Volume: 6 Issue: IV Month of publication: April 2018

DOI: http://doi.org/10.22214/ijraset.2018.4833

Water Quality Index (WQI) based Analysis of Water Quality at Hand Pump Locations, Allahabad City

Dr. Anuj Kumar Purwar[1]
[1]Assistant Professor School of Engineering and Technology IGNOU, New Delhi

Abstract: Water quality index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea of the possible problems with water in a particular region. The indices are among the most effective ways to communicate the information on water quality trends to the public or to the policy makers and water quality management. In the present work, an integrated geographic database has been created using GIS consisting of water quality parameters of Allahabad city. The evaluation of the quality of water has been done by computing Water Quality Index (WQI) using Social Accounting System model. Model has been implemented under GIS environment for water quality indexing. Based upon the analysis carried out, it may be concluded that almost all the hand pumps require treatment of water for bacteriological contamination to make it safe for drinking or else the consumption of this water may be stopped to reduce the outbreak of health hazards. The GIS based database and spatial model is developed for water quality indexing for Allahabad city are modular and can be updated or modified easily for further use in a different city.
Keywords: GIS, Water Quality Index, Seasons

I.INTRODUCTION

Ground water is source for water supply in many parts of the world catering to the requirements of one third of global population. Over extraction of ground water has also affected its quality leading to saline ingress in coastal areas as in case of Oman, Bahrain, and India. It is reported that biological contamination in the form of the fecal coliform count in Asia's rivers is 50 times higher than the WHO guidelines making the local population vulnerable to high risk level. In fact, the declining status of global fresh water resources both in terms of quantity and quality may prove to be the dominant issue on the environment and development agenda of the coming century. There are many natural constraints to access to fresh water like uneven distribution, temporal and spatial variation in the climatic conditions and variations in geology and topography including soil cover. Against this backdrop of a dismal scenario, it is encouraging to note that citizens of Jordan and Israel, two of the most water scarce countries in the world have access to adequate supplies of safe water largely due to effective and sound water management strategy warranting large scale propagation and emulation (Biswas, 2003).

India is the oldest civilization in the world with a population of one billion people. It has an area of 329 million hectares and occupies about 2% of the world's area but has 15% of its population. The country has a variety of weather conditions. The summer temperatures rise to as high as 50ºC in many parts of the country and at the same time the Himalayan range has ice capped mountains. These mountains serve a source of water for most of the northern states of India. Monsoon season is from June to October and showers India with plenty of water. It is estimated that annual rainfall in India is 400 million hectare meter. However hardly 20% of this is utilized, rest of it reaches the sea or evaporates. Although there is plenty of a water supply, India has perpetual drought conditions. Summer season spans for four months (typically from March to June) when most water bodies including dams dry out. In India, in spite of substantial emphasis on water supply sector, only about 82% of the urban household covering 85% of urban population had access to safe drinking water as of 1991. Due to improper planning of water conservation, today India is ranked 122 out of 130 nations for its water quality and 132 out of 180 nations for its water availability (Nawlakhe, 1995).

A.GIS and Water Quality Mapping

Technological revolution has provided a new dimension to the information systems, which led to the emergence of new specialized branch of knowledge and computer networks. There has been a rapid development in the field of geographic information science. Geographic Information System (GIS) provides information on all geographical variables and has a vital role to play in the water related studies. A GIS is a computer based system which is designed to assist decision makers. Typically, such a system will include

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

spatial data relevant to the decision, analytic tools to process the data in ways meaningful for decision makers, and output or display functions (Internet 1).

GIS has also been used for specific decisions in the environmental domain, particularly in the areas of water pollution, crop, livestocks, flood, and forest management. GIS can be used for the mapping of water quality in a more efficient way that could be helpful in managing the quality of water for supplying in the city. Once a GIS based database is developed, it can be used for analyzing water related problems that a city is facing.

