. The riverbed data with elevation information is obtained repeatedly and becomes a grid data Mosaic. The technical route is shown in figure 4.

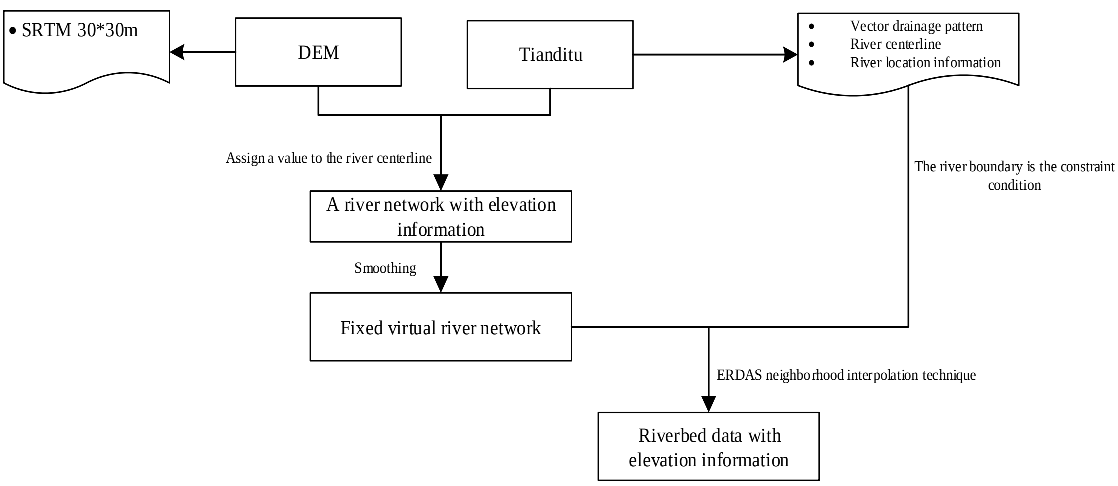

Fig.2 Revise DEM Technology Roadmap

6. DEM abnormal point correction technique

With the development of hydrodynamics, DEM repair methods are becoming more and more mature. Based on the map of heaven and earth, the paper superimposes the location information of the natural water system on the basis of DEM as the constraint condition for the extraction of watershed features[24-25]. The location information of natural river system is completed by electronic map rasterization, which forms the standardized river channel information. Scalar channel vectorization refers to the determination of the flow direction of the grid on the river network according to the continuous position information and DEM information. The scalar river course is used as another information source for the extraction of watershed features, that is, the river system layer of a large number of electronic maps is used as additional information of DEM to control the river position of the extracted digital river system, so as to extract the watershed feature information matching with the natural river system. The obtained water system map is edited on the opposite side in ArcGIS to ensure that the surface is continuous and the river center line is extracted. Find the grid of rivers in DEM data. In gis, a river is generally represented as a set of interconnected line segments, while DEM data is represented as a number of square grids. Rivers passing through a DEM grid need to satisfy that the river line segment is within this grid. Or the river line segment intersects with the edge of the grid to obtain the corresponding elevation information, and the obtained actual river centerline is given elevation information in the DEM grid.

Flow direction is one of the most important information in watershed hydrological model. Because the calculation of catchment area at each point in the basin and the extraction of the river network are based on the flow direction, the accuracy of the flow direction determination directly affects the simulation accuracy of the hydrological model of the basin. The direction of water flow is determined by the deep and grand evolution method, that is, the direction of the main channel and the grid on the channel is determined by the track of the lowest point of the rasterized channel.

According to the principle that the upstream elevation is greater than the downstream elevation, the smoothing process is carried out (Fig.5). The river course generally shows a downward trend, but there are some places where the riverbed slope is unfavorable, most of the inverse slope is the result of elevation data error. You don't want to include unnatural inverse slopes in your model, and you can mitigate this problem by making small changes to the heights of the vertices and nodes on the segment. If upwelling cannot be eliminated in this way, smoothing can be done by editing a point on the plot or by editing the elevation value of the flow. Take special care to ensure that the node next to the exit does not have the opposite situation. If the selected flow segment is smooth, a new flow segment is selected to be smoothen with an unfavorable slope or combination. The smoothing process is repeated until there is no flow segment with the opposite slope. By smoothing all the flow segments, the inverse slope of the convection is corrected and the next step is taken. The processed river network with elevation information was transformed into a grid and embedded into the original DEM data to obtain new DEM elevation data.

