ASSESSMENT OF MORPHOLOGICAL CHANGES OF RIVER BANK USING REMOTE SENSING AND GEOLOGICAL INFORMATION SYSTEMS, A CASE STUDY RED RIVER IN HANOI AREA.

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ABSTRACT

This paper presents research results on river morphology by remote sensing data analysis, comparing and verifying with real observation result and some existing maps (topographic maps, land use map, ...). The results show that phenomenon deposition varies the year and the different stages of a year. Period 1996 - 2003, deposition area was 26.3 km^2, located along the right bank in Ba Vi district, north of Dan Phuong district, northern of Me Linh district, Dong Anh district, metropolitan area; erosion area was 11.7 km^2, in Vinh Phuc, opposite Ba Vi district, Phuc Tho district and south of Me Linh district. From 2003 to 2011, deposition area was 11.2 km^2, distributed mainly in the riverbank of Vinh Phuc Province, Phuc Tho district and south of Me Linh district; erosion area was 23.8 km^2 from Ba Vi district to inner city. From 2011 to 2013, siltation occurred weakly, around 0.6 km^2; erosion occurred sharply at the left bank of Ba Vi and Phuc Tho, Dan Phuong, Thanh Tri with an area of 14.8 km^2.

Key words: River bank, Red river, HUMG Hanoi

1. INTRODUCTION

River morphology describes the shape of river bank and how they change over time. River morphological changes includes riverbank change (bank-erosion, bank-siltation) and mudflat change. Red river, in Hanoi area, with the length around 110 km and the width around 1,2 km – 4,0 km is strongly effected by not only flow motivation and regime, inhomogeneous geologic factors, but also inequality and imbalance of riverside, lead to erosion and siltation of river bank and mudflat. This problem caused some difficult to deploy economic-social plans.

The use of remotely sensed data and geographic information system (GIS) in study and assessment in river morphological changes has became popular and brought satisfactory result [2, 8].

2. REMOTE SENSING IN STUDY MORPHOLOGICAL CHANGES OF RIVER BANK

To get good results, the remotely sensed data need pre-processing, in which, ratio correction and geometric correction are critical, indispensable steps in change detection.

Classification using remotely sensed data is categorization of pixels into classes based on value of pixels gray level. According to spectral properties, spatial structure and characteristics of the subjects, some rules are applied to classify the objects. [1, 3]. The authors used two classification methods: *(1) Supervised classification*: using training classes: the areas on the ground for which there is ground truth. The spectral signatures of the training areas are used to classify similar signatures in the remaining pixels of the image. Expert knowledge is very important in this method since the selection of the training samples and adopting a bias can badly affect the accuracy of classification. *(2) Spectral unmixing*: determine the relative abundance of materials that are depicted in multispectral or hyperspectral imagery based on the spectral characteristics of material. The reflectance at each pixel of the image is assumed to be a linear combination of the reflectance of each material (or endmember) present within the pixel.

Change detection methods using remote sensing data include:

+ *Post classification comparison*: The method implies each image independent classification, followed by a thematic overlay of the classifications. The results are change matrix of the transitions between each class on the two dates. One issue with this method, less frequently commented on, is the importance of producing consistent classifications for each of the independent classifications. [9]

+ *Direct classification*: The 2 dates images are first combined in a single composite layer-stack, and the composite data set classified to produce the final change map in a single step. As with conventional post-classification comparison using separate training data for each date, no radiometric normalization is required.

+ *Image differencing*: Involves subtraction of 2 images, pixel by pixel. In the differenced image, spectral changes are highlighted as relatively high positive or negative values. Unchanged pixels are associated around zero. Image differencing can be carried on a single band or multiple bands. It is a relatively simple approach. However, image differencing does require radiometric normalization. Some kind of image differencing method: Raw image differencing, change vector analysis, correlation analysis, image rationing, vegetation index differencing, normalizes image differencing, radiometrically normalized image differencing, principal component analysis, etc. [10]

+ *Combination*: Identify spectrum change to indicate change areas, after that, classify these areas and identify them.

Flowchart of creating morphology change map is showed below (Figure 1):

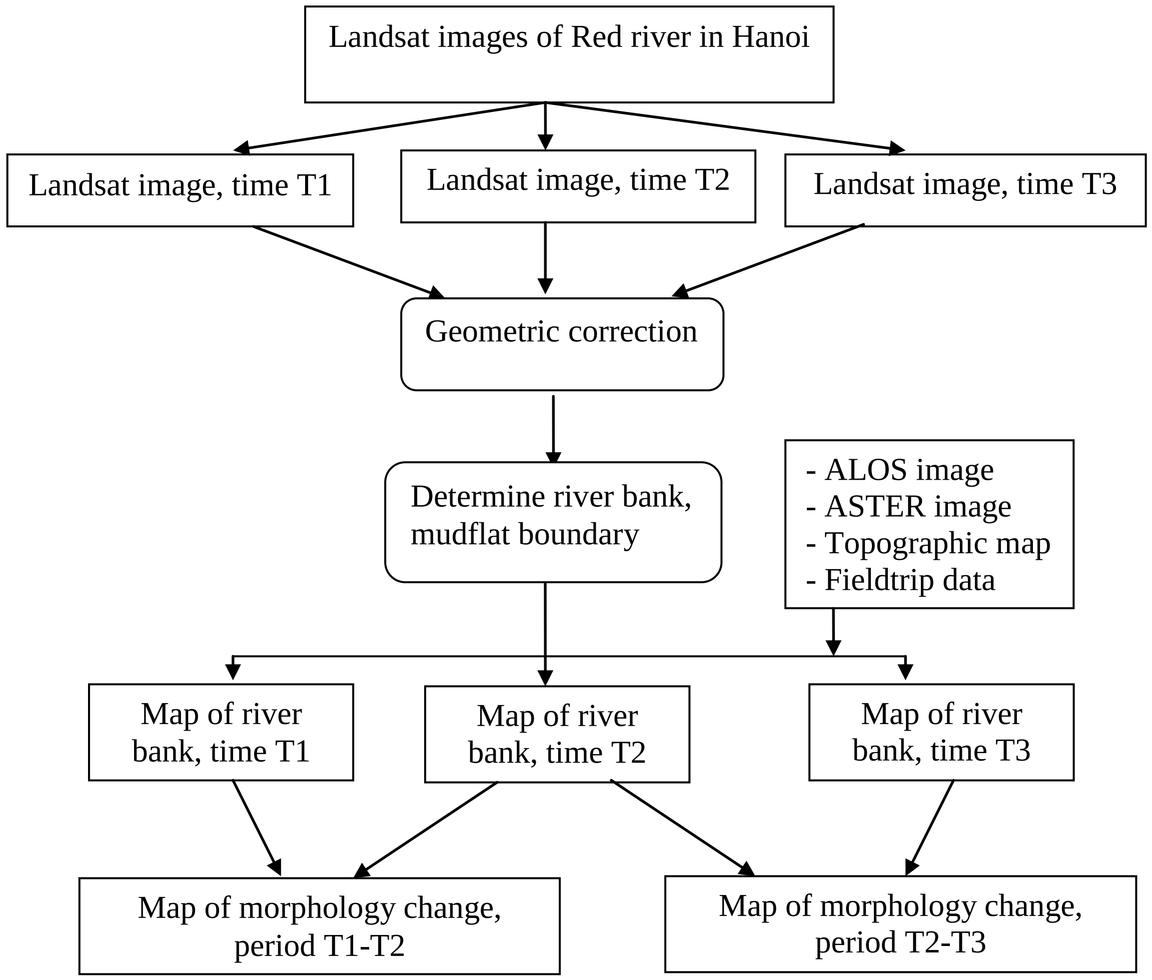


Figure 1. Flowchart of creating morphology change map of Red river bank in Hanoi

GIS software is used to analyze data and administrate study area maps [2].

The primary data were used TM, ETM+ sensor of Landsat satellite and Landsat 8 for four different years: 2/01/1996, 13/01/2003 (Figure 2), 19/11/2011 and 9/6/2013. Moreover, ASTER image, ALOS image, fieldwork data, topographic map were used as additional data.

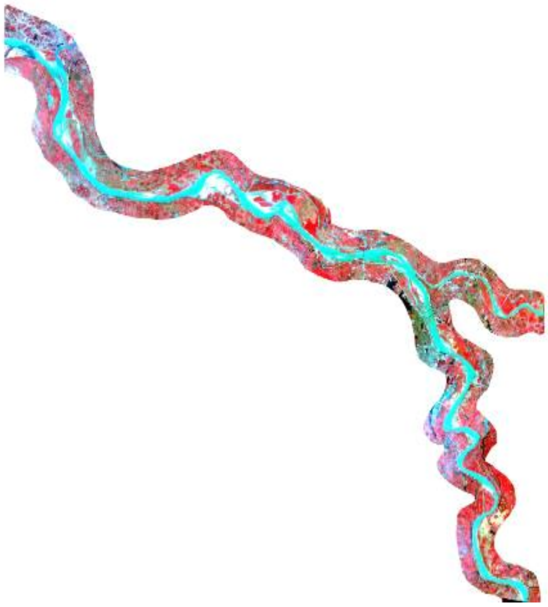


Figure 2: RGB 4:3:2 of Red river in Hanoi area on 13/1/2003

3. RESULT

The morphological changes map of Red river in Hanoi (VN2000 projection) are showed in Figure 3, 4, and 5.

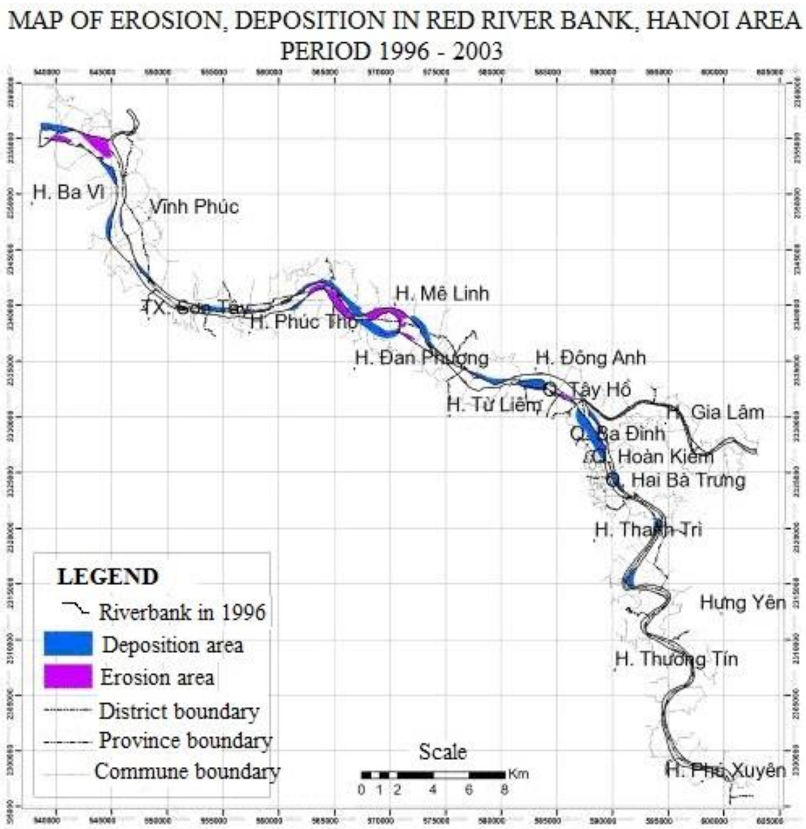


Figure 3: Map of erosion, deposition in Red river bank, Hanoi area, period 1996 - 2003

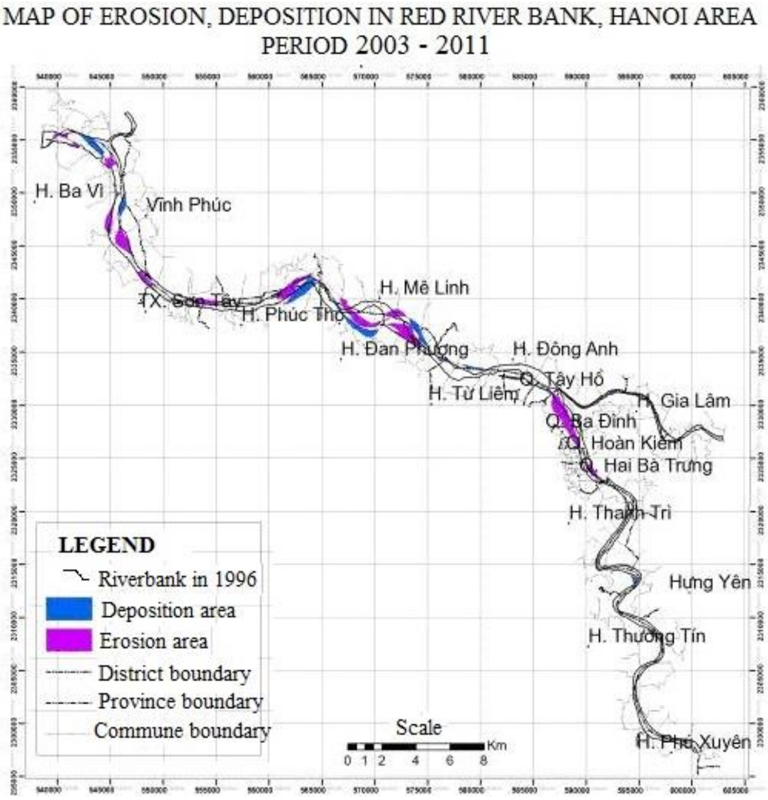


Figure 4: Map of erosion, deposition in Red river bank, Hanoi area, period 2003 – 2011

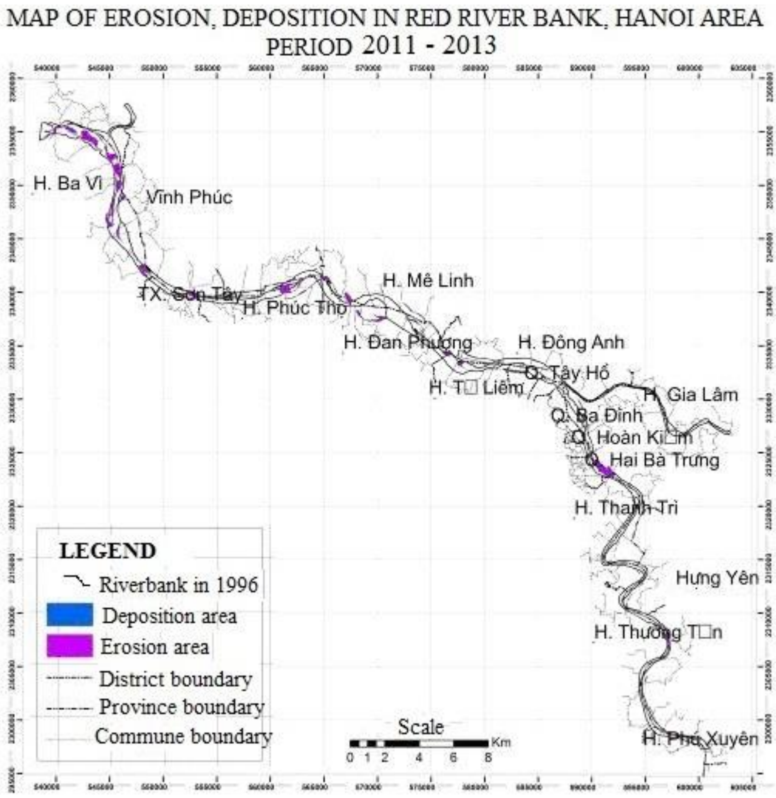


Figure 5: Map of erosion, deposition in Red river bank, Hanoi area, period 2011 – 2013

Table 1: Erosion and Deposition area statistic

No	Period	Erosion		Deposition	
		Position	Area (km^2)	Position	Area (km^2)
1	1996 – 2003	Ba Vi, Phuc Tho and south of Me Linh districts	11,7	Ba Vi district, north of Dan Phuong, north of Me Linh, Dong Anh and inner-city.	26,3
2	2003 – 2011	From Ba Vi district in the inner city area.	23,8	Phu Tho và sud south of Me Linh districts	11,2
3	2011 – 2013	On the left bank of the Ba Vi, Phuc Tho, Dan Phuong, Thanh Tri Districts	14,8	In the inner city area	0,6

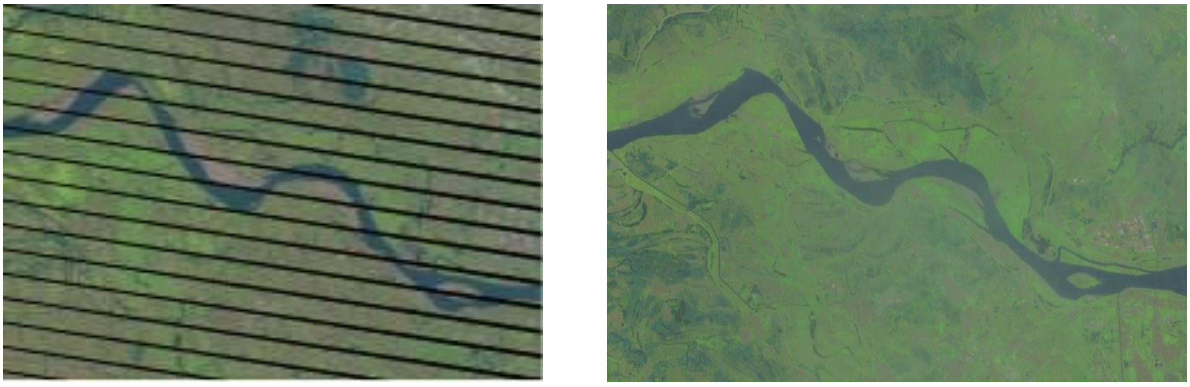
4. CONCLUSION AND DISCUSSTION

- *Period 1996 – 2003*: Formed inshore mudflat along the right bank in Ba Vi district, north of Dan Phuong district, northern of Me Linh district, Dong Anh district, metropolitan area, deposition 26,3 km^2. Erosion area was 11.7 km^2, in Vinh Phuc, opposite Ba Vi district, Phuc Tho district and south of Me Linh district.

- *Period 2003 – 2011*: deposition area was 11,2 km^2, distributed mainly in the riverbank of Vinh Phuc Province, Phuc Tho district and south of Me Linh district; erosion process occurred strongly with 23,8 km^2 from Ba Vi district to inner city. Deposition and erosion processes led to channel movement in Phuc Tho, Me Linh and Dan Phuong. (Figure 6).

Year 1996

Year 2003



Year 2011 Year 2013

Figure 6: Red river in Phuc Tho, Dan Phuong, Me Linh district

- *Period 2011 – 2013*: Siltation occurred weakly, approximately 0.6 km^2; erosion occurred sharply at the left bank of Ba Vi and Phuc Tho, Dan Phuong, Thanh Tri with an area of 14.8 km^2.

Figure 7: Field trip along Red river bank, Hanoi on 18th, 19th and 21st May 2013

The results are fitted field survey, not only between current state (late May 2013) and riverbank map compiled from Landsat image collected on 9/6/2013, but also between history process and riverbank map in the years ago. So, according to research purpose, especially for rapid assessment, Landsat image is a good data source. However, the Scan Line Corrector (SLC) of Landsat 7 ETM+ failed, these products have data gaps, so they need correcting before using.

The authors studied and found out the cause of erosion, accretion processes in Red riverbank, including synthetic factors: flow motivation – the strongest impact exogenous factor, flow regime, inhomogeneous geologic factors, inequality and imbalance of riverside.

In addition, human’s activities, such as excessive sand mining, building bridges, building embankments also affected to channel changes.

REFERENCES

[1] Ho Dinh Duan. 2005. “*Digital Remote sensing* image *processing”*. Ho Chi Minh city institute of resources geography.

[2] Truong Xuan Luan et al. 2005. “*Geographical Information Systems in Geology*”. Textbook of Hanoi university of Mining and Geology.

[3] Nguyen Ngoc Thach. 2005. “*Principal of remote sensing*”. Vietnam National University, Hanoi.

[4] Earth Observation Research and Application Center Japan Aerospace Exploration Agency. 2008. “*ASTER Data User Handbook*.”

[5] Earth Observation Research and Application Center Japan Aerospace Exploration Agency. 2008. “*ALOS Data User Handbook*.”

[6] Envi User’s Guide.

[7] Internets

[8] Kabir Uddin et al. 2011 . “*Assessment of morphological changes and vulnerability of river bank erosion alongside the river Jamuna using remote sensing*”. International Society for Photogrammetry and Remote sensing.

[9] Abdullah Almutairi et al. 2010. “*Change detection accuracy and image properties: A study using simulated data*”. Remote sensing. ISSN 2072-4292.

[10] Dengsheng Lu et al. 2005. “*Land-cover binary change detection methods for use in the moist tropical region of the Amazon: a comparative study*”. International Journal of Remote sensing Vol. 26, No1.