

## Environmental Management Plan for Wadi Al-Kouff Natural Park Using Geographical Information Systems (GIS)

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### ABSTRACT

Environmental management is an important current issue as well as in the future. The management is necessary to conserve the natural resources and reserves. This paper aims to set a management and protection plan for Wadi Al-Kouff Park, which is lying in Al-Jabal Al-Akhdar in the north-eastern part of Libya. The Park has a large area which is about **32, 122 ha**; however, this area is being decreased as consequences of urban sprawl and natural resources over-exploitation. Several official reports and studies point out that the park is very rich in wildlife and heavily forested. Unfortunately, it does not receive the required attention, and is not yet getting the right management. It seems that the park is losing its biodiversity and this study strives to highlight how this issue can be addressed with Geographical Information Systems (GIS). GIS is a well-known technology, it is an attractive and effective methodology that has been successfully implemented in this field. It has become a standard tool for natural resources management and spatial problems. This work suggests utilizing ten **GIS** techniques to cover the Park's nature and its surrounding area. These techniques are selected due to their suitability to the considered case study. Moreover, they can also be implemented to support a project of applying environmental management in the whole region of Al-Jabal Al-Akhdar. This study also conducted a face-to-face questionnaire to clarify the necessity to utilize GIS in various aspects. Finally, the study reveals the major five problems resulting from the present non-use of GIS in Libya.

**Keywords:** Wadi Al-Kouff Park, GIS Techniques, Environmental Management, Spatial information (**database**).

## الملخص

الإدارة البيئية قضية مهمة حالياً ومستقبلاً. فهي مهمة لحماية الموارد الطبيعية، لذلك يجب إستخدام تكنولوجيا ناجحة في هذا المجال، أصبحت تكنولوجيا نظم المعلومات الجغرافية أداة قياسية وفعالة في إدارة الموارد الطبيعية، نظم المعلومات الجغرافية هي الطريقة الفضلى للتعامل مع المشاكل البيئية، جاءت فكرة هذه الورقة بهدف وضع خطة إدارة بيئية لمحمية وادي الكوف، حيث أنه وبالرغم من أن لمحمية وادي الكوف مساحة كبيرة (32,122 هكتار) إلا أنها في تناقص بسبب الأنتهاكات التي تمارس من قبل السكان المحليين، فوفقاً للمستندات الرسمية فالمحمية تحوي مجموعة كبيرة من الأحياء البرية والبحرية ولكن هذا لا ينطبق مع الواقع. المحمية لا تخضع لإدارة سليمة. لذا تم إختيار عشر تقنيات معتمدة في أساسها على تكنولوجيا نظم المعلومات الجغرافية. هذه التقنيات العشر تم إختيارها وفقاً لطبيعة المحمية و المنطقة المحيطة بها. تصلح فكرة هذه التقنيات لأدارة أى محمية حول العالم كما أنها تدعم عملية تفعيل فكرة الأدارة البيئية في منطقة الجبل الأخضر. تم وضع إستبيان معتمد على المقابلة الشخصية. هدف هذا الإستبيان للتأكد من حاجة الناس في ليبيا إلى إستخدام نظم المعلومات الجغرافية في جوانب أخرى غير الإدارة البيئية. خمس مشاكل رئيسية خلّصت إليها الدراسة أكدت الحاجة إلي تطبيقات أـ GIS في ليبيا، وبناءً على ذلك تم وضع توصيات للحد من هذه المشاكل.

