FIG WORKING WEEK 2019

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"Geospatial Information for a Smarter Life and Environmental Resilience"

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Monitoring Urban Surface Water Bodies Changes Using MNDWI Estimated From Pan-sharpened Optical Satellite Images

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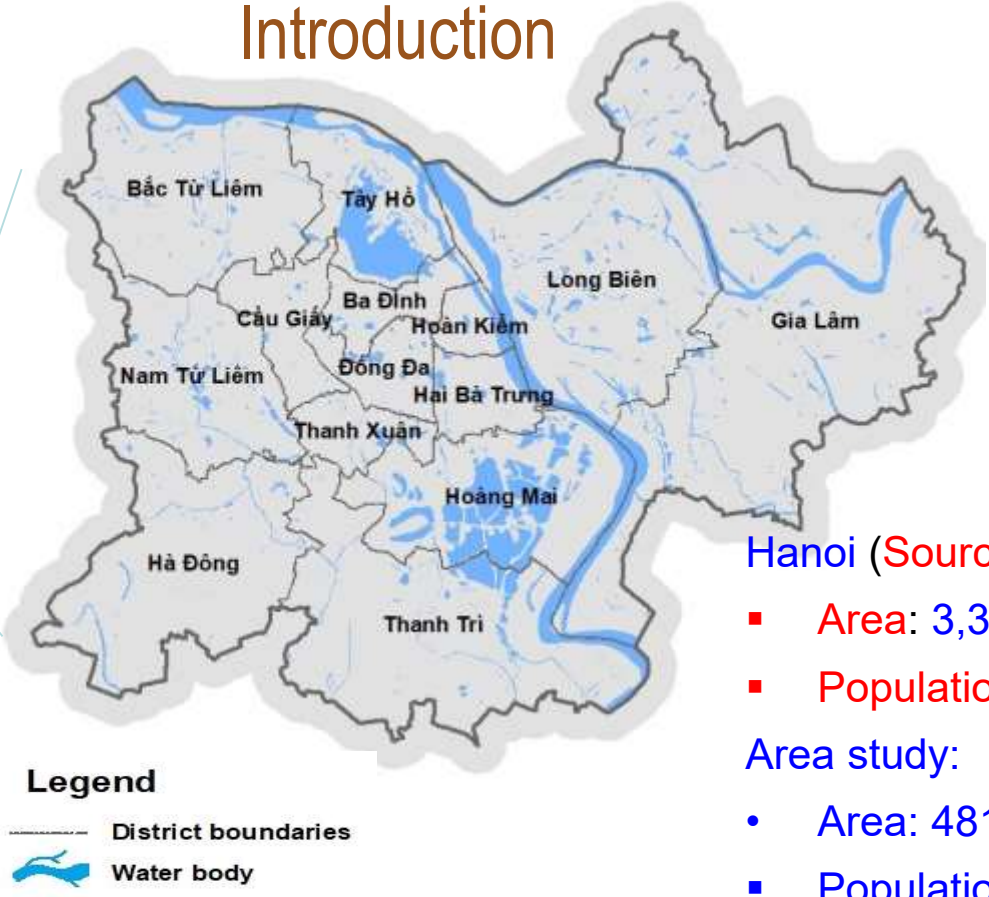
Introduction

