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Research Article

URBAN LAND PLANNING AND CHANGE DETECTION USING SATELLITE IMAGES (CASE STUDY: ANZALI WETLAND WATERSHED)

Borhan Riazi, Seyed Masoud Monavari, *Ali Bali, Nematollah Khorasani and Mir Masoud Kheirkhah Zarkesh
Department of Environmental Science, Science and Research Branch,
Islamic Azad University, Tehran, Iran
**Author for Correspondence*

ABSTRACT
Using satellite data in investigating land spatial changes stands as a significant tool in prompt planning regarding environmental monitoring and management. In recent decades, unwise land use in Anzali Wetland Watershed, Guilan, Iran has caused widespread pollution and destruction. The present study took advantage of multi temporal images from MSS1975, TM 1989, ETM+ 2000, and IRS-lissШ 2007 to investigate land use change during a 32-year time span based on six land use classes. In order to categorize the uses into classes, maximum likelihood by average and pilot data covariance matrix was employed. The results showed widespread land use change in a way that urban land use expanded from 4,878 in 1975 to 19,089ha in 2007.

Keywords: *Anzali Wetland, Urban Development, Satellite Images, Land Conversion*

INTRODUCTION

Land conversion for development purposes along with population growth has caused rapid change in land use and land cover leading to environmental destruction. Physical expansion of cities in recent years induced issues such as loss of agricultural and forest lands and increase in marginalization (FAO, 2007). Growing trend in land use conversion, especially in the recent two decades, has greatly affected ecological existence of fragile, vulnerable ecosystems, including forest lands, resulting in natural use reduction and the consequent agricultural and urban conversion (FAO, 2010). As traditional methods of land use detection are time consuming and costly, employing multi temporal satellite images and digital maps has widely gained grounds (Dontree, 2003). Residential expansion in response to population and economic growth is deemed inevitable. However, good management decisions as well as selecting new sites for urban development can minimize imprudent land conversion (Ashraf & Yamaguchi, 2009).

Research on land conversion across Sindh watershed, Pakistan by using the 1978's, 1990's, and 1998's satellite images suggests a 21,990-hectar forest land shrink, mainly due to forest land conversion to agriculture use as well as agricultural land to urban use (Siddiqui *et al.*, 2004). In addition, in Montana, USA, integrating environmental, economic, and social parameters with spatial data from 1860-2000 and the linear modeling of these revealed an ongoing conversion of agricultural and forest land to either urban or various agricultural uses (Richard, 2003). In Oaxaca, Mexico, pine forest area experienced a change from 4.18% to 2.5%; evergreen rain forest from 14.64% to 8.89%; and agricultural lands from 6.68 to 8.11% - during 1980 and 2000 (Gomez-Mendozaa, 2006). Also, to investigate coastal land cover along northern Egypt, TM and ETM+ images from 1987 and 2001 were utilized (Shalaby and Tateishi, 2007). Urban development is one of the most significant factors triggering land conversion. Other studies in the US demonstrated urban development by 34% between 1982 and 1997, mostly because of agricultural and forest land conversion. Furthermore, based on studies conducted in Beijing, China by landsat TM satellite images from 1986, 1991, 1996, and 2001, change in different land uses was determined. The results showed that most of the land use change took place in the urban area (Wu *et al.*, 2006). Similar studies suggest that land use in China has undergone considerable alteration since the 1980's (Wu *et al.*, 2006). Land use and land cover change in Dhaka, Bangladesh, was modeled by remote sensing to investigate and

foresee appropriate lands for urban development (Ashraf & Yamaguchi, 2009). Land cover change in Egyptian lands was also studied by multi-range data. This study analyzed the precision of multi temporal data as well as trends in land cover change (Bakr *et al.*, 2010). Additionally, Dontree produced vegetation maps and investigated forest land conversion to agriculture in Thai forests in 1972, 1989, and 2002 employing MSS, TM, and ETM images (Dontree, 2003). Tipaniat and Nitin used landsat satellite images form 1995, 2000, and 2002 accompanied by RGB-NDVI technique to monitor mangrove forest area change (Tipaniat and Nitin, 2003).
Accordingly, the present study aims at investigating land use change and growing trend in urban habitat development, which plays a crucial role in pollution increase in Anzali Watershed in northern Iran.

MATERIALS AND METHODS
Anzali Wetland Watershed (AWW) constitutes a small part of the Caspian Sea Watershed. The latter has an area of 360,200km^2, including AWW (a Ramsar site). AWW elevation ranges between 25 to 3105m (JICA, 2005). This watershed encompasses low, flat plains, mountainous area, and Anzali Wetland. Figure 1 demonstrates AWW's geographical location in Iran and Guilan Province.

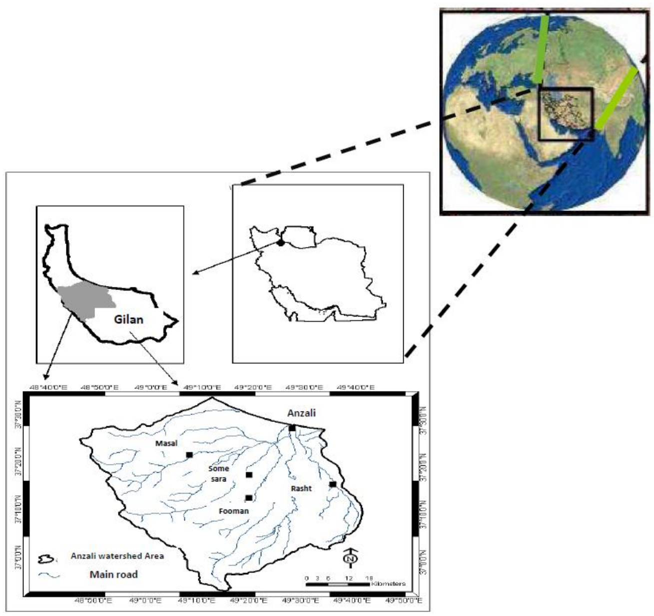

Figure 1: ***Global and national location of AWW***

In this study, topographical maps at a scale of 1:250,000, satellite images from MSS (1975), TM (1990), ETM (2000), and IRS (2007) together with GPS data form fieldwork were used. Relative geometric correction and gray level reduction were executed by nearest neighbor and image correction. In addition, 40 control points were determined for terrestrial reference. The resulting maps from the satellite date classification were compared with the field facts from the control samples by using maximum probability algorithm to verify the maps. After producing the final land use maps by NDVI, Cross Tabulation (the most common and suitable change detection technique) was employed to make a pair wise comparison between maps belonging to each time span in order to determine the extent and trend of land use change. This technique has proved to be the most effective due to independent, simultaneous use of two images and less normalizing issue concerning sensors and atmospheric conditions. Once the quantities of different land uses during different periods were determined, their changes were calculated through corresponding equations including post classification analysis, i.e. each land use change by percent or hectare in certain period. Figure 2 depicts the research process.

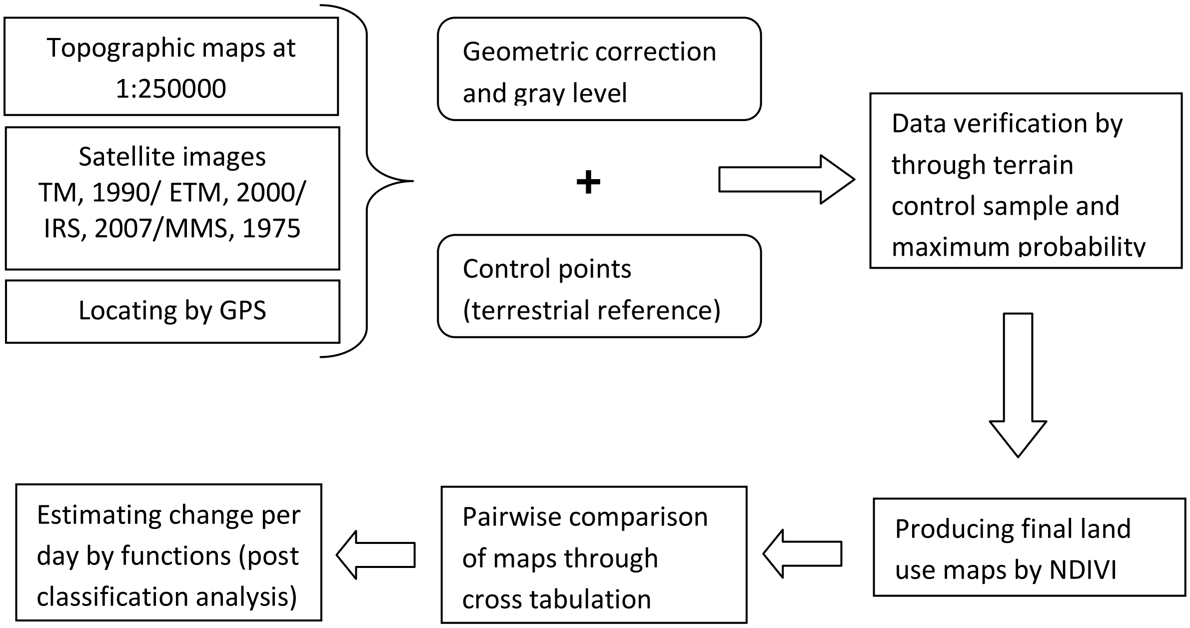

Figure 2: Research process

RESULTS AND DISCUSSION

Results

Overall, six land use classes were detected within the area, including natural vegetation, agricultural and horticultural land use, urban and constructed land, land with poor vegetation and wasteland, wetlands, and water resources. Resolution of land use maps amounted to 68.8, 86.8, 88.7, and 82.5 percent for 1975, 1989, 2000, and 2009 respectively. The change detection results showed that natural vegetation conversion to urban land use during 1975 and 1989, 1989 and 2000, and 2000 and 2007 equaled 1,298ha, 1,583ha, and 497ha respectively (Table 1). In the case of agricultural and horticultural land converted to urban use, the conversion amounted to 3198ha between 1975 and 1989, 3,606ha between 1989 and 2000, and 2,209ha between 2000 and 2007.

Table 1: Estimated land use in AWW, 1975-2007

Land use (ha)	1975	1989	2000	2007	Change tendency
Natural land cover	165,024	158,978	154,279	132,734	Decreasing
Agriculture and horticulture use	128,690	111,828	118,437	120,655	Decreasing
Land with Poor vegetation and wasteland	41,725	56,667	55,142	70,798	Increasing
Wetlands	10,207	10,182	6,902	6,495	Decreasing
Water resources	8550.54	8457.93	8434.35	9303.21	Increasing
Constructed land	4,878	12,961	15,879	19,090	Increasing

Table 2: Land conversion to urban use and construction in AWW

Time period Use class	**1975-1989 (ha)**	**1989-2000 (ha)**	**2000-2007 (ha)**	**Change rate (- or +)**
Natural land cover	1,298	1,583	497	-
Agricultural and horticultural land	3,198	3,603	2,209	-
Land with poor vegetation and wasteland	2,765	3,464	678	-
Wetlands	103.08	125	80.82	-

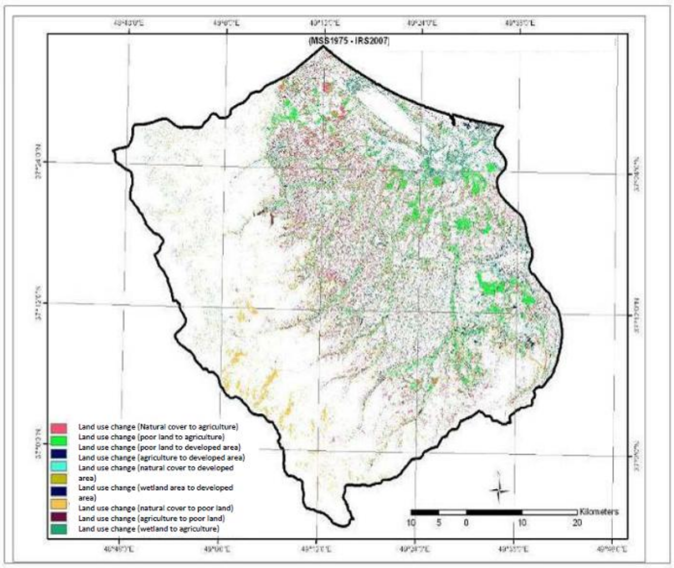

Figure 3: Land use change in AWW (1975-1985)

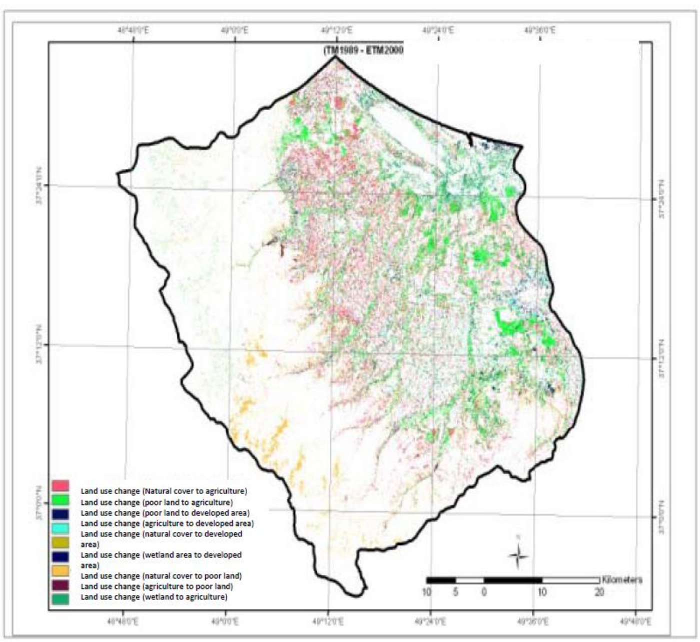

Figure 4: Land use change in AWW (1989-2000)

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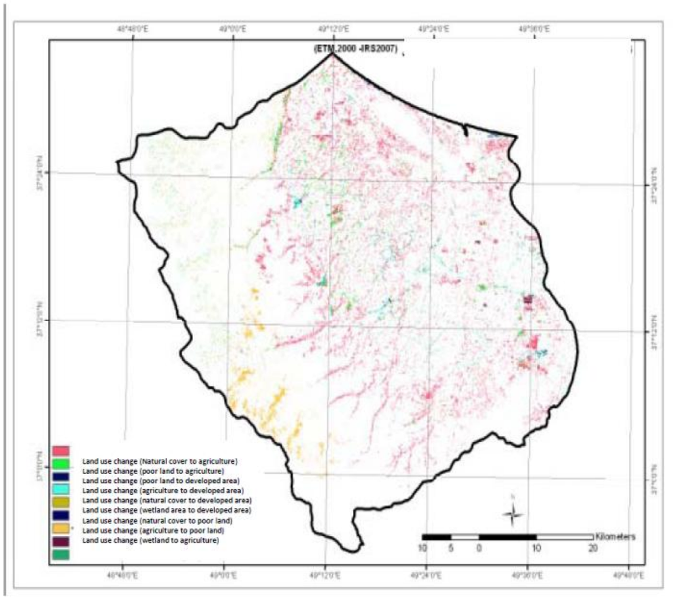

Figure 5: Land use channge in AWW (2000-2007)

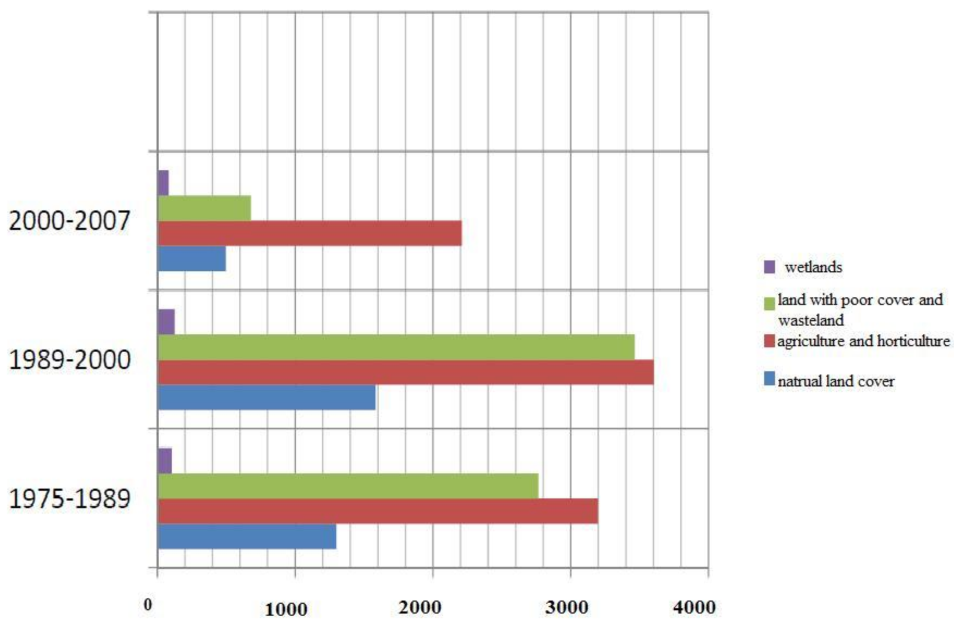

Figure 6: Comparison between various land use conversions in AWW (1975-2007)

The conversion of the land with poor vegetation and wasteland to urban use during 1975 and 1989 was 2,765ha; between 1989 and 2000 was 3,464ha; and during 2000 and 2007 was 678ha. Moreover, during the 1975-1989 periods an area of 103ha of wetland area was transformed to urban use. This was 125ha for 1989-2000, and 81ha for 2000-2007. As it can be seen the furthest conversion took place in the latter time span. Table 2 and Figures 3 to 6 above demonstrate these changes in the time spans investigated.

Discussion and Conclusion

Also, Alig's (2010) and Zhang's and Zhang's (2007) findings introduce similar results in terms of rapid urban development and forest and agricultural land withdrawal. In the study area in all periods, urban land expanded mainly because of population growth and infrastructure development in a way that farmlands, margin of some wetlands, and part of forests at the edge of villages were allocated to urban use – which is in line with Dontree (2003), Zhang and Zhange (2007), and Kramer *et al.*, (2007). Furthermore, Anzali Wetland area diminished during the time span under investigation mostly because agriculture and aquaculture developed in the adjacent villages. Additionally, water body area showed increase which mainly happened because of additional fish ponds for aquaculture. The study results suggest relative change in the patterns of natural resources management and urban development in that natural land destruction lowered over time because of better environmental conservation management and control over land conversion.

Recommendations for slowing down land conversion include finding new sites for urban and industrial development based on ecological capability; conducting land use planning to determine natural potential of land at national and regional level based on the existing natural, socioeconomic and cultural resources; introducing effective management models for land management; monitoring annual land management by RS; implementing conservation plans in forest lands and halting their conversion; and aiding farmers in preventing agricultural land conversion.

REFERENCES

Alig RJ, Latta GS, Adams DM and McCarl BA (2010). Mitigation greenhouse gases: the importance of land base interaction between forests, agriculture and residential development in the face of changes in bioenergy and carbon prices. *Forest Policy and Economics* **12**(1) 67-75.

Ashraf M and Yamaguchi Y (2009). Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. *Applied Geography* **29** 390-401.

Bakr N *et al.*, (2010). Monitoring land cover changes in a newly reclaimed area of Egypt using multi-temporal Land Sat data. *Applied Geography* 1-14.

Chavez PS (1996). Image-based atmospheric corrections-Revisited and improved. *Photogrammetric Engineering and Remote Sensing* **62** 1025-1036.

Dontree S (2003). Land use dynamics from multi temporal remotely-sensed data: a case study Northern Thailand – *Proceedings of Map Asia 2003 Conference*, Malaysia.

FAO (2007). FAO. Available: http://www.fao.org.

FAO (2010). FAO. Available: http://www.fao.org.

Gomez-Mendozaa LE, Vega-Penab MI, Palacio-Prietoa J and Galicia L (2006). Projecting land-use change processes in the Sierra Norte of Oaxaca, Mexico. *Applied Geography* **26** 276–290.

JICA (2005). Anzali watershed master plan. Report for Department of Environment of Iran.

Kramer E *et al.*, (2007). Monitoring Georgia's Wetland Trends Using remote Sensing, *Georgia Water Resources Conference*. University of Georgia.

Richard A (2003). Modeling of land use change in Montana from 1860 to 2000. *Applied Geography* **25** 47 – 63.

Robert E Kennedy *et al.*, (2009). Remote sensing change detection tools for natural resource managers: Understanding concepts and tradeoffs in the design of landscape monitoring projects. *Remote Sensing of Environment* **113** 1382-1396.

Shalaby A and Tateishi R (2007). Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the Northwestern coastal zone of Egypt. *Applied Geography* **27** 28 – 41.

Siddiqui MN, Jamil Z and Afsar J (2004). Monitoring changes in reverie forests of Sindh-Pakistan using remote sensing and GIS techniques. *Advances in Space Research* **33** 333–337.

Tipaniat U and Nitin KT (2003). A satellite based monitoring of changes in mangroves in Krabi, Thailand. *Proceedings of Map Asia Conference 2003, Malaysia*.

Wu Q *et al.*, (2006). Monitoring and predicting land use change in Beijing using remote sensing and GIS. *Landscape and Urban Planning* **78** 322–33.

Zhang J and Zhang Y (2007). Remote sensing research issues of the National Land use Change Program of China. *ISPRS Journal of Photogrammetric & Remote Sensing*.