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

Authors: VU Anh Tuan, LE Thi Thu Hang, NGUYEN Hong Quang
Vietnam National Space Center – Vietnam Academy of Science and Technology
Contents

1. Introduction
2. Method
3. Results
4. Conclusion
Introduction

Hanoi (Source: GSO, 2011)
- Area: 3,329 Km²
- Population: 6,6996 M

Area study:
- Area: 481 Km²
- Population: 3,0526M
The change in the number of lakes in Hanoi 2010-2015
(From Hanoi Lake Report 2015)
Method

1. Normal Difference Water Index (NDWI):

\[
NDWI = \frac{\rho_{\text{green}} - \rho_{\text{NIR}}}{\rho_{\text{green}} + \rho_{\text{NIR}}}
\]

2. Modified NDWI (MNDWI)

\[
MNDWI = \frac{\rho_{\text{green}} - \rho_{\text{SWIR}}}{\rho_{\text{green}} + \rho_{\text{SWIR}}}
\]
Data set

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


**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 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.
Landsat pixels are classified to water with value > 0.12;
- Sentinel-2 pixels are classified 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 pixels of houses and trees in urban areas
Correlation coefficient between satellite images and Hanoi water body reported in 2015
Change of water surface

RapidEye images, resolution of $5 \times 5$ 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...

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

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.
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!