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CASE REPORT

Land use change detection and prediction using Markov-CA and publishing on the web with platform map server, case study: Qom Metropolis, Iran

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ABSTRACT

To achieve sustainable development, detailed planning, control and management of land cover changes that occur naturally or by human caused artificial factors, are essential. Urban managers and planners need a tool that represents them the information accurate, fast and in exact time. In this study, land use changes of 3 periods, 1994-2002, 2002-2009, 2009-2015 and predictions of 2009, 2015 and 2023 were assessed. In this paper, Maximum Likelihood method was used to classify the images, so that after evaluation of accuracy, amount of overall accuracy for images of 2013 was 85.55% and its Kappa coefficient was 80.03%. To predict land use changes, Markov-CA model was used after assessing the accuracy, and the amount of overall accuracy for 2009 was 82.57% and for 2015 was 93.865%. Then web GIS application was designed via map server application and evoked shape files through map file and open layers to browser environment and for design of appearance of website CSS, HTML and JavaScript languages were used. HTML is responsible for creating the foundation and overall structure of webpage but beautifying and layout design on CSS.

***Keywords*:** Land Use Change; Urban Growth; Markov-CA; Web Design; Map Server; Web GIS

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1. Introduction

1.1 Land use change and prediction

Land use change is one of the world's major studies and especially in developing countries is more important. Land use change is a Complex and dynamic process caused by the action and reaction among environmental, social and economic factors at different spatial and temporal scales[1,2]. Land use change in urban areas usually demonstrates economic development, increased migration to urban areas and population growth accordingly change. Urban growth prediction is for evaluation the development, position, features and conse-

quences of urban development, planning and management decision-making of an urban area[3-7], and also it provides a scientific foundation for decisions about sustainable development and land use[8].

Urbanization and an increase in urban land use is a dynamic process including changes in comprehensive of land cover with the increase of human population[9]. Predictions of changes in land use have a chief role in planning process. Prediction can aid in the appraisal of development factors. It enables urban planners to prepare facilities to keep development[10,11], and suggests directions for future development and this allows landowners to develop a plan[12]. Many studies have been conducted to assess the land cover and land use change (LCLUC) that have implied different methods and software to classify the changes[13-17]. Web-based geographic information system is made to provide GIS services on the web platform and nowadays many of governmental agents, municipal services centers, financial units, location information data base and tourism centers and dozens of agents as such, use these systems to provide their services for the users. Nevertheless, web GIS doesn't only belong with big organizations and agents, with the increasing development of technology and the ease of access to improved software, and providing these services has become important for executives and administration managers for increasing the efficiency and pace of decision making. Many studies have been done about the evaluation of land use change and its prediction through the world, but prediction of urban growth in the field of web, in terms of web GIS, distinguishes the research from the others. This study aimed to evaluate and predict land use changes in framework of web GIS. Coding is done with map server and layout design of the website is done with HTML, CSS and JavaScript. Advantage of web GIS is availability of information layers for all people all over the world.

1.2 Web GIS

Providing information on the Internet is a fast and easy access to information for the public. The geographic information system is capable of processing and analyzing information in a short time with the higher accuracy in this environment. Also graphic and descriptive information with different formats will have different local coordination. If the capabilities and benefits of Internet and geographic information system integrate in an environment as "web GIS" can be a comprehensive information system and efficient tool for management in high levels. Web GIS is a combination of the Internet and GIS (Geographic Information System)[18]. In other definition, web GIS is a kind of technology that is used to illustrate and analyze data and in particular spatial data via Internet. It brings in the advantages of the Internet and GIS. It provides a new ability to access the spatial data for public so that there is no need to buy the expensive GIS software[19].

2. Materials and methods

2.1 Description of study area

Qom, also spelled as Ghom, is the capital of Qom province and eighth largest city in Iran. It lies 125 kilometers or 78 miles by road southwest of Tehran, on a low plain. Its geographic coordination information is 34° 38′ 24″ N, 50° 52′ 35″ E. Its area is about 123,073 km^2. At the 2011 census, its population was 1,074,036, comprising 545,704 men and 528,332 women. It is situated on the banks of the Qom River. The city is located in the boundary of the central desert of Iran (Kavir-e-markazi). **Figure 1** shows the geographic location of the study area.

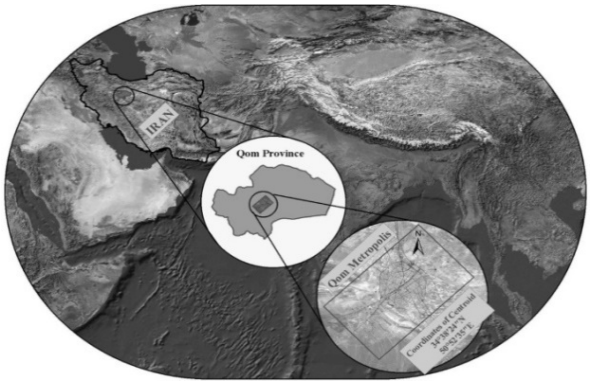

Figure 1. Study area.

Qom is counted as one of the focal centers of the Shiʿa both in Iran and around the globe. Since the revolution, the clerical population has risen from around 25,000 to more than 45,000 and the

non-clerical population has more than tripled to about 700,000.

2.2 Article process

Several studies have been conducted about evaluation of land use changes and land use prediction. This study includes 2 stages: (1) Investigation and prediction of changes; (2) Web GIS application design with map server software. The second stage indicates the innovation of the study that hasn't been done in the recent researches.

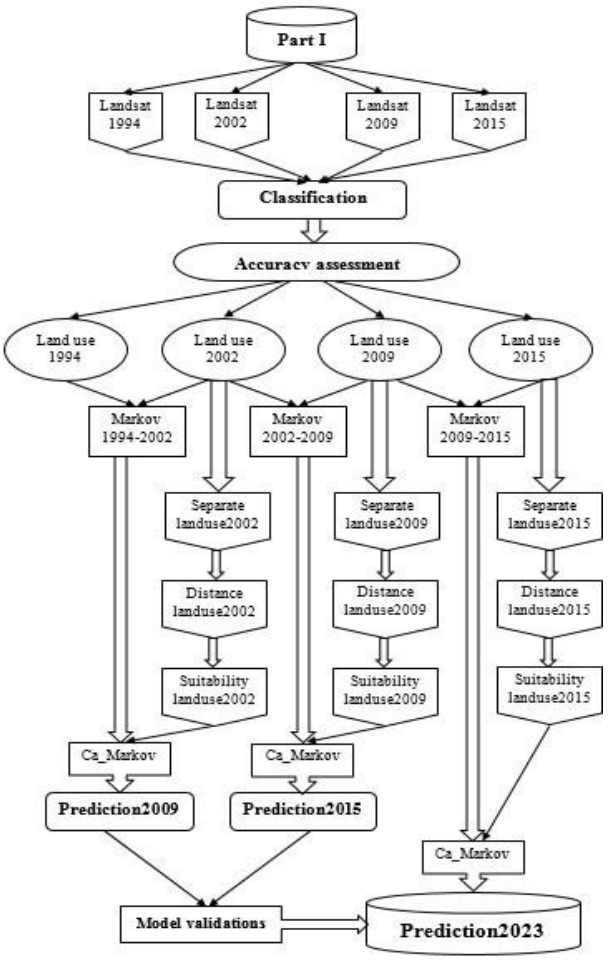

Diagram 1. The steps of the first part of the article**.**

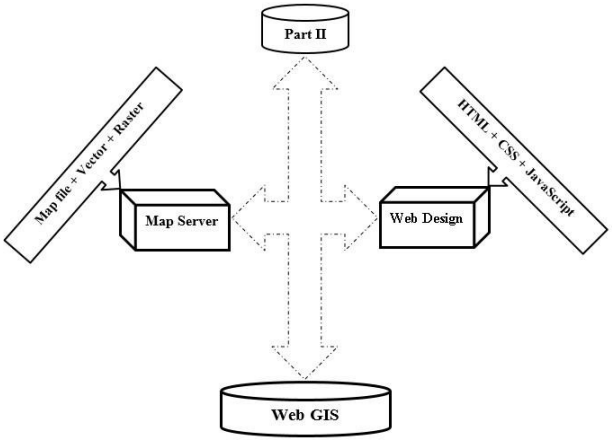

Diagram 2. The steps the second part of the article**.**

Table 1. Features of image of land sat satellite

Satellites	Sensor	Year	Month	Day	Spatial resolution (meters)
LANDSAT_5	TM	1994	August	11	30
LANDSAT_7	ETM+	2002	August	9	30
LANDSAT_5	TM	2009	August	4	30
LANDSAT_8	OLI	2015	August	5	30

In this study, land use changes of 3 periods, 1994-2002, 2002-2009, 2009-2015 and predictions of 2009, 2015 and 2023 is assessed. For this, land use images of 4 mentioned years have been downloaded. The related information is given in **Table 1**. After geometric and radiometric corrections, images were classified and changes and predictions of land use were studied. **Diagram 1** shows the process of first stage of study.

The second stage is to design the web GIS application. To this, coding the map file via Notepad++ is done and raster and vector layers were published on the Web environment via map server and open layer. For designing the layout of web GIS, HTML, CSS and JavaScript have been used. **Diagram 2** indicates the process of second stage of study.

2.3 Land use classification

Classification can be a decision-making process in which image data transmit to the specified class. In fact, the classification is mapping of a multispectral space to complication space. Different bands of image make multispectral space and every pixel in this space defined as a vector, so that every member of this vector represents the amount of pixel in a specific band. Classification methods are of the most common methods for extracting information from satellite images. Diversity of classification methods allows users to produce various information, such as producing of land cover maps, calculating the volume of density of vegetation, uncovering the changes and etc. Flexibility and maximum reliability of classification methods rather than other methods has caused this method to be the most important method to extracting used information. All of the classification methods seek to discover complication (class) that can ascribe the pixel to it with maximum reliability and acceptability. Many classification methods have been introduced to the world of remote sensing, which every method applied a specific

way of classification and extracting accurate information from complications. Each of these methods has taken a general logic and a set of assumptions and based on them, have developed their algorithm. In this paper, Maximum Likelihood classification method is used.

2.3.1 Maximum Likelihood

Maximum Likelihood classification is one of the most popular methods that is a pixel based method. In Maximum Likelihood classification, class is linked to a pixel if most likely that pixel belongs to that class. In the mathematical terms, it can be written in forms of equation 1.

Equation 1 $x \in w_i \ if \ P(w_i|x) > P(w_j|x)$ for all $j \neq i$ x $\in w_i$

It means that pixel with the spectral amount vector x belongs to class w_i if the probability of belonging of this pixel to this class meant $P(w_i|x)$ is higher than probability of other classes. For calculating these probabilities, Biz law is used. This law is written as equation 2:

Equation 2 $P(w_i|x) = \frac{P(x|w_i)P(w_i)}{P(x)}$

In this formula, x is the vector of spectral values and w_i is i-th spectral class. $P(w_i|x)$ is the secondary probability (posterior probability) w_i class and it is calculating for all classes. Secondary probabilities will be the basis for decision making in Maximum Likelihood method. $P(x|w_i)$ is the probability of finding a pixel at position X, in the multispectral space. $P(w_i)$ is the initial probability of class of w_i. The initial probability indicates the overall percentage of a class in the image. $P(x)$ is the probability of finding a pixel with definite vector spectral values in the multispectral space. After calculating different parts of Biz law, probability vector of $P(w_i|x)$ can be produced that eventually with which decision will be made. Therefore, algorithm of this classification defines as calculation of these complementation and comparison of different secondary probabilities of various classes with each other.

2.4 CA-Markov model

Markov analysis model is a statistical tool that uses transition probability matrix based on neighborhood effects in a spatial influence algorithm[20]. When applied to land use and many other applications, Markov chains often specify both time and a finite set of states as discrete values. Transitions between the states of the system are recorded in the form of a transition matrix that records the probability of moving from one state to another[21].

Markov model takes into account past states to predict how a particular variable changes over time. The applicability of Markov model in land-use change modeling is promising because of its ability to quantify not only the states of conversion between land use types but also the rate of conversion among the land use types[22].

One inherent problem with Markov is that it provides no sense of geography. The transition probabilities may be accurate on per category basis, but there is no knowledge of the spatial distribution of occurrences within each land use category. To solve this problem, CA–Markov chain was developed to add a spatial dimension to the model using cellular automata. A cellular automaton is an agent or object that has the ability to change its state based upon the application of a rule that relates the new state to its previous state and its neighbor[23].

Cellular Automaton–Markov (CA–M) model is an interesting approach to model both spatial and temporal changes:

(a) The Markov process controls temporal dynamic among the cover types through the use of transition probabilities. (b) Spatial dynamics are controlled by local rules through a CA mechanism, considering either neighborhood configuration and transition probabilities. (c) GIS and remotely sensed data can be used to define initial conditions, to parameterize CA–M model, to calculate transition probabilities and determine the neighborhood rules[24].

CA-Markov model combines cellular automata, Markov chain, multi-criteria, and multi-objective land allocation to predict land cover change over time[22].

2.5 Map Server

Map Server creates map images from stored spatial digital data format. It can manage both vector and raster data. Map Server can render more than 20 different vector data formats, such

as shape files, Post GIS and Arcs DE geometries, Open DAP, Arc/Info coverages, and Census TIGER files.

It's not necessary all the information represented on a map to be in vector format. For instance, aerial or satellite photos of a region can be showed behind rendered vector data to make a clearer picture of how those vector elements relate to real-world features. Map Server can read two raster formats natively: GeoTIFF and EPPL7, but it can read more than 20 formats (including Windows bitmaps, GIFs, and JPEGs) via the GDAL package. However, although Map Server understands and can render these raster types, it can't tag images with spatial information.

Map Server can operate in two different modes: CGI and Map Script. In CGI mode, Map Server performs as a CGI script in a web server environment. Its setting up is easy and provides a fast, straightforward application. In Map Script mode, the Map Server API is available from Perl, Python, or PHP. The Map Script interface is a flexible, featured application that can still benefit from advantage of Map Server's templating facilities. Map Server is template based. When first conducted in response to a web request, it reads a configuration file (called the map file) that expresses the layers and other elements of the map. It then produces and saves the map. Next, it reads one or more HTML template files that are identified in the map file. Each template contains conventional HTML markup tags and specific Map Server substitution strings. These strings are used, for example, to specify the paths to the map image that Map Server has produced, to clarify which layers are to be rendered, and also to identify zoom level and direction. Map Server substitutes present values for these strings and then send the data stream to the web server, which then forwards it to the browser. When a requester changes any form elements on the page (by changing zoom direction or zoom value, for example) and clicks the submit button, Map Server gets a request from the web server with these new values. Then the cycle starts again. Map Server automatically performs several tasks while produces a map. It labels features and prevents collisions between neighboring labels. It provides for the use of both bitmapped and TrueType fonts. Label sizes can be fixed or can be changed to scale with the scale of the map. The option of not to print labels for specified map scale ranges is also provided.

Map Server generates legends and scale bars (configurable in the map file) and creates reference maps. A reference map indicates the context of the presently showed map. For instance, if the target region is North Dakota, the reference map would display a small map of North Dakota, with the content of the current map outlined within it. Zooming and panning are under user control. Map Server creates maps by stacking layers on top of one another. As each is rendered, it's placed on the top of the stack. Every layer displays features selected from a single data set.

Features that needed to be displayed can be selected by using UNIX regular expressions, string comparisons, and logical expressions. Because of the resemblance of data and the similarity of the styling parameters (like scale, colors, and labels), you can think of a layer as a theme. The display of layers is under interactive control, which lets the user to select layers that are to be rendered. While layers can't be produced on the fly, empty layers can be populated with dynamic data and manipulated via URLs. Map Server has strong and sophisticated query capabilities, but in CGI mode, it lacks the tools that allow the kind of analysis provided by a true GIS. Map Server is not a full-featured GIS: no integrated DBMS (Database Management System) tools, limited analytical abilities, and no tools for georeferencing.

Since Map Server's functions can be accessed via an API from variety of programming languages (such as PHP, Perl, and Python), it can serve as the base of a strong spatially aware application that has many of the analytical and reporting functions of a true GIS. Moreover, as there are not any integrated tools for dealing with spatial data, there are third-party tool sets that perform many (although not all) of these functions. When executing as CGI in a web environment, Map Server can render maps, display feature data, and perform rudimentary spatial queries. When accessed via the API, the application becomes notably more powerful. In this environment, Map Server can execute the same tasks it would as CGI,

but it also has access to external databases via program control, as well as more complex logic and a larger repertoire of possible behaviors.

2.6 Open Layers

Open Layers is an open source, client side JavaScript library for making interactive web Maps, and viewable in nearly any web browser. It is written with JavaScript language that allows maps be easily placed within web pages. Since it is a client side library, it requires no special server side software or settings.

When it is called client side, it refers to the user's computer, specifically their web browser. The only thing you need to do to make Open Layers work is the Open Layers code itself and a web browser. When it is calledlibrary, it means that Open Layers is an API (Application Programmer Interface) that provides you with tools to develop your own web maps.

Open Layers supports GeoRSS, KML (Keyhole Markup Language), Geography Markup Language (GML), GeoJSON and map data from any sources using OGC-standards as Web Map Service (WMS) or Web Feature Service (WFS), such as Yahoo maps, Microsoft virtual earth, and Google world wind. This software provides the functions such as zoom and repositioning as well as ability to edit and digitize. Open Layers makes creating powerful web-mapping applications easy and fun. It is very powerful but also easy to use. It's an open source, free, and has a strong community behind it. So if you want to dig into the internal code, or even improve it, you're encouraged to do so.

2.7 Web design

Web design is the skill of making and run of the web pages. Web is part of the Internet. Web is storage of Internet pages that every page has defined address and by which they are routed or found. The user that is logged into the Internet (their computer is connected with the other computers on the Internet) can access to the desired web page through the storage of pages by typing the page address in the address bar.

Web pages contain information, including text, image, video, audio and more. This content displayed to the user by three layers:

1) Content layer (content is created by HTML)

2) Presentation layer (presentation is created by CSS)

3) Behavior layer (behavior is created by JavaScript)

2.7.1 HTML

HTML stands for Hyper Text Markup Language. HTML is the standard language of web design. In fact, HTML language is the first, simplest, most versatile and most important language for web design. Whatever you see when you visit a web page is the results of your browser interpret of HTML. In other words, a browser doesn't know any code or control of server-side, such as the codes of asp and php and understandable code for them is HTML. Generally, all of the web programming languages are somehow related to HTML. For example, php, JavaScript and .NET programming languages, in addition to having the laws and standards, get help from HTML so that written codes in a specific format are places within the HTML codes.

HTML is a markup language which means that different parts are separated by components named tags. Each of which has its own application and related properties. These tags can tell the browser what type of element every section of pages is and what should be displayed.

A HTML document is a text-based file that usually named with suffix of .html or .htm and its content forms from HTML tags. Web browsers are able to understand and interpret the tags of HTML, read every of them from the HTML file and then display (render) its content to the user.

In a HTML page, a variety of elements such as text, headlines, photos, charts, etc. can be used and for each element the related tag of <>….</> should be used.

2.7.2 CSS

HTML is fundamental for web. It is a computer language that is used to develop template and web design. On the other hand, HRML should be used as a language for layout design or adjustment of appearance of web pages. This task is

done with other technologies such as CSS. In fact, nowadays, HTML is used for making foundation and overall structure of the web page and beautifying page layout design is up to CSS.

Cascading Style Sheets (CSS) is a language web that describes the style of an HTML document. CSS explains how HTML elements should be displayed on screen, paper, or in other media. Cascading Style Sheets (CSS) is a mechanism for adding style (e.g., fonts, size, colors, display mode, and spacing) to web documents. CSS can control the layout of multiple web pages all at once. Actually, CSS saves a lot of work. When a browser (e.g., Firefox, Chrome, etc.) reads a style sheet, it will format the HTML document according to the content and information in the style sheet. There are three ways of inserting a style sheet for development: (1) external style sheet; (2) internal style sheet; and (3) inline style. With an external style sheet, it can change the look of an entire website by changing just one file. An internal style sheet may be used, if one single page has a unique style and inline style may be used to apply a unique style for a single element. In this paper, the external style sheet is used.

2.7.3 JavaScript

By means of HTML language, a variety of web pages with all required components such as texts, tables, images, forms etc. can be created. But HTML is merely a design language and is incapable of programming, controlling forms, and responding to the application events and user performance. That is why JavaScript is important to have this capability. JavaScript is just a coding language by which linking the user and the site is possible. JavaScript is a scripting coding language.

Scripting languages recipes are executed by the browser on the user's computer and don't need a certain help to run. These languages are called client side. In contrast, languages such as ASP.NET get run first by the web server and then output in terms of HTML language which is sent to run in the browser. This language is called server side.

JavaScript is a programming language that is placed within the HTML codes and runs on the user's browser. JavaScript has the ability to change the contents of elements displayed on the visitor's browser, so that there is the possibility of dynamic pages.

JavaScript has a variety of abilities and possibilities, such as ability to change the text displayed on the browser, changing the colors, backgrounding color and position of elements used in the web design, changing the specification of elements and their CSS, animating, interacting with user via elements such as Text Box, Radio Button, Text Area etc. reacting to user actions such as changing the pics by moving the mouse over them, displaying a warning message to the user, doing math calculations, making HTML codes dynamically and according to the requirements, interesting menus with animation, collecting users information from the website and surveying them.

2.7.4 Host

Host is so called the server or the computer that can store and save your websites files. These files can be web pages, pictures, CSS files, JavaScript files or any other kind of files. Host space has a unique internet address called IP, a unique domain and a unique name that makes your computer be known in the network. In other words, Hosting of a website is to provide a suitable place as the main base for sending and receiving information via the internet, which technical term is called web Hosting. There are 3 types of Host including: (1) Shared Hosting; (2) Virtual private Server; and (3) Dedicated Server.

2.7.4.1 Shared Hosting

Shared Hosting is the most common, cheapest and most convenient type of hosting. Shared Hosting is a service in which Host space of a server is divided between multiple websites.

Advantages and disadvantages of Shared Hosting:

1) It is the cheapest type of Host. You don't need to pay a large sum of monthly payments.

2) It is easy to use. The server is pre-configured with popular options. Your hosting company takes care of the security and maintenance of changes you make on the website.

3) You have shared your server with other websites. If one of those sites is really "busy"

(number of visits is much), it makes pressure on other websites on this server and makes their speed come down.

4) It is not much flexible and it is incapable of installing software on it.

2.7.4.2 Virtual Private Server—VPS

Virtual private server is basically a service between shared Hosting and dedicated server. In this type of Host, hardware is shared between users of VPS as well, but is partitioning using virtualization technology in which every partition has its own dedicated resources. It can almost fully be configured as a Dedicated Server.

Advantages and disadvantages of virtual server: 1) Full control: customers have full access to the root server and can configure settings in order to meet their needs.

2) It is affordable. The cost of this type of Host is more than Shared Hosting and less than Dedicated Server.

When clients have full access to a server, they can use all of its resources personally. Advantages and disadvantages of Dedicated Server:

1) Flexibility and customization: customers can choose their needed software and hardware from the server to meet their demand.

2) Dedicated resources and guaranteed performance.

3) Full control: customers completely have access to the root and can configure settings in order to meet their needs.

4) Required technical knowledge: in this type of Hosting, the customer is responsible for managing and controlling the server.

5) High cost: the cost of this type of server is not shared with other customers.

3. Results

3.1 Classification and land use change

Remote sensing technology has many applications for mapping land use and land use changes detection. Traditional data collecting method for production of these maps is land mapping which is costly and time consuming. Today, with the help of satellite images and classification methods of images, providing maps is easier. Image classification is done by comparing values and spectral characteristics of each pixel with predetermined characteristics. For this, sample or training points for classification were used. **Figure 2** represents classified images of 1994, 2002, 2009 and 2015.

Due to increasing changes of land use and need of managers and experts to be aware of changes trends in order to policy making and giving solutions to solve the present problems, it seems like that detection methods to determine changes trends over the time are essential (**Figure 3**).

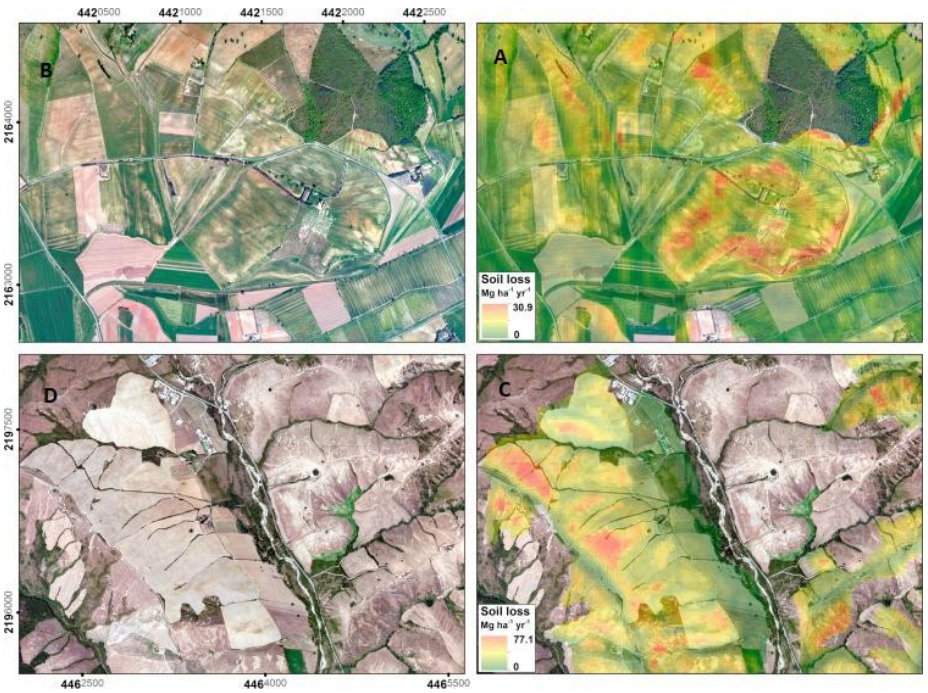

Figure 2. Classified images of Landsat with method Maximum Likelihood. (a): year1994, (b): 2002, (c): 2009, (c): 2015.

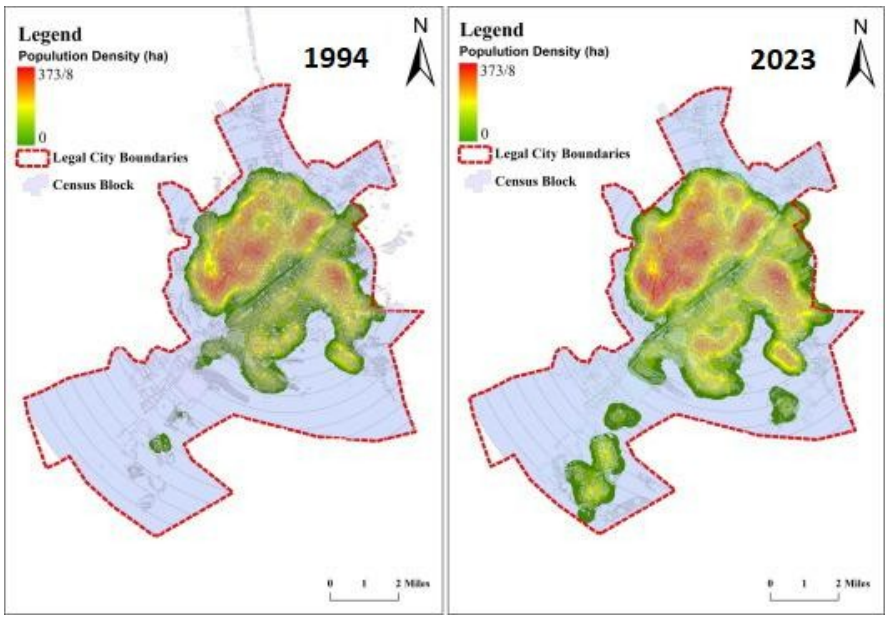

Figure 3. Urban growth between 1994-2023**.**

3.2 Prediction of land use change

Beside to detection of past changes of a region, forecasting of future changes is of great importance. Forecasting and modeling of spatial phenomenon such as simulation of land use change, growth of urban development and etc. are as tools in the management of natural resources and monitoring of environmental and urban changes. These changes reflect human interaction with the environment and its modeling can be effective in decision making and macro scale planning. In this paper, Markov chain modeling has been used for land use change modeling of Qom city. **Figure 4** indicates predicted land use change map of Qom city for the years 2009, 2015 and 2023.

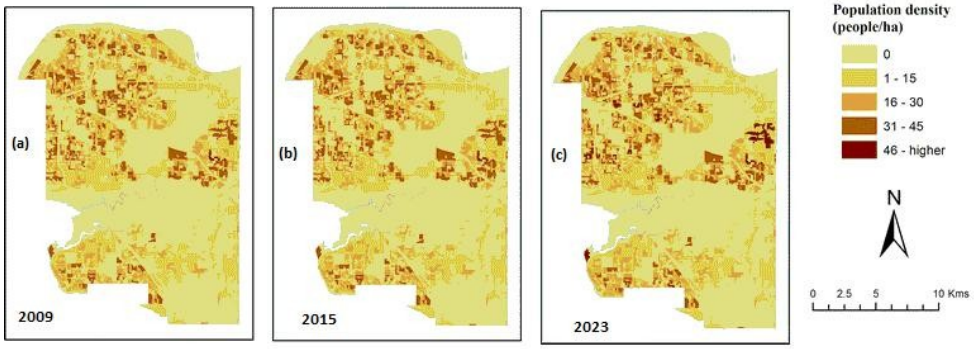

Figure 4. Predicted map with Markov chain method. (a): 2009, (b): 2015, (c): 2023**.**

Markov chain analysis is a useful tool for modeling of land use change where describing the changes and land process is hard. Markov process is used when modeling of the future of a system completely based on its previous system is possible. Markov chain analysis describes land use change from a period to another and uses it as a basis for mapping the future changes. This act is done via developing of a probability matrix of land use change from time 1 to time 2.

3.3 Accuracy assessment

No classification using remote sensing data is complete without accuracy testing. Analyst and user of classified map want to know with which accuracy amount, the classification on land has been set on the picture. The term precision adapts with accuracy. In digital image processing, the tool for measuring of accuracy is to match the standard information at a given place with the information at the same place on the classified image. In general, accuracy assessment is based on comparing two maps, that one is based on remote sensing data analysis and the second is derived from definite data called Ground Truth or Reference Data. Easiest method of evaluation is

the comparison of classified map with defined data with regard to regions placed in each class. This method leads to the production of a report of the spatial content of the class that is in accordance. After all the required parameters were determined, sampling is possible. Sampling can be done via field assessing or via using the previous data like present maps or spatial images.

In this regard, field assessment was adopted. Samples were introduced into the software and required calculations were performed. The results of accuracy assessment represented as error matrix. The variety of parameters and values that indicate the type or accuracy of error in the results are extracted from the error matrix.

3.3.1 Error matrix

Assessing the error and calculating of classification accuracy usually is done according to statistical parameters derived from error matrix. Error matrix is the result of comparison between pixel, defined pixels (on the ground truth) with errors ponding pixels in the classification results. Label of each defined pixel is compared with corresponding pixel. According to matrixes, different parameters are extracted in order to express accuracy and error that the most famous of them are overall accuracy and Kappa coefficient. Overall accuracy is an average of classification precision that shows the ratio of appropriate classified pixels to the sum of the clear pixels and Kappa coefficient calculates the classification accuracy rather than a random classification. It means that Kappa coefficient gives the classification accuracy rather when an image is completely randomly classified. This can be mean that after removing the effect of chance in the classification, the amount of accordance with ground truth will be calculated. **Table 2** shows the classification and prediction accuracy.

Table 2. Classification and prediction accuracy

	Year	Area (Ha)				Accuracy assessment	
		Urban land use	Nonurban	Vegetation	Fallow	Overall accuracy	Kappa
Classification of landsat-8	1994	4443.47	25025.13	2247.13	5803.13	-	-
	2002	5103.64	23274.75	1811.14	7329.32	-	-
	2009	6160.28	19441.43	2298.08	9619.07	-	
	2015	7938.86	19585	1857.13	8136.97	85.55555556	80.03
Prediction	2009	5595.43	22707.5	1759.23	7450.48	82.57	-
	2015	6993.01	19375.5	2536.34	8606.74	93.865	-
	2023	10104.23	18242.74	1627.38	7538.24	-	-

3.4 Application of the web GIS

After coding (Some pieces of written codes are displayed in **Figure 5**), the output will be the application that includes a one level with sub levels (**Figure 6**) that consists of base map (**Figure 7**), and shape file layers of Iran (**Figure 8**), Qom province (**Figure 9**), classified layers (**Figure 10**) and predicted layers (**Figure 11**) are displayed for different years. For making this application works online, it needs a Host that VPA is the best choice that should be installed map server software on this Host. With this step, the application is publically available on the Internet.

```
var map, layer;

function init(){
    map = new OpenLayers.Map( 'map' ,{ controls: [] } );
layer1 = new OpenLayers.Layer.WMS( "Base Map",
        "http://localhost/cgi-bin/mapserv.exe", {map: '/ms4w/apps/webgis/htdocs/map1.map',layers: 'raster'}
        ,{maxResolution: 'auto'} ,  {transitionEffect: 'resize'} ); // more on Resolutions later.
                // setting maxResolutions to auto is necessary because default is 360 deg / 256 px.
                layer1.isBaseLayer=true;
layer2 = new OpenLayers.Layer.WMS( "Boundaries of Iran",
        "http://localhost/cgi-bin/mapserv.exe", {map: '/ms4w/apps/webgis/htdocs/map.map',layers: 'Boundaries of Iran'}
        ,{maxResolution: 'auto'} ,  {transitionEffect: 'resize'} ); // more on Resolutions later.
            // setting maxResolutions to auto is necessary because default is 360 deg / 256 px.
            layer2.isBaseLayer=true;

layer3 = new OpenLayers.Layer.WMS( "Province of Iran country",
        "http://localhost/cgi-bin/mapserv.exe", {map: '/ms4w/apps/webgis/htdocs/map.map',layers: 'Province of Iran country'}
        ,{maxResolution: 'auto'} ,  {transitionEffect: 'resize'} ); // more on Resolutions later.
                // setting maxResolutions to auto is necessary because default is 360 deg / 256 px.
layer3.isBaseLayer=true;


layer4 = new OpenLayers.Layer.WMS( "Qom Province",
        "http://localhost/cgi-bin/mapserv.exe", {map: '/ms4w/apps/webgis/htdocs/map.map',layers: 'Qom Province'}
        ,{maxResolution: 'auto'} ,  {transitionEffect: 'resize'} ); // more on Resolutions later.
                // setting maxResolutions to auto is necessary because default is 360 deg / 256 px.
layer4.isBaseLayer=true;
```

Figure 5. A view of the Notepad++ software.

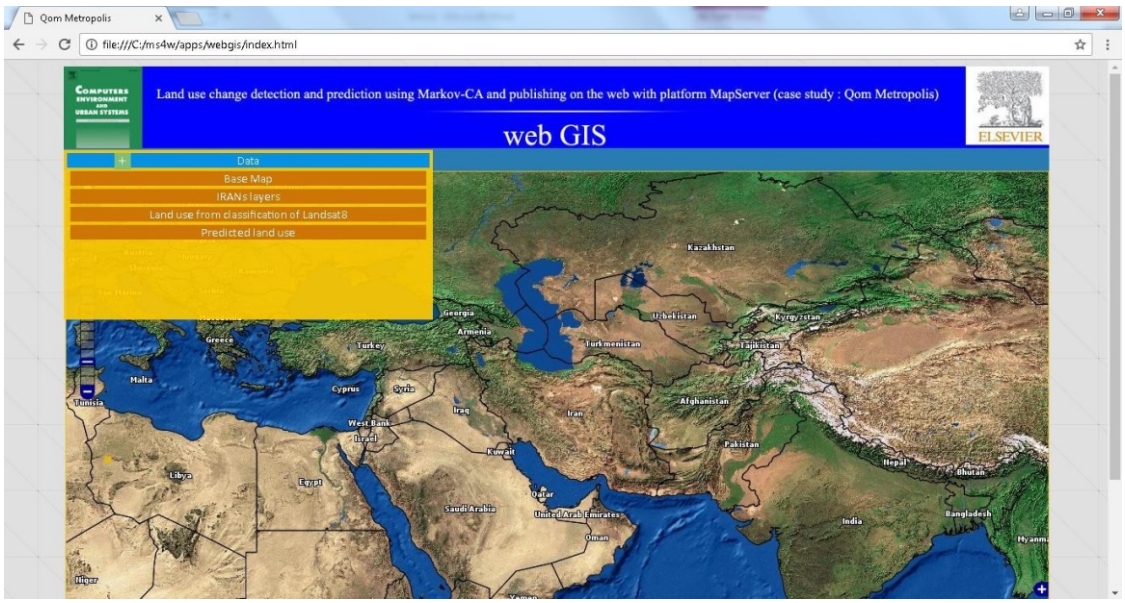

Figure 6. A view of the designed menue of web GIS**.**

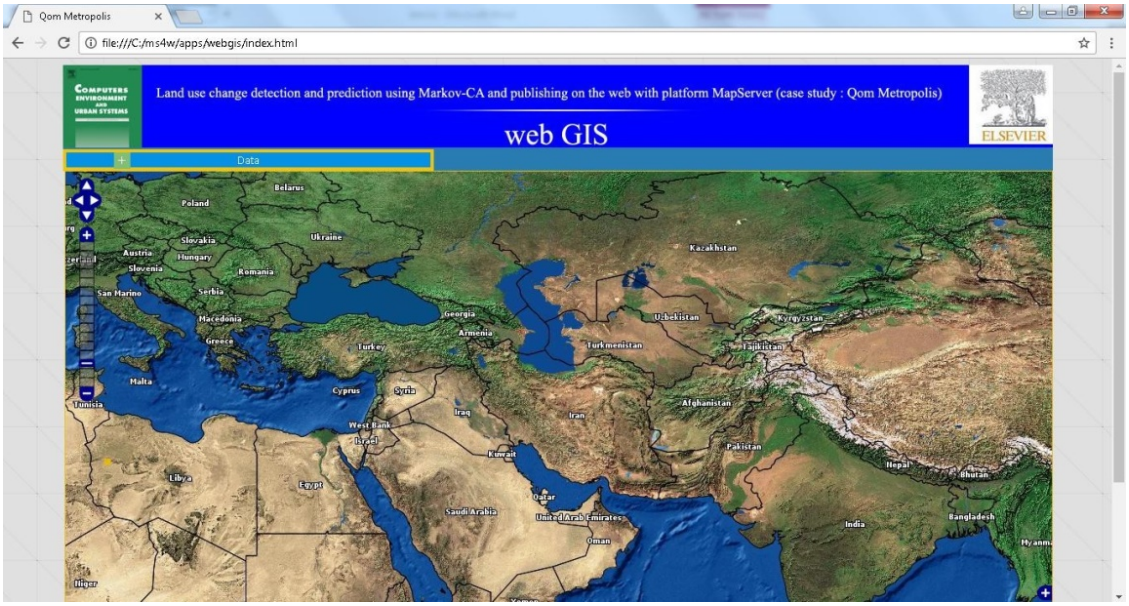

Figure 7. A view of the designed basemap of web GIS**.**

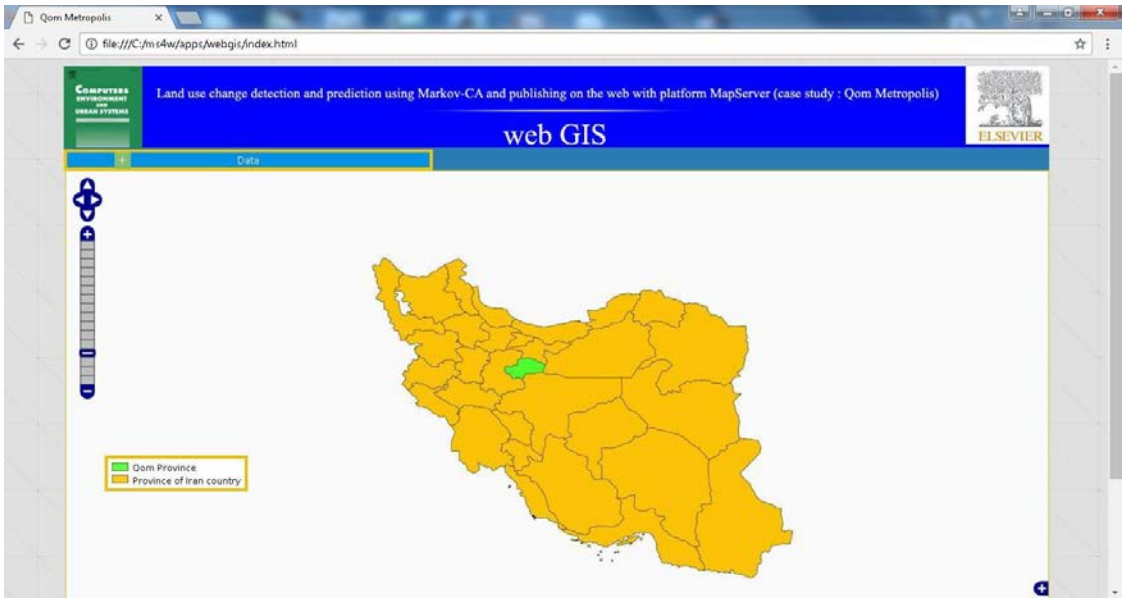

Figure 8. A view of the shape file layers of Iran**.**

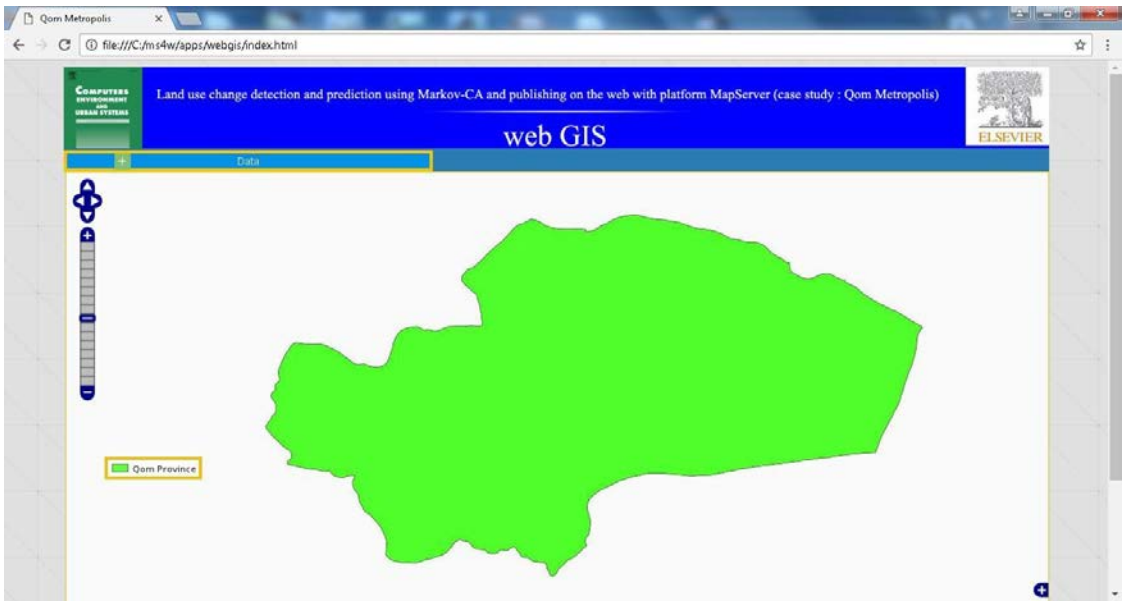

Figure 9. A view of the Qom province.

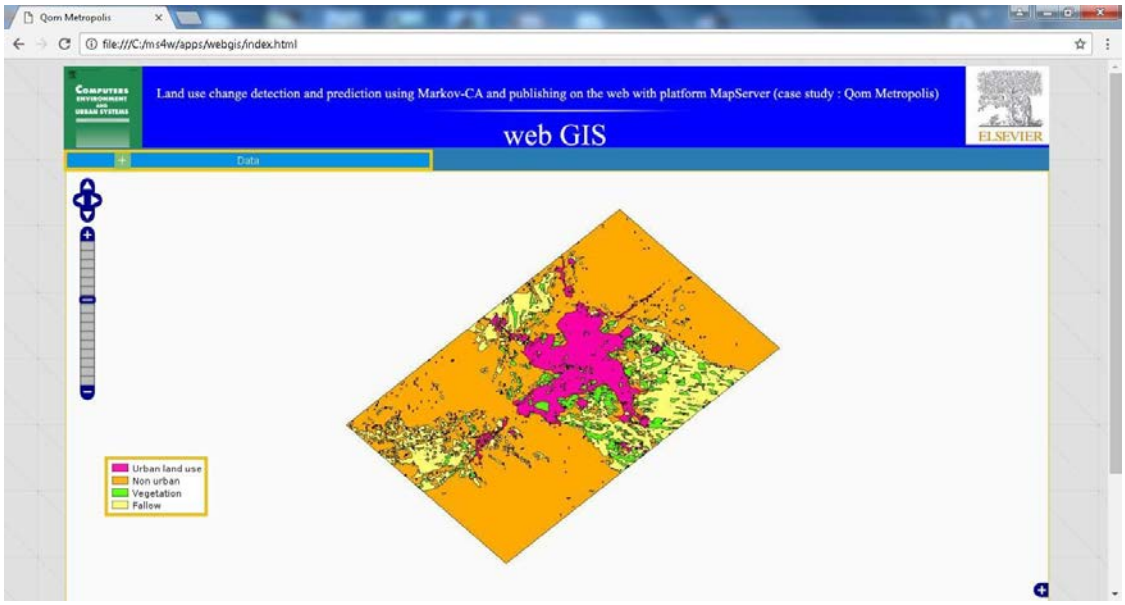

Figure 10. A view of the classified layers.

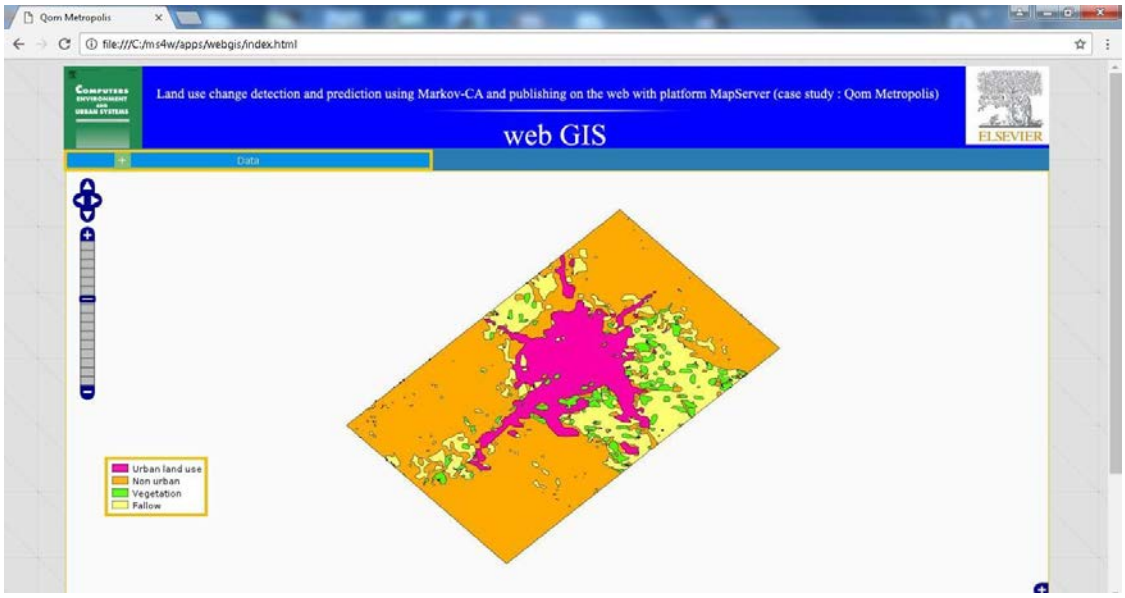

Figure 11. A view of the predicted layers.

4. Discussion

Due to the fact the great importance of land use and land cover change detection and prediction in management and decision making, the accuracy and availability of the prediction maps is crutial. Many previous researches have been done in this field of study that has concentrated on the producing the detection and prediction maps of land use change but not publishing them to the public. The point that makes present research to be distinguished from previous ones is publishing the results in terms of online and up to date maps on web GIS. In this regard, Markov model helped to predict the urban growth in future to determine the urban growth pattern. CSS, HTML and JavaScript programming languages are open source; therefore they are efficient in design of web GIS and are available for researchers. In this paper, via these programming languages, classification and prediction maps were designed without any problem. Previous studies were just about producing the maps and fast and online availability of these maps for all were neglected. This research demonstrated that it's possible to make all of the researches and studies available, so that leads to the use of map server software through the web GIS map designs.

In addition to the map server open source software, there is other open source software too, such as Geo Server. It is recommended that in future studies, Geo Server software is used beside the map server software.

5. Conclusion

Knowing the direction and pattern of land use changes enables the urban managers and planners to implement the necessary infrastructures and to apply the accurate and precise decisions for the future. This study aimed to predict and detect the land use changes of Qom metropolis. Land use changes of 3 periods containing 1994-2002, 2002-2009, 2009-2015 and predictions of 2009, 2015 and 2023 were studied. In this regard, Maximum Likelihood method was used to classify the images, so that after evaluation of accuracy, amount of overall accuracy for images of 2013 was 85.55 % and its Kappa coefficient was 80.03%. To predict land use changes, CA-Markov model was used. The amount of overall accuracy for 2009 was 82.57% and for 2015 was 93.865%. To make the maps available for the public, web GIS application was designed via map server application and evoked shape files through map file and open layers to browser environment and for design of appearance of website CSS, HTML and JavaScript languages were used.

Results showed that Qom metropolis has changed a lot and land use has dynamically expanded. The direction of urban land use change chiefly is along the routes to outside of the city, however, urban land use has an inside-out growth pattern, and the main changes will occur in south- west.

Conflict of interest

The authors declare that they have no conflict of interest.

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