NATIONAL WORKSHOP
on
WATER QUALITY
(Including Drinking Water)

Book of Abstracts

Guest Editor:
AL. Ramanathan
Jawaharlal Nehru University, New Delhi

February 1 - 2, 2002

School of Environmental Sciences
Jawaharlal Nehru University
New Delhi - 110 067

Proposed Notification on River Regulation Zone

a. The notification could be similar to the CRZ notification, and should restrict, regulate or prohibit various activities in specified stretches of rivers to a specified distance on both sides from the natural levee. The distance will vary from a minimum of 500 m to the point reached by the 10- year peak flood in the plains.

b. River courses need to be divided into various "ecozones" or 'reaches' depending upon their climatic and geomorphic features, state of degradation, human use and potential for restoration. The activities to be regulated may be site-specific for each zone. The activities to be regulated include: various forms of encroachment on river beds and floodplains, particularly all permanent constructions; further channelization by levees; disposal of solid wastes, and landfills in floodplains; intensive agriculture using agrochemicals and manure; uncontrolled extraction of sand; intensive grazing and excessive harvesting of vegetation; immersion of idols (especially those using non-degradable and toxic substances); disposal of dead bodies, and religious offerings in indiscriminate manner, etc. Even mass bathing, wallowing of cattle and washing of clothes should be regulated.

c. The MOEF should set up a Committee to draft the notification which must take into consideration all scientific, technical, socio-economic, cultural and administrative aspects. The Draft should be discussed in another Workshop with representatives of different stakeholders, government agencies and administration, before circulation to the States for comments.

Any Comments on this draft notification may be sent to Prof. Brij Gopal, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi - 110 067, Email: dkb0400@mail.jnu.ac.in

ENVIS NEWSLETTER

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EDITORIAL

The sudden demise of Dr. Anil Agarwal, well-known environmentalist is sad news for our ENVIS Centre. He was instrumental in projecting Non-governmental activities in the field of environment including water quality, environmental policy and law. It is hoped that the organisation he founded, namely Centre for Science and Environment will continue all activities initiated by him.

Winter is always a season of seminars and workshops. There is yet another workshop on Water Quality being conducted by one of our faculty members. Hence this issue of the newsletter, with the organiser of the workshop acting as the guest editor, contains all the abstract of the presentations being made in this workshop. This workshop in divided into four broad catagories namely Surface water, Groundwater, Drinking water quality and Water quality modelling. Speakers from across the country and few international members are deliberating these issues.

In addition, the recommendations of the last workshop namely UNESCO-JNU workshop on Ecohydrology held in Nov. 2001 is also given in this newsletter. We are also enclosing herewith the recommendations of MOEF-JNU workshop held in November 2001 on Conservation of River and Floodplains in India conducted by one of our faculty members.

Further, a proposed draft notification on River Regulation Zone is also given for the response of the readers. Due to constraints of space, we have given only a few recent publications and workshops of interest in Biogeochemistry and Environmental law. As usual some recent news items of importance to environment are also listed.

Happy Reading!

Prof. V. Subramanian

Editor

Report and Recommendations
UNESCO - MOEF - ENVIS - JNU
International Training Workshop on ECOHYROLOGY
SES, JNU, New Delhi, During 26-29, Nov. 2001.

During the concluding session held from 9 a.m. to 1 p.m. on 29th Nov. and chaired by Prof. Raymahasay of IIT, Kanpur, the organiser made brief summary of the workshop proceedings. This can be synthesised as follows:

1. During the half day special session on the western Ghat region of Kerala and Karnataka, a number of presentations were made related to the ecosystem in that region. Of the nine technical papers, the first one by V.Subramanian and V.Ittekkot of Germany dealt with the nature of organic matter in the rivers of Kerala; the second paper by Sujatha and others from the Kerala Forest Research Institute, discussed the ecohydrological investigations being carried out by their Institute on some of the interior watershed regions. The third and fourth papers by Anuradha Verma and Sujit Bajpayee of National HydroPower Corporation dealt with the water quality of rivers in Kerala, karnataka and Goa regions. The fifth paper by Pradeep Kumar of Water resources Institute in Calicut considered the effect of forest clearing on some climatic parameters in the watershed while the sixth presentation by Venkatesh from National Institute of Hydrology focussed on the hydrological and Soil impact of natural and anthropogenic forest disturbances. The seventh speaker Thiruvikramji from Kerala University talked about solute variations in some of the minor water sheds in Kerala while the eighth speaker Raymahasay from Indian Institute of technology, Kanpur showed a modelling approach to understanding the sediment and water geochemical aspects of rivers in general and the last speaker Srinivasa Murthy of Madras University gave a paper on ground water quality in some of the western Ghat region of Tamil Nadu. Thus, the session discussed a wide range of approach to ecohydrological studies of the western Ghat region in Kerala.
2. Based on presentations made as stated above along with the suggestions given by the session chairpersons (Prof. P.S. Ramakrishnan of JNU and professor Narendra Saikya of Nepal), a research proposal on Western Ghats water sheds in Kerala and Karnataka involving a number of institutes working in the areas, with the co-ordination of JNU, will be made and edited by circulation to the participating organisations and finalised before submission to UNESCO.
3. Similarly presentations, numbering thirty-six were made during the other sessions of the workshop dealing on a wide ranging topics and regions. These discussions will be suitably synthesised and an inter regional project proposal will be worked out in consultations with the experts in neighbouring countries for the consideration of suitable regional level funding sources.
4. All the invited speakers and active participants in the Training workshop were given certificate of participation duly signed by the Dean of the School of Environmental Sciences, JNU.

Abstracts of Proceedings of the National Workshop on Water Quality (including drinking water). During 1 - 2nd February, 2002, at SES, JNU, New Delhi - 67

Theme – Surface Water

CHEMICAL BASIS FOR WATER QUALITY PARAMETERS

V. Subramanian

School of Environmental Sciences, JNU, New Delhi - 110 067

Almost all the inorganic and organic parameters that are used to define water quality has chemical origin. Either they are: (a) Naturally derived during the soil-water interaction in case of surface waters and aquifer rocks in case of ground waters; (b) Derived from enriched mineral sources particularly for elements such as Arsenic, Mercury and other toxic metals; (c) Contributed by uncontrolled effluents from different types of industries; (d) Urban area input from domestic and other sources; (e) Spillage during transportation processes of various natural and man made materials; (f) Sea water intrusion into the sub-surface water region in coastal areas; (g) Agricultural run off in cultivated regions; (h) Atmospheric deposition, both wet and dry, direct onto various water bodies; (i) Dispersal of wind transported particles in dry regions and their chemical interaction in the aquatic environment and finally (j) In-situ modification of water due to water- sediment- biota and organic interaction both in stagnant and moving water bodies. For each such situation, the nature of interaction can be easily quantified and hence source assigned for specific contaminants. Mass balance calculation is essentially to account for individual parameters from its source to its sink . Microbiological properties, generally measured and normalised in terms of Most Probable Number, have independent origin but their levels are generally related to chemical and/ physical processes that take place in the water column. Caution should be exercised in comparing quality of a given water body to various known standards since these standards - CPCB, WHO or EPA- have specific conditions of application.

WATER QUALITY (PHYSICO-CHEMICAL) ANALYSIS OF HARIKE WETLAND, PUNJAB

Arshdeep Kaur, Chader Parkash and Anish Dua

Department of Zoology, Guru Nanak Dev University, Amritsar

Harike Wetland, a designated Ramsar site is at the confluence of two rivers, the Sutlej and the Beas and is situated in the Punjab State. The rivers are the easternmost tributaries of the Indus river system. The wetland supports a very good fishery and attracts a large number of migratory birds every winter. The present study revealed that the water quality is deteriorating at all the sites and the damage is more towards the river Sutlej. This can be related to more townships and industries on the

banks of Sutlej. It was observed that there is a gradual increase in Temperature, Electrolytic Conductivity, Total Dissolved Solids, Alkalinity, Hardness, Calcium and Magnesium in the Harike waters. This can be attributed to increased siltation, discharge of untreated effluents & municipal waste, and pollution due to agrochemicals from the nearby agricultural fields. Dissolved Oxygen remained about 7 mg/L almost throughout the period. The hardness and total alkalinity values remained above 80 mg/L and 60 mg/L respectively.

THE NEYYAR RIVER BASIN, KEARLA, INDIA: A HYDROGEOCHEMICAL PORTARIT

Sabu Joseph[1] and K.P. Thrivikramaji[2]

[1]Dept. of Environmental Sciences and [2]Dept. of Geology,
University of Kerala, Kariavattom Campus, 695 581

The Neyyar river basin (area= 492 km^2) located on the western slope of Western Ghats in Kerala (N.Lat. 8°15′00″ & 8°40′00″ and E. Long. 77°00′00″ & 77°20′00″), originates at a place called Agastyamalai in the highland, flows through the midland and low land before finally joining the Laccadive sea at Poovar. This sixth order river (length= 73 Km), with its stream net in rural and / or urban settings, monsoonal climate with a distinct seasonality and intensely farmed catchment, attracts large inputs of chemical fertilizers, soil amendments and pesticides into it. A dam to store water for irrigation, constructed in the highland created a reservoir and resulted in flow regulation. In this study, the river load, (both dissolved, DL and suspended, SL) discharge and their characteristics and transformations due to anthropogenic actions are examined.

Like in other monsoonal river system draining a Precambrian crystalline terrain, the dominant ionic constituents of the dissolved load (DL) are calcium, sodium, potassium, magnesium, chloride, silica, sulphate, and bicarbonate. Chemical erosion, anthropogenic input of materials and atmospheric contribution dictated the profile of the dissolved concentration of elements in the river. Concentration of the ions are within permissible limits and the water in Neyyar falls with in the drinking water standard. As expected in any other part of the world, the relation between suspended load (SL) and dissolved load (DL) content are complementary. In the summer season or during the base flow stage, the SL content is minimal, whereas the DL is very dominant. But opposite is true for the monsoon season or the bankful stage. Borrowing of river-bed-sand has immensely contributed to a sharp increase in SL even during base-flow.

GEOCHEMICAL COMPOSITION OF THE FLOATING SOIL MASSES OF THE LOKTAK LAKE: A WATER QUALITY IMPACT PERSPECTIVE

Chandan Mahanta

Civil Engineering Department, IIT Guwahati, Guwahati-781039, Assam

Some key aspects of hydrology, biodiversity and water quality of the Loktak lake (largest wetland of Northeast India; catchment area 980 sq. km.) are associated

with its heterogeneous floating soil mass (few centimeters to several metres in size) mixed with vegetation and organic matter locally called "Phumdi". Mostly composed of free-floating plants and partly decomposed roots and rhizomes, these have caused severe infestation throughout the total water-spread area of almost 500 sq. km, occupying about two third of the lake. The proliferation of phumdis have led to reduced water holding capacity, deterioration of water quality, interference in navigation, declined power generation capacity and fallen overall aesthetic value of the lake. Without adequate baseline data, the cause of degradation of the lake ecosystem cannot be determined. However, water chemistry and particulate geochemistry of these floating mass and exchange of chemicals with the underlying water has remained unexplored. In this effort, pore-water and soil samples collected from different phumdis at selected locations were analyzed to study the major ion chemistry and particulate chemical concentrations to have an idea about the extent of degradation of the lake. The soils contained in the phumdis indicated low bulk density (0.12 to 0.28 g/cm^2) and high porosity (45% to 58%). Water chemistry of the samples collected around the floating mass scattered over different parts of the lake indicated low dissolved oxygen level ranging between 1.5 to 5 mg/l and slightly acidic pH values. Nutrient availability was indicated to be low with dissolved P concentration of the order of 0.1 to 0.3 mg/l. The soil masses showed particulate organic carbon ranging between 11% and 16%. Mean concentrations of a few trace metals both in the phumdis and bottom soils were found to be similar to natural background values indicating little change in the settling silt load (about 0.34 million tonnes estimated to be deposited each year) brought by runoff, though the phumdi soils were richer in organic matter than the bottom sediments, exhibiting high adsorption potential. Soil samples collected from the phumdis indicated organic matter content as high as 36%. Siltation (mainly due to large scale deforestation, landslide and road construction in the catchment), human encroachment, acute eutrophication and chemical pollution are the major factors of water quality deterioration in the Loktak lake. Industrial effluents are negligible, but fertilizers and pesticides used in agricultural practices around the lake, municipal wastes brought by Nambul river that runs through the Imphal city, soil nutrients from the denuded catchment area and domestic sewage from extensive settlements in and around the lake are responsible for degraded water quality

The hydrology of Loktakl lake is complex. Though the processes of water quality deterioration and quantity reduction in the Loktak lake are yet to be clearly understood and correctly estimated, the chemical composition of the floating soil masses provides ground for a qualitative assessment. The current over-exploitation of the lake is likely to continue, resulting in increasing pollution and further degradation of the lake in future. Considering the spread of the lake in the Moirang valley and its role for fisheries and biodiversity, the impact to the ecology of the entire region could be critical. Current restoration efforts have not been adequate to counter this trend so far. Enhanced water holding capacity by hydrologic interventions at critical

zones and control of nutrient input/pollutants from point and non-point sources are necessary to improve flow, capacity and water quality.

ROLE OF RIVERS IN GLOBAL CLIMATE CHANGE

Deepak Dhingra and Ashis Kumar Patra
Department of Earth Sciences, Indian Institute of Technology, Roorkee - 247 667

Rivers are the major weathering agents on the continents and carry enormous amounts of water and sediments (dissolved and suspended) into the world's oceans From our understanding of the geochemistry of natural waters, it is clear that chemical weathering of silicates leads to consumption of carbon dioxide which is a greenhouse gas. The relationship of weathering and CO_2 drawdown can be understood by following equation:

$CaSiO_3 + 3H_2O + 2CO_2 \rightarrow Ca^{2+} + H_4SiO_4 + 2HCO_3$(2 moles released)

$Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$(Only 1 Mole released)

For every mole of silicate weathered, 1 mole of CO_2 is locked and not returned to the atmosphere. Over a period of time, they may lead to CO_2 deficit in atmosphere and thereby lead to global cooling. Different drainage basins have different geological set up such as varied lithology and different physico-chemical environment and tectonics. Then, of course, each river has got a different discharge. The waters draining different types of rocks are characterized by their own chemical and isotopic signature. This signature depends both upon on chemical composition of bedrock and on the rate at which it is eroded. The Sr isotopic ratio, Ca/Na, HCO_3/ Na and Mg/Na ratios are particularly well suited to distinguish between carbonate, silicate or rain. We basically aim at understanding the contribution of different geological set ups in terms of carbon dioxide draw down by studying their signature in river water.

HYDROCHEMICAL CHARACTERISITIC OF RAINFED SURFACE WATER TANKS IN RAMANATHAPURAM COAST, TAMILNADU

B. Gowthaman, K. Vaithiyanathan and J.F. Lawrence
Department of Geology, Presidency College, Chennai - 600 005.

Water both groundwater and surface water is the most vital resource, which is contributing a major share in meeting the requirements of domestic, industrial and agricultural needs. Ramanathapuram coast is a semi-arid region, which receives a annual average rainfall of 980 mm. The Northeast monsoon contributes 70 % of rainfall. Nearly 900 naturally formed rainfed tanks in geological past of the study area holds the rainwater during the monsoon and for a short while in the post monsoon too. Twenty-eight samples have been collected during monsoon period of year 2000 from the surface tanks of the study area and analyzed. With the analyzed results, the surface water has been classified using HYCH program. The following thematic maps have been prepared Viz. Total Dissolved Solids, Salinity and Sodium Hazard, Hardness,

Chloride / Bi-carbonate ratio and Water Classification using GIS. From these, it is inferred that water resources are affected by the saline water encroachment along the northeastern and Southern coastal regions. Interior parts fall under fresh water having some intermediate water quality. C5S4 type water, which type water having very high Sodium and high Salinity is observed along the above mentioned coastal regions. Similarly brackish salt and permanent hard water have been identified along the same coastal locations. Groundwater is being pumped near Uppur and Valinokkam (Loc.s 9 & 26) for the saltpans and these development activities may enhance the salinity water encroachment of this area.

ENVIRONMENTAL GEOCHEMISTRY OF TAMIRAPARANI RIVER BASIN, SOUTH INDIA

R. Arthur James and R. Ramesh

Institute for Ocean Management, Anna University, Chennai - 600 025.

Fresh water is a finite resource that without appropriate consideration given to its quantity and quality will not support development particularly in perennial river basin. The major causes of water quality degradation in river basin includes, discharge of toxic chemicals, long range transport of atmospheric pollutants and contamination of river water in substances such as excess of nutrients N and P. The Tamiraparani river basin is one of the most important smaller and perennial river basin in Tamil Nadu. It originates in the Western Ghats and meanders through a distance of about 150 km with a drainage area of 5869 km^2. The geochemistry of the river water shows alkaline nature. The total dissolved solids (TDS) are higher during summer (520 mg/l) and lower during monsoon (360 mg/l) season. The rock water interaction and ground water inflow influences the water chemistry. Among the major ions HCO_3 derives from both silicate (54%) and carbonate (44%) weathering. Chloride contributes about 26% followed by Na (8%), SO_4 (7%), Ca (5%), Mg and H_4SiO_4 (4%) of the total dissolved solids. A five fold increase in trace metals (As, Cr, Cu, Ni, Se and Zn) were observed in the downstream region which is derived mainly from anthropogenic sources.

PRELIMINARY STUDY ON WATER QUALITY ON RIVER INDUS

N. Madhavan

School of Environmental Sciences, Jawaharlal Nehru University, New Delhi

Major ion chemistry of the Indus, and most of its headwater tributaries show the following order Ca (54 ppm) > Mg (12 ppm) > Na+K (10 ppm) and HCO_3 (64 ppm) > SO_4+Cl (28 ppm). In the Indus River tributaries, however, Na+K (7 ppm) and SO_4+Cl (15 ppm) predominate. The Sr component in the source water of Indus (glacial water) is less (0.02 ppm). The calculated Ca/Na, Sr/Na ratios, and strontium compositions of these glacial melts show they represent the silicate end member. These calculations suggest that Sr in the glacial melt water is of silicate origin. The Sr in main channel of Indus is 0.3 ppm and has to be supplied from other sources such as weathering

of carbonates and evaporites. This study underscores the importance of weathering of silicates, carbonates, and evaporites in contributing to the Sr concentration and the source waters of the various smaller glacial melts to the major river Indus. The freshwater resource is difficult to assess, owing to a complex and rapidly changing geography of water supply and use.

RECENT VIEWS ON WATER QUALITY AND RIVER BASIN MANAGEMENT IN EUROPE

L.C. Lundin and R.K. Saxena

Dept of Earth Sciences, Uppsala University, Sweden

In Europe and elsewhere there has been a focus on water management and water quality since the mid-90's. It has been realized that solving problems with water quality calls for a holistic view of the catchment, including the land use and human activities within it. The recently implemented EU Water Framework Directive aims to ensure sustainable water use by year 2010 in all Member States. The main concept in the directive is to focus on the river basins, ensuring that all measures work together coherently. In Sweden, being a Member State, the directive is in the process of implementation, leading to a new legislation, merging 15 environmental acts into one Environmental Code. A division of the country into a number (most likely in the order of ten) pertaining to River Basin Districts with their own River Basin Authorities, including a common district and authority seated in Finland for the northernmost river basins, is being set up. Fifteen environmental quality objectives (EQO) have been decided upon, of which six directly aim at improved water quality and most others have indirect impact on water quality, e.g., "a varied agricultural landscape". In general the EQOs state that: groundwater should be of high quality, lakes and watercourses should be potential sources of water supply, nutrients and pollutants should not affect marine environments, and unnatural eutrophication and acidification should be eradicated. The plans span over the next 20-25 years. The legislation and objectives call for new approaches within water management and research in several areas; e.g., monitoring networks, assessment of natural background levels, development of holistic approaches to river basin processes, and mass budgets of nutrients and pollutants at various scales.

EFFECT OF LAND-USE CHANGE ON WATER QUALITY OF THE TAMIRAPARANI RIVER BASIN, SOUTH INDIA

R. Ramesh

Institute for Ocean Management, Anna University, Chennai - 600 025

Water and land are primary resources that face serious conflicts among sectoral users. The available land is undergoing rapid changes in its use and cover and so is the quality and quantity of the available water. Central questions pertaining to the effects of changes in land-use and land-cover on water quality are:

a) What are the causes, processes, impacts and responses of these changes in land use and cover on water resources utilization, particularly during the recent times?

b) Is it possible to estimate in reasonable terms, the magnitude, direction and pace of these changes?
c) How can the understanding of the land use and land cover dynamics and changing water quality, be used for policy guidance?

These are essentially the questions that have been addressed in this paper for a specific river basin: the Tamiraparani.

The Tamiraparani river basin is one of the most important perennial river basins in Tamil Nadu, south India. The conversion of forests to agricultural land has had an impact on the biogeochemical cycles of C, N and P. This paper focuses on nutrient biogeochemistry and its transport characteristics within the river and its flux to the Bay of Bengal. Spatial and seasonal variations of dissolved inorganic nutrients (NO_3^-, NO_2^-, NH_4^+, PO_4^{3-}, TDP and H_4SiO_4) were measured from the samples collected from the entire basin, for both the pre and post-monsoon seasons. Distinct seasonal variability in nutrients especially N and P was obvious. In general, the nutrient concentrations were high in the entire river basin but distinct changes were observed between the pre and post monsoon seasons. The very high nutrient levels observed in the headwaters during post-monsoon rapidly decreases with increasing river order. In the mid-stream, the effect of dam plays a vital role in the temporary storage of nutrients during pre-monsoon. However, when discharge is high during monsoon, the effect of floodwaters is felt far below, giving rise to very small spatial changes in nutrient levels in the downstream region. Thus, a clear stratification in nutrient content between the upstream and downstream reaches has been observed and is represented as: forest watershed (upstream)> agricultural inputs (downstream) damming (midstream). It is also clear that in the downstream region, excessive runoff from agricultural areas has significantly elevated N and P content at the point of confluence with the Bay of Bengal.

The most dominant river basin change in land use in this river basin has been the clearing for forests for agriculture. Because of this, non-point sources of pollution (viz., agricultural runoff) have increased considerably over the recent past. Intensive agricultural practices in this basin has led to the additional input of fertilizers which again is a significant N and P source to the river basin. The vast differences in spatial distribution of nutrients through the course of the river is due to the confluence of several tributaries, channels and canals entering the main river at different points. In addition, the presence of large dams across the river plays a vital role in trapping the nutrients particularly during summer. Hence, we have observed a non-linear distribution of nutrients and other elements through the entire course of the river. Our results show that agricultural activities have caused a two-fold increase in nutrient level in the surface water during post-monsoon, in comparison to the pre-monsoon. In the upstream region, the natural forest ecosystem enhances storage of N while the presence of reservoirs reduces nutrient concentration in the midstream significantly. Sediments on the upstream part of the river (forested), act as a sink for C and N with a high concentration of total carbon (2.2%), nitrogen

(0.13%) and amino acid (574 µg/l) and decreases significantly as it flows downwards through the urban and agricultural landscapes. However, in the coastal zone, the concentration of C and N increases because of the capacity of the estuarine ecosystem to trap the nutrients and other organic matter derived from the upstream sources, either naturally or through pollution.

Besides "anthropogenic nutrients", this river also receives organochlorine pesticide residues from non-point sources. It has been estimated that HCH residue levels in the surface waters (51 - 829 ng/l) is quite significant in comparison to the major world rivers. In spite of the ban on usage of DDT compounds for agriculture, we have recorded high quantities of this compound at two locations (> 5 ng/l) along the entire river. Perhaps, the persistent use of DDT in eradicating mosquitoes contributes to its high levels in the surface waters and in the sediments.

The estuarine system thereby acts as an effective filter for sediments and pollutants in the coastal zone. Other factors that probably influence nutrient distribution in the Tamiraparani River include the N:P ratio - the nutrient utilization by phytoplankton or primary production. Phosphorus was found to be the controlling nutrient in this river basin. Two main problems have been identified based on the biogeochemistry of this river: i) effect of damming, which significantly restricts not only water movement but also nutrient fluxes from the upstream to the Bay; ii) non-point sources such as agricultural runoff, largely affects the surface water quality.

HYPORHEIC BIOTOPE : A SELF PURIFICATION ZONE IN FLUVIAL ECOSYSTEM

Ramesh C. Sharma

Department of Environmental sciences, H.N.B.Garhwal University, Post box-67, Srinagar-Garhwal, 246 174, Uttaranchal

Hyporheic biotope is a potential characteristic of an aquatic ecosystem. It acts as a refuge/hatchery for the aquatic fauna. Hyporheic organisms have been recently recognized as one of the most potential and essential characteristics of the life for the proper functioning of aquatic ecosystem and as means for coping with natural and anthropogenic environmental changes. River water in the Garhwal. Himalaya is deteriorated by non-point pollution, natural and anthropogenic disturbances in the catchment area. Hyporheic biotope, the ecotone between the surface and groundwater of mountain fluvial ecosystem has been identified as a potential zone fore self-purification of infiltrated water through filtration, sedimentation deposition and biological decomposition. This zone is the most vulnerable habitat to environmental change. Hyporheic habitat of Garhwal stream heterotrophic light discontinuity serves as a dividing line between surface and ground water. Functioning of the Hyporheic biotope of fluvial ecosystems of Alaknanda river of Garhwal Himalaya has been assessed through the examination of environmental variables (substrate, temperature, conductivity, DO, pH, PO_4, NO_3, etc.,). Inventorying and monitoring of Hyporheic organisms (macrozoobenthos, microzoobenthos,

microphytobenthos and microbes) have been undertaken for a period of two years for identifying their role in improving the quality of water of the Alaknanda Diversity indices of Hyporheic organisms have also been calculated for assessing the quality of water. Suggestion has been made for conserving the Hyporheic organisms so that they can be instrumental in improving the quality of the water of the river Alaknanda.

WATER POLLUTION DUE TO DISPOSAL OF INDUSTRIAL EFFLUENT IN THE VICINITY OF COPPER AND FERTILISER COMPLEX

S.K. Singh

Civil Engineering Department, Delhi College of Engineering, Bawana Road, Delhi - 110 042

Water is one of the basic need of human being. Due to urbanisation and industrialisation pollution of water resources is taking place. Ground water pollution is more serious than the surface water pollution as even detection of ground water pollution is difficult. Ground water in our country is getting polluted because of percolation of different sorts of wastes being disposed on surface or into sub-surface. The polluted water which is source of water supply causes a number of water related infections and diseases to the human being. A case study of ground water contamination from industrial effluent has been discussed in this paper. Khetri Copper Plant which is a constituent of Hindustan Copper Limited is situated in Khetri area of Rajasthan. The effluent from this industrial complex is being discharged into a seasonal river Singhana through a nallah. The study shows that the ground water in nearby area has been deteriorated considerably due to effluent disposal. The effect of rain on quality of ground water has also been discussed. In nearby area it is observed that the concentration of contaminants has also increased after rain, inspite of getting reduced due to dilution taking place due to recharge of ground water.

INFLUENCE OF WATER QUALITY ON THE RIVERINE ECOLOGY OF THE RIVER BRAHMAPUTRA

S.P. Biswas and Sanchita Boruah

Department of Life Sciences, Dibrugarh University, Assam, 786 004

The water quality of the river Brahmaputra is highly influenced by a wide range of natural factors (geological, hydrological, meteorological, topographical) as well as anthropogenic (deforestation, construction for flood control, wetland drainage) which in turn has influenced the stability of the river ecosystem. This has resulted in the zonation of the river into five different habitats therefore influencing the faunal distribution. The ecohydrology and nutrient status of the river water is interlinked with annual floods and the present study shows a positive correlation of the hydrobiological characters with transparency ($r = 0.73$; $P < 0.05$) and TDS ($r = 0.51$; $P = 0.05$) while negative correlation with current flow ($r = -0.59$; $P = 0.05$) and water temperature ($r = -0.42$; $P = 0.05$). The ecotonal or riparian zones provide adequate food and shelter and also breeding ground for the riverine fauna during flood and enhance

the productivity of the riverine ecosystem. Fish yield is also found to be positively correlated with flood impulse ((r = 0.81; P < 0.05).

MICROBIAL QUALITY OF TREATED DOMESTIC WASTEWATER IN URBAN AREAS: STATUS AND ISSUES

M. Sundaravadivel and S. V. Srinivasan

Central Pollution Control Board, East Arjun Nagar, Delhi - 110 032

Rapid urbanisation in India has lead to generation of huge quantity of domestic wastewater in urban areas. Most of the cities and towns collect and treat their wastewater using sewage treatment plants (STPs) before disposing into the environment. The treatment units installed in these STPs satisfy mainly the standards for BOD, COD, SS etc., prescribed by regulatory bodies. Water quality monitoring studies carried out by various national and international agencies (including the Central Pollution Control Board) often report that the freshwater bodies in India contain high levels of organic and microbial pollutants. Despite being identified as one of the major water polluting parameters, limiting microbiological standards have yet to be prescribed for disposal of domestic wastewater.

In this paper, the performance of STPs employing different treatment technologies with respect to microbiological parameters in terms of Total Coliform (TC) and Fecal Coliform (FC) removal efficiencies are reported. From the analysis of these results, the need for technologies that can improve microbiological quality of wastewater is identified, as also for prescription of standards for microbiological parameters for urban wastewaters.

NUTRIENT ENRICHMENT DUE TO POINT AND NON-POINT SOURCE OF POLLUTION IN TWO DIFFERENT AQUATIC BODIES

M. Vikram Reddy

Department of Zoology & Environmental Science Prog.

Applied Ecology Laboratory, Kakatiya University, Warangal - 506 009, A. P

Plant nutrients particularly nitrogen and phosphorus in excess quantities entering the aquatic bodies both lotic and lentic ones from the catchment areas cause nutrient enrichment, a condition known as Eutrophication of these water bodies. An investigation was carried out on the nutrient enrichment, using bioindicators, due to point source pollution, muniipal sewage inflowing into an urban lake, and the non-point source pollution being agricultural run-off draining into a rivulet running amidst the paddy fields. Both of these water bodies were observed since last five years, their water surface being thickly covered by water hyacinth. However, earlier to that the macrophyte was not seen on both of these water bodies. Some of the water quality parameters of these two water bodies such as dissolved oxygen, biological oxygen demand, pH, hardness, nitrogen nitrate and phosphate were analyzed. The mean dissolved oxygen levels varied from <1 mg/l to about 3 mg/l at different stations in the littoral zone of the lake. When the inflow of the municipal sewage was prevented

to a large extent by constructing a physical barrier, entering the lake the dissolved oxygen levels improved significantly in the littoral zone water of the lake. Some of the benthic macroinvertebrate bioindicators, Tubificidae, larvae and pupae of Chironomidae, and other dipteran species, of organic pollution, present earlier disappeared and the density of the former one that was dominant, declined. However, the agricultural run-off containing the nutrients applied in the form of inorganic and organic fertilizers in farmers' paddy fields, could not be stopped entering the rivulet due to which there was a perrenial cover of water hyacinth on the surface of its water. Its dissolved oxygen levels at different stations were low, which was due to the pimary and secondary effects of nutrient enrichment.

SOLUTE ACQUISITION PROCESSES CONTROLLING CHEMISTRY OF GLACIAL MELTWATERS IN THE GANGA HEADWATER STREAMS, GARHWAL HIMALAYAN, INDIA

Syed I. Hasnain

Glacier Research Group, School of Environmental Sciences

JNU, New Delhi - 110 067

Detailed analytical data base of major cations and anions have been created on glacier melt-waters and proglacial streams during last decade in the Garhwal Himalyan to assess the Geochemical processes. Ca^{2+} and Mg^{+} are the major cations and HCO_3^- and SO_4^{2-} are the most dominant anions in these waters. A high correlation among HCO_3, Ca and Mg a relatively high contribution of (Ca + Mg) to the total cations (TZ+) and high (Ca + Mg/ Na + K) ratio indicate carbonate weathering could be the primary source of the dissolved ions. Carbonic acid weathering is the major portions - producing reactions in the Alakananda River, while it is coupled reaction, which controls the solute acquisition processes. Dominance of Ca^{2+}, HCO_3^- and SO_4^{2-} in glacial meltwater near the glacier snouts and downstream suggests that the weathering is dominated by coupled reactions involving sulphide oxidation and carbonate dissolution. To know the geochemical factors controlling the chemical nature of water, R- mode factor analysis on major ion data from headwater streams has been performed.

MEASURES FOR SILT FREE WATER IN POWER CANAL

P.L. Patel

Delhi College of Engineering, Delhi - 110 042

Several measures like silt excluder and silt extractor are being provisioned to control the silt entry into power canal and thus ensure silt free water for power houses apart from discuuing these measures in brief, existing design considerations of silt excluder have been discussed. Some existing criteria for design of sediment excluder, require modification based on some recent investigation on bed load and suspended load transport of non-uniform sediment. These proposed modifications are described in detail with their improvements over existing criteria.

HYDROCHEMISTRY OF FEW RIVERS DRAINING THE WESTERN GHATS, INDIA

Anuradha Verma[1] and Sujit Kumar Bajpayee[2]

[1] School of Environmental Sciences, JNU, New Delhi - 110 067,

[2] NHPC Ltd, Teesta-V, HE project, Singtam, Sikkim

Water samples were collected from a few rivers draining the Western Ghats between 1999 and 2001 in pre-monsoon, monsoon and post-monsoon. The rivers showed significant seasonal variation in the total dissolved solids (TDS) between the seasons due to the difference in surface runoff and marine influence. Chloride is the most abundant anion in the Mandovi, Zuari and Kalinadi. The rivers of Kerala on contrast have bicarbonate followed by chloride as major anion and calcium and magnesium as major cation. The marine influence was more prominent in the rivers Mandovi, Zuari (in Goa) and Kalinadi (in Karnataka) as compared to the rivers in Kerala as indicated by the Gibbs diagram. The silica stability diagrams are consistent with the presence of keolinite along with chlorite and illite in the sediments of the rivers. The rivers of Goa and Karnataka have significantly higher denundation rates due to the high gradients as compared to the rivers of Kerala. These rivers contribute about 54 x 10^6 t/yr of dissolved load to the Arabian Sea.

ANTHROPOGENIC INFLUENCES ON MAJOR DISSOLVED CONSTITUENTS IN THE HIGHLY UTILISED RIVER PERIYAR, KERALA

P.G. Jose and V. Subramanian

School of Environmental Sciences, JNU, New Delhi - 110 067

Water samples from 29 locations from the along the River Periyar and its tributaries were collected during monsoon (June, 1989) and non-monsoon (January, 1990). Unlike most Indian rivers pH of river Periyar is slightly acidic, becoming highly acidic for the industrial belt, influenced by acidic wastes dumped into the river. The EC and the dissolved ions varied both seasonally and spatially in Periyar. The reduction of EC and dissolved constituents by about 50% as the river descents to the plains shows the influence of the tributaries Idamalayar and Puyamkutty Ar which flow through relatively pristine grasslands. The high PO_4^- concentration in the midland stretches of the river (upto 0.4 ppm) can be attributed to fertiliser use. The average dissolved silica concentration (14 ppm) is higher during the monsoon season and is higher than both the Indian and world average. The average Chloride concentration (8 ppm) was found to be comparable to other Indian rivers. The average bicarbonate and sulphate concentrations are far below that of other Indian rivers; probably due to lack carbonate rocks and sulphate minerals in the basin.

THE NATURE OF SPRING DISCHARGE IN THE WESTERN HIMALAYAN WATER SHED

Varun Joshi and G.C.S. Negi

Land and Water Resources management Division,

G.B. Pant institute of Himalayan environment and Development

Garwal Unit, P.O.Box. 92, Srinagar(Garwal). Uttaranchal.

In this region springs and seepage's are the main source of water for the drinking water. Despite the fact that these mountain provide life giving water to

millions of the downstream people through perennial river system, the inhabitants are compelled to collect potable water from far off distances, reduce water consumption, consume unhygienic water and face social conflicts. But these sources are either drying up or their discharge is diminishing fast. The discharge patterns are mainly depends on the recharge zones characteristics or type of springs. The recharge zone depends upon vegetational cover, in addition to geological and geomorphologic control in the recharge zones. In the present paper springs discharge pattern in Durgar Gad water shed explores interaction off springs discharge with rainfall, land use and morphological characteristics of the springs.

YAMUNA AT DELHI-PAST AND FUTURE

Roop Narain
Research Officer, Hydrological Observations Circle (Noida),
Central Water Commission, Research Unit, B-5,
Qutub Institutional Area, New Delhi – 110 016

River Yamuna has played an important part in the development of the cities of Delhi and Agra over the time immemorial. It has been a good source of water for drinking, for the inhabitants in the cities and for irrigation, for the rural population along the banks. However, over the last hundred years there has been a considerable growth in population in Delhi whereas the quantity of water available in Yarnuna river has decreased overtime due to more withdrawals in the stream reaches, which has caused concern among the present planners and policy-makers of the city. The concerns have been compounded by the steady deterioration in the quality of water also.

In this paper, the issues of importance and development of Yamuna and Delhi have been discussed with special reference to their past and their future in view of the anticipated problems especially on waterfront. The paper has been divided in three parts. The first part of paper deals with the historical backgrounds and topography of Yarnuna and Delhi.

The second part deals with the various problems and causes of water supply and population in the region. In this part the development of water availability for Delhi, treatment facilities for waste water, quantum of rainfall and the factors responsible for water crisis such as population pressure, non-pricing of water, non-private participation in water supplies, transmission losses in distribution system huge demand of multi-storey complexes and (misplaced) emphasis on water harvesting and a brief account of sources of pollution in the surface and sub surface water bodies have been discussed.

The third part discusses the availability of water in future, the impacts likely to occur due to severe pollution being experienced in the river as well as in the groundwater tables and the strategies and remedies that should be evolved/adopted for the long-term sustenance of the city and river. These are briefly discussed under awareness, regulated water supplies, check on influx of people in the city, adequate

pricing of water harvesting of rain water on substantial scale, selectively use of waste water and ultimately a question mark has been raised over the long-term sustenance of good-quality water supply in Delhi.

In the conclusion a brief attempt has been made to indicate that the ultimate solution for the cities like Delhi would be removal of the subsidy factor from the water supply and treatment expenses.

ANTHROPOGENIC ACTIVITY AND ITS IMPACT ON HYDRO-GEOCHEMISTRY IN THE HIGH ALTITUDE HIMALAYAN ENVIRONMENT, GANGA HEADWATER, INDIA

Sarfaraz Ahmad and Syed Iqbal Hasnain
Glacier Research Group, SES, JNU, New Delhi-110 067

For evaluating the effects of farming and development of the orchard on pristine stream water chemistry, the major ion chemistry of water samples from the anthropogenically manipulated and pristine streams in high altitude catchment, Ganga Headwater, Himalaya is described. The result provides a database on pristine stream environment, against which the assessments of the anthropogenic influence on water chemistry has been concluded. In present study the results showed that the terraced agriculture and Apple orchard contributing to the difference in chemistry of stream waters. Water chemistry of streams draining from disturbed landforms showed higher degree of chemical weathering, consequently high solute concentration and less seasonal variability. Along with land-use change the rapid increase in fossil fuel burning and consequently tremendous increase in NOx and SOx emission in the regional atmosphere. It may increase in deposition of acidic oxide and may pose a threat of acidification and eutrophication problem in the region. Because the low alkalinity and diluted water with high concentration of SO_4^{-2} in the stream water derived from the pyrite oxidation suggest increased atmospheric deposition of SOx and NOx compound is likely to cause acidification in near future. These information bases give an early warning of a dormant problem and provide a scope to employ the right kind of land management and policy without much loss of natural resources in near future.

ARSENIC CONTAMINATION IN WATER AND ITS CONTROL

S.K. Singh and Arun Kr. Gupta
Civil Engineering Department, Delhi College of Engineering
Bawana Road, Delhi - 110 042

Arsenic contamination in water is a grave concern in the national and international perspective. The problem of arsenic contamination in water in general and in ground water in particular in some parts of India and other countries has been reported as world's biggest episode of arsenic pollution. Conservation of sources and management of groundwater quality, therefore, have become the need of the time. Attempts has been made to present information about arsenic pollution and give a

state of art of arsenic pollution. Some remedial measures to overcome the problem of arsenic pollution have also been discussed.

SUSTAINABILITY ISSUES ASSOCIATED WITH RICE - WHEAT PRODUCTIVITY IN NORTH WEST INDIA

Naveen Kalra, Shakeel A. Khan, M.Z. Hussain and Uday Anand Soni
Centre for Applications of Systems Simulation (CASS),
Indian Agricultral Research Institute (IARI), New Delhi-110 012

The productivity of rice-wheat cropping system is a great concern in North West India. The decline or static trend of yield in Punjab, Haryana and western Uttar Pradesh has been noticed. There is a need to evaluate the causes of this decline, so that the suitable management options can be implemented for sustained productivity. The cropping system has resulted in nutrient mining at a faster rate as noticed from the decline in the organic carbon contents in most of the regions. The delay in sowing of wheat associated with late harvest of paddy also causes significant reduction in wheat yields of the region. The higher consumptive water use associated with this cropping system has resulted in decline in water table in most regions of Punjab and Haryana. The faulty water management practices for higher water requiring crops like rice and wheat has also resulted in nitrate pollution problems in few pockets. The recent modification in the pest's population is also a matter of concern. In some parts of Punjab and Haryana, the introduction of additional rice crop in the summer season has caused ground water depletion at relatively faster rates. Soil physical environment associated with puddling of soil for rice crop also creates soil structural problems. There is an urgent need to evaluate all the related system's components to suggest appropriate agronomic and inputs resource management options in order to sustain the productivity of this important cropping system.

NEED FOR INVENTORISATION OF INDUSTRIAL EFFLLUENTS

Manju Rawat
School of Environmental Sciences, JNU, New Delhi - 110 067

Indiscriminate disposal of untreated industrial wastes constitutes the major component of environmental pollution. Effluents/wastes discharged from industries such as tannery, iron and steel works, plastics, painting, dyes and dyes intermediates etc. are a cause of serious concern. In order to combat pollution caused by these point sources there is a need to inventorise the constituents of effluents/ waste coming out from any industry. Regular inventorisation on the one hand would ensure taking up of effective preventive measures by the industries and on the other hand would help in developing proper effluent treatment plant and disposal from them so that flora and fauna can be protected.

This paper calls for the inventorisation of effluents/wastes from the small-scale industries for proper waste management i.e., end of pipe treatment of wastes, beside this there is need of adoption of cleaner production.

IMPACTS OF HARVESTING ON REGENERATION OF BAMBOO DENDROCALAMUS STRICTUS IN THE EASTERN GHATS OF ANDHRA PRADESH

T.V.B. Krishna Rao, M. Sivasankaravel and S. Anbukumar

Civil Engineering Department, Delhi College of Engineering, Delhi

A comparative study was done on the impacts of harvesting on the regeneration of bamboo Dendrocalamus strictus (Nees) in the Eastern Ghats of Andhra Pradesh at two harvest sites viz. sites allocated to Forest Department and ITC–BPL. Data pertaining to the structure of the bamboo stands and harvesting strategies adopted were collected using 3 belt transects with the width of 20 m. In each transect, 20 quadrats of 20 ´ 20 m size were placed randomly. Studies indicated that over harvesting was prevalent at both the Forest Dept. (43 %) and ITC – BPL (23 %) sites, when compared to the ideal '3n' harvest rate. Low regeneration at ITC – BPL site can be attributed to lack of management practices like mounding of clumps (1 % vs. 62 % at Forest Dept. site), coupled with practices like clear felling of clumps (18 % vs. 2 % at Forest Dept. Site). Though harvest rate was higher at Forest Dept. Site, regeneration was better, probably because of better management practices. Appropriate management of clumps after harvest is necessary to obtain better regeneration.

WATER POLLUTION PROBLEMS AND POLLUTION CONTROL STRATEGY IN INDIAN TEXTILE INDUSTRY

M. Subba Rao[1], R.K. Suri[1] and Dinesh Chand[2]

[1] *Ministry of Environment & Forests,Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi - 110 003.*

[2]*Department of Drinking Water Supply,Ministry of Rural Development, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi - 110 003.*

The textile industry is a key sector in India from the perspective of generating employment and earning foreign exchange. However, this industry posess a serious environmental problem. This industry requires large quantity and high purity of water during various stages of processing to get the finished product. Therefore, the discharge of waste water would obviously be very large and depends upon the type of process employed.

The presence of various chemicals in the waste water makes it highly coloured, alkaline and difficult to treat. It is often found very difficult to remove the colour completely from the treated effluent and it also requires expensive treatment like using activated carbon. The presence of colour in the treated effluents not only make it aesthetically unpleasant but also scares the people in using the same for any domestic or irrigation purpose. The high concentration of dissolved salts in the effluents also makes the effluent unfit for agriculture use. The various treatment options of the effluent depends upon where the treated effluent is ultimately proposed to be disposed of. In this paper an attempt has been made to discuss the water pollution problems associated with the textile industry and various pollution control strategies available to overcome these problems.

Theme – Ground Water

IMPACT OF URBAN POLLUTION IN THE ADYAR RIVER AND THE ADJACENT GROUNDWATER IN CHENNAI CITY

G.V. Suresh[1], G.J. Chakrapani[1] and R. Ramesh[2]

[1] *Department of Earth Sciences Indian Institute of Technology, Roorkee- 247667*

[2] *Institute of ocean Management Anna University, Chennai - 600025*

Surface water sourses are normally a major source of recharge to the groundwater system and consequently, a possible source of contamination of groundwater, when these water courses are polluted as it often happens in an urban environment. Several ephemeral streams/rivers traverse the Chennai city. The Adyar river flows across the Chennai city and is heavily polluted by means of municipal and industrial waste waters. An attempt has been made here to study the present status of pollution in the river and the possible influence on the groundwater of the adjacent areas. The study revealed high concentrations of Nitrite, Ammonium and Phosphate in the river and groundwater, and in many locations in the city. The study clearly showed the influence of river water on groundwater quality. Correlation analysis between river and groundwater suggest that the contamination of groundwater at many places towards downstream might be due to the pollution of river by a few point sources like outlets from industrial units and untreated sewer drains from human settlements located in the upstream areas. The easterly hydraulic gradient might also have favored the downstream migration of contaminants.

GROUNDWATER QUALITY MAPPING FOR AGRICULTURAL PURPOSES IN A SEMI-ARID RIVER BASIN IN TAMIL NADU

K. Kumaraswamy

Reader, Department of Geography, School of Earth Sciences, Bharathidasan University, Tiruchirappalli - 620 024.

All water samples contain various salts in solution but the kind and amounts vary depending upon their sources of origin, places of their movement and the geologic-geomorphic conditions. A generalized statistics of the groundwater quality or quantity does not express which parts of the basin / area are highly favourable for development and where not. Generally, the spatial pattern of a particular salt is associated with other salts present in the parent rocks and soils of the area. Various agents of erosion and deposition like river, wind, groundwater etc., affect the higher / lower salt content of the area appreciably. Vaippar basin, a rain shadow tract in Tamil Nadu, is selected to study the spatial pattern of salinity - alkalinity levels for agricultural purposes.

To assess the groundwater quality, 82 groundwater samples have been collected throughout the basin during July and December months. The major water quality measures like EC, SAR and pH have been estimated for all the samples. Based on the modified Richard's classification of groundwater for irrigation purposes,

developed by Kumaraswamy (1984), has been used in this paper to classify the groundwater samples for agricultural purposes.

The analysis of chemical constituents and their derivatives determine the alkalinity and salinity levels of groundwater samples and the level of contamination by select chemical substances. Usually, the upper limit of EC for water used in irrigation is 5000 micromhos / cm at 250 Celsius. But the same quality waters may not suit for all crops or for all climate conditions. In the Vaippar basin, the EC value varies between 500 and 15000 mmhos/cm. The spatial pattern of the EC is uneven and it is higher in all those areas where higher TDS values occur. While adopting the Wilcox's (1955) method of classification, of irrigation waters, no sample shows water of excellent quality (less than 250 mmhos/cm). Fifty percent of the wells portray either doubtful to unsuitable quality conditions for irrigation purpose. Only 5 to 8% of the wells oscillate between doubtful condition and good quality during rainy months. Thus, the EC values furnish evidence that the groundwater quality of the basin is not satisfactory for irrigation. The high EC values are found in intensively cultivated and densely populated areas.

Normally, groundwater of good quality (SAR) value of 10-25, unless any one of the elements viz. Chloride, sulphate, carbonate, predominates as the constituents. In Vaippar basin, the high SAR values are found only in the central basin . Moderate SAR values are noted outside the central basin, and in most parts of the basin the sodium concentration is not in itself a quality problem. Sodium saturates with the increase of other chemicals (other than calcium and magnesium) and resulted to alkalinity and salinity problems. The hydrogen ion concentration (pH) pattern shows that the alkalinity is widespread all over the basin. The average pH value for the basin is 7.89 and it varies between 7.2 and 8.4, indicating the dominance of alkalinity. The lower part of the basin is deteriorated with higher alkalinity problems.

Based on modified Richard's classification (1964), the groundwater samples of Vaippar have been classified (Table 1). About 50% of the samples show medium to very high salinity hazards in the basin. The sodium is high to very high in about 20% of the groundwater samples.

The spatial distribution of the saline-alkaline hazard classes, thus derived, shows small patches of low salinity and low alkalinity zones are found (C2S1) close to the confluence of the river Vaippar. The water quality is a severe handicap to the soils having C5S4 class of ground water with very high salinity-alkalinity levels and when used for irrigation makes the soil condition worse and barren. Fallow lands are not uncommon in these areas. Close to these patches, the groundwater samples are either C4S4 or C4S3 classes (high salinity, very high to high alkalinity).

The study shows that, among various chemical parameters, the salinity and alkalinity influence the agricultural activities to a considerable extent in the basin. By adopting the modified groundwater classification methodology, about 50 % of the water samples are doubtful to unsuitable conditions and about 20 % are with high to very high alkalinity problems for agricultural purposes. The spatial patterns of the combined effects of the salinity-alkalinity problems delineate the areas for reclamation and effective use of groundwater for agricultural purpose.

ASSESSING THE EFFECTS OF SODIC WATER IRRIGATION ON SOIL AND GROUNDWATER QUALITY

M.J. Kaledhonkar[1] and Ashok K. Keshari[2]

[1] *Division of Irrigation and Drainage Engineering, Central Soil Salinity Research Institute, Karnal 132001*

[2] *Department of Civil Engineering, Indian Institute of Technology, New Delhi-16*

In the semi arid regions of the North -Western India, wheat based crop rotations namely rice-wheat, cotton-wheat and millet-wheat are common. The semi arid climate prevailing in this part of the India necessitates the application of supplemental irrigation by means of canal and ground water for optimizing crop production. In case of limited canal supply, farmers are more dependent on groundwater supply for irrigation water. However, in several districts of Punjab, Haryana, Uttar Pradesh and Rajastan groundwater is of poor quality (i.e. either saline or alkali). Sodic groundwater adversely affects the crop production in about 25% and 21% of total cultivated area in states of Punjab and Haryana, respectively. As intensive agriculture is practiced in the region, the indiscriminate use of sodic ground waters for crop production may enhance the rate of sodification of the root zone. It may adversely affect the soil physical and chemical properties of the soil. In order to maintain the productivity level of the agriculture, the farmers are tempted to use the gypsum on large scale. The Ca^{2+} ions from the applied gypsum may enter into soil exchange complex while dissolved Na^{+} and SO_4^{2-} ions may reach to groundwater through unsaturated zone as deep percolation. The use of sodic water in agriculture and application of gypsum to prevent sodification process may deteriorate the soil health and groundwater in the long term, respectively. The present study is aimed to assess the potential effects of such processes. In this paper, the UNSATCHEM model is used to assess how textural classes of the soil influence sodification process. Simulations for different textural classes are carried out while keeping the quality parameters of the sodic water the same. The sodic water quality is mainly defined by the sodium adsorption ratio (SAR) and residual sodium carbonate (RSC). The effect of the individual quality parameter like SAR or RSC on sodification is also judged through simulations. The conjunctive use of sodic and canal water is generally practiced by farmers. Simulations are carried out to investigate the effect of change of irrigation water quality on sodification process. Further two cases of gypsum application to reverse the sodification process are considered and its effects on the movements of Na^{+} and SO_4^{2-} ions through deep percolation are investigated.

GROUND WATER CONAMINATION THROUGH LANDFILLS IN NCT DELHI

A.N Bhowmick[1], Arijit Dey[2] and D. Chakraborty[1]

[1]*Member Secretary, Central Ground Water Authority, New Delhi*

[2]*Scientist, Central Ground Water Authority, New Delhi*

The hazard of urban landfills to ground water via leachates if one of the major environmental problems our country is facing in the 21st century. During last decade, solid waste produced in India had been at nearly twice the rate of the

population growth. The total municipal waste generated from Indian Cities is estimated around 48,184 tonnes per day, of which 62% is contributed by 23 metrocities alone comprising about 51% of the total population of class I cities. Leachates, an inevitable product from landfills, containing mostly volatile organic compounds, synthetic organic compounds and heavy metals, in absence of protective measures like liners, leachate collection and treatment systems undoubtedly poses serious threat to the ground water system.

The capital city of the country alone generates about 5000 Metric Tonnes a day, which is about 5 times the national average. NCT Delhi has 16 filled up landfills covering an area of 180 hectares and three active landfills, covering an area of 60 acres. As per an estimate (Dinesh Kumar et al, 2001) the landfills of NCT Delhi cumulatively generate a significant quantum of 814800 cum of leachates annually, which is alarming from ground water quality point of view

In the present paper issues related to ground water contamination through Municipal landfills leachates in NCT Delhi have been discussed. An attempt has also been made to evolve abatement measures on 'Hydrogeologic design principles' and policy guidelines for mitigating the menace of ground water contamination through landfill sites.

FLUORIDE CONCENTRATION IN GROUND WATER IN INDIA AND ITS EFFECT ON HUMAN HEALTH -AN OVERVIEW

Jawed Raza, M.K.Garg and S.Shekhar

Central Ground Water Board, NH-IV, Faridabad, Haryana

Over the years rapid strides have been made in India to mould the availability of water to match country's manifold water demand. However, in some part of the country ground water pollution problem has not been addressed properly. Water is frequently referred to as a universal solvent, because it has the ability to dissolve almost all substance; that comes in its contact. Some elements are essential in trace amount for human being while higher concentration of the same can cause toxic effects. Fluoride is one of them. It is a conclusive fact that concentration between 0.6 to1.2 mg/ l is essential to protect teeth decay, while higher concentration (beyond 1.5 mg/l) can cause teeth mottling and still higher concentration of fluoride may lead to different major health hazards .The importance of developing quality drinking water system facilities in any health care programme of the country can hardly be over emphasized.

It is, therefore, imperative that groundwater, free from higher fluoride concentration needs to be explored & where ever the concentration is high, mitigation strategies have to be adopted on urgent basis. Fluorosis was first detected in India among cattle's by farmers of Nalgonda district (A.P) during early 1930's .It was during years later; the same disease was detected in human being. However subsequent investigations have established that, the total number of states declared endemic for fluorosis are 15 by the year 1992. In this paper an attempt has been made

to synthesize available information on fluoride concentration in ground water of the country, its effect on human health and possible remedial measures have also been looked in to.

IMPACT OF OVER-DEVELOPMENT ON QUALITY ASPECTS OF GROUND WATER REGIME IN NCT, DELHI

S.K. Mohiddin and D. Chakraborty

Scientists, Central Ground Water Board, Jamnagar House, Mansingh Road, New Delhi – 110 011

Natural replenishment of ground water resources occurs very slowly, therefore, excessive continued exploitation of ground water at a rate greater than the natural replenishment causes decline in ground water levels as well as deterioration of quality. Evidences of decline in quantity are more pronounced and corrective measures can be taken up to arrest the decline in quantity. But quality deterioration is more concealed and may result into complete deterioration of ground water beyond correction, except leaving the aquifer without any ground water development. Systematic analysis of ground water quality in NCT, Delhi with time series shows that the quality deterioration and shallow ground water from more and more areas turning fresh to brackish/ saline. Presently about 45% of NCT, Delhi has brackish to saline water where as the saline area in 1997 was only 25%. Effective ground water management techniques are suggested to arrest the spreading of aerial extent of brackish water zones is suggested.

SUSTAINABILITY OF FRESH GROUND WATER RESOURCES OF NATIONAL CAPITAL TERRITORY OF DELHI

S.B. Singh and S.K. Mohiddin

Scientists, Central Ground Water Board, Jamnagar House, Mansingh Road, New Delhi-110 011

Chemical quality of ground water in N.C.T., Delhi varies with depth and space. Brackish ground water mainly exists at shallow depths in Northwest, West and Southwest districts with minor patches in North and Central Districts also. In alluvial formations, the quality of ground water deteriorates with depth, which is variable in different areas. The ground water is fresh at all depths in the areas around the ridge in the Central, New Delhi, South and Southwest Districts and also Chattarpur basin. In the areas west of the ridge, in general, the thickness of fresh water aquifers decreases towards north-west, the thickness of fresh water zones being limited in major parts of west and south-west. In the flood plains of Yamuna, in general, fresh water aquifers exist down to 30-45 m. Thus a limited thick fresh ground water resource is present in NCT, Delhi that need to be protected. Static Ground Water Resources have been calculated considering the thