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Rural sustainability under threat– The assessment of land use changes to urban area and its impact on surroundings rural settlements

Parvaneh Jalerajabi[1,*] , Reza Ahmadian[2]

Abctract

In developing countries, urban development and rural to urban transition usually takes place in an unmanaged way and they are associated with a series of socio-economical and environmental issues and problems. Urban growth has enlarged the modification of natural resources and has changed land use and land cover patterns in these countries. Land-use and land-cover change, as one of the main driving forces of global environmental change, is central to the sustainable development debate. Rapid land use/cover changes leading to the degradation of natural resourses that are major problems impeding sustainable development. Detection of such changes may help decision makers and planners to understand the factors in land use and land cover changes in order to take effective measures and can help them to minimize these negative impacts. Remote sensing and GIS techniques may be used as efficient tools to detect and assess land use/cover changes. In this work Zanjan city have taken as case to study the urban expansion and land cover change that took place in a span of 27 years from 1984 to 2011. Zanjan has experienced a huge urban growth during the last three decades. This transition has led to the destruction of natural and agricultural lands and rural settlements. In this paper, using Landsat Satellite images in 1984, 1991, 2000 and 2011 land use changes in Zanjan city area were evaluated. In order to detect and evaluate land use changes, image differencing, principal component analyses and Fuzzy ARTMAP classification method are applied. The results revealed that the land use change has occurred for the area of about 4518.32 hectares in the period 1984-2011 in built up area and dry farming and regolith and waste land have most change to built -up area that respectively 1986.84 and 2520.63 hectares. These changes have led to merger of two of the rural settlements including Sayan and Gavazang in Zanjan city.

Keywords: *Sustainable development, Urban growth, Rural to urban transition, Land use change*

1- PHD student of Islamic Azad University- Sceince and Research Branch of Tehran
2- Assistant Professor Of Islamic Azad University- Central Branch of Tehran
Email : *Parvaneh.jalerajabi@gmail.com*

1. Introduction

Cities in both developed and developing countries are experiencing huge urban and population overgrowth and rural to urban transition. Urban growth that is defined as change in traditional physical texture and function of a rural landscape into an urban form (Thapa and Murayama 2011) indicates the spatial and temporal dimensions of land cover/land use change at the level of the urban landscape (Cheng 2003). In fact, many cities are rapidly growing at their fringes, engulfing villages and farmlands and transforming them into dense industrial and commercial areas, or less dense suburban developments(Huang., Zhang and Wu 2009). Unmanaged Urban Growth has led to consumption of land resources and degradation of vast areas of suitable lands and their conversion into impervious surfaces. In many cases, these alterations have occurred without an understanding of their consequences. In order to analyze land conversion in cities, Current technologies such as Geographical Information Systems (GIS) and remote sensing provide a cost effective and accurate alternative to understanding landscape dynamics.These methods can be used as innovative tools to support spatial urban planning for sustainable development (Zanganeh Shahraki et al. 2011). The digital data form of satellite imageries helps in maintaining the Spatial Data Infrastructure (SDI) which is very essential for monitoring urban expansion and change detections studies(Sundarakumar et al. 2012). The remote sensing satellite data in multi-resolution and multispectral means to provide spatial information for land cover/ land use at different levels for various aspects as built-up land, agricultural land, forests, wastelands and water bodies etc. So, the land cover/land use maps prepared using multi-data and multispectral data provides different levels of spatial information which are used in change detection studies (Lo 1981).

Various remote sensing techniques have been used in the literature to detect changes in different environments over time. Many researchers have employed satellite imagery for land use mapping as well as change detection. In these studies remote sensing tools have been used along with change detection techniques, to assess the changes in land use and land cover over time. Change detection techniques have been reviewed by many authors. Singh, (1989), Lu et al. (2004) and Coppin et al. (2004) have reviewed the most important change detection techniques. They listed univariate image differencing, image regression, image rationing, change vector analysis (CVA), background subtraction, principal component analysis (PCA), vegetation indices differencing, Chi-square method, artificial neural network (ANN) and different classification methods, as the most frequently used techniques used by different researchers (Burrough 1986), (Singh 1989), (Lu et al. 2004). Sunar (1996) has compared the results of five different techniques: band combination, subtraction, band division, principal component analysis and classification, in Ekitally, Turkey(Coppin et al. 2004). This study revealed that the principal component analysis (PCA) shows better results comparing with classification results. Ahadnejad Reveshty (2011) used principal component analyses and Fuzzy Artmap classification method and concluded that this method has very high confidence comparing with other classification methods (Sunar1998).

In the present research, supervised classification based on Fuzzy Artmap is employed to detect land use changes occurred in the Zanjan area, Iran.

2. Material and Methods

In this paper, Landsat TM images captured in 1984, 1991, 2000 and 2011 are employed for digital image processing. "figure 1" shows Landsat TM image were used in this study. Also "figure 2" summarizes the methodology steps. The data used in this study, the pre-processing, and processing procedures are shown in this flowchart and are described in detail in the following sections.

2.1. Study Area

The city of Zanjan, capital of Zanjan Province is located between 36˚38′56" to 36˚42" 22"N and 48˚25′42" to 48˚33′05"E. The study area covers Zanjan city and its surrounding area with 34330.95 hectares that four rural settlements including Sayan, Gavazang, Payeen koh and Do-asb are located in this area. Zanjan population in 1986 was about 215,458 people and its

population has been reached to 386,851 people in 2011, the population growth rate in this period was about 2.2 percent. Sayan and Gavazang population from 1233 and 71 people in 1986 has been reached to 0 people in 2011. Two other rural settlements population has been increased in this period of time.

In this selected Area considerable land use changes have occurred due to urban developments, rural developments, and industrial developments in the east and north-east where these rural settlements are located and that major changes in the crop pattern are ongoing. These changes are assessed in this research using multi temporal satellite imagery and GIS.

2.2. Methods

Various methods have been employed for classification of satellite imagery. Supervised and unsupervised classifications are two commonly used classification methods, which have been followed in many change detection studies. Supervised classification is much more accurate for mapping classes. These methods are based on the quality and quantity of training sample data, and they will provide "a matrix of change information" for the muli-temporal images. However, the most challenging and time consuming step in these methods is to select accurate and high quality training site samples in sufficiently large number (Lu et al. 2004). Fuzzy Artmap is one Supervised classification Method. Recently, artificial fuzzy methods were used widely because they show very high accuracy in comparison with the conventional ones like Maximum Likelihood classification (MLC), inimum distance classification, and Parallelepiped classification (Ahadnejad Reveshty 2011). In this paper, the fuzzy adaptive resonance theory (Fuzzy Artmap) is employed for image classification. First, 741 (RGB) color composites of Landsat images were prepared (figure(1)). Then, training areas were selected for 7 land cover classes, which are built-up area, orchards, irrigated agriculture land, dry farming, water, regolith and waste land. These training areas were determined, referring to aerial photographs and GIS thematic maps. To assess the accuracy of classification, topographic maps and aerial photos were employed. Overall accuracy was estimated to be around 93.%. "Figures 3 to 6" show the results of land use classification and "Table (1)" shows the summary of the classification

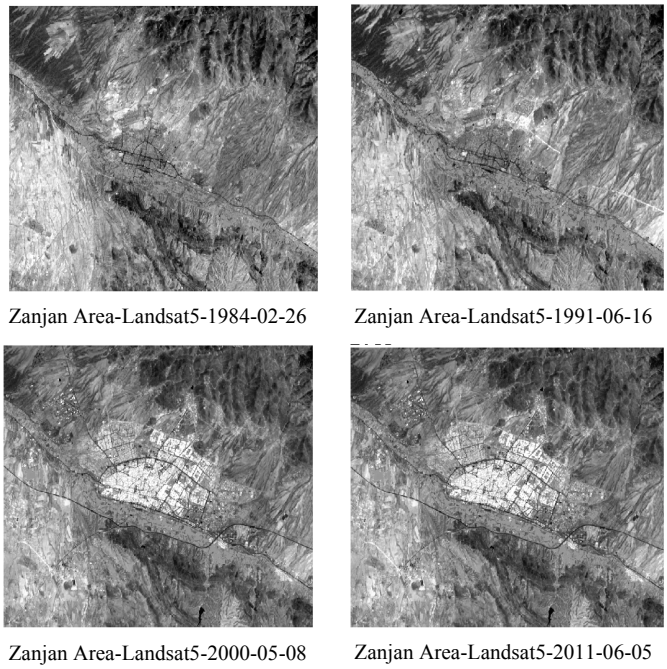

Figure (1). Color composite (RGB= bands 7, 4, 1) of. Landsat TM images

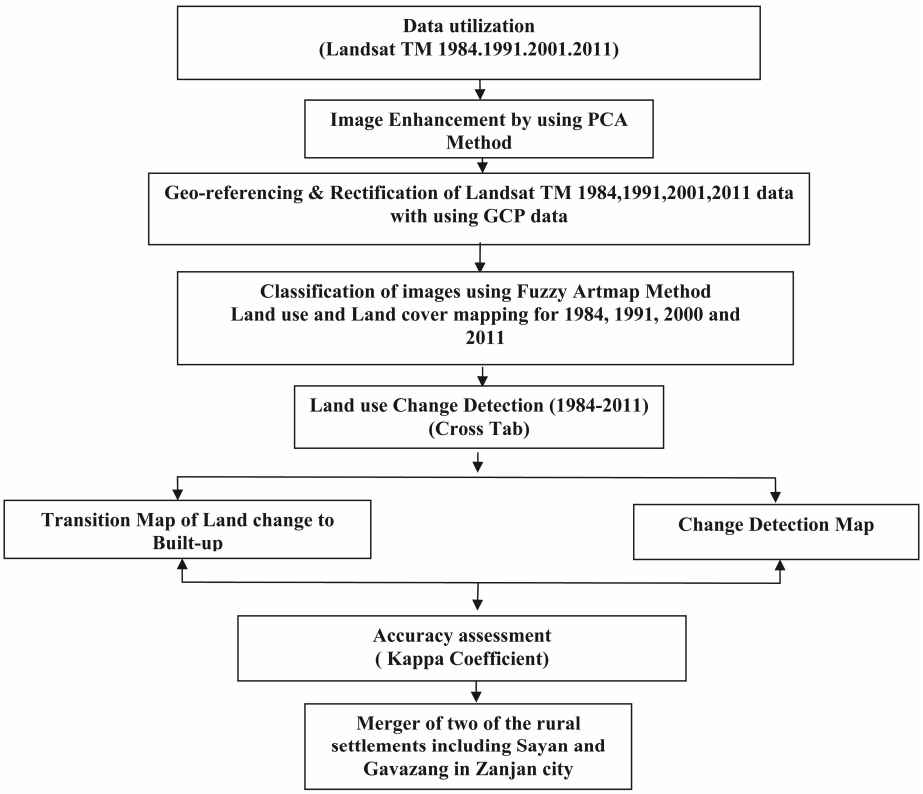

Figure (2). Flow chart showing the major steps research.

3.Results

The classification results for the four different times revealed that the land use of the target area has changed about 25% during the period of 1984-2011. "Table 2" shows the estimated land use transitions based on the comparison of the classification results for the 1984 and 2011 images. The results show that built -up area changed from 2855 hectare in 1984 to 7377 hectare in 2011. Land use changes analysis show that in case study area dry farming and regolith and waste land have most change to built-up area that respectively 1987 and 2521 hectares. Also water body and orchards have minimum changes to built-up area that respectively 32 and 26 hectares. Table (3) shows land use transition to built-up area in case study area during 1984-2011 and "figure 7" shows The areas that have changed to built-up in the period of 1984-2011.

Other analysis related to land use persistence in the period of 1984-2011 in case study area. It means that how much of land use and land cover and what areas have persistence in during of study periods and has not changed. According to this analysis about 15019 hectares of land use and land cover have not any changes and 19265 hectare of land use and land cover has been changed in the study period 1984-2011. "Table 4" shows Estimated land use persistence and changes in the period of 1984-2011. Regolith and Waste land and Pastures with respectively 4272 and 4228 hectare have most persistence in comparing with another land use and Irrigated Agriculture Land with 174 hectare has lowest persistence in case study area. It means Irrigated Agriculture Lands have largely changed to other types of landcovers. Also Waste land with 8011 and dry farming with 6191 hectare have maximum changes and orchards with 203 hectare have minimum changes in Zanjan area between 1984 and 2011.

In general, Land use change has occurred for the area of about 19265 hectares in the period 1984-2011. About 2825 hectares of these changes are related to agriculture lands and pastures. Changing in agriculture lands has

changed the two of rural settlement including Sayan and Gavazang and turned them into the new suburban areas of Zanjan. "figure 8 shows the trend of Zanjn city growth in period 1984-2011 and its impact on changing the rural settlements to new suburban areas. Land use/cover changes of surrounding lands of these rural settlements to urban built-up area that was evaluated in this study, specially dry farming and irrigated agriculture land changes, respectively 245 and 1987 hectare have led to merger of Sayan And Gavazang in Zanjan city.

Table (1). Summery of Land Use Change In Study Area (Hectares)

Class	Landuse Type	1984	1991	2000	2011
1	Built-Up Area	2855	4825	5063	7377
2	Orchards	393	615	1151	966
3	Irrigated Agriculture	1942	1926	236	525
4	Dry Farming	10014	6695	11135	7603
5	Water	49	42	54	40
6	Regolith & Waste land	12283	11006	10218	8716
7	Pastures	6795	9222	6473	9105
	Total	34331	34331	34331	34331

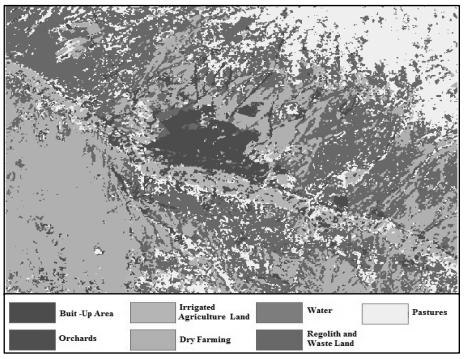

Figure (3). Result of land use classification for Zanjan, Iran using landsat TM image captured in 1984

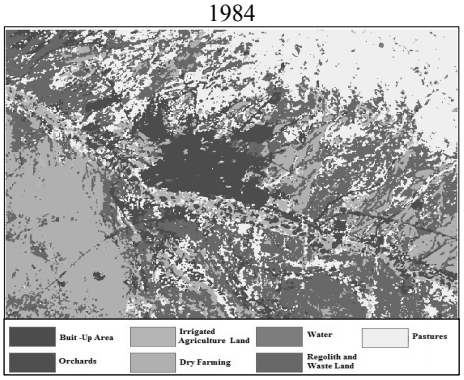

Figure (4). Result of land use classification for Zanjan, Iran using landsat TM image captured in 1991

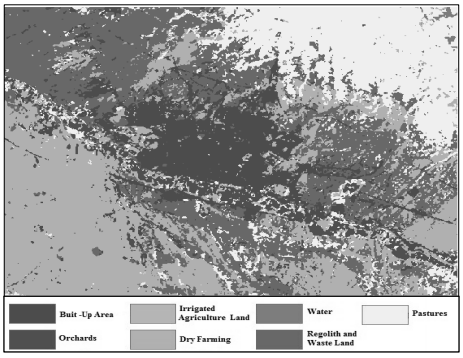

Figure (5). Result of land use classification using Landsat TM image captured in 2000

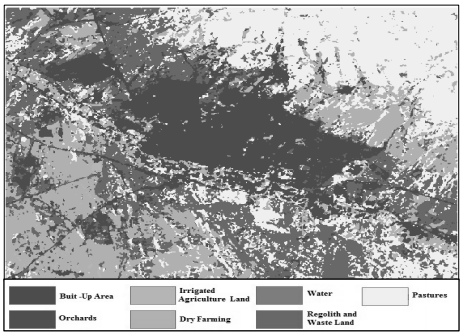

Figure (6). Result of land use classification using Landsat TM image captured in 2000

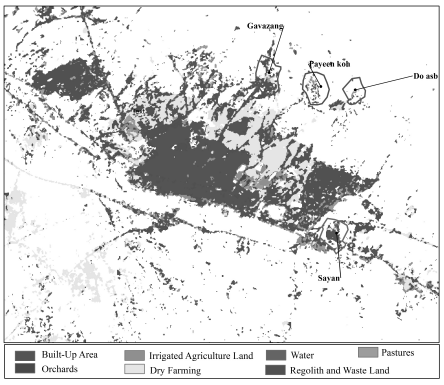

Figure (7). The areas that have changed to built-up in the period of 1984-2011

Table (2). Estimated land use transitions in Zanjan area between 1984 and 2011 (Hectare).

Class	1	2	3	4	5	6	7	∑	
1	2332	-	-	-	-	357	165	2855	8
2	32	190	34	77	-	13	48	393	1
3	245	518	174	603	0	65	336	1942	6
4	1987	90	179	3823	9	2983	944	10014	29
5	26	-	0	2	-	16	4	49	0
6	2521	-	53	2026	21	4272	3389	12283	36
7	593	85	57	792	8	1040	4218	6795	20
∑	7736	882	498	7323	38	8747	9105	34331	
	23	3	1	21	0	25	27		100

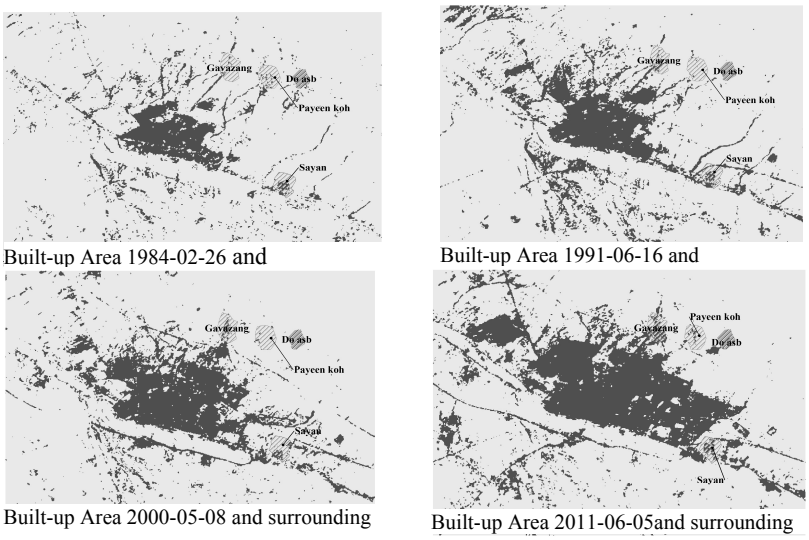

Figure (8). The trend of Zanjn city growth in period 1984-2011
and its impact on changing the rural settlements to new suburban areas

Table (3). Estimated Land Use Transitions to Build-up Area in Case Study Area Between 1984 and 2011 (Hectare)

Class	Landuse Type	1984	2011	Change to built up 1984-2011	Percentage change to built-up
2	Orchards	393	966	32	0.41
3	Irrigated Agriculture	1942	525	245	3.17
4	Dry Farming	10014	7603	1987	25.68
5	Water	49	40	26	0.34
6	Regolith & Waste land	12283	8716	2521	32.58
7	Pastures	6795	9105	593	7.67

Table (4). Estimated Land use Persistence and Changes Zanjan Area During 1984 and 2011 (Hectar)

Class	Landuse Type	land use persistence	land use change
	Built-Up Area	2332	523
2	Orchards	190	203
3	Irrigated Agriculture	174	1768
4	Dry Farming	3823	6191
6	Regolith and Waste land	4272	8011
7	Pastures	4228	2569
	Total	15019	19265

4. Conclusions

From the above study it can be concluded that there is remarkable increase in urban area in Zanjan city. The use of remotely sensed data showed that Zanjan has had a significant change in land use/cover over the last 27 years. Using satellite-derived land use/cover maps (1984, 1991, 2000 and 2011), and Fuzzy Artmap classification method land use changes to urban area and its impact on surroundings rural settlements was recognized.

The study has mentioned remotely sensed data can provide information for effective routine tasks related to environmental inventorying and monitoring.

The results of this study also revealed that dry farming land around major towns and settlements are recognized as critical regions in terms of land use changes, and special protection measures are needed to be taken. In case of improper planning, these regions will be changed to settlements in a very short time, which is totally in contradiction to sustainable development.

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پایداری روستایی در معرض خطر- ارزیابی تغییرات کاربری زمین به حوزه شهری و تأثیر آن بر روی محیط سکونتگاه‌های روستایی

پروانه ژاله رجبی[1,*]، رضا احمدیان[2]

چکیده

در کشورهای در حال توسعه، توسعه شهری و گذار از شرایط روستایی به شهری، معمولاً به شکل بدون مدیریت اتفاق می‌افتد. با مشکلات و موضوعات محیطی و اقتصادی- اجتماعی همراه است. رشد شهری اصلاحات منابع طبیعی را افزایش داده الگوهای پوشش زمین و کاربری آن را در این کشورها تغییر داده است. تغییرات کاربری و پوشش زمین که به‌عنوان یکی از نیروهای محرک تغییرات محیطی کلی است، از مباحث اصلی توسعه پایدار است. تغییرات سریع پوشش و کاربری زمین به افت منابع طبیعی که مشکل مهم بازدارنده توسعه پایدار است، منجر شده است.بررسی چنین تغیراتی می‌تواند به تصمیم گیرندگان و برنامه ریزان برای فهم عوامل تغییرات کاربری و پوشش زمین، به منظور اتخاذ اقدامات مؤثرو حداقل رساندن این اثرات منفی کمک کند. تکنیکهای سنجش از دور و GIS می‌توانند به عنوان ابزارهای کارا برای بررسی و ارزیابی به تغییرات کاربری و پوشش زمین مورد استفاده قرار گیرند. در این کار شهر زنجان به عنوان مورد مطالعه توسعه شهری و تغییرات پوشش زمین که در بازه ۲۷ ساله از ۱۹۸۴ تا ۲۰۱۱ ، اتفاق افتاده، مورد بررسی قرار گرفته است. زنجان در سه دهه اخیر رشد شهری کلانی را تجربه کرده است. این تغییر به نابودی زمین‌های طبیعی کشاورزی و سکونتگاه‌های روستایی منجر شده است. در این مطالعه با استفاده از تصاویر ماهواره‌ای landsat در ۱۹۸۴، ۱۹۹۱، ۲۰۰۰ و ۲۰۱۱ تغییرات کاربری زمین در زنجان ارزیابی شده است. به منظور کشف و ارزیابی تغییرات کاربری زمین، تفاوت عکسها، تحلیل ترکیبات اصلی و روش طبقه بندی ARTMAPFuzzy به‌کار گرفته شده است. نتایج نشان می‌دهد که تغییرات کاربری زمین برای ناحیه ای در حدود ۴۵۱۸/۳۲ هکتار در دوره ۲۰۱۱-۱۹۸۴در ناحیه ساخته شده و کشاورزی اتفاق افتاده است و زمین‌های سنگلاخ و بایر بیشترین تغییر به بخش‌های ساخته شده را داشته‌اند که به ترتیب ۱۹۸۶/۸۴ هکتار و ۲۵۲۰/۶۳ هکتار بوده است. این تغییرات به ادغام دو شهرک روستایی سایان و گاوازنک در شهر زنجان منجر شده است.

واژه‌های کلیدی: *توسعه پایدار، رشد شهری، تغییر زمین‌های روستایی به شهری، تغییر کاربری زمین*

۱- دانشجوی دکتری شهرسازی، دانشگاه هنر تهران

۲- استادیار دانشگاه آزاد اسلامی، واحد تهران مرکزی