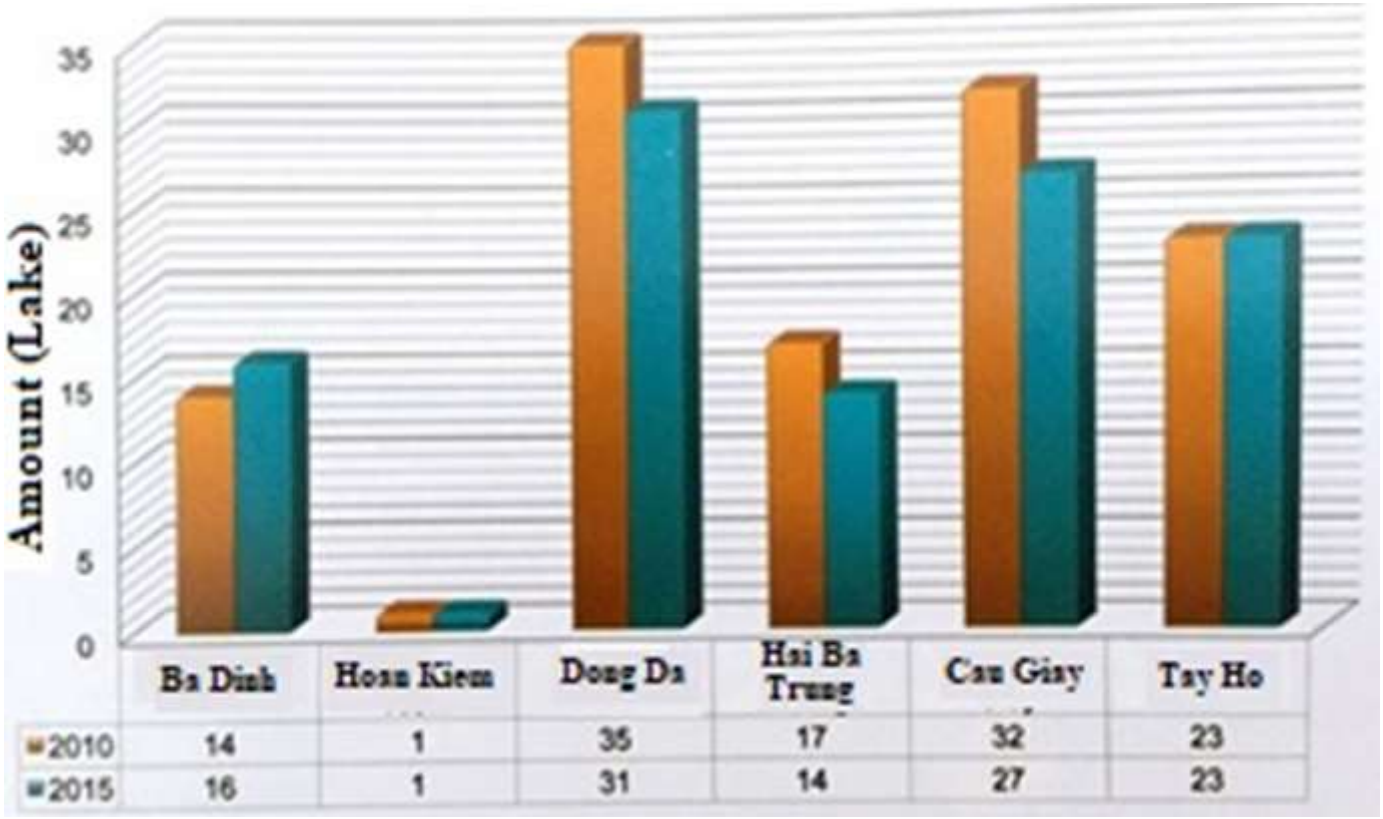


Hanoi (Source: GSO, 2011)

- Area: 3,329 Km^2
- Population: 6,6996 M

Area study:

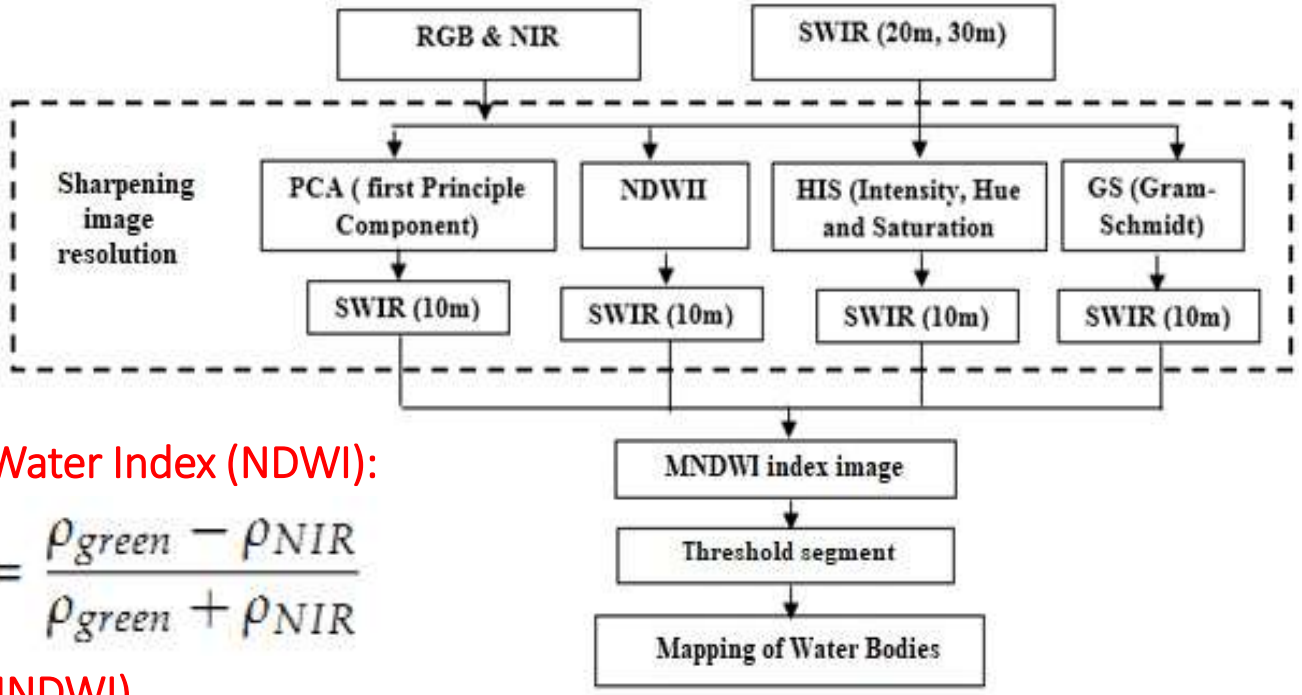
- Area: 481 Km^2
- Population: 3,0526M



The change in the number of lakes in Hanoi 2010-2015

(From Hanoi Lake Report 2015)