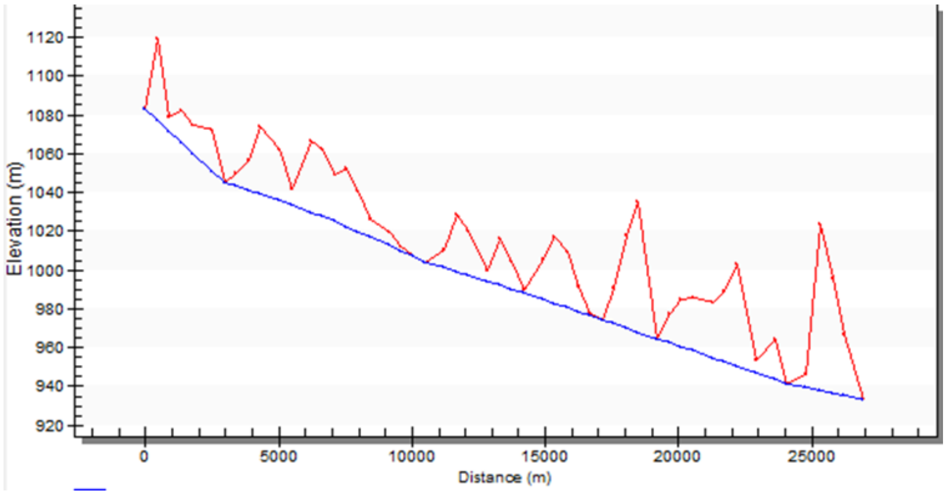

Fig.5 A bridge smoothness

7. TIN bed interpolation technique

Surface modeling and interpolation are the core issues of DEM, which run through the core of hydrologic analysis. Currently, there are many kinds of DEM modeling techniques[26], the most common are regular GRID[27] and irregular triangulation network (TIN) modeling methods. The shape and size of the triangular mesh depend on the density and location of the irregularly distributed sampling points.

In this paper, the riverbed shape in the water system map is taken as the boundary, neighborhood difference value is carried out according to the elevation of the center line of the river network. According to the elevation of the center line of the river network and the actual measurement data, the channel surface is interpolated with a 3*3 grid, and the value outside the riverbed area is assigned to zero.

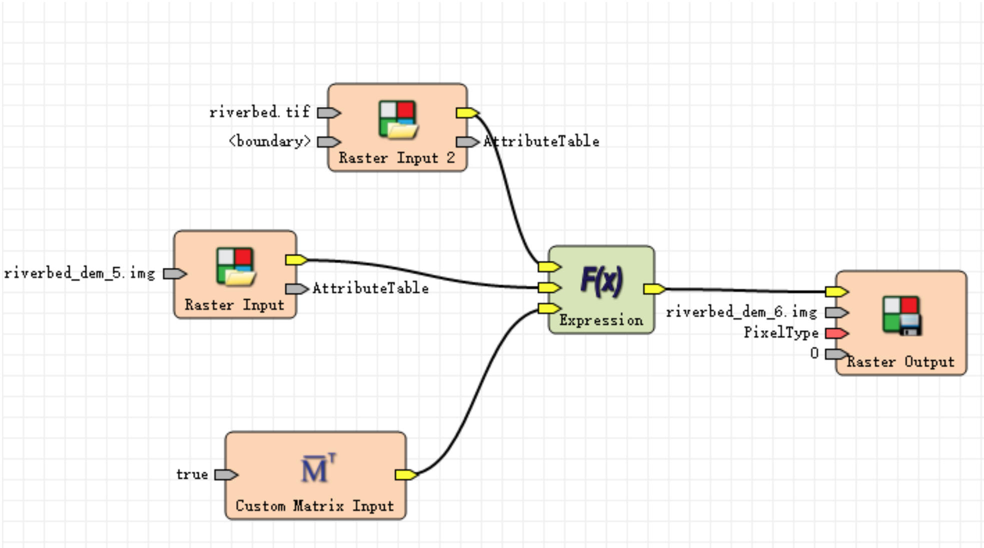

FIG. 6 ERDAS interpolation flow chart

8. Conclusion

After establishing a riverbed model with sounding data, it can be considered to use it in combination with water quality model or meteorological model, such as SMS and other hydrological software, to establish flood area simulation and simulate the process of flood inundation. The simulation results can show the maximum submerged water depth and runoff velocity during the flood process, etc. Based on the simulation data, the flood control and disaster prevention methods in the flood prone areas can be further studied.

References

1. The ISDR (International Strategy of Disaster Reduction) Secretariat. Living with Risk, A global review of disaster reduction initiatives, Preliminary version[R]. Geneva, July2002.
2. Mao Dehua,He Xinlin He Xinguang,et al.Review and prospect of research on flood risk analysis at home and abroad (Ⅰ) :status quo of research on risk analysis of flood hazard[J].Journal of Natural Disasters,2009,18(1):1-2.
3. Tith MA. Floodplain determination using HEC-RAS and geographic information system. Austin (TX): Taylor & Francis, Taylor & Francis.1999.
4. Ghanim, A.A.J. Simulation of flood inundation of a low lying area of Ma'abar town in Yemen using remote sensing and GIS[J]. Journal of Engineering and Applied Science, v 59, n 3, p 247-264, June 2012; ISSN: 11101903
5. Rahmati, Omid,Zeinivand, Hossein,Besharat, Mosa. Flood hazard zoning in Yasooj region, Iran, using GIS and multi-criteria decision analysis. Geomatics, Natural Hazards and Risk, v 7, n 3, p 1000-1017, May 3, 2016; ISSN: 19475705, E-ISSN: 19475713; DOI:10.1080/19475705.2015.1045043
6. Xinag Suyu, Chen Jun, Wei Wenqiu. Urban Flood Submerging Simulation Analysis Based on Gis[J]. EARTH SCIENCE,1995, 20(5), 575-580.
7. Ge Xiaoping, Xu Youpeng, Zhang Qi, Zhang Lifeng. A method for flood submerged area simulation based on GIS[J]. Advances In Water Science,2002,13(4),456-460. DOI:10.14042/j.cnki.32.1309.2002.04.011.
8. Ding Zhixiong,Li Jiren,Li Lin.Method for flood submergence analysis based on GIS grid model[J]. Journal of Hydraulic Engieering 2004,6(6), 56-67. DOI:10.13243/j.cnki.slxb.2004.06.010.
9. Jiang Ling, Tang Guoan, Wang Chun,et al. Fast and Accurate Data Extraction of Flood Submerged Area Based on F-DEM[J].Journal of Geo-Information Science,2013,15(1),68-73. DOI: 10.3724/SP.J.1047.2013.00068.
10. Wang Xianjun, Liu Guangxu.Watershed Extraction and Flood Inundation Simulation of Hilly Area in South China:Taking the Upstream of Gan River for Example[J]. China Rural Water and Hydropower,2017,5,161-169. DOI:1007-2284(2017) 05-0161-05.
11. Zhang Min,Liu Qingsheng,Liu Gaohuan. Extraction method and application analysis of river network based on digital elevation model[J]. Jiangsu Agricultural Sciences, 2011,39(2), 5-9. DOI:10.15889/j.issn.1002-1302.2011.02.012
12. Zhao Yuanyang,Ding Yongsheng,Sun Dan,et al. Watershed hydrology analysis based on Arcpy programming modified DEM[J]. Journal of Dalian Maritime Univ. 2016,42(04):55-60.
13. Wang Jianhu, Hao Zhenchun, Li Li. Extraction of drainage structure from digital elevation model by combination with raster river network[J]. Journal of Hehai University (Natural Sciences),2005,33(2):119-122.
14. Yang Song, Wang Shangdong, Zhuo Zhongwen,et al. Research on Extraction of Watershed River Network Based on DEM Enhanced by Digital River System[J]. Journal of Water Resources and Architectural Engineering,2013,11(2),123-126.
15. Meng Qinghai, Han Mei, Zhao Minghua,et al. A PRELIMINARY STUDY OF THE MIHE RIVER ALLUVIAL DILUVIAL FAN AND THE PALAEOCHANNELS[J]. JOURNAL OF SHANDONG NORMAL UNIVERSITY (NATURAL SCIENCE), 1999,14(1),46-50
16. NASA[OL].http://www2.jpl.masa,gov/srtm/
17. Zhao Jian,Jia Zhonghua,Luo Zhi.Extracted catchment properties from DEM using ARCGIS [J]. Journal of Water Resources and Water En-

gineering,2006,17(1):74--76.

18. Wang Li,Li Haiqiang,Ma Fang,et al. Extraction Method of Basin Drainage Network Based on SWAT Model[J]. China Water & Wastewater, 2014,30(13),92-95.
19. Research System Inc. Rivertools user's guide ［EB /OL].[2009--04 --06]. http: / /www.rivertools. com / .
20. Kang Jun,Sun Jia,Chen Bingyan. Automated Extraction of Watershed Characteristics Based on Archydro Tools:A Case Study of Fujiang Wa[J]. Journal of Southwest China Normal University(Natural Science Edition),2017,42(6), 83-86. DOI:10.13718/j.cnki.xsxb.2017.06.015.
21. FORMETTA G，ANTONELLO A，FRANCESCHI S，et al．Hydrological modelling with components: A GIS-based open-source framework[J]. Environmental Modelling＆Software,2014,55:190－200．
22. Maidment D.GIS and Hydrological modeling:an assessment of progress. In:Third International Conference on GIS and Environmental Modeling[J]. Santa Fe,NM,1996:20-25
23. Chen Jiabing,Li Huiguo, ZHeng Daxian,et al. A Study on the Classification of Watersheds in Fujian Province Based on DEM[J]. Geo-Information Science, 2007.9(2) :97-77.
24. Turcotte R,Fortin J P,Rousseau A N. Determination of the drainage structure of a watershed using a digital elevation model and a digital river and lake network[J]. Journal of Hydrology,2001.240:225-242.
25. Huili Chen, Qiuhua Liang, Yong Liu, Shuguang Xie. Hydraulic correction method (HCM) to enhance the efficiency of SRTM DEM in flood modeling[J]. Journal of Hydrology, 2018, 5(556): 56-70.
26. Song Xiangyang,Wu Faqi. Research of Soil and Water Conservation. Research of Soil and Water Conservation,2010,17(5),45-50.
27. He Xiaohui,Chen Nan. Stream Network Extraction Based on Digital Elevation Model Data of Regular Grids[J]. Remote Sensing Information, 2015,30(1), 134-138.