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Water Quality Assessment of River Ganga using Remote Sensing and GIS Technique

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Abstract Sustainable management of water resources involves reserve upholding, proficient utilization, and eminence management. Although, activities relating to quantity appraisal and management in terms of river discharge and water resources planning are given attention at the basin level, water quality assessment are still being done at specific locations of major concern. The greatest compensation of using remote sensing data for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain, which is very crucial for booming scrutiny. The GIS technology provides suitable alternatives for proficient supervision of large and intricate databases. Information from satellites is becoming more and more important for natural resources management and research.
Keywords *Ganga; Water Quality; Spatial Distribution; Remote Sensing; GIS*

1. Introduction

Water resources in India are very erratically disseminated both spatially and temporally. Over the years, increasing population, urbanization and extension in agriculture and domestic water utilization has accentuated the circumstances (Sargaonkar and Deshpande, et al., 2003). Water pollution not only affects water quality but also threats human health, economic development and social prosperity (Kumar, et al., 2004). In attendance research is aimed to understand some of the crucial problems of surface quality and management with the help of newest available techniques in an incorporated manner. Ganga, the countrywide river of India, is now miserably exhausted in flow and entirely polluted due to edifice of dams and barrages, expulsion of unprocessed community and industrial wastes, floral assistance and cremation of dead bodies on its bank. A study of Physico-Chemical parameters of surface water quality has been undertaken to evaluate collision of urbanization on water quality of river. Geographic information system (GIS) is used to symbolize the spatial allocation of the parameters and raster maps were produced. The technique also permit identification of the possible factors that influence the water systems and are responsible for the variations in water quality, which thus offers a valuable tool for developing appropriate strategies for effective management of the water resources (Mellinger, 1987; Farnham, et al., 2002; Simeonov, et al., 2003; Simeonova, et al., 2003; Lambrakis, et al., 2004; Mendiguchia, et al., 2004; Singh, et al., 2004). The investigation was carried for pre-monsoon seasons in the month of March. A total 25 samples of river water from Dudhiya Dham to Kankhal was taken in the month of March in the year 2011. Ganga is well thought-out blessed by people for providing the life- giving and life-underneath relieve for the environment and ecology. But today, Ganga has turned into a putrid violent flow greatly polluted with unprocessed mess, industrialized effluents and wastes, or farming runoffs, intercept by massive diversion of flows. The water excellence and human strength are closely associated. The quality of water is mainly disturbed by human actions (Hem, 1991). Nowadays, many industries have developed in Uttarakhand state viz. pharmaceutical, textiles, toy making, colorings etc. They use to assemble the waste directly or indirectly into the watercourse which affects the BOD, COD, turbidity and also causes the Physico-chemical changes.

2. Study Area

Haridwar district is located in south – western part of Uttarakhand State. It lies from 77°58'31.27"E 30°9'20.853"N to 77°46'50.995"E 29°42'45.424"N East longitude and falls in Survey of India Degree Sheet Nos. 53 J, F, G and K. In Figure 1 its revealed that Haridwar district connect to Dehradun and Pauri limits, Bijnor district of Uttar Pradesh in the south-east, southern boundary with Muzaffarnagar district of Uttar Pradesh while the western part is bounded by district Saharanpur. The geographical area of the district is 2360 km^2, gigantic bulk of Haridwar lies within Gangetic Plain, which is composed of fertile alluvial deposits brought down from the Himalaya by the Ganga River its tributaries and distributaries. Figure 3 Shows geology and geomorphologically of district Haridwar and can be alienated into four geomorphic units, these are flood plain, lower piedmont plain, upper piedmont plain and structural hills.

