ASTER DATA IN MONITORING FLOOD APPLICATION

Case study: The Kon – Ha Thanh River_Binh Dinh

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ABSTRACT

Flood mapping of Kon – Ha Thanh river, Binh Dinh province plays the very important role for the prevention from loss of life and to reduce damage to sites of high economic development.

This paper introduces how to use ASTER image for monitoring flood at Kon – Ha Thanh river, speciallize in creating watersheds on providing basic information for hydrological modelling, forecasting and flood mapping. Results of the research describe in brief terms flood characteristics of Kon – Ha Thanh river and the capability of the integration of remote sensing and GIS for flood monitoring.

1. INTRODUCTION

Floods have always been a great disaster causing many losses of human beings and properties, especially the downriver region in Kon River and Ha-Thanh River of Binh Dinh province is one of the most frequent flooding areas in VietNam. Therefore, many flood-preventing solutions have been made and the flood hazard prediction map also plays a quite important role to provide the helpful information in preventing and reducing losses caused by floods. However, the accurate and necessary information for flood monitoring is not enough and effective tools for disaster prevention in this area are also insufficient supporting assessment of consequences and damage by post-flood investigations.

Kon - Ha Thanh river project was carried out to research how to use ASTER image for providing useful information for hydrological modelling (VRSAP is one of the models rather familiar to many Vietnamese organizations) to estimate the water levels which flood can cause a threat to human life and economic activity. The advantages of ASTER data (including DEM data) is a source that providing basic information for investigation of relationships between spatial flood characteristic and the measurements of ground hydrometrical stations.

This paper introduces how to use ASTER image for monitoring flood at Kon – Ha Thanh River, specialize in creating watersheds on providing basic information for hydrological modelling, forecasting and flood mapping. At present, the creating input data for models of flood prediction such as VRSAP (VIETNAM) or Runoff block of SWMM (USA) was almost based on contour lines of topography maps. Therefore, we also want to introduce

the method how to use of the RS data in creating basin automatically on software PCI Geomatica (V9.0) to obtain input data with a high and stable accuracy. This research is a necessary and useful step to make a calculating program for defining basin that can replace the manual methods in making the flood hazard prediction map automatically in Vietnam.

2. OVERVIEW OF WATERSHED

Watershed is a geographic space which receives precipitation and restores a part of these precipitations in the form of discharges at a single point (for instance a river).

The main work of this paper is creating watersheds from the remotely sensed data. An initial conditioning to create watershed is must produce three data sets that are of general utility for all subsequent steps. First is Fill Depression, a DEM with depressions filled. Second is Flow Direction for each cell. The others is Flow Accumulation in which each cell receives a value equal to the total number of cells that drain to it.

- ***Filling Depressions:*** To create an adjusted "depressionless" DEM in which the cells with low value (contained in depressions) will be replaced by the lowest value of neighboring cells. In the special case where flow routing is of interest within a depression, the original DEM values would be used rather than the depressionless DEM, and the flow paths within the depression would terminate at the bottom of the depression rather than at the data set edge.
- ***Flow Directions:*** To be the direction water will flow out of the cell. It is encoded to correspond to the orientation of one of the eight cells that surround the cell (x) with the value of the eight cells were encoded as follows:

1	2	3
4	**x**	5
6	7	8

For example, if cell x flows to the left in the matrix, its flow direction will be encoded as a 4.

There are three possible conditions to consider in determining flow direction:

+ Condition 1 occurs when all eight neighboring cells have elevations higher than center cell. The flow direction will be encoded as negative for such a cell, indicating an undefined flow direction. Condition 1 cells are single-cell depressions. They will not be present after the first step of the depression-filling procedure but are included in the flow direction procedure for completeness.

+ Condition 2 is the case where the distance-weighted drop from the center cell is higher for one cell in the neighborhood over all of the other seven and the flow direction is assigned to this cell. Distance weighted drop M_x is calculated by:

$$M_x = \frac{z_x - z_i}{S_{xi}}$$

with z_x : the center cell's value (x)

z_i : the neighbor's value

S_{xi} : distance from the center cell to the neighbor cell, is √2 for a corner cell and 1 for a noncorner cell.

Most cells are condition 2 cells.

+ Condition 3, when two or more cells are equal in having the greatest distance-weighted drop, the flow direction is assigned logically using a table look-up operation. For example, if three adjacent cells along one edge of the neighborhood have equal drops, the center cell is logically chosen and assigned as the flow direction. If two cells on opposite sides have equal drops, one is arbitrarily chosen.

