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Development of Information System for Evaluating Ground Water Quality in an Urban City of Eastern India

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Ground water is the major source of water supply in urban India. Understanding and assessment of groundwater quality for drinking and irrigation uses is therefore imperative to maintain its quality in any fast growing city like Bhubaneswar in Eastern India. A framework was developed in Visual Basic 6.0 software to generate quantifiable estimation of water use for drinking as well as irrigation purpose using different water quality parameters. Different forms have been prepared for water quality assessment and showing standard values for water quality parameters. Twenty different water quality parameters for drinking and nineteen water quality parameters for irrigation purposes were analyzed using 55 water samples of the study region. The total weightage of water quality parameters were analyzed in this software module. Different forms were created for entering the water quality parameters for evaluation. Formats have also been prepared for depicting desirable limits of different water quality parameters for indented purposes. This software module can be used as a ready-made package for assessing characteristic of water quality parameters for drinking as well as irrigation purposes.

***(Key words**: Information system, Water quality, Drinking and irrigation)*

Groundwater is the most preferred source of water for various users on account of its easy availability, dependability and low investment. The demand on groundwater has increased numerously in recent years. Supplying relatively good quality water, groundwater fulfills 50 percent demand of urban and industrial sectors (Ghosh and Sharma, 2006). Groundwater is annually replenished primarily through the rainfall & subsequently by surface water bodies such as rivers, lakes, tanks etc. At the same time, groundwater quality in some region got deteriorated due to seepage from industrial discharge, leakage of septic tanks/ sewerage system and soak pits has reported from several places. This increasing level of groundwater pollution particularly in urban areas is a matter of serious concern of Central Groundwater Board (CGWB, 2010).

Groundwater quality parameters are determined by many factors such as interaction of water with aquifer materials, influence of anthropogenic activities, evaporation, precipitation and other climatic variables. Being an important water source for drinking as well as irrigation, the quality of groundwater must be carefully managed within the standards recommended by Indian Statistical Standards Institution (ISI, 1991) and World Health Organization (WHO, 2004). In order to assess and sustain the quality of groundwater, it becomes essential to know its chemical character by measuring relevant parameters for its use in intending purpose. Irrigated production system contributes to more than 50% of the net production that needs to be maintained to meet the ever increasing demand of the burgeoning population in India. Water quality appraisal and assessment is a subject of discussion presently under agricultural irrigation. Water quality fluctuates with temperature, evaporation, amount of rainfall received at a particular period, anthropogenic involvement and the type of resources. Monitoring water quality at regular intervals is tiresome but crucial to ensure the quality of produce, and the soil and water quality in continuum. Understanding the character of water, identify the indicating parameters along with extracting information as much as possible from the water quality data set is the key to monitor water quality with ease and precise manner (Das *et al.*, 2010).

A precise assessment of quality of groundwater resource is a pre-requisite for long term planning and development in that region. The Ground Water Information System is a web based information system contains water level data and water quality data for the different States of the country developed by Central Ground Water Board (GWIS, 2013). An

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information system has been developed by Drinking Water Quality Regulator for Scotland for testing and monitoring of water quality parameters. Among 51 different water quality parameters, the ten most important parameters were analyzed for drinking purposes in Scotland (DWQR, 2013). Bhubaneswar the capital city of Odisha in eastern India is rapidly progressing by widening road, augmenting connectivity, developing various institutions, hospitals, complexes which eventually intensifies the activities per unit land mass and enhances the susceptibility of underground aquifer to get contaminated by diverse sources. The purpose of the study was to recognize the quality of groundwater and scale down the information to the level to identify key parameters for managing water quality for drinking and irrigation use in a fast growing city.

MATERIALS AND METHODS

Information systems and software are a key technology in this era of Information revolution in which the data is processed to get desired information and its dissemination to the end user as well as for decision making. Bhubaneswar, the capital city of Odisha was the study area, is situated between 20°12′ to 20°25′N latitude and 85°44′ to 85°45′E longitudes with an altitude of 40 – 45m above mean sea level (msl) which receives annual rainfall of 120 – 140 cm (average) during June to September with humid warm climate. Fifty five water samples covering 135 sq km area both from open dug wells and bore wells were collected in the month of April 2011 during pre-monsoon period for analysis. The mainly used of these water resources are for drinking, cleaning, preparing meals, washing and other domestic purposes. Even though the State Odisha, is blessed with average annual rainfall of 1482 mm groundwater is also a major contributor towards agricultural activities. The hydro-geological situations are quite conducive for steady replenishment of groundwater. Considering the high potential of groundwater development, Government has been encouraging groundwater exploitation by announcing popular subsidy schemes in the specific regions. But while developing groundwater structures for irrigation use, it is necessary to ensure its sustainable use in long-term basis.

Different forms have been prepared for water quality assessment and showing standard values for water quality parameters. Twenty different water quality parameters for drinking and nineteen water quality parameters for irrigation purposes were analyzed using 55 water samples of the study region. The marks were allotted to each water quality variable based on the seriousness of the impact in terms of its effect on crop growth, soil fertility and adjacent environment. Assigning a point value to each parameter, the variables were weighed on a ten-point scale and the percentage of acquired scores thus reflects the suitability of water for particular use. The total weightage of all water quality parameters were calculated in this software.

Microsoft Visual Basic 6.0 software was used in developing the front end formats in the software module. The information system was designed in such a way that it can be easily installable and effective operational under Microsoft Windows environments (Nayak *et al.*, 2013). Forms included text boxes, command buttons, combo boxes were designed for easy access in the system. The storage and retrieval of the data was mainly based on a software programme that supports the processing of large data quantities and the results were presented as per user's requirement.

RESULTS AND DISCUSSION

A framework was developed to generate information on water quality, process and downscale the water quality data for its rational utilization in intending purpose. Information generated on groundwater quality first figured out through hydro chemical facies identification, scaled down to form similar classes using hierarchical cluster analysis, unraveled the variability of discriminating variables through variance analysis to recognize them as

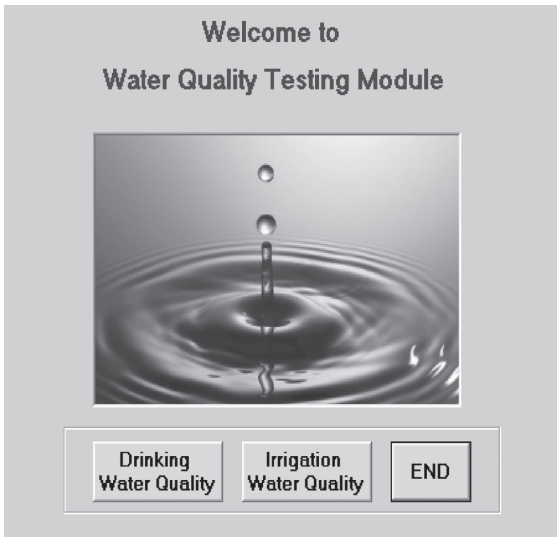

Fig. 1. Welcome window of the Software system

water quality indicators. Performing correlation and regression statistics the study again showed to estimate the indicating variables with least possible effort for periodical assessment of water quality parameters (Das, 2009).

The developed software system after installation automatically starts in a welcome window with title of the application appears with two options to enter in 'Drinking Water module' or 'Irrigation Water module' as shown in Fig.1. After selecting the drinking water module, another form opens with a list of 20 water quality parameters and option to enter the values of the parameters as described in Fig. 2.

The importance and weightage of each water quality parameters were assigned in this software module for calculation of the total usability of the

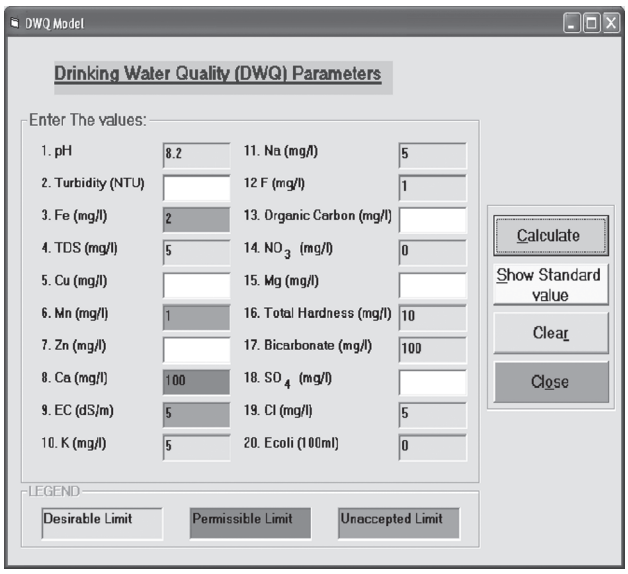

Fig. 2. Data format for entering drinking water quality parameters

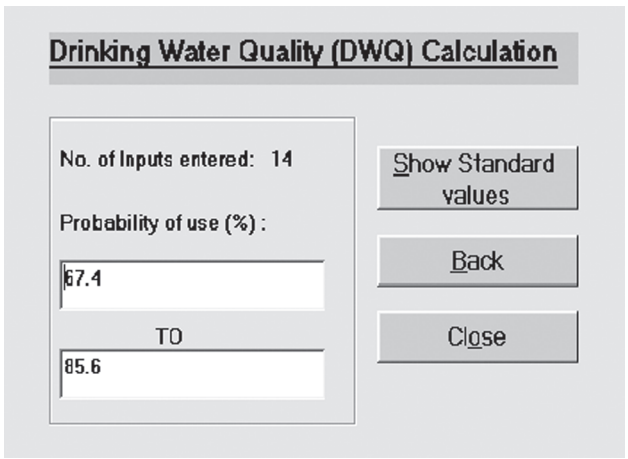

Fig. 3. Result module of the software system

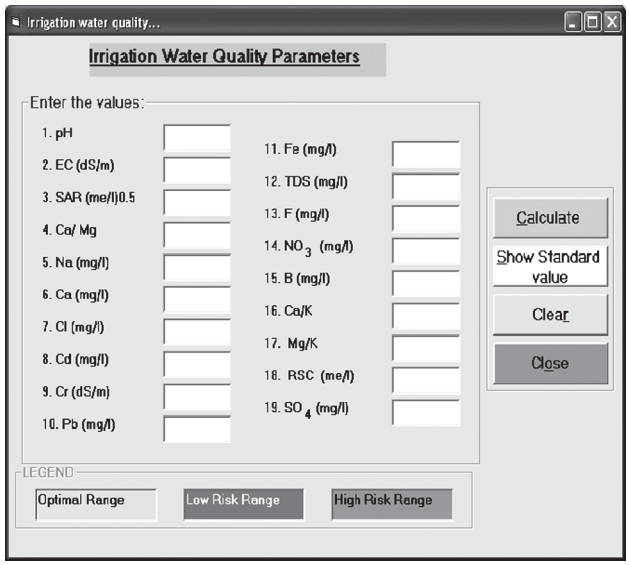

Fig. 4. Software module for testing Irrigation water quality

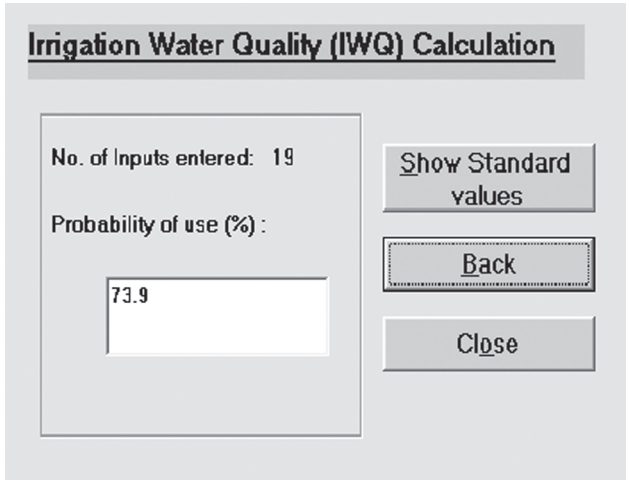

Fig. 5. Result module for irrigation water quality

water. The software system is designed in such a way that while entering the values of the water quality parameters in the text box, the color of the text box changes according to the values for desirable limits, permissible limits and unaccepted limit. The user can easily understand the range of that water quality parameter. After entering the values for the parameters, the user can click on the Calculate button to see the result and the percentage of usability of the water for drinking purposes as shown in Fig. 3. The system shows the outputs like 'The water is not usable', if any one of the three important water quality parameters like Floride, Nitrate or Ecoli is out of range. Another option is also created in the software module to see the standard values for water quality parameters.

While selecting for Irrigation water quality analysis module, a form opens with an option for

entering nineteen water quality parameters into the module as displayed in Fig. 4.

CONCLUSION

This information system developed based on the important water quality parameters for drinking as well as irrigation use. Sustainable development and efficient management of groundwater resources requires an effective information technology tool for the dissemination of information to different stakeholders. This will help to develop appropriate measures in improving the agricultural scenario of the region. This software module can be used as a ready made package for assessing characteristic of water quality parameters for drinking as well as irrigation purposes.

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