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Aim and Scope of IJENS's

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A GIS-Based Multi-Criteria Evaluation to Ecotourism Suitability Site Selection in Arasbaran Protected Area, Iran

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Abstract: Today, ecotourism is a major tourist activity around the world. Arasbaran protected area as a mountainous area in northwest of Iran has high potential for attracting eco-tourists due to its natural pristine nature and biodiversity. This study developed a spatial method for evaluation of ecotourism potential using geographic information systems (GIS). First, the effective criteria were chosen according to the previous studies. Standardization of the criteria was conducted using suitable fuzzy functions and the weights of the criteria were derived through the analytical hierarchy process (AHP). In the next step, criteria were combined using Weighted Linear Combination (WLC) method to reveal the suitability of ecotourism. Eventually, for land zoning according to ecotourism value, the module of Zonal Land Suitability (ZLS) was applied and around 37 zones were introduced for ecotourism at the study area. The result of this study showed that the most suitable ecotourism area of Arasbaran protected area is 6.45 percent (5200.62 ha) with attention to pixel with suitability more than 200. Overall, the results revealed that MCE method is capable of evaluation of Arasbaran protected area for ecotourism. Also, the geographical information system was found a useful tool, allowing combination of many criteria and Boolean layers.

Keywords: Ecotourism, Weighted Linear Combination Method, land planning, Multi Criteria Evaluation, ZLS

1. INTRODUCTION

Today, tourism as one of the most dynamic economic activities, plays an important role in the sustainable local development. It is a process that has long been associated with particular forms in order to provide psychological, cultural, social and economical needs of human communities (Salmanmahini et al., 2008; Yan et al. 2017). Ecotourism is one of the new branches of tourism that is the responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education to staff and guest (TIES, 2015). Ecotourism focuses on the resources and attractions that visitors and tourists provide through the natural environment (Nino et al. 2017; Liu 2016; Suryabhagavan et al., 2015). Today, ecotourism is a major tourist activity around the world. Ecotourism development, such as other developments has positive impacts and negative impacts on host communities (Salmanmahini et al., 2008).

Therefore, appropriate management for ecotourism development is essential inorder to maximize positive impacts and minimize negative impacts on all aspects of tourism (Courvisanos& Jaina, 2006). Unfortunately, due to inadequate environmental assessments and audits, many ecotourism destinations tend to be both hazardous and self-destructive (Tsaur& Lin, 2006). From the past few decades upwards, in lots of countries, the planning of the land based on land use planning and ecological land capability evaluation is considered as the most important tool and factor of sustainable development (Kheikhah Zarkesh et al., 2011).

Ecotourism evaluation and site selection should be regarded as an important tool for the sustainable development of tourism in protected areas. The goal of zoning and site selection exercises is to find the optimum location that satisfies a number of predefined criteria (Masoodi etal., 2016). The process of site selection typically involves two main phases: screening (identifying a limited number of candidate sites from a broad geographical area given a range of selection factors) and evaluation (Vahidnia and et al., 2009; masoodi et al., 2016).

There are a variety of analytical methods for evaluating land based its capabilies. Traditional methods of GIS site

selection and evaluation are based on the transformation of effective layers into classified maps, for example, through use of a Boolean model equal value to all suitable areas regardless (Louviere et al., 2000).

Boolean model, however, has defects such as givingof their position in reference to their factors (Hajehforooshnia et al., 2011). There are a few studies on ecotourism evaluation in Iran, that the most of them, have used Boolean logic using either the Mac-Harg or Makhdoum method (Makhdoum, 2013).

Recent developments in the Geographical Information System (GIS) have led to significant improvements in our capability for decision-making processes in land allocation and environmental management using Multi Criteria Evaluation (MCE) (Bhaya& Chakrabarty.,2016; KianiSadr et al., 2019; Asmamaw& Gidey., 2018).

The Geographical Information System (GIS)-based multi-criteria decision-making approach enables decision-makers to evaluate the relative priorities of decision-making criteria based on a set of preferences and indicators that do not have necessarily the same nature (Ahmadi et al., 2015; Mahdavi et al., 2014; Kianysalmi et al., 2016). multi criteria MCE) used to rank and achieve the priorities for the alternatives of a decision.

MCE is most commonly achieved by one of two procedures: The first involves Boolean overlay whereby all criteria are reduced to logical statements of suitability and then combined by means of one or more logical operators such as intersection (AND) and union (OR). The second is known as weighted linear combination (WLC) wherein continuous criteria (factors) are standardized to a common numeric range, and then combined by means of a weighted average (Eastman, 2012).

This paper describes a geographic information system (GIS)-based multi-criteria decision making approach for zoning ecoutourism potential of Arasbaran protected area in Iran and selecting the best zones by applying Zonal Land Suitability (ZLS) approach. This work assessed potential suitable areas for ecotourism based on physical characteristics of the land. In this process, research, applied a type of multi-criteria evaluation (MCE) method called weighted linear combination (WLC) in a GIS environment to evaluate the ecotourism suitability, the presented method evaluates overall of study area using a grading scale from 0 to 255 (Byte Scale). Where 0 defines a site without any capability for ecotourism while 255 indicates the most suitable site for ecotourism.

2. MATERIAL AND METHODOLOGY

2.1. Study Area

The study was conducted in a part of the Kaleibarchay watershed, the Arasbaran protected area, also known as "Qaradagh" or "Qaraja dagh" is a large mountainous area stretching from the Qusha Dagh, massif, south of Ahar, to the Aras River in East Azerbaijan Province of Iran.

The region is confined to Aras River in the north, Meshgin Shahr County and Moghan in the east, Sarab County in the south, and Tabriz and Marand counties in the west. This region confines to 38°40' to 39°08'N and 46°39' to 47°02'E38°40' to 39°08'N and 46°39' to 47°02'E, and covers an area about 80600 hectares. It is about160 km away from the capital city Tabriz (Fig. 1).

Biogeographically, this area is called the Hirakano-vasini region or Arasbaranian region. It is in a highly mountainous region rising from 259 to 2896 m above sea level (highest peak Keshish-Qelbisii). The average annual rainfall in this region is 400-600 mm. Average annual temperature is variable from the lowest height (the margin of the Aras River) to high mountains and from 17° C to 5° C, respectively (Darvishi et al., 2016).

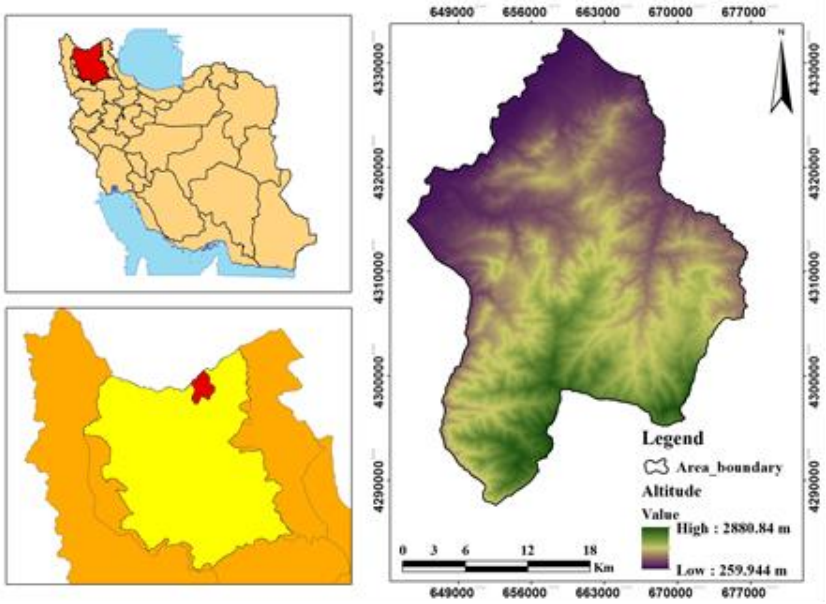

Figure 1. Geographical location of the study area

2.2. Data and Methodology

In the present study, the methodological approach to evaluate the ecotourism potential capability was divided in to seven major stages as follows:

- Identifying effective criteria on ecotourism value in the study area

- Preparing spatial and non-spatial data

- Standardizing the criteria maps

- Determining the weight value of each criterion by using AHP method

- Implementing WLC for criteria maps inorder to assign ecotourism value

- Assessing of study area using Zonal Land Suitability (ZLS) approach to ecotourism final zoning.

2.2.1. Identifying Effective Criteria on Ecotourism Value in the Study Area

In this study eight criteria including, vegetation cover (Vegetation density), slope, distance from roads, distance from rivers, distance from villages, distance from natural attraction and wildlife habitats, soil erosion and geology were identified based on reviewing resources, data accessibility and expert opinions

2.2.2. Preparing Spatial and Non-Spatial Data

In the present study, the data were collected from a variety of sources (Table 1). In order to prepare the vegetation cover (Vegetation density), The Normalized Difference Vegetation Index (NDVI) was drived from Landsat OLI images (acquired in July, 2018), based on this individual measurement as follows:

$$NDVI= NIR- R/ NIR+ R$$

That here NIR is Near InfraRed band or band 5 of using satellite images and R is Red band or band 4 of Landsat OLI images.

Table 1. List pf data and original sources (Data acquisition)

Data	Source
Digital Elevation Model (DEM)	Department of Natural Resources and Watershed Management
Soil erosion, Geology map	Department of Natural Resources and Watershed Management,
Landsat satellite image	USGS EARTH EXPLORER website
Accessibility routes, Rivers, Villages	Department of Environmental Conservation
Natural and cultural attractions	Department of Environmental Conservation

Slope was calculated from Digital Elevation Model of 30 m pixel with in Idrisi software and applying Surface Analysis Module. In addition, Distance Module was used to calculated distance from roads, distance from rivers, distance from villages, distance from natural attraction from related layers.

2.2.3. Standardizing Criteria Map

The fuzzy majority is considered as an aggregation procedure which incorporates the opinions of the majority of decision-makers through preference. The ultimate aggregated amount characterizes the value of the majority of the most similar amounts. The similarities between pairs of preference values can be computed using a support function, Sup (a, b), which can be denoted as the support for 'a' from 'b' where:

$$\text{Sup}(a, b) \geq \text{Sup}(x, y) \text{ if } |a - b| < |x - y|, \text{ (Pasi\&Yager, 2006).}$$

Therefore, the closer argument values lead to more support from each other (Drobne& Lisec, 2009). Table 2 indicates the fuzzy function by using the criteria considered in this study.

Table 2. The shape of membership functions and control points of different criteria

Criteria/factors	Shape of membership functions	Control points	
		Starting point	End point
Vegetation cover	Symmetric (Linear)	a= 0	b= 0.60
distance from roads	Monotonically decreasing (Linear)	a= 0	d= 3000
distance from rivers	Monotonically decreasing (Linear)	a= 0	d= 2500
Slope	Monotonically decreasing (Linear)	a= 0	b= 15
Soil erosion	User-defined	a= 0	d= 5
distance from villages	Monotonically decreasing (Linear)	a= 0	d= 4000
Geology	User-defined	a= 0	d= 7
distance from natural attraction	Monotonically increasing (Linear)	a= 0	d= 2000

2.2.4. Determining the Weight Value of Each Criterion by Using AHP

Weighting the defined criteria is considered as an important stage and the reliability of its consequences can guarantee the results. The weight the criteria was done by AHP method based on paired weighting. Then, the geometric mean method was used to calculate the weight of the factors and the incompatibility ratio was estimated. The probability value represents the probability of the corresponding random degrees, upon which the values of less than 0.1 are considered as good, and those are more than 0.1 are incompatible. It is worth noting that the weight the criteria should be re-established (NeisaniSamani etal, 2018).

2.2.5. Implementing WLC to Integrate Criteria

Weighted linear combination established by Eastman in1995 is regarded as the most common method to integrate the criteria for analyzing land suitability (SalmanMahini& Kamyab, 2010). Weighted linear combination, or simple additive weighting, is based on the concept of an average weighted in which continuous criteria are standardized to a common numeric range, and then combined by a weighted average. Regardingthe weighted linear combination, factors are combined by applying a weight to each followed by a summation of the results to yield a suitability map:

$$S=\sum (w_i\ x_i)$$

where S represents suitability, w_i indicates the weight of factor i, and xi is considered as the criterion score of factor i. In those cases, where Boolean constraints are used, the procedure can be modified by multiplying the suitability calculated from the factors by the product of the constraints:

$$S=\sum (w_i\ x_i) \prod c_i$$

Where c_j represents the criterion score of the constraint j. All GIS software systems provide the basic tools for evaluating such a model (Eastman, 2012).

2.2.6. Zoning the Study Area for Ecotourism Value Using Zonal Land Suitability (ZLS) Approach

In this research, zoning of study area based on ecotourism value was done using ZLS method. ZLS is abbreviation of Zonal Land Suitability. This method is a non-pixel, regional and polygon base approach that uses of macro properties or the same site selection at the Idrisi software and has three defaults;

- Using of Land should be based on several goals
- It selects the best pixels for the defined purpose from the pixels of maps.
- It Selects the most preferred region for each defined purpose (saeidi et al., 2014: Siroosi et al., 2019).

To execute this command, first, the macro file should be created. Macro files must have the extension. IML (for IDRISI Macro Language). This file can be created in the IDRISI Edit module. Then, the user should Choose Run Macro from the File menu. At this point, running macro mode requires the following parameters;

- Input filename (the image containing values to use in the calculation)
- The minimum suitability threshold
- The minimum area of the place
- output filename (the new image to be created) (Eastman, 2012).

According to the mentioned description, ecotourism suitability map that created using MCE method, by applying Run Macro and allocating value 200 for suitability threshold and minimum area of 20 hectares, was zoned. The zones are then ranked in descending order by the value of their zonal land suitability to facilitate the decision process.

3. RESULTS

In this study, at first steps, effective criteria on ecotourism were identified, mapped and standardized (fig. 2). Then, each criterion was weighted using AHP method. Weights related to criteria are presented in Table (1).

The weights indicate the relative importance of each criterion compare to their overall value in landscape. In this study, Inconsistency Ratio, calculated 0.03, since it is smaller than 0.10, then degree of consistency is acceptable.

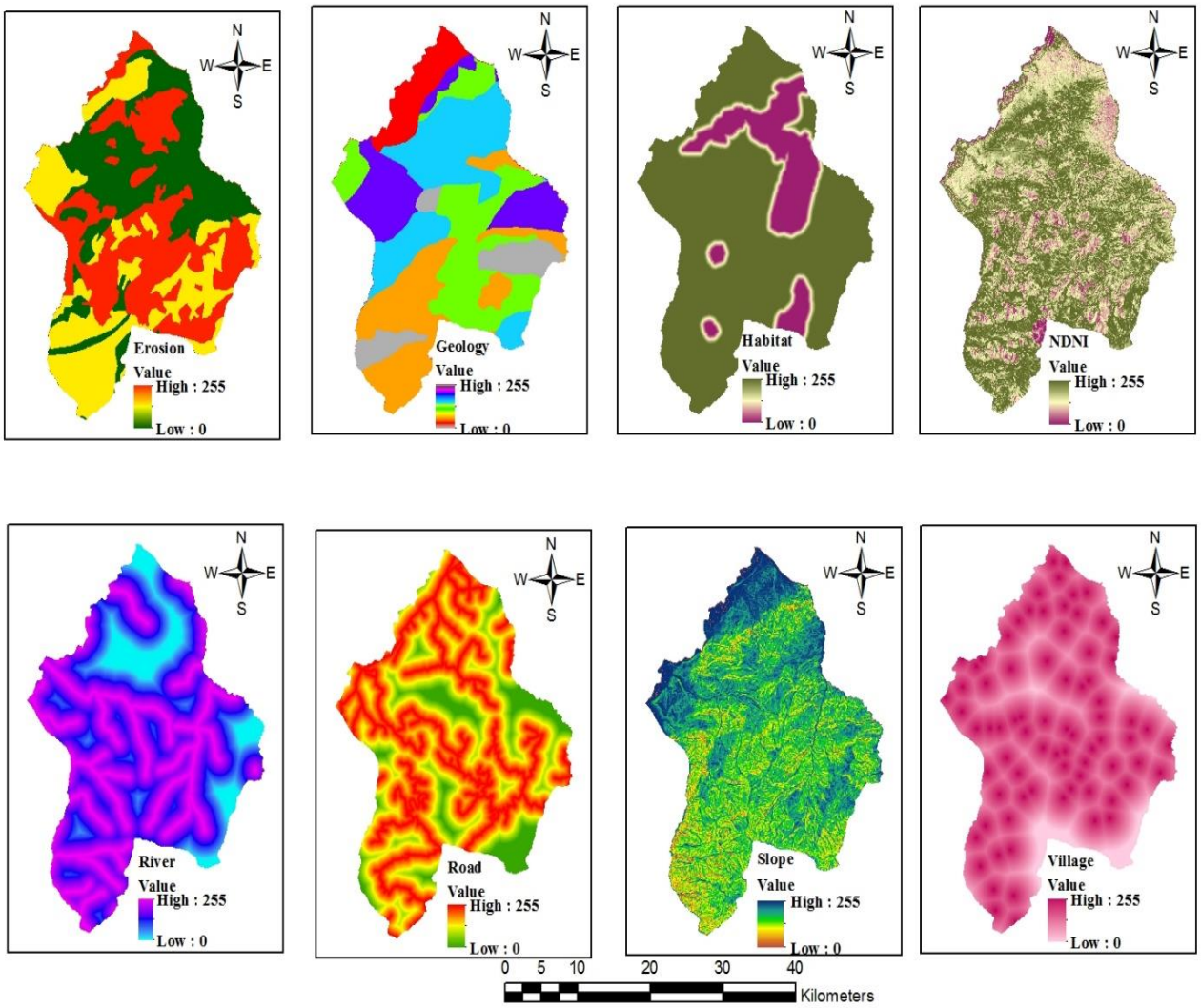

Figure 2. Standardized factor layers used for ecotourism suitability mapping in Arasbaran protected area, East Azerbaijan Province, Iran.

Table 1. The weights of criteria obtained through AHP method

Factors	Weight
Vegetation cover	0.2484
distance from roads	0.1727
distance from rivers	0.1359
Slope	0.1071
Soil erosion	0.0604
distance from villages	0.1727
Geology	0.0194
distance from natural attraction	0.0816
Inconsistency Ratio	0.03

Based on the results of the criteria weights, the effect of each criterion is determined on the final composition of the maps. The result of applying the weights and combining the maps together using the weighted linear combination method is fuzzy map (Fig. 3) which shows different degrees of suitability over the range of 0–255**.**

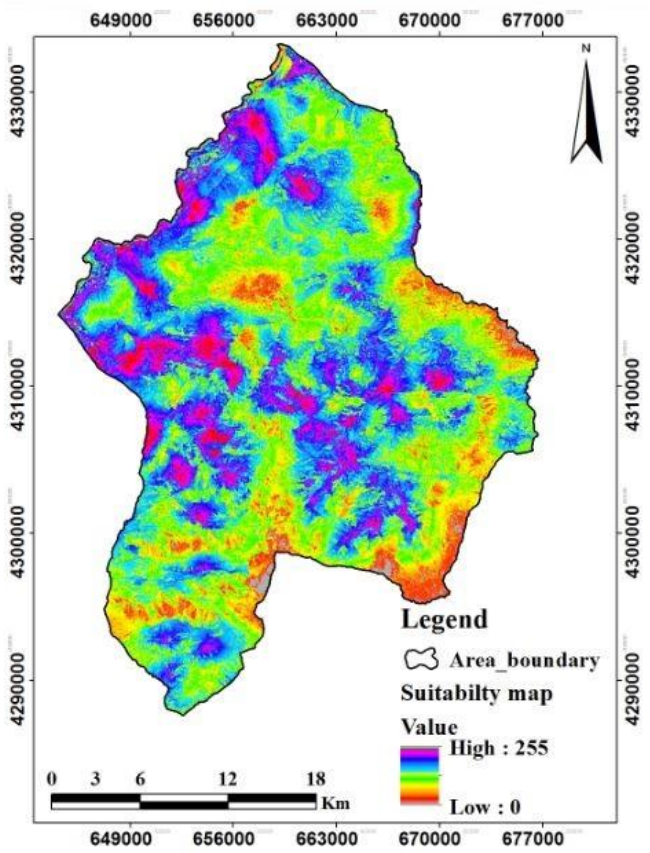

Figure 3. Final ecotourism suitability map

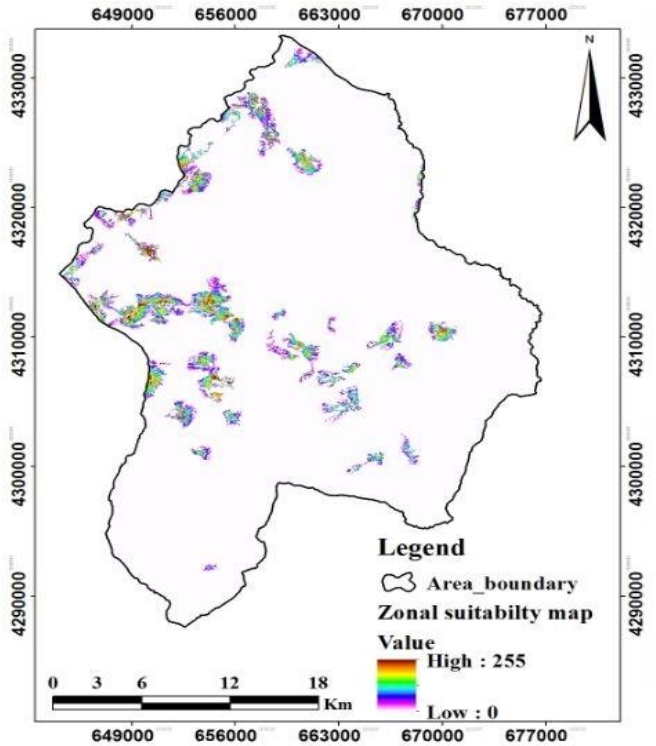

Figure 4. Zonal land suitability map for ecotourism

The application of the zonal land suitability on MCE map in Arasbaran protected area indicated that there are 37 zones for ecotourism that their zonal land suitability varied from 12 to 3259 (Fig. 4). Then, of these 37 zones, 13 zones were introduced as the most suitable area for the ecotourism (Fig. 5) and (Table 2).

Table 2. Zonal land suitability and area of 13 zones for ecotourism

Number of zones	Minimum suitability	Maximum suitability	Area (ha)	Average land suitability
96	201	251	1072.37	226
282	202	249	3917.46	225.5
888	201	217	34.92	209
1190	202	239	696.71	220.5
1213	208	232	925.16	220
1417	200	221	223.72	210.5
1549	207	234	300.46	220.5
2018	204	243	945.37	223.5
2470	202	219	516.13	210.5
2562	205	236	300.54	220.5
2833	204	220	256.4	212
2988	200	224	191.12	212
3018	200	221	230.53	210.5

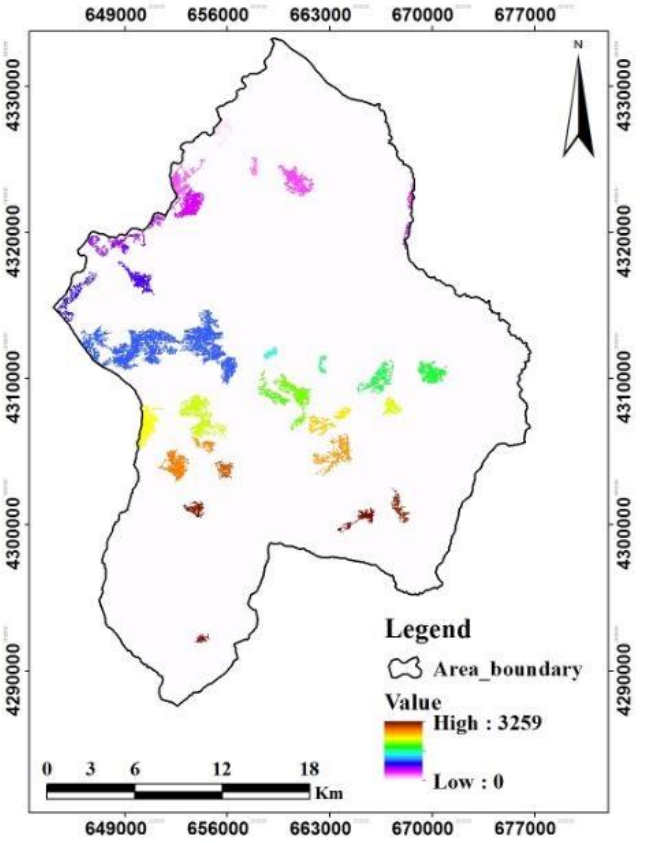

Figure 5. Map of the most suitable zones for ecotourism

4.DISCUSSION

The main purpose of this study, is to evaluate ecotourism potential in the Arasbaran protected area, Iran. Evaluation of ecotourism potential is essential when developing any region effectively. This foresight and planning will also serve to prevent wastage of financial and human resources (Masoodi et al., 2016).

The used approach in this research, integrated the evaluation abilities of MCE method and the analytical tools of GIS and showed the use of GIS as a decision support system (DSS).

At the first step, the model assessed the potential of the land for ecotourism by combining criteria, the relative importance weights of factors were estimated using the analytical hierarchy process (AHP). Initially, the land evaluation is performed on a cell by cell basis.

The Weighted linear combination (WLC) used to estimate, the suitability of each cell for ecotourism. Figure 3 illustrate the suitability map for ecotourism in the study area, which is different in the utility of the cells. More utility represented more value and lower utility indicated the lower value of the ecotourism.

Based on the weights of criteria that obtained through AHP method, Vegetation cover, distance from roads and distance from rivers were identified as the most effective criteria in transferring the values of ecotourism in the study area.

The weighted linear combination method is more flexible than the Boolean approach. It lets to criteria to be standardized consistently, and retaining important information about degree of suitability. It also lets the criteria to be differentially weighted and to trade off with each other.

While a variety of standardization technique are important to seek for any multi-criteria problem, they result in layers that indicate the suitability of location in the overall study area. The WLC method results in continuous suitability layer that makes selecting special sites for ecotourism, or any other allocation, problematic.

In the WLC approach, site suitability was clearly specified and the only problem for site selection was one of adjacency.

With a continuous result, first, there is the problem of determining what locations should be chosen from the set of all locations, each of which has some degree of suitability.

This problem was considered by adding the post-aggregation constraint that suitable sites must be at least 20 hectares in size and at least have a suitability threshold of 200. The most suitable zones cover an area around 9610.89 hectares that is 11.92 percent of the entire study area.

The model then evaluated the ecotourism suitability for each zone. This zonal suitability is acquired by calculating the average of the suitability of all cells belonging to each zone. In the final step, zones were ranked in descending order by the value of their zonal land suitability. From among the zone, planners and decision makers can choose the best in terms of availability.

5.CONCLUSION

This study aims to evaluate ecotourism potential of Arasbaran Protected Area, Iran. The application of Geographical information system and Multi-Criteria evaluation approach efficiently assists ecotourism management and planning. MCE is an appropriate tool for ecotourism planning, because it considers various criteria that have a significant impact on decision making. Usage MCE has prosperously identified different levels of ecotourism suitability, taking into account various factors and constraints. The results of this paper, by identification of suitable areas for ecotourism activity can help decision-makers to provide an appropriate management plan restricting ecotourism activities only in places with high potentials for ecotourism development. Applying and integrating various approaches along with different factors and using tools to quantify these factors, decrease reliance on qualitative criteria. Accordingly, it can impede, applying personal opinions in decision making and will help to attain more practical and reasonable concepts for land planning and evaluation.

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A Review of Criteria In Rain Water Harvesting Management

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Abstract: Rainwater harvesting has gained renewed interest in the arid and semi-arid regions since the 1970s. It is important to consider how significant amounts of water can be harvest from a single catchment location. Papers selected address a wide range of rainwater harvesting problems, including the regionalization of nature curves. The rural population has limited income, a high susceptibility to climate change, conventional agricultural activities and adversely affected water shortages. Rain Water Harvest is an alternative cause to water shortages and groundwater depletion issues. The discovery of suitable rainwater harvesting sites is an essential move towards optimizing the amount of water harvesting and mitigating the ecological effect by using remote sensing and GIS techniques. In this article, the main requirements and parameters for selecting appropriate sites for rainwater harvesting have been extract from previous studies.

Keywords: Rainwater harvesting, AHP, Water Harvesting criteria, Approach of Water Harvesting, GIS

1. INTRODUCTION

Owing to the rapid growth in the human population over recent decades, Climate changes and variety are faced by the ever-increasing water requirement in the Rainwater harvesting scheme, which is a technology of water sources that is centuries old. The world's water needs are rising twice as rapidly as the population (FAO, 215 C.E.), according to the Food and Agriculture Organization.

The rainwater harvesting system captures rainwater from impermanent surface areas such as rooftops and road floors or from natural surfaces and stores water in indoor and outdoor storage systems such as reservoirs and basins and surface dams (Lasage & Verburg, 2015) (Campisano et al., 2017). Current water sources in the country are under rising population pressure, rapid urbanization, industrial management and irrigated agriculture, which lead to water scarcity and food security issues. Water shortages are estimated to reach around 1.8 billion people by 2025, while water scarcity is predicted to be present for two-thirds of the planet (UN, 2014).

Rainwater harvesting is helping to fulfill one of the priorities of sustainable development (safety and sustainable water quality and sanitation for all in rural areas. In urban areas, the rainwater harvesting process is widely used for a number of purposes, such as agriculture, factories, cleaning and washing vehicles, etc.). Alternate systems for water supply and storm water management (Van der Sterren et al., 2012) (Hanson & Vogel, 2014). Population-enhancing farming practices can take place at an astounding level In the semi-arid climate, where water is a significant constraint on agricultural production, rainwater harvesting and management systems are becoming increasingly common (S N Ngigi, 2003). Water harvesting by rainwater structures is part of the surface water that flows downstream to the bottom of the channel (Stephen N. Ngigi et al., 2007).

The sustainable use of water supply in agriculture is essential to the food crisis. Rainwater harvesting has been a revived concern for thousands of years since 1980. Water scarcity and soil moisture problems in the arid and semi-arid regions are continually affected. These issues affect crop production and increase the risk of food production (Wu et al., 2018). (Ammar et al., 2016) indicated that rainwater harvesting could be define as a method for the collection, storage and conservation of rainwater runoff in arid and semi-arid areas. Rainwater harvesting has been extremely useful, particularly in drylands where water shortages are simultaneously approaching. In addition to growing water availability, rainwater harvesting recharges local groundwater sources and improves job opportunities. Water harvesting is widely used to solve the problems of water shortages and improve the available water supply.

Rainwater harvesting is harvesting and managing rainwater runoff to increase the availability of water for domestic and agricultural use and the maintenance of the ecosystem (Mekdaschi & Liniger, 2013). Nevertheless, it is a significant step towards maximizing water supply and land productivity in semi-arid areas to find potential sites for rainwater harvesting (Isioye, 2012). According to several parameters, rainwater harvesting sites are updated (Mahmoud & Alazba, 2015) and various technologies and/or methodologies are required for successful site selection (Ghani et al., 2013) (Al-Adamat et al., 2010) (de Winnaar et al., 2007a). The socio-economic and physical life of a specific area should also be taken into account in the correct choice of location (Al-Adamat et al., 2010). It is therefore very important to optimize the available water by collecting water to determine key factors influencing both the decision-making process and the best scale in relation to the target area around it (Wu et al., 2018).

2. METHODS FOR RAINWATER HARVESTING SITE SELECTION IN ARID AND SEMI ARID AREA

Relevant locations and technological design identification are the two key factors behind the success story of rainwater harvesting equipment (Al-Adamat et al., 2012). Various approaches can be used to combining selected parameter with the appropriated web- based rainwater-harvesting tool. Different experimental experiments in arid and semi-arid regions around the world have used two types of parameters (biophysical and socio-economic). The research group focuses on integrated biophysical components of biophysical components (Kahinda et al., 2008) and integrated socio-economic components (land, slope, land use cover, soil type) (Isioye, 2012) (Kumar et al., 2008) (Ziadat et al., 2012) (Bulcock & Jewitt, 2013) (Krois & Schulte, 2014).

Approaches and methods available to identify sites using biophysical and socio-economic parameters such as; GIS and Remote Sensing (Bamne et al., 2014) (Al-Shamiri & Ziadat, 2012), GIS and remote sensing hydrological modelling (Mahmoud & Alazba, 2015), Harvesting management and GIS techniques with remote sensing data (Krois & Schulte, 2014) (Khan & Khattak, 2012) (Tera'at El Mansuriyah St, 2012). Although, GIS and remote sensing tool is an implementation tool for appropriate site identification, better efficiency and more data-rich areas, the combination of rainwater harvesting multi-criteria analysis and GIS-based harvesting management are highly preferred methods and/or software. All methods and techniques used in previous research studies on the selection of rainwater harvesting sites have certain restrictions (Wu et al., 2018).

Many authors, for example (Campisano et al., 2017; Basinger et al., 2010; Bouma et al., 2016), examined the evolution of the rainwater harvesting system. In the wider range of climatic situations and applications for example. In Australia (Rahman et al., 2012), (Schuetze, 2013) in Germany, and in the United State (Basinger et al., 2010). While in Brazil and Italy (Ghisi, 2010), in United Kingdom (Sarah Ward & Butler, 2016), in China (GOULD et al., 2014), in addition in South Korea (Han & Mun, 2011), in West Asia and in North Africa (Bouma et al., 2016) (Ziadat et al., 2012) (Sharifi et al., 2015). The efficiency of rainwater harvesting is being demonstrated in water saving and conservation around the world. The quality of rainwater collected depends largely on the environment, tank material, and rainwater harvesting system maintenance. Heavy metals and nutrients can be present in rainwater harvested from roof catchment (Van der Sterren et al., 2013) (Hamdan, 2009). The use of properly designed first-line flush equipment and regular maintenance of the rainwater harvesting system can significantly improve the quality of the collected water (such as washing roof surfs, goose rings, tanks and first-line flush devices; inspecting the mosquito and vermin entry points; or removing overhanging trees from the roof).

The rainwater harvesting system modeling aims to fulfill the predicted water requirements for rainwater availability (Hanson & Vogel, 2014) (Hajani & Rahman, 2014). This is typically done by continuous inflow and outflow simulation (S Ward et al., 2012) (Ghisi, 2010) or by analytical (Hanson & Vogel, 2014) (Ghisi, 2010) (Eroksuz & Rahman, 2010) or stochastic analysis (Basinger et al., 2010) (Sharifi et al., 2015) or through a web-based platform incorporating geospatial plumage patterns (Fonseca et al., 2017). The rainwater portion of the rainwater system is also analyzed (Van der Sterren et al., 2009) (DeBusk et al., 2013). The inclusion in the design of rainwater harvesting can have a major effect on the determination of the acceptable size of the tank (e.g. greenhouse gas emissions, materials used to establish the rainwater harvesting system). The effect of climate change considerations could also have an impact on the size of the tank (Haque et al., 2016).

3. CRITERIA USED FOR SELECTING SUITABLE RAINWATER HARVESTING SITES

There are many parameters that can be used to determine appropriate water harvesting sites, many research studied on rainwater harvesting have been carried out by the researchers and some factors have been considered by each researcher. There are key and sub-factors, depending on the situation and method of analysis. Table 3.1 shows the study of researchers and the parameters used such as Rainfall, Slope, Soil texture, Drainage density, Land use land cover, Road distance, location, materials and discharge, Socioeconomic, Structural and Tectonic Geology and Settlement and Agriculture.

Table 3. Selection criteria of Biophysical and Socio-economic for rainwater harvesting in different references

Researcher(s)	Research Title	Rainfall	Slope	Soil texture	Drainage density	Land Use Land Cover	Distance from area, road, materials and discharge	Socio- economic	Structural geology and tectonic	Settlement and agriculture
(Noori et al., 2019)	Dam site suitability assessment at the Greater Zab River in northern Iraq using remote sensing data and GIS	•	•	•	•	•	•		•	
(Hameed, 2013)	Water harvesting in Erbil Governorate, Kurdistan region, Iraq Detection of suitable sites using Geographic Information System and Remote Sensing	•	•	•	•	•				
(Ahmad & Verma, 2018)	Application of Analytic Hierarchy Process in Water Resources Planning: A GIS Based Approach in the Identification of Suitable Site for Water Storage	•	•	•	•	•	•			•
(FAO, 2003)	Soil and terrain database for Southern Africa	•	•	•	•	•	•	•	•	
(Tumbo et al., 2006)	Determination of suitability levels for important factors for identification of potential sites for rainwater harvesting	•	•	•	•	•				
(Al-Abadi et al., 2017)	A GIS-Based Integrated Fuzzy Logic and Analytic Hierarchy Process Model for Assessing Water-Harvesting Zones in Northeastern Maysan Governorate, Iraq	•	•	•	•	•	•			
(Al-Adamat et al., 2010)	Combining GIS with multicriteria decision making for siting water harvesting ponds in Northern Jordan	•	•	•	•	•	•	•		
(Anane et al., 2012)	Ranking suitable sites for irrigation with reclaimed water in the Nabeul-Hammamet region (Tunisia) using GIS and AHP-multicriteria decision analysis	•	•	•	•	•	•	•		•
(de Winnaar et al., 2007b)	A GIS-based approach for identifying potential runoff harvesting sites in the Thukela River basin, South Africa	•	•	•	•	•	•			
(Haile & Suryabhagavan, 2019)	GIS-based approach for identification of potential rainwater harvesting sites in Arsi Zone, Central Ethiopia	•	•	•	•	•	•		•	

(Kahinda et al., 2008)	Developing suitability maps for rainwater harvesting in South Africa	•	•	•	•	•	•		•	
(Al-Adamat, 2008)	GIS as a decision support system for siting water harvesting ponds in the basalt aquifer/NE Jordan	•	•	•	•	•	•		•	•
(de Winnaar et al., 2007a)	A GIS-based approach for identifying potential runoff harvesting sites in the Thukela River basin, South Africa	•	•	•	•	•				
(Ammar et al., 2016)	Identification of suitable sites for rainwater harvesting structures in arid and semi-arid regions: A review	•	•	•	•	•	•	•		•
(Jasrotia et al., 2009)	Water balance approach for rainwater harvesting using remote sensing and GIS techniques, Jammu Himalaya, India	•	•	•	•	•	•			
(Isioye, 2012)	A multi criteria decision support system (MDSS) for identifing rainwater harvesting site (S) in Zaria, Kaduna state, Nigeria	•	•	•	•	•				
(Buraihi & Shariff, 2015)	Selection of rainwater harvesting sites by using remote sensing and GIS techniques: A case study of Kirkuk, Iraq	•	•	•	•	•				
(Gavit et al., 2018)	*Rainwater Harvesting Structure Site Suitability Using Remote Sensing and GIS*	•	•	•	•	•	•			
(Al-shabeeb, 2016)	The Use of AHP within GIS in Selecting Potential Sites for Water Harvesting Sites in the Azraq Basin -Jordan	•	•	•	•	•	•		•	
(Karimi & Zeinivand, 2019)	ntegrating runoff map of a spatially distributed model and thematic layers for identifying potential rainwater harvesting suitability sites using GIS techniques	•	•	•	•	•				
(Kumar et al., 2008)	Delineation of potential sites for water harvesting structures using remote sensing and GIS	•	•	•	•	•				
(Mahmoud & Alazba, 2015)	The potential of in situ rainwater harvesting in arid regions: developing a methodology to identify suitable areas using GIS-based decision support system	•	•	•		•				
(Paper et al., 2018)	Optimum Site Selection of Water Harvesting Structures Using Geospatial Analysis and Multi Criteria Evaluation Techniques	•	•	•	•	•			•	•
(Singhai et al., 2019)	GIS-based multi-criteria approach for identification of rainwater harvesting zones in upper Betwa sub-basin of Madhya Pradesh, India	•	•	•	•	•				•

(Ramakrishnan et al., 2009)	SCS-CN and GIS-based approach for identifying potential water harvesting sites in the Kali Watershed, Mahi River Basin, India	•	•	•	•	•				•
(Ramakrishnan et al., 2008)	Delineation of potential sites for water harvesting structures through remote sensing and GIS techniques: A case study of Kali watershed, Gujarat, India	•	•	•	•	•				
(Ahmed & Al-manmi, 2019)	Delineation of Groundwater productivity Zones with the integration of GIS and Remote Sensing methods , Bazian Basin , Sulaymaniyah , Kurdistan	•	•	•	•	•			•	
(Zakaria et al., 2012)	Rain Water Harvesting and Supplemental Irrigation at Northern Sinjar Mountain, Iraq	•	•	•	•	•		•		
(Salar et al., 2018)	Identification of suitable sites for groundwater recharge in Awaspi watershed using GIS and remote sensing techniques	•	•	•	•	•		•	•	•
(Ibrahim et al., 2019)	Suitable site selection for rainwater harvesting and storage case study using Dohuk Governorate	•	•	•	•	•				
(Singh et al., 2009)	Selection of suitable sites for water harvesting structures in Soankhad watershed, Punjab using remote sensing and geographical information system	•	•	•	•	•			•	

DISCUSSION

In this review, about 31 published research in different years from 2003 to 2019 have been review to get a good result for using the better factors in rainwater harvesting studies. Through the review found were, most effective factors that have been considered in 90- 100% of the researches are Rainfall, Slope, Soil texture, Drainage density and land use/ land cover as it is shown in table 3.1. In level two 45- 55 % of the researchers adding the factors of distance from the area, road, materials and discharge to the mentioned factors. 15-25% adding the factor of socio-economic. However, 25-35 % considered structural geology and tectonic to the above main factors. At the last 20, 25 % included settlement and agriculture with their main factors in the process of selecting a suitable site for rainwater harvesting.

However, the important factors can be classified into more precise parts, for example, a division land use/ land cover into residential areas urban and rural, public gardens, home gardens, roads, and determining the quality of materials used in construction. The classification of the factors makes the study very accurate. As well as there are a lot of things that should be studied in the future to obtain final conclusions, for example, chooses the best method between all methods that can be used in water harvesting to reduce the time and obtain a good result. Also for the future work the site visit should be included to verify the land contains, and checking the realty of the area with the remote sensing data.

CONCLUSION

The use of rainwater harvesting allows the city directly to mitigate the crisis in water in the arid and semi-arid regions. There is no location in the region defined as appropriate means this location is appropriate as enclosed spaces, small villages or other hydraulic factory structure prevention may socially affect some of these sites. Rainwater development should be apply through a field study because the spatial scope of the survey does not ensure that all sites in a region identified as low-appropriate areas.

In conclusion, the review demonstrated the importance of the main factors uses in rainwater technology work to find a suitable area for water harvesting. However, there are many methods can be used to find potential sites for water harvesting, like the Analytic Hierarchy Process, Fuzzy and Weighted Linear Combination….etc. depending on the researcher's likelihood, there are too many reviews appear the comparison between the methods and show the important way. Depending on the study result, the main

criteria that can be consider in the rainwater harvesting studies are; Rainwater, Land use/ Land cover, Drainage density, Soil texture and Slope.

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Schwarzian Derivative of Third Chaotic Transition in Mercury Based Superconductors

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Abstract: The superconductivity displays some nonlinear quantum properties such as quantum chaotic transitions, effective mass of quasi-particles. The calculation of the effective mass equation of the mercury based superconductor has a crucial step in order to determine chaotic behavior of the sample. The sample has three quantum chaotic points; the critical transition (T_c), paramagnetic Meissner transition (T_{PME}) and the quantum gravitational transition temperatures (T_{QG}). T_c and T_{PME} were already investigated by means of Schwarzian derivative and it was found that the Schwarzian derivatives are both negative at two chaotic points. In the study, the third quantum chaotic point of the system, T_{QG} is investigated by the Schwarzian derivative of the effective mass of the sample. As is known, the object's mass varies in a gravitational field. Hence, it is determined that the Schwarzian derivative of the effective mass, which has the negative value, shows the quantum chaotic transition in the system. At the vicinity of T_{QG} where the first derivative of the net effective mass has a maximum value, the plasma frequency shifts from microwave to infrared. As a result, it is proposed that the Schwarzian derivative is a convenient mathematical method for precise prediction of chaotic points and transitions in superconducting systems.

Keywords: Mercury based superconductor, Nonlinear behavior of the superconducting system, Schwarzian Derivative, Quantum chaotic transition.

1. INTRODUCTION

The superconductivity possesses some nonlinear quantum properties such as magnetic flux quantization, Josephson Effect, solitonic behavior of the system, electron-phonon interaction (occurrence of Cooper pairs), quantum chaotic transitions, effective mass of quasi-particles etc [1-6]. The nonlinear quantum properties of the mercury based layered superconductors were investigated by Z.Güven Özdemir from our research group via Schwarzian derivative [1] in the context of two chaotic transitions; the critical transition temperature, T_c and paramagnetic Meissner transition temperature, T_{PME} which are determined from magnetic moment versus temperature data [2,7,8]. Moreover, it was proved by Z.Güven Özdemir for the first time that the Schwarzian derivative method, which was mathematically used in order to determine the chaotic points of the Hg-based cuprates, is a suitable mathematical model in order to predict the chaotic transition points in non-linear superconducting systems, precisely [1].

In this study, the third chaotic transition, which cannot be observed on the magnetic moment versus temperature graphic, was investigated. The net effective mass equation of the quasi-particles (Cooper pairs or electron pairs) of the mercury based superconducting sample calculated by Ongüas Equation has a crucial step in order to determine third chaotic transition point of the sample. At the third chaotic transition called T_{QG}, a special quantum gravitational transition appears where the plasma frequency, f_p of the Hg-based cuprate shifts from microwave to infrared region at superconducting state [9-11]. As is known, when an object enters a gravitational field, its mass decreases [12]. From this point of view, at the vicinity of T_{QG}, the first derivation of the net effective mass of the electron pairs, which has a maximum value in negative region, is important for the superconducting system where some symmetry breakings accompany the quantum chaotic transitions [11]. Hence, the study is devoted to the mathematical treatment of the third quantum chaotic transition by means of negative values of the Schwarzian derivative in order to show chaotic behavior of the mercury based nonlinear superconducting system.

2. $HgBa_2Ca_2Cu_3O_{8+x}$ SUPERCONDUCTOR and EFFECTIVE MASS of QUASI-PARTICLES

Mercury cuprates exhibit the highest critical parameters such as the critical transition temperature, high critical magnetic fields and critical current density values among

the other high temperature superconducting materials. Due to these special features of the bulk superconducting $HgBa_2Ca_2Cu_3O_{8+x}$ (Hg-1223) samples, the preparation methods such as oxygen annealing procedures and the determination of magnetic and electrodynamics properties the superconducting sample such as the plasma frequency, anisotropy factor and Josephson penetration depth have importance for not only theoretical investigations, but also technological applications. In order to obtain electrodynamics parameters mentioned, the grain size of the superconductor, t and the average spacing of copper oxide bilayers, d, which are in nano or micrometer scale, are required to be measured. The average spacing of CuO_2 layers, d is shown in the primitive cell of the Hg-cuprates shown in Figure 1a [13-17].

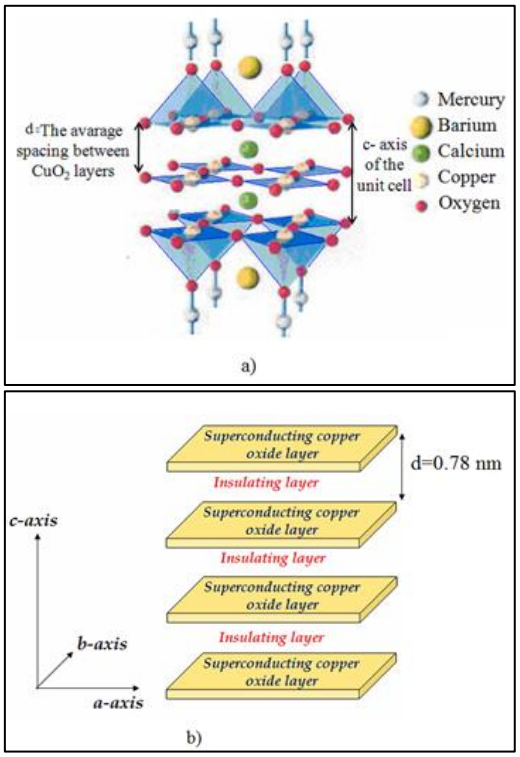


Figure 1. (a)The primitive cell of Hg-based cuprate. (b)The schematic presentation of the intrinsic Josephson structure (IJJ).

The primitive cell of the Hg-based CuO_2 layered superconducting sample contains three superconducting copper oxide planes that are separated by insulating layers of the distance of 0.78 nm and the primitive cell of the sample is considered as an intrinsic Josephson junction (IJJ) array (Figure 1b) [13-17]. In other words, the primitive cell of the superconducting sample, which has the lattice parameters within $a=b=3.8684$ Å and $c=15.7152$ Å, displays superconducting properties in nano structure. Moreover, the intrinsic Josephson junction including superconducting-insulating-superconducting layers is considered as nano-capacitor. Furthermore, it was shown that the micro-whiskers in the mercury based samples was spontaneously grown for the over oxygen annealed sample [15]. Hence, the sample investigated has a promising potential for nano-electronic devices, the high frequency applications and new electronic inventions. As a result, the superconducting sample investigated in the study, which displays nonlinear quantum properties in nano and micro dimensions, has some advanced technological application properties.

The high temperature superconducting structure is totally characterized by the same superconducting order parameter ψ (i.e.wave function). As is known, the only variable of the order parameter is the phase difference, φ. The calculation procedure of the net effective mass, m^* of electron pairs of the Hg-1223 sample is established by invoking an advanced analogy between the supercurrent density J_s and the third derivative of the phase of the quantum wave function of the superconducting relativistic system. The derivation method of the net effective mass equation is given in details in references [9-11].

The net effective mass equation of the electron pairs of Hg-cuprates called as Ongüas Equation, is given in Equation (1) [9,11,18],

$$\frac{1}{\varphi_0 m^*} = \frac{dJ_s}{dx} = \frac{c\phi_o}{8\pi^2 d}\left[-\frac{1}{\lambda_j}\right]^3 exp\left[-\frac{x}{\lambda_j}\right] \qquad (1)$$

where λ_j, c, ϕ_o, d and φ_o are the Josephson penetration depth, the speed of light, the magnetic flux quantum, the average distance between the CuO_2 layers and the phase value at $x=0$ in the Josephson junction, respectively. In order to investigate the temperature dependence of the net effective mass, the distance parameter, x in Equation (1) has been chosen as 0.3 μm which is smaller than the lowest λ_J values for both the optimally and over oxygen doped samples.

In the study, the parameter x in Equation (1), which is selected within the Josephson penetration depth, is taken as the constant value for every temperature range for both samples. Hence, the only variation of the superconducting systems is temperature. The net effective mass versus temperature graphics for the optimally and over doped samples obtained by the Ongüas equation are illustrated in Figure 2a and b, respectively.

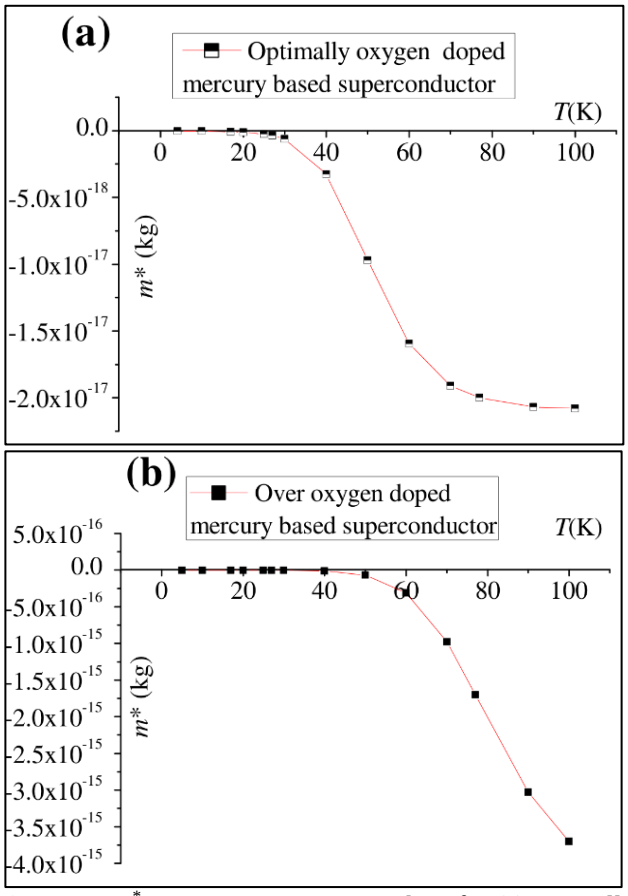


Figure 2. m^* versus temperature graphics for (a) optimally and (b) over oxygen doped samples.

Hg-based cuprates have hole-type of conductivity. Hence, the negative sign of m^* verify the hole-type conductivity in the Hg-based samples. The other explanation is that the negative net effective mass values can be interpreted as the formation of an anti-gravitational force which has the reverse sign to the gravitational field of the Earth [9,11]. The mass of an object is variable in a gravitational field [12]. Therefore the third quantum critical transition phenomenon of the superconducting system is identified from the first derivative m^* to temperature.

In the study, the third quantum critical transition temperature region for the superconducting samples, where f_p shifts from microwave to infrared in the electromagnetic spectrum [13,14,16,19] (Table 1) that corresponds to quantum gravitational phenomenon is studied. The superconducting system has constant entropy hence the temperature is the only variable. In superconducting system, temperature variation can be considered as time variation. Hence the quantum gravitational effect, which is observed by the variation of temperature, is consistent with the El Naschie's quantum gravity. According to El Naschie's quantum gravity, the gravitational field slows down time flowing. It is also true that the changing the speed of the passing time (or temperature) can create a gravitational effect [20]. Due to this reason, the derivatives with respect to temperature can be considered as the derivatives with respect to time. At the vicinity of T_{QG}, the first derivation of the net effective mass to the temperature, $(dm^*)/dt$ for the various oxygen doped samples, which has also the maximum value in negative region, is considered as an indicator of the intrinsic gravitational field of the superconducting sample investigated. In the study, the maximum value of the $(dm^*)/dt$ is called as the super critical temperature, T_{sc}. The phenomenon of the quantum gravitational effect appears at the temperature interval between 25-77 K for optimally and over doped samples [9,11,13,16].

Table 1. f_p values for (a) optimally and (b) over oxygen-doped Hg-1223 superconductors.

(a)

$T(K)$	$f_p(Hz)$
4.2	8.303×10^{13}
27	3.363×10^{13}
77	8.303×10^{12}

(b)

$T(K)$	$f_p(Hz)$
5	3.295×10^{13}
17	2.175×10^{13}
25	1.981×10^{13}
77	1.866×10^{12}
90	1.537×10^{12}

3. THE SCHWARZIAN DERIVATIVE of THE THIRD CHAOTIC TRANSITION

In order to investigate the chaotic behaviors of the systems, the most convenient mathematical method is the derivative process. Schwarzian derivative method is utilized to find a sufficient condition for the chaotic transitions of nonlinear dynamical systems. The Schwarzian derivative $Sf(x)$ of a locally univalent analytic function f at point x, is defined by

$$Sf(x)=\left(\frac{f''(x)}{f'(x)}\right)'-\frac{1}{2}\left(\frac{f''(x)}{f'(x)}\right)^2 \qquad (2)$$

where $f(x)$ is a function with one variable, $f'(x)$ and $f''(x)$ are first and second continuous derivatives of the equation, respectively. The Schwarzian derivative of a function, which is used for the limiting the behavior of dynamical systems, has a negative when the system behaves chaotically [21-24]. In order to investigate the chaotic behavior in Hg-cuprate layered superconductors, the Schwarzian derivative of the m^* of Hg-cuprate superconductors are calculated the equation given below,

$$S\left[m^*(T)\right]=\frac{(m^*)'''(T)}{(m^*)'(T)}-\frac{3}{2}\left(\frac{(m^*)''(T)}{(m^*)'(T)}\right)^2 \quad (3)$$

where $(m^*)'(T)$, $(m^*)''(T)$ and $(m^*)'''(T)$ represent the first, second and third order derivatives of m^* with respect to temperature, respectively. The variations of the related derivatives with temperature for the optimally and over doped samples are given in Figure 3a and b.

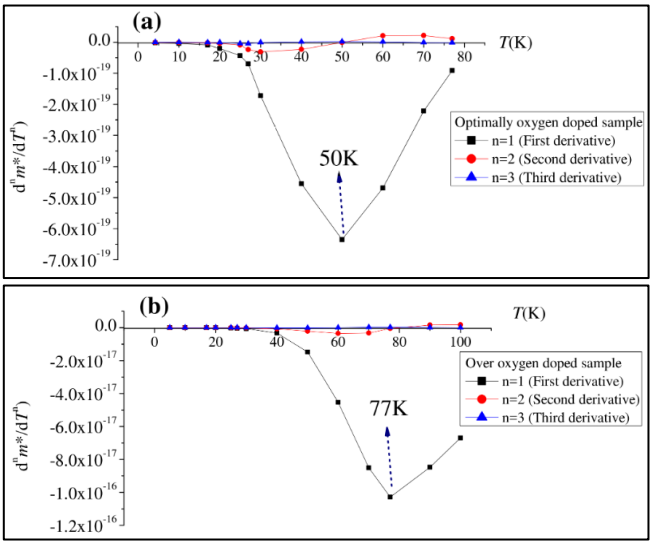
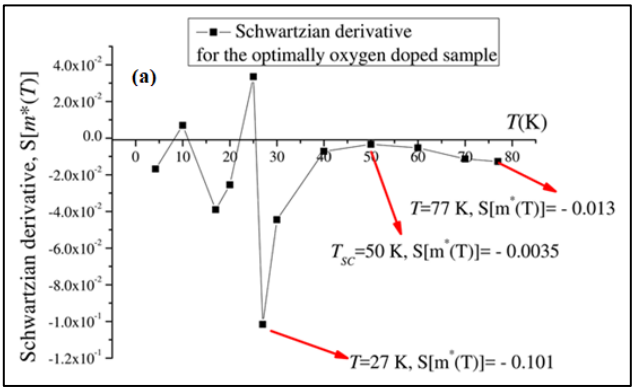


Figure 3. The variation of the first, second and third-order derivatives of m^* to temperature for (a) the optimally and (b) over oxygen doped samples.

The first, second and third order derivatives components of the m^* are taken in order to calculate $S\left[m^*(T)\right]$. The Schwarzian derivatives of the net effective mass of the optimally and over oxygen doped samples are shown Figure 4a and b, respectively.



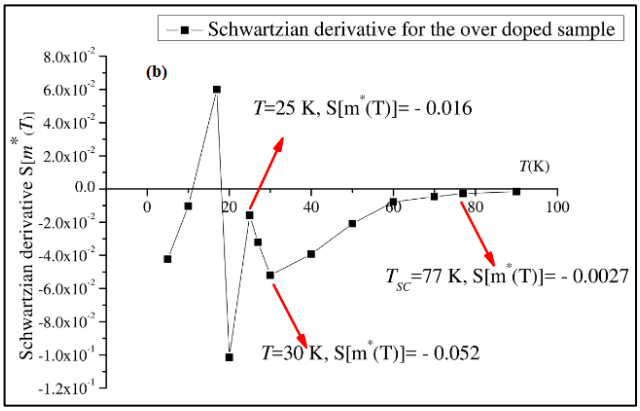


Figure 4. The Schwarzian derivative of m^* for (a) the optimally and (b) over oxygen doped samples

4. DISCUSSION

In the work, the Schwarzian derivative method is used for predicting the chaotic behavior mathematically in the mercury based high temperature nonlinear superconducting system for determining the third chaotic point. The third chaotic point called the quantum gravitational transition temperature, T_{QG}, where the quantum gravitational field appears, manifest itself as the maximum of negativity in the Schwarzian derivatives of the net effective mass-temperature data for both the optimally and over doped samples between 25-77 K temperature range. As shown in Figures 4a and b, the negative tendency of Schwarzian derivative at T_{SC}, at which the first derivatives of m^* for various oxygen doped samples have also maximum negative value, goes on the temperature interval of the third chaotic point, T_{QG} that locates at the temperature interval of 25-77 K. The phenomenon of the third chaotic transition temperature, T_{QG} is coincided to the fact that when a particle enters a gravitational field, its mass decreases [12]. Moreover, it was determined that Schwarzian derivative values at T_{SC} for both optimum and over doped samples have negative values, which corresponds to -0.0035 and -0.0027, respectively (Figure 4a and b). As is seen in Figure 5, the Schwarzian derivative has same values for both samples at some temperatures.

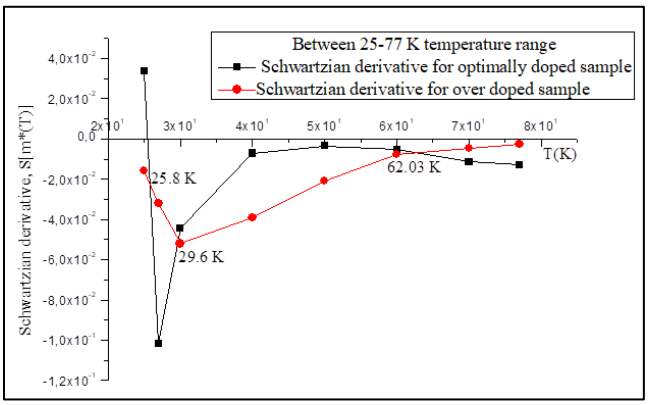


Figure 5. Schwarzian derivative for optimally and over doped samples between 25-77 K temperature interval.

According to Table 1, the various doped samples behave as microwave cavity. By lowering the temperature from 77 K to 25 K, it starts to emit infrared region. After the shifting to infrared region, the third chaotic transition is completed for both samples (Figure 4a and 4b). Moreover, it is understood that the oxygen doping does not the effect of the existence of the quantum gravitational field and also the chaotic transition of the system, that is proved by negative Schwarzian derivative peaks but it lowers the super critical temperature, T_{sc}.

5. CONCLUSION

The superconducting order parameter, of the superconducting system that totally represents the system, is utilized to derive m^* of the superconducting system. By recalling the phase difference of the wave function which is the only variable of the system, m^* of the mercury based superconductor is established by using an advanced analogy between the supercurrent density and third derivative of the phase of the quantum wave function of the superconducting system to temperature. Ultimately, Onguas Equation (Equation 1) gives the relationship between m^* and the phase of the superconducting state. As is known, the mass of object decreases in a gravitational field. Hence, the existence of the gravitational field, i.e. the third transition temperature T_{QG} is determined by means of the variation of the effective mass of the quasi-particles. As a result of the mathematical study, it is proposed that the negative Schwarzian derivative of m^* is a convenient mathematical method for precise prediction of chaotic transitions in nonlinear superconducting condensed matter systems as well. Hence, the Schwarzian method used in the study, which explains chaotic properties of the nonlinear superconducting system, is consistent with the fundamentals of superconductivity.

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A New Arabic Coding Scheme

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Abstract: In this paper, we designed a new Arabic letter encoding scheme based on the characteristics of the Arabic language to solve many Arabic coding problems, especially those related to formulation problems. In the proposed coding scheme, we were able to represent the Arabic letter and its accent marks using one byte instead of two, thus, the size of the Arabic text was reduced in half. The suggested coding scheme can be used as a bilingual coding scheme instead of ASCII in an Arabic platform environment or as a text compression scheme.

Keywords: ASCII, Coding scheme, represents letters, compression scheme, and Arabic text compression.

1. INTRODUCTION

The most important difficulties faced by the developers of these technologies are the lack of technical academic research related to Arabic, which is why they simulate applications based on European languages with the representation of an Arabic craftsman. Although this simulation may succeed in solving one aspect of the Arabic language, it fails to build a complete processing system for it. The formation itself is one of the outstanding problems so far because the solutions used to process The Arabic language are linked to solutions based mainly on languages that are devoid of composition [1]. The current treatment of The Arabic language considers the movement to be an object in itself and can only be dealt with as part of the letters of the word, but dealing with the language without formation is a treatment that lacks perfection and is not without ambiguity in understanding and here it should be noted that the correct and complete treatment of the Arabic language must be delayed Considering the composition as a prerequisite in understanding the Arabic language, i.e. the introduction of Arabic texts or the construction of processes to form texts subjectively, such programs exist, but they are still inaccurate and cannot be relied upon in practical applications. Machine translation to and from The Arabic language is one of the most complex tasks that can be faced by those working in the field of developing Arabic language techniques and accessing practical solutions in this field is one of the very vital images of the user and Arab companies, especially the presence of the Internet and the huge content of information available in it. In multiple languages, some hasty solutions have emerged in the field of translation, but they have not succeeded and developed because they are not relying on in-depth research in linguistics, it is nothing more than an improved version of electronic dictionaries [2]. In this research, our study focused on finding an appropriate way to represent Arabic letters and their composition by returning to the basis of the Arabic language and its written letters in the past before drip and formation and we reached record results that serve the field of application of computer technologies and contribute to reducing the volume of Arabic information and data Stored and transferred as an introduction to trying to develop correct processing of Arabic language computer [3].

2. BACKGROUND THEATRICAL

2.1. Encoding

Encoding is that the way toward changing over information into an organization required for a few data preparing needs, including:

- Program assembling and execution
- Data transmission, stockpiling, and pressure/decompression
- Application information preparing, as an example, record change

Encoding can have two implications:

- In PC innovation, encoding is the way toward applying a specific code, for example, letters, images, and numbers, to information for transformation into a comparable figure.
- In gadgets, encoding alludes to simple to computerized

transformation [4].

Encoding incorporates the usage of a code to vary remarkable data into a structure that can be used by an outside technique. The sort of code used for changing over characters is known as the American Standard Code for Data Trade (ASCII), the most consistently used encoding plan for records that contain content. ASCII contains printable and nonprintable characters that address promoted and lowercase letters, pictures, diacritics checks, and numbers. An unprecedented number is given bent specific characters [5].

2.2. Unicode Encoding Model

There are a few frameworks used to coded data and dialects. Follows are the four degrees of the Unicode Character Encoding Model can be summed up as:

- ACR: Abstract Character Repertoire, the arrangement of characters to be encoded, for instance, some letters in order or image set
- CCS: Coded Character Set planning from a theoretical character collection to a lot of nonnegative numbers
- CEF: Character Encoding Form planning from a lot of nonnegative numbers that are components of a CCS to a lot of successions of specific code units of some predetermined width, for example, 32-cycle whole numbers
- CES: Character Encoding Scheme a reversible change from a lot of successions of code units (from at least one CEFs to a serialized arrangement of bytes). [6]

Notwithstanding the four individual levels, there are two other valuable ideas:

- CM: Character Map planning from arrangements of individuals from a theoretical character collection to serialized groupings of bytes crossing over every one of the four levels in a solitary activity
- TES: Transfer-Encoding Syntax a reversible change of encoded information, which could contain printed information

The IAB model, as characterized in [RFC 2130], recognizes three levels: Coded Character Set (CCS), Character Encoding Scheme (CES), and Transfer-Encoding Syntax (TES). Nonetheless, four levels should be characterized to sufficiently cover the qualifications required for the Unicode character encoding model. One of these, the Abstract Character Repertoire, is verifiable in the IAB model. The Unicode model likewise gives the TES a different status outside the model, while including an extra level between the CCS and the CES [7].

3. ARABIC STANDARD SPECIFICATIONS

In 1981, the Arab Organization for Standards and Standards, which was partnered with the Arab League and situated in Jordan, shaped an advisory group to decide the Arabic norm for Arabic letters in the field of data. A progression of these details was given from 1981, most as of late in November 1986, when the association endorsed the standard determinations (ASMO 708) for the trading of data on the PC in eight twofold numbers and recorded around the world under the number (ISO/8895-6). In this particular, it contains 120 characters, in addition to the eight balance devices, which are in progression: you plan to open, at that point you mean to add, at that point you expect to break, and afterward the opening, the join, the division, the force, the stillness [8]. The Arabic numbers in the (ASMO 708) English numerals involved similar English numbers. This determination is described by [9]:

- The presence of a location for each of the 28 characters.
- The presence of six sites of al-Hamza in different forms أ إ ؤ ئ آ
- Having a tethered t-site and another for a thousand cabins.
- The presence of eight formation sites isًٌٍَُِّْ in the order shown.
- The existence of the hiving in the ASCII table position between the connected letters.

As this standard is over 30 years late for the presentation of Arabic in PCs, PC makers have built up their particulars, making it hard for them to fix them in light of the significant expenses. Along these lines, a few arrangements of character frameworks kept on existing, contingent upon the PC producers. In as per the standard 708, a few Arab bunches were given, incorporating Arab Window Collections in Bahrain, Sakher in Saudi Arabia, IBM, and Microsoft Americas. The last gathering started to spread more than others after the oppression of windows and it is expected that it will stay prevailing, overpowering, and dropped in all or most different structures. It is noted among the restriction frameworks that the topic of the request for letters in order relies upon the gathering utilized, since every one of these sums has believed the synthesis to be letters, so the request for letters at the composing is viewed as the creation of a letter to be considered in the request. It brings about the gathering itself deciding the request technique. On the off chance that the letters are dissipated in the gathering table, the request will be dangerous, particularly if the character is taken as the letter as per its area in the table, as in the gathering number 864 for I.B.M. The areas of the uncommon letters (ء, ة, ى, –) all fluctuate from gathering to gathering, creating an alternate request when utilizing one and changing to the next [9].

4. REPRESENTATION OF ARABIC LETTERS

Before utilizing accentuations, the Arabic letter set contains 15 letters, four of them having single articulate, nine having two articulates, and 2 having three articulates for each the complete is 28 in the wake of utilizing diacritics to utilize each character with solitary elocution.

Four pieces are expected to speak to 16 letters (15 unique letters in addition to space). To achieve this, we separated the letters into two gatherings: the first letters and the inferred letters by adding accentuation to the first letters (and the assignment dependent on the strategy for drawing the letter) as appeared in Table No. 1.

Table 1. The original and derived letters

Original	Derived	Original	Derived	Original	Derived
الألف		ر	ز	ف	ق
ب	ي	س	ش	ل	ك
ن	ت، ث	ص	ض	م	
ح	ج، خ	ط	ظ	هـ	
د	ذ	ع	غ	و	

From Table 1, it very well may be noticed that there are letters that don't have a subsidiary and letters with more than one subordinate, for example, 'هـ' and 'ن'. To make the subordinate is just one for "ح" and "ن", the second subsidiary of "ن" is to be moved, and the second subsidiary for "ح", which is "خ" moved to the area in the table that relates to the first letters with no subsidiary. The quantity of passages in Table 1 is fifteen sections and it is very adequate to speak to the first letters utilizing four pairs, however, there is a letter that must be remembered for the portrayal on account of its essence in the content and it is a void and it needs to discharge one of the passages of Table No. 3.2 for example move one of the first letters and make it a subordinate of another unique letter This case is relative exactly "ء", which can be viewed as gotten from the letter "أ", and there is the letter "ة", included as inferred for the letter "هـ" and the outcome can be appeared in Figure No. 2.

Table 2. Original and Derivative Arabic Letters

Original	Derivative	Original	Derivative	Original	Derivative
ا	ء	ر	ز	ف	ق
ب	ي	س	ش	ل	ك
ن	ت	ص	ض	م	ث
ح	ج	ط	ظ	هـ	ة
د	ذ	ع	غ	و	خ

Table 3. Quartet representation of original

Char.	Rep.	Char.	Rep.	Char.	Rep.	Char.	Rep.
ا	0000	د	0100	ط	1000	م	1100
ب	0001	ر	0101	ع	1001	هـ	1101
ن	0010	س	0110	ف	1010	و	1110
ح	0011	ص	0111	ل	1011	Space	1111

The original letters in Table 3 can be represented using four bits as shown in Table 4.

Table 4. Quintet representation of the letters of the Arabic language

B_0							
1	0	Line		B_1	B_2	B_3	B_4
ء	ا	16	0	0	0	0	0
ي	ب	17	1	0	0	0	1
ت	ن	18	2	0	0	1	0
ج	ح	19	3	0	0	1	1
ذ	د	20	4	0	1	0	0
ز	ر	21	5	0	1	0	1
ش	س	22	6	0	1	1	0
ض	ص	23	7	0	1	1	1
ظ	ط	24	8	0	0	0	0
غ	ع	25	9	1	0	0	1
ق	ف	26	10	1	0	1	0
ك	ل	27	11	1	0	1	1
ث	م	28	12	1	1	0	0
ة	هـ	29	13	1	1	0	1
خ	و	30	14	1	1	1	0
chng	space	31	15	1	1	1	1

To plan a right portrayal for non-diacritic Arabic letters, a fifth paired piece is included with an estimation of (0) if the letter is unique and (1) if the letter is a subordinate, for instance (00011) speaks to the character "**ح**" and (10011) speaks to the character "**ج**" and (01101) speaks precisely **"هـ"** (**11101**) speaks exactly "**ة**", etc for the remainder of the letters in Table 4. For operational necessities, the image (11111) is viewed as the image for changing to ASCII portrayals (it will be clarified later), and space is spoken to

by (01111). The quintet is an adequate portrayal for all Arabic letters as appeared in Figure 5. Arabic letters contain two gatherings: the associated and the isolated letters as per the detailing and the spelling decides that rely now and then upon the diacritics character (will be clarified later), the supervisor program will draw the letters on the screen or the paper with its appropriate structure contingent upon the definition and spelling rules. At this point, non-diacritic Arabic letters are spoken to by five pieces rather than the eight-bit portrayal presently being used, accordingly, three pieces are decreased [10][8].

5. REPRESENTATION OF THE DIACRITICS CHARACTERS

To speak to the diacritics in the Arabic language, we have seen that the diacritics incorporate Sokon, Fatha, Dhama, Kasrah, and Tanween each of the past, which are four diacritics notwithstanding the Tanween and Shaddah, and we isolated the arrangement into two unique and inferred gatherings, given that the Tanween of every diacritic as appeared in Table 5.

Table 5. The original and derived from movements

Original	Diacritics shape	Derivative
Sokon	**Non-diacritic**	◌ْ
Fatha	◌َ	◌ً
Dhema	◌ُ	◌ٌ
Kasrah	◌ِ	◌ٍ

In Table 3.6 we put the Sokon as unique diacritics with no subsidiary. In the Arabic language, there are letters without diacritics characters that are written in words to show the possibility of more than one potential diacritic character, so we have to start a no-diacritics character in the table which must be a default diacritics character. To speak to such a case, we will consider that Sokon is diacritics gotten from "no-diacritics ". Similarly, as in the past passage, we will add three pieces to speak to the diacritics character as appeared in Table 6.

Table 6. Representation of diacritics characters

Diacritic	Representation	Diacritic	Representation
No diacritics	**000**	**Sokon**	**100**
Fatha	**001**	**Tanween Alfatha**	**101**
Dhema	**010**	**Tanween Aldham**	**110**
Kasrah	**011**	**Tanween Alkasar**	**111**

In Arabic letters, there is another diacritics character called "shadda" (ّ) utilized if a word contains a rehashed character therefore, furnished that the primary letter is with Sokon diacritic, shadda is wiped out in the proposed portrayal.

Here it ought to be noticed that the letter (ا) is without a diacritic and the letter (آ) is a similar letter with Sokon diacritic and the letter (آ) can be composed as twofold "ا" without a diacritic, while 'ى' is composed 'ا' with "ٰ diacritic. The letter "ء" has four different structures composed by the spelling decides that rely upon diacritics character go before or followed, they are (أ, إ, ؤ, ئـ). In this way, we had the option to speak to the Arabic letter and its diacritics utilizing one byte rather than two, and in like manner, the size of the Arabic writings was diminished into half. Table 6, shows the portrayals of the test of two distinct letters followed by every single imaginable diacritic.

6. ARABIC LETTERING PROGRAM

From the foregoing, it is clear that we have allocated a storage value for each of the Arabic letters, and the truth is that the letters stored in the computer storage do not resemble the letters on the screen or on the printer, and the truth of this difference is from the way letters are written within Arabic texts because most Arabic letters are not written in one form within the words but rather most letters have more forms that differ according to their position in the word.

Table 7. "ص" and "ك", with diacritic representations

Character	8-bit coding	Decimal value	Note
ص	00000111	7	Without diacritics
صَ	00100111	39	7+32
صُ	01000111	71	7+64
صِ	01100111	103	7+96
صْ	10000111	135	7+128
صً	10100111	167	39+128
صٌ	11000111	199	71+128
صٍ	11100111	231	103+128
ك	00011011	27	Without diacritics
كَ	00111011	59	27+32
كُ	01011011	91	27+64
كِ	01111011	123	27+96
كْ	10011011	155	27+128
كً	10111011	187	59+128
كٌ	11011011	219	91+128
كٍ	11111011	251	123+128

In general, each letter has three forms, which are: at the beginning of the word (frontal), at the end of the word (final), and in the middle of the word (middle). In addition, the letters of the Arabic language are divided into three groups as shown in table 8, they are:

1. 8 letters have the same form in the three positions they are: (ا,د,ذ,ر,ز,و,ط,ظ.)
2. 17 letters have the same form in frontal and middle and differ from the final position; they are (س, ش, ص, ض, ب, ت, ث, ن, ي, ح, ج, خ, ف, ق, ك, ل, م).
3. 3 letters have different form in each position they are (ع غ, هـ).

The first group is considered as the separated letters, while the second and the third groups are the connected letters which written connected to the previous or next letter or connected with both.

Table 8. Forms of Arabic letters

Arabic character	frontal	middle	final
ا,د,ذ,ر,ز,و,ط,ظ	ا,د, ذ, ر, ز,و,ط,ظ	ا,د, ذ, ر, ز,و,ط,ظ	ا,د, ذ, ر, ز,و,ط,ظ
ب, ت, ث, ن, ي, ح, ج, خ س, ش, ص, ض ف, ق, ك, ل, م	بـ,تـ, ثـ, نـ, يـ, حـ, جـ, خـ سـ, شـ, صـ, ضـ فـ, قـ, كـ, لـ,مـ	بـ, تـ,ثـ, نـ,يـ, حـ, جـ, خـ سـ, شـ, صـ, ضـ فـ, قـ, كـ, لـ,مـ	ب, ت, ث, ن, ي, ح, ج, خ س, ش, ص, ض ف, ق, ك, ل, م
ع, غ, هـ	عـ, غـ, هـ	عـ, غـ, هـ	ع,غ or غ ه or هـ

8. CHNG CODE

We have agreed according to the above to name the letter which represents (11111) as the change code (chng) as it appears in Table No. 8. The Arabic text maybe contains any other characters or symbols or numbers which are not an Arabic letters or diacritics and can be represented by ASCII table provided that each must be preceded by chng code.

9. GENERAL STRUCTURE OF THE CODING AND ENCODING ALGORITHM

The fundamental structure of the coding calculation is portrayed in Figures 1, 2 which clarify the flowchart of the proposed coding and encoding calculation individually. The application utilizes the Arabic letter set as a string called letter set = 'ابنحدرسصطعفلمهو ءيتجذزشضظغقكثةخ', which is requested in exceptional succession proposed beforehand in this proposition. The Arabic language is correctly supported; hence, the most right letter is in position 1, etc the last letter is the most left character. The diacritics characters are put away in the string variable called diacritic="ً ٌ ٍ َ ُ ِ ّ ْ" in the coding program. The calculation gives two choices: coding and encoding. The coding method chip away at blending the Arabic letter with its diacritic code in a solitary portrayal code, while the encoding methodology is used to isolate them for composing. Python 3.8.5 is utilized to construct the coding and encoding calculations.

Algorithm 1, Algorithm 2 depicted the essential steps to perform the coding and encoding algorithms.

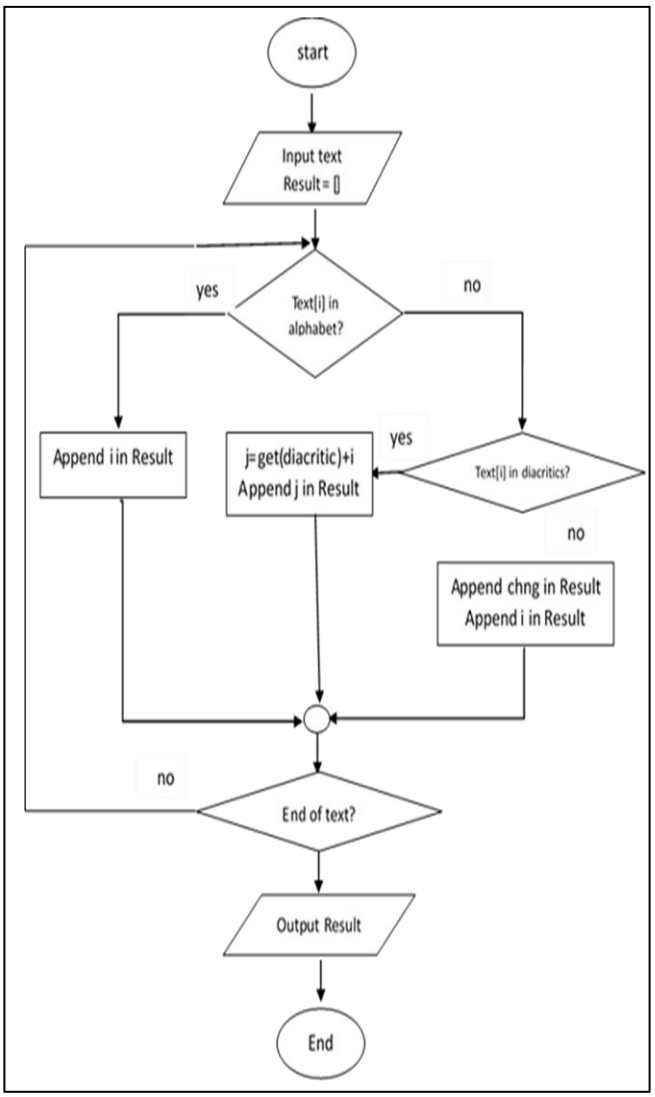

Figure 1. Flow chart of the Coding algorithm

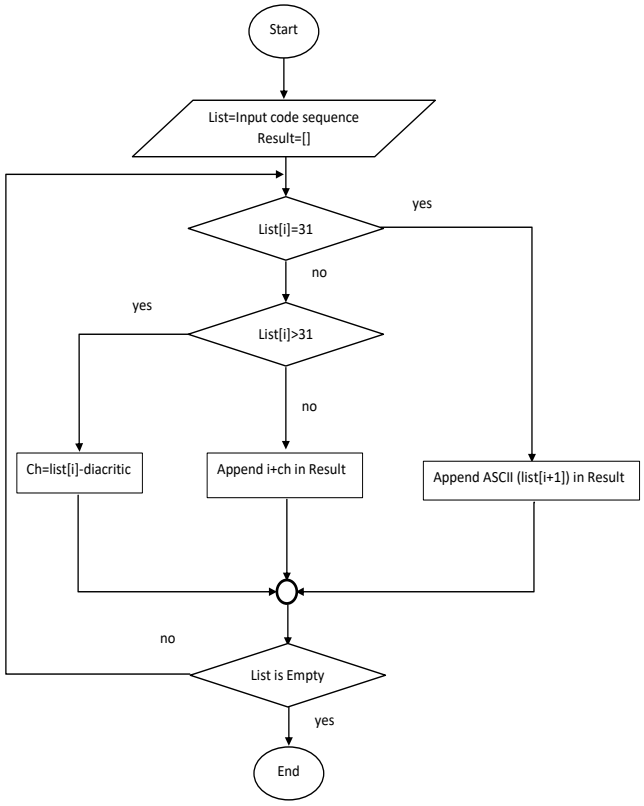

Figure 2: flow chart of the Encoding algorithm

10. EXPERIMENTAL RESULTS ANALYSIS

The principal objective of planning and building Arabic letters encoding plan is to utilize a strategy gotten from understanding the letter and diacritics in the Arabic language to locate a reasonable portrayal of the Arabic letter and its diacritic, and we have come to make a portrayal of the character and its diacritics in the size of one byte, while they were spoken to by the size of two bytes. In this manner, we got a pressure proportion identical to 50 percent. While, if Arabic writings were utilized without diacritics, the content would not be compacted. Table No. 9 demonstrating the pressure proportion for four records with a similar book, the main document has a 100% diacritical extent and the subsequent record contains a similar book, however at a proportion of 60% of diacritics the third record contains similar content at a proportion of 30% of diacritics and the fourth document contains similar content without diacritics.

Table 9. Encoding Results

Arabic Text File	Original File Size (KB)	Encoded File Size (KB)	Compression Percentage
File1.txt	10.0KB	3.4KB	66%
File2.txt	8.28KB	3.3KB	61%
File3.txt	5.69KB	3.2KB	44%

11. CONCLUSION

In this article, we have intended to develop a new compact and basic encoding system to represent the Arabic letters as an alternative to the ASCII system in an Arab operating environment, which is an important and basic part of the line of embarking on building Arabic operating environments (systems) and its application needs to alter the currently used keyboard or design a new model It fits with the new acting. Without that, the new representation system could be used in other applications such as a parsing system or a text compression system.

One of the most contributions of this article is to build a representation based on a deep understanding of the Arabic language and not as it was in the past, where the Arabic letters were represented in a similar way to represent the Latin language.

The second contribution of this article is in the field of data compression, we creating a compressed representation of at least 66%.

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