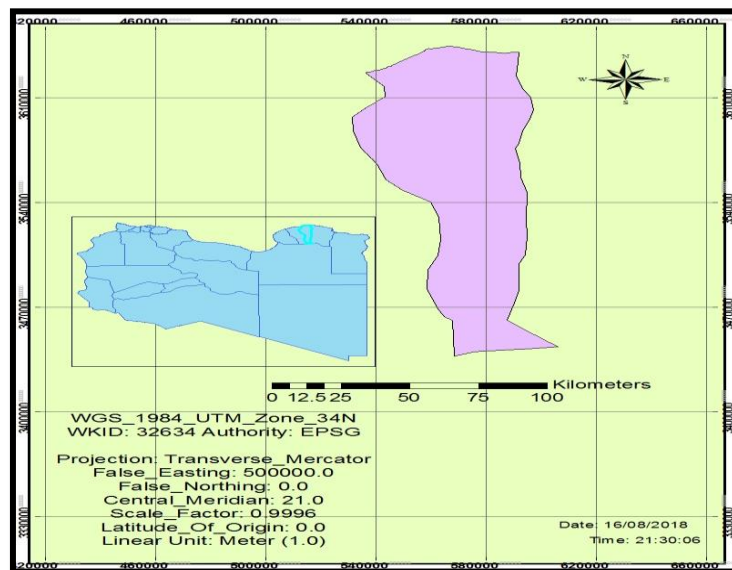
الكلمات المفتاحية: محمية وادي الكوف، الجبل الأخضر، تكنولوجيا نظم المعلومات الجغرافية، الإدارة البيئية، المشاكل المكانية، قاء، دة البييات.

## Introduction

GIS depends on computers for collecting, storing, analyzing and displaying spatial information (Burrough and McDonnell, 1998). The decision-makers transform data into knowledge to support decisions. To Warren (1995); GIS is a technology dealing with social construction. Its processes depend on social motivations and political

economy. Neglecting these aspects lead to marginalizing communities (**Harris and Weiner, 1998**). Libyans do not use **GIS** and remote sensing technologies on a wide range. They use **GIS** in a limit use such in the political aspect for army purposes. **GIS** in Libya never been used in infrastructure improvements or even environmental aspects. Environmental management is including Parks' protection and management. The Libyan **GIS** and remote sensing experts have a duty in developing these sectors. This paper is considered to be the first step in this. After intensive studies, a plan based on potential **GIS** applications was considered. This would be effective in many aspects if supplied with a good database. This paper views the usage of **GIS** possibility in environmental management. Improve and protect natural reserves is necessary. Wadi Al-Kouff Park is one of the important Parks in the east of Libya. It is located in the north of the region of Al-Jabal Al-Akhdar in Libya (**see fig. 1**) between longitudes **21°30'0"** and **22°0'0"** E and on latitude **32°40'0"** N.

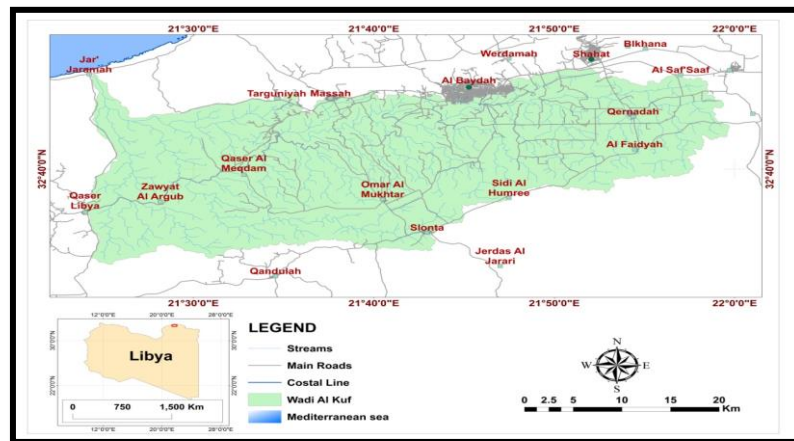
Source: designed by the researcher in 2018 using ArcGIS 10.3  
Figure 1: Shows Al-Jabal Al-Akhdar borders and location



This Park is a national treasure. Its an important international tourist destination, as it includes wide biodiversity. There are many species of natural forest's vegetation such as *Eucalyptus sp.*, *Pinus sp.* (pine), *Artemisia herba-alba*...and more medical plants (**ACSAD-KOUFF, 1984**). Thus, it is very important to look after, and improve this natural national treasure. This paper suggests proposes ideas depends on using

geographical information systems (GIS). The Park lacked the right management system during the previous years. This map below shows the location of Wadi Al-Kouff basin in Libya.

Source: Special Vision Company (2016)  
Figure 2: Wadi Al-Kouff Basin



## The Study and its Objectives

The paper targets to encourage applying the technology of **GIS** in Libya on a wide range. This includes social responsibilities; to promote development in the country. Few limited studies that share this paper's view. The paper propose a brief study of enhancing the use of **GIS** in other sectors than environmental management. This study has direct and indirect objectives;

1. The direct objective is putting a management and protection plan for Wadi Al-Kouff National Park.
2. The indirect one is setting to highlight problems of non-use of the GIS.

## Problem Statement

- What is the right way to save **Wadi al-Kouff Park** as a national treasure from more neglect?
- Do the Libyan citizens need the **GIS** applications to improve all their lives in all aspects of life?

## Materials and Methods

This research relied on using descriptive and analytical method. It describes the reasons that led to **Wadi Al-Kouff** Reserve deterioration. It analyzes the Park's nature and its components. And to try to find out the uses of **GIS** in this field and other various sectors. The data were gathered through field survey. Many data were registered during this visit. Registering and collecting data was a necessary step. This assisted in having a clear view of choosing the appropriate solution. besides, research tools represented in review the previous references and studies. Many associated pieces of literature were reviewed. This helped in having an idea about their approaches. And take the advantage of them. Also, the Internet used to access the latest in **GIS** in environmental planning. Also the ArcMap (\*) tools were used to analyze the relevant database. Moreover, a questionnaire designed to detect the Libyans' need for **GIS** applications. Not only in the environmental management sector but also in other fields. The questionnaire was written in simple Arabic words. A sample of **16** people were chosen randomly to test the questionnaire. This was in the period from September to November **2015**. The main survey was undertaken from March **2016** to April **2016**. The number of participants in the main test was **30** people. All these participants were chosen from different genders, ages and locations. They also have different qualifications, ranging between PhD holders and uneducated. Their ages range between **19** and **65** years. The sample included opinions of **14** females and **16** males.

## The proposed plan and why is it?

The Park suffers from ignoring. There is serious neglect in dealing with animals and plant communities. Most of the Park is usurped by residents. Wadi Al-Kouff lacks to guards save it from more occupation. Its area threatened with more occupation by residents. According to **ACSAD-KOUF (1984)**, the Park area started with **32, 122** ha then became restricted to a size of **9,000** ha. If the current situation continues, we will lose this national treasure soon. This study is a serious try to manage and protect **Wadi Al-Kouff Park**. Ten techniques were chosen to put a **GIS**-based management and protection plan. These ten techniques supposed to be applied depending on a

database. It should include full information about the Park and its location. This paper's plan protects the Park against more and more deterioration. The **GIS** database and spatial analysis (\*) were used for this target.

According to Tasha and Shelly (2008), spatial analysis uses many analytical techniques. This help in getting useful information. According to (Hamad, 2010) **GIS** tools include many sets of analysis. Observation techniques and discover data from a geographic view. Some of these sets used to examine and solve the study area problems. Thus present data in an understandable form. All the location's characteristics and **Wadi Al-Kouff Park's** nature were considered. Manage and protect the Park is the direct aim of this study. These proposed ten techniques target to protect the Park from more neglecting. With one condition; stop re-grow new plants or bring any new animals' species to the Park until the next stage. And that starts after applying the suggested plan and achieving its goal. Transform Wadi Al-Kouff Park from National Park to International Park will be probable after applying this plan. At this stage, tourists from in and outside the country will be allowed to visit the Park.

### **The questionnaire and why is it used?**

A face-to-face questionnaire was designed to gather the data from **El-Beida** city. It aimed to determine the Libyans' needs to the benefits of using **GIS**. Apply **GIS** is important to improve infrastructure and lifestyle. The questionnaire target is present the capita's life difficulties without **GIS** applications. It was designed to draw the attention of the government to the **GIS** usage in many sectors. The questionnaire concentration was on the roads and transport sector. Also, it included some emergency services. Five problems were emerged by the end of the questionnaire. These problems will be discussed as follows:

### **Examples on Successful GIS Applications Used in Many Governments**

**GIS** is adept at spatial analysis. This analysis depends on spatial data (**location description data**). **GIS** technology proved its successes by many organizations and

agencies. Most governments use Geographical information systems (**GIS**) in different purposes;

**1. In Abu- Dhabi in 2010: GIS** applications were used in the education sector. They used it to map the schools' locations, libraries, and road networks. Besides, they affiliated the **GIS** to be one of the schools' teaching modules. This applied to the students from the first primary year to the fifth primary year (أبو زيد، 2010م).

