EasyChair Preprint

№ 4022

Changes in the channel of the section of the Red River flowing through the Hanoi region

Tu Dinh, Natalia Kharlamova, Elena Ionkina, Ha Nguyen and Victor Krasnoscshekov

August 10, 2020

Changes in the channel of the section of the Red River flowing through the Hanoi region

Tu Dinh[1, 2, 3*], *Natalia* Kharlamova[1], *Elena* Ionkina[1], *Ha* Nguyen[3], and *Victor* Krasnoscshekov[4]

[1]Volgograd State Technical University, Volgograd, Russia
[2] Vietnam – Russia Tropical Centre, Hanoi, Vietnam
[3] VNU University of Science, Hanoi, Vietnam
[4] Higher School of International Educational Programs, Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, Russia

Abstract. The article substantiates the need to study the fluctuations of the area of the Red riverbed in the area of the city of Hanoi in certain historical periods. A methodology for studying the river, including methods of remote sensing of the Earth (remote sensing) and Geographic Information System (GIS), is proposed. It is established that during each historical period, the riverbed changes in the direction of a gradual balance of bends, erosion of the banks and growth between the two banks. The influence of climate change on spatial changes in the riverbed was analyzed using a superimposed map and ceilings. Explosive fluctuations in the area of the riverbed were detected during periods of peak floods and greatest droughts. The results of the research that formed the basis for building a spatial security corridor and planning operational and environmental solutions on both banks of the river are presented.

1 Introduction

The length of the river in Vietnam is about 560 km. It is the second largest river system (after the Mekong) that flows through Vietnam into the South China Sea. The Red River consists of three main tributaries: Da, Lo, and Thao. It is also the largest river in the North of Vietnam, flowing in a natural state with a large current, the difference between two large water seasons, a large amount of sediment draining into the basin due to alluvial deposits. Therefore, the river is very complex, often there are changes in flow and erosion, which causes great difficulties in the use of the river, as well as in the use of coastal land.

Urban environmental management in the Hanoi region has attracted increasing interest in recent years, as evidenced by a large number of studies, both in Hanoi and other cities [1-9]. However, these studies focus mainly on environmental pollution. Changes in the soil cover of the Hanoi region can be studied using satellite images [10]. This technique is often used for environmental monitoring of territories [11-14].

* Corresponding author anhtu2893@gmail.com

In 2006-2007, the city of Hanoi, with the assistance and support of the city of Seoul (South Korea), studied the basic planning project for the development of the Red River through Hanoi. The study of spatial changes in the section of the Red River canal that passes through Hanoi between 1999 and 2013 was conducted with the aim of creating a scientific basis for the creation, implementation, evaluation and construction of the "Red River City" project.

Remote sensing and its methods were used to study fluctuations in the red riverbed. The remote sensing methods [15], as well as GIS methods, are widely used for monitoring the quality of inland waters [16]. Water changes can be effectively studied using Landsat images [17, 18]. In our study, we applied these modern methods and a powerful tool to study the process of Red River bed fluctuation.

To control the state of water bodies simultaneously with space survey, monitoring with express methods is used [19-26]. This allows to clarify a number of important points that may not be fully detected when surveying the territory.

2 Methods

2.1 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). It is easy to compare fluctuations in riverbed area 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.

N	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

It should be noted that equipment with hybrid photodetectors [27-29] and photosensitive sensors [30, 31] was used for the images.

2.2 Image processing method

The figure 1 shows the progress of the research. After the acquisition, the Landsat image was calibrated and corrected, so it was only necessary to eliminate noise, sharpen, adjust the spectrum. For extraction at the waterline, the image is displayed in a 5/2 channel format. An imaging was then taken to classify land cover using a classification algorithm

with a minimum distance test. It is a categorization method 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 closest ROI (unless the user specifies a standard deviation or standard threshold distance).

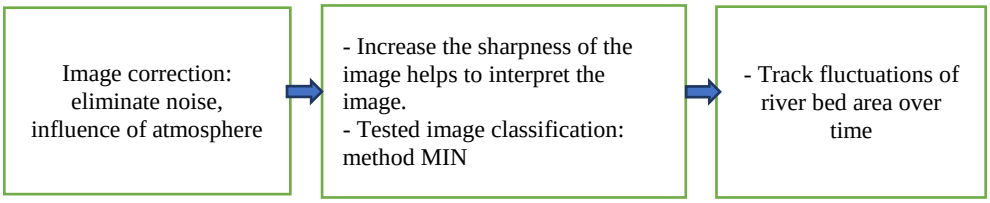
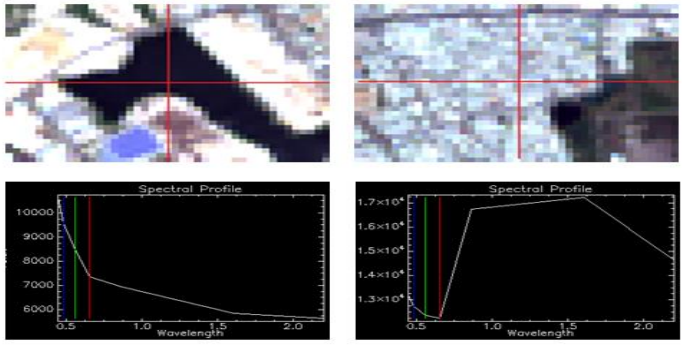


Fig. 1. Progress.

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 2), the keys for classification are identified as follows:



River surface area Coastal area

Fig. 2. 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. Clouds and silt affect the appearance of objects in 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 3.

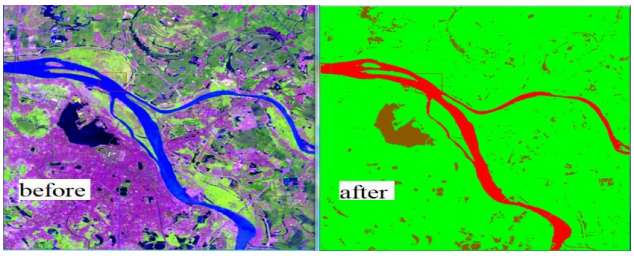


Fig. 3. Results before and after sorting using the method.

2.3 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 used the map overlay method to display and calculate volatility.

3 Results

3.1 Fluctuation of river bed space over time is shown in figure 4.

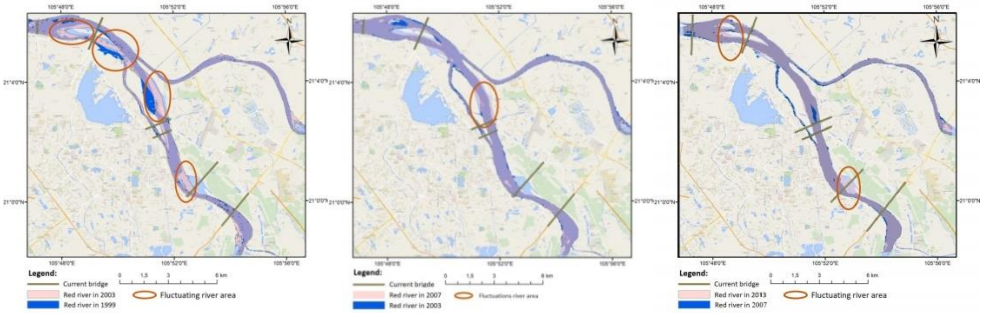


Fig. 4. Fluctuation of river bed space over time: 1999-2003; 2003-2007 and 2007-2013

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.

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.

In the 2007-2013 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.

3.2 Changes in river bed space due to climate change is shown in figure 5.

The figure 5 on the left 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. During this flood, the Red River bed expanded to more than 1.6 km distributed to the southwest.

At the end of 2009, the Red River was severely affected by a drought. Figure 5 in the center 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.

Spatial fluctuations in the section of the Red River passing through Hanoi during the historical flood (08/2008) and historical drought (11/2009) are shown in figure 5 on the right.

Fig. 5. Fluctuation of the Red River during the historical flood in 08/2008 and the historical drought in 11/2009.

4 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

1. T. B. Minh Nguyen, and A.T.M. Nurul Amin, Environment, Development and Sustainability **4**, 279–297 (2002)
2. T. T. Viet Nga, Groundwater Management in Asian Cities **2**, 273-299 (2008)
3. V. Yushkova, G. Kostin, R. Davydov, V. Dudkin, and L. Valiullin, IOP Conference Series: Earth and Environmental Science **390(1)**, 012016 (2019)
4. G. Shafeev, E. Barmina, L. Valiullin, A. Korshunov, and R. Denisov, IOP Conference Series: Earth and Environmental Science **390(1)**, 012016 (2019)
5. M. Petrichenko, N. Vatin, D. Nemova, N. Kharkov, and A. Staritcyna, Applied Mechanics and Materials **627**, 297-303 (2014)
6. R. Davydov, V. Antonov, S. Makeev, V. Dudkin, N. Myazin, E3S Web of Conferences **140**, 02001 (2019)
7. N. Rumyantsev, O. Bondareva, S. Makeev, and V. Krasnoshekov, IOP Conference Series: Earth and Environmental Science **390(1)**, 012037 (2019)
8. M. Kozar, L. Sabliy, M. Korenchuk, S. Makeev, A. Korshunov, and V. Kosolapov, IOP Conference Series: Earth and Environmental Science **390(1)**, 012002 (2019)

9. S. Van, A. Cheremisin, A., Chusov, F. Switala, and R. Davydov, IOP Conference Series: Earth and Environmental Science **390(1)**, 012011 (2019)
10. J. Zhao, and C. Liu, Wuhan University Journal of Natural Sciences **15**, 355–362 (2010)
11. A.A. Petrov, Journal of Communications Technology and Electronics **63(11)**, 1281-1285 (2018)
12. A.A. Petrov, and D.V. Shapovalov, Journal of Physics: Conference Series **1400(4)**, 044008 (2019)
13. V. Fadeenko, I. Fadeenko, V. Dudkin, and D. Nikolaev, IOP Conference Series: Earth and Environmental Science **390(1)**, 012022 (2019)
14. V. I. Antonov, R. V. Davydov, V. I. Maslikov, and A.V. Cheremisin, Journal of Physics: Conference Series **1368(4)**, 042076 (2019)
15. D. Maktav, and S. Berberoglu, Journal of the Indian Society of Remote Sensing **46**, 1201–1202 (2018).
16. F. Ma, Q. Wang, and M. Zhang, EURASIP Journal on Image and Video Processing **63**, (2018)
17. S. J. Purkis, and R. Pasterkamp, Coral Reefs **23**, 5–20 (2004)
18. Q. Xing, C. Chen, and P. Shi, Ocean Science Journal **41**, 97–104 (2006)
19. R. Davydov, V. Antonov, D. Molodtsov, A. Cheremisin, and V. Korablev, MATEC Web of Conference **245**, 15002 (2018)
20. N. S. Myazin, V. V. Davydov, V. V. Yushkova, and T. I. Davydova, Journal of Physics: Conference Series **917(4)**, 042017 (2017)
21. V. V. Davydov, V. I. Dudkin, N. S. Myazin, and V.Yu. Rud, Instruments and Experimental Techniques **61(1)**, 140–147 (2018)
22. V.V. Davydov, E. N. Velichko, N. S. Myazin, and V.Uy. Rud, Instruments and Experimental Techniques **61(1)**, 116–122 (2018)
23. N. Myazin, Y. Neronov, V. Dudkin, and V. Yushkova, MATEC Web of Conference **245**, 11013 (2018)
24. N.S. Myazin, V.V. Davydov. V.V. Yushkova, and V.Yu. Rud, Environmental, Research, Engineering and Management **75(2)**, 28-35 (2019)
25. N.S. Myazin, V.V. Davydov, V.V. Yushkova, and V.I. Dudkin, Journal of Physics: Conference Series **1400(6)**, 066008 (2019)
26. N.S. Myazin, V.V. Davydov, V.V. Yushkova, and N.I. Taranda, Journal of Physics: Conference Series **1410(1)**, 012130 (2019)
27. K.J. Smirnov, Journal of Physics: Conference Series **1368(2)**, 022073 (2019).
28. K.J. Smirnov, S.F. Glagolev, and G.V. Tushavin, Journal Physics: Conference Series **1124(1)**, 022014 (2018)
29. K.J. Smirnov, S.F. Glagolev, N.S. Rodygina, and N.V. Ivanova, Journal of Physics: Conference Series **1038(1)**, 012102 (2018)
30. A.V. Sachenko, V.P. Kostylyov, I.O. Sokolovskyi, A.V. Bobyl, E.I. Terukov, and M.Z. Shvarts, Technical Physics Letters **43(2)**, 152-155 (2017)
31. D.M. Zhigunov, A.S. Il'in, A.S., P.A. Forsh, A.V. Bobyl, E.I. Terukov, and P.K. Kashkarov, Technical Physics Letters **43(5)**, 496-498 (2017)