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Land Use Land Cover Change Detection Using Geomatic Methods, Habania Area of Interest as the case study

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Abstract

In this paper geomatic approaches used to study the impacts of desertification and cities expansion on land used. The productivity of agriculture were really effected by desertification, which is caused by changes in the climate and unsustainable land use. the populations growing leads to cities expansion urban growth puts pressure on priceless agricultural resources. To evaluate these processes, geomatic methods, such as remote sensing, GIS (Geographic Information Systems), and spatial analysis, provide vital tools. The green belt and local crop productivity were negatively effected by the indiscriminate urban growth that attacked agricultural lands in general and those near the city in particular. For a specific time between 2000 and 2020; this paper focuses on the Habania area of interest was chosen because it contains a diversity of land cover, including urbanو agricultural areas and water bodies. LANDSAT 5, 7, and 8 satellite images were used. The classifying process using ERDAS Imagine software; the period divided into two phases, 2000 to 2009 as a first phase and 2009 to 2020 as a second phase, to assess the effects of desertification and urban growth on the agricultural lands. According to the first phase's findings, urban areas increased by more than (4.5%) while vegetation areas decreased by more than (6.5%), and desert regions increased by more than (4%), while water areas decreased by more than (2.5%), while in the second phase, there was an increase of (5.5%) in vegetation coverage and an increase in water areas of more than (2.5%) and an increase in urban areas by more than (4%), at the expense of a decrease in desert areas of more than (12%). We additionally see a consistent increase in urban areas of about (4.5%) of the total area every ten years. When comparing the results over the entire research period find that the percentage of water has returned to what it was in the original year, the vegetation areas has decreased by (1%), urban areas has increased about (9%), and the desert areas has decreased by roughly (8%). The summary that there is good planning where the main results explain that the expanded of the urban areas were distributed to 89% to desert and barren lands and 11% only to the vegetation areas.

***Keywords*—** Land Use, Land cover, Urban Growth , Geomatic Methods

INTRODUCTION

The delicate balance between agricultural productivity, sustainable land management, and urbanization is a major issue in the context of worldwide land-use trends. With an increase in global population, there will be a greater need for agricultural products and urban growth, particularly in regions where desertification brought on by climate change and water scarcity poses a major threat to such cities. The possibility of desertification turning once-fertile agricultural regions into barren wastelands is one of its effects. Therefore, the fundamental land-based method to lessen climate change and its adverse effects is sustainable land management [1]. The problem is made more difficult by the concurrent spike in demand for both food production and urban infrastructure as the world's population rises. However, these increasing needs frequently conflict with the need to preserve arable land, a conflict that is particularly apparent in areas where desertification is seen as a serious threat [2]. A shadow is cast over formerly productive agricultural terrains, threatening to turn them into ineffective wastelands, by the inexorable march of desertification, which is propelled by a trifecta of climate change, unsustainable land management practices, and the persistent expansion of metropolitan centers [3, 4].

The physical characteristics and varieties of either manufactured or natural objects that blanket the Earth's surface are referred to as land cover. It includes all of all kinds of land surfaces, such as forests, grasslands, wetlands, urban areas, water features, agricultural fields, and arid land. A common building block in geographic information systems (GIS) and remote sensing is land cover [5]. For the purpose of analyzing and managing changes in land use, repercussions on the environment, it is essential to know about land cover. The term "land use" describes the human uses and activities that a particular piece of land is put to. It includes a wide range of tasks and duties related to a specific piece of land, such as those related to a place to live manufacturing, agriculture, recreation, conservation, transportation, and infrastructure [5]. Studying land use and land cover change is critical to identifying the current situation and managing natural resources, and thereby solving the environmental issue [6]. Remote sensing, Geographic Information Systems (GIS), and spatial analysis are just a few of the tools and technologies that make up geomatic approaches, which allow for an accurate and comprehensive investigation of changes in land cover and their effects [7].

Food security is seriously threatened by desertification because it lowers agricultural output. On the other hand, urban growth, which is fueled by a population surge in cities, results in land-use changes that frequently encroach upon prime agricultural fields, creating problems for food production and the possibility of land-use conflicts. Additionally, the growth of metropolitan areas threatens the sustainability of the environment by causing increased pollution, habitat loss, and resource use.

Ramadi City is a useful case study for examining the intricate relationships between these processes and their effects on agricultural land because it is situated in an area where desertification and urbanization are converging. The interaction between these two phenomena emphasizes how urgent it is to use geomatic methods to fully assess their impact, facilitating informed decision-making, and ultimately guiding policies intended to strike a balance between the requirements of urban development and the preservation of agricultural productivity.

This paper employs geomatic approaches as a thorough analytical strategy to assess the cumulative effects of desertification and urban growth on agricultural land in the Ramadi City region, by using geomatic techniques to illuminate the patterns, scope, and effects of desertification and urbanization on agricultural lands in Ramadi City. Remote sensing images and GIS software can be used to assess the detection process. There are numerous methods available for this study, including Maximum Likelihood, Clustering, and Classification Methods (supervised, unsupervised). The process's class requirements are the number of training samples and the quality of the images. The typical training sample selection method utilized in this study is also known as the selection of training samples from a two-dimensional satellite imagery [8].In this paper, samples from 15 different types of plant, 5–10 types of water, roughly 18 different types of urban, and 6 different types of desert were employed. The level of urbanization has been rising, which has led to numerous trends in construction. As a result, human activity has altered nature to create patterns that are impermeable.

A Review of Relevant Studies Influencing this Paper:
NH Hamed (2020). They are estimating the changes in land cover for Karbala City between 1992 and 2013, and they take into consideration both the temporal and subtle changes in urbanization and land cover. This is done primarily to provide for a better understanding of the relationship and actions between urban growth and urban environmental problems. The data from Landsat 4 (MSS) 1992, Landsat 7 Thematic Mapper (ETM) 2003, and Landsat 8 Operational Land Imager (OLI) 2013 were used for the target of the research, in order to take action and have greater control over land surface features [9].

Enas R. W. (2022). They employed satellite data to examine Land Use/Land Cover (LULC) in the study area of Karbala. In order to determine the rates of change, trends, and magnitude of changes in LULC between 2001 and 2017, multispectral satellite data (Landsat 5 TM images and Sentinel-2 MSI images) were used to identify agricultural land, urban land, barren land, and water bodies. The findings showed that whereas water bodies and arid lands dropped by approximately 6.89% (337.088 km2) and 2.40% (117.258 km2), respectively, over the adopted period, agricultural lands and urban areas rose by around 1.24% (60.686 km2) and 8.05% (393.6603 km2). The accuracy assessment was completed, and the results showed that images classified for the years 2001 and 2017 had an overall accuracy of 90.88% and 91.03%, respectively [10].

INTER CONNECTEDNESS OF DESERTIFICATION, URBAN GROWTH, AGRICULTURAL LAND WITHIN LAND-USE CHANGES

Through land-use changes, desertification, urban expansion, and agricultural land are all closely related; each influence and is influenced by the others. For successful land management, environmental sustainability, and the long-term well-being of both rural and urban inhabitants, it is essential to comprehend these intricate relationships. In order to assess and monitor these interrelated processes and enable informed decision-making to solve the problems that desertification and urban growth on agricultural land present, geomatic approaches are an invaluable tool. Through a series of intricate interactions and feedback loops, these three elements are closely connected, shaping the landscape and having a significant impact on both the environment and human societies:

a. Competition for land and land conversion: As cities grow, they frequently encroach on surrounding agricultural lands. The amount of arable land is directly impacted by this process of land conversion, which converts productive agricultural land into urban infrastructure. Agricultural usage, soil fertility, accessibility, and cropping pattern are some of the main elements that determine the economic worth of land [11]. As a result, places that are prone to desertification are especially susceptible to losing their ability to support agriculture owing to urbanization.
b. Fragmentation and Isolation: Urban expansion fragments agricultural land in addition to reducing its overall amount. A decline in agricultural output may result from the fragmentation of agricultural landscapes into smaller, isolated regions, which disturbs long-established farming methods [12]. Due to the difficulty of implementing sustainable land management techniques, fragmented agricultural land is therefore more vulnerable to the negative consequences of desertification, such as soil erosion and decreased water availability.
c. Desertification and urban expansion both have serious negative effects on the ecosystem. Desertification makes it harder to sustain agricultural activities in impacted areas by causing soil degradation, biodiversity loss, and changed water cycles [13]. On the other hand, urban expansion

leads to increased pollution, the destruction of habitats, and changing microclimates, all of which can put additional stress on the biological systems that support agriculture.

d. Food Security and Livelihoods: The loss of agricultural land caused by urbanization and desertification can have a direct effect on food security. There is a chance of decreased food output, higher food prices, and food scarcity as there is less arable land accessible for cultivation. This has an impact on rural communities' reliance on agriculture and may cause rural-to-urban migration as residents look for alternate economic options in rapidly growing metropolitan areas. The tools for restoring damaged land and halting additional land degradation should be education, changes in agricultural policy, and technical advancements [14].
e. Resource Allocation and Management: Because these processes are interrelated, it is important to use cautious resource allocation and land management techniques. To reconcile the needs of expanding urban populations with the preservation of agricultural productivity and the environment, governments and policymakers must take into account the sustainable use of agricultural land, the mitigation of desertification, and urban planning [15].

GEOMATIC METHODS

The core concepts of geographical data collection, management, and analysis provide the theoretical foundation of geomatics, which includes remote sensing, Geographic Information Systems (GIS), and spatial analysis methods. The theoretical foundations of electromagnetic radiation contact with the Earth's surface serve as the basis for remote sensing, a key component of geomatics [9]. This covers spectral signature knowledge, sensor expertise, and the physics of data collection from satellites, aircraft, or ground-based devices. On the other hand, GIS is based on the concepts of database administration, spatial analysis, and cartography [16]. The theoretical underpinning of geomatics offers a transdisciplinary framework for comprehending and modifying spatial data, enabling reasoned decision-making in a variety of areas, such as resource distribution, disaster response, and environmental management.

To study and forecast changes in land use, various theoretical frameworks and models have been created. The "Land Change Modeler" is one famous example, which uses the idea of cellular automata to simulate and forecast urban expansion patterns depending on variables including population increase, infrastructure development, and land suitability [17]. The "Land Transformation Model" also makes use of agent-based modeling and economic theories to analyze the dynamics of land-use change brought on by market forces, government interventions, and individual decision-making. These theoretical frameworks help to inspire better land management and sustainable planning methods by providing useful insights into the intricate interplay of factors influencing changes in land use. For spatial studies to be accurate and reliable, it is essential to address any potential difficulties and restrictions brought on by the use of geomatic methodologies. These difficulties frequently include problems with data availability and quality, the requirement for highly technical knowledge, and the possibility of mistakes in data processing and interpretation that may affect the reliability of research findings and decision-making procedures.

STUDY AREA

A thorough analysis of areas where desertification and urban expansion are prevalent and have substantial effects on agricultural land led to the choice of Ramadi city as the research area. The degree of desertification, the rate of urbanization, the frequency of agricultural activity, and the availability of geological information all play a role in the selection of specific places or regions within the research area. The research area therefore provides the framework for the application of geomatic methodologies to collect, analyze, and interpret data, providing a thorough assessment of the impact on agricultural land

and guiding solutions for sustainable land management and policy formulation. Fig 1 show study area. The following are the explanations for picking Ramadi City as the study area:

1. It is the administrative hub of the Anbar Governorate and is regarded as a key city with a dense population.
2. The city is surrounded by productive farmland, which is one of the governorate's most significant sources of agricultural crops.
3. The city's economic operations are becoming more diverse, and the food industries are expanding their industrial activity.
4. The city's proximity to the capital increased its significance in the following ways:
    - The potential to supply the capital with more agricultural crops because of the proximity.
    - Residents of the capital travel there to work, reside, or attend one of its colleges.
5. Between 2006 and 2010, the city experienced two phases of military and terrorist acts.

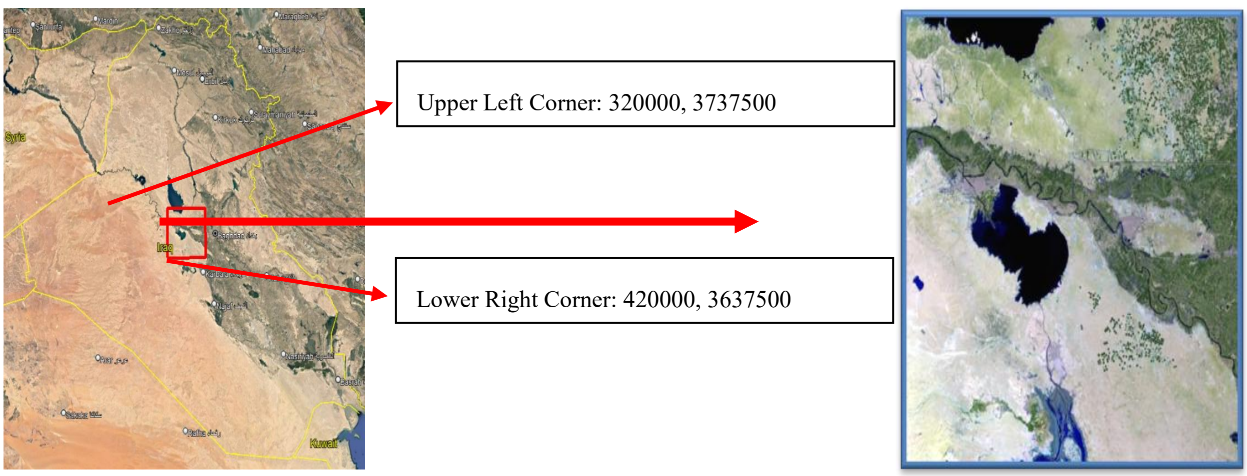

Figure 1. study area satellite image

ATASETS FOR DATABASE DESIGN A APPROACHING TECHNIQUEND

In order to assess the Impact of Desertification and Urban Growth on Agricultural Land Using Geomatic Methods- Ramadi city, sets of multi-temporal and spectral remote sensing images were categorized. Three images from satellites were acquired. consecutively in 2000, 2009, and 2020. The same vegetative season and 0% cloud cover were present in the images. The aquired data was taken from the USGS free earth explorer search engine (https://earthexplorer.usgs.gov/).
Information from the demographic census and topographic maps was also used for analysis and referencing. In order to match the smallest resolution imagery, the images have a spatial resolution of 30m. Different methods were used to fix a number of problems with the images, which had some distortions. Table 1 displays the specifics of the supporting data and remote sensing data. a variety of thematic map overlays, such as the Al-Ramadi administrative. In Fig. 2, the study's workflow is displayed

Table 1. Data base of Ramadi city as study area

Satellite image	Resolution	Year
Landsat 5	30m	2000-03-31
Landsat 7	30m	2009-04-01
Landsat 8	30m	2020-03-30
Supporting data		
Topographic map	1:25000	
Supporting AL-Anber censuses	2000 to 2020	

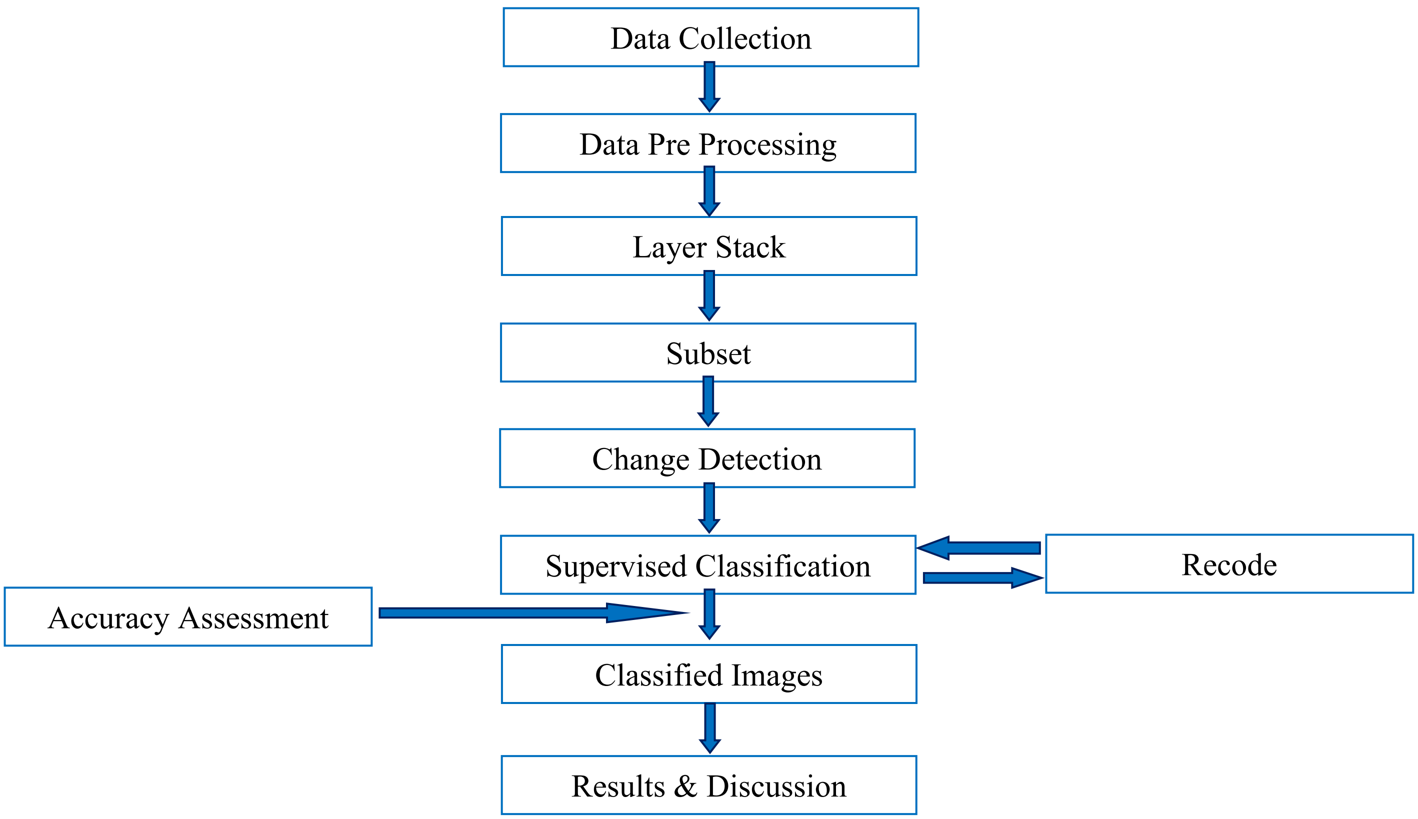

Figure 2. the study's workflow

METHODOLOGICAL INTEGRATION

The goal of this research is to create images that are categorized, then compute the areas of specific classes (Desert, Vegetation, Urban, and Water), and identify changes that have occurred over the course of the research's years (Change detection), before discussing the findings. The majority of the software utilized for the experimental work was Geomedia professional and ERDAS Imagine.

DATA PRE PROSSESSING

Geometric rectification is guaranteed in order to prevent geometric disfigurement from the deformity image. This feat was accomplished using calibration data from the sensor, measured data from the same position and attitude, ground control points, atmospheric conditions, etc. to create a relationship between the geographic coordinate system and the picture coordinate system. According to the type of processing or data sources, there are numerous geometric correction methods. By returning the new image (as source) to the previous image, which was taken as the basis (target), image to image geometric correction was applied. the result by using GeoMedia professional software and the value of RMS for both 2009 and 2020 images based on 2000 image is small that the difference are1.574 and 2.023.
Environmental parameters (agricultural, water areas, desert lands, and urban areas) are examined, and since we are aware that each parameter responds differently to wavelength limits, bands are combining into a multiband image to aid in our analysis or the parameter identification that is needed. These images ought to be of equal dimension (in terms of rows and columns). To accomplish the goals of this study, Layer Stack was created for the bands that were chosen. USGS assigned bands (2,3,4) for each application [9]. These bands were utilized because this study called for a clear image of the vegetation, which can be acquired through the infrared channel.
Compared to the area of interest, which is around 100 km by 100 km, the downloaded Landsat scene encompasses a region of about 185 km by 185 km. To make our research simpler and concentrate on the area of interest, it is sense to remove a portion of this bigger image.figure3, shows the pre processing for one image of case study.

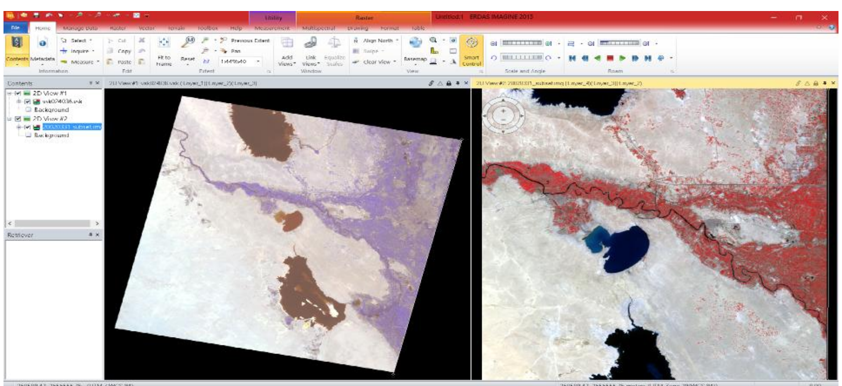

Figure 3. the study's workflow

SUPERVISED CLASSIFICATION AND RECODE

The core of this work, which is a common method for identifying land use, is image classification. With image classification, it is simple to group different types of land use under the supervision and definition of the program. For time series of satellite imagery that has been processed similarly to the previous stage, maximum likelihood supervised classification (MLC) is used as an image classification technique. The

maximum likelihood algorithm is one of the methods most frequently used for categorizing images. The method's foundation is based on categorizing each pixel according to its relevant class. As a result of this assignment procedure, a raster is produced. Every pixel is tagging a class. According to observations, the amount of pixels. The sample classes have been gathered in four different sorts. However, the amount of training samples collected varies depending on the composite raster's color fluctuations. Figure. 4, shows supervised classification.
The recode tool is used after the classification is complete to reduce the number of K means classes used to the number needed for the classification (for example, the number of K means used in the unsupervised classification was 12 classes while the required number of classes for our study was only 4), so the recode tool was used to group the similar classes into one class.

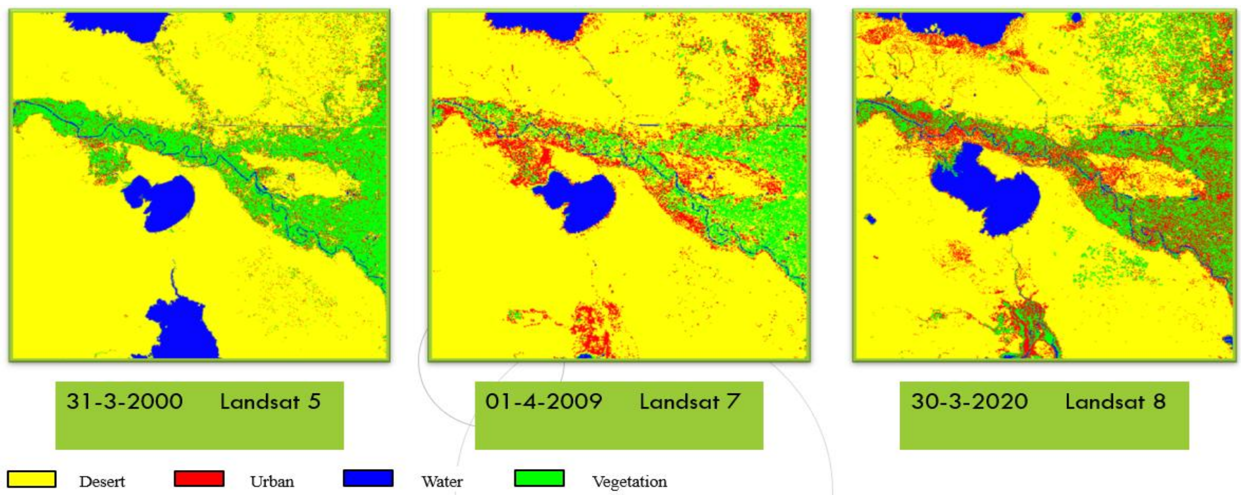

FIGURE 4. Supervised Classification

CLASSIFICATION ACCURACY ASSESSMENT

It is crucial to accurately examine maps of land cover that have been derived. Maps offer details about how the resources of the world are distributed. Maps are a useful tool for estimating the size and distribution of resources, examining resource relationships, and choosing appropriate locations for certain operations. Because judgments are dependent on data retrieved from these maps, it is important to understand how accurate the generated land cover map is. Any map's accuracy can be evaluated by comparing the positions of points with comparable positions found by highly accurate traditional ground surveying. Comparisons with reference data, which are obtained by choosing random sample points from the change detection highlight images and comparing these points between the classified map and reference data, were used to assess the accuracy of the classified maps. The Reference data was gathered using Landsat Image satellite imagery.

RESULTS OF CLASSIFICATION AND ACURACY ASSESSEMENT

In the year 2000, the Desert occupied more than 73% of the entire area and dominated over the other classes, while the Urban, Water, and Vegetation took up just around 4%, 7%, and 15% of the total area, respectively.In 2009, we can see that the results were inconsistent, rising in certain classes and falling in others when compared to the same regions in 2000. Table 2. Classification Results . Figure. 5,shows Supervised Classification Results The outcomes from the two years prior (2000 & 2009) will once again vary in the year 2020. The accuracy assessment's findings indicate that, overall, more than 83% of the points were true, which is a respectable and successful outcome as showen in table 3.

Table 2. Classification Results

class	Change area 2000/2009		Change area 2009/2020		Change area 2000/2020	
	Hectare	%	Hectare	%	Hectare	%
Vegetation	-65000	-6.541	+54000	+5.507	-10292	-1.034
Urban	+46000	+4.625	+42000	+4.237	+88235.2	+8.862
Water	-25000	-2.515	+26000	+2.685	+1689.8	+0.17
Desert	+44000	+4.43	-124000	-12.428	-79633	-7.998

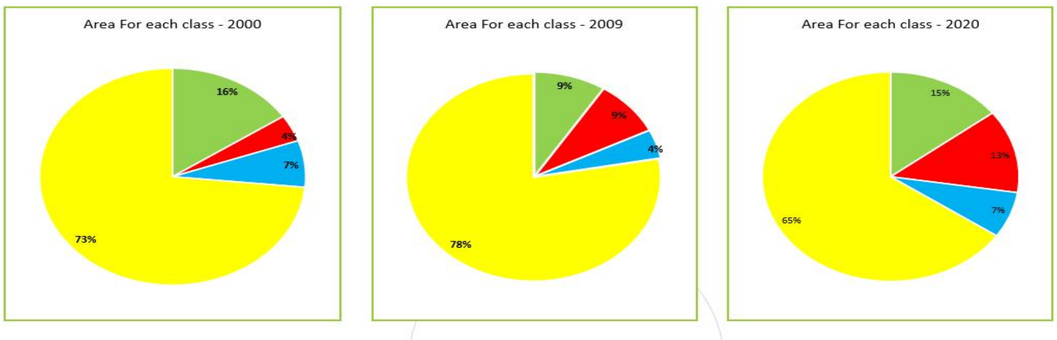

Fig. 5, Supervised Classification Results

Table 3. accuracy assessment Results

	Vegetation	Desert	Urban	Water	SUM	Percentage
Vegetation	11	3	1	0	15	73.33%
Desert	0	14	1	0	15	93.33%
Urban	1	4	10	0	15	66.67%
Water	0	0	0	15	15	100%
SUM	12	21	12	15	60	
	91.67%	**66.67%**	**83.33%**	**100%**		83.33%

CONCLUSION AND RECONDITE

The assessment of the effects of urbanization and desertification on agricultural land using geomatic approaches has, in the end, provided remarkable insights into the intricate interactions between these forces within our changing landscapes. We have been able to clarify the spatial and temporal dynamics of desertification and urban growth, as well as their negative effects on agricultural land, through the deployment of modern geospatial technology. The results highlight how urgent it is to solve these issues if we are to secure global food security, environmental sustainability, and effective land management. In providing precise and current data, geomatic approaches have proven invaluable in enabling informed decision-making and the design of plans to reduce the negative effects of these processes.
Although this research has shed light on important issues, there are a number of directions for future investigation. Future research should first focus on creating predictive models that can identify trends of

desertification and urbanization, enabling proactive land-use planning and policy creation. In-depth case studies at the local and regional levels should also be carried out in order to tailor interventions to particular situations while taking into account dynamics in the environment, economy, and culture. Third, to improve the precision and efficacy of land-use change detection and prediction, it is necessary to investigate the possibility for combining remote sensing and GIS technologies with cutting-edge disciplines like machine learning and artificial intelligence.

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