Moreover, the Department of Transport in Abu Dhabi launched the Darb website "www.darb.ae". It specializes in geographic information systems in the field of transportation. It allows users to access the latest information and data on roads. It provides users with transportation facilities services through the Internet (2020, (البيانات الجغرافية المكانية).

**2. In Saudi in 2012: GIS** 4D analysis developed for the target of determining the flood risks in Mecca- Saudi. This determination included flood water quality and quantity during **30** years. It also studied the relationship between flood volume and urban growth. This study clarified which roads face the risks of runoff in these days or in the future (Abdelkarim and Gaber, 2019).

**3. In Palestine: GIS** was used to control urban expansion. It was using quality technical images and maps. GIS applications play an effective role in the preparation of structural plans. The Ministry of Planning launched a special department for geographic information systems. It uses **GIS** in the field of preparing studies, maps and drawing up plans at the national and human levels (سمارة، 2010 م).

**4. The state of Kuwait** is one of the first Arab countries that adopted the use of **GIS** since **1981**. It has established a national centre for **GIS**. It serves all the ministries through an electronic network. Also it connects the centre with sub-units in each ministry (الخزامي، 2002م).

### **What is The Suggested Management and Protection Plan?**

It is a plan to manage and protect **Wadi Al-Kouff** Natural Park from more and more neglect. It includes ten **GIS**-based techniques. The main supposed impact of applying this plan is to stop losing this national treasure. This plan depends on using ten techniques based on having a good database. This database has to include all the details about the nature and the topology of the Park. Also, it has to include data about its biodiversity and ....etc. **GIS** can deal with this data via ArcGIS (**ArcMap**). Subsequently, a map to the Park after several steps will be ready. To get the fruits of this plan have to apply it same as the order below:

#### **First Technique: Provide the Park with a Touristic Administration.**

Most of the Park has occupied by the residents. They transformed it into a pastoral area. This continued carelessness lead to more negligence and depletion in the touristic production. This technique was suggested to develop and protect the Park from more deterioration. To achieve this technique goal should use a precise database clarify the Park's touristic elements. **GIS** can deal with it via **ArcGIS**. This technique provides the Park with strong environmental management. And protect its components from any intrusion. Applying this technique is the first step forward to saving this national treasure.

#### **Second Technique: Provide the Park with an Environmental Observation Centres.**

This approach works hand in hand with the previous technique. Any new management system has to ensure its control. This technique can help with this. The Park environment needs protection against human interactions. Most of the Park's area has taken by the local citizens; they deal with it as private property. To apply this technique must have a clear map shows the highest locations inside the Park. This map can be prepared using **GIS** and precise elevations' data. Thus determine the suitable locations to establish the observation centres. To increase this technique effective is needed data about the Park area. This help in calculating how many



centres are needed. These observation centres have to be connected with main control room. Each one of these observation points needs at least a team of two people to manage it.

### **Third Technique: Provide the Park with Specific Entrance Points.**

The current situation at the Park is a disaster. Anyone from the surrounded area can enter the Park at any time from any site. This behaviour affected the Park components 'animals and plants'. Apply this technique is essential to control the visitors' flow. The first thing has to do is analyze the data of the Park's location and its area. This helps in creating an assistive map. It has to clarify the highest locations in the Park. This help in choosing where to establish the potential entrance points. The nature of the surrounding area and the Park space are decisive factors in this decision. They impact on choosing the entrance points' locations and how many ones does the Park need.

