Using GIS technology for land suitability analysis to select drainage project location: Nasiriya city south of Iraq as a case study

Haidar Razzaq Mohammed¹, Hayder A Alkanaani², Humam K Alowaid³
¹Civil Engineering Department, University of Technology, Baghdad, Iraq
²Surveying Department, Institute of Technology, Middle Technical University, Baghdad, Iraq.
³Deanship, Institute of Technology, Middle Technical University, Baghdad, Iraq.

Abstract. The main aim of this paper is to produce a theoretical basis for the selection of drainage project location by using the GIS technology. Nasiriya city that located in the southern part of Iraq has been selected as a case study. The site must be ideally chosen where it must be subjected to specified standards. The model of a suitable site was constructed utilizing a model developer in ArcGIS. It was assembled dependent on the spatial system which is known as the weighted linear combination. The final suitable maps were produced by coordinating different models. In this work, the feature of exactness in the determination of the most fitting site for the foundation of the drainage venture, which is viewed as one of most significant elements that lead to extend the arable area. Thus process should be the basic leadership for the choice of the most appropriate site as indicated by strict procedures and consistent choice. The outcomes result from the procedure suggested that six areas were chosen according to indicated factors. The scores were depended on experts and literature. The Locations were determined in the examination zone by embracing the GIS incorporated Analytic Hierarchy Process. The most suitable areas among them for the development of drainage venture serving the rural regions as indicated by spatial analysis were picked dependent on the characteristics of the proposed area. The proposed location no 3 was the best of them where it fulfils all factors firmly. Unsustainable administration prompts a horrible impact on arable area and results in the loss of the appropriate strategy. The mistake in the choice of the most reasonable site for the venture not only lead to pressure on the system but also a collapse in the water system framework of the agricultural reality of the country.

Keywords: Drainage System, Geomatics, Urban Planning.

1. Introduction
One of the most important challenges is to extend food production in a very property manner so it will feed the world's population that is growing apace [1]. World increment and production, combined with unsustainable consumption patterns, adding plenty of pressure to land, water and different basic resources is employed for common fraction of all the water within the world in the field of irrigation, it's obtained four-hundredth of the entire agricultural production from irrigated areas. Unsustainable management and inadequate irrigation comes result in poor performance of irrigation projects. financial condition correct style and lack of exactness within the choice the foremost applicable web site for the network of voidance and hydraulic structures designed on network construction, operation and maintenance are shortcomings that result in weakness within the performance of avoidance systems [2].

The study area situated in Nasiriya city. Figure 1 represents boundaries of the study area that wealthy by totally different crops. Agricultural watersheds are typically drained by agricultural drain systems that are designed to permit straightforward transport of water from land and profit agriculture and agricultural yield because of the reduced level of water within the fields [3]. It should be simply accessible in irrigation management info that helps the supervisor and is characterised most irrigation-related information geographically. The utilization of geographic information systems are of very
important within the creation of databases for irrigation systems so as to be simply, redundant
information may be accessed and no data ought to be collected and recorded in an exceedingly
systematic manner and mutualist. Most of the irrigation areas have giant maps cover the walls of
lobbies and boardrooms. Generally, these maps showing the borders of constituencies and therefore
the encompassing areas. In several cases, pens are accustomed talk over with the distribution system
and within the maps full of written notes remodelled the years. In developed countries; drainage may
be an extensive water management tool. However, in most developing countries, agricultural
productivity and development have nonetheless to achieve the brink level at that evacuation becomes a
viable investment. Various factors such as: the absence of knowledge among framers and policy
makers, institutional deficiencies, and non- valuable government strategies. Conjointly explain a
portion of the distinction in progress between developed and developing countries inside the condition
of evacuation [4]. Though the geographical data system software system package will produce helpful
and vibrant maps and geographic info systems is quite simply a map. We will almost certainly utilize
GIS in an exceedingly sort of capacities inside the administration of irrigation undertaking like
mapping, a device for database uprightness, and arranging/the board and geographical information
systems apparatus can be utilized in demonstrating device [5].

A geographic information framework is likewise critical in the administration of irrigation ventures
to draw layers, information passage, investigation and handling of the information and yield results
and reports. Drainage alludes to the procedure and practices used to expel overabundance water from
the soil surface and from the soil profile. The two general kinds of drainage practices are surface and
subsurface. Surface drainage is the expulsion of overabundance water from the soil surface.

