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METHODS, TOOLS AND BEST PRACTICES

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The cover image is a photo of a street in the city of Naples during the COVID-19 pandemic quarantine (April 2020)

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Contents

99 REVIEW PAGES

Gennaro Angiello, Federica Gaglione, Carmen Guida, Rosa Morosini, Andrea Tulisi

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Evaluating metropolises grow and their impact on the around villages using Object-Oriented Images.

Analysis method by using Sentinel-2 and Landsat data

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Abstract

Development of the margin of metropolitan cities is always challenging with regard to the continuous urbanization. The forecast of future changes in the rural landscape is one of the most important issues to be considered in the process of sustainable rural development. The apparent characteristics of rural landscape changes are the result of the interaction between several natural and human factors. Landscape analysis, as well as the identification of best management strategies, can be improved when the useful information on its changes is available over a wide period of time to assess the impact of the changes it has existed. In this study, we tried to extract the changes in the selected villages of the Ardabil metropolitan area by using Landsat-7 and Sentinel-2 images. This study was conducted using supervised classification methods and the best method was chosen based on the overall accuracy 98.91, and high Kappa coefficient 0.96. The results showed that the changes area of settlement area in a village from 2000, as compared to 2018, is about approximately 5.1 km^2. Worth noting that, in this study, by increasing the efficiency of the classification of satellite images of Sentinel-2 comparison with Landsat-7, the accuracy of classification has also improved.

Keywords

Metropolises grow; Object-Oriented based method; Remote Sensing; Satellite Images; Sentinel-2.

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1. Introduction

Rural and urban development is one of the main priorities in the process of progress towards sustainable economic development in order to improve the quality of life and the preservation of the environment (Bramhe et al., 2018). Despite the rapid growth of urbanization in the world, the rural-based model continues to be a unique and influential way of locating populations and human activities. This issue is important because it takes into account better livelihood opportunities in urban communities and prioritizes a country's macroeconomic planning system to promote quantitative and qualitative indicators in the social, economic and physical areas of rural communities. Meanwhile, the physical condition of rural has always undergone structural and structural transformations. The fluidity of the physical structure of rural settlements is linked to a large part of the geographic area by changing the state of the earth. Since attention is paid to this factor from a purely economic point of view to a social and environmental concept, and the physical planning system that is based on it, has established a close relationship with the land use planning and spatial planning system, the tendency to physical planning in response to the challenges that arise from the lack of attention to the environmental and social dimensions of land use. Spatial imbalances, environmental problems caused by inappropriate land use, increasing demand for land in rural areas, and preserving production capacity, especially food, are among the challenges that believed in physical planning and priority attention to these areas. To justify the organization of physical changes. Development of the margin of metropolitan cities is always challenging with regard to continuous urbanization (Valdiviezo et al., 2018). The forecast of future changes in the rural landscape is one of the most important issues to be considered in the process of sustainable rural development. The apparent characteristics of rural landscape change are the result of the interaction between several natural and human factors. Today, it is well-known that preserving natural resources and prospects is a fundamental requirement for a sustainable future, especially in rural development, which is considered with regard to the economic, social and environmental dimensions of sustainable development in integrated management has taken (United Nations, 2015). Rural and urban links and interactions are an increasing component of livelihoods and production systems and promote better management of compulsory urban and rural interactions: (i) supporting and encouraging sustainable resource management; (ii) better practices in agricultural management and Management; and (iii) preserving our natural resources for future generations. For this reason, forest fires are today recognized as a global environmental and social problem with a predicted potential outlook for land abandonment and climate change (Bramhe et al., 2018). Since the main purpose of processing satellite imagery is to provide thematic and efficient maps, the choice of the proper classification method plays a significant role in this regard. By categorizing images, a pixel is assigned to a class. Extracting information from satellite imagery is by classifying the most widely used methods (Nazmfar & Jafarzadeh, 2018). Object-Oriented satellite image analysis is a technique used in digital image processing, which has recently been developed in conjunction with pixel-based analysis (Burnett & Blaschke, 2003). In pixel-based image processing, pixel-based information is standard and benchmarked. This is the basis of processing in the object-oriented processing of values and information of a similar pixel set that is referred to as an object or phenomenon (Drăgut & Eisank, 2012). Sentinel 2 is part of the Copernicus program designed and created by the European Space Agency to collect information from the ground. Sentinel 2 includes two imaging satellites called Sentinel 2A and Sentinel 2B. Sentinel 2A is currently in orbit and imaging the ground, and Sentinel 2B is expected to be launched in the future. The three main missions of Sentinel 2 include 1 Providing multi-spectral multi-spectral images with high-resolution spatial and temporal resolution; 2 providing and improving landscaping and spatial image data; 3. Collecting information for next-generation products. Such as land cover maps, land-use maps, and geophysical variables. Therefore, data from Sentinel 2 satellites can be very useful in areas such as land monitoring, crisis management, and security services. With enhanced observation capabilities, it ensures continuity and complementarity with Landsat and SPOT (Satellite Pour l'Observation de la Terre) observations (Fletcher and European Space

Agency, 2012). This mission aims to meet different user needs and to improve numerous Copernicus operational applications (Sentinel, E. S. A. (2); Team, 2007) such as: Land monitoring service: land use and land cover state and changes; Bio geophysical parameters estimation; forest monitoring; urban mapping; spatial planning; agro-environmental monitoring; natural resource monitoring; land carbon/carbon storage; global crop monitoring; coastal zone monitoring; soil sealing; Risk management: floods and forest fires, subsidence and landslides, volcano eruptions; Food security/early warning systems; Water management; Soil protection; Terrestrial mapping for humanitarian aid and development; Global change issues. Many authors have already experienced the great potentialities of Sentinel-2 data to: classify crop and tree species (Immitzer et al., 2016); monitor natural and anthropic vegetation (Bontemps et al., 2015; Greco et al., 2018; Song et al., 2017); map glaciers (Paul et al., 2016) and water bodies (Du et al., 2016; Toming et al., 2016; Yesou et al., 2016); assess and monitor water constituents (Dörnhöfer et al., 2016); classify burn severity (Fernández-Manso et al., 2016; Huang et al., 2016); map built-up Sub-Pixel Landscape Feature (Radoux et al., 2016). As an optical remote sensing system operating in the wavelength range between 0.443μm and 2.190μm, Sentinel-2 data are sensitive to cloud cover. To correctly implement Copernicus applications and, in general, for retrieving accurate surface parameters, the first required step is the detection of clouds into the Sentinel-2 MSI (Multispectral Instrument) imagery because these can severely disturb the correct extraction of atmospheric or surface information using optical remote sensing satellite data (Greenhough et al., 2005; Huete et al., 2002; Kaufman, 1987; Nakajima et al., 2011; Woodcock et al., 2008; Gao and Li, 2017). Singh and Gapta (2016) investigated the possibility of increasing the accuracy of image categorization methods using image composition techniques. In his research, he concluded that the use of Brovey methods and analysis of the main components could have significant results in improving the accuracy of classification methods. Topaloglu et al. (2016), entitled Sentinel-2 and Landsat 8 for the accuracy of the classification of land cover/for use in the map, to study the accuracy of different categorization methods for extracting land cover user. The result of their work shows that the maximum probability and SVM methods have produced better results than other classification methods. Liu and Yang (2015) examined the changes in urban land use and urban development using satellite imagery and geographic information systems. He concluded that the combination of methods of measurement and GIS could provide a better indication of urban land changes. Analyzing the evolution of rural time through environmental changes and prospects may lead to a greater understanding of the transformations associated with natural events and human activities. Rural perspective may be considered as a result of the integration of land cover classes, providing ecosystem services and developing opportunities for different needs of different stakeholders (Sandker et al., 2010). Landscapes are the result of a continuous reorganization of land for their adaptive use and spatial structure with economic and social demand changes in history (Dannebeck et al., 2009). Specifically, over the past decades, rural landscapes have been affected by disruptions to rural systems: the intensification of a single product on one side and the marginalization and abandonment of farms on the other. Imani (2014), in his doctoral dissertation titled Physical-spatial Transformation in the rural settlements around Ardabil (1975-2011), examines the physical and physical changes of villages around the city of Ardabil between 1975 and 2011. In their research, he concluded that the villages around Ardebil have undergone a variety of changes, including in the economic, physical and cultural spheres.

2. Materials and methods

2.1 Study area

Ardabil Province in the northwest part of Iran has an area of approximately 17,800 Km^2. This province is located between the geographical coordinates of 37.45 to 39.42 and the north latitude of 48.55 to 47.3 in the east of the Greenwich Meridian. Ardabil city is one of the metropolises of Iran and located in the center of

Ardebil province and northwest of Iran. The area of this city is about 3,810 Km^2 (Fig.1). According to the report of the Ardebil Meteorological Station at 1,372 meters, the precipitation of this city was reported to be 327.7 mm in 1,372. To do this research, three rural sites have been selected around the metropolitan area of Ardabil. Golmoghan Villages, Sham Asbi, and Mollabashi. These three villages are located on the edge of the metropolitan city of Ardabil and have been moving towards the metropolitan city of Ardabil over the past few years.

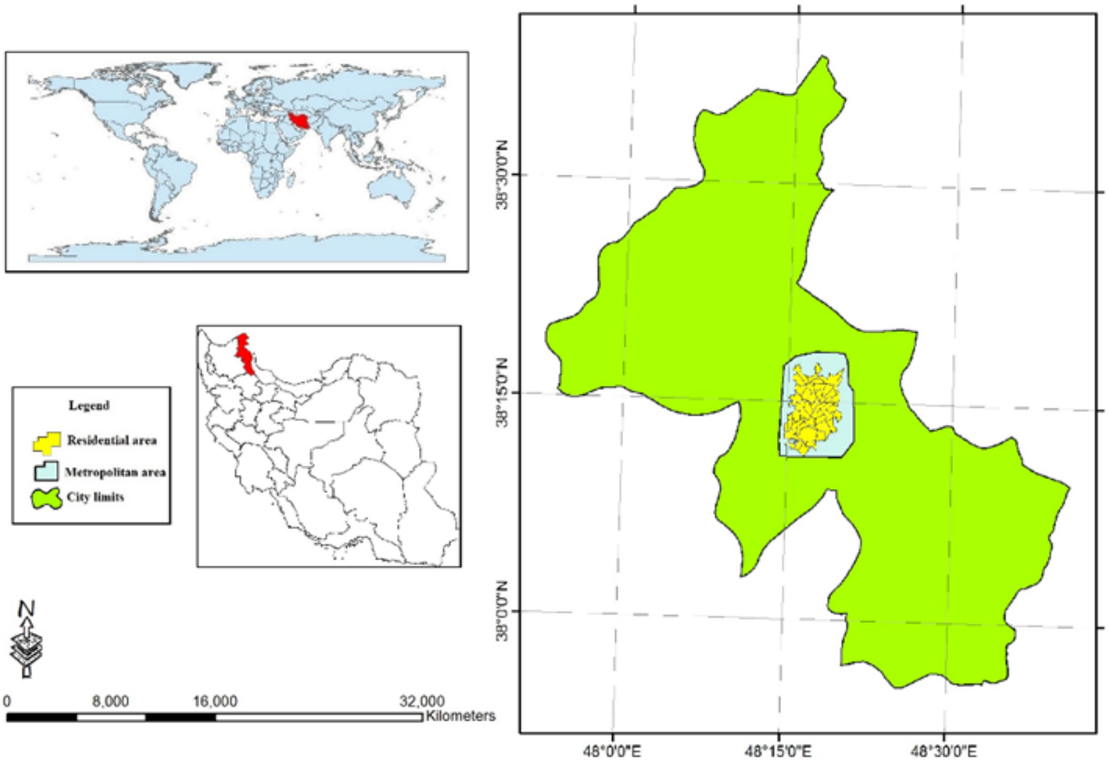

Fig. 1 Location of the studied area

2.1 Data collection and processing

The first step in this research was to collect archives of remote sensing images of the studied area and to implement specific subject maps. All initial drawing processing, land cover classification of satellite imagery and spatial analysis were performed using ArcGIS 5.1 software, ENVI 5.3, eCognition software and Sentinel images software especially SNAP software. The analyses were conducted using archival documents, historical maps, topographic maps, thematic maps, statistical data management and remote sensing images of Sentinel-2A and Landsat-7 for 18 years (from 2000 to 2018). Different maps of land use were created by comparing the classification and extracting the number of changes. Finally, to identify areas where the landscape has evolved naturally, the maps of the areas are identified manually by spatial analysis tools and compared at different times over the course of the 18-year period.

Remotely sensed data obtained on multiple dates can be used to identify the type and spatial distribution of changes taking place in the landscape (Friedl et al., 2002; Zhan et al., 2002). In this study, Landsat 7 satellite imagery from 2000 through 167, 33 and 167 lines, and 34 rows related to Ardebil province, as well as the satellite image of Sentinel-2, Level 1C, was used for 2018. Landsat 7 images from ETM have been pre-processed by ENVI software. First, the images were categorized in the software as a bundle set with bands 1 to 5 and band 7 for Landsat 7. Then, both images of 33 and 34 mosaic together to cover the image of the area in question. Figure 2 illustrates the process of doing research in graphical form.

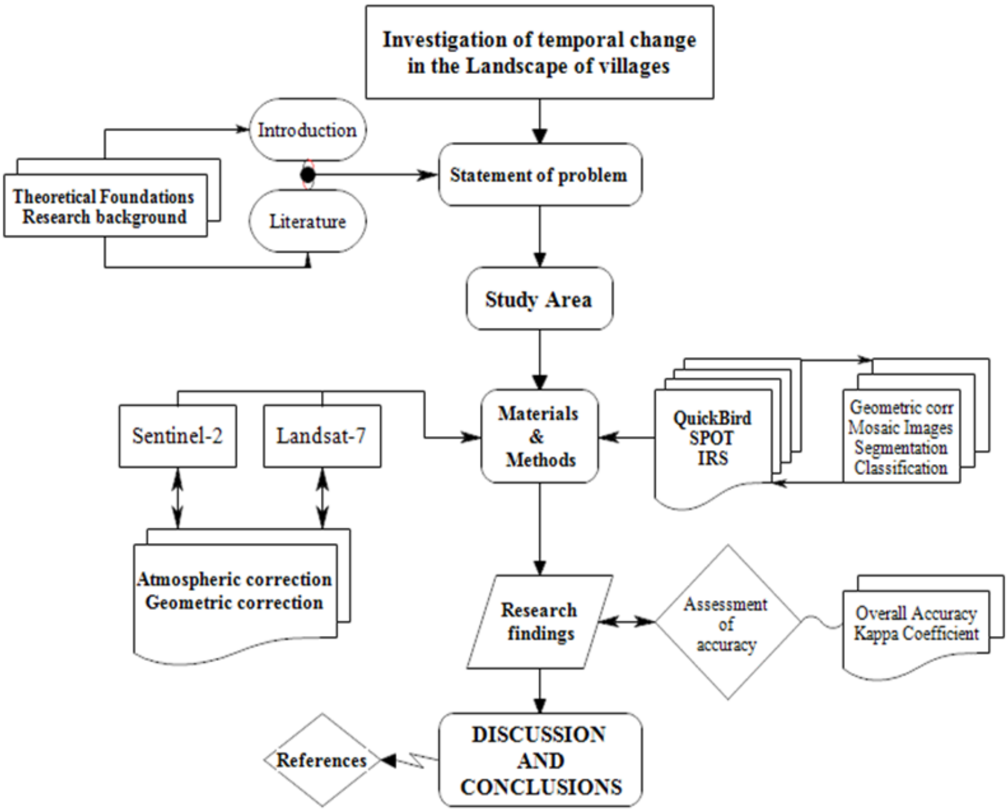

Fig. 2 The algorithm of the research process

After mosaicking the images, the image of the study area was extracted. For the purpose of extracting control points for a controlled classification, the first integration of satellite images of the 2005 HDR satellite SPOT5 into four-band resolution with a resolution of 10 meters, a single-band IRS image with spatial resolution of 5.8m, the Quick Bird images with a spatial resolution of 2.44m, and then segmentation are performed. All images intended for segmentation in the e Cognition software environment were created by creating a project, then weights and the appropriate color combination for segmentation and the appropriate segmentation scale were created. Segmentation was performed using Multiresolution Segmentation method in this research. Segmentation method with multiple spatial separations minimizes the average heterogeneity of image objects locally. This method can be applied at the level of image objects or pixel levels to create new image objects (Nazmfar & Jafarzadeh, 2018).

Therefore, the existing methodology of segmentation algorithm from bottom to top, based on a local technique, in the numerical value of the number of pixels, attempts to merge two to two similar pixels. Segmentation with multiple spatial resolutions is an optimization method that maximizes the heterogeneity of the average pixels to the minimum and the corresponding homogeneity.

In order to precisely extract the training points for supervised classification, the segmentation of the selected images from the sites was initially initiated. Tab. 1, shows the parameter of scale and coefficients of shape and compression in multiresolution segmentation. Eventually, after the creation of the satellite image, it was taken to the educational points. Educational points are multiples of the study area in four classes: 1. habitat areas, 2. vegetation, 3. water zones, 4. areas of bare soil without vegetation, for each of these classes a number of points Teaching based on the formula for the removal of points where n (n-1), where n is the number of classes, is the number of more than 30 points (in this case the point is the same as the polygon). After removing the educational points, supervised classification was done in different ways.

Site name	Number of segments	Additional Layers	Compactness	Shape	Scale
Agricultural lands	226	IRS-Snir-QB1-QB2-Q3	0.4	0.6	65
Human complications	953	IRS-Snir-QB1-QB2-Q3	0.3	0.7	10
Soil	194	Snir-QB1-QB2-Q3	0.2	0.8	60
Water areas	53	IRS-Snir -NDVISP	0.5	0.5	150

QB=QuickBird; Snir =NIR for SPOT; NDVISP=NDVI for SPOT sat;

Tab.1 Parameter of coefficients and scale of shape and compression for multiresolution segmentation

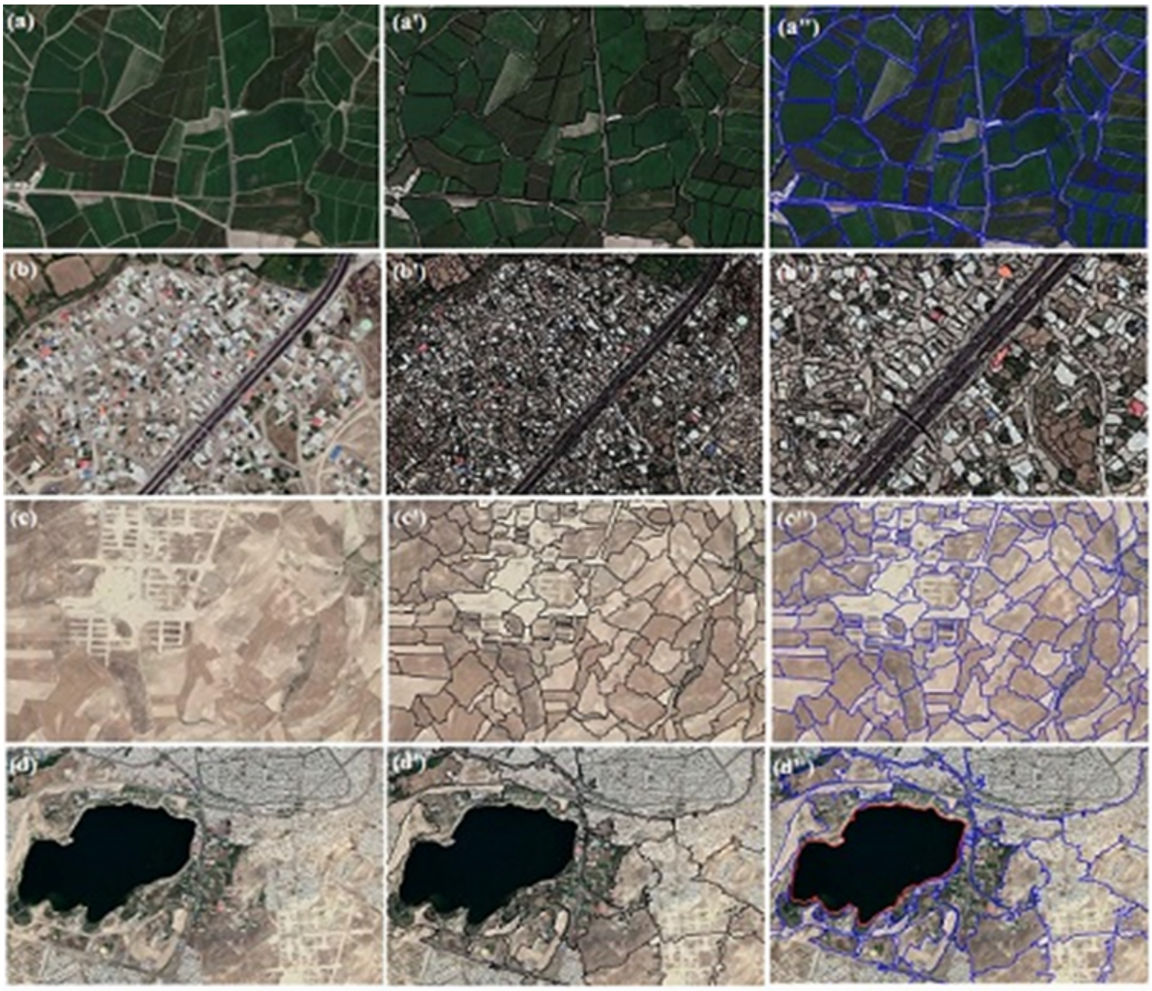

Fig.3 In the first column the selected sites (a, b, c, d), in the second column the segmented images (a′, b′, c′, d′) and in the third column the segmented images are illuminated (a″, b″, c″, d″)

After removing the training points, we are attempting to run a variety of supervised classification. In this study, six methods of supervised classification have been used. Tab.2, shows the types of methods, as well as the overall accuracy and Kappa coefficient.

As shown in Tab. 3, the classification method has Maximum Likelihood to overall accuracy 98.91% and Kappa coefficient 0.96 is chosen as the best method in terms of accuracy. Then, the next steps of the study are continued using the Maximum Likelihood classification method. Each satellite image was classified in 6 different classes. Classes are categorized as follows: 1) Plowed soil; 2) Construction soil; 3) Road and pavement; 4) Vegetation Cover; 5) Residential Region; 6) Water Area. After satellite images were categorized into ENVI image processing software and SNAP software, ArcGIS software was called and executed in order to extract the size of the changes and also create the final maps.

Accuracy Type	Parallel piped	Minimum Distance	Maximum Likelihood	Neural Network	Spectral Angle Mapper	Spectral Information Divergence
Overall Accuracy (%)	79.25	87.22	98.91	92.09	83.27	85.93
Kappa Coefficient	0.68	0.84	0.96	0.88	0.74	0.76

Tab.2 Types of methods and the overall accuracy and Kappa coefficient

The results are shown in Fig. 4 and 5, as well as in Tab. 3, respectively. The size of the changes for each of the classifications is given in Table 3. Each of the changes to the Landsat-7 image of the year 2000, as well as the Sentinel-2 image of 2018.All units of change are in square kilometers. Figure 4 represents the most commonly used image for the Landsat 7 satellite image for the year 2000. In Fig. 5, the image is classified using maximum likelihood for the Sentinel-2 Level 1C satellite image that is relevant to the study area in 2018, shows. In Figure 6, the plot of the land-use change variation from 2000 to 2018 is shown in Landsat and Sentinel image processing.

Year	Plowed soil	Construction soil	Road and pavement	Vegetation Cover	Residential Region	Water Area
2000	36.13	81.23	9.83	27.33	26.62	1.96
2018	56.16	46.37	31.51	37.70	31.33	2.69

Tab.3 The size of the changes for each of the classifications (in km^2)

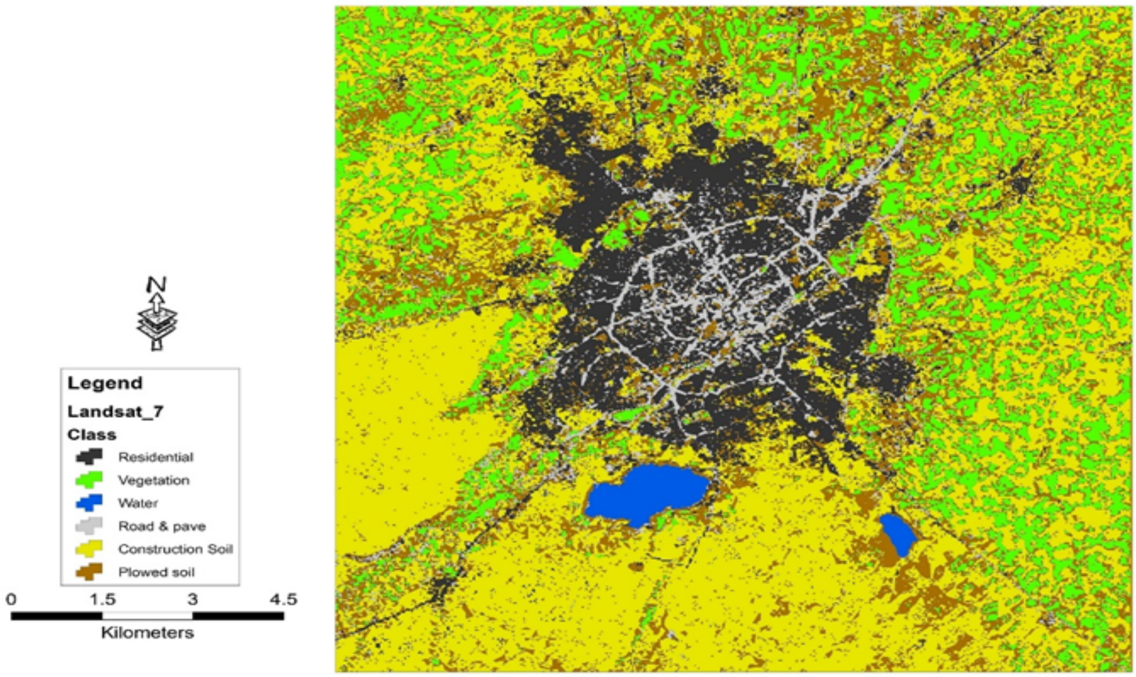

Fig. 4 The algorithm of the research process

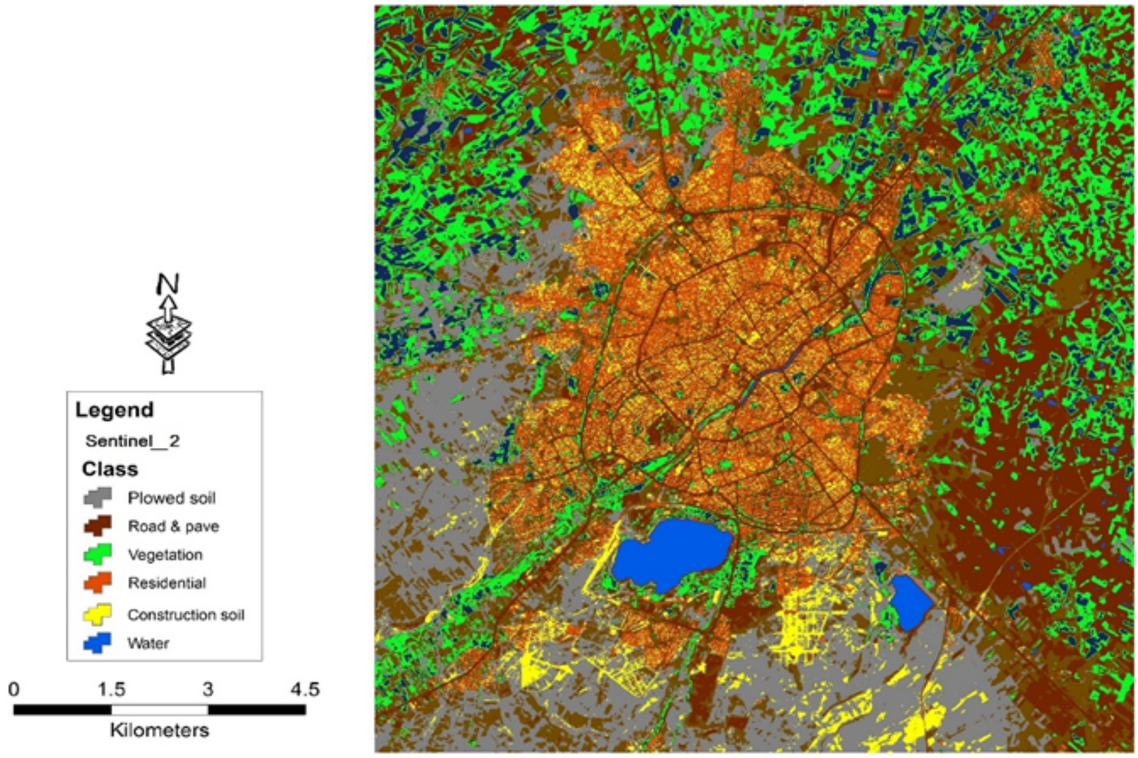

Fig.5 Sentinel-2 categorized image for 2018, in the Maximum Likelihood Method

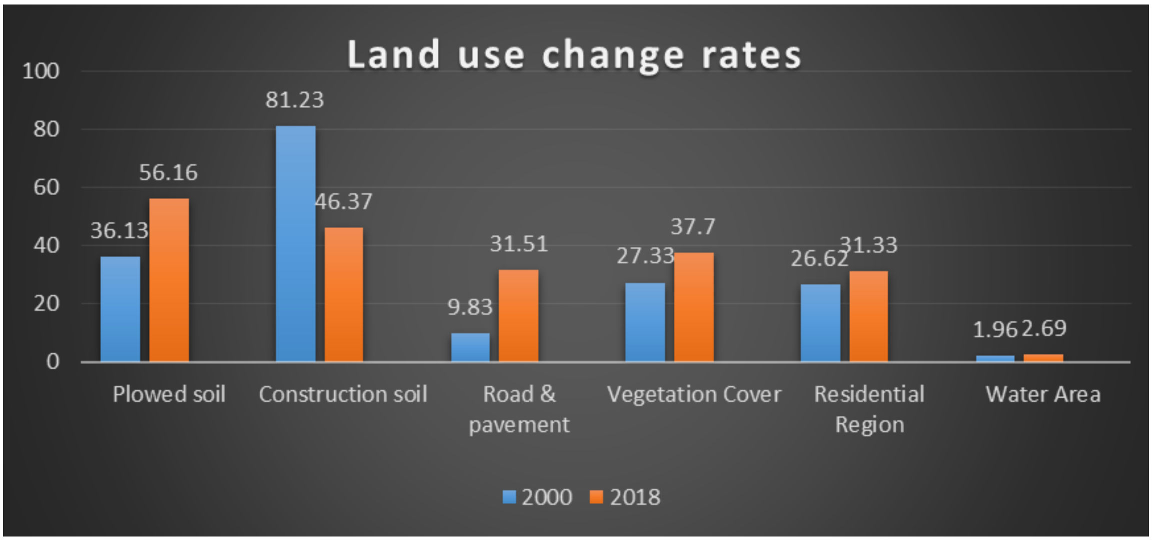

Fig.6 The plot of the land-use change variation from 2000 to 2018

In Figures 7 (a) and 7 (a'), the side of the growth of the Ardabil metropolitan area changes has been shown to the surrounding villages. In Fig. 7(a), the black box shows the location of the Sham Asbi village in Sentinel is classified satellite image. Fig. 7(a'), the black box represents the actual location of the Sham Asbi village on the margin of the metropolis of Ardabil using the Google Earth image.

In Figures 7 (b) and 7 (b'), the side of the growth of the Ardabil metropolitan area changes has been shown to the surrounding villages. In Figure 7(b), the black box shows the location of the Golmoghan village in Sentinel-2 is classified satellite image. In Figure 7(b'), the black box represents the actual location of the Golmoghan village on the margin of the metropolis of Ardabil using the Google Earth image.

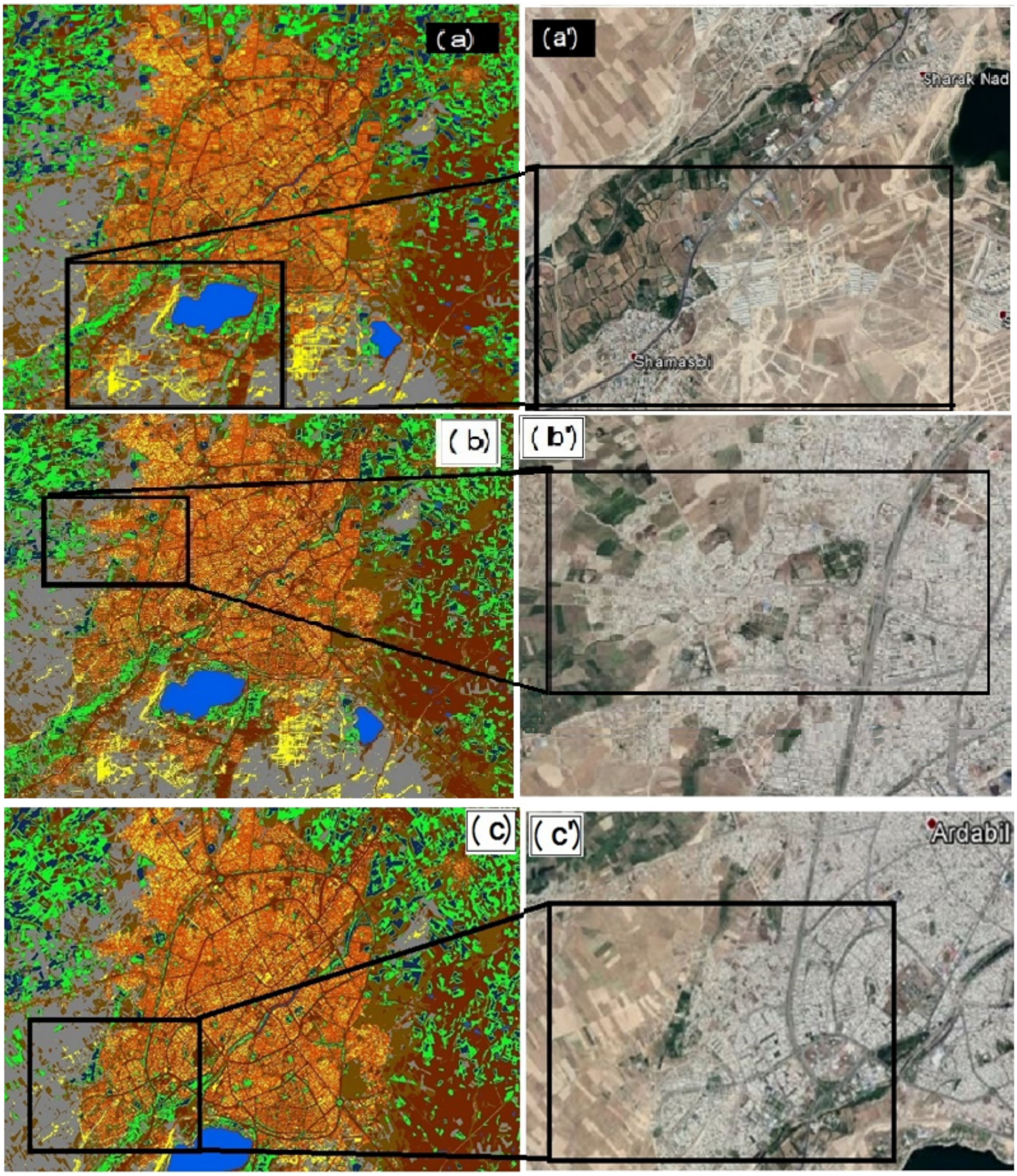

Fig.7 The direction of urban land-use changes in the metropolitan area of Ardabil towards the Sham Asbi (Figures a and a') and area of Ardabil towards the Golmoghan (Figures c and c')

Finally, in Figures. 7 (c) and 7 (c′), the side of the growth of the Ardabil metropolitan area changes has been shown to the surrounding villages. In Fig. 7(c), the black box shows the location of the Mollabashi village in Sentinel-2 is classified satellite image. Fig. 7(c′), the black box represents the actual location of the Mollabashi village on the margin of the metropolis of Ardabil using the Google Earth image.

In Fig. 8, changes in Golmoghlan villages, Sham Asbi and Mollabashi were shown during the two study periods of 2000 and 2018. In particular, inside the black box of the letter (a) of the 2000 image, the residential use of the Golmoghan village is seen with black pixels. This residential property of the Golmoghan village is displayed in the black box of the letter (a′) of 2018, with yellow and orange pixels. Inside the black box (b) of 2000, the residential use of the Mollabashi village with black pixels as well as the residential use of the village will be displayed in box (b′) for 2018; with yellow and orange pixels. Inside the black box of the letter (c) of the 2000 image, the residential use of the Sham Asbi village is seen with black pixels. This residential property of the Sham Asbi village is displayed in the black box of the letter (c') of 2018, with yellow and orange pixels.

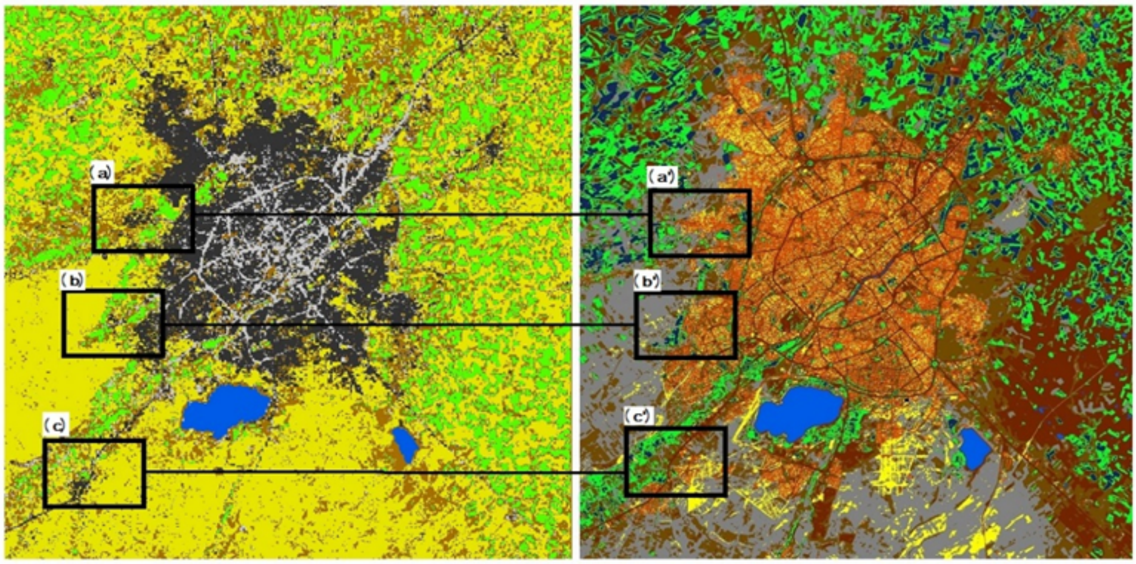

Fig.8 Land Use changes in Golmoghlan villages, Sham Asbi, and Mollabashi during the two study periods of 2000 and 2018

3. Result and discussion

Today, due to the urbanization process, the need to review changes in urban environments has been taking place over the years. Identifying these changes can help managers and planners to pinpoint effective factors for land use change and land cover, and thus to plan and to manage their control (Hidayati et al., 2018).

For discovering and evaluating the changes in multi-dimensional data, the measurement of data can play a key role, due to the cheapness and speed of data acquisition, and the geographic information system can play an important role in analyzing the data.

It is important to note that the size of the study area, as well as the spatial resolution required to select a satellite type, is important. The amount of available OBIA literature is increasing rapidly, to the extent that we can now see sub-topics emerging such as specific OBIA hierarchy and scale concepts. Object-oriented processing of satellite images is one of the ways to visualize land-use change. The results of this research have resulted in the clarification of several important issues regarding the metropolitan area of Ardabil: First, in this study, according to the maps derived from the classification of Landsat and Sentinel satellite images, as shown in Fig. 4, Fig. 5 and Tab. 3, the variation in land use type of a Residential type from a value of 26.225 square kilometers in 2000 increased by 31.33 square kilometers in 2018. Also, the land use and road use rates increased from 9.83 km^2 in 2000 to 31.51 km^2 in 2018. As well as the Construction Soils dropped from 81.23 km^2 in 2000 to 46.37 km^2 in 2018.

Increasing the level of land use and Road and Pavement classes, in contrast to the significant reduction in the use of land under construction, indicates the precision of the land use drawings drawn from the two study periods. Reducing the soil class under construction suggests that housing construction and urban construction should be increased from 2000 to 2018, which is an increase in Figures 4, 5 and Tab.3, to well shown. Secondly, according to Fig. 7, the Ardabil metropolitan area can be well considered for settlement changes. Fig. 7(a), indicates the direction of land use change in Ardabil city towards the village of Sham Asbi, which is highlighted in Fig. 5, in yellow, and in Figures 7(a) and 7(a'), with a black box. In Figure 7(b), for changing the land use of the Ardebil residential area to the Golmoghan village, shown in Fig. 5 in gray, and in Figures 7(b) and 7(b'), is displayed with a black box.

According to the above figures, the Golmoghan village seems to have become a townhouse state and is actually swallowed by the Ardabil city metropolis. Fig. 7(c), shows the land use change of the Ardebil metropolitan area towards the Mollabashi village, which is highlighted in Fig. 5 in gray and in Fig. 7 (c) and 7(c'), with a black box.

The village has also become a city district over time, and in fact, the village has been swallowed by the Ardabil city metropolis. Also, according to Figure 8, it can be seen that the land use changes in the Ardebil metropolitan area are directed towards the villages located on the west and southwest of the metropolitan area. The reason for this is that on the east, north and northeastern parts of the metropolitan area of Ardebil, there are agricultural lands, and in the west and southwest, there are very low agricultural and cultivated lands, and there are more dispersed soils in this area Side. Imani (2014), in his doctoral thesis, concluded that the Golmoghan villages and Sham Asbi, as compared with other villages around Ardabil, have undergone a major transformation and have grown to the Ardabil metropolis. According to Imani (2014), it can be stated that the result of this research, which is obtained by using satellite imagery, is acceptable.

4. Conclusions

Information about the built areas and its amount are necessary for urban planners to understand the urban growth pattern, to grow, the type of urban expansion, etc. In recent years, researchers have achieved optimal results and techniques in the use of satellite image processing, in particular, high-resolution spatial resolution. In order to match the results, Google Earth satellite images are used in the context of the post-extraction process. The results are promising, and the proposed approach could be used for urban extraction of Sentinel-2A satellite data. Benefits The proposed method is simple, accurate, and easy to understand and requires open source data as input. The program for the future research work is to find the Sentinel-2A image to find the appropriate mix band and index range to extract other terrestrial coverings such as plants, water, land, etc. The results of this study indicate that the extent to which villages near metropolises can be subjected to severe land use changes, especially residential and infrastructure used in the countryside. Also, the location of the village in the metropolitan area can lead to the rapid growth of the metropolis toward the desired village and at a relatively small-time, it will cause the village to be devastated by the construction of the metropolis. This study showed that the residential development of Ardebil's metropolitan area is lower for villages with land use than vegetation and land. According to the results of this study, in the near future, one should see the transformation of the Sham Asbi village into one of the local neighborhoods of the city of Ardabil.

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