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USING SPATIAL INTERPOLATION TECHNIQUES (IDW) - A CASE STUDY OF MAN RIVER BASIN AKOLA BULDHANA DISTRICT OF INDIA

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Abstract: Spatial variations in ground water quality of Man River basin in the Akola and Buldhana district of Maharashtra India have been studied using geographic information system (GIS) technique. Groundwater is one of the most important natural resources. Groundwater has become a necessary resource over the past decades due to the increase in its usage for drinking, water supply, irrigation and industrial uses etc. Groundwater resources are now facing threats due to anthropogenic activities. The groundwater quality is equally important as that of quantity. Mapping of spatial variability of groundwater quality is of vital importance and it is particularly significant where groundwater is primary source of potable water. Geographical Information System (GIS) is used for the spatial analysis and it is a powerful tool for representation and analysis of spatial information related to water resources. The major water quality parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids have been analysed. The spatial variation maps of these groundwater quality parameters were derived and integrated through GIS. The final integrated map shows three priority classes such as High, Medium and Low groundwater quality zones of the study area and provides a guideline for the suitability of groundwater for domestic purposes.

Keywords: GIS, Groundwater, drinking-water, physicochemical parameters, spatial interpolation (IDW).

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53

INTRODUCTION

The continuous circulation of water between ocean, atmosphere, and land is called the hydrologic cycle. The hydrologic cycle can be viewed as a major machine on the planet, controlling distribution of water on the earth. Groundwater is one of the major links in the hydrologic cycle. Groundwater forms the invisible, subsurface part of natural hydrological cycle. Inflow to the hydrologic system arrives as precipitation, in the form of rainfall or snowmelt. Outflow takes place as stream flow or runoff and as evapotranspiration, a combination of evaporation from bodies of water, evaporation from soil surfaces, and transpiration is delivered to streams both on the land surface, as overland flow tributary channels; and by subsurface flow routes, as inter flow and base flow following infiltration into the soil (Freeze & Cherry, 1979). Excluding the freshwater that is locked up in the form of polar ice caps and glaciers, about 97 percent of the worlds freshwater exist in aquifers.

The present study has been carried out in district Akola and Buldhana of Maharashtra state. In the present study the available physio-chemical data of 45 locations, the data was obtained from Central ground water authorities of concerned districts. The physio-chemical data contained the information about various water quality determining factors. The data was digitized and put up in ArcGIS Software for Spatial Interpolation and based on previous experience most commonly used interpolation methods viz; Inverse Distance Weighted (IDW) and nearest Neighbor were applied to the above data for generation of continuous raster surface for studying the influence of each interpolation technique and best judging which interpolation technique is best. Through this study it is hoped that basic Interpolation method needed to study the water quality of this area further in future has been generated.

1. Study Area

The Man river basin is situated in Akola and Buldhana Districts of Maharashtra which is located between 20°54'59" N latitude and 76° 41'23'' E longitude covered by survey of India Top sheets no. 55 D/7, 55 D/9, 55 D/11, 55 D/13, 55 D/14 and 55 D/15 on 1:50,000 scale. It can be approached from Amravati about 110 Km. the study area is occupied by alluvium and Deccan basalts which are horizontally disposed and is traversed by well-developed sets of joints.

The Man River basin which is a major tributary of Purna River lies towards the western and southern part of Akola and Buldhana district. The total area covered by Man River basins **447.80** Sq. Kms. the study area is occupied by alluvium and Deccan basalts which are horizontally disposed and is traversed by well-developed sets of joints.
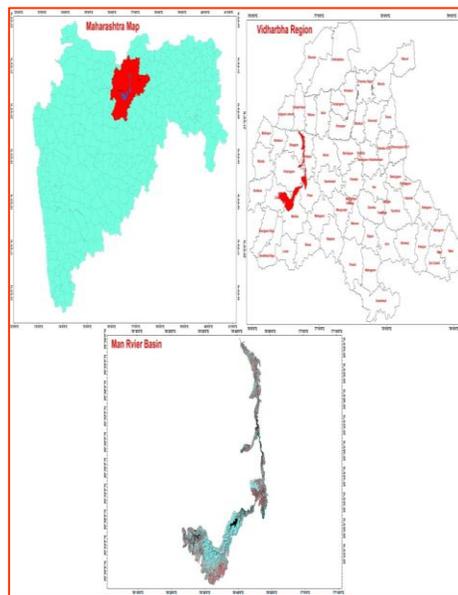
Fig.1 Location map of Man River basin.