B. Objectives Of The Present Work

Now-a-days, GIS has become an indispensable tool for mapping and monitoring of water quality in an efficient way. Further, the water quality parameters of three different seasons, namely, winter, summer and monsoon seasons have been used. In particular, the main objectives of the present work are:

1) Generation of GIS based database for water quality parameters of Allahabad city
2) Implementation of water quality index model under GIS environment
3) Development of GIS based water quality index maps

C. Concepts Of Water Quality Indexing And Scoring

The main objective of water quality index is to turn complex water quality data into information that is understandable and usable by the public. Water quality index based on some very important parameters can provide a simple indicator of water quality. It gives the public a general idea of the possible problems with water in a particular region. The indices are among the most effective ways to communicate the information on water quality trends to the public or to the policy makers and water quality management. It is also defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water .the concept of indices to represent gradation in water quality. Figure 1 given below shows the relation between water quality index and different users.

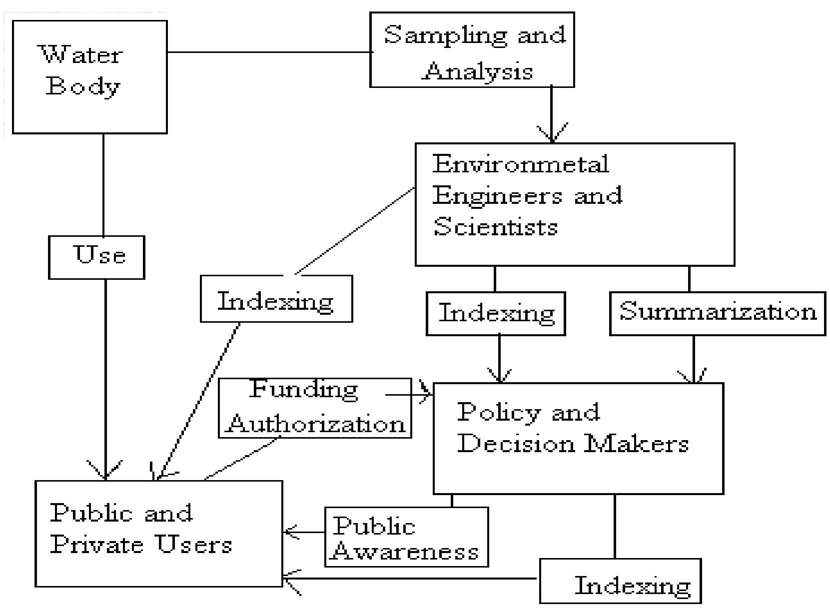


Figure 1: Requirement of water quality index

Figure 2 shows below the steps involved in the index construction, in which:

1) An observation is defined as the set of values measured for an n-parameter water quality vector (in this example, $n = 7$);
2) A score is defined as a measure of agreement between an observation and the control vector (the set of desired va1ues for the water quality vector); and
3) An index is defined as a number derived from a series of observations or from a group of Scores.

5106

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue IV, April 2018- Available at www.ijraset.com

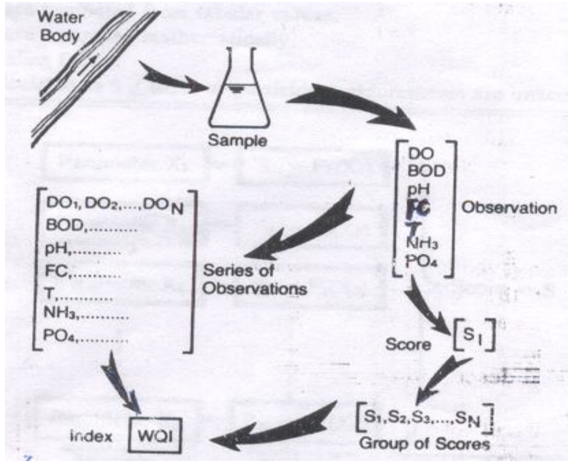


Figure 2: Steps involved in the index construction

An observation requires definition of the components of the water quality vector and is associated with a particular sample (taken at a Particular location and time). An observation is, therefore, a representation of a unique point in part, in the quality history of the water body. A score requires definition of the control vector for the water body (or at least the segment being sampled). A score also requires definition of a scale to measure agreement between the control vector and the quality vector (Roy and Richard, 1980).

An index requires definition of the relationship between groups of scores (or a series of observations) and the quality or score of the water body being indexed. This relationship depends upon the type of observations being scored as well as the intended use of the water body. The score of an observation may be scale, i.e., related to a fixed measure of agreement to the control vector, or preference, i.e. ranked according to the relative agreement to the control vector when compared with other observations. Either method requires some well-defined procedure for measuring "closeness of fit," but this measurement need not require knowledge of the end use of the water (other than that implied by the control vector). The score may be calculated by transforming the parametric deviations from the cont values into subscores and then aggregating the subscores. Alternatively the score may be calculated by averaging the ratings of experts who presumably consider the antagonistic or synergistic attributes of parametric interactions well as individual parametric deviations from the desired values.

As the intent of the score is to relay information on water quality, the numerical value of the score should increase with increased agreement between the control vector and the quality vector being scored. In addition, the score should vary between zero and some power of 10 in order to convey an intuitive concept of the index range to the recipient (e.g., 0-1, 0-10, and 0-100) and the quality of sample conveyed by the score should be in the accordance with common understandings of the relative meaning of scores. There are many water quality indexing methods, which takes different number of parameter. Table 1 shows representative quality scoring methods (Landwehr and Deinger, 1976).

Table 1: Representative quality scoring methods

Name	Developer	Number of variables	Procedure
Quality Index	Horton	10	WQSA[a,c]
National Sanitation Foundation Index	Landwehr Brown, et al	9(2)[f]	Method1:WQSA[b] Method2:WPSM[b]
Implicit index of pollution	Pratti, et al	13	WQSA[d,e]
River pollution index	McDuffy and Haney	8	WQSA[d,e]
Social accounting system	Dinius	11	WQSA[d,e]
Objective water quality	Harkins	Not fixed	Nonparametric Multivariable Ranking procedure

[a]Weight sum of subscores multiplied by two coefficients representing temperature and pH
[b]Subscores all computed by empirical curves
[c]Subscores are computed from tabular values
[d]Subscores are computed mathematically
[e]Includes scaling factor
[f]Score is calculated as 0 if toxic or pesticide measurements are unacceptable.

II.METHOLOGY

The present study has been carried for Allahabad city which is covered between 25°31'04"N to 25°22'44"N latitudes and 81°55'00"E to 81°54'04"E longitudes. The boundaries of the city are selected from the distribution map available from Jal Sansthan, Allahabad (Figure 3).

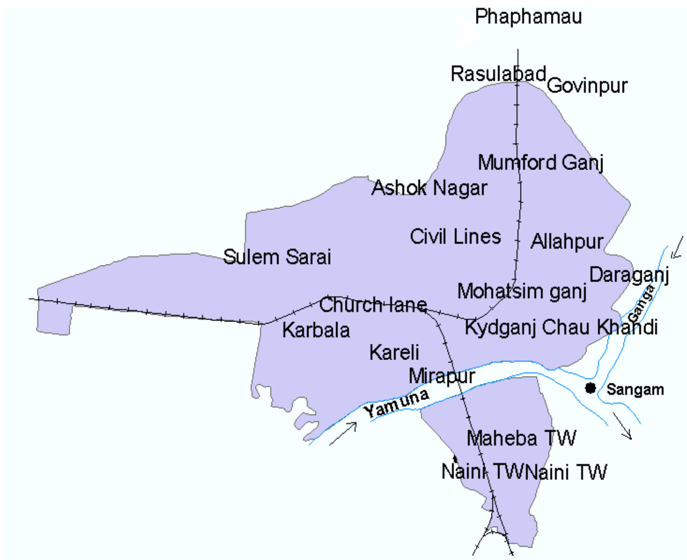


Figure 3: The Study Area

A. Collection of Data

In the present study, topographic maps, covering Allahabad city, published by Survey of India and city map prepared by Nagar Mahapalika Allahabad have been used. These maps show various features of the city. The scales of the 63G topographical map is 1:250,000 and the scale of 63G/15 is 1:50,000. The utility services map for Allahabad town with scale 1:20,000 has been provided by Jal Sansthan, Allahabad. Water quality data for present study are taken. Water quality data are taken from Jal Sansthan for all three seasons and for tube wells, hand pumps, clear water reservoir and water treatment plant.

B. Geo referencing of the Maps

The various maps collected were scanned at 300 dpi. The ArcGIS 8.3 software has been used for present study. Registering a map is first step towards generating a database. After registration of a map, it fits into its real world coordinate and gives us real distances and relative locations of various places. In this process, maximum numbers of control points which are well distributed in maps are identified from the paper map and have been used to the scanned map in the ArcMap to register it. Polyconic projection system with India Everest as datum has been used because the same system has been adopted by Survey of India.

