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Change detection of Lakes in Pokhara, Nepal using Landsat Data

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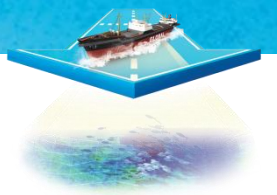
Outline of Presentation

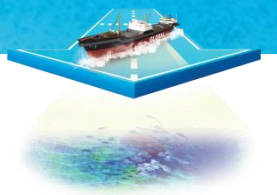
1. Introduction
2. Objective
3. Test site
4. Data
5. Method
6. Results and Discussion
7. Conclusions
8. References

01 Introduction



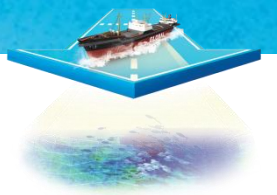
- Pokhara, city of lakes, is second largest and most beautiful tourist place in Nepal.
- Out of seven lakes, the large three: Phew, Begnas and Rupa are famous for tourist attraction, whereas the rest are small and less known.
- These lakes not only provides fresh water for agriculture and aquatic products and attract tourists but also plays equally important role in terms of natural water cycle, climatic regulation, ecological and environmental balance

01 Introduction



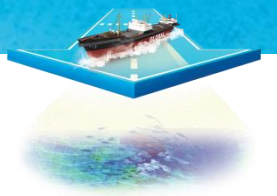
- But, these lakes are facing challenges due to climatic and anthropogenic activities.
- As these changes are slow and takes long time, the damage unnoticed to take measures.
- Hence, long historic data provided provide concrete evidence of change, which help us understand the cause and prevent further change.
- Series of optical remotes sensors such as KOMPSAT, Landsat, SPOT, and Worldview etc. are continuously observing and capturing the earth surface since last four decades.

01 Introduction



- Surface water study and change has its own importance.
- Landsat series are the most common optical remote sensors for mapping of waterbodies.
- Numerous water extraction algorithms for optical remote-sensing images have been developed.
- Unsupervised methods, due to the ease of use, low computational cost, and the fact that less human knowledge is needed are easy and popular ones.
- NDWI, MNDWI etc. used with threshold Zero for unsupervised classification of surface waters in Landsat series data.

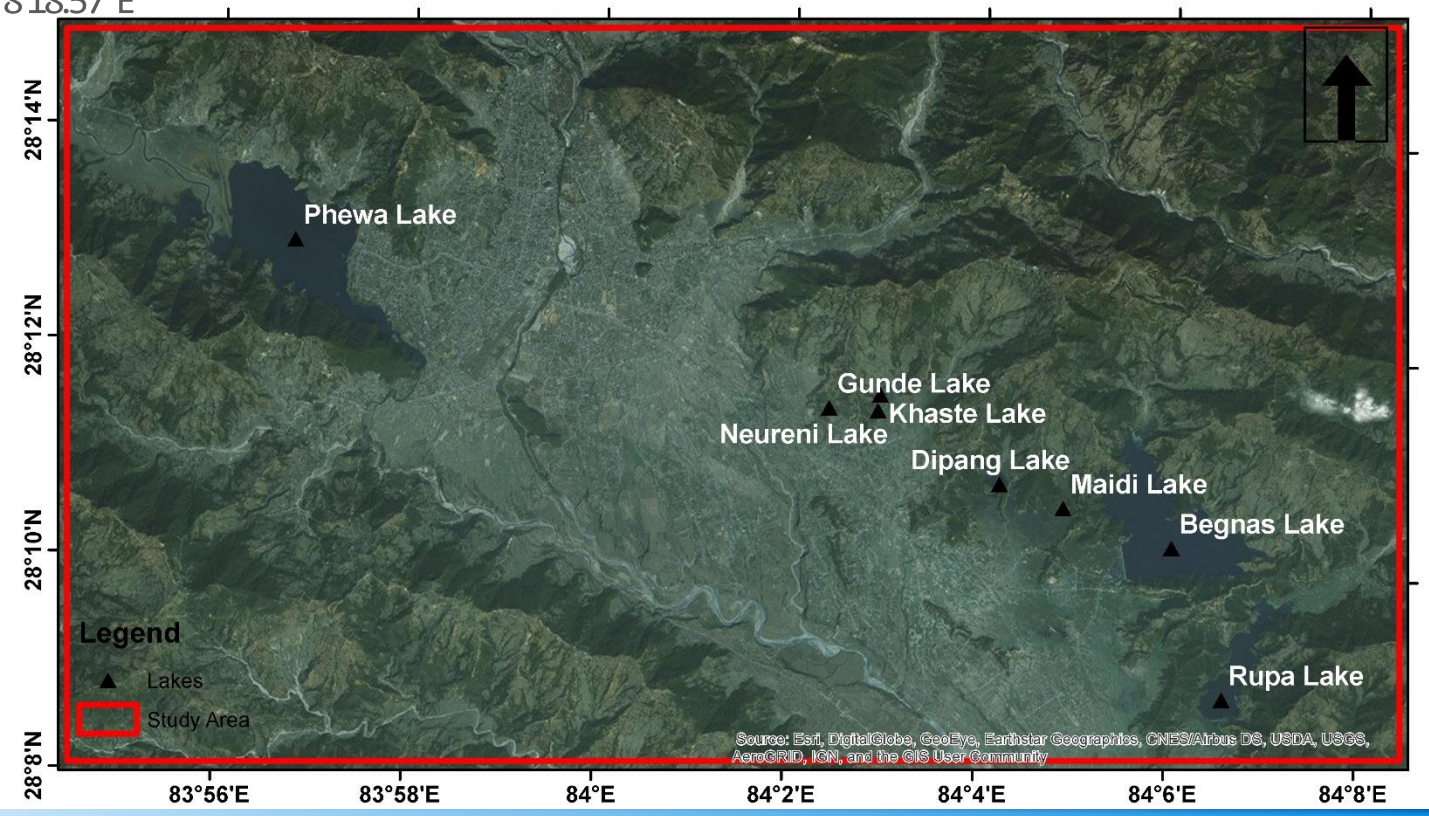
02 Objective



- Use the water indices to detect the change of lakes in Pokhara city using Landsat data of 25 years gap. Following indices were used :
  - Normalized Difference Vegetation Index (NDVI) ,
  - Normalized Difference Water Index (NDWI), and
  - Modified Normalized Difference Water Index (MNDWI)
- Examine the ability of water indices unsupervised for change de tection.
- Detect change and compare the performance of the results am ong the methods.

03 Test site

- Pokhara city
- Around seven lakes.
- Geographically bounded:
  - 28° 08'2.56"N to 28°15'9.85"N
  - 83°54'30.20"E to 84° 8'18.57"E



04 Data

- Mid resolution Landsat series satellite image. (GLOVIS)
- Similar season.
- Preprocessed for radiometric calibration and area of interest extraction.
- NDVI, NDWI and MNDWI derived.

Specification of Landsat TM, and OLI data used in the study.

Satellite	Sensor	Path/Row	Year	Resolution	Wavelength
Landsat 5	TM	142/40	1988	30	Band 1: 0.45–0.52 Band 2: 0.52–0.60 Band 3: 0.63–0.69 Band 4: 0.76–0.90 Band 5: 1.55–1.75 Band 7: 2.08–2.35
Landsat 8	OLI		2013		Band 1: 0.435–0.451 Band 2: 0.452–0.512 Band 3: 0.533–0.590 Band 4: 0.636–0.673 Band 5: 0.851–0.879 Band 6: 1.566–1.651 Band 7: 2.107–2.294 Band 9: 1.363–1.384

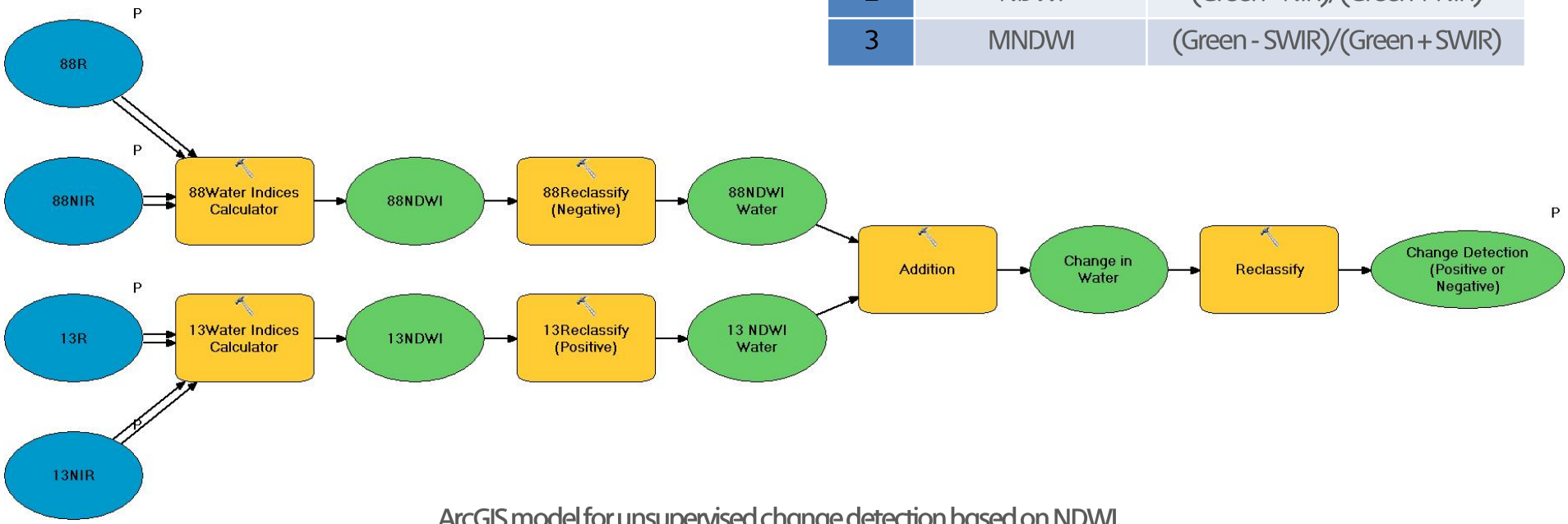
05 Method

- Three cases:
  - Normalized Difference Vegetation Index (NDVI) ,
  - Normalized Difference Water Index (NDWI), and
  - Modified Normalized Difference Water Index (MNDWI)

Formulae of spectral Indices applied in the study area.

S. No.	Spectral indices	Formula
1	NDVI	(NIR - Red)/(NIR+ Red)
2	NDWI	(Green - NIR)/(Green + NIR)
3	MNDWI	(Green - SWIR)/(Green + SWIR)

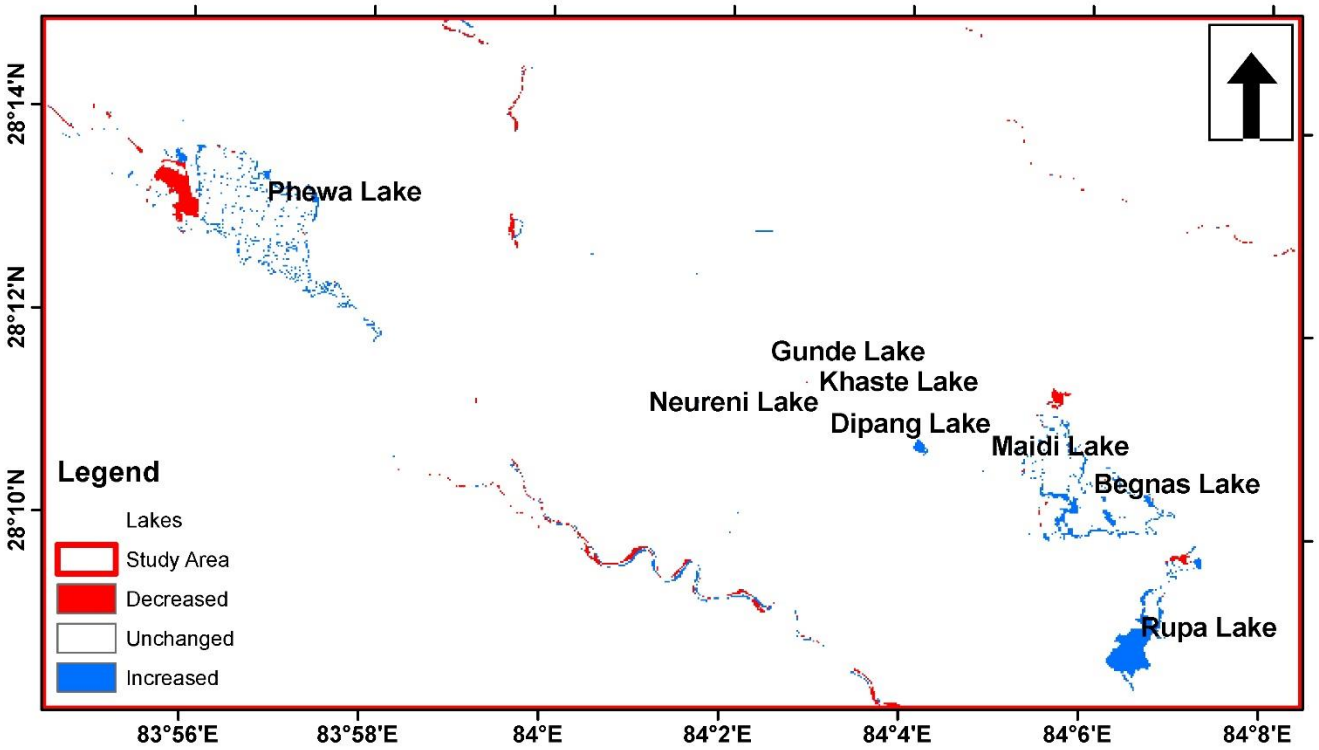
- Model developed for NDWI in ArcGIS:



ArcGIS model for unsupervised change detection based on NDWI.

06 Results and Discussion

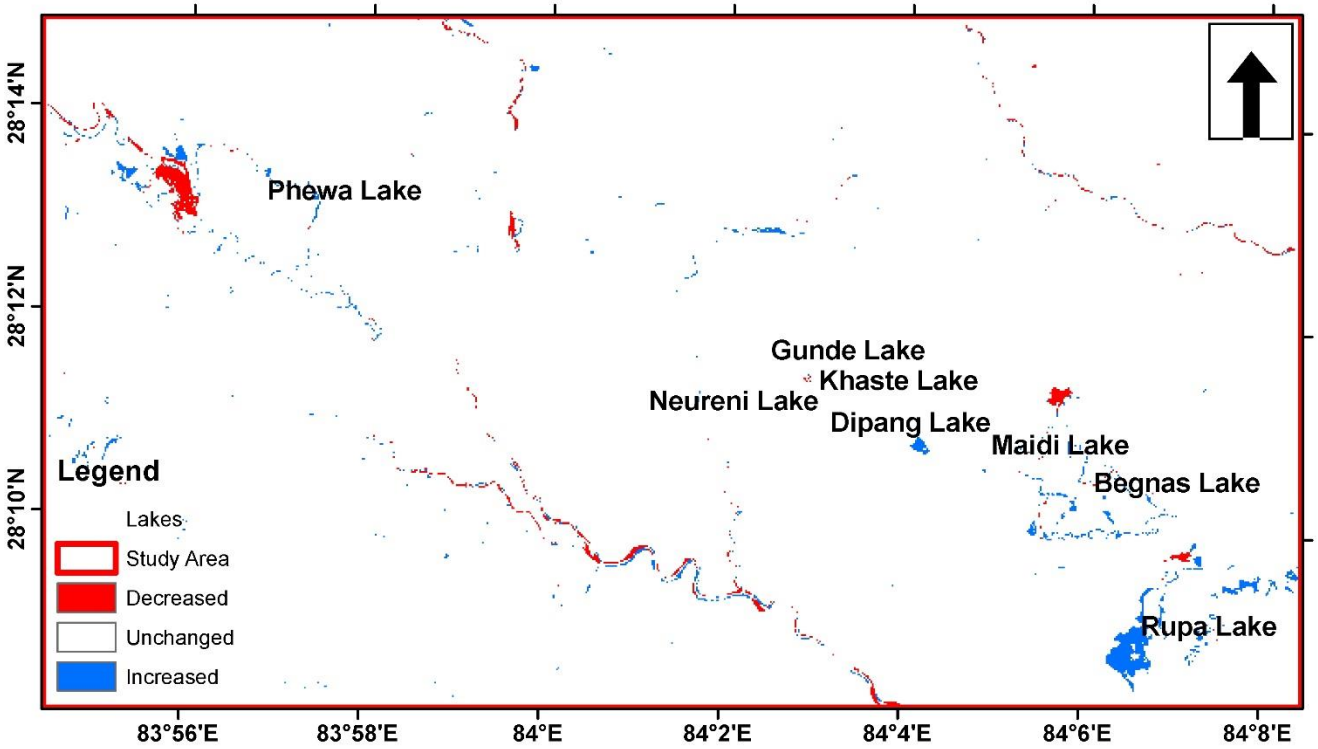
- Change is visible but much salt and pepper effect.
- The issue could be due to threshold issue.



NDVI based

06 Results and Discussion

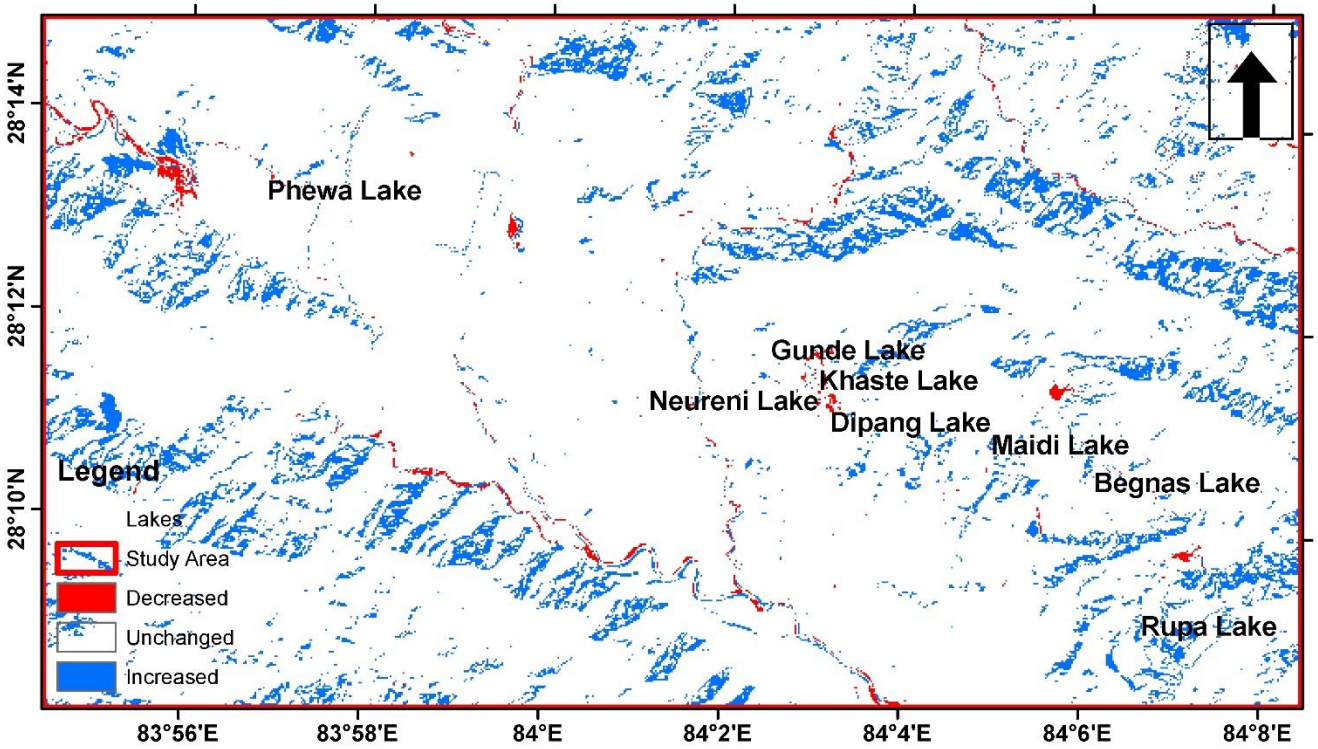
- NDWI shows much better change in surface area.
- Phewa Begnas and Rupa has more change and Dipang is shows with additio n of water surface.



NDWI based

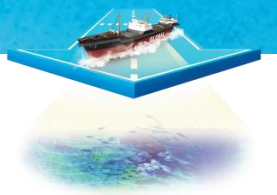
06 Results and Discussion

- Poor change detection, misclassified hillside shadows.
- Not perfect threshold for binary classification.



MNDWI based

07 Conclusions



- For smaller lakes, mid resolution Landsat image pixels were unable to detect the water whereas for larger ones, they were successful.
- NDWI , NDVI shows better change detection than MNDWI, which sho ws change in larger lakes Phewa, Begnas and Rupa.
- The result can be very useful in countries like Nepal where areas cann ot be field visited are difficult or the area of water related disasters like flood or debris dam.
- Similar methodology can be adopted to other specific interest based on the suitable detection indices such as built-up area, agriculture.

08 References

1. Li, L.; Xia, H.; Li, Z.; Zhang, Z. Temporal-Spatial Evolution Analysis of Lake Size-Distribution in the Middle and Lower Yangtze River Basin using Landsat Imagery Data. *Remote Sensing* **2015**, *7*, 10364-10384.
2. Jiang, H.; Feng, M.; Zhu, Y.; Lu, N.; Huang, J.; Xiao, T. An Automated Method for Extracting Rivers and Lakes from Landsat Imagery. *Remote Sensing* **2014**, *6*, 5067.
3. Rokni, K.; Ahmad, A.; Selamat, A.; Hazini, S. Water Feature Extraction and Change Detection using Multitemporal Landsat Imagery. *Remote Sensing* **2014**, *6*, 4173.
4. Acharya, T.D.; Lee, D.H.; Yang, I.T.; Lee, J.K. Identification of Water Bodies in a Landsat 8 OLI Image using a J48 Decision Tree. *Sensors* **2016**, *16*, 1075.
5. Frazier, P.S.; Page, K.J. Water Body Detection and Delineation with Landsat TM Data. *Photogramm. Eng. Remote Sensing* **2000**, *66*, 1461-1468.
6. Tulbure, M.G.; Broich, M.; Stehman, S.V.; Kommareddy, A. Surface Water Extent Dynamics from Three Decades of Seasonally Continuous Landsat Time Series at Subcontinental Scale in a Semi-Arid Region. *Remote Sens. Environ.* **2016**, *178*, 142-157.
7. Sivanpillai, R.; Miller, S.N. Improvements in Mapping Water Bodies using ASTER Data. *Ecological Informatics* **2010**, *5*, 73-78.
8. McIver, D.K.; Friedl, M.A. Using Prior Probabilities in Decision-Tree Classification of Remotely Sensed Data. *Remote Sens. Environ.* **2002**, *81*, 253-261.
9. Sethre, P.R.; Rundquist, B.C.; Todhunter, P.E. Remote Detection of Prairie Pothole Ponds in the Devils Lake Basin, North Dakota. *GIScience & Remote Sensing* **2005**, *42*, 277-296.
10. Du, Z.; Linghu, B.; Ling, F.; Li, W.; Tian, W.; Wang, H.; Gui, Y.; Sun, B.; Zhang, X. Estimating Surface Water Area Changes using Time-Series Landsat Data in the Qingjiang River Basin, China. *Journal of Applied Remote Sensing* **2012**, *6*, 063609-063609.
11. Feyisa, G.L.; Meilby, H.; Fensholt, R.; Proud, S.R. Automated Water Extraction Index: A New Technique for Surface Water Mapping using Landsat Imagery. *Remote Sens. Environ.* **2014**, *140*, 23-35.

08 References

12. Feyisa, G.L.; Meilby, H.; Fensholt, R.; Proud, S.R. Automated Water Extraction Index: A New Technique for Surface Water Mapping using Landsat Imagery. *Remote Sens. Environ.* **2014**, *140*, 23-35.
13. Ji, L.; Zhang, L.; Wylie, B. Analysis of Dynamic Thresholds for the Normalized Difference Water Index. *Photogrammetric Engineering & Remote Sensing* **2009**, *75*, 1307-1317.
14. Xu, H. Modification of Normalised Difference Water Index (NDWI) to Enhance Open Water Features in Remotely Sense d Imagery. *Int. J. Remote Sens.* **2006**, *27*, 3025-3033.
15. Rogers, A.S.; Kearney, M.S. Reducing Signature Variability in Unmixing Coastal Marsh Thematic Mapper Scenes using S pectral Indices. *Int. J. Remote Sens.* **2004**, *25*, 2317-2335.
16. McFEETERS, S.K. The use of the Normalized Difference Water Index (NDWI) in the Delineation of Open Water Features. *I nt. J. Remote Sens.* **1996**, *17*, 1425-1432.
17. Tulbure, M.G.; Broich, M. Spatiotemporal Dynamic of Surface Water Bodies using Landsat Time-Series Data from 1999 t o 2011. *ISPRS Journal of Photogrammetry and Remote Sensing* **2013**, *79*, 44-52.
18. Malahlela, O.E. Inland Waterbody Mapping: Towards Improving Discrimination and Extraction of Inland Surface Water Features. *Int. J. Remote Sens.* **2016**, *37*, 4574-4589.
19. Xie, H.; Luo, X.; Xu, X.; Pan, H.; Tong, X. Evaluation of Landsat 8 OLI Imagery for Unsupervised Inland Water Extraction. *I nt. J. Remote Sens.* **2016**, *37*, 1826-1844.
20. Rouse Jr, J.; Haas, R.; Schell, J.; Deering, D. Monitoring Vegetation Systems in the Great Plains with ERTS. *NASA special p ublication* **1974**, *351*, 309.

Thank You !!!