2. Methodology

In order to carry out the research the 45 groundwater quality samples were collected. Ancillary data containing various water quality parameters such as pH, and other physio-chemical parameters like concentration of Cl, SO4 etc. were collected from the department of the central groundwater board. Later field work to various locations was organized to collect the co-ordinates (lat/long) of the locations of the ancillary data, with the help of Global Positioning System (GPS) pertaining to the water quality parameters collected from the two respective departments. Figure 2 below shows the methodology in flowchart below. Physio-Chemical Data of water Quality Determining factors obtained from Central Ground water Board. IRS-LISS image of October 2014. For ground truthing Trimble GPS was used for validating and locating the various water resources sites of the study area. The further step was to digitize groundwater ancillary data using the MS Excel and assigning of GPS locations to each point which was otherwise without locations for the creation of the database then the groundwater ancillary data and the spatial data (co-ordinates) which were collected with the help of GPS were joined in the ArcGIS 10.1 software. After linking the spatial and non-spatial data the groundwater quality point layer was generated for further analysis. Later on the other analysis was carried out using the IDW (Inverse Distance Weighted) Interpolation in Geographic information system environment using the Arc Map software. Interpolation creates a continuous (or prediction) surface from sampled point values. The continuous surface

representation of a raster dataset represents height, concentration, or magnitude for example, elevation, pollution, or noise. Interpolation makes predictions from sample measurements for all locations in a raster dataset whether or
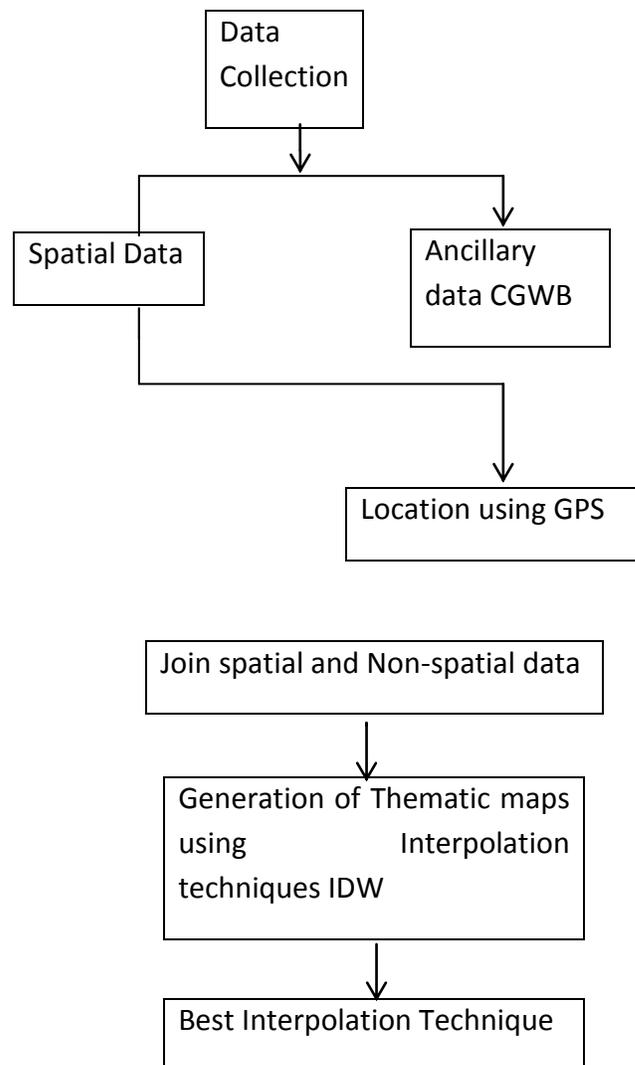
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Fig. 2 Overall Methodology Adopted

Not a measurement has been taken at the location. In the present data analysis we used IDW (Inverse distance weighted) interpolation technique and nearest neighbor.

3.   RESULTS & DISCUSSIONS

One interpolation methods were implemented in this study Inverse Distance Weighted (IDW). These interpolation techniques were compared to get the best interpolation techniques i.e., to see which of the interpolation technique gives the result which is more acceptable. The results are given with the ranges of values for two interpolation techniques. From the table it is apparent that some parameters show increase in value and some show decrease. The values are inferred using Bureau of Indian standards as Desirable, Permissible Limit and Non-potable. In addition to this various thematic layers of interpolation have been generated using the above parameters as input to ArcGIS spatial analyst module for interpolation. The interpolation maps generated shows the influence of each water quality factor in the study district. Water quality interpolation results are generated for various layers like pH, EC, TDS etc. The interpolation maps generated have been shown from Figure 3-

