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CHANGE DETECTION FOR URBAN EXPANSION IN BAGHDAD CITY AL-DOURA AREA USING GEOGRAPHIC INFORMATION SYSTEMS

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Abstract
The Al-Doura region is undergoing a deterioration in soil quality as a result of the ongoing expansion of residential areas. The expansion is leading to environmental degradation, affecting native plant life and the overall ecosystem. This study employed remote sensing techniques to analyze and comprehend land patterns in the Doura region throughout a defined timeframe, with particular emphasis on the influence of the Doura refinery. The research conducted from 2013 to 2023 was categorized into five distinct areas: urban, water, soil, streets, and plants. This categorization was achieved by utilizing remote sensing data and the ENVI tool. The classification was executed via the support vector machine classifier. The results demonstrate notable changes in the Doura, marked by a swift and substantial growth of the metropolitan region. The expansion has led to a significant reduction in green spaces, with the urban area comprising 21.21% in 2013, rising to 36.71% in 2018, and further increasing to 60.16% in 2023. The categorizations suggest a decrease in the availability of arable land, indicating the expansion of the residential area of Al-Doura. Urban development intensifies land surface temperatures and adds to air pollution. A sustainable approach is necessary to address the presence of the Al-Doura refinery, with a focus on achieving a balance between economic and environmental requirements.

1.0 INTRODUCTION
The Al-Doura Refinery, situated in Iraq, serves as a major plant for processing petroleum products in the area [1]. The facility has machinery with sophisticated refining capabilities that enable the extraction of substantial parts and their transformation into lighter oil products. Although this refinery is essential to improving the quality and efficiency of oil utilization, it presents hazards that can be harmful to the environment and the general population [2]. Refining tasks may produce toxic pollutants, such as sulfur dioxide and nitrogen oxides, which add to air pollution. releasing such pollutants can result in negative effects on the environment and the health of people [3]. The conversion of farmland into homes occasionally requires removing of native plants. A shortage of plants leads to a reduction in essential biological functions, such as the absorption of carbon dioxide and the development of areas for water draining. Therefore, this results in a rise in the absorption of contaminants into underground water reserves, resulting in the poisoning of both water and air [4]. Converting land into housing might lead to

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modifications in air pollution. High levels of vapor organic compounds (VOCs) and the particles may have negative impacts on the health and well-being of people who live inside. The growing development of these chemicals in the environment could represent an imminent threat to human health [5]. In essence, the continuing operation of the Daura Refinery and the transformation of surrounding land into homes have negative effects. Specifically, this relates to the contamination of water and air. The mentioned changes highlight the necessity of employing sustainable addresses and implementing environmental laws that minimize the impact on people and habitats [6].

The presence of the Al-Doura Oil Refinery in the Al-Doura area in the capital, Baghdad, Iraq. Oil refining operations in this refinery can result in air pollution and the unsuitability of the area surrounding the refinery for housing, as it leads to air pollution due to emissions of air pollutants such as carbon dioxide and nitrogen oxides, and this affects air quality. In the surrounding area and increases the risk of residents contracting diseases of the competitive system, in addition to water pollution resulting from production and refining operations due to the leakage of harmful chemicals into groundwater and local water bodies [7]. Water pollution here affects public health and environmental life. The refinery also causes the generation of unpleasant odors and noise. In addition, industrial processes produce loud noise cause inconvenience, and affect the comfort of residents. The world's surface area has changed quickly and unexpectedly for a variety of reasons, such as population expansion, climate change, and the reduction in agriculture, among many others [8]. Due to these causes, the environment deteriorated, land cover changed as a result of human activities altering the physical characteristics of the Earth's surface, and biological and agricultural practices decreased. In order to preserve the environment, changes in land cover must be carefully evaluated and tracked. Monitoring these trends is also necessary to meet administrative and growth objectives [9]. Land cover is constantly changing due to both natural occurrences and human actions.

