GIS BASED LAND USE LAND COVER CHANGE ASSESSMENT OF ISLAMABAD, CAPITAL TERRITORY USING GOOGLE EARTH ENGINE

Muahammad Javed[1*], Aftab Ali[2], Ejaz Ali[3], Asghar Ali[4], Assadullah[5]

*[*1,2,3,5]Department of Computing and Information Technology , Faculty of Computing (FOC), Gomal University. D.I.Khan*
[4]Department of Electrical Engineering, Faculty of Engineering and Technology (FET), Gomal University, D.I.Khan

ABSTRACT

Geographic Information Systems (GIS) has mainly two components, first one is the front end interface mapping and second one is the data base. Google earth engine provide us a cloud computing platform which helps to use the direct access of mapping and coding without downloading the maps and other components. Google earth engine is cloud computing platform which provides online access to the concern data directly rather than down loading. GIS maps based data are online available on google earth engine to access through java script coding. Through concern java script coding, we can extract the satellite data via GIS from the google earth engine. Through these satellite data we can generate maps and information base tables through the CVS excel files as per requirements. We have used the Landsat satellite data through the google earth engine.
Keywords: *Geographic Information Systems, Map, Google earth engine*

INTRODUCTION

Two main important aspects of urban growth and sprawl assessment are Land Use (LU) & Land Cover (LC). The definitions of both LU and LC are significant. LC represents the biophysical characteristics of the earth surface, while LU is the human determination applied to these characteristics on the way the LC is used (Lambin et al., 2001). LC specified a region that is enclosed by impervious surfaces, forest, agriculture, wetland, vegetation, water types and other land, while LU by what means the people practice the LC infrastructure, conservation, development or mixed uses. The various types of LC are used and managed by human agent, interest and policy makers (Deng et al., 2013). LULC Changes (LULCC) influences human culture, atmosphere, biodiversity, hydrological cycles, and biogeochemical phenomena (Couclelis et al., 2005; Zhang et al., 2014).To perceive and examine LULCC patterns, we have combine the

Satellite Remote Sensing (SRS) data with Geographic Information Systems (GIS). The SRS data is being utilized across the globe for analyzing the past and future trends and the patterns using cost effective manner. On the other hand, GIS is being utilized for capturing, assessing, mapping, estimating and modelling of geospatial data. Google Earth Engine (GEE) using Java script merges the utilization of both SRS data and GIS analyses, whereas SRS data can be acquired and analyzed without downloading it and process the data using geospatial techniques for achieving the desired goals. GEE has been utilized by various researchers and developers to analyze trends, change detection and difference assessment of various applications including but not limited to LULC (Butt et al., 2012; Hua et al., 2018).

The changing trends in LULC are being observed all over the world including Pakistan. Due to swift

population growth and modern urban settlements, Agricultural land is being used for commercial and residential purposes. This process of migration continues for various reasons. Being a developing country, Pakistan has seen a huge increase in this regard in the past few years. But in this study, Islamabad the capital territory of Pakistan is taken as a case study to assess the LULCC using GEE. The masterplan of the capital city was prepared back in 1960, however, the masterplan is not being followed in true letter and spirit due to rapid urban growth and commercialization. How a well-planned city is being affected due to rapid changes in LULC (Butt et al., 2012; Iqbal et al., 2013).

LULCC analysis will help to use in the study area of multispectral Landsat satellite data. Various LULC classes will be considered for assessing the change. Usually, two classification techniques including supervised and unsupervised are utilized for assessing the change, however, in this study supervised classification technique will be used. In supervised classification technique, Machine Learning Method (MLM) will be opted.

2. RELATED WORK

2.1 Satellite Remote Sensing (SRS)
Remote Sensing (RS) is directly concerned with technical methods, aerial views & collecting the space information. The history of observing the earth from airplanes is more than one and a half hundred years old. The popular of invention and progress has been highlighted in the last four or five decades. In the history of remote sensing, the first observation of the Earth using balloons in the 1960s. After that platforms have progressed time to time.

2.2 Geographic Information System (GIS)
To understand this concept of GIS first of all we have to focus on the subject name geographic information system (GIS). The word Geographic is a Greek word in which geo means the earth surface and graphic means to describe, to explain or to write. The full meaning is the study of the earth with all its features. The literal translation of this phenomena would be the "to explain, to write or to describe the earth will all its features." Geographic is contained on two letters the geo and the graphic. Geo is earth and graphic is an art to display then the word geographic belongs the characteristic of a particular region. After understanding the meaning of geographic we can explain it how it relates to our work. The GIS is computer oriented mapping technology which will help us to assess the information through the satellite images. Through the GIS not only we can obtain the concerned accurate data regarding the satellite images but it is also helpful to perform some tasks according to your desired tasks. It could helpful to achieve different databases to perform actions, such as inquiry and numerical examination with maps. . Unlike spreadsheets, the traditional method provides help and tools with innovative ways of understanding questions and solving them from a database. These extraordinary abilities differentiate this technology compare to their information system. It doesn't have a limited range of information. It directly concerns with public private wide range entities with a huge information, It helps to generate valuable information according the modern technology for the event description, result calculation and various phenomenon planning schemes that range from space.

2.3 Land Use Land Cover (LULC)
Through the human activities the changes and modifications happens on Earth surface are simply known as Land use and Land cover changes globally. LULC changes are playing an important role in study and analyzing in ecosystem as well as in environmental studies. The changes on earth surface might be happen due to different scenarios. LULC conversion is scientific method in which the registration of satellite image is being in a correct way. There are many types of techniques in different ranges are used to attain LC changes in urban area as well all over as per desired or concerned area. These methods or techniques are might be further classified into different categories like composted images & comparison images .in which Compare graded images; Collection of classified images; Radar classification.

To understand how LULC technique works properly we have focus one GIS & Remote sensing (RS). Remote sensing is scientific

research area in which we use different digital geographical tools and study area to access the LUCLC dynamics. GIS and GEE (Google earth engine) are main two most important field to assess the LULC assessment through the RS (Remote sensing). To detect and monitor any physical entities and their characteristics of any specified area through measuring the from satellite images with the help of its reflecting and emitted radiation capacity at a distance.

The method of image evaluation after cataloging has been assumed in this study in order to get superior result of classification. In addition, it describes the terrestrial images and identifies the types of land use. There are six types of classes of LULC have. Followings are the six types of LULC classes' water, agriculture, waste land, urban land, forest land and the companion land.

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft). Special cameras collect remotely sensed images, which help researchers "sense" things about the Earth.

2.4 Google Earth Engine (GEE)

This Technology is directly concerned with the digital online earth mapping on cloud which is used to answer various complex problems including but not limited to LULC. End users can solve their problems using web based Integrated Development Environment (IDE) platform. The best part of GEE is that analyses are carried out in IDE without downloading the data on the machine using cloud computing. GEE processes the SRS data and other data sources with more robust and availability of various packages. Landsat SRS data is most commonly being used for timer series analysis using GEE. LULC studies have been frequently carried out using GEE (Tamiminia et al., 2020)

2.5 Machine Learning Method (MLM)

Machine Learning Techniques contains the Artificial Neural Network (ANN) and the Support Vector Machine (SVM), Fuzzy techniques, Random Forest etc. however, in this study ANN and RF MLM techniques will be utilized. Various studies have been carried out for LULC classification and change detection using RF methods using SRS datasets. This technique gives better results for LULC classification and modelling. RF MLM technique using GEE is hardly utilized in the study area for LULC change detection. The RF MLM technique is based on random and bagging algorithms (Halder et al., 2011)

3. METHODOLOGY

In this study, both the primary and secondary information will be acquired. Primarily satellites images would be used for the study to classify the LC types. This includes digitization of LU classes using GEE for different years using history images facility in order to build the training to assess the continuous population growth and urban development process, Pakistan's Federal Bureau of Statistics and population census records will help to gather a variety of data. Sites to compare the spectral signature for unsupervised classification and computer based analysis.

In this study, SRS datasets and ground/field data will be utilized for LULC classification and change assessment.

**Fig 1: location of the study area Islamabad**
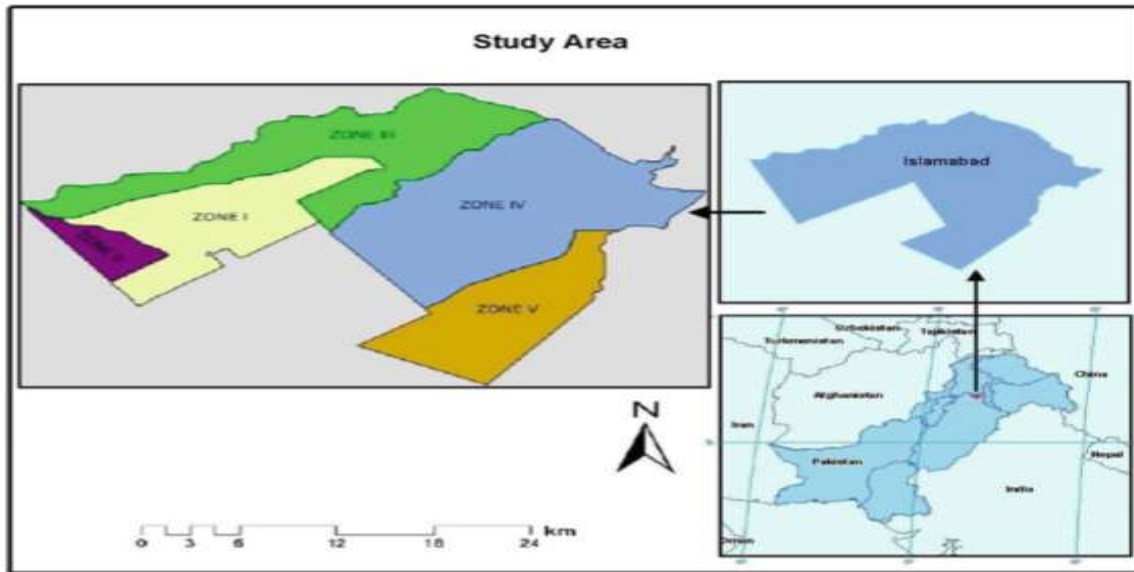
The datasets of different time period will be used to acquire the desired goal. Ground data be collected or gathered for geo-referencing and validation. Image preprocessing steps would be performed for geometric and radiometric correction.

Financial/Economic data composed with Gross Domestic Products (GDP) for agriculture, facilities and industrialized would be acquired from Pakistan Bureau of Statistics, whereas the annual GDP growth rate would be estimated. Along with the economic data, population data would also be acquired from Population Census of Pakistan. Moreover, planning guidelines connected to LU improvement will be gained from the Capital Development Authority (CDA) of Islamabad City. Islamabad is the capital city of Pakistan. Having longitude and latitude range of 33.43°N 73.04°E and covers an area of 1,165.5 km² of which 906 km² is Islamabad.

Islamabad was planned and made to be a modern capital city for Pakistan. It's situated between the Marglla Hills at the northern end of POTOHAR Area. It was recognized in 1960.

Fig1.2: location of the study area, The Capital city Islamabad (Pakistan)
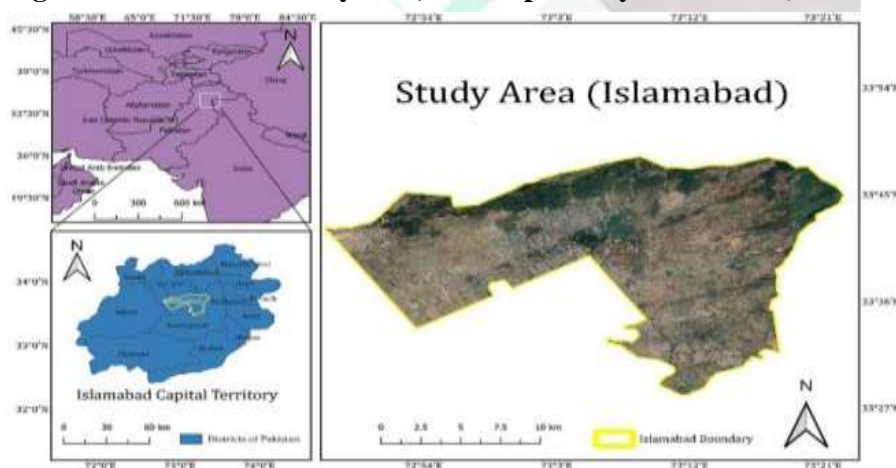
3.1 Development of a Classification Scheme

There are different techniques used in this regard. In fact, there is no reasonable cause to assume a complete record to suffice for more than a short period of time, since the patterns of LU and LC vary according to natural resource requirements. Each rating is tailored to the needs of the user, and some users will be pleased with an catalogue that does not approach most of their requirements. In an effort to develop a rating system for use with remote sensing methods twill provide effective framework to meet the needs of the majority of users, some standard guidelines for evaluation will be established first.

The method of image evaluation after cataloging has been assumed in this study in order to get superior result of classification.
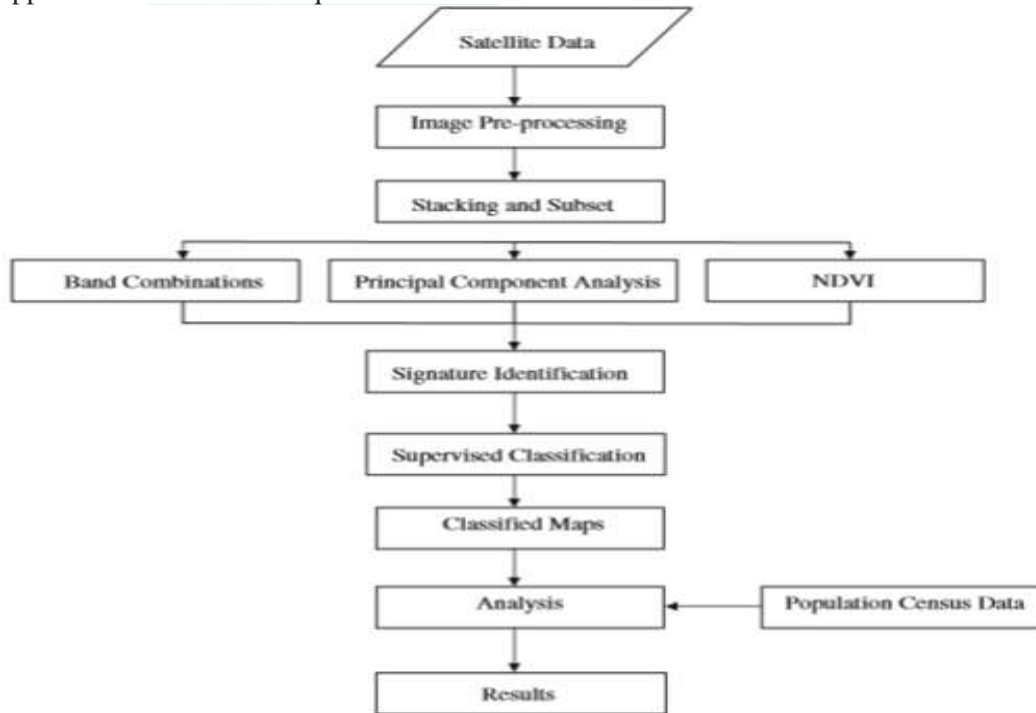

Fig 3: General flow of Proposed Study

In addition, it describes the terrestrial images and identifies the types of land use.

To understand this, there are six types of land use, urban (built-up), water reservoir, agricultural land, forest cover areas, grass land and companion land were selected to the study & analyses.

3.2 Analysis Techniques

In this study following analysis techniques would be used.

- Calculate the area of the resultant LU and LC types for each studied year and compare the results later.
- RF Classification algorithm
- Change detection among different years
- Land consumption rate and absorption coefficient

The first three techniques above would be utilized for identifying change in the LU types. Therefore, they have been combined in this study.

4. RESULTS AND DISCUSSION

This section presents the over all analysis performed during proposed research. It contains static, LULC changes, and projected population and city growth rates. The results are presented in maps, charts and statistical tables.

The maps data is taken by the maps through the Land used Land covered distribution technique.

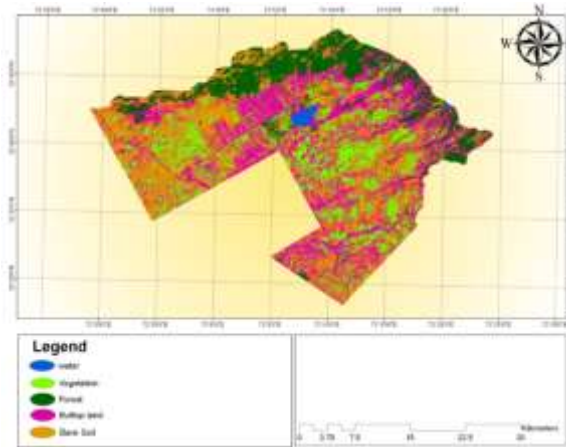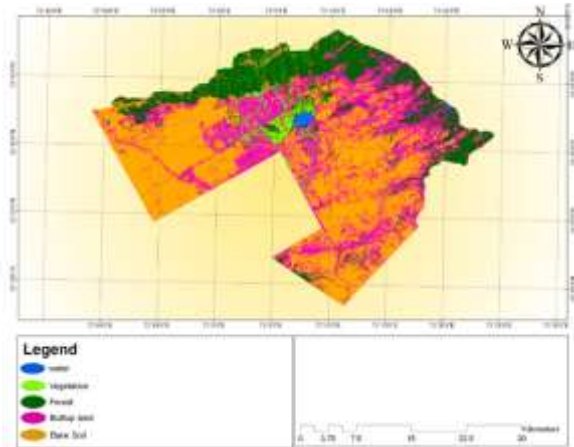**Fig.4 :** Land use/land cover classified map of 199

Fig..5: Land use/land cover classified map of 2020

The problem of expansion of the urban areas has affected the settlement pattern and land uses around the suburban, which at the same time partially increased the area and population as well. Settlement pattern around the cities have affected the urban expansion badly.it also badly affect the land use pattern in the same sense. Due to heavy urbanization and migration urban development in surrounding of city is increased with the passage of time. And the land cover area is also affecting directly due to this urbanization. It causes series effect on the environment each passing years. It also cause the increase of manmade structure the industries machines, hosing societies, markets and roads. Urban development and population is directly proportion subject in this relationship. As we have discussed the increase in urbanization and population are directly proportion. It shown the census data of this area is fully integrated. From years 2011 to 2018 the population data of Islamabad was establishing from the census report. Through census report it is noticed that the population rate in Islamabad is increasing rapidly.

Table .1. Estimated Population and Growth rate of Islamabad

Year	Population(In million)	Growth Rate
2012	1.33046437	0.2307692
2013	1.345162	0.375236
2014	1.344958	0.524938
2015	1.34962	0.335259
2016	1.3534517	0.222966
2017	1.35297	0.372441
2018	1.354995	0.073937

on the basis of estimated population and growth rate of Islamabad illustrated in Table.1 can be represented as graphically as depicted below in Fig. 6

Fig. 6. Population Growth rate of Islamabad 2011-2018
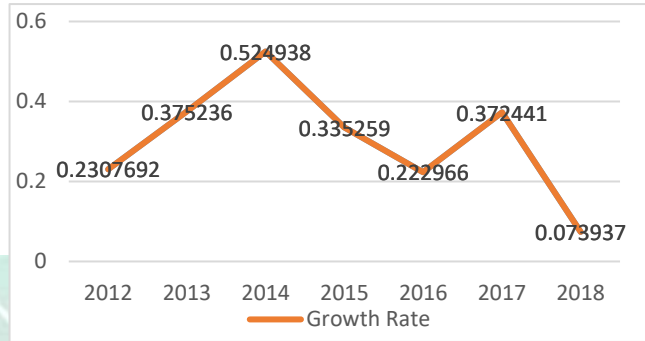
5. Comparison with existing studies

The key objectives of our research is to drive data between the population growth rate and quick the urbanization to access the LULC changes in last thirty years. Through the satellite maps and detailed information data we may differentiate the LULC changes of last thirty years. In last thirty years Islamabad which was planned city and the connected Rawalpindi unplanned city have been experienced with the massive land use land cover changes. Our research is based on the using the platform of google earth engine which helps us to directly access the data from GIS mapping data & detailed information. This idea was developed in different countries for assessment of differed cities. In Pakistan there were other common systems to plan any city which was too costly and time taken process and that was also not fulfill the future challenges. Here we have taken the previous time period data compare the changes with existing data. Through these comparisons we have easily to access the future precious for developing a new modern plan city for a better life pattern. In our research results we compare our digital research information with the previous statistical data by human efforts. Its gives more accurate and concrete results. As we have classified LULC in four different classes the Built-up land, bare land, vegetation or agricultural land and water body land. Through the selection of following four we have obtain the results in which 5.7% to 25.7% of built-up areas are increased which is approx. 52 to 233 km^2.Where the bare land is decreased from 42.2% to 18.1%.Due to master plan and CDA efforts the vegetation is increased from 4.7% and the surface water body 2.5% decreased .Population growth rate is uncared in the bare land area due to which bare land is decreased. The detailed research would be informative for the policy makers in future to plan something good for the betterment of the Islamabad city using LULC changes information and previous records with also the growth rate in population and urban sprawl information to develop the sustainable goals.

Table.2 Comparative Analysis

Previous Research Results		Our Research Results	
Classes	Ratio	Classes	Ratio
Vegetation	5.7% Increased	Vegetation	4.7% Increased
Bare Solid	3.6% Decreased	Bare Solid	2.5% Decreased
Water bodies	38.7% Decreased	Water bodies	42.2% Decreased
Forest	2.7% Decreased	Forest	2.8% Decreased

6. CONCULUSION

According to data obtained with the help of satellite images, from 1998 to 2022, the built-up area of Islamabad city has increased by 25 to 33 percent. Due to unplanned construction in the adjacent rural areas of Islamabad, several urban population growths, pollution and resource supply are also facing many other problems. Due to this migration, agricultural land in the nearby rural areas of Islamabad is creating urban sprawl, which is affecting the planning of the capital. Due to unplanned population growth, the natural beauty

and environment of Islamabad city is deteriorating along with the agricultural land. The results of all these problems suggest that the implementation of the master plan of Islamabad city should be ensured. The rate of land consumption described that the expansion in population of the Islamabad was much high in 1998/2022, which is not appropriate for Islamabad city as this population ratio is gradually increasing. Spreads towards its rural areas. The real reason and the most important problem is that the expansion and continuous expansion of the local population. Master plan of Islamabad does not allow outward expansion in the adjoining rural areas at all. Islamabad Pothohar. Soil studies of the region show that the region is susceptible to soil erosion. According to the plan, once the vegetation cover is degraded, the land is cleared (CDA, 1973). However, contrary to the Islamabad Master Plan, the ongoing construction and population expansion creates instability in the natural resources, which is seriously harming the planned development of the area.

In addition, the land absorption coefficient was also calculated between the years 1998/2022. Conflicting to the modern concept of urban planning in the municipal area of Islamabad, a land use plan could not be prepared. Rather, plans were typically designed and implemented as and when needed. Such approaches led to fragmented development of the region. For example, the CDA designed model villages as well as sanctioned national institutions such as universities and research centers, thus concluding land use planning for the national park area. The plans adopted were arbitrary and fraught with uncertainty about implementation and projected future impacts. As a result, expansion and construction work continues without developing the site and in violation of the master plan. CDA buys land from local residents and develops it as per master plan guidelines.

Timely and accurate information about the changes can be obtained. These aerial observations can be very useful in urban studies research. These aerial photographs are very useful in urban studies. The resolution of aerial photographs taken by modern technology is much better, but these aerial photographs are not easy to access. For modern urban studies and research, we have to depend more on satellite images. With the help of these

images many types of planning can be carried out. Changes can be made. In the scientific field, they are very useful for the future changes and planning of the earth, for example, with the help of satellites it can be easy to plan a new urban population land, water, settlement, infrastructure in plain and hilly areas planning can be very simple.

In this research, I have addressed five main important land cover classes which are the following vegetation, bare land, forest, built-up area and reservoir. Changes in plants cover and land cover concluded the process of suburbanization are recognized and mapped using distantly identified data. The combination of previous scientific record & statistic data drives us to analyze a concrete result. Through the study and analysis from 1998 to 2022, we conclude that the assessment of the five classes shows that the trend of urban development is increasing rapidly. Land structure is constantly changing due to rapid urban development. Where there was agricultural land, today housing colonies have been built. Unplanned migration to cities is a cause of environmental pollution and very dangerous for the survival of human life. In this research, with the help of scientific research, soil structure, samples, consumption rate as well as soil absorption capacity have also been introduced with the help of modern scientific methods. Attempts have also been made to estimate population growth with the help of scientific formula-

It is a fact that although the increase in urban sprawl cannot be stopped, but at the rate at which it is increasing, systematic planning can achieve the desired objectives by limiting its spread. The increase will not make any significant difference in soil structure and environmental pollution. Islamabad needs to take many more important steps to maintain a green and green city. The most important of which is strict implementation of agricultural land conversion laws. In addition, more awareness and practical steps for plantation. This can lead to significant positive results in reducing urban-rural migration and improving the environment. With the help of maps, agricultural land conservation should be implemented in every situation with the help of urban migration should come. In this research, under Land Use Land Cover, aerial maps can provide clear help in

planning the city by estimating the land geography. The same modern scientific method is also being adopted in many big cities of the world.

REFERENCES

Abdullah, A.Y.M., Masrur,A., Adnan, M.S.G., Baky, A.A., Hassan, q.k., Dewan, Spatio-temporal patterns of land use/land cover change in the heterogeneous coastal region of Bangladesh from 1990 to 2017,2019.

Butt, M.J., Waqas, A., Iqbal, M.F., Muhammad, G. and Lodhi, M.A.K., Assessment of urban sprawl of Islamabad metropolitan area using multi-sensor and multi-temporal satellite data, Arabian Journal for Science and Engineering,2012.

Couclelis, Where has the future gone? Rethinking the role of integrated land-use models in spatial planning, Journal of Environment and planning, 2000.

Deng, H., He, Z., Chen, Y. The land use spatio-temporal pattern simulation in metropolitan fringe of the Sichuan Basin: A case study in Yanjian District, Ziyang City, Sichuan. Scientia Geographical Sinica,2013.

Fox, D. M., Witz, E., Blanc, V., Soulie, C., Penalver, N. M., Dervieux, A. A case study of land cover change (1950–2003) and runoff in a Mediterranean catchment. Applied Geography,2012.

Hua, Y., Dong, Y., Batunacun. An automatic approach for land-change detection and land updates based on integrated NDVI timing analysis and the CVAPS method with GEE support. ISPRS Journal of Photogrammetry and Remote Sensing,2018.

Hussain, S., Mubeen, M., Ahmad, A., Akram, W., Hammad, H.F.,Ali, M., Masood,N., Amin, A., Frarid, H.M., Sultana, S.R., Fahad, S., Wang, W., Nasim, W.,. Using GIS tools to detect the land use/land cover changes during forty years in Lodhran District Pakistan,2022.

Iqbal, M. F., Khan, M. R., Malik, A. H. Land use change detection in the limestone exploitation area of Margalla Hills National Park (MHNP), Islamabad, Pakistan using geo-spatial techniques, Journal of Himalayan Earth Sciences ,2013.

Kiefer, R.W., Lillesand, T.M., Chipman, J.W.,. Remote sensing and image interpretation. John wiley and Sons,2004.

Lambin, E. F., Turner, B., Geist, H. J., Agbola, S. B., Angelsen, A., Bruce, J. W., Xu, J. The causes of land-use and land-cover change: Moving beyond the myths. Global Environmental Change,2001.

Mutanga,O , Kumar L.Google earth engine applications,Remote Sensing,2019.

Sasmito, S.D., Taillardat, P., Clendenning, J.N., Cameron, Clint., Friess, D.A., Murdiyarso, D., Huntley, L.B.,. Effect of land-use and land-cover change on mangrove blue carbon,2019.

Talukdar, S., Singha, P., Mahato, S., Pal S., Liou, Y.N., Rahman, A., .Land-use land-cover classification by Machine learning classifiers for satellite observation,2020.

Tamiminia, H., Salehi, B., Mahdianpari, M., Quackenbush, L., Adeli, S., Brisco, B. Google Earth Engine for geo-big data applications: A meta-analysis and systematic review. ISPRS J. Photogramm. Remote Sens, 2020.

Wang, Q., Guan, Q., Lin, J., Luo, H., Tan, Z., Ma, Y.,. Simulating land use/land cover change in an arid region with the coupling models, 2021.

Zhang, W., Liu, M., Qi, Y.. Land-use scenarios simulation based on the CLUE-S model in Kunming. China Journal of Ecology, 2014.