I. pH

The pH of the solution can be defined as the negative logarithm to the base 10 of the hydrogen ion concentration in moles per liter the pH scale has a range from 0 to 14. Neutral water has a pH of **7.0** indicating equal number of H^+ and OH^- ions; and alkaline water has pH > 7.0 implying a preponderance of OH ion and acidic water with a pH < 7.0 indicate a dominance of H^+ ions. Each stream organism is adapted to a specific pH range. The pH in most rivers unaffected by humans ranges from 6.5 to 8. The pH range of survivability of most freshwater organisms ranges from about 4.5 to 9. Western soils, which are typically alkaline, are a natural contributor to elevated pH conditions. Humans contribute to elevated pH primarily in the form of nutrient runoff (most commonly fertilizer), which leads to algae growth and higher pH. Low pH can be especially harmful to aquatic organisms. Low pH affects (physiological, biological) functions of aquatic life through reduction of enzyme activity and effectiveness stream miles. Low pH results when atmospheric

For pre 2014, pH values are higher in north and southern part of the basin and lower values in lower southern part of the basin in village Shahapur, modhapur, Amdapur, Mohadari etc.,
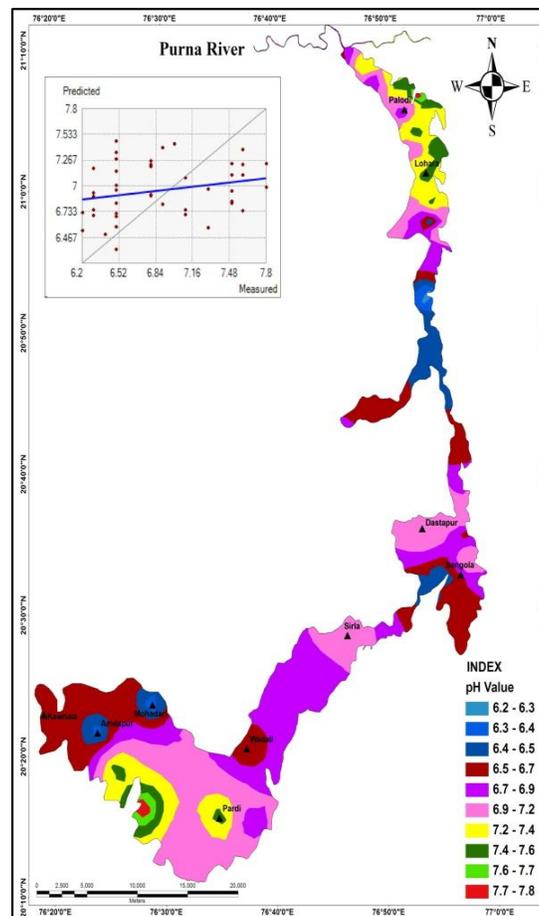
Fig. 3 pH map of study area

II. Electrical Conductivity (EC)

Electrical conductivity is the ability of a substance to conduct an electrical current, measured in microsiemensper centimeter (ms/cm). Ions such as sodium, potassium, chloride give water its ability to conduct electricity. Conductivity is an indicator of the amount of dissolved salts in a stream often is used to estimate the amount of total dissolved solids (TDS) rather than measuring each dissolved constituent separately. The ability of a cube 1 cm. on a side to conduct an electrical current is called electrical conductivity; this is the reciprocal of resistivity and is measured in mhos. Since, mhos are too large a unit for fresh water, micro mho is used. This is a function of temperature and the kind of ions present and the concentration of other ions. These readings are adjusted to 25^0c so that variation in conductivity is a function only of the dissolved ions in water. Hence, the unit in micro mhos/cm at 25^0c. The range of electrical conductivity (EC) in the area is 320 to 1600for pre monsoon of 2014 respectively.

The spatial distribution of electrical conductivity (EC) for groundwater during pre-monsoon period for 2014 is shown in Fig. Generally the electrical conductivity of groundwater in alluvial unconfined aquifer. Higher EC is found particularly on north–western part of the area, due to the presence of good basaltic aquifer, which recharge quite regularly by rainfall as compared to alluvium. Conductivity indicates the presence of ions within the water, usually due to in majority, saline water and in part, leaching. It can also indicate industrial discharges. The removal of vegetation and conversion into monoculture may cause run-off to flow out immediate thus decrease recharge during drier period. Hence, saline intrusion may go upstream and this can be indicated by higher conductivity.
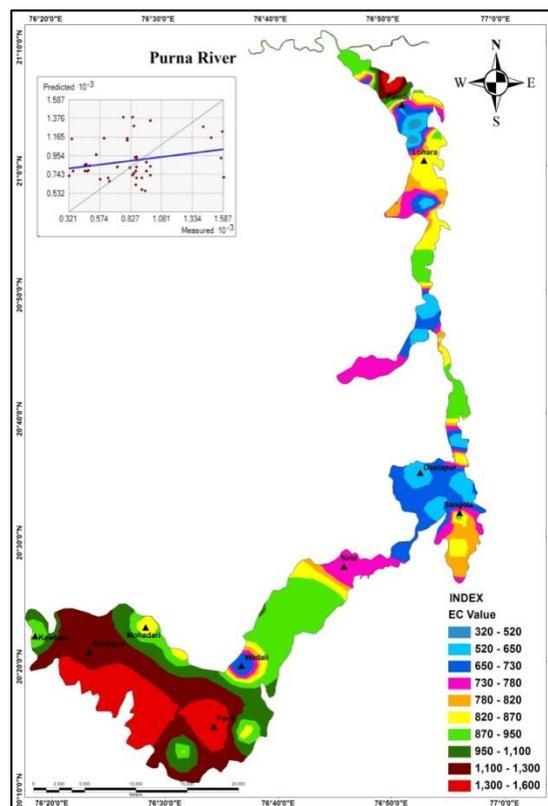

Fig. 4 EC map of study area

III. Total Dissolved Solids

Total dissolved solids (TDS) are a measure, in milligrams per liter (mg/l), of the amount of dissolved materials in the water. Ions such as potassium, sodium, chloride, carbonate, sulphate, calcium, and magnesium all contribute to the dissolved solids in the water. In many instances resource agencies use the terms TDS and salinity interchangeably, since these ions are typically in the form of salts. Measuring total dissolved solids is a way to estimate the suitability of water for irrigation and drinking. This is an important parameter for drinking water because high TDS values may result in a 'salty' taste to the water. Groundwater often has higher levels of dissolved solids than surface water because of its contact with aquifer geologic material and more time to dissolve rock and mineral materials. When stream flow is at base flow conditions, most of the source water is from groundwater, and dissolved solids concentrations are high. When stream flows are high from rain or snowmelt, dissolved solids measurements typically are low.

It is the concentration of non-volatile substances present in the water in molecular dispersed and colloidal state. Due to surface & subsurface movement of water, it contains a wide variety of dissolved inorganic chemical constituent in various amounts. The concentration (in ppm.) of TDS classified water as,

Fundamentally, it is based on concentration of NaCl, which in turn determine the conductivity which has a bearing on TDS. Conversion between TDS and conductivity in micro Siemens or micromho's/cm. at 25^0, TDS in ppm. And varies between 0.55 – 0.75.A value of 0.90 has been arrived at gave a relation that for groundwater in the range of 100 – 5000 micromoho's/cm at 25^0c. 1 ppm. TDS = 1.56 EC x 10^6.TDS in the study area ranges between 340 to 680 for pre monsoon2014 (Fig.5).

Table. 1 Results showing TDS and water quality values

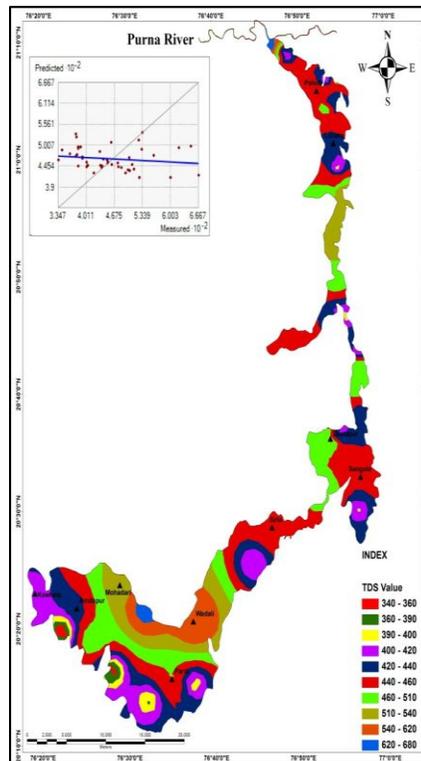| T D S	Water Quality
< 1000	Fresh
1000-10000	Brackish
10,000 – 1,00,000	Saline
> 1,00,000	Brine

Fig. 5 TDS map of study area

4. CONCLUSION

From the current study it has been found that Inverse distance weighted interpolation technique is the best way of determining the water quality, As in this technique the chances of error are minimized to a great extent and chances of deviation of original value are extremely low.

5. ACKNOWLEDGMENT

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