The goal of this work is to apply of GIS in drainage venture for choice of the most reasonable
regions for the drainage project. The site must be ideally elected it must be less risk, near rural area.
Picking the best site for undertaking isn't a simple assignment to achieve. Investigation must think
about many related factors likewise, the truth of the study area, just as the plans of governments and
past involvement in this hard assignment. The area information of these tile channel systems are
restricted and the tile channel situation formats are perplexing, making location of subsurface systems
a significant instrument in evaluation of field hydrology and in understanding progression of water
through these farming areas [6].

The main objectives of the current study area:

a) To specify factors to enable us to select suitable sites for drainage project.
b) To produce GIS maps within the study area that will be used for analysis as a4 basis for
   strategic planning
   c) Finally, a selection of preferred locales was carried out.

2. Methods and materials

2.1. Thematic layers

Land-use and common vegetation data, surmised from satellite image, digital elevation model and
field work, may contribute significant hints for distinguishing between swampy and salted regions as
sort of noticeable harvest responses are characteristic of soil saltiness. Land-use data is additionally
important to gauge the advantages realistic if the seepage issues of the task region are tackled. For
recognizable proof purposes, accessible land-use information are commonly utilized. For this reason,
rancher cooperation is key. Remote detecting (RS) upheld by hands on work is a valuable device to
create new maps or to refresh existing ones.

Remote sensing and geomatics have promoted an expansion of studies that use AHP with spatial
information through GIS. The spatial data are the Digital Elevation Model (DEM),
Landuse/Landcover, dataset show streets systems, Villages and Landcover of study territory fit as a
shapefile. Water body and soil type: Dataset show water bodies, waterways and soil types in study
zone. Satellite Imagery LandSat8. Regarding Questionnaire they were surveyed through experts
looking over for determining scores of criteria, the indicators were chosen by Questionnaire and
literature review.
Figure 1. Study area
2.2. Selected factors related to drainage project
Factors were specified through expert's questionnaires and literature review. In this study, use of geomatics for the selection of the most appropriate site for drainage networks site, according to the following Factors:

I. Factor (Dr1): Topography of study area, explicitly, an uneven or slanting territory can be a test. Spill water system works commendably if the laterals can be continued running along topographic lines. Frameworks run times might be changed as per deflecting overflow. Voyagers and centre turn frameworks are guideline speaking outlandish on rough and genuinely slanting territory [7,8].

II. Factor (Dr2): Towns and urban areas must close to project [9].

III. Factor (Dr3): The slant of waterway area, the preferred land is flat [10].

IV. Factor (Dr4): Vicinity to arable zones that should be watered. Where these zones are considered as the key objective of any drainage system.

V. Factor (Dr5): Soils with a small or medium infiltration capacity [11].

VI. Factor (Dr6): rainfall, precipitation, lands with high-force rainfalls that surpass the ordinary penetration limit, so visit waterlogging happens on the dirt surface [10].

2.3. Model building
The model of appropriateness area was summed up by utilize a model builder in ArcGIS10.5. It was made dependent on weighted linear blend [12,13], in fact the heaviness of the corelative centrality determined individual factor and an all-out count, V (xi), is then led for every basis with increasing the weight by the scale an incentive for that factors. The last appropriateness maps were created by joining different datasets with variables through model. In view of AHP process the accompanying equation were utilized

\[ P.E = \lambda_{\text{max}}. E \]  

P The comparison matrix (n\times n), for n criteria, (The priority matrix).  
E Is the Eigenvector (n\times 1), (The priority vector).  
\lambda_{\text{max}} is the Eigenvalue

\[ CR = \frac{CI}{RI} \leq 0.1 \]  

Values for RI according to Saaty and Vargas [14]. (Tables 1 and 2)  
The consistency index CI can be straightforwardly figured from the matrix with  
\[ CI = (\lambda_{\text{max}} - n) / (n – 1) \]  
Saaty and Vargas [14] suggested a modification of the preference matrix if the consistency proportion CR surpasses an estimation of 0.1.

3. Results and discussion
Our current work looks at the extraction of tile drainage systems, taking into account the constraints and methodology of the data sets used. Understanding the optimum combination of data sets, together with the methodology used, provides a perspective and guidance for tile drainage detection. The whole study focuses on identifying the type of data used and the characteristic combination of methodology used. The focus for sewage disposal plan of action is to reduce groundwater levels in refined zones. Nonetheless, doing so may escalate definite local or territorial groundwater slope, and infiltration in the project area could also be expanded.
3.1. Application of GIS integrated analytic Hierarchy process

It is known that the list of consistency of the corresponding mutual matrix is randomly selected by a random index (RI) score. Ordinary RI values for custom matrices were generated from 1 to 15 with Example 100 [15]. The relation to the calculation is CR (consistency ratio). If the CR is less than 0.1 the specified weights can be used [16] formulas 2 and 3. Eight experts took part in the survey, and only two of these reactions were rejected due to conflicting correlations with more than 0.1 CR (Table 3 and Figure 2).

Table 1. Scale for pairwise comparisons

| Level                       | Value |
|-----------------------------|-------|
| Equally preferred           | 1     |
| Equally to moderately preferred | 2     |
| Moderately preferred        | 3     |
| Moderately to strong preferred | 4     |
| Strongly preferred          | 5     |
| Strongly to very strongly preferred | 6     |
| Very strongly preferred     | 7     |
| Very strongly to extremely preferred | 8     |
| Extremely preferred         | 9     |

Table 2. RI values

| No. of criteria | Random index |
|-----------------|--------------|
| 1               | 0            |
| 2               | 0.58         |
| 3               | 0.90         |
| 4               | 1.12         |
| 5               | 1.24         |
| 6               | 1.32         |
| 7               | 1.41         |
| 8               | 1.45         |
| 9               | 1.49         |
| 10              |              |

3.2. Land suitability for drainage system

In order to increase the production of agricultural crops, the agricultural drainage must be well selected. Where drainage projects are a system in which water is discharged into the field or soil. This can include control of rainwater, and control of water [17].

It should be remembered that the most important thing in the selection process for relevant areas is that non-agricultural areas were omitted from the comparison process carried out.

The classes are reclassified so that the derived data sets should be combined so that we can create an appropriate map to identify the potential locations of the irrigation project [18]. However, this was not possible. In order to merge them into present form, they had to be equal to the same extent. To merge data sets, you must first set them up on a standard measurement scale. What is highlighted in Figure 3 is the best place for a sewer system.
Table 3. The weight of each factor (geometric mean method).

| Criteria | Dr1 | Dr2 | Dr3 | Dr4 | Dr5 | Dr6 | Weights |
|----------|-----|-----|-----|-----|-----|-----|---------|
| Dr1      | 0.31| 0.48| 0.27| 0.20| 0.23| 0.18| 28.044% |
| Dr2      | 0.09| 0.05| 0.05| 0.03| 0.02| 0.05| 6.396%  |
| Dr3      | 0.12| 0.07| 0.11| 0.20| 0.11| 0.11| 12.00%  |
| Dr4      | 0.21| 0.09| 0.07| 0.13| 0.24| 0.21| 15.03%  |
| Dr5      | 0.09| 0.05| 0.06| 0.04| 0.07| 0.19| 7.92%   |
| Dr6      | 0.17| 0.26| 0.43| 0.40| 0.33| 0.25| 30.61%  |

The proposed site for building drainage project was selected in location 3 according to the following aspect this site is near to roads, arable areas and in low land. In the planning and design of drainage systems and affiliated activities (e.g. drainage water quality management), and to ensure long lasting success and adequacy of discharge structures stakeholder contribution is significant. In most agriculture discharge project; agriculture users are the key stakeholders.

On the other hand; other crucial stakeholders’ perspective should be taking in consideration; such as environmental and community organizations (groups), and road authorities Design factors should also seek the interests of stakeholders and match the capacities of farmer groups and match the capacities of farmer groups. Stakeholder participation is essential for project success in any case; whether the project is new or linked to the renewal, updating or upgrading of the existing system. (Figure 4).
Figure 3. Best Locations for Drainage System
4. Conclusions
The Integrated Geographic Information System with AHP was an astonishing tool for demonstrating various sorts of factors identified with the decision of drainage system. Exorbitant spillage from channels, supplies and watered rural land frequently adds to the recovery of groundwater, which causes flooding, which can essentially add to the requirement for modern drainage systems. Diminishing water system water misfortunes is essential for introducing financially productive drainage gear. So soil drainage can likewise beneficially affect the earth, too structured and well-overseen drainage systems can control the soil slope. Simultaneously, soil corruption and desertification are anticipated. The mix of drainage and water system is utilized to recover huge plots of land that have been surrendered because of salt gathering.
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