Method



1. Nomal Difference Water Index (NDWI):

$$NDWI = \frac{\rho_{green} - \rho_{NIR}}{\rho_{green} + \rho_{NIR}}$$

2. Modified NDWI (MNDWI)

$$MNDWI = \frac{\rho_{green} - \rho_{SWIR}}{\rho_{green} + \rho_{SWIR}}$$

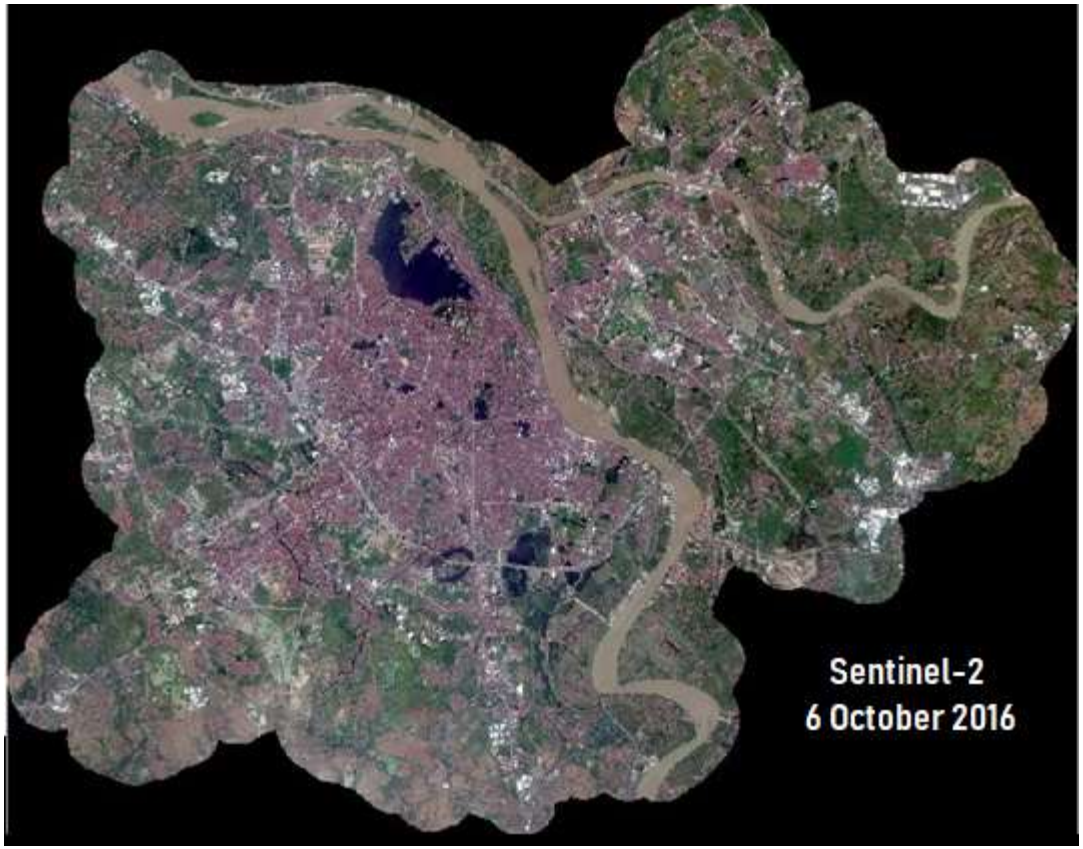
Data set

- Landsat 5: 2008-2011
- Landsat 8: 2013-2017
- Sentinel-2: 2015-2017

Landsat 5: 7/8/2008; 5/11/2009; 8/11/2010; 24/9/2011

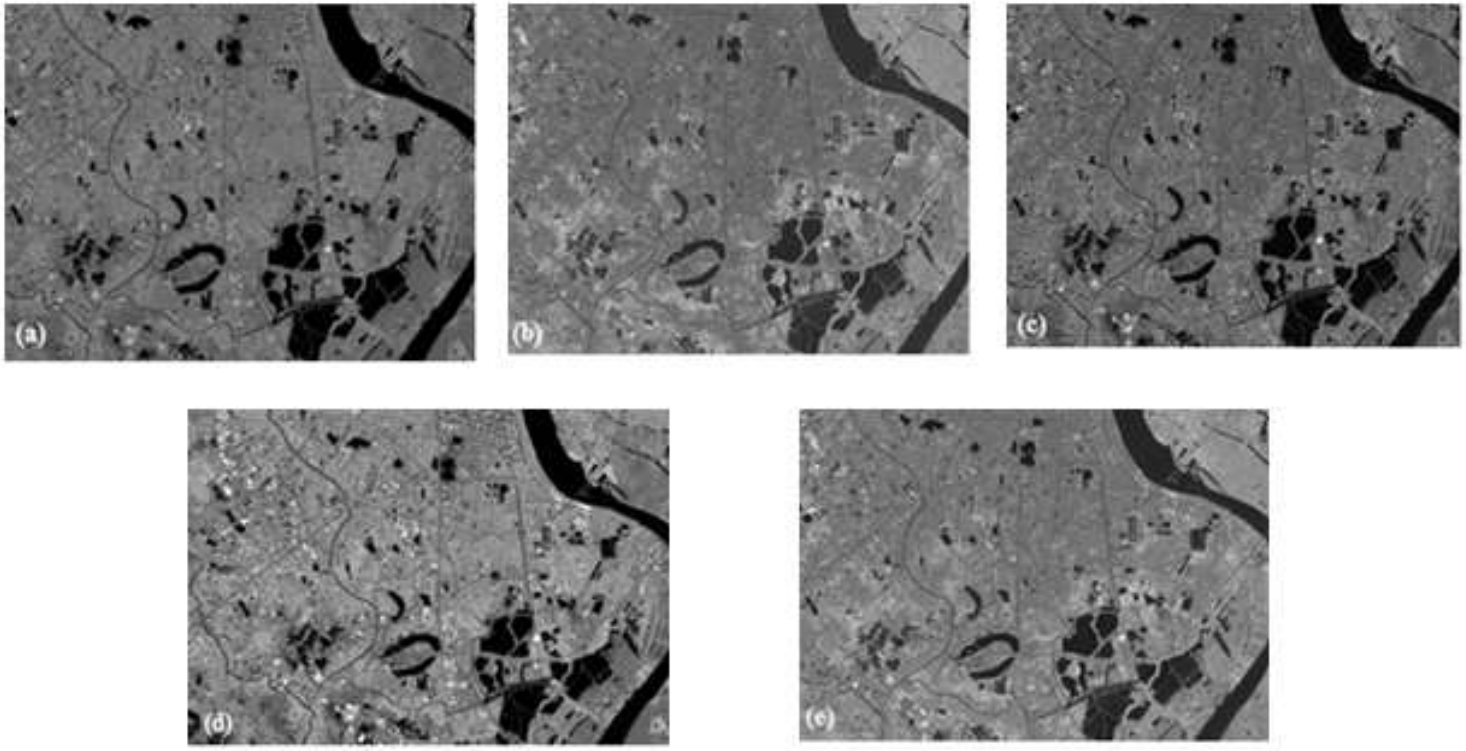
Landsat 8: 7/12/2013; 18/1/2014; 11/7/2015; 1/6/2016; 4/7/2017