- ***Flow Accumulation***

The third procedure of the conditioning phase makes use of the flow direction data set to create the flow accumulation data set, where each cell is assigned a value equal to the number of cells that flow to it. For example:

7	8	7	7	6
8	8	7	8	7
8	5	8	7	6
8	8	7	8	7
5	5	5	5	5

Fig.1 Flow Direction

0	0	0	0	0
1	0	2	2	0
0	2	7	0	4
0	1	0	14	0
0	2	6	7	24

Fig.2 Flow Accumulation

3. STUDY AREA AND USED DATA

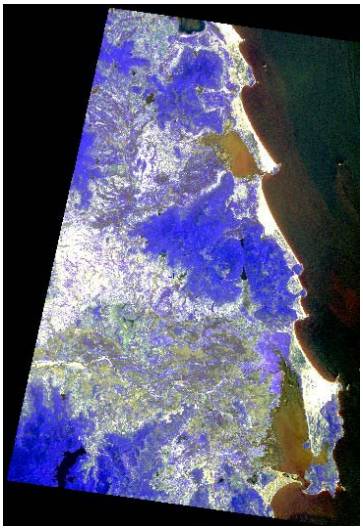

Fig.3 ASTER data

Fig.4 Study area

The Kon and Ha Thanh river basin belongs to Binh Dinh province, has a very complex river-network and topography divided clearly in two parts: mountain area in the upstream and plain area in downstream of river basin. Flood season from May to December, in which period from October to November has highest flood events.

In order to establish the flood hazard prediction map for this area, remote sensing data used is ASTER image that collected in April 2003. This image can provide DEM data level 3A01, band DEMZV, in the WGS84 coordinate system that can be used to create contour lines, basins, elevations, average slopes to provide input parameters for models of flood prediction such as VRSAP (VIETNAM) or Runoff block of SWMM (USA).

GIS data of study area are registered in the coordinate system of Viet Nam (HN72). The objective of this research is to integrate remote sensing data, GIS (Geographic Information System) data and hydrological modelling to auto-establish flooding map, and then use GIS tool to analyze and monitor natural disasters. Therefore, all data must be registered at the same coordinate system as GIS data.

In this paper, we apply the proposed technique to create watershed from ASTER image using the software PCI Geomatica 9. Experimental results show that this technique can replace the manual methods to provide input parameters for models of flood prediction.

4. EXPERIMENTAL RESULTS

The method is used to create basin automatically by using DEM data of ASTER image consisting of four major stages as follows:

- **First stage:** to gain three data sets that mentioned above (Fill Depression, Flow Direction and Flow Accumulation), we use PCI Geomatica software and run the DWCON algorithm on the Focus module of PCI. The taken results:

  Fill Depression Layer (its vision is not different with initial DEM data, but its value is different from DEM value in fact), Flow Direction Layer, Flow Accumulation and Flow Delta

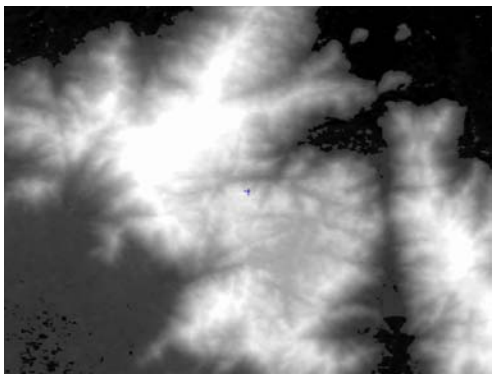

Fig.5 Fill Depression Layer

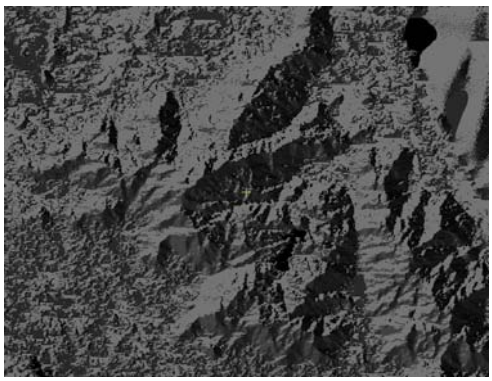

Fig.6 Flow Direction

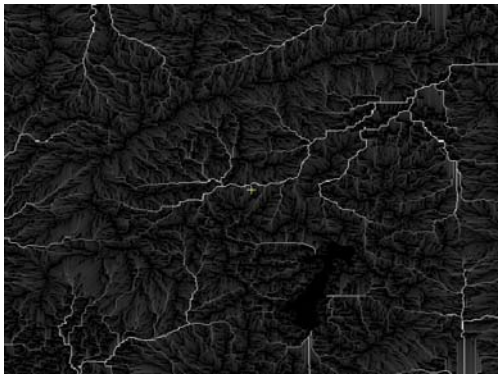

Fig.7 Flow Accumulation

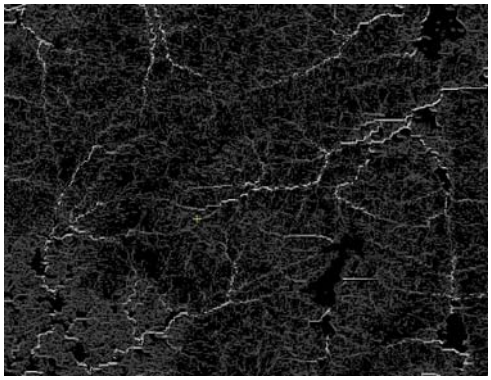

Fig.8 Flow Delta

- **Second stage:** to use the SEED algorithm of the PCI Geomatica software, the input data of this SEED algorithm are two results that received from DWCON algorithm (Flow Accumulation and Flow Delta). For this algorithm, we can create automatically or by inputting a text file with coordinate of points that we want to create watershed.

- **Third stage:** this is the step to create watersheds from results getting from SEED algorithm by using WTRSHED algorithm. However, to strengthen the information provided by satellite data with processing of remote sensing technology, we continue to vectorlize watershed result for overlaying with GIS data.

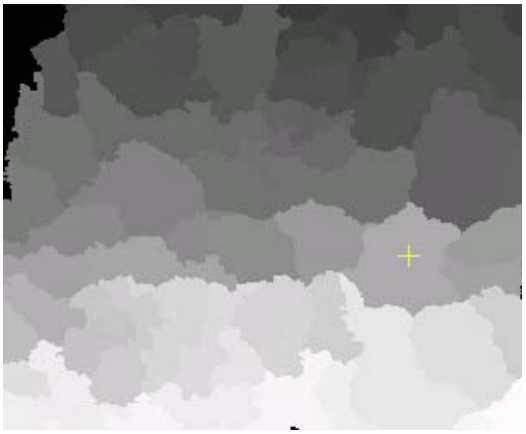

Fig.9 The watershed result

Fig.10 The vectorlized watershed

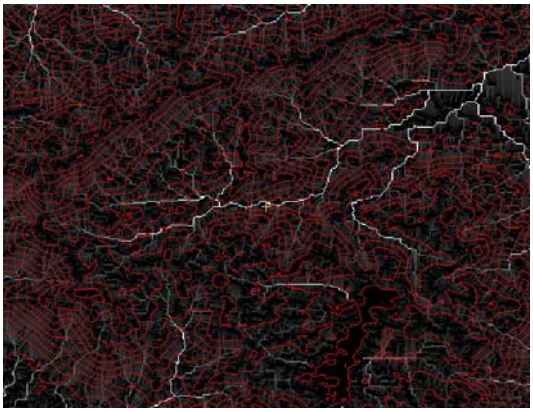

Fig.11 Overlay Flow Accumulation with Contour line

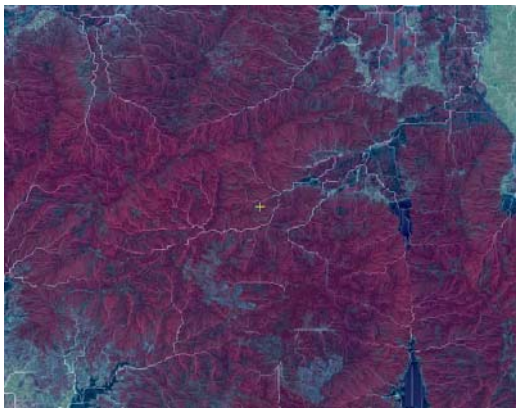

Fig.12 Overlay Flow Accumulation with ASTER image

- **Fourth stage (integrating with GIS):** we carry out to vectorlize the output data for each watershed by using Focus module of PCI software with RTV algorithm. After that, we can overlay these results (vectorlize watershed and flow accumulation) with GIS data.

At this result, we can use GIS function to know perimeter, area of each watershed and provide basic information for hydrological modelling, forecasting and flood mapping. The method allows using of the RS data in creating basin automatically with a high and stable accuracy. It can replace the manual methods in making the flood hazard prediction map automatically in Vietnam.

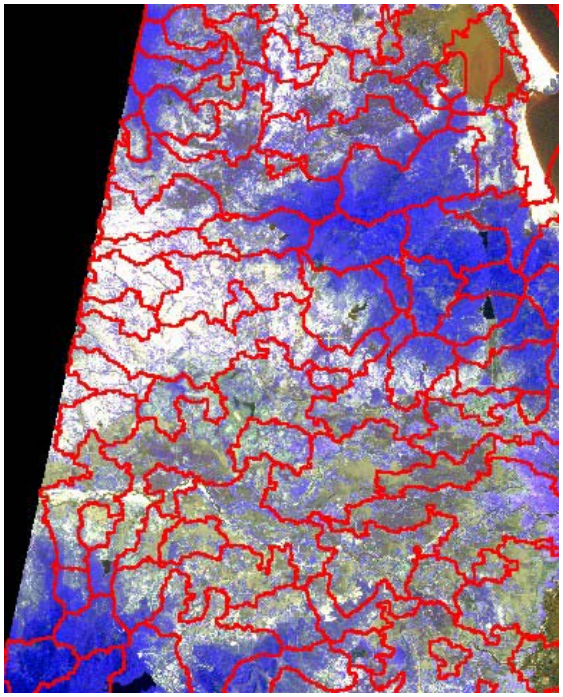

Fig.13 The watershed polygons

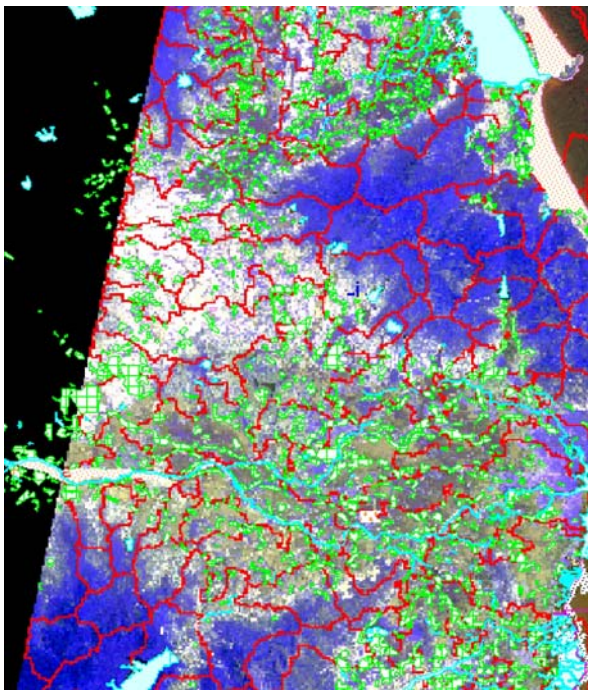

Fig.14 Overlay watershed with GIS data

5. CONCLUSION

In this paper, we apply the proposed technique to create watershed from ASTER image using the software PCI Geomatica 9. Experimental results show that this technique can replace the manual methods to provide input parameters for models of flood prediction.

The integration of GIS and remote sensing technology can economize time, expense and gain the result with better degree of accuracy. With the advantage of ASTER image is having DEM data, we can also update GIS data relative to transportation and river system,… that aim to provide basic information for investigation of relationships between spatial flood characteristic and the measurements of ground hydrometrical stations.

6. REFERENCES

V.F.Usachev. *The Role of Remote Sensing for Flood Control - Monitoring of Russian Rivers*: The Worldwide Magazine for Geomatics August 2003.

F.Chiari, M.Delhom, J.B.Filippi, J.F.Santucci. *A GIS based Methodology for the Modeling and the Simulation of Watershed*

PCI Geomatics. *Introduction to Geomatica Course Guide Version 9.0*

PCI Geomatics. *Introduction to OrthoEngine Course Guide Version 9.0*

S.K.Jenson and J.O.Domingue. *Extracting Topographic Structure from Digital Elevation Data for Geographic Information System Analysis*: Photogrammetric Engineering And Remote Sensing, Vol. 54, No. 11, November 1988, pp. 1593-1600.