Monitoring these modifications has become simpler. The integration of remote sensing (RS) with geographic information systems (GIS) yields valuable information about cities and their environs. Numerous studies show how crucial GIS and RS are for tracking land deterioration. The continuous development of modern technology and geographical systems confirms the ability of scientific research to monitor land degradation and track changes [10]. Through sensors that operate across different image directions, important results have been achieved through the successful application of RS methods supported by the remote sensing group. These results are very useful for designers and executives who need complete knowledge of terrain features. RS data has now achieved recognition as an essential tool for predicting the condition of land cover, monitoring the state of the environment, and controlling resources from nature [11]. Previous research has used multiple satellite sources to determine land cover change processes over time. Land cover assessment is considered an essential element in environmental, social, and economic studies It provides vital data necessary for developing legislation that encourages a harmonious relationship with the environment [12]. The management of environmental systems is improved through the services provided by research services and geographic information systems. When GIS methods are combined with digital image processing methods, it facilitates the process of monitoring and evaluating changes in land cover and monitoring many temporal and geographical dimensions that cover global and local spaces [13]. Monitoring changes is an essential strategy for monitoring the development of cities and the state of the environment. It includes noticing alterations in the state or presence of things or events over an amount of time. Many automated techniques have been developed for categorizing images by dividing them into various categories based on their spectral features [14].

The use of supervised methods for classification, such as the support vector machine method, is frequently employed in field classification. The method involves dividing pixels based on their spectral properties [15]. There are many concerns about congestion and environmental pressures resulting from the growth of radioactivity due to the expected increase in population in Iraq, especially in major cities such as Baghdad. This has led to the transformation of wild areas into urban areas, which led to a state of environmental imbalance and increased economic and social security concerns [16]. Urban geomorphology includes assessing the impact of human activities on land use, especially concerning supervision and planning of development projects. The presence of human factors is important for managing urban expansion. Therefore, these factors must be studied to manage urban expansion to reduce the risks it poses to the city’s surroundings [17].

The choice of the area for research was decided on these established standards. The project seeks to study the variables and methods that contribute to understanding this progress. In addition to studying the variables in the Doura region, given that it is an industrial area located on the outskirts of the capital, Baghdad, and because it was surrounded by vegetation, with the increase in population, this industrial area turned into a residential area. And highlights the impact of urban geography on the physical growth of the city, with a focus on the Doura area, due to the presence of the Doura refinery there and uses technological progress and contemporary physical tests to study and understand the growth and use of land patterns in the Doura region over a certain time .Sarmad H. Mahal *et al.* [18] (2022) used remote sensing to study Baghdad City province's urban expansion and climate impact. Changes in land use and cover (LULC), normalization difference in the vegetation index (NDVI), normalization differential established index (NDBI), and land surface temperature are analyzed. These characteristics were measured using GIS. The 2001–2020 study used Landsat (5,8) overall Sentinel-2A data to track urbanization expansion, vegetation, or land surface temperature. Mena A. Fadhel *et al.* [19] (2022) detected a buildup of cadmium in the ground of Baghdad, Iraq, Twenty samples of soil were collected at random in November 2020 to guarantee complete coverage of the research region.

The study findings showed that the amount of cadmium in the area varied from 0.121 to 1.78 mg/kg. All recorded instances of cadmium are within the permissible limits defined by the World Health Organization (WHO), which is 3mg/kg. The order in which of mean cadmium content by land use is as follows: roadsides, agricultural areas, homes, industrial areas, trash disposal sites, and business districts. The spatial examination of the map revealed that there was more cadmium on the Al-Karkh side than on the Al-Rissafa side of Baghdad city. Hadeel Kh. Hammood *et al.* [20] (2021) employed remote sensing techniques to measure and analyze the distribution of the Pb-214 Lead isotope in the soil of Baghdad. Radiological dangers associated with Baghdad, Iraq. The concentration of particular radioactivity of radioactive elements was measured and evaluated, both naturally occurring and artificially induced, in 48 soil samples from distinct sites in Baghdad. The analysis of the isotopic distribution of heavy rounds in Baghdad has been conducted using remote sensing data techniques and the Global Positioning System (GPS). Concentrations were measured and observed using Geographic Information Systems (GIS). The interpolation maps revealed that the concentration of lead isotopes is highest in the central and western regions of Baghdad, gradually decreasing in other locations.

