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Seasonal Wilderness Identification System using Remote Sensing Techniques: Riyadh Region as a Case Study

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Abstract.

Seasonal wilderness areas are those which turns temporarily into vegetation after the raining season. Most Saudi families love to visit seasonal wilderness areas to spend few days outside their congested cities. The only ways to find such areas which have more vegetation than others are by asking friends, relatives or finding them by accident. Some areas remain unknown until the temporal greenery disappears and they become part of the desert. This research proposes a dynamic mechanism of identifying seasonal wilderness areas using the techniques of GIS and remote sensing. Normalized Difference Vegetation Index (NDVI) technology with a proper change detection technique is applied to classify the seasonal greenery areas with other non seasonal ones like farms or others permanent vegetated lands.

Keywords: GIS; Remote Sensing; Change Detection; Riyadh.

1 Introduction

The term wilderness have varied across time and cultures. Culturally, wilderness is defined as many things, from any natural area to the urban wilderness[1]. In North America, the government classifies specific areas of public land as wilderness[2]. More extremely, the Christian tradition characterizes the wilderness as an evil, cursed place, lacking in water like deserts[3]. Olson[4] described wilderness as ”escape from the perplexing problems of everyday life and freedom from the tyranny of wires, bells, schedules, and pressing ”. In this research, wilderness areas are those which turn into green during the rain season. In spring, majority of Saudi people visit green wilderness parks which are situated on outskirts of cities to enjoy nature, beauty and to escape from life stress[5]. To explore new areas to visit, most people ask friends or colleagues about the best places that they have ever visited or heard of. People tends to happily share pictures or videos of newly discovered wilderness parks so their friends and relatives can visit and enjoy them before spring season ends. To save time, people tends to go to well-known areas close to the city; the thing that made them crowded and uncomfortable for many of them. There is a need for a more dynamic way of identifying the green wilderness areas instead of the traditional one.

In the coming section, the related literature is presented focusing on similar studies about remote sending and change detection, in Section3, the methodology of images analysis and change detection is proposed. Finally, Section5 includes the conclusion and short indication for future studies.

2 Background

The advancement of GIS and remote sensing encouraged research to employ them in areas like weather simulations, climate monitoring and many other disciplines. The work accomplished by Landres et al.[6] discusses potential applications of GIS to tourism planning. Banaszek et al. [7] proposed a methodology to classify the geological developments of lands and rockets in Sosnowiec and Bedzin towns during 1927-2009 based on geographical information systems (GIS). In Eskisehir city, the local multiplicity used GIS system to identify suitable lands to construct open green areas[8]. abuk et al.[9] suggests that using GIS applications in environmental and ecological planning studies excels traditional assessment methods. Corrie[10] aims to perform an analysis to determine additional vegetation that exists on public lands and private preserves using a GIS database of Palm Beach Countys. The developed GIS model by Tiwari et al.[11] tries to identify areas that have considerable conservation priority and suitable for further development at various levels. Another study used the applications of GIS and remote sensing to explore the environmental impacts of tropical coastal zone of Southern Nigeria[12]. Liu et al.[13] identified the suitable conservation areas to allow a sustainable urban expansion in south-eastern China. Weerakoon[14] proposed a methodology to identify the best land for agriculture based on soil analysis. In the coast of Rio Grande do Norte state in Brazil GIS was used to find potential areas for cultivation[15].

In this research, change detection is used to find a difference between satellite images of the same area at different time periods. Change detection as a method to identify significant differences in satellite imagery were applied at different times that can be used for change detection. Change detection is used to identify or define the differences in objects or phenomena at different times through observation [16][17] [18] . This process is usually applied to detect changes between two or more images of the earth surface over a period time. GIS plays an important role in this process by updating feature data based on new imagery. NDVI attributes classifies the satellite images vegetation area as bright areas, while dark areas indicate the lack of vegetation areas [19][20].

3 Methodology

Our methodology is concerned with selecting and determining the best way of identifying green wilderness parks. Satellite images are collected from a selected study area, processed in three phases and then combined into one rectified image, which is to be analyzed subsequently. Then, the greenery areas are extracted and excluded from other areas. The final step is to produce digital maps for green wilderness areas Figure1. The study area considered for this research

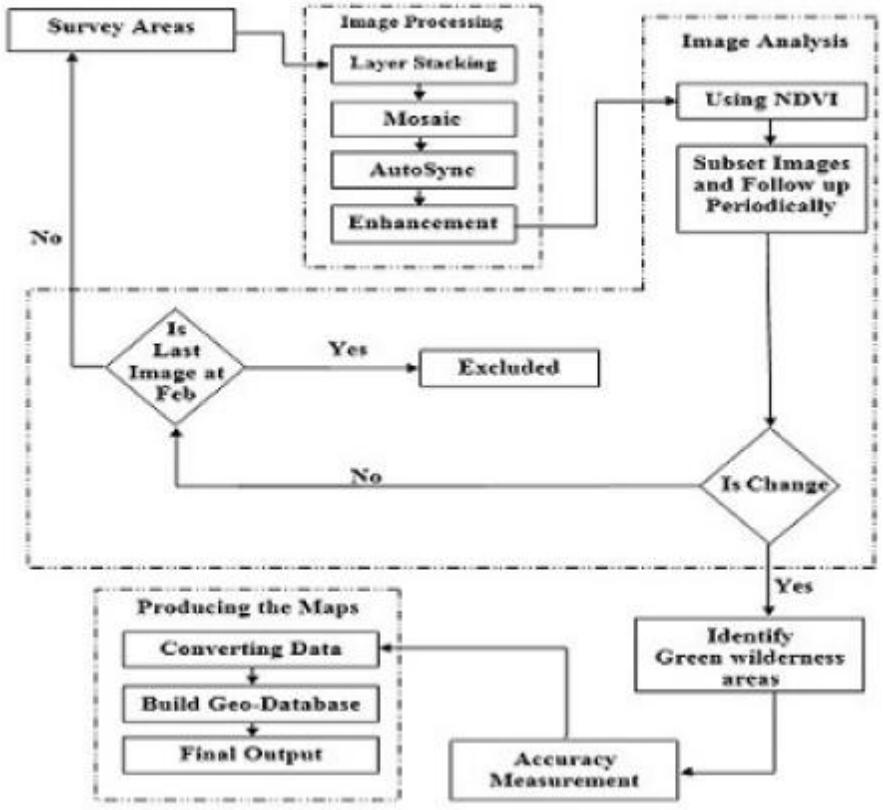

Figure 1: Image Detection Algorithm

Figure 2: Riyadh Region (Study Area)

is Riyadh county Figure2 which contains the capital city of Saudi Arabia. Riyadh is the most populated and the second largest county in the country, measuring 380,000 Km2 covering 20 districts.

3.1 Phase I:Area surveying

In order to avoid the confusion between the suitable and unsuitable areas such as residential areas, cities, villages, and small towns, an extensive survey is conducted on the Riyadh region. Unsuitable areas which are classified as non green wilderness are filtered out.

3.2 Phase II: Image processing

The images should be processed before detecting variance. This processing is made through four stages. First, stacking layers should be built. Following that is a process of collecting images, and extracting it to one image. After that, the AutoSync model is used to correct the imagery. Finally, the image is enhanced to achieve higher resolutions.

3.3 Phase III: Image analysis (identify green wilderness area)

The goal of this phase is to analyze the images in order to identify green wilderness areas which is one of the most important part of this research. In this stage, the satellite images are analyzed through the NDVI technique to identify grass areas and green plants, and subsequently the exclusion of other areas such as residential, sandy or even empty areas. After that, these areas are cropped within known coordinates to follow up the process periodically. Finally, these green wilderness areas are studied for signs of perceptible change.

3.4 Phase IV: Accuracy measurement

In order to ensure that all of the collected data was correctly processed, accuracy measurement is made through the use of field validation. In doing this, a random area is selected to for testing, thereby proving the validity of the research findings.

3.5 Phase V: Producing maps

The final stage is designing maps for the green wilderness areas. This stage contains three sections: (1) the conversion of the satellite images to digital maps, (2) building a geo-database, (3) taking out the map in final form with location coordinates and other important locations information.

4 Result

The proposed methodology provides satellite images for a particular area analyzed to identify and discover the green wilderness areas. Coordinate points were selected within the study area,

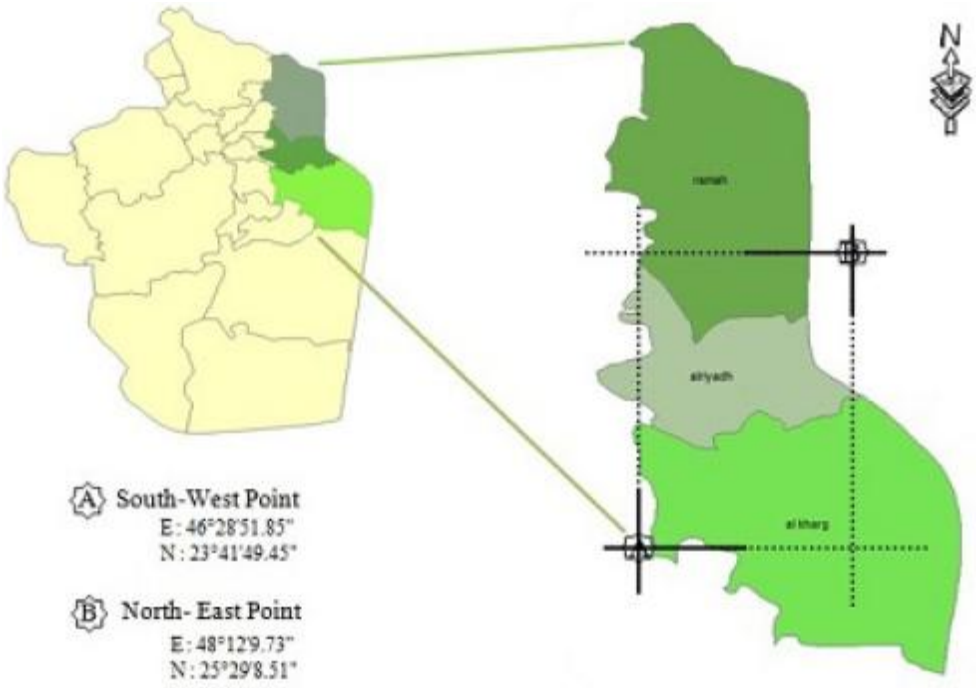

Figure 3: Areas Classification

and then the satellite image was provided in November 2013 Figure3. As shown below in Figure 4 seven bands were collected and reformatted in the unified band in order to clearly show the picture. This mechanism is known as layers stacking process. The main reason for this process is that the clarity of the satellite image is not sufficient through one or two bands; therefore, it is imperative to integrate the seven bands to enhance the lucidity of the image. Then, the

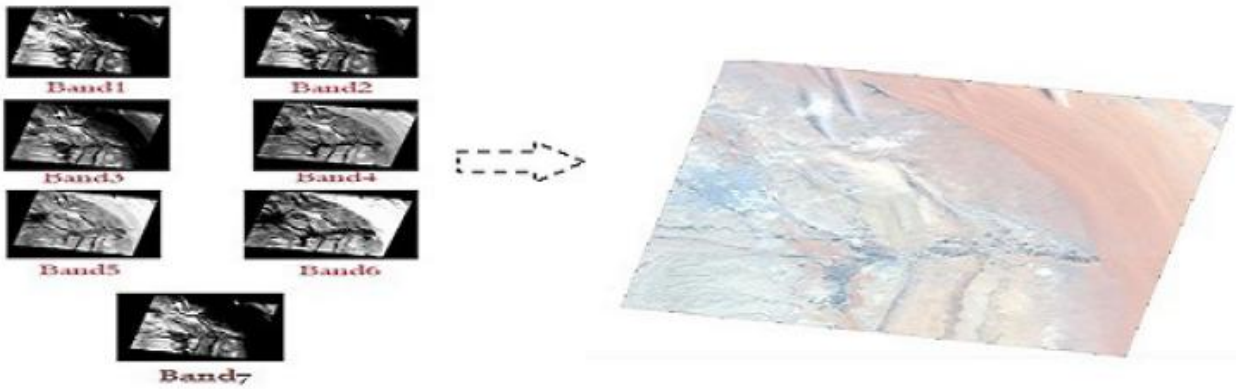

Figure 4: Layer Stacking Proces

images (geo-referencing) are collected and merged to produce a single image within a certain area. This mechanism is called the Mosaic process Figure5.

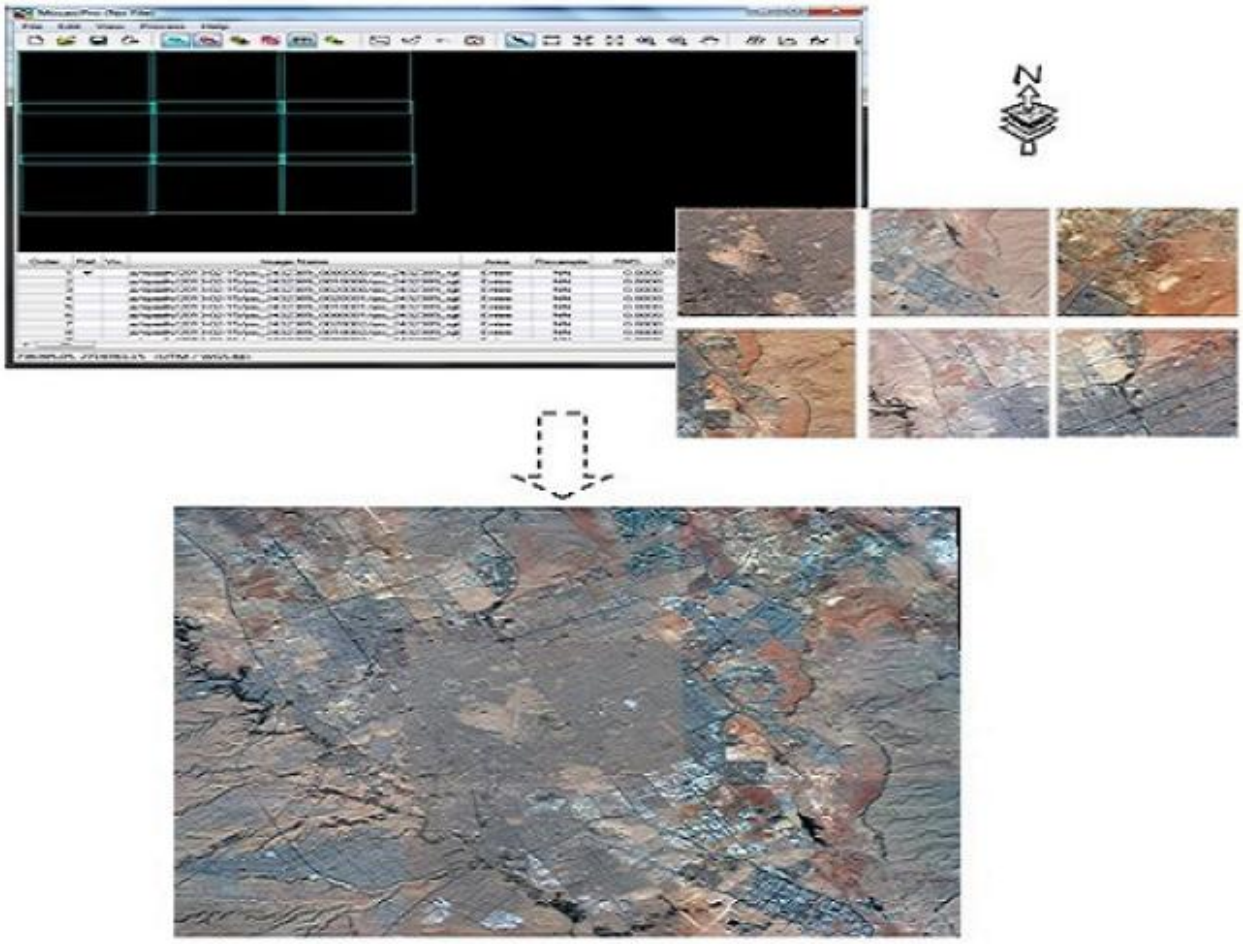

Figure 5: Mosaic Process

Usually overlapping between merged images occur in mosaic process leading to inaccuracies in the point positions; therefore, AutoSync process follows to make the required correction on pixel by pixel basis Figure6. The final stage is to enhance the image clarity before it is used

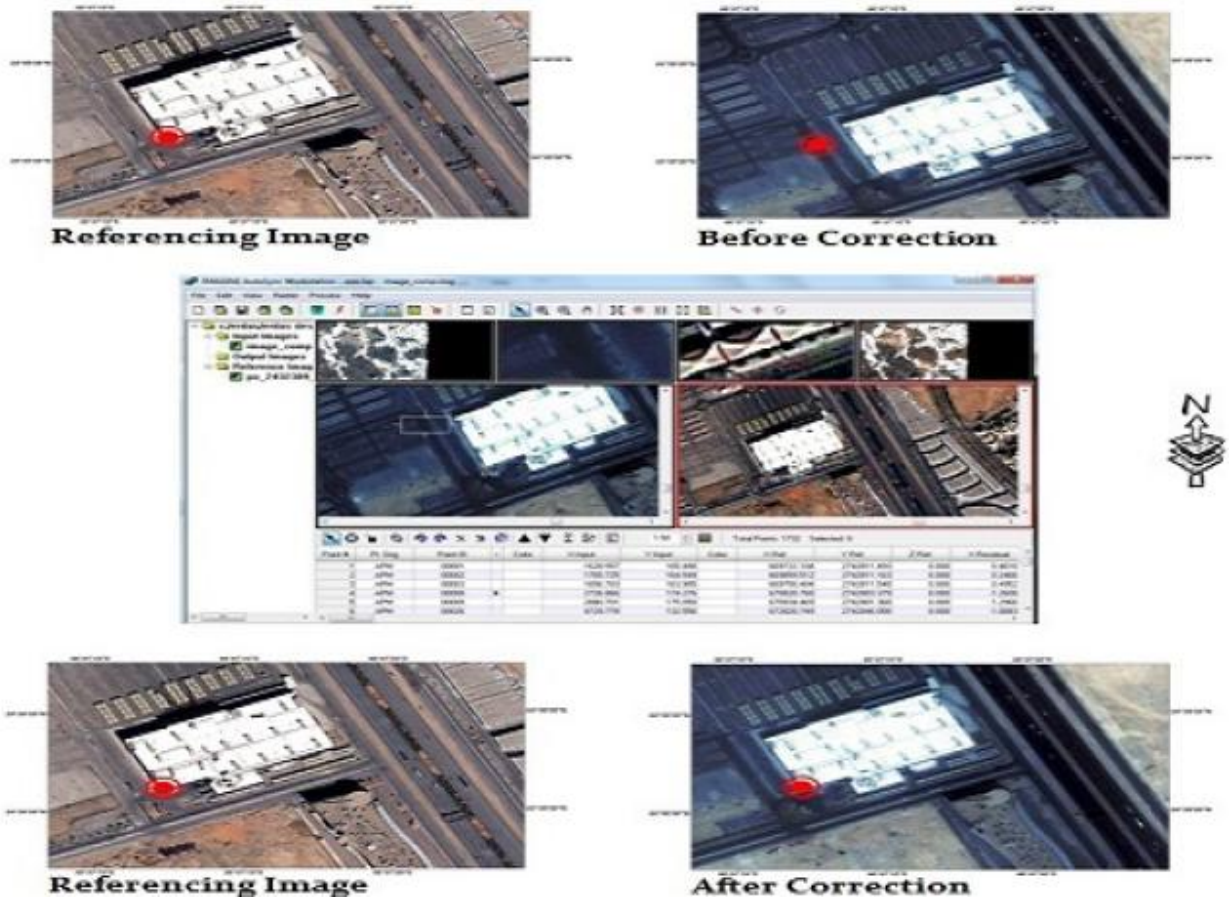

Figure 6: AutoSync Process

by the NDVI technique to discoverer the greenery areas. This step uses the NDVI technique to identify green places in the image, and excludes other areas Figure7. The NDVI technique targets Band 4 and 3 to select the green plants in the soil. It classifies greenery areas into two groups, bright and dark areas, indicating the lack of greenery. After identifying the greenery areas in the map as shown in Figure8; they are cropped (subset Image) and stored with its full details its coordinates, the captured date of the image etc., Figure9. Then the image is followed up periodically and change detection is conducted on a certain time frame.

To detect any greenery changes, another image is obtained for the same area in different time frame Figure10. If no change is detected the processes resume as explained in the proposed flow

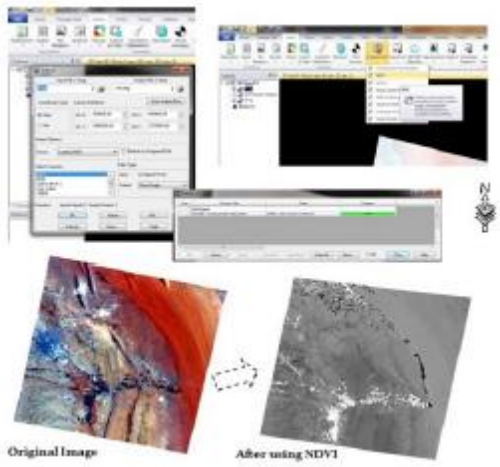

Figure 7: NDVI Process

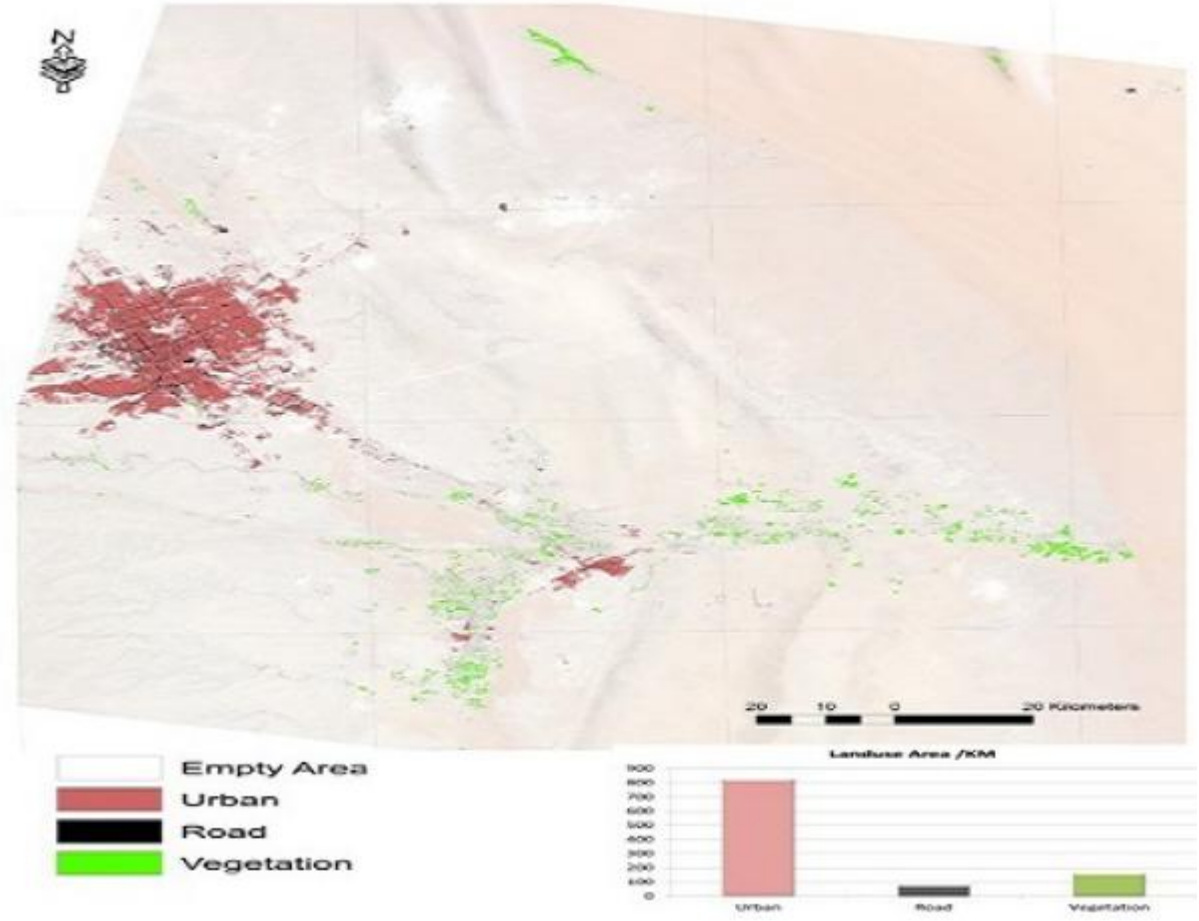

Figure 8: Greenery Areas (Kuraim Destrict)

chart Section3. In case, however; a change is detected the design production follows to produce a digital map of the cropped area. The process use ArcMap to convert the image from Raster to Vector format by

drawing the image polygon which represents the boundary of the specific area Figure 11. After converting and drawing the area, a geo-database is built that contains detailed

ID	Name	Coordinates		Acquisition date	
		X	Y	Date 1	Date 2
1	Khuraim garden	47°17'46.7"	25°21'39.7"	Nov 2013	Feb 2014

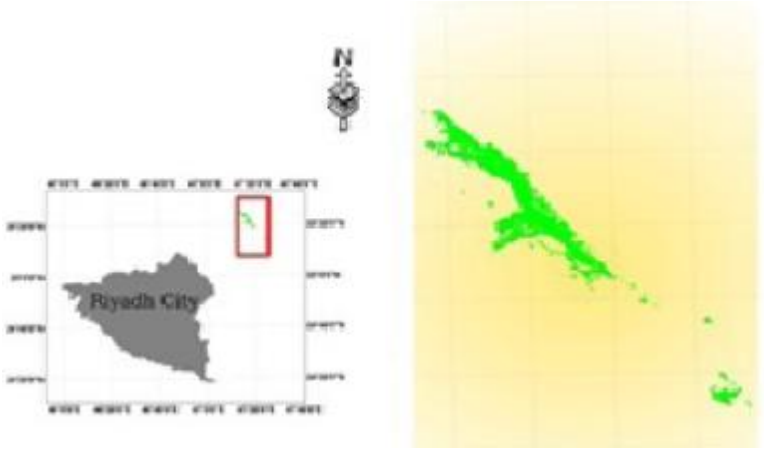

Figure 9: (Subset Image)

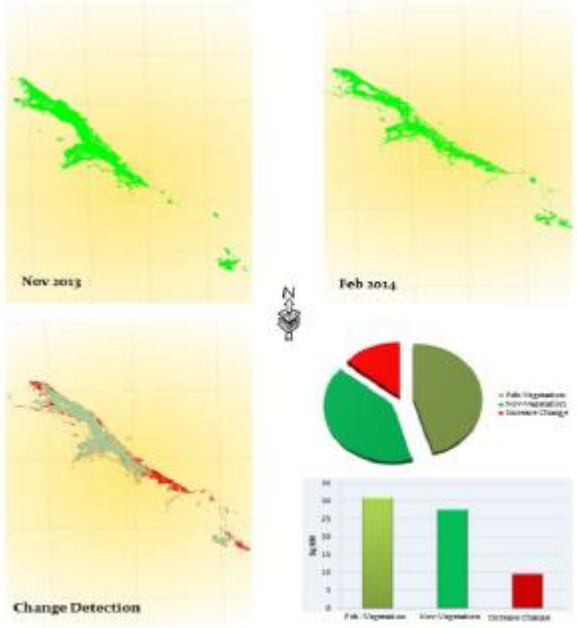

Figure 10: Change Detection Process

information about the green wilderness area, such as the area name, the area type, coordinates etc. In the final step, the digital map of the green wilderness areas are produced containing detailed information about the nearest police stations, civil defense centres, hospitals and health care centers as shown in Figure12.

One of the main findings of implementing our proposed methodology is that it turns out

Figure 11: Conversion Process

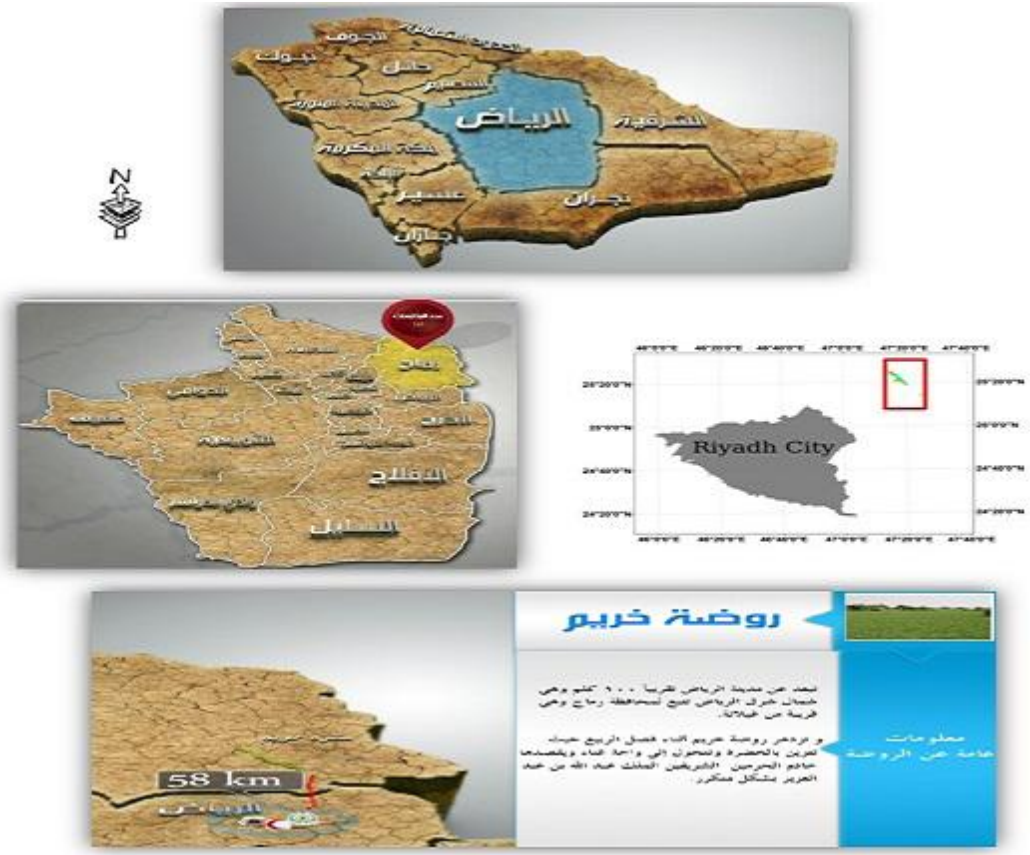

Figure 12: Final Output

that using the NDVI technique to determine greenery areas is complex due to difficulties in the classification of the greenery types. The NDVI technique combines all areas containing green vegetation and does not discriminate between area types. However, a positive factor is that it shows the shape of the

analyzed area. One of the drawback of the study was related to the shape of the green area. A green area with equal shape and dimensions (either circular or semicircular) means the area is private property or farms, not green wilderness areas. Furthermore, there were also other greenery areas inside the city boundary Figure13.

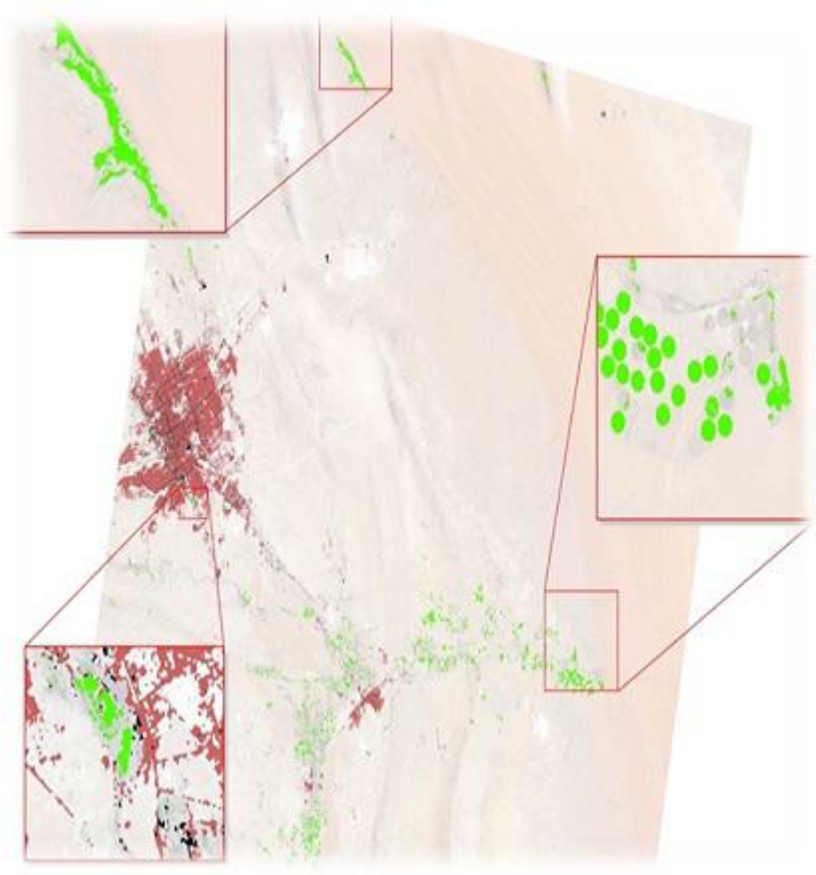

Figure 13: Greenery areas

Green wilderness areas that have been considered valid areas were found to be residential areas with different lengths and shapes. Therefore, these areas have been excluded and cannot be considered green wilderness areas. Throughout the study area, greenery areas have been classified as either a green wilderness area suitable for the context of our study or a non-green wilderness area. Non-green wilderness areas that are found to be private properties (farms) or green areas contained within the city boundary are not utilized in this research and were excluded. To identify the excluded areas in this research, several images have been provided during the months of July and September 2013, indicating that the useful areas in this research are empty of greenery in this period Figure14. Through the images, it is possible to show that the Khuraim area changed during certain periods of the year. In July and September 2013, the plants and green areas disappear in that region while those plants reappear in March 2014 image.

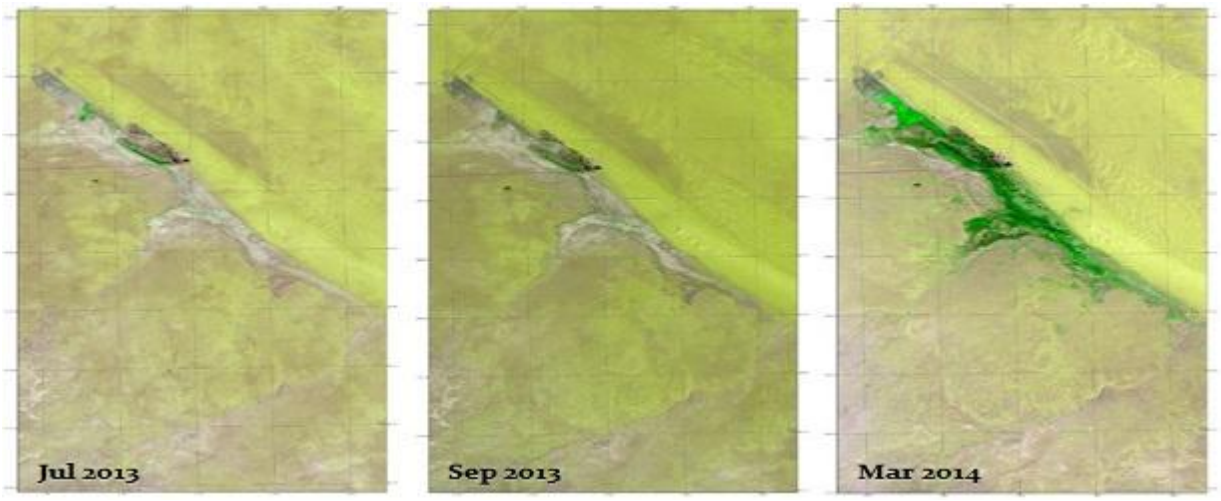

Figure 14: Khuraim area

Conversely, in the images shown in Figure15, the green wilderness areas that do not change throughout the year were studied and compared with other images taken in the summer period (defined as July-September). The study results showed no change in these areas, therefore they were considered non-green wilderness areas. This is because greenery areas appear in green wilderness areas at a certain periods of the year, and not throughout the year. The regions containing vegetation around the city boundaries and were considered non-green wilderness areas are shown in Figure16.

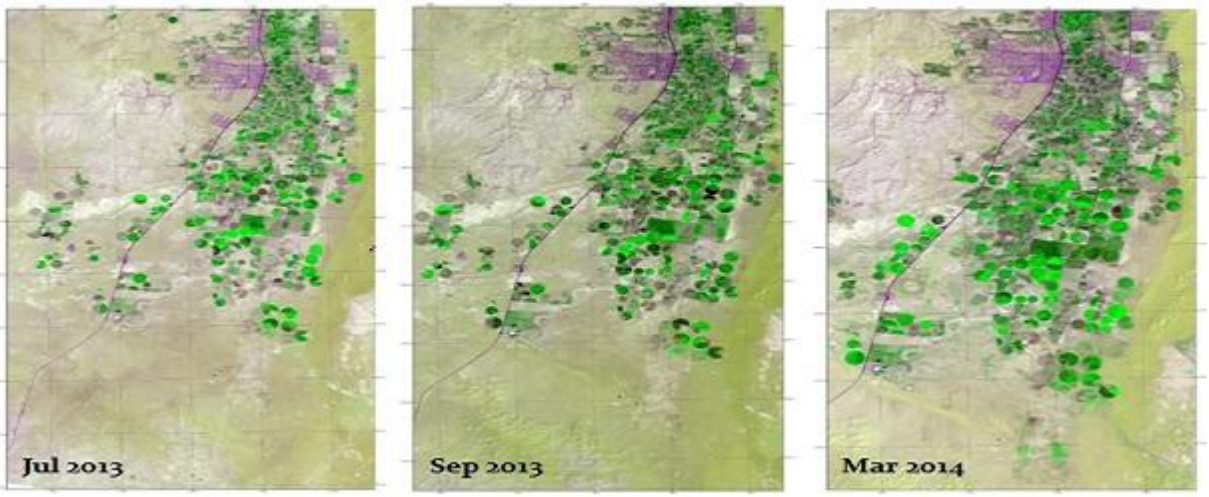

Figure 15: None Wilderness Areas

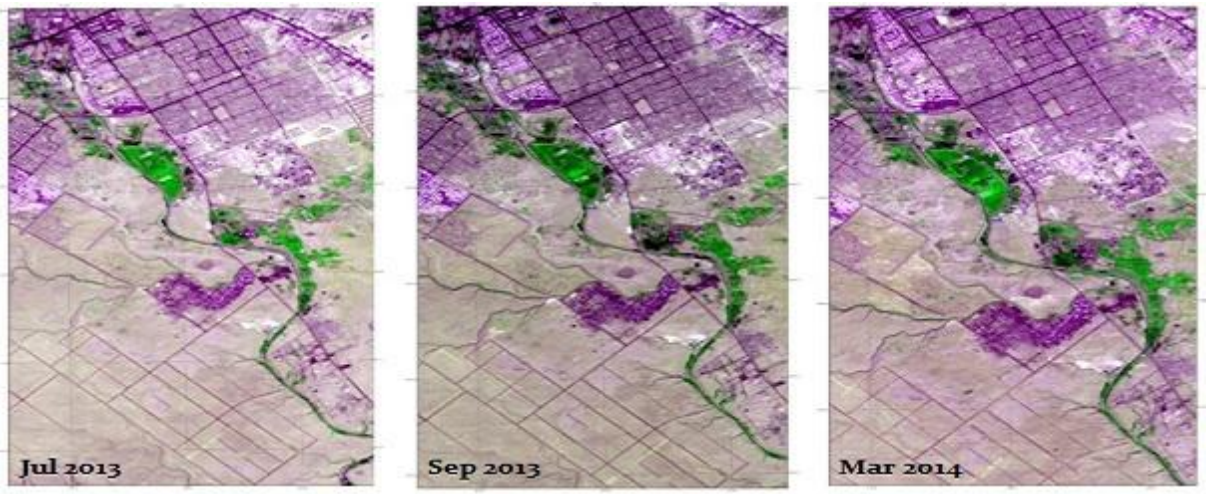

Figure 16: Surrounding None Green Wilderness Areas

5 Conclusion

It is a challenging and complicated task to locate wilderness areas containing vegetation and greenery. The purpose of this research paper is to employ the techniques of GIS and remote sensing in order to identify green wilderness areas in and around Riyadh, the capital city of Kingdom of Saudi Arabia. Multiple techniques have been used, including the NDVI procedure which detects and identifies greenery areas. This technology is used to locate green spaces of various sizes which appear in satellite images. In addition, the change detection technique (image differencing) was implemented to examine variations in green wilderness areas, specifically, the degree to which the greenery in such regions has increased or diminished. While the NDVI technique is the most effective means of locating areas containing greenery, a significant shortcoming of this procedure is that it cannot identify which zones are wilderness areas and which are not. This paper proposed a methodology intended to address this flaw by capturing and analyzing different images of the areas at different times of the year. At the end, regions were divided into two categories: green wilderness areas and non-green wilderness areas. The latter were not relevant to this study and thus were excluded.

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