

# Soil Zoning of Bushehr City Based on Geotechnical Properties by ARCGIS Software

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**Abstract** – In order to do a proper planning for a project, we need to have some initial information about the issue related to that project. For example, to implement a development plan, it is necessary for us to have some basic information about the project area. ARCGIS software (Geographical Information System) having the capability of zoning based on soil properties, combining different maps and extracting special data from this combination and searching for certain information from available maps, can significantly distribute to implementation of such projects. In this study, we are going to zone the soil of Bushehr city based on geotechnical properties. These properties include LL, PI, SPT, C, and the type of the soil. The zonings have been done by two IDW and NATURAL methods. The data have been extracted from hundreds of exploratory boreholes that have been excavated at the area of Bushehr city.

**Keywords** – Zoning, Geotechnical Properties, Bushehr's Soil, ARCGIS.

## I. INTRODUCTION

Planning for every work needs to have the related information about that work that this is also true about the planning for human use of the land. From the beginning of planning to use land, collecting data has been the most important problem for planners [1, 2]. First they did this important task by gathering the statistics about the sources and sampling of them, and gradually found that they need local information about the sources or special information in order to perform the better and precise planning. The planners found the solution of the problem in mapping the sources [3, 4]. After the World War II and the development of interpretation of aerial photography, source mapping became easier. Geographical information system (GIS) was created for computer storage and management of the land data as a system and became widespread. This system was introduced by Tomlinson for mapping, assessment and planning of the land. The objective of this paper is to present the zoning maps of the various geotechnical properties of the soil in Bushehr that have been obtained from different excavations at the level of Bushehr city. These maps have been obtained using IDW and NATURAL methods. These maps provide an initial view for designing engineers that help to do more economic and more precise planning.

## II. DEFINITION OF GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Geographical information system is an integrated system including hardware, software and data that give the

possibility that the entered data into computer are stored, analyzed, transferred, evaluated and recorded and then published as the mapping and tabular data and also as a model of geographical areas. In any way, GIS is a technique or mechanical tool that can be used in detecting data (subject mapping), analyzing, interpreting and summarizing data, the evaluation of economical power and social-economical need for using the land by human being, environmental changes, recognition of the destructions, wasting and pollutions and the most important of all, regional planning or in its today terms, using in environmental planning which includes the all abovementioned cases. GIS is a bridge between databases of resources and management [5, 6]

The four pillars of establishment of GIS include hardware, software, data and user. GIS is an informational system related to local (geographical) data. In a vast and general view, such systems are instruments to process the local data and converting them to information to be used in decision-takings.

When we use GIS in a project, we can apply three ArcGIS applied software, that is, ArcCatalog, ArcMap and Toolbox [7, 8]

ArcGIS is an applied program that is used to manage data storage, database projects and record and review the metadata. ArcMap is used for any version, creating the map and doing map-based analysis. ArcToolbox is used to change and convert data and process the topologies. Any GIS work, whether simple or complex work can be done using these three applied softwares including mapping, data management, geotechnical analysis, correction and revision of data and processing the topologies [9]

## III. MODELS OF GEOGRAPHICAL DATA

ArcGIS stores and manages the geographical data with a number of formats. Three basic models that are used by ArcGIS include vector data, raster and TIN. We can also enter a tabular list of data into GIS [6]

## IV. VECTOR MODELS

One way of representing geographical phenomenon is to display with points, lines and polygons. This kind of the global representation is generally called vector data model. Vector models are particularly used for storage and display the discrete topologies such as buildings, pipelines and compartment limits.

The points are the pair coordinates of X and Y. the lines are as a set of coordinates that define a shape. Polygons

are a set of coordinates that define the borders of an area. The coordinates are often asset of pairs (X, Y), or triples (X, Y, and Z); in this case, Z displays a value such as the height [7].

## V. RASTER MODELS

In raster model, the world is represented as a surface that has been distributed as a regular network of cells. The coordinates X and Y are known at least as one corner of a raster fragment, so these coordinates can be located in a geographical space. Raster models are used to store and analyze data that are interconnected at a surface. Each piece (fragment) has a value that displays the membership in a class or category or an interpretive value. Raster data include the photos and networks. Images such as aerial photographs, satellite images or scanned maps are often used to generate GIS data [7].

## VI. TIN MODELS

In an irregular triangulated network model, the world is shown as a network of irregular connected triangles that is drawn from space points by values of X, Y, and Z. TINs are an effective way to store and analyze the surfaces. Inhomogeneous surfaces that are less and more variable in some areas can be modeled carefully. This is done through the values of taken data accompanied with triangulated surfaces by raster. Thus, where the changes of surface are much, the more number of the points are included, and where the changes are lower, the lesser points are included. ArcGIS stores the triangulated surfaces as the data set of TIN [7].

## VII. INFORMATION USED

The information used in this study is the same geotechnical properties of the soil of Bushehr city that include L.L, P.L, C, , S.P.T and the type of the soil. These data have been obtained from hundred exploratory boreholes excavated in the area of Bushehr city. A part of this information has been obtained from mechanic laboratory of Bushehr soil and reminder from direct referring to the employers. These data have been collected in tables accompanied with the local situation based on UTM coordinates, and then have been introduced to the software. In order to obtain the height from the sea level, the heights of the points have been measured by GPS device at many points in the city. In this research, ARC MAP 10 and ARC catalog 10 at ARC GIS 10 software have been used. Data we have are as points, that is, the information, that we have taken, has been at points with different distances. First, the information we have, should be converted to the applicable data in the Arc GIS software. For achieving this purpose, the information of intended points (L.L, P.L, C, , S.P.T and the type of the soil) are prepared as document file of excel file (as the table that has been shown later in this paper). ArcMap software in ArcGIS inserts these data into the sheet as points. For zoning the intended area, we should generalize these points to the surface by instrument we have in this software. This instrument is interpolation.

Data are gathered as an excel file, and as it is shown bellow, geotechnical properties accompanied with height from the sea level are presented in this table. After receiving data, the software can zone each of intended properties as maps that a sample has been presented here at the section of zoning maps.

Some data of the boreholes that have been used in this research are presented in table 1.

Table 1: Some data of the boreholes that have been used in this research

y	x	Elev(m)	Dep(m)	jens	C	Q	S.P.T	L.I	P.I
483457	3205466	3.80	3.00	2.00	0.06	30.00	20.00	17	0
483465	3205420	-0.13	5.00	1.00	0.02	31.00	11.00	0	0
483262	3205398	-6.23	10.50	1.00	0.01	33.00	50.00	0	0
488076	3200252	0.00	3.00	5.00	0.05	28.00	5.00	25	8
488076	3200252	-2.00	5.00	3.00	0.04	30.00	11.00	25	6
488076	3200252	-4.00	7.00	5.00	0.05	29.00	9.00	29	11
488076	3200252	-10.00	13.00	3.00	0.05	26.00	9.00	25	7
488115	3200124	-3.00	5.00	5.00	0.06	28.00	8.00	25	5
488115	3200124	-5.00	8.00	3.00	0.03	30.00	7.00	39	21
484026	3204737	-0.50	9.00	4.00	0.22	13.00	36.00	36	4
483099	3205117	-3.50	7.00	1.00	0.00	30.00	11.00	22	7.5
483099	3205117	-6.50	10.50	8.00	0.00	31.00	14.00	22	8
483089	3205468	-6.85	10.50	1.00	0.00	32.50	24.00	16	3
483049	3205465	-7.15	10.50	1.00	0.00	31.00	15.00	23	8.5
483638	3206143	-3.10	8.00	1.00	0.09	26.00	23.00	22	0
483591	3206093	-1.00	8.00	9.00	0.13	22.00	26.00	15	0
483825	3205818	-3.80	10.50	2.00	0.03	35.00	55.00	0	0
483884	3205743	0.40	5.00	10.00	1.00	0.00	55.00	52	10

### VIII. THE RESULTS OF GIS SOFTWARE

Zoning the soil of Bushehr city is performed according to the different properties of the soil by ARC GIS software using IDW and NATURAL methods.

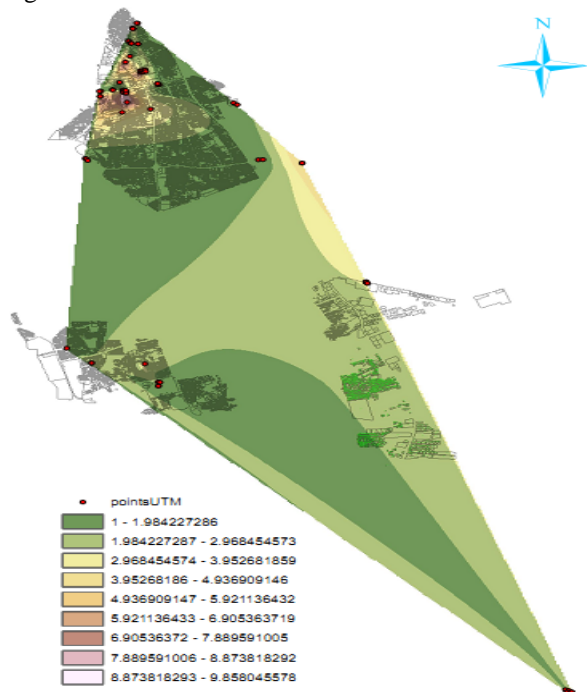


Fig.1. Soil zoning based on the type by NATURAL method

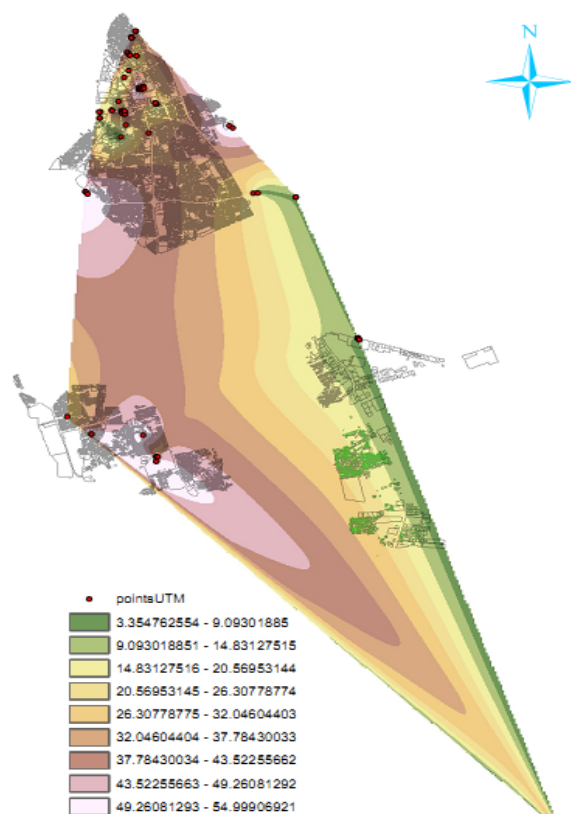


Fig.3. Soil zoning based SPT by NATURAL method

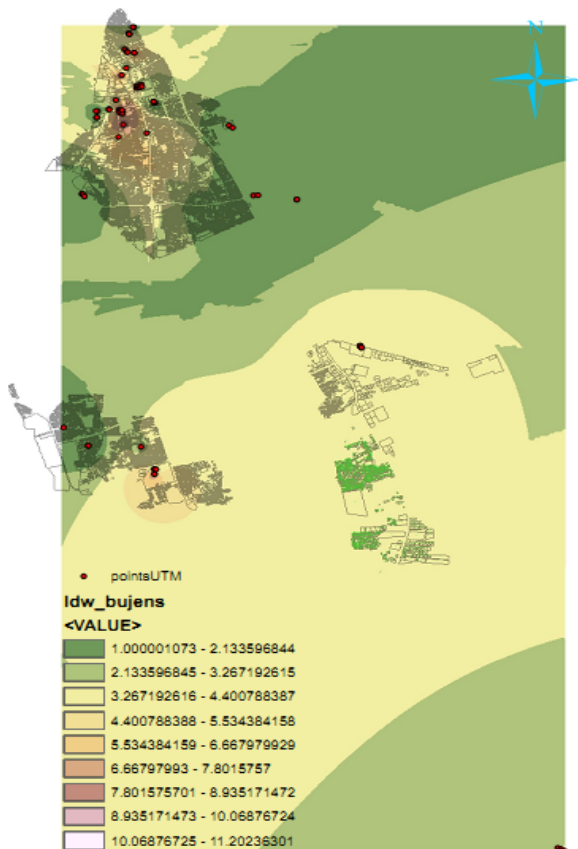


Fig.2. Soil zoning based on the type by IDW method

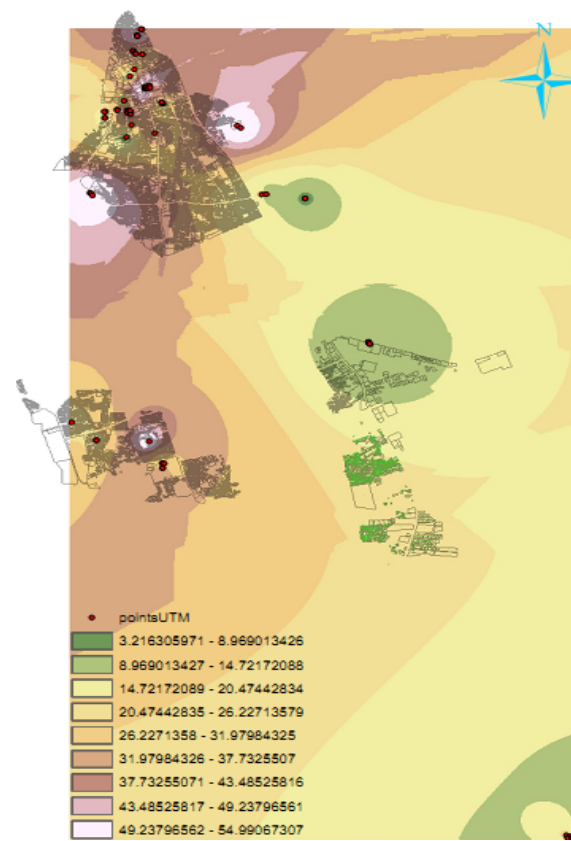


Fig.4. Soil zoning based on SPT by IDW method

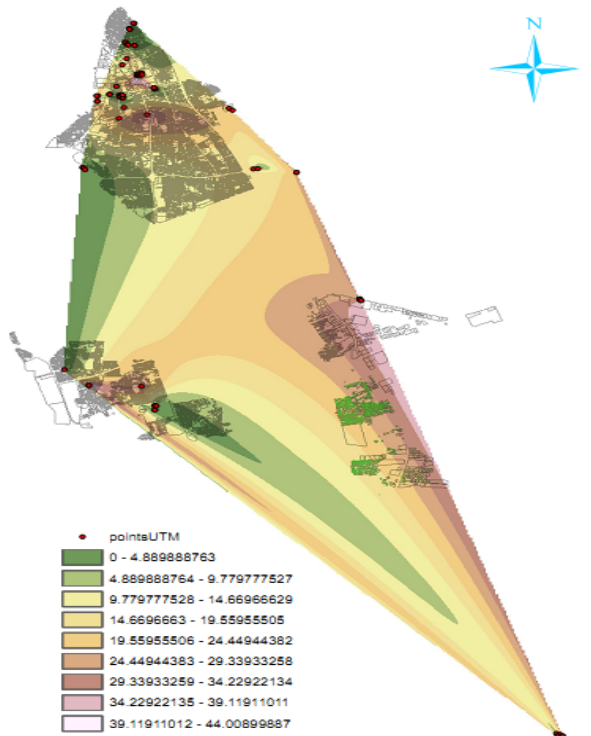


Fig.5. Soil zoning based on L.L by NATURAL method

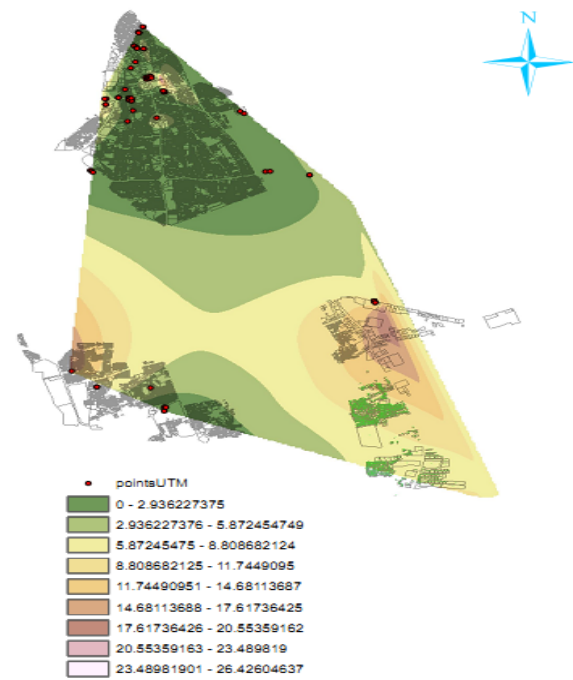


Fig.7. Soil zoning based on P.I by NATURAL method

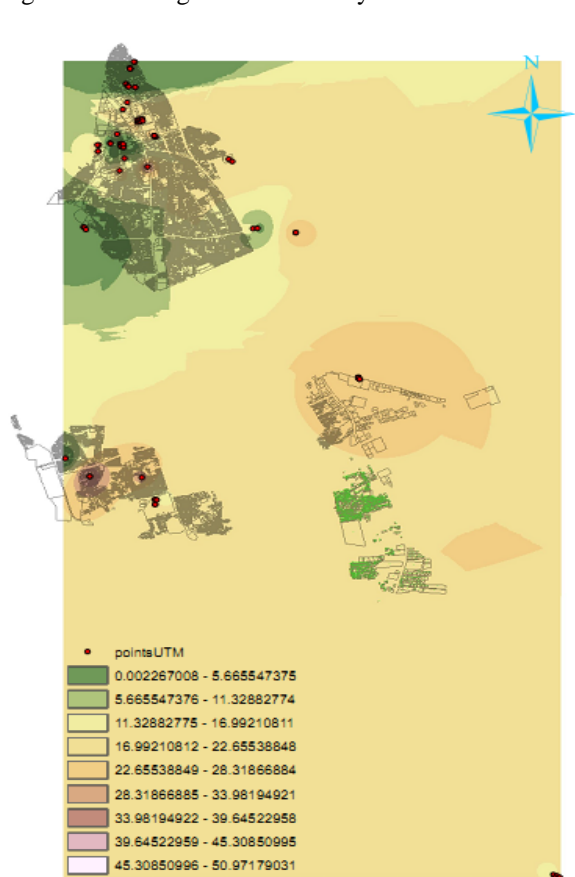


Fig.6. Soil zoning based on L.L by IDW method

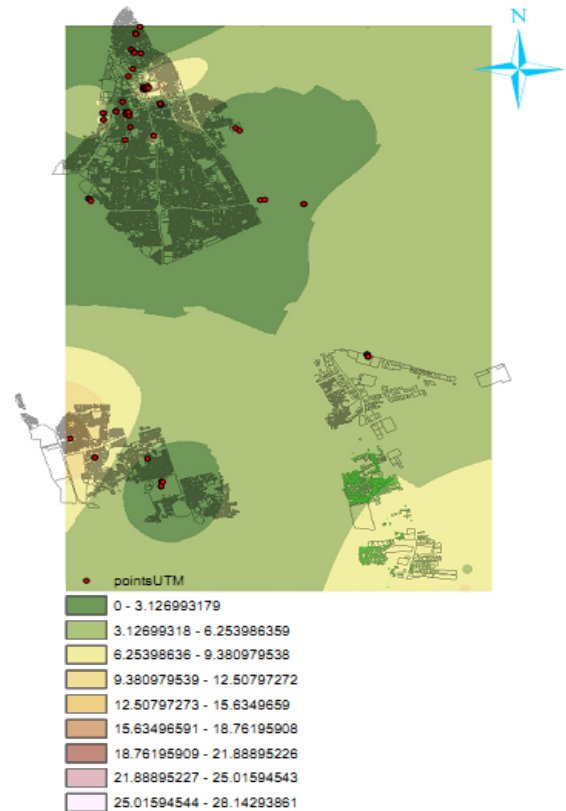


Fig.8. Soil zoning based on P.I by IDW method

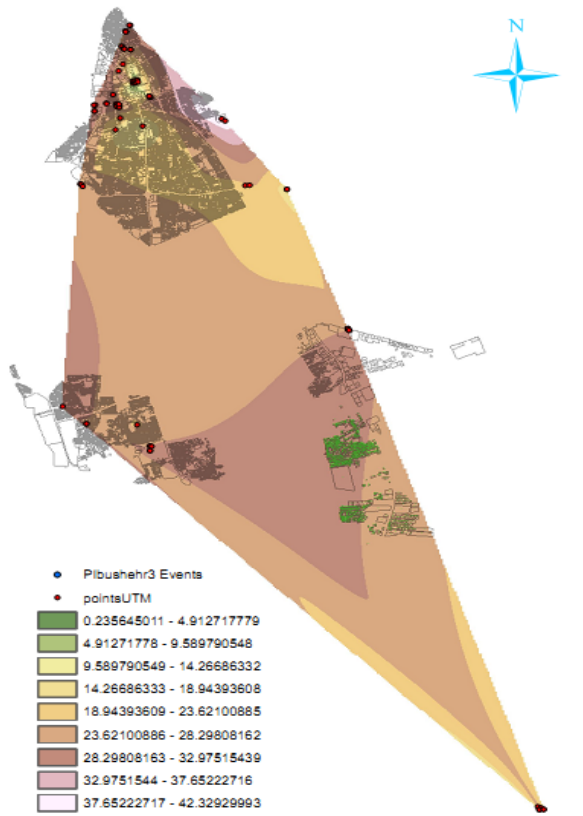


Fig.9. Soil zoning based on C by NATURAL method



Fig.11. Soil zoning based on C by NATURAL method

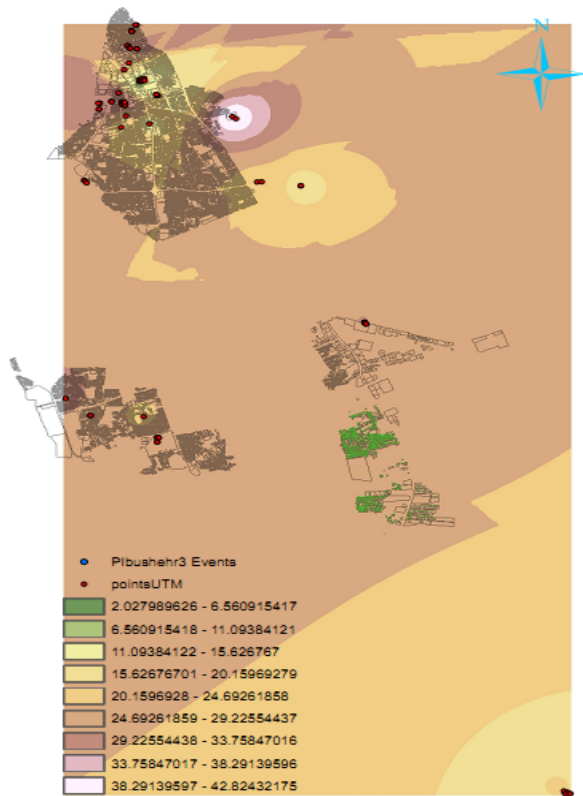


Fig.10. Soil zoning based on C by IDW method

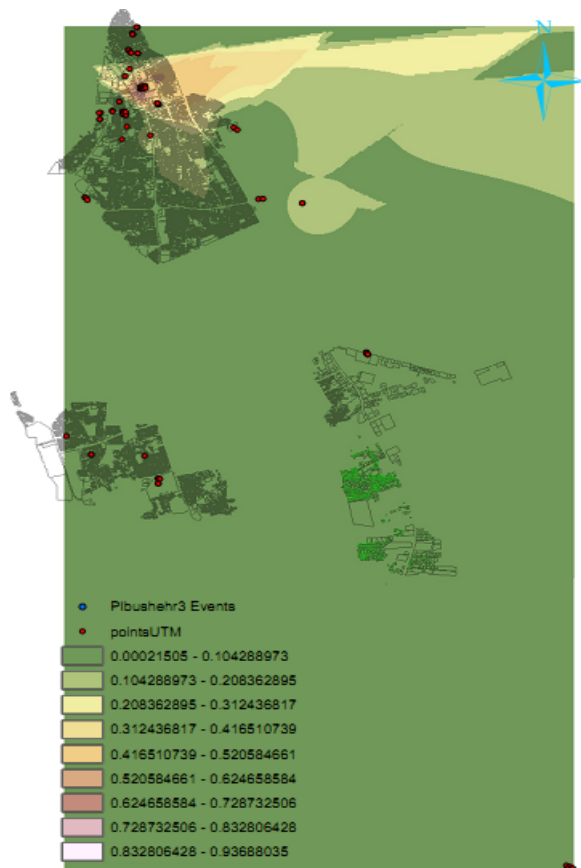


Fig.12. Soil zoning based on C by IDW method

## IX. CONCLUSIONS

According to the results of zoning the soil based on the type of soil by ARC GIS software, it is seen that a big part of the soil of Bushehr city has been composed of silty sand and silt with low doughy property. Due to establishment of two aerial and naval bases in Bushehr, the city is divided into two northern and southern parts. At northern part that is known as the city center, its central part has been composed of the clay with high doughy property, silty clay, sand, and a very small part of clay and sand mixture with high doughy property. In this part, we reach to the sea from three sides that its composition is of silty sand and silt with high doughy property. At southern part, in the part adjacent to the sea (the west), the soil is composed of silty sand and silt with low doughy property, and the soil of the east part is composed of clay with high doughy property, silty clay, sand and mixture of sand and clay. From height zoning maps, we can see that the southern part of the city is significantly higher than the northern part because just that part of the city is far from the sea.

## REFERENCES

- [1] Javadi, B. and Mojarrad, F. (2011). Soil zoning of Iran based on minimal temperatures. *Journal of geography and environmental planning*, Vol 39, issue 3.
- [2] Ebrahimi, S. (2010). Study of hydrocarbon pollution around Sarkhoon refinery, *Journal of research on soil and water*, Vol 16, issue 4.
- [3] Jahanseir, R. Study of the influence of the risk effects of soil drifting on the amount of drifting using GIS, An MSc thesis at Gorgan University.
- [4] Abdinam, A. An investigation of the preparation of the soil salinity map using correlation method between imaginary and soil salinity data in the Qazvin plain (2005). *Pajuhesh & Sazandegi*, Vol. 64: 33-38.
- [5] Yang, C. R. and Tsai, C. T. (2000). "Development of a GIS-Based Flood Information System for Floodplain Management and Damage Calculation." *Journal of the American Water Resources Association*, 36(3), pp 567-577.
- [6] McCoy, J. ,and K. Johnston. (2002). "Using ArcGIS Spatial Analyst." , ESRI Press,232 pp.
- [7] Bonham-Carter , G.F. (1994). "Geographic Information System for Geoscientists:Modelling With GIS.", Delta Printing Ltd., Ontario, 398 pp.
- [8] Zeiler, M. (1999). "Modeling Our World", The ESRI Guide to Geodatabase Design, ESRI Press.
- [9] MacDonald, A. (2001). "Building a Geodatabase", ESRI Press, 480 pp.