Ahmed F. Hassoon *et al.* [21] (2021) remote sensing technology is being used to monitor and assess variations in temperature in Baghdad's city center employing Landsat satellite images from 2000 to 2015. Various processing and procedures were utilized on the images implementing GIS 10.6 and ERDAS 2014, including image correction, extraction, supervised classification, and selection as training samples. In 15 years, the surface temperature of Baghdad has risen by 8 degrees Celsius. This is because of the urban areas growing and an increase in human activity, especially since 2003, resulting in a greater urban area of around 198.41 km2. Many parks were lost to development and farmland turned into homes. Commercial and industrial uses. Surface rises in temperature led to associated rises in air temperature, with the lowest temperature rising by within 1.44 ºC and the greatest temperature by about 0.76 ºC. Ayah A. Hussein *et al.* [9] (2021) modeled walkways, public transit, and a projected elevated train using GIS. The present public transit system and the projected rail service were compared. For each station, the coverage area and population it can serve were computed using 2020 census data for the appropriate zones. The closest Commercial, Instructive, Governmental, or Hospital institution to the centroid of 43 zones was found using network datasets. An increased rail service cut travel time between Al-Sadr City and four destinations by 62%, 40%, 46%, and 65%, respectively. Stations 8–10 had the largest population, according to demographic statistics.

2.0 METHODS

The following steps were followed to know the developments occurring subsequent 2013 in the study area.

2.1 Support Vector Machine

Support vector machine (SVM) Strong machine learning algorithm SVM performs classification tasks. Among the supervised learning relatives, SVM excels at binary classification, where the goal is to classify data points into two groups. SVM determines the hyperplane that best separates classes in feature space. Strategically placing this hyperplane maximizes the margin, the distance between it and the nearest support vectors from each class. In circumstances where data is not linearly segregated within the original space of features, SVM uses the kernel approach [22]. This approach raises input characteristics in a higher-dimensional region where hyperplane class separation is possible. Standard kernel functions include linear, polynomial, RBF, and sigmoid. SVM aims to find the hyperplane that optimizes class separation and minimizes classification errors. An optimization procedure solves the quadratic programming problem [23].With a regularization parameter (C), SVM balances margin and classification errors. A lower C number allows for some misclassifications, whereas a higher C value makes the margin tougher and may overfit. After training, SVM predicts new data point class labels by determining their hyperplane positioning. SVM is a versatile classification technique that can handle linearly and gradually separable data, making it essential for machine learning applications [24]. SVM can generalize across two different classes if the method is provided with a set of labeled data in the training set. For the SVM, the most important task is to find a hyperplane that can distinguish between similar and different classes of data.

However, there may be a large number of hyperplanes that are capable of performing this task, therefore it is important to pick one that has a large enough margin between its two classes to allow for easy classification in the future if a new data point becomes available that is difficult to classify. Works well in complex three-dimensional environments [25]. The approach works even when dimensions surpass samples. It requires less memory since it only employs a tiny amount of the choice function's support vectors. Due to support vector rather than data points, stability is great. The datasets have not been subjected to any assumptions SVM can predict numerically. The black box method is used. The employment of the overfitting approach is predisposed in this individual. Math that is extremely precise [26]. SVM is a category of supervised learning techniques employed for classification, regression, and outliers' detection. The positive effects of SVM involve, efficient in spaces with multiple dimensions [27]. Maintain effectiveness when dimensions exceed samples. Decision operation uses support vectors, a subset of learned points, saving memory. Adaptable: Decision function kernel functions can vary. Customers can choose custom kernels [8].

2.2 Images Used and Data Available

The study area was located in the southern region of Baghdad city (the Al-Doura area) with an area of 26.6517 km^2 and this region is situated between 33° 25' 73.371" latitude and 44° 39' 45.656" longitude. Fig .1(a) in this study, is a satellite image download of the USGS United States Geological Survey [28]. Were taken via operational land imager (OLI) which was picked on (19/9/ 2013), (17/9/ 2018) and (16/9/ 2023) which covers the research region within seven spectral packages beginning the first for the seventh, located in the space coordinates row (38) and path (167), as shown in Figure 1. ENVI 5.3 is the program used in the study where the chosen beams for the image in the study area are blue, green, red, near-infrared, and shortwave infrared (SWIR2).

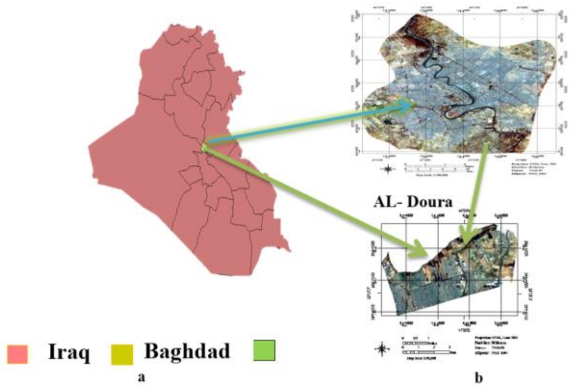

Figure 1: (a) Location of the studied area of Iraq (b) Image of the study area by Landsat_8 satellite (Al-Doura area)

2.3 Working Environment

Using the equation below, the digital number was converted into a reflectance value (physical unit) for the reflectivity of the top of the atmosphere [29]:

$$\rho\lambda = \frac{M_P * Q_{cal} + A_P}{\sin\theta} \quad (1)$$

$\rho\lambda$: TOA reflection of the planets, MP: reversal multiplicative calibration agent to package, Q_{cal}: L1 pixels quantity at DN, θ: angles for sun altitude, A_P: reflectance additional scaling agent to band.

Layer stacking stacks image packets. Opening the image requires starting ENVI 5.3 and selecting the satellite image for band collection. An instrument from the toolbar or resource menu is chosen for band collecting. Different situations may need image correction and contrast augmentation. User settings and analysis parameters choose bands from the original image. Once the desired bands are selected, ENVI 5.3 software collects them using satellite image data. After processing, the image is kept for study or data use. Users should reference the ENVI 5.3 user guide for band-collecting tool instructions, and reliable findings need a basic grasp of satellite imagery processing and analysis. Clipping images with research area administrative borders is frequent in image processing. ENVI 5.3's band-collecting approach helps analyze and understand satellite images and research aircraft data. In ENVI 5.3, open the image, choose the satellite image, and use the

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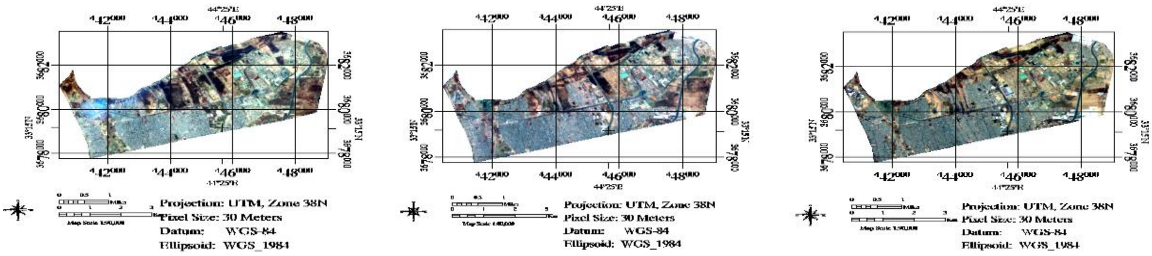
toolbar or resources menu to gather bands. Image rectification and contrast enhancements are useful in many situations.

Based on analytical criteria, bands from the initial image are selected and band collecting begins immediately. The band data is stored in a format appropriate for study or data use after collection. For applying geographical information to space or aerial image graphs, ENVI 5.3 uses shape files to represent geospatial data like lines, points, and regions through a geographical perspective. Image viewing and file-type applications start with ENVI 5.3. Users can pick a helicopter or space image for this step. Select the toolbar or select the apply shape files button. Spatial and geographic analysis sections use this tool. A form filename is needed for processing. The selected file is utilized with an image. Click here for more details about visualizing geographical data as a file on the image. The shape file utility applies form files to images. After selecting the form file, this job displays or determines image geographical information. After adopting the format file, geographical data may need to be analyzed and adjusted for different applications. Shape Files provide geographic boundary specification, point distribution analysis, and image mapping. This strategy aids geographical analysis and aerial image interpretation. Figure 2 shows shape files administrative boundary images.



2013 2018 2023

Figure 2: Images of the study area after the cutting

3.0 RESULTS AND DISCUSSION

Calculate the class count. Look at the image. ENVI 5.3 is to be opened, and the satellite image from which bands are to be extracted is to be selected. The currently accessible tool is to be chosen. The band collecting item is to be located in the toolbar or resources menu. Flexible techniques such as the rectification of images and an increase in contrast are to be considered. The bands to be formed from the original image are to be selected. Bands desired for the original image are to be selected based on the parameters of the analysis being performed. After selecting the desired bands, the collection procedure is to be initiated. ENVI 5.3 will band stack satellite image data. Upon completion of the band collection procedure, the processed image is to be saved in a format compliant with standards for future study or data utilization. The image to which type files are to be applied in ENVI 5.3 is to be accessed.

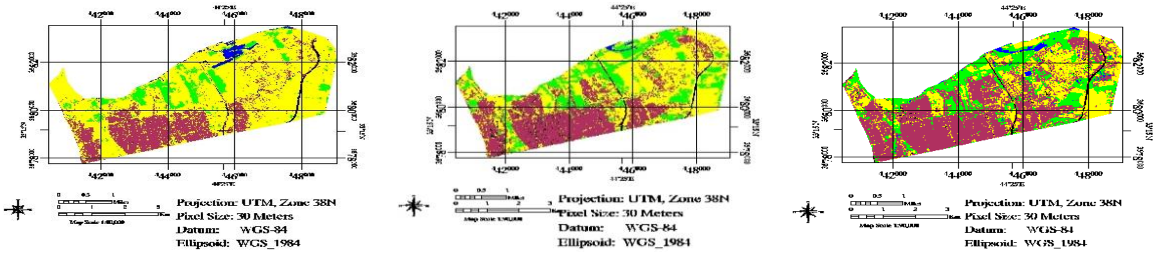
The Apply Shape File tool is to be located in the toolbar or list, typically found in parts designated for spatial and geographic analysis. The filename of the form is to be provided, and the file to be used for the selected image is to be chosen. Apply Shape Files is to be utilized to apply form files to the image, displaying or recognizing the geographical data of the file within the image. After applying the format file, the findings are to be studied to understand and adjust geographical data for different applications. Applying Shape Files may establish geographic boundaries, assess the distribution of points, and overlay geographical data over an image. This approach provides a powerful tool for analyzing and improving comprehension of geographical data included in space and aerial images. The research area is selected based on training sets for each year, using a support vector machine classification method. The land cover of the survey area may be classified into five primary categories: soil, vegetation, water, urban areas, and streets, as seen in Table 1.

Table 1: Selecting the appropriate training group

Classes	Color
Out of image	
urban	
water	
soil	
street	
plant	

Expand the image for classification. Select the satellite image to extract bands in ENVI 5.3. An accessible toolbar or resource menu instrument is used for band gathering. Image correction and contrast enhancement are considered versatile methods with potential advantages. Bands from the original image are blended based on analytical findings. ENVI 5.3

gathers satellite imaging spectral bands after band selection. The image is stored in a format appropriate for study or data use after banding. Users must understand satellite image processing and analysis for appropriate results. Figure 3 shows the classification amounts after classification assignment and training group selection.



2013 2018 2023

Figure 3: Images after classification

Jeffries-Matusita indexes let image processing researchers compare digital images in chosen collections [30]. These indices measure data dispersion across sites using statistical deviations. They calculate distance to measure classification accuracy, which is essential for assessing image categorization discrimination across categories. A considerable Jeffries-Matusita index difference suggests great layer differentiation and a large data gap between both groups. It's important to note that noise or distortion may influence the Jeffries-Matusita distance, emphasizing the necessity of large datasets for accurate classification. Typically, this distance is used as a complementary measure alongside accuracy testing to provide a comprehensive evaluation of image categorization performance. In image analysis and classification, the Jeffries-Matusita distance helps determine digital image class distinguishability. Measure training subclass spectral separability using Jeffries-Matusita dimension standards.

All training group pairs from subclasses had a distance larger than 1.9 over two years, except for two with limited separability. First, urban and soil have 1.82209316, and second, soil and street have 1.88939241. Precision estimation Researchers evaluate using Jefferies-Matusita distance statistics. Overall Classification, prediction models in image processing, remote sensing, and machine learning, are often evaluated on accuracy. Overall accuracy assesses the precision and effectiveness of a model in predicting various classes within the dataset. Verified correctness by comparing factual data with classified image data. Classification accuracy was measured using user, product, and total accuracy. The total accuracy is determined by the perturbation matrix, which is derived from the product's accuracy and the user's accuracy. Multiplying the number of successfully classified pixels by the number of pixels determines product correctness. User accuracy measures how well pixels are categorized. This equation shows full precision [25] :

$$Accuracy = (Digit\ of\ right\ categorized / total\ number\ of\ pixels) * 100\% \quad (2)$$

The Kappa factor, which extent from 1.0-0 The characterization of the Kappa factor is shown below [31]:

$$k = \frac{n\sum_{i=1}^{p} xii - \sum_{i=1}^{p}(xi \times x+i)}{n^2 - \sum_{i=1}^{p}(xi \times x+i)} \quad (3)$$

N: overall digit for practice pixel, P: digit for portion, $\sum xii$: overall crumb for confusion matrix, $\sum x$: totality for line I, $\sum x{+}i$: totality for pole i.

The validity of the results was assessed based on the training packages elected to calculate the accuracy of the overall arrangement. The values of 3 years are 86.4198% in 2013, 81.1935% in 2018, and 92.1182% in 2023, while the interactive values of Kappa are 0.8161 in 2013, 0.7571 in 2018, and 0.953 in 2023, and the results of the classification showed a high level of agreement (as shown by the high kappa factors) and a high level of accuracy (as indicated by high gross precision). Calculate the statistics of every classified scene. and the methodology used in this study is shown in Figure 4.

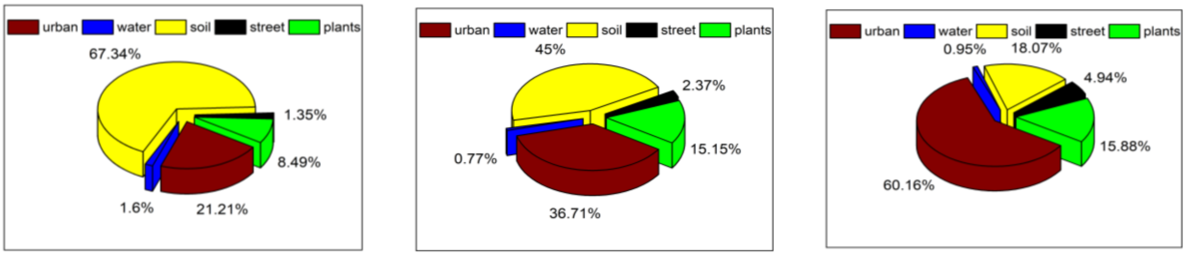
Figure 4: The steps of our operations to the results

After operations were completed in order of results, they appeared in Table 2 and during 2013, 2018, and 2023.

Table 2: The classes covering percent and area of the study area

classes	urban	water	soil	street	plants	Out of image
color	maroon	blue	yellow	black	green	white
2023%	25.103	0.822	15.073	0.891	11.841	25.103
2023%	12.449	0.407	7.475	0.441	5.872	12.449
2018%	18.264	0.22	24.499	1.318	9.44	18.264
2018%	9.057	0.108	12.15	0.653	4.681	9.057
2013%	11.397	0.862	36.19	0.728	4.564	11.397
2013%	5.652	0.427	17.947	0.360	2.263	5.652

By studying the classification rates of urban areas and comparing them across the years of study, as shown in the figure, we find that the year 2023, compared to 2013, was characterized by clear urban growth as Shown in Figure 5.



2013 2018 2023

Figure 5: The classification results of the study area using supervised support vector machine for (2013-2023) years

The validity of the results was evaluated by calculating the overall classification accuracy using the chosen training groups. The classification accuracy scores for the three years can be found in Table 3, showing high overall accuracy as well as elevated Kappa coefficients in the classification results.

Table 3: Classification results with the highest accuracy and kappa coefficients

Title	2013	2018	2023
Overall Accuracy %	86.4198	81.1935	92.1182
Kappa Coefficient	0.8161	0.7571	0.9053

From 2013 to 2023, the size of the urban area in the southern part of Baghdad doubled. It was 21% in 2013, rose to 36% in 2018, and continued to evolve steadily to 60% in 2023. The study focused on measuring residential change in Al-Doura because of its significant impact on pollution levels and environmental quality. The indiscriminate distribution of biota made accurate measurement difficult and selected a role, an old and crucial element, for its role in reducing pollution and maintaining environmental balance. The report evaluates the region's pollution reduction efforts, regulating temperatures and preventing pollution in Baghdad.

4.0 CONCLUSION

The classifications show a decline in soil land, indicating the ongoing expansion of residential areas in the Al-Doura region. Increasing residential areas at the expense of green and desert areas can lead to environmental degradation and a decrease in diversity in the region. The construction may affect the native plant life and the ecosystem of the area, thereby impacting the flora and fauna dependent on this particular environment. Urban sprawl might lead to increased land temperatures and the deterioration of air quality and decrease in plant development in lush desert environments may hinder carbon dioxide storage and climate change mitigation. Urban sprawl may increase the need for public services such as schools, hospitals, and infrastructure. Residential areas can add to ambient noise and traffic congestion, affecting the general quality of life and mental health of their inhabitants. The lack of natural spaces and the growth of residential areas might hinder environmental sustainability at a regional level. The surrounding environment can negatively affect the environmental, economic, and social sustainability of residential communities.

Sustainable development and maintaining the quality of life in the region require continuous coordination between the government and the community to balance the growth of residential areas with the conservation of green and desert spaces. The Al-Doura oil refinery's impact on the region must be thoroughly and sustainably managed, with an emphasis on balancing economic, social, and environmental needs. Achieving this balance requires robust cooperation between governments, businesses, and society, committed to enacting policies and actions that promote sustainability and protect the environment for present and future generations. Effective monitoring of pollution control technology, advocating for environmental maintenance and safety practices, fostering environmental awareness, and community involvement. Advocating for innovation in energy efficiency and clean technologies is crucial for decreasing detrimental emission.

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