Sentinel-2: 22/10/2015; 6/10/2016; 31/10/2017

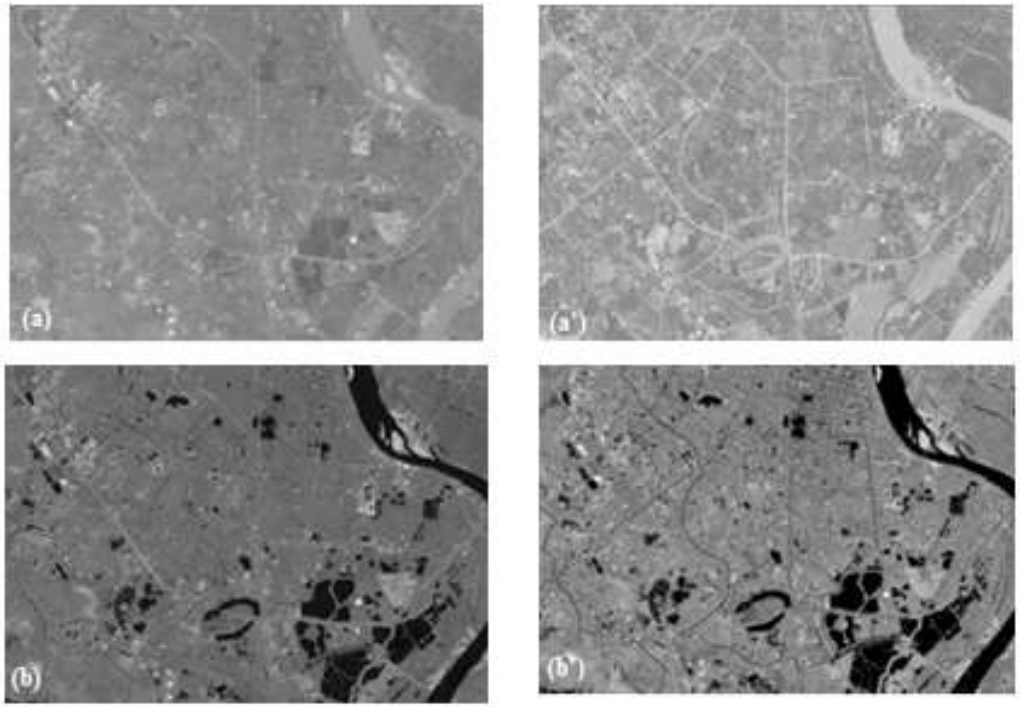


Results

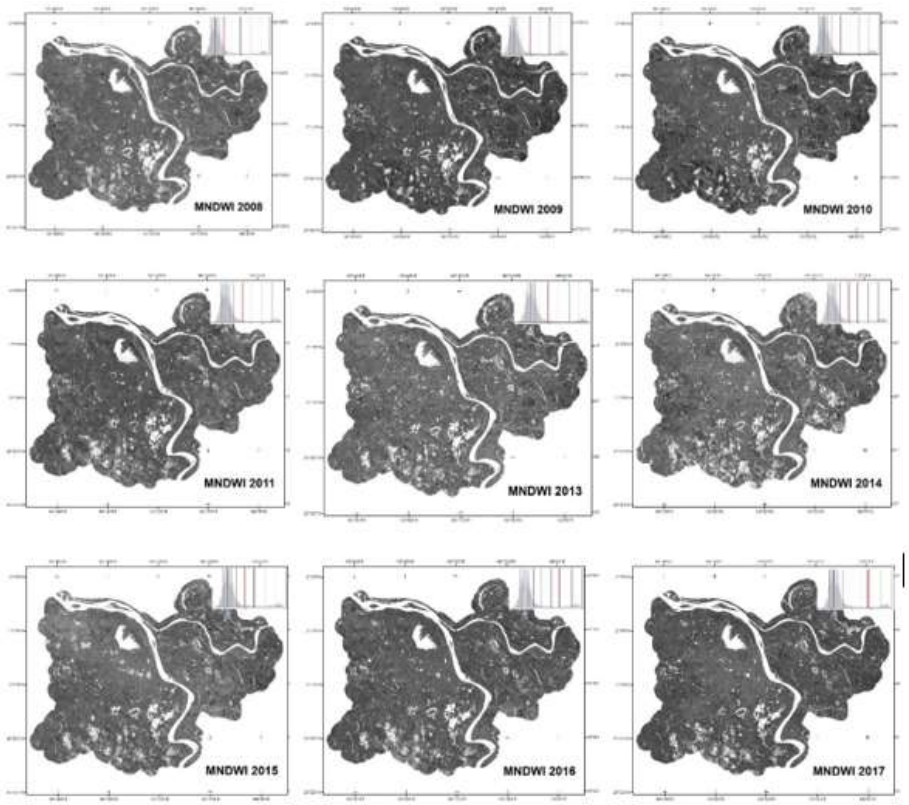
Sharpening



Results of different methods of sharpening SWIR band sentinel-2 image from 20m resolution to 10m, (a) SWIR band with a resolution of 20m; (b) GS method (Gram-Schmidt); (c) IHS method; (d) method of using NDWII; (e) PCA method



Results before and after sharpening Landsat 8 images from 30m resolution to 15m (a) (a '): band 3 (green) before and after sharpening; (b) (b ') band 6 (SWIR) before and after sharpening