### **Fourth Technique: Limit the Allowed Number of Visitors.**

Direct the visitors inside the Park assist in decrease their intervention. This will happen if there is no big crowd at the Park. Determine how many visitors can the Park endures per day is essential. This determination is easy using spatial analysis tools. This depends on many aspects such as the biodiversity distribution inside the Park. Detecting this distribution need an accurate database to map it. Analyse the relevant database via ArcMap gives this map. It has to clarify the different capabilities of each site within the Park. Thus, confirm the allowed visitors' number at each site. This technique saves the calm nature inside the Park.

### **Fifth Technique: Stop Using Private Transports Inside the Park.**

This technique is essential to avoid undesired crowd and damage within the Park. It provides the Park with more calm and protection. Big heavy vehicles can affect the plants and soil negatively. Also, influence the animals' behaviour. Apply this approach keeps the regular conditions stable inside the Park. Also enhances the protection plan aim. This procedure is functional if the Park provided with specific

and deliberated transports type. These vehicles' count must be suitable for all the Park's characteristics. And they must be managed by the Park's administration.

**Sixth Technique: Establish New Functional Effective Road Network Inside the Park.**

Visitors' movements, whether, by car or on foot affect soil and young plants. This technique helps protect the soil and small young plants against any potential damage. This needs a good **GIS** database to map the young plants' distributions inside the Park. It helps in choosing the suitable locations for the roads network. It must be divided into main and secondary roads. Cars are allowed on the main roads. While the secondary roads allowed the visitors to walk on foot. Visitors cannot use any transports within the secondary ones.

**Seventh Technique: Provide the Visitors with Heuristic Booklets.**

These booklets are very helpful for a systematic Park. This process assists visitors to find their direction with least damage. It is technique guides the visitors also protects the Park's components. **GIS** needed to design these booklets. They must include signs and map show the roads network. The roads inside the Park should have the same signs on their both sides. This helps the visitors to follow the guidelines.

**Eighth Technique: Stop the Human Expansions Inside the Park.**

The wildlife, in general, is sensitive to any changes. Establishing big projects such as big restaurants or hotels is wrong decision. Such these expansions can increase the crowd inside the Park. Thus the daily number of visitors will be out of control. Activating this technique assists in saving animals and plants against any intrusions.

**Ninth Technique: Appoint Staff of Plant Scientists and Veterinarians.**

This step is necessary to keep the Park healthy. It helps in monitoring the main components of the Park and keeps it in good conditions. It is effective in treating any

disease or infection from the beginning. It is a great procedure to stop any potential losses.

### **Tenth Technique: Use Trained Employees to Work as Environment Police.**

This technology helps in protecting the Park from human interference. This crew keeps the park under control. Their duty is to preserve the biodiversity at the Park. This process offers extra care. The main task of this rescue team is to make sure that visitors follow the Park's instructions. And understand the rules of the park and not to break them.

At the first stage: these techniques in general aim to protect and manage the Park. After getting this goal it will be possible to move on to the next phase. The second stage is bringing new species of animals and plants. The idea of these techniques is suitable to manage any Park not just for **Wadi Al-Kouff Park**.

## **Findings and Discussion**

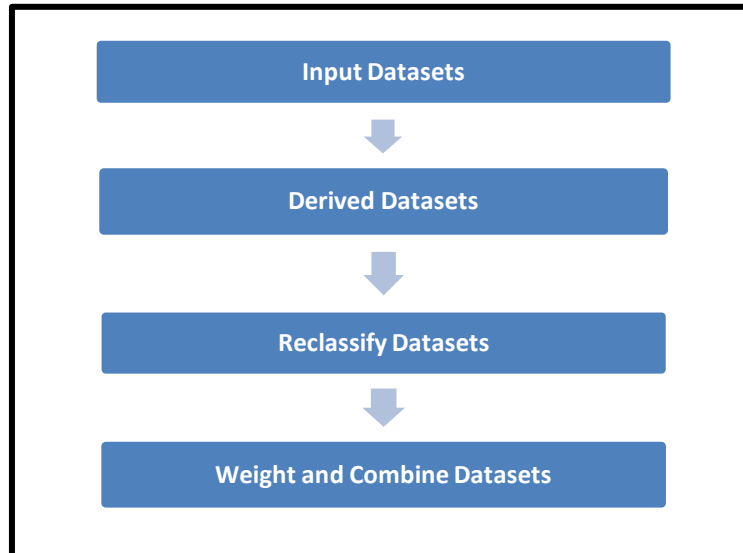
### **The Suggested Plan and Preparing the Data**

Wadi Al-Kouff Park needs plan that helps in resisting the neglect. According to **ACSAD- KOUF (1984)** the Park includes many species of animals and unique plants. But nothing on the land except the Lama animals and some neglected trees and shrubs. The Park suffers from serious neglect. It lacks the right management system. Its area is decreased because of the residents' occupation. There are no guards to save it from more neglect. This paper's plan is a great solution that depends on **GIS** technology in solving all these problems. This idea started with a search for an effective way to deal with such spatial problems (\*). The Park needs specific entrance points. Also should find suitable locations for observation centres....and more else. After intensive study and search found that; **GIS** is a suitable way for this mission. This technology proved its ability to solve such spatial problems in many sectors. Therefore, Input datasets needed to get Derived Datasets passing throw many steps.

This produces a map assists in managing the Park. Four steps were followed for this (see fig. 3).

Source: Designed by the researcher (2020)

Figure 3: The four steps to produce the desired map



All these steps achieved using the Spatial Analyst (\*) toolbar. This study Input Datasets include; elevation, location boundaries, roads, and wildlife distribution. These Input Datasets used in form of layers to get Derived Datasets. These layers were added to the table of contents of ArcMap. This helped in having an assistive map shows the Park and its topology and nature. Thus put successful and effective management and protection plan. Reclassify (\*) these Derived Datasets was an essential step before weight and combine them. This step was achieved to transform the Derived Datasets into a common scale (from 1 to 10). This step was done to ease combining them. A value of 10 was given to the most suitable feature. While a value of 1 to the least suitable one and the values in between were ranked. For example, to detect the highest sites (derived layer) in the Park was essential to Reclassify the 'Elevation layer' (Input Datasets). This process was achieved to find suitable locations to establish environmental observation's centres. The 'Elevation layer' reclassified by giving a value of 10 to the highest locations. And a value of 1 was given to the lower

ones and ranking the values in between. This was achieved using the Spatial Analyst toolbar;

(Spatial Analyst > Reclassify > the Input raster (Ex: - Elevation) > Classify > Method > Equal interval > Classes > click 10 (the desired classes counts) > Ok.).

This was repeated for all the following Input Datasets;

- Location boundaries
- Roads
- Wildlife distribution

To get the following result (Derived Dataset);

- Distance to Neighbours
- Distance between main sites and roads
- Density of Wildlife

Weight and combine these Derived Datasets was the next step. The layers were given an influence percentage according to their importance;

Reclassify distance to Location neighbours	(50%)
Reclassify the highest sites in the Park	(25%)
Distance between main sites and roads	(10%)
Density of Wildlife distribution	(15%)

All the values divided by 100 to normalize them;

Reclassify the highest sites in the Park	(25%)	25/100	(0.25)
Reclassify distance to Location neighbours	(50%)	50/100	(0.50)
Distance between main sites and roads	(10%)	10/100	(0.10)

Density from Wildlife distribution (15%) 15/100 (0.15)

These new values used to weigh and combine the Derived Datasets as following:

- (Spatial Analyst > Raster calculator > (D.C) Reclass<sup>(\*)</sup> the **Highest sites in the Park-sites** > Multiply > Click **0.25** > Add)
- (Spatial Analyst > Raster calculator > (D.C) Reclass the **Distance to neighbours from location** > Multiply > Click **0.50** > Add) the
- (Spatial Analyst > Raster calculator > (D.C) Reclass the **Distance between main sites and roads** > Multiply > Click **0.10** > Add)
- (Spatial Analyst > Raster calculator > (D.C) Reclass the **Density from Wildlife distribution** > Multiply > Click **0.15** > Add)

The final result of each step is a layer (**map**). These layers can be used separately or in combination to have one map as desired. It presents all the required details to start the management and protection plan.

### The questionnaire and its Results

The questionnaire was designed to discover if Libyans need **GIS** applications all for environmental management. Using **GIS** is essential in different sectors, for example, transport and road network.

Five problems were found by the end of this questionnaire:

First: the spatial distribution. About **17** participants confirmed going to their works within **5-15** mins by car or public transports. While **13** of them required more than **30** mins to go to their works without delay. But all agreed that it is difficult if they are obliged to go on foot. The journey to work takes **15- 30** mins by cars. So, the spatial distribution in **El-Beida** and its countryside is unfair. Plus to this, they confirmed they spend more time waiting for a bus. A serious problem emerged as a result of this.

There are no public bus stations or taxis in El-Beida. So there is no accurate time to catch a bus or hire a taxi. Catch a bus sometimes needs one minute or less, and other times needs more than **15** minutes. It is a service controlled by the bus owners not by government authority.

Second: describing addresses. The participants could not describe their addresses or even their work address. All their answers changed into questions;

- How can we describe it?
- What should we say to describe it?
- Can we say this or this? ....etc.

There is a serious problem in describing a specific address for everyone. Thus, the citizens need to the postcodes' service to ease their lives. This needs **GIS** to activate it in the right way.

Third: traffic and roads problems. Participants were asked if the city requires more bridges. This considered as a solution to solve the traffic crowd and late arrival at work. All the participants agreed on the same answer 'yes it needs bridges'. So, the transport and road planning evaluation needs more study and planning. GIS tools are needed, in particular, Spatial Analysis.

Fourth: the emergency service. When the participants were asked about if it is easy to have this service and how long they have to wait to get help? All the participants ensured they do not know if there is an emergency number. All they ensured when they face an emergency case they use their private cars. As a result of the questionnaire, the emergency service is not activated. Government has to give more interest to this service. And announce an easily remembered emergency number, or activate it if there is one. Also need to study the potential emergency units' locations. Each unit should serve an exact area to ease serving all residents in a short time.

Fifth: parking areas. Participants confirmed there are no parking areas anywhere. They have to park their cars in the wrong places for a long time. They ensured in case there is a car park it is usually smaller than the served area. Government has to

consider this service during the roads' planning projects.

## Conclusion

A plan of ten GIS-based techniques proposed to manage and protect the Park from more neglect. Choosing these ten techniques was depending on the Park location and its nature. A GIS map was created via four steps. These are Input Datasets, Derived Datasets, Reclassify Datasets, and finally Weight and Combine Datasets. Using this map is the first step in achieving these techniques' target. These techniques work side by side to save the Park from more neglect. If this plan is applied, it will lead to a massive improvement in the Park. Thus, it will be possible to open it for tourists from around the world. And declare it as International Park instead of National Park. Many governments had used the GIS for many aspects in several sectors and it has proved its ability in dealing with them. Moreover, face-to-face questionnaire designed to confirm the importance of GIS in many sectors. A sample of 30 participants was chosen for this aim. Most of them have difficulties arriving to their destination without transports. By the end of the questionnaire, five problems were found. These problems are;

1. Unfair spatial distribution
2. Difficulties in locating addresses
3. Roads and traffic problems
4. Non-activated emergency services
5. No functional car Parks

Libyan citizens need to use GIS applications on a wide range. Not only for the environmental management aspects but also to improve the infrastructure level.

## Recommendations

1. To increase awareness between citizens about the importance of the National Parks.
2. All the National Parks in Libya are national treasure. They deserve to be protected against human intrusions.
3. The Libyan government has a duty to protect Wadi Al-Kouff Park against any



deterioration.

4. Libyan government has to involve the GIS applications into any planning projects in Libya.
5. The infrastructure in Libya needs to be improved on all the levels using GIS technology.
6. The emergency service needs to be activated. The government has to establish emergency points everywhere to answer emergency calls. This is easy using GIS.
7. The road and transportation networks sector needs more attention from the government

\* \* \* \* \*

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