C. Integrated Geographic Database

As mentioned above, the attribute data feeding could be carried out simultaneously with the digitization or it could be done at a later stage after digitizing all the features in the map(s). At any time, if one wants to update this data, it could be done by directly overwriting the old data. The attribute data table of a particular feature is then linked to its corresponding location in the shapefiles. Thus, the water quality parameters are now linked to each location of hand pump as well as to the tube well sampling locations as attributes as well as for water treatment plant and clear water reservoir. In this way, the integrated geographic database is prepared for Allahabad city for further analysis of water quality.

5108

III. RESULTS AND DISCUSSIONS

After calculating WQI by selected model in GIS environment for all study locations, water quality index maps have been developed for winter, summer and monsoon seasons. Comparative graphs of water quality index models also have been prepared for the study area. WQI study has been done for selection of areas that have potable water based upon the study of water quality model. In the following sections, results are presented along with discussions. The study for computation of WQI has been done for all three seasons, *i.e.*, winter, summer and monsoon. The WQI calculated from this model using GIS are presented tabular as well as in thematic map form.

Thus, according to this model, minor treatment of water is required at all locations except Mohatsimganj which requires extensive treatment of water because WQI at this location is less than 70. Further, Table 2 shows WQI values for hand pump locations for all three seasons while Figure 4 shows map of all hand pumps locations where WQI value is less than 90 and require minor treatment. In all the three seasons, WQI at all locations is less than 90.

Table 2: WQI at hand pumps locations for all three seasons

Sampling Location	WQI (winter)	WQI (summer)	WQI (monsoon)
Katra Market	82.34	70.81	71.3
Civil Lines	81.15	73.66	74.42
Colonelganj	82.3	81.74	83.71
Lukerganj	82.1	80.15	75.09
Mutthiganj	79.91	71.06	72.93
Beniganj	81.79	75.49	83.74
Naini	82.4	72.58	84.44
Maheba	82.53	82.24	84.31

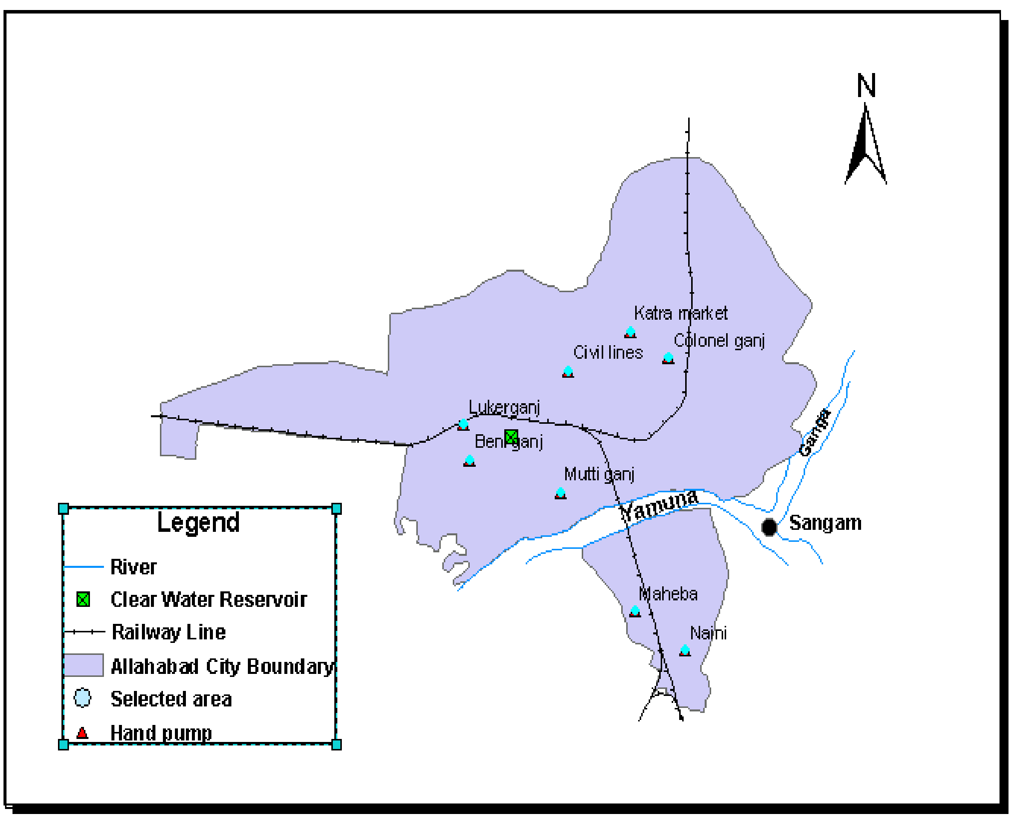


Figure 4: Hand pumps having WQI less than 90 in all seasons

IV. CONCLUSIONS

In the present work, an integrated geographic database has been created using GIS consisting of water quality parameters of Allahabad city. The evaluation of the quality of water has been done by computing Water Quality Index (WQI) using model, namely, Social Accounting System model. Model has been implemented under GIS environment for water quality indexing. Based upon the analysis of the results carried out, the following conclusions have been drawn:

A. The GIS based evaluation have given the spatial, graphical and statistical representation of hand pumps water parameters for assessing the quality of water for drinking purpose in Allahabad city by water quality indexing model and for the computation of WQI for winter, summer and monsoon seasons.

B. Based upon the analysis carried out, it may be concluded that almost all the hand pumps require treatment of water for bacteriological contamination to make it safe for drinking or else the consumption of this water may be stopped to reduce the outbreak of health hazards.

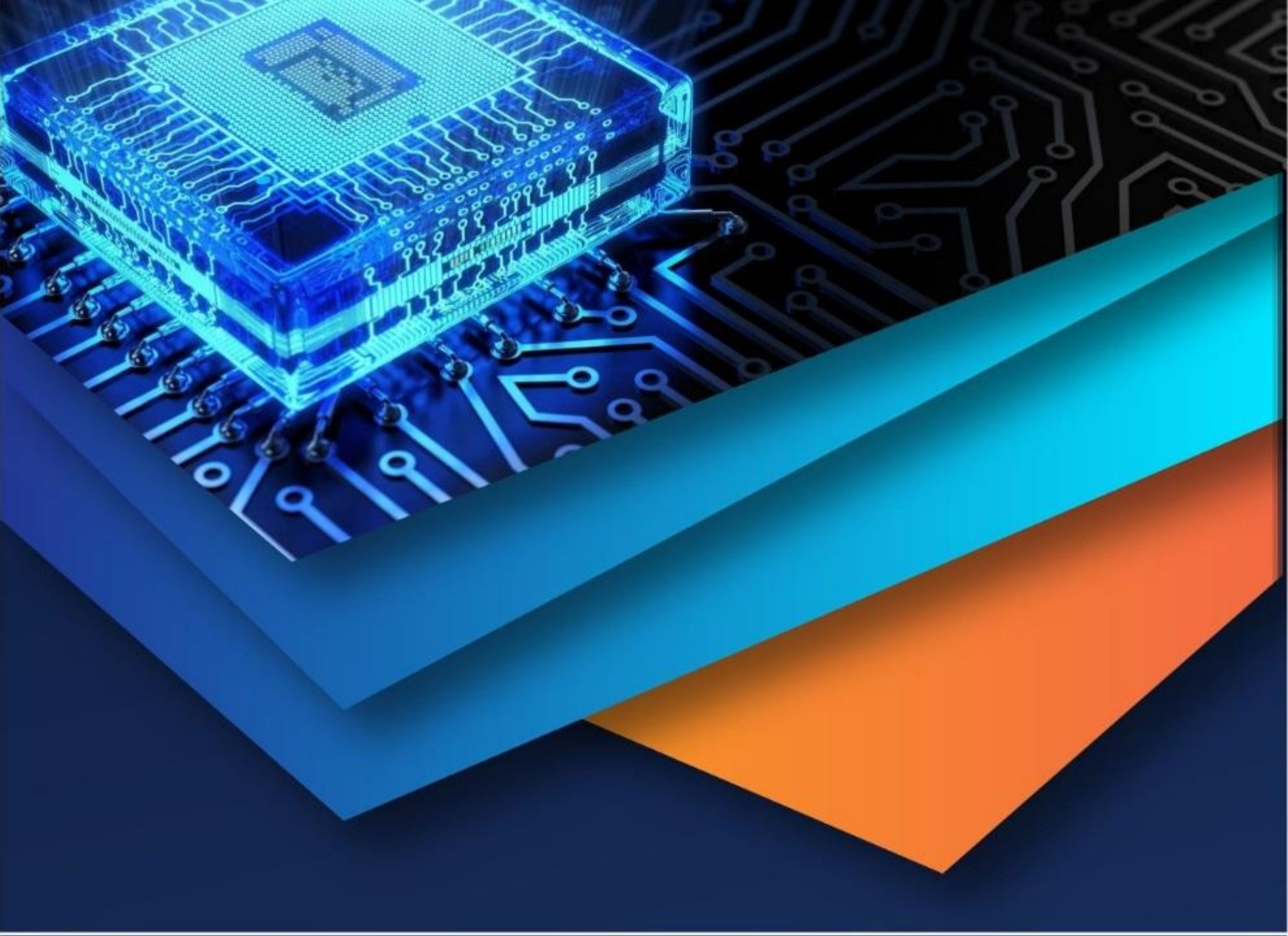
C. It is suggested that effective chlorination should be done for water from tube wells and hand pumps for protection from bacterial contamination.