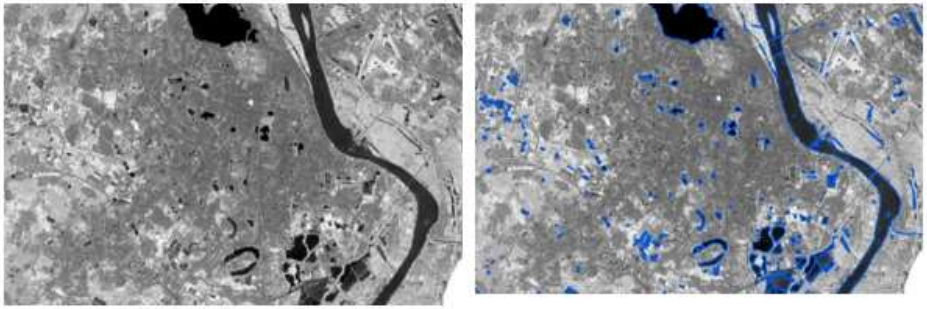


MNDWI water index image with adjusted thresholds. The sub-image in the right-up shows the grey histogram of the image and the red line indicates the obtained threshold in the period of 2008-2017

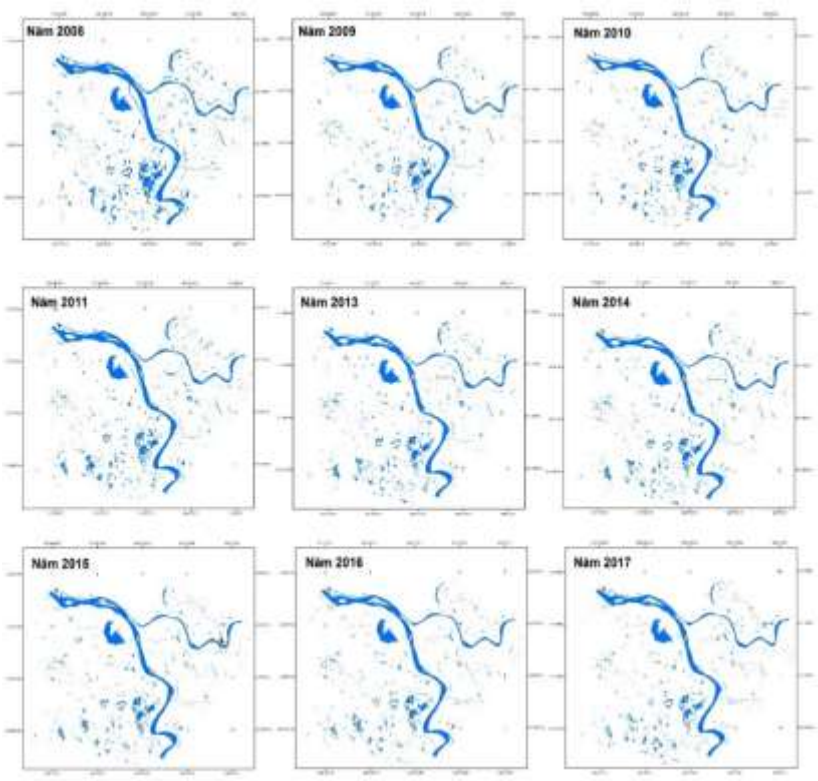
Image index and threshold segment

- Landsat pixels are calssified to water with value > 0.12;
- Sentinel-2 pixels are classidied to water with value > 0.4

Mapping of Water Bodies



Extracting water from MNDWI index image (sentinel-2 image) with pixel value threshold > 0.4



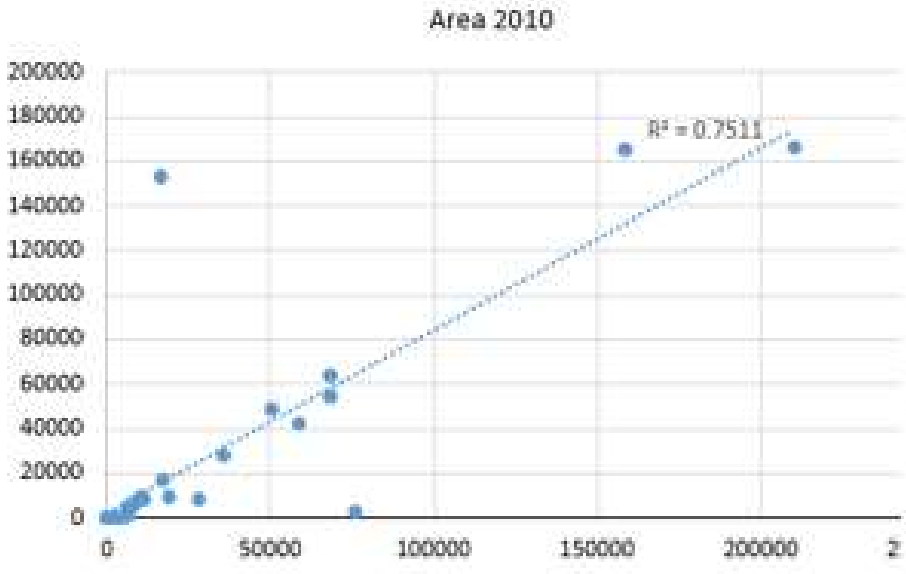
Map of surface water extraction from the MNDWI index image for the period of 2008-2017