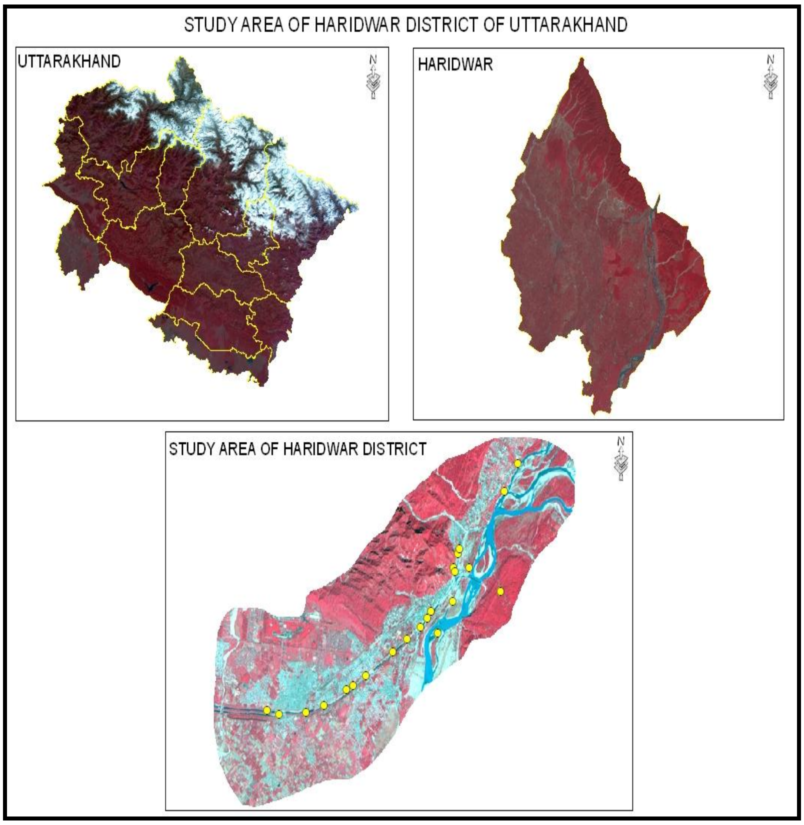

Figure 1: *Location Map of Study Area*

3. Methodology

3.1. Geo Database

The water samples were collected during March 2011. The total 25 samples were collected from Dudhiya Dham to Kankhal area of Haridwar. The samples location were identified and recorded with help of GPS, the water samples collected in prerinsed clean one liter polythene bottle having double stopper facility to its full capacity without entrapping air bubbles inside it when the water samples from all the monitoring stations were received, systematic analysis of the water samples was undertaken. Seven parameters are studied which are necessary for biotic community transparency. Dissolved oxygen, biological oxygen demand for analysis of samples, methods followed was of APHA 1998. Total 25 samples were selected in Haridwar along Ganga River with the help of GPS.

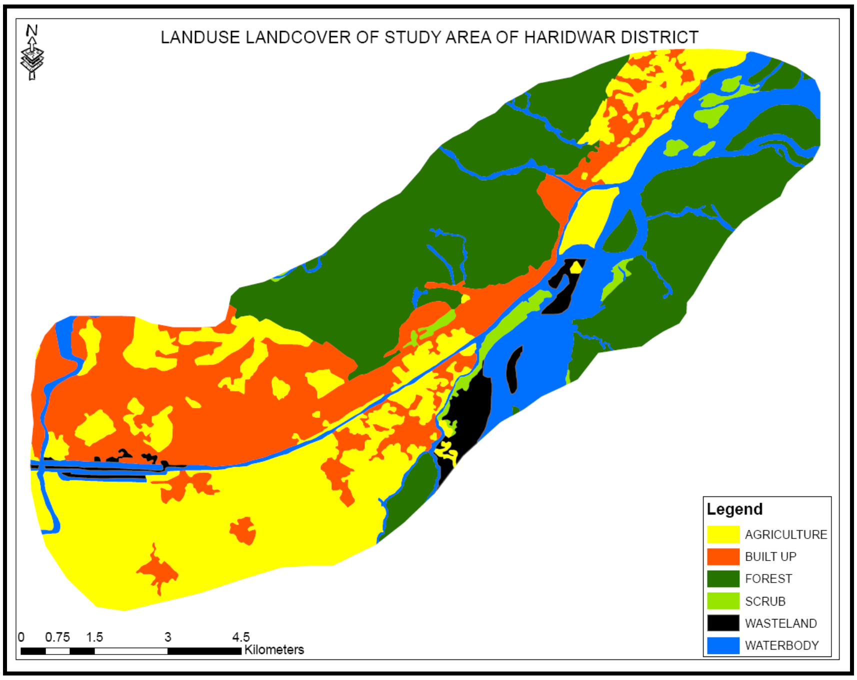

Figure 2: *Landuse and Landcover of the Study Area*

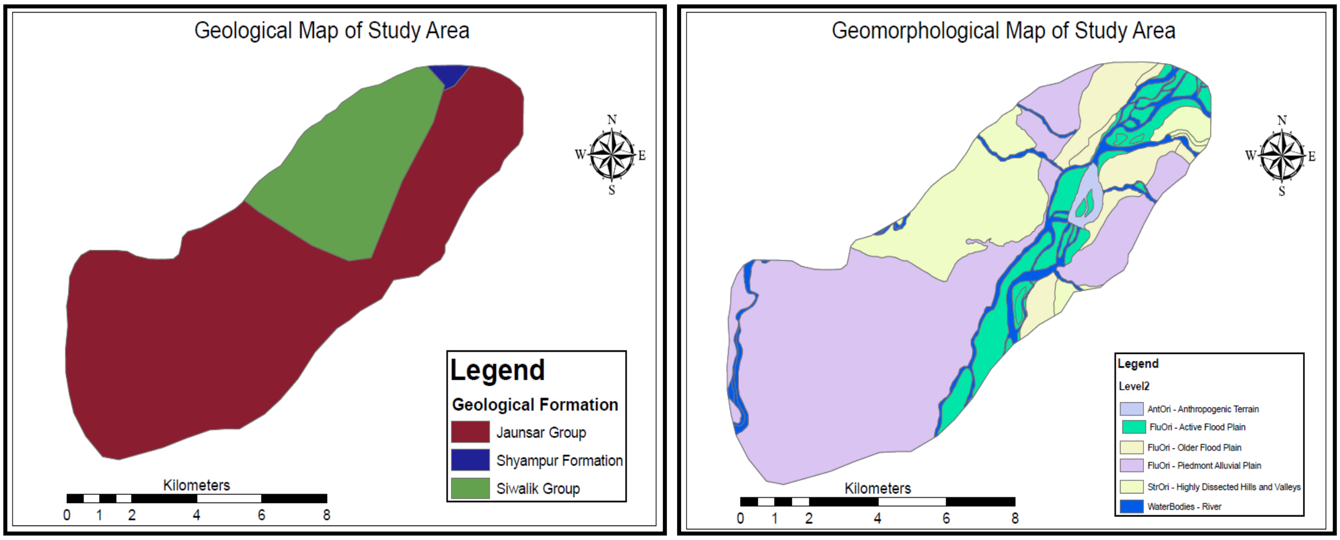

Figure 3: *Geology & Geomorphology of the Study Area*

3.2. Geographic Information System (GIS) Analysis

Geographic Information System (GIS) has the capability for capture, storage, manipulation, analysis and retrieval of multiple layer resource information occurring both in spatial and non spatial forms (Mishra and Patel, et al., 2001). GIS can act as a powerful tool for modeling water quality. Various Thematic maps which are helpful understanding and managing water resources can be prepared with the use of GIS (Bindu and Joshi et al., 2012). In this study spatial interpolation technique through inverse distance weighted (IDW) approach of GIS has been used. In this technique sample points on different locations are selected for estimating output grid value. It determines cell value using a linearly weighted combination of sample points and controls the significance of known points upon the interpolated values based upon their distance from the output point thus a surface grid is generated as thematic isolines (Asadi et al., 2007).

3.3. Concept of IDW Interpolation Method

IDW interpolation explicitly implements the assumption that things that are close to one another are more alike than those that are farther apart. To predict a value for any unmeasured location, IDW will use the measured values surrounding the prediction location. Those measured values closest to the prediction location will have more influence on the predicted value than those farther away. Thus, IDW assumes that each measured point has a local influence that diminishes with distance.

4. Results and Discussion

The average values of the major parameters are taken of water samples collected during premonsoon season in the month of March 2012. Transparency, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Solid (TS), Total Suspended Solid (TSS), Total Dissolved Solid (TDS), and pH are represented with the help of spatial interpolation and GIS technique.

4.1. Dissolved Oxygen

The Dissolved oxygen refers to the amount of oxygen (O) dissolved in water (Abassi, 1999; Dwivedi and Pathak, et al., 2007). In Figure 4 it shows that dissolved oxygen is elevated in Dudhiya Dham and low in Kankhal area. Low DO can result in fetid smelling causing water to infect in many cases. A low Dissolved Oxygen intensity is also a sign of eminent heat that can alter the stability of aquatic life in the river. Dissolved oxygen is usually expressed as a concentration of oxygen in a volume of water; the dissolved oxygen varies from 4.92 to 6.28.

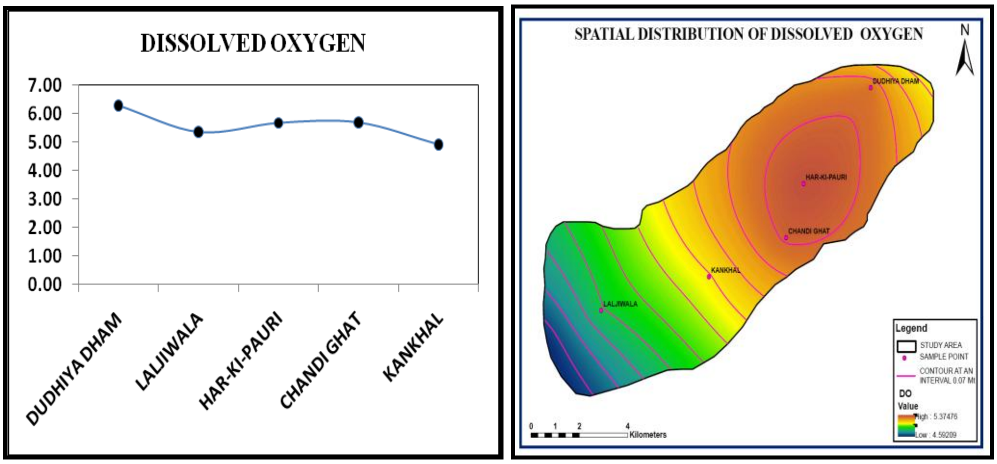

Figure 4: *Dissolved Oxygen*

4.2. Biological Oxygen Demand

Biochemical oxygen demand is used to describe the potential of domestic and industry wastewaters to pollute surface waters. Biochemical oxygen demand measures the amount of oxygen consumed by living organisms (bacteria) in decomposing the organic portion of a waste (Rabee, Abdul-Kareem and Al-Dhamin, et al., 2011). In Figure 5 it shows that Biological Oxygen Demand is moderately high in the city area although it is low in Dudhiya Dham which is relatively less populated. The biochemical oxygen demand of the treated wastewater is used to determine the optimal rate of discharge that will ensure the health of the receiving body of water. The rate of expulsion is predominantly.

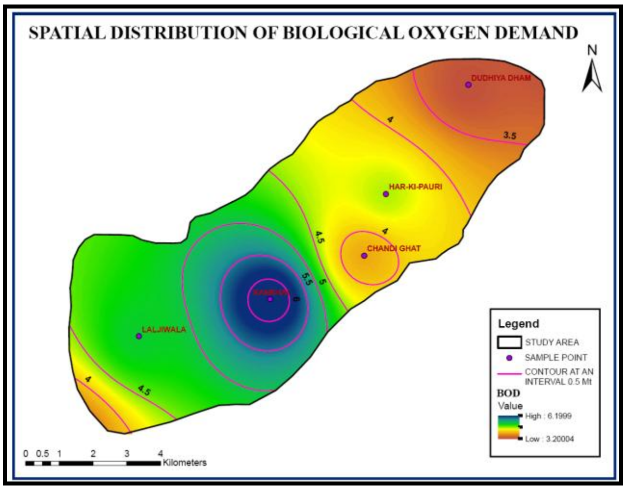

Figure 5: *Biological Oxygen Demand*

4.3. Hydrogen Ion Concentration (Ph)

The pH value of aquatic system is an important indicator of the water quality and the extent pollution. The pH is fairly high in urbanized area and comparatively low in Dudhiya Dham which is less developed as representing in the Figure 6. The pH for the water samples varied from 8.1 to 8.32 with an average value 8.2 which indicates that water is slightly alkaline in nature, leading to serious drinking problem and also dangerous to aquatic biodiversity.

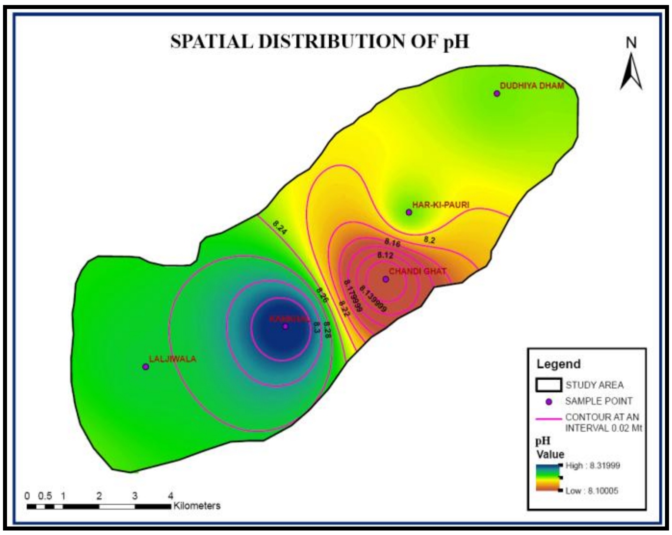

Figure 6: *Hydrogen Ion Concentration*

4.5. Turbidity & Total Suspended Solid

Turbidity refers to water transparency. The greater the amount of suspended solids in the water, the murkier it appears, consequently the turbidity values will be higher. It sound seen in the Figure 7 that turbidity is reasonably high in the centre heart of the city. Turbidity values ranged from a minimum of 24.58 to a maxi-mum of 33.22 with an average value of 28.06 (NTU) while the lowest TSS value was 24.83mg/L and the highest was about 91.45 mg/L.

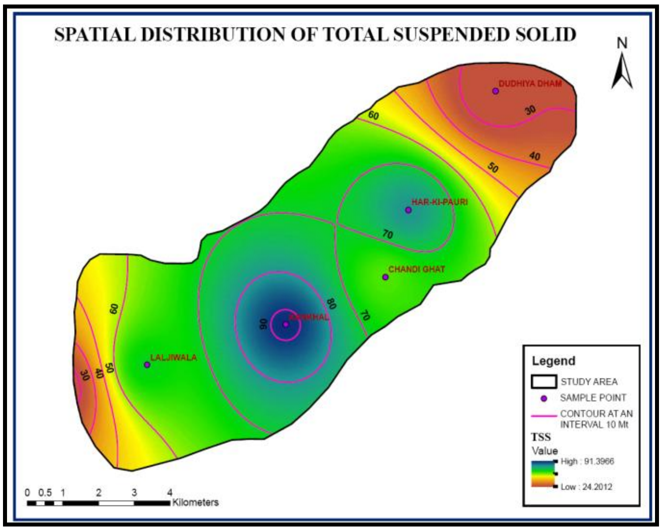

Figure 7: *Total Suspended Solids*

4.4. Total Dissolved Solid

Salinity is expressed in two different ways, either as electrical conductivity (EC) or as Total Dissolved Salts (TDS). The values of Conductivity varied from 793.42 to 1189.76 µs/cm, representing in the Figure 8. TDS values ranged from 335.80 to 988.60 mg/L with an average value of 770.77 mg/L. The most advantageous limit of TDS in drinking water is 500 as per WHO standard, and many of the samples are exceed the limits.

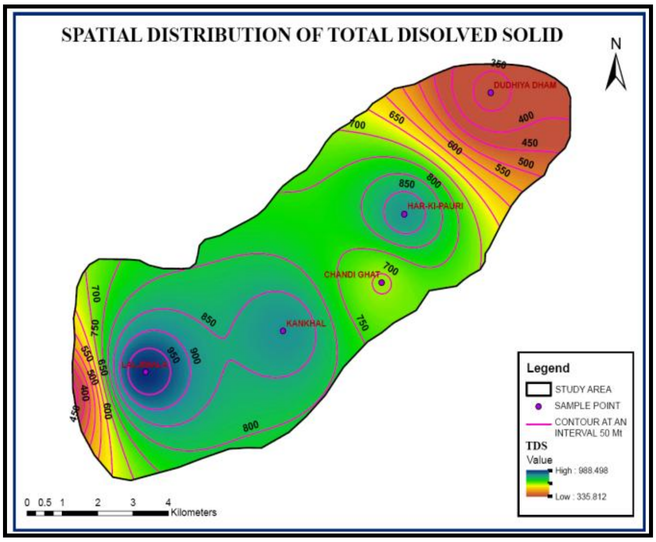

Figure 8: *Total Dissolved Oxygen*

4.6. Transparency

Transparency, like turbidity, is a measure of how far light can travel in water. The transparency of the River water is usually a measure of the relative concentration of the inorganic particles that account for most of the total suspended solids. The fewer particles that occur suspended in a sample of water, the easier it is for light to travel and the higher the water's transparency, or clarity. Transparency is measured using a Secchi disk or a transparency tube (a plastic tube with a Secchi disk pattern at its base).

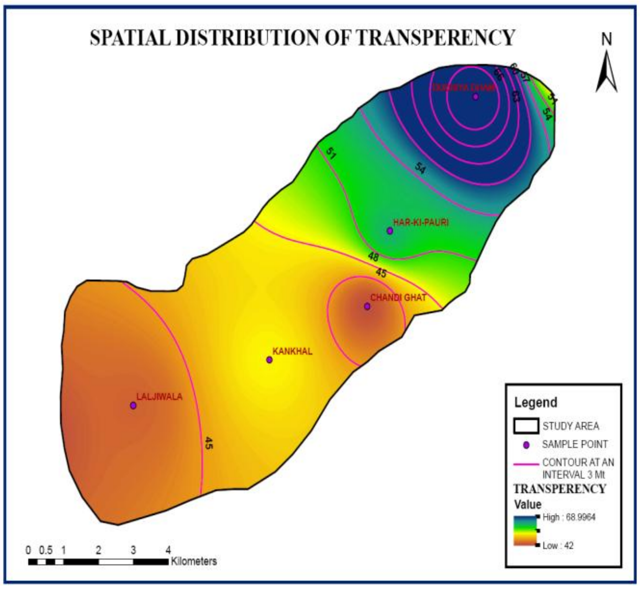

Figure 9: *Transparency*

Water clarity, or transparency, is commonly measured with a Secchi disk. The clarity of lake water is reduced by the presence of suspended sediment, bits of organic matter, free-floating algae, and zooplankton (Jarvie, Neal and Withers, 2006). Secchi disk Transparency is a low-cost and effective measurement of water clarity. A Secchi disk, a 20 centimeter (8 inch) diameter metal or weighted plastic disk normally black and white, is attached to a measured line and lowered into water until it can no longer be seen. The depth at which it disappears is known as the Secchi disk Transparency. The minor the concentration of floating particles, the better the expanse light can go through the column of water and the greater the transparency. In Figure 9 it shows that Transparency is elevated in Dudhiya Dham 69 cm and is stumpy in Kankhal in 48 cm.

Figure 10: *Field Photograph* ***Figure 11:*** *Field Photograph*

5. Conclusion

In recognition of the problem of water pollution in Ganga as of national dimension, the river Ganga was declared as National River by the Prime Minister in 2008 with the constitution of Ganga River Basin Regulatory Authority. It is a solemn pledge to ensure its perennial flow in all its natural quality, quantity and natural piety. It introduces a code of conduct and self-discipline. It aspires for maximum involvement and participation of the people or stake holders, and innovative strategies for its restoration. The spatial distribution analysis of water quality in the study area indicated that many of the samples collected are not satisfying the drinking water quality standards, the dissolved oxygen is decreasing while biological oxygen demand & transparency is increasing as the urban sprawl was expanding which is leading problem to aquatic biodiversity of river. The pH of the water is also high which indicates that water is alkaline in nature. The results obtained gave the necessity of making the public, local administrator and the government to be aware on the crisis of poor water quality prevailing in the area. The government needs to make a scientific and feasible planning for identifying an effective groundwater quality management system and for its implementation. For this, public awareness on the present quality crisis and their involvement and cooperation in the actions of local administrators are very important. Finally, it is concluded that the remote sensing technology has great potential to revolutionize water monitoring and management in the future by providing unique and new data to supplement the conventional field data. Rapidly expanding GIS technology will play a central role in handling the voluminous spatio-temporal data and their effective interpretation, analysis, and presentation, though such applications will raise some new problems. Developing technologies like RS, GPS and GIS are really catalysts for innovative approaches to currently unsolvable water resources problems. The constraints for RS and GIS applications in developing nations must be overcome to reap maximum benefits of these promising technologies.

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