D. The GIS based database and spatial model is developed for water quality indexing for Allahabad city are modular and can be updated or modified easily for further use in a different city.

REFERENCES

[1] Anbazhgan, S. and Nair, Archana M. (2004), "Geographic Information System and Groundwater Quality Mapping in Panvel Basin, Maharashtra, India", Jr. of Environmental Geology, Vol.45, No.5, pp: 753-761.
[2] Bhargava, Devendra Swaroop (1985), "Expression for Drinking Water Supply Standards", J. of Environmental Engineering, Vol.111, No.3, pp: 304-316.
[3] Biswas, K. Dilip (2003), "Water Quality Management-A National Concern", A Report from Central Pollution Control Board Delhi.
[4] Daniel, A. Okun (2001), "Principle for Water Quality Management", Jr. of Environmental Engineering, Vol.103, No.6, pp: 1039-1055.
[5] Dinius, S. H. (1972), "Social Accounting System for Evaluating Water Resources", Jr. of Water Resources Research, Vol.8, No.5, pp: 1159-1177.
[6] Garg Santosh Kumar (2002), "Water Supply Engineering", Khanna Publishers, Delhi, pp: 425-429.
[7] Internet 1: http://www.gisdevelopment.net
[8] Internet 2: http://www.gis.com
[9] Landwehr, J. Maciunas and Deinger, R. A. (1976), "A Comparison of Several Water Quality Indexes", J. of Water pollution Control Fed., Vol.48, No.5, pp:954-958.
[10]Nawlakhe, W. G., Lutade, S. L., Patni, P. M. and Deshpande, L.S. (1995), "Groundwater Quality in Shivpuri District in Madhya Pradesh", Indian J. Environ. Health, Vol.37, No.4, pp:278-284.
[11]Prabhakar, T. Clement (1998), "Remediation of Contaminated Ground Water– Lessons from U.S.A.", J. of Indian Water Works Association, Vol. 8, No.2, pp:241-247.
[12]Ramaraju, H. K. (2003), "Water Quality Assessment and Mapping in Pilot Districts of 'Jal Nirmal' Project, Karnataka, India", J. of Indian Water Works Association, Vol. 9, No.3, pp: 223-227.
[13]Rekha, V. G. (1993), "Water Quality Survey of Allahabad City (Eastern Part)", M.E. Thesis, M.N.R.E.C., Allahabad.
[14]Roy, O. Ball and Richard, L. Church (1980), "Water Quality Indexing and Scoring", J. of Environmental Engineering, ASCE, Vol.106, No.4, pp: 757-771.
[15]Samuels, William B. (1993), "Lakemap: A 2-D and 3-D Mapping Systems for Visualizing Water Quality Data in Lakes", Water Resources Bulletin, American Water Resources Association, Vol.29, No.6, pp: 917-921.

5110



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY