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CASE STUDY

Land use changes using multi-layer perception and change modeler

S. Roshanbakhsh[1,*], S.A. Modaresi[1], J. Karami[2]

[1] *Department of Art and Architecture, Islamic Azad University of Yazd, Yazd, Iran*
[2] *Department of Urban Planning and Design, Faculty of Art and Architecture, Tarbiat Modares University, Tehran, Iran*

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ABSTRACT: Developing countries display strong tendency towards urbanism. Therefore, cities are increasingly threaded by irregular development. An unplanned rapid growth of cities exert devastating impacts upon environment as well as socioeconomic properties, including a reduction of natural spaces, a swarm of vehicles, a reduction of agricultural lands, influences on natural drainage, and a reduction of water quality. All these cases are indications of relationship between human activities and land use changes. Accordingly, an understanding should be gained about land use change and land covers. The present study evaluates land use change and land covers in Hamedan. In order to accomplish this objective, the data were gathered from landsat thematic mapper images of 2002 and 2009. By employing multi-layer perception, the researchers could determine 5 use classes: 1) plant cover, 2) water, 3) type 1 soil, 4) type 2 soil, and 5) urban areas. Next, the classes' changes of the classified images (2002-2009) were surveyed by using Land Change Modeler (LCM) and land use change figures and maps were prepared. The findings reveal the greatest extensions in cases of type 2 soil and then urban areas. Other classes were primarily limited. Nearly 800 hectares of Hamedan's agricultural lands and plant covers were destroyed from 2002 to 2009.

KEYWORDS: Artificial Neural Network; Land Change Modeler (LCM); Land Use Change; Multi-Layer Perception (MLP); Thematic Mapper (TM)

INTRODUCTION

In the Third World countries, cities are increasingly developed and extended due to a variety of reasons. Unplanned rapid development of cities harms urban environment and natural environment. Also, irregular urban patterns are established. Accordingly, an awareness of urban development trends and prospective urban development management should be gained by gathering urban information. Remote-sensing satellites are the most common resources for detection, quantification, and mapping out changes of use (Abel El-kawy *et al.,* 2011). A use clarification and modelling can build an acute awareness of land use change and establish proper strategies for its management by utilizing remote-sensing data in GIS environment (Coppin *et al*., 2014; Bark, *et al*., 2010; Mendoza *et al*., 2011). Cities of Iran (one of Third World countries) are increasingly developed. A growth and development of urbanism in Hamedan Province, located in west of Iran, have harmed most plant covers of this region, about which the respective authority figures should be concerned. Some studies have concentrated on this area of research.kamyab examines Gorgan urban development (1987-2001) by using artificial neural network. The findings highlight significant impacts of land use typology upon Gorgan urban development. Land-farmed use, numbers of urban cells, and pasture use exert the most crucial effects on Gorgan urban development. Khoi and Murayama (2010) apply Land Change Modeler (LCM) and artificial neural network to forest change modelling in

*Corresponding Author Email: *smn.roshanbakhsh@gmail.com*
Tel. +98 9128530305 Fax: +98 2532504852

National Park of Tam Dao by using satellite Images (1993, 2000 & 2007) for a clarification and prediction of forest changes in 2014 and 2021. Their findings reveal a reduction of forest cover from %18.3 in 2007 to %15.10 in 2014 and %12.66 in 2021. Thapa and Murayama (2011) use LCM for Nepal urban development modelling. They model years of 2020, 2030, 2040, and 2050 by observing and analyzing satellite images of 1991, 2001, and 2010 and by using historical, environmental, conservational scenarios. Sefyaniyan(2009) evaluates Isfahan land use changes (1987-1998) and finds significant changes in agricultural lands. Also, Zayeri Amirani and sefyanian (2010) examine Isfahan land use changes and view growth of population as the main cause of a land cover reduction and a dwelling use extension. This study intends to survey Hamedan land use changes by using Multi-Layer Perception (MLP) (one of artificial neural networks) and LCM.

This study was carried out at Faculty of Art and Architecture, Islamic Azad University of Yazd during 2016.

MATERIALS AND METHODS

Study area

Hamedan Province measures 19493 and is located in the west of Iran and between and 59 minutes and and 48 minutes of northern latitude and between and 34 minutes and and 36 minutes of eastern longitude of Greenwich. This province is separated from Zanjan and Ghazvin Province (northwards), Lorestan Province (southwards), Markazi province (eastwards), and Kermanshah Province and some areas of Kurdistan (westwards). Hamedan city is located in Alvand Mountain slope and 1741 m above sea level. The data were gathered from Landsat TM images of 2002 and 2009 and vector-formatted data of Hamedan City, extracted from Iran Geodesy Organization databases. Additionally, ARCGIS9.3, ENVI4.6, and IDRISI 17.0 were used. Fig. 1

An Image Classification & MLP

In image classification process of MLP, training pixels are usually selected between hundreds and thousands because a multitude of introduction can make samples overlapped. Training pixels are used for data analysis. In the next stage, input and output nodes are estimated. Output and input nodes are calculated on the basis of numbers of classified images and numbers of input images respectively. Moreover, hidden layer nodes are measured by the Eq. 1:

$N_h=INT(N_i*No)^{1/2}(4-2)$

N, , and are input nodes, output nodes, and hidden layer nodes respectively.

Finally, last controlling parameters of the classification process are introduced. They are as follows: 1) RMS, which is an indication of acceptable error, 2) numbers of cycles which are replicated in training process (extreme cycles result in extreme train-

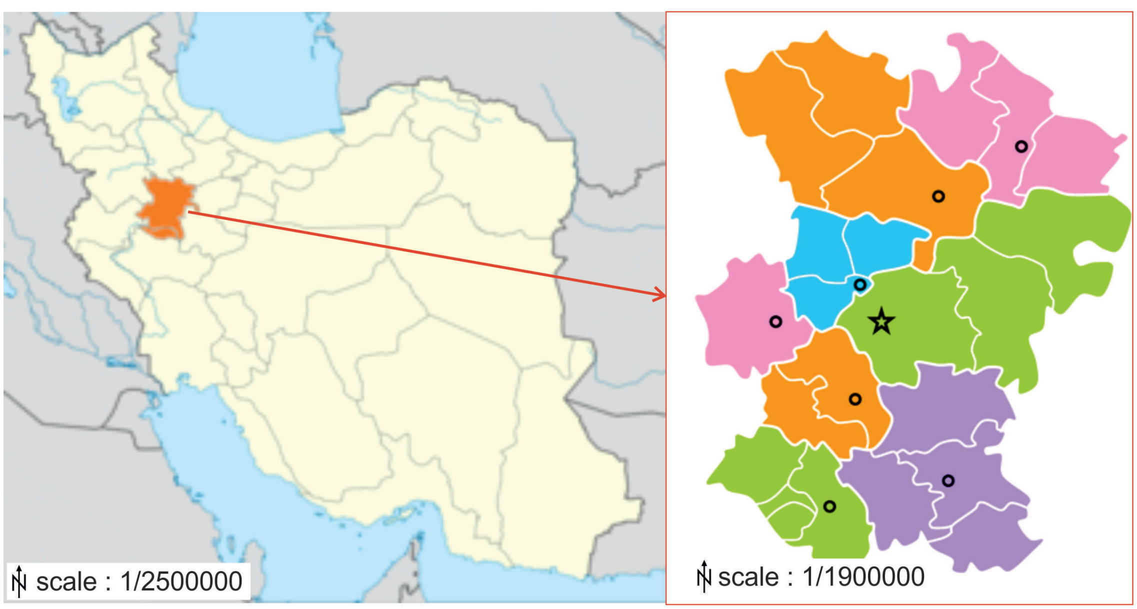

Fig. 1: The location of the study region

ing), and 3) precision of results which is an indication of classification process end and is measured on the basis of introduction of training sample pixels in each level. In the case that MLP precision is less than %50, these parameters should be changed and training process should be replicated. This condition is likely caused by the following. Fig 2.

- A low or high level of RMS;
- A very low precision; and
- Very few cycles.

LCM analysis of changes was performed by examining two classified images of land cover changes, which were foundations for an understanding about the studied region change origin. These two pictures should have similar guidelines and similar spatial properties.

False colorful images of each year were generated by combining bands 2, 4, and 7. These images made contribution to a visualization of the studied region use typology. The monitored MLP classification was used for the land cover maps. In the first step of monitored classification, the areas used as training samples for each class were defined (Eastman, 2006). By making a visual perception of false colorful images and by conducting a survey for the training samples, the researchers could determine 5 use classes: 1) plant cover, 2) water, 3) type 1 soil, 4) type 2 soil, and 5) urban areas. Then, the training samples were generated and separated by employing digital training model. Next, the satellite images were classified by employing MLP method. As land use changes should be clarified for environment analysis, planning, and management, the researchers analyzed the land cover maps (2002 and 2009) by utilizing LCM which made contribution to an evaluation of the land use changes and their impacts upon species and biodiversity. Fig 3.

RESULTS AND DISCUSSION

The following figures were generated by using the prepared maps and LCM. Fig 4 and 5.

From 2002 to 2009, the concerned classes were extended and reduced (Fig 4 and 5). The greatest extensions occurred in cases of type 2 soil and then urban areas. Other classes were primarily reduced. As Fig 3 shows, Hamedan's plant cover were gradually and significantly reduced. Nearly 800 hectares of Hamedan's agricultural lands and plant covers were destroyed from 2002 to 2009. Conversely, urban areas were significantly extended to 2735 hectares; however, nearly 900 hectares of urban areas were destroyed. Type 2 soil was reduced by 2193 hectares. Also, 2460 hectares of other classes were changed into this class. As Fig 4 shows, net changes of each class were measured by subtracting each class hectares changed into other classes from hectares of other classes added to this class.

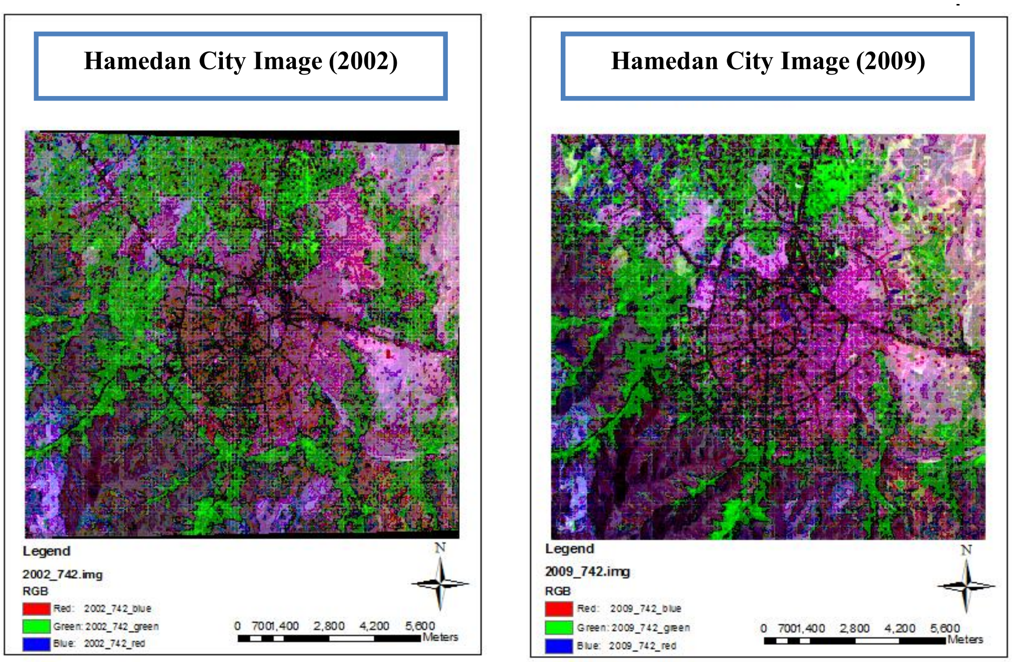

Fig. 2: Hamedan's false colorful images of bands 2, 4 and 7 (2002 and 2009)

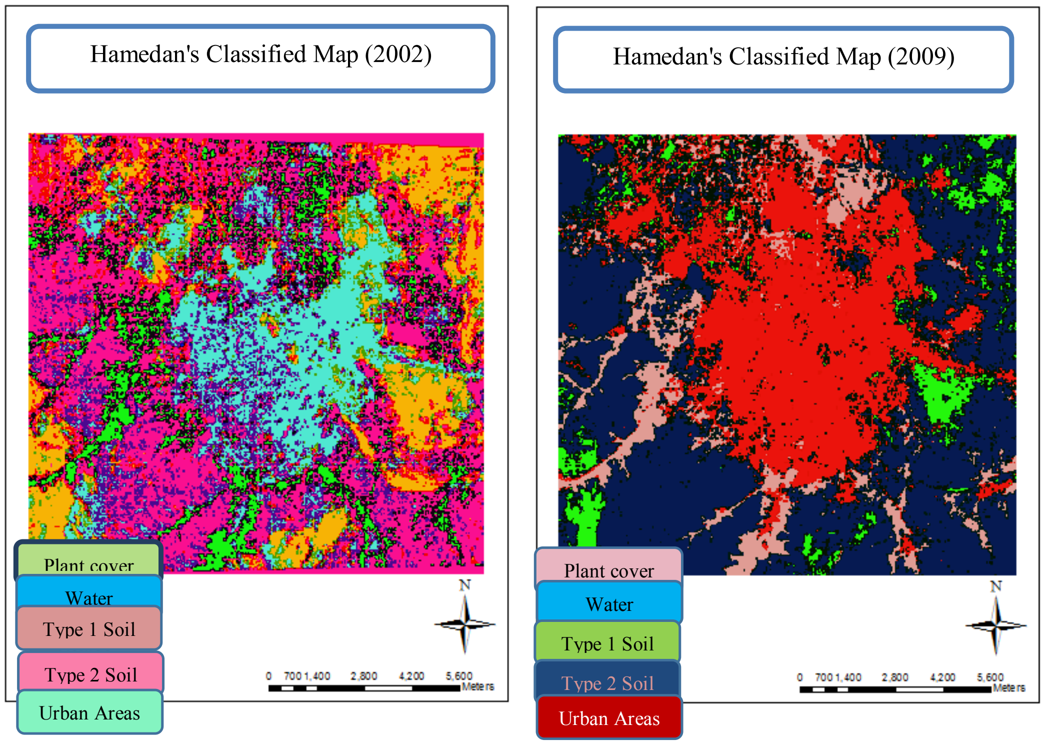

Fig. 3: Hamedan’s classified images (2002 and 2009)

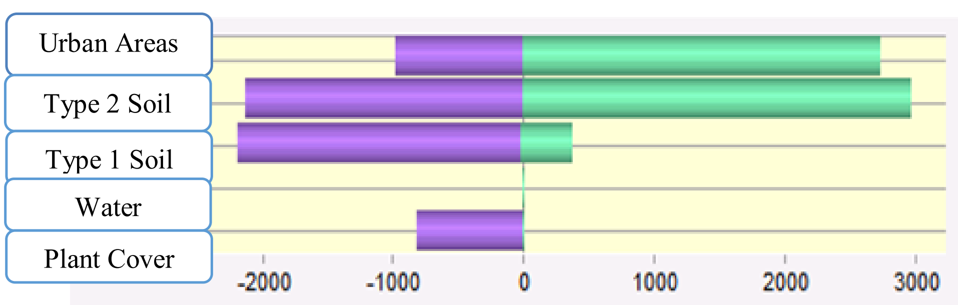

Fig. 4: A reduction/an Increase of classes in 2002- 2009 (ha.)

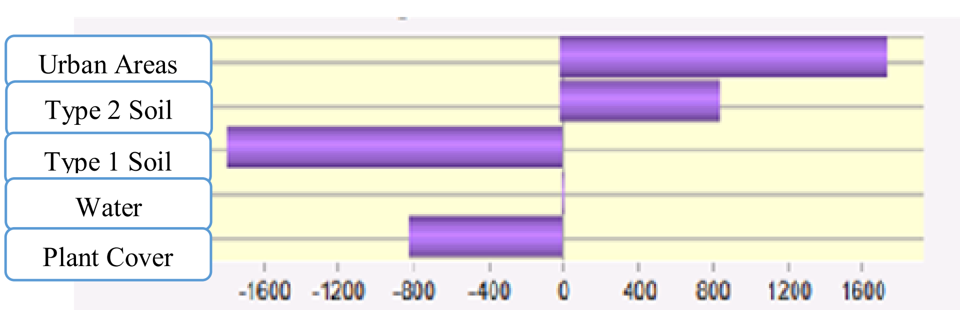

Fig. 5: Net changes of each class

As mentioned above, urban areas and type 2 soil were extended. Conversely, water, type 1 soil, and plant cover were reduced. Fig 5 shows the classes' changes in the classified changes. Accordingly, from 2002 to 2009, all classes changed. Some changed more considerable and some changed slowly. Fig 6.

For expressing these changes, the researchers evaluated net changes and specific changes of each class separately. Urban areas were extended by 2735 hectares. Type 1 soil was reduced by 2193 hectares. Type 2 soil was extended by 2983 hectares. Water areas and plant covers were reduced by 5 hectares and 815 hectares respectively (Fig 4). With regard to the above-mentioned findings and as Figure 5 shows, Type 1 soil, type 2 soil, and plant cover were changed into urban areas, of which type 2 soil had the greatest changes. Large areas of plant covers (nearly 278000 hectares) were changed into urban areas from 2002 to 2009. Type 2 soil (508 hectares) and type 1 soil (291 hectares) were also changed. Therefore, large areas of plant covers were destroyed in this period. Fig 7.

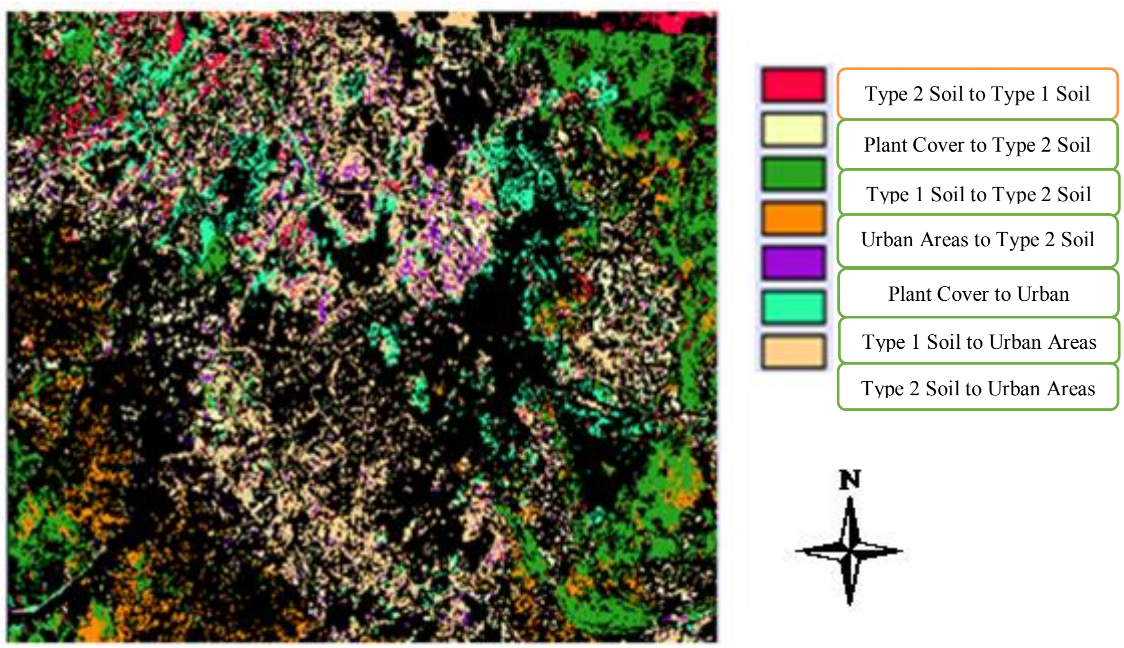

Fig. 6: The classes' changes (2002-2009)

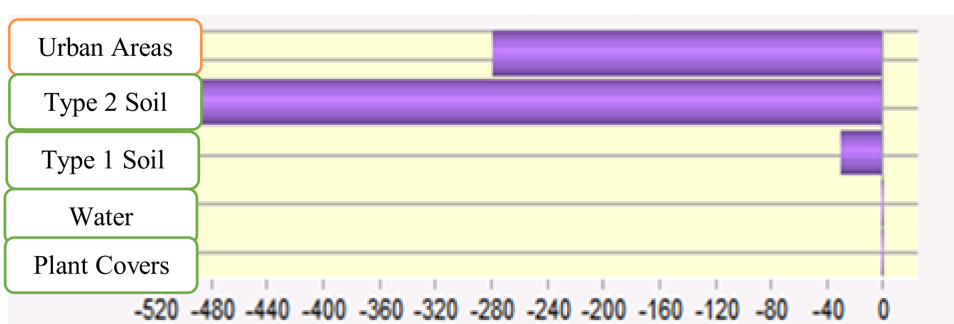

Fig. 7: Net changes of plant covers and their inclusion in other classes

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

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