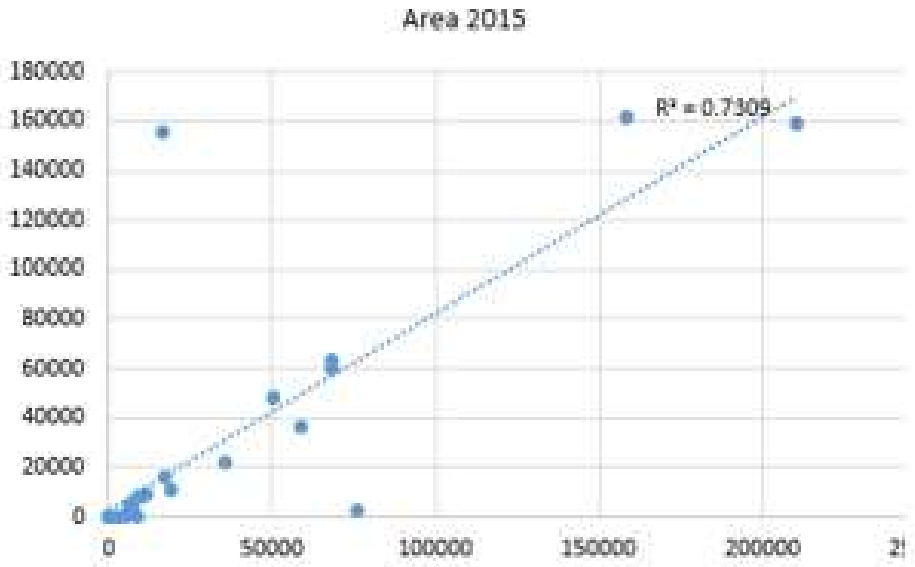
- Large lakes are well extracted

- Small lakes (<4000 m²) classified at low accuracy is easily confused with pixcels of houses and trees in urban areas

No	Lake	District	The report of Hanoi Lake in 2015		Satellite Images		No	Lake	District	The report of Hanoi Lake in 2015		Satellite Images	
			Area 2010 (m2)	Area 2015 (m2)	Area 2010 (m2)	Area 2015 (m2)				Area 2010 (m2)	Area 2015 (m2)	Area 2010 (m2)	Area 2015 (m2)
1	Ho Truc Bach	Ba Dinh	158,453	158,453	165,600	161,900	24	Ho Thien Quang	Hai Ba Trung	58.686	58.686	42.400	36.300
2	Ho Thanh Cong	Ba Dinh	50,046	50,046	48,700	48,500	25	Ho Quynh	Hai Ba Trung	7,201	7,201	4,800	2,800
3	Ho Ngoc Khanh	Ba Dinh	35,881	35,881	27,900	22,369	26	Ho Quang Trung	Hai Ba Trung	10,736	10,736	9,800	8,432
4	Ho Giang Vo	Ba Dinh	68,300	38,300	54,900	63,635	27	Ho Hai Ba Trung	Hai Ba Trung	11,415	11,415	8360	9500
5	Ho Dam Tron	Ba Dinh	9,536	9,536	8,650	8,600	28	Ho cong vien Tuoi Tre	Hai Ba Trung	17,302	17,302	17,214	16,457
6	Ho Bach Thao 2	Ba Dinh	5,906	5,906	3,900	4,500	29	Ho canh ho Ao Ca Bac Ho	Hai Ba Trung	6,304	6,272	1,283	1,243
7	Ho Bach Thao 1	Ba Dinh	6,679	6,679	5,490	5532	30	Ho ca Bac Ho	Hai Ba Trung	27,709	18,944	18,100	11,000
8	Ho Thu Le	Ba Dinh	68,521	68,521	63,635	60,247	31	Ho Bay Mau	Hai Ba Trung	210,270	210,270	166,500	159,140
9	Ho Dam	Ba Dinh	9,536	9,536	7,213	8,156	32	Ao Ngo 153/34 Vinh	Hai Ba Trung	19,257	7,275	15,000	3,200
10	Ao Chua mot Cot	Ba Dinh	202	202	NA	NA	33	Ho Thanh Nhan	Hai Ba Trung	76,000	76,000	63,200	52,900
11	Ho Trung Kinh	Cau Giay	NA	4299	NA	2,200	34	Ho Can	Hai Ba Trung	16,325	16,325	152,800	155,700
12	Ho Trung Kinh	Cau Giay	4,078	4,078	NA	3,822	35	Ho Van Chuong	Dong Da	13,418	13,418	15,400	13,403
13	Ho Q.Uy Cau Giay	Cau Giay	2,814	2,814	NA	2,533	36	Ho Nam Dong	Dong Da	42,876	42,876	31,500	33,300
24	Ho nghia trang	Cau Giay	10,533	10,533	10,800	9,400	37	Ho Linh Quang	Dong Da	22,700	22,108	12,900	11,100
15	Ho Nghia Tan	Cau Giay	43,706	43,706	29,700	33,600	38	Ho Lang Thuong	Dong Da	14,797	14,797	11,100	17,000
16	Ho cong vien cau	Cau Giay	NA	43,053	NA	40,111	39	Ho Ho Me	Dong Da	10,061	10,061	10,700	12,600
17	Ao doi dien NT	Cau Giay	24,276	22,935	17,200	20,456	40	Ho Hoang Cau	Dong Da	135,100	135,100	16,200	15,700
18	Ho Tu Lien	Tay Ho	26,446	25,579	32,703	34,306	41	Ho Ba Mau	Dong Da	43,448	43,448	22,800	33,900
19	Ho Tay	Tay Ho	5,160,000	5,160,000	4,986,000	4,965,900	42	Ho Hoan Kiem	Hoan Kiem	120,000	120,000	93,600	92,400

Correlation coefficient





Correlation coefficient beween satellite images and Hanoi water body reported in 2015

