EasyChair Preprint

№ 3776

Study Changes in the River Red Section Flowing Though Hanoi Area Using Landsat Satellite Images

Tu Dinh Vu Anh, Natalia Kharlamova, Elena Ionkina and Ha Nguyen Thi Thu

July 7, 2020

STUDY CHANGES IN THE RIVER RED SECTION FLOWING THOUGH HANOI AREA USING LANDSAT SATELLITE IMAGES

Dinh Vu Anh Tu [1,2,3] *, Natalia Vladimirovna Kharlamova*[1]*, Elena Sergeevna Ionkina* [1]*, Nguyen Thi Thu Ha*[3]
[1] Volgograd State Technical University, Volgograd, Russia
[2] Vietnam – Russia Tropical Centre, Hanoi, Vietnam
[3] VNU University Of Science, Hanoi, Vietnam

ABSTRACT

In order to create a scientific basis for the implementation of the urban development project on the banks of the Red River, it is necessary to calculate the historical fluctuations in the area of the river bed in order to ensure the normal development of the river and minimize damage to the natural ecosystem. Using remote sensing (RS) methods and the Geographic Information System (GIS), we studied the change in the area of the Red River Canal in the periods 1999, 2003, 2,007, 2008, 2009 and 2013. During each historical period, the river bed changes in the direction of a gradual balance of bends, erosion of river banks and growth between two sides, especially in the mud and sand between the rivers. The effect of climate change on spatial changes in the riverbed in accordance with the five time steps was analyzed using an overlaid map and ceilings. At first, some sections along the Red River were investigated and compared with the results obtained in satellite images. Then we calibrated the images, eliminated the noise, honed and tuned the spectrum. After that, layers of water information for the studied river section were extracted from the Landsat image data and placed in separate layers in the GIS The tendency of expansion of the river channel to the northeast with a gradual movement of the channel to the southeast with the simultaneous smoothing of bends is established. During periods of peak floods (August 2008) and the greatest drought (November 2009), explosive fluctuations were detected in the canals. The research results are the basis for building a spatial security corridor and planning operational, environmental solutions on both sides of the river.
KEY WORD: GIS, Red river, ecological and environmental, safety corridor.

INTRODUCTION

The Red River is 1200 km long, originating from Yunnan (China), flowing into Vietnam in Lao Cai, flowing into the South China Sea at the four gates of Tra Ly, Ba Lat, Ninh Co and Day with a length of about 560 km in Vietnam. . This is the second largest river system (after the Mekong) flowing through Vietnam into the South China Sea. The Red River is made up of

three major tributaries, the Da, Lo and Thao Rivers. This is also the largest river in the North of Vietnam flowing in a natural state with large flow, the difference between the two large water seasons, the large amount of sediment flowing in the basin due to the alluvial deposit, so the river is very complicated, changes in flow and erosion occur frequently, causing great difficulties when using the river as well as using riverside land.

In 2006 - 2007, Hanoi City with the cooperation and support of Seoul City (South Korea) studied a project of basic planning of Red River development through Hanoi. Study on spatial changes in the Red River bed section running through Hanoi in the period 1999 - 2013 in order to build a scientific basis for the establishment, implementation, evaluation and construction of the Project "Red River City". Using remote sensing and GIS methods to study the process of river bed fluctuations, this is a modern method and a powerful tool capable of solving problems at macro level in a short time. The results of the study contribute to providing a scientific basis for the analysis of the space of the river bed over time and through extreme weather events in order to conserve the Red River ecosystem and actively respond to climate change.

THE STUDY RIVER

The 40 km long section of the Red River flowing through Hanoi City is a typical part of a delta river with a width of 1-3 km, existing in two branches: Gia Lam and Hanoi (Lach Quyt). changes in flow and changes cause erosion and accretion to a very large scale across many kilometers. The depth of tens of meters makes it very difficult for traveling on the river, constructing buildings along the river and using land on both sides of the river. If there are no political structures to stabilize the flow to prevent changes in the mainstream and limit developments, the construction of facilities outside the river is always problematic. This is the main reason that for hundreds of years, the ports of goods, passengers and tourism have not built completely civil constructions, green parks and calamities, and the environment has been polluted.

The study area is the section of the Red River flowing through the center of Hanoi City, the section starting from Thang Long Bridge and ending at Thanh Tri Bridge with a length of about 25 km. This part of the river is greatly influenced by the urban development process of the city, and is also an area that greatly affects human activities on both sides of the river.

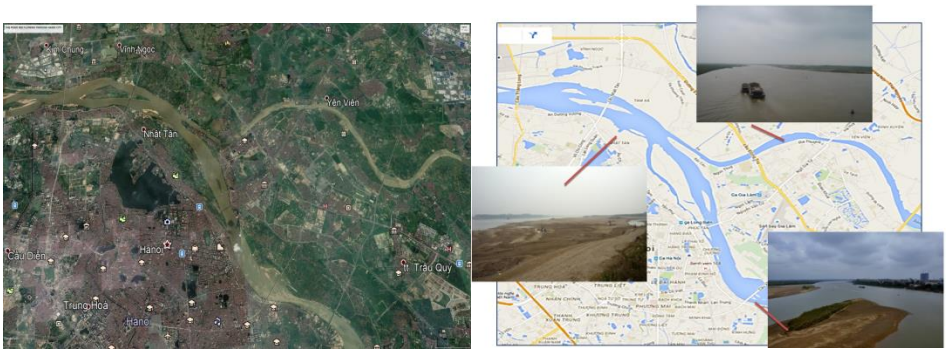


Figure 1. Location map of study area

METHODOLOGY

I. Photo data used

Within the scope of the study, the image data used are Landsat TM and Landsat 8 images of 1999, 2003, 2007, 2008, 2009 and 2013 that were collected at the US Geological Department's website. is http: // glovis.usgs.com. The position of the image collected Path / Row: 127/45 and are in the coordinate system WGS 84, zone 48N. The images selected in the study of changes in the riverbed are those from 1999, 2003, 2007 and 2013 which were collected on days with equivalent river water level of 850 cm (according to the data of Hanoi hydrographic station). easily compare fluctuations of river bed space over time. Two images collected during the historical flood (August 2008) and historical drought (November 2009) were recorded on the Red River to compare the fluctuations of the river bed due to these extreme events.

	Date/Year	Path / Row	**Sensor**
1	20/09/1999	127/45	ETM+
2	05/05/2003	127/45	ETM+
3	08/11/2007	127/45	ETM+
4	30/08/2008	127/45	ETM+
5	05/11/2009	127/45	TM
6	18/12/2013	127/45	OLI

Table 1. List of satellite imagery

II. Image processing method

Figure 2 shows the progress of the research. Landsat image after being collected has been calibrated and corrected, so it only needs to eliminate noise, increase sharpness, adjust the spectrum. To conduct the extraction of

the waterline, the image is displayed as a channel ratio of 5/2. Then, the image was conducted to classify land cover using classification algorithm with the Minimum Distance test. This is a method of categorizing using the average vector of each ROI and calculating the Euclidean distance from each unknown pixel to the average vector of each layer. All pixels are classified to the nearest ROI layer (unless the user specifies the standard deviation or standard distance threshold).

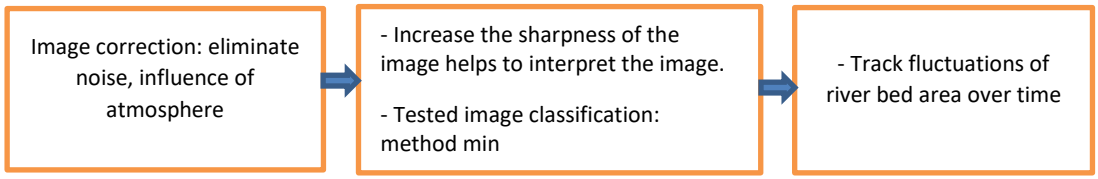
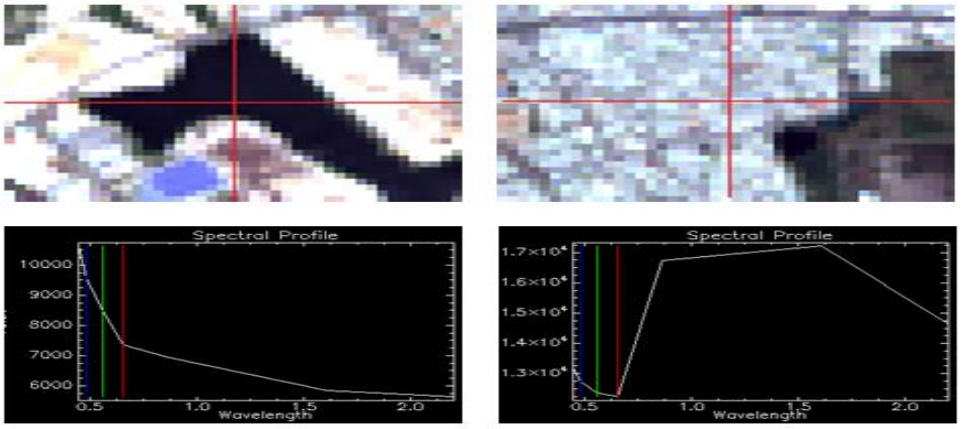


Figure 2. Progress

In this study, two objects need to be classified: river surface area and coastal area. Based on the spectral reflection characteristics of each object type (Figure 3), the keys for classification are identified as follows:



river surface area coastal area

Figure 3. Real color composite photos of sample objects and the corresponding spectrum graph

Landsat TM images with artificial color combination are made up of three channels 4 (Red), 3 (Green) and 2 (Yellow), through basic processing and band selection to minimize the image. effects of clouds and silt on the representation of objects on the image. The color of the objects shown in the image is a fake color. After classification, the river bed area and the coastal area have been extracted as shown in Figure 4.

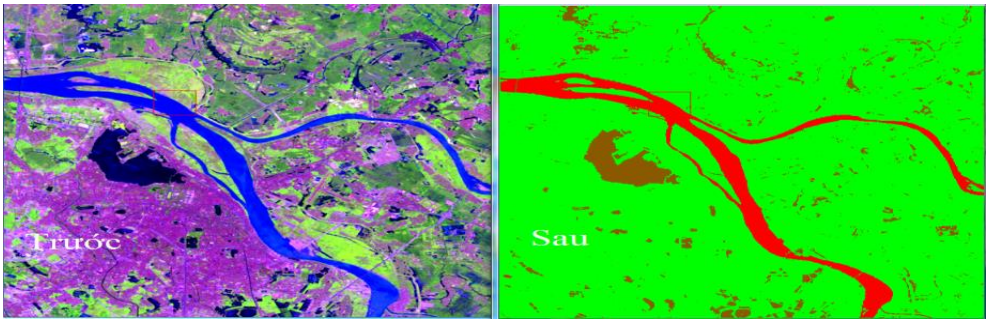


Figure 4. Results before and after sorting using the method

III. Mapping volatility method

The map overlay is a convenient spatial analysis tool and an important factor behind the development of GIS technology. Overlapping is a collection of spatial data and attributes of two or more data layers, and the tool is one of the most popular and powerful data analysis in GIS.

In the project, the water information layers on the research river section are extracted from Landsat image data and put into separate layers in GIS. Then use the map overlay method to display and calculate volatility.

RESULTS

I. Fluctuation of river bed space over time

1. Period of 1999 - 2003

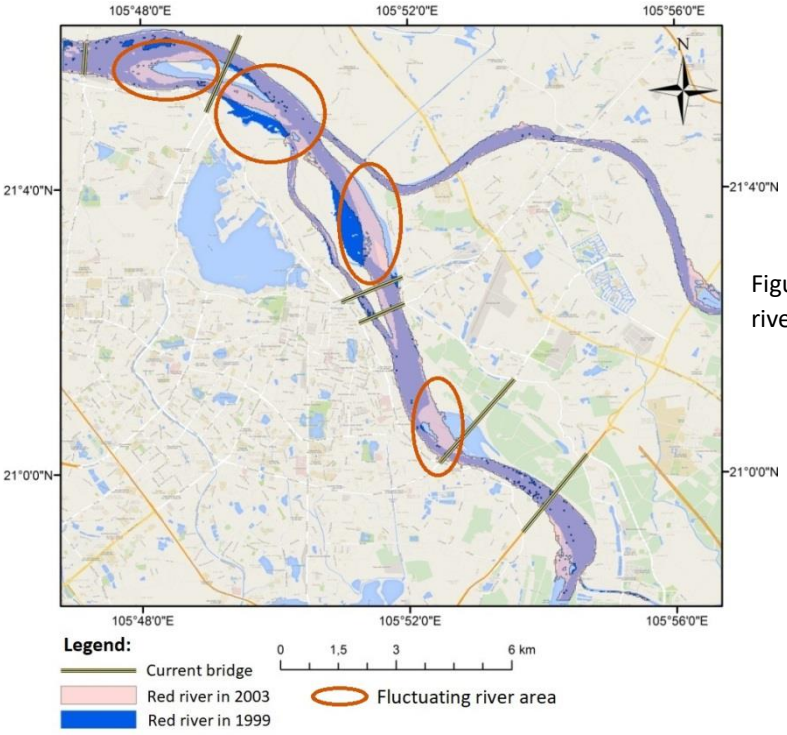


Figure 5: Fluctuation of river bed 1999 - 2003

When the map overlap the fluctuations in 1999 and 2003, the current fluctuations became more pronounced. When compared by this period, the river bed in 2003 tended to shift to the Northeast. Tu Lien area narrowed and moved to the Northeast more than 600m. Sand dunes in Nhat Tan bridge area and Tu Lien are getting smaller and smaller.

2. Period of 2003 – 2007

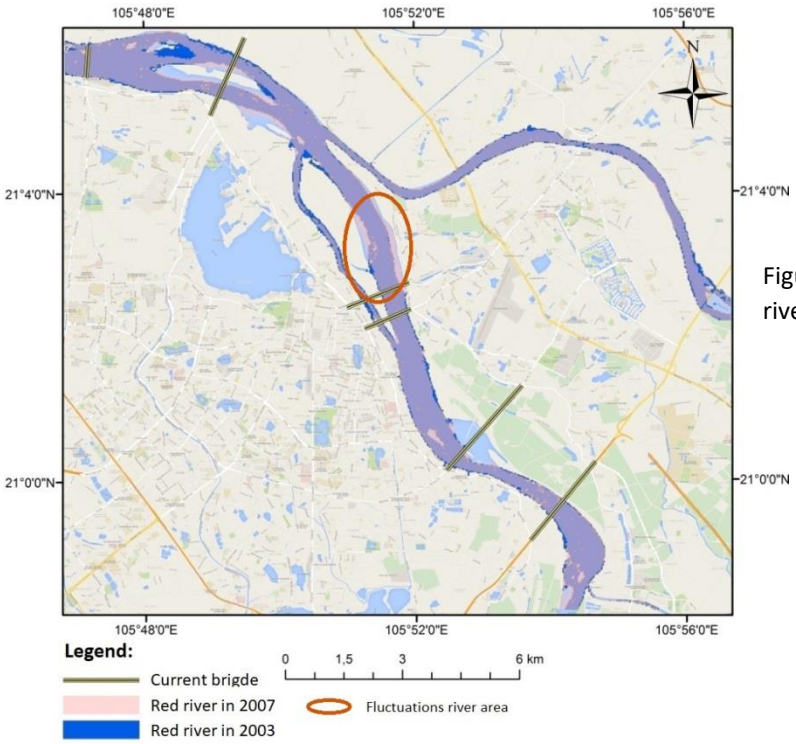


Figure 6: Fluctuation of river bed 2003 - 2007

In the 2003-2007 period, the river seemed to be more stable than the previous period, the Tu Lien alluvial area was expanded to more than 600m compared to more than 500m in 2003.

3. Period of 2007 – 2013

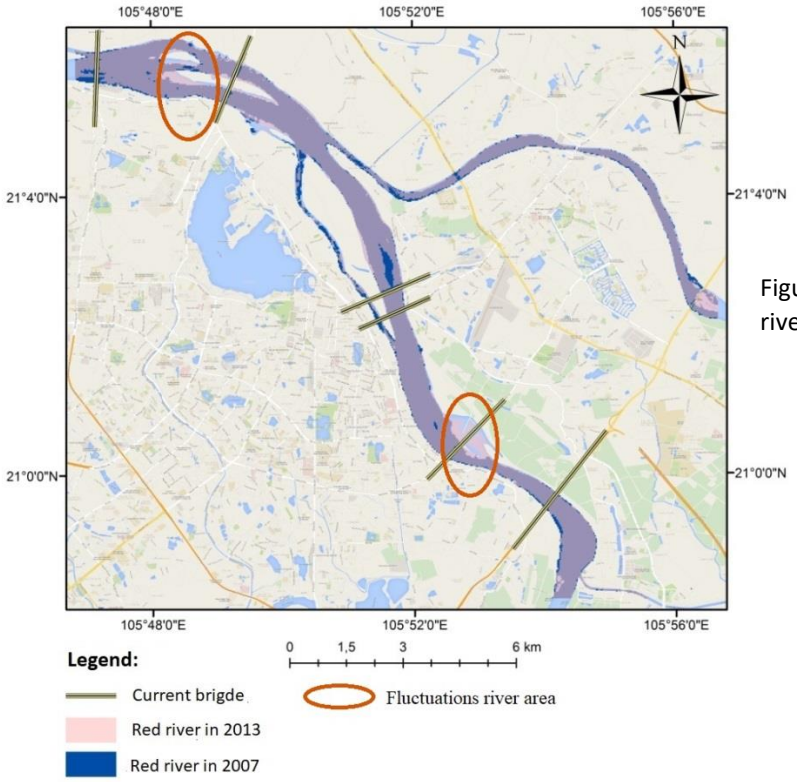


Figure 7: Fluctuation of river bed 2007 - 2013

In this period, the most changed area was the foot of Vinh Tuy bridge, the river bed expanded suddenly from nearly 600m in 2007 to more than 1100m in 2013 to the Northeast.

II. Changes in river bed space due to climate change

Figure 8 below shows the space of the Red River on August 30, 2008 when the Red River was at the end of the historic flood in 2008. Heavy rains pushed the Red River high, as shown in Figure 8, During this flood, the Red River bed expanded to more than 1.6 km distributed to the southwest.

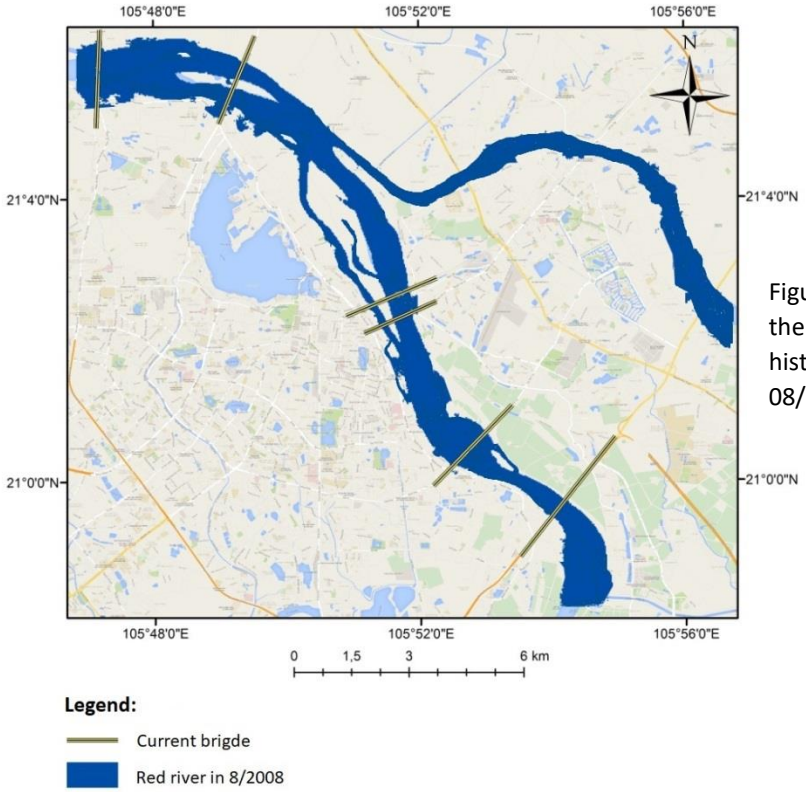


Figure 8: Fluctuation of the Red River during the historical flood in 08/2008

At the end of 2009, the Red River was severely affected by a drought. Figure 9 below shows the space of the Red River on November 5, 2009. Accordingly, the river bed seems to be narrowed to the utmost, Tu Lien beach is connected to the mainland, the branching line creating Tu Lien area disappears.

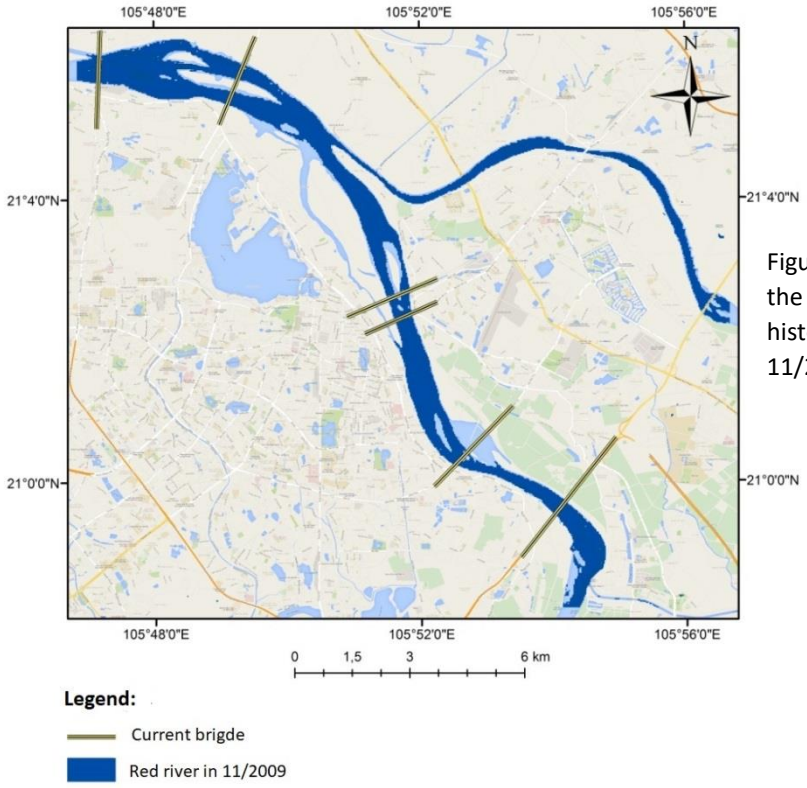


Figure 9: Fluctuation of the Red River during the historical drought in 11/2009

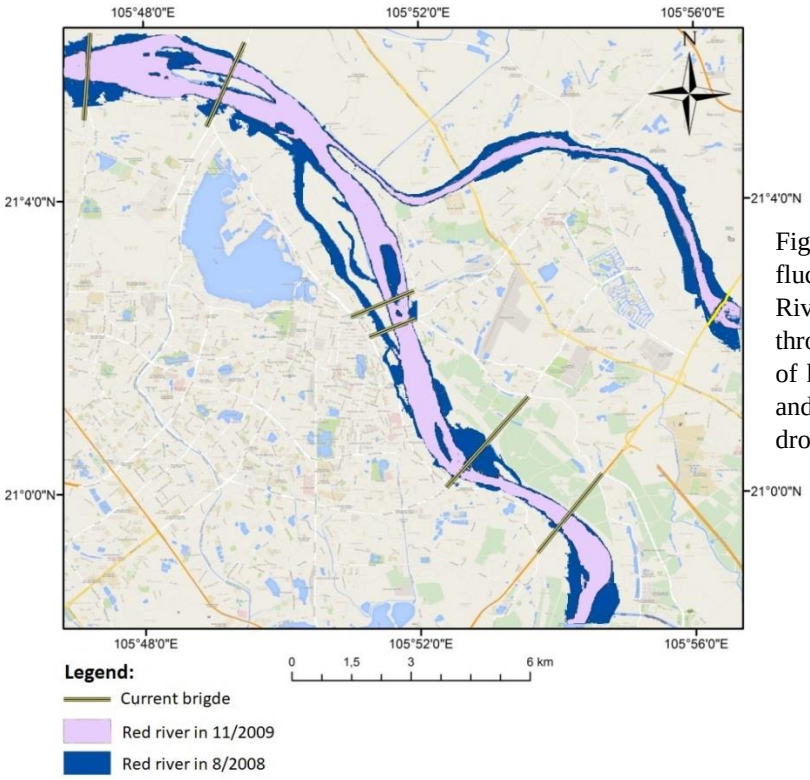


Figure 10: Spatial fluctuations in the Red River section running through Hanoi at the time of historic flood (08/2008) and the time of historical drought (11/2009)

CONCLUSIONS

The section of the Red River flowing through Hanoi plays a particularly important role in supplying and draining water to the city, adjusting the microclimate and providing a natural living environment for the people of the city. This river section also plays an important role in waterway transport in Vietnam.

In the period of 1999 - 2013, the Red River section flowing through Hanoi had many changes in the position and space of the river bed. For each historical period, the river bed changed in the direction of gradual balance of bends, erosion of the river banks and accretion between the two sides, especially the mudflats and sand between the rivers.

In order to build a scientific basis for the implementation of the city's planning project for the Red River bank, it is necessary to take into consideration the historical fluctuations of the river bed space to ensure that the river bed is developing normally to minimize damage to the river's natural ecosystem.

Studying the spatial changes of the Red River in times of extreme natural disasters such as historical floods, historical droughts it is necessary to have appropriate solutions to conserve riverbeds and build safety corridors in the future.

REFERENCES

Ministry of Natural Resources and Environment, Vietnam ; 2008: *National target program to respond to climate change, Hanoi*, 2008, 65 pages.

Nguyen Ngoc Thach; 2005: *Remote sensing establishment" Agricultural Publishing House*

Manh Cuong; 2015: *City Planning Project on the Red River: Still" stuck "with flood drainage.*

Sevil Ranjbar,Arvind Singh; 2020: *Entropy and Intermittency of River Bed Elevation Fluctuations*

Li, L.Q., Lu, X.X., Chen, Z.; 2007: *River channel change during the last 50 years in the middle*
Yangtze River: *an example of the Jianli reach. Geomorphology (in press).*

Moody, J.A. and Troutman, B.M; 2002: *Characterization of the spatial variability of channel*
morphology. Earth Surface Processes and Landforms, 27, 1251–1266.

Surian, N.; 1999: *Channel changes due to river regulation: the case of the Piave River, Italy. Earth Surface Processes and Landforms 24, 1135–1151.*

Rinaldi, M.;2003: *Recent channel adjustments in alluvial rivers of Tuscany, central Italy. Earth Surface Processes and Landforms 28, 587–608.*

Khan, N. I., and A. Islam; 2003: *Quantification of erosion patterns in the Brahmaputra-Jamuna River using geographical information system and remote sensing techniques. Hydrological Processes 17, 959 - 966.*

Kummu, M. Lu., and X.X. Rasphone., A R. Sarkkula, J. Koponen, J.; 2008: *Riverbank changes along the Mekong River: Remote sensing detection in the Vientiane–Nong Khai area. Quaternary International 186, 100–112*

Lillesand, T. M., & Kiefer, R. W; 2000: *Remote sensing and image interpretation. (4th ed.) New York7 Wiley.*

Lane, S.N., Richards, K.S.; 1997: *Linking river channel form and process: time, space and causality revisited. Earth Surface Processes and Landforms 22, 249–260.*

Marcus, W.A., Legleiter, C.J., Aspinall, R.J., Boardman, J.W. and CRABTREE, R.L.; 2003: *High spatial resolution hyperspectral mapping of in-stream habitats, depths, and woody debris in mountain streams. Geomorphology, 55, 363–380.*

Wedsite*: http://en.wikipedia.org/wiki/Ha_Noi*

http://en.wikipedia.org/wiki/Red river

Wedsite: + Download Landsat image

http://glovis.usgs.gov/

+ Google Photos

https://maps.google.com/

https://earth.google.com/