Change of water surface

RapidEye images, resolution of 5 x 5 m (left), MNDWI index images (right): new lake (red); lost lake (green, yellow)

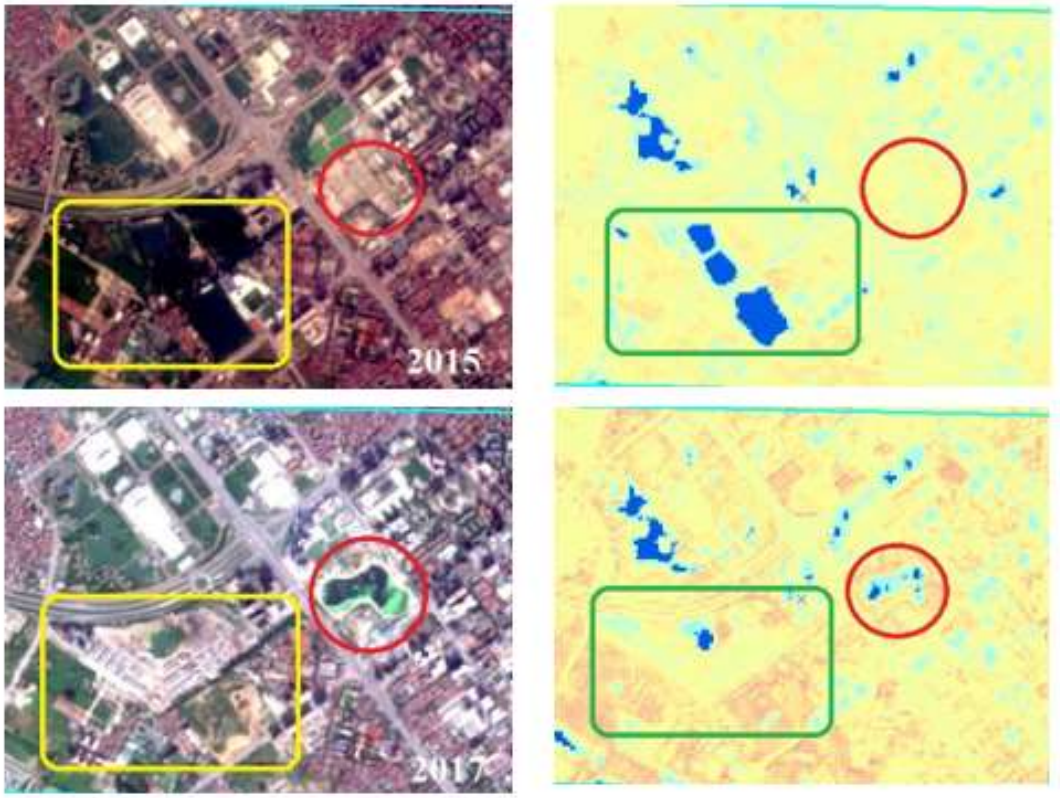
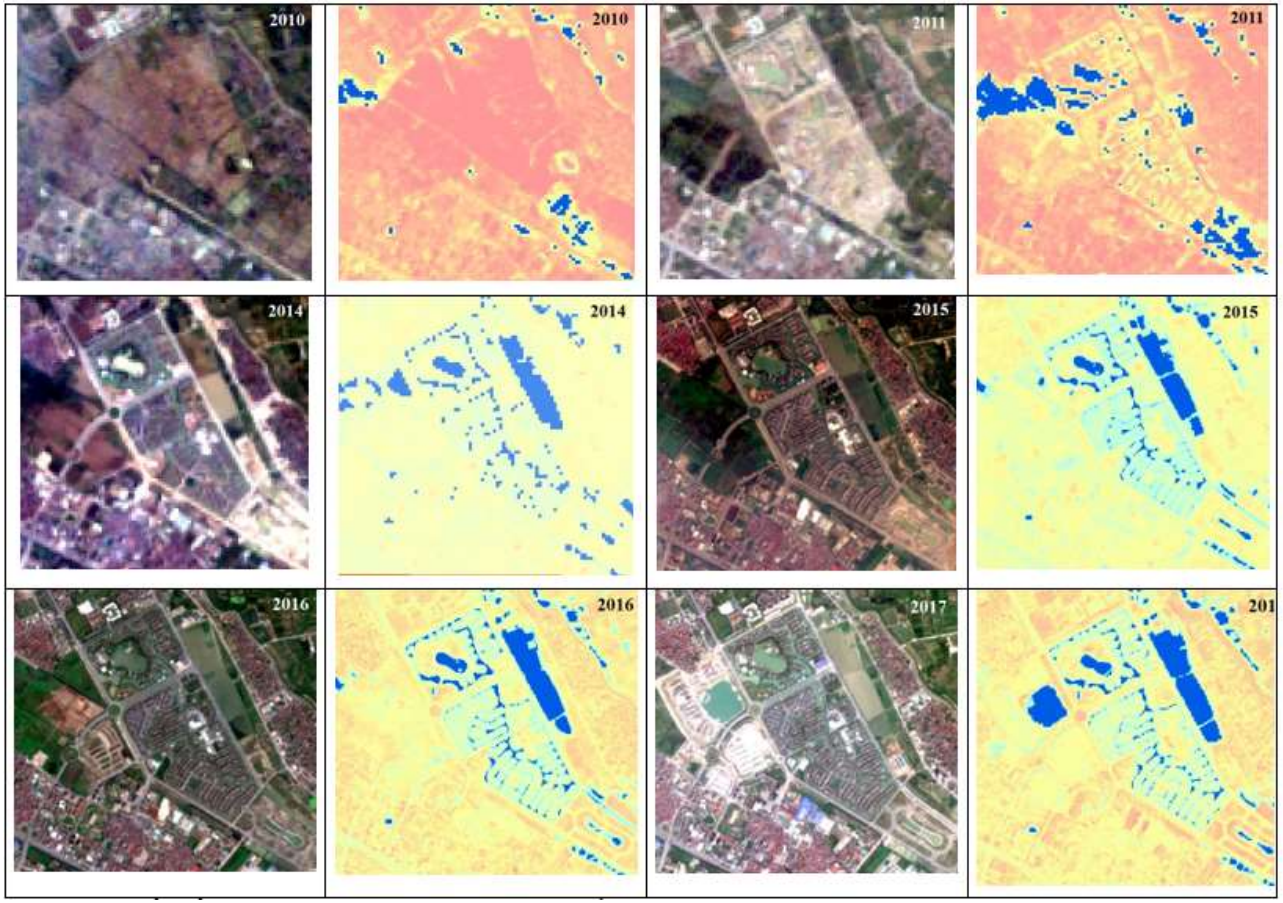


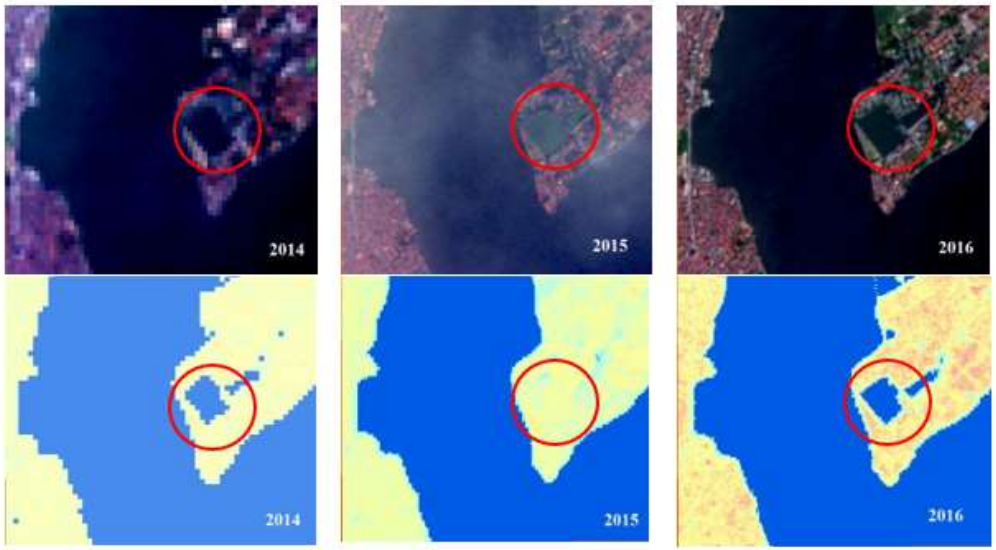
Image of Bac Tu Liem district area

Change in surface water body of VINHOMES RIVERSIDE urban area in Long Bien district in the period of 2010-2017



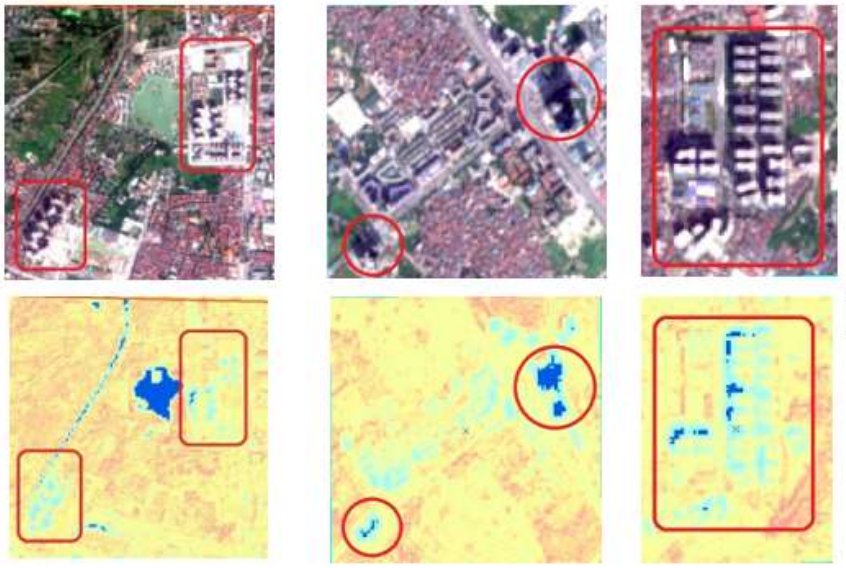
Natural color composite images (left), MNDWI index images (right)

Influence the shadow of the house, the plant element…



Natural color composite images (above) and MNDWI index images (below): Vegetation covers the lake surface in 2015 so using the MNDWI index image does not extract lake surface water. Observing natural images and MNDWI index images of 3 years of 2014, 2015, 2016, we can extract the surface water of that lake.

RapidEye image resolution of 5 m (above), MNDWI index image (below): using RapidEye image to exclude house shadow



Conclusion

- To use, optimize the spectrum bands with better resolution of Sentinel-2 and Landsat images to sharpen the resolution for SWIR bands, and thereby calculating and extracting the water body more accurately
- The optimal thresholds for the study area were estimated and the results were also compared with the data reported in the 2015 Hanoi Lake. We found a good correlation between them.
- This threshold has only been tested with the study area, not consulted and tested with other areas.
- Proposing and using a number of methods to eliminate mistaken objects with water in urban areas based on the shape, size, position of the object, tracking data series, referring to other data ...
- However, the urban surface water body is usually small so this study only assesses whether or not. Detailed assessment of changes in the area of urban surface water bodies requires higher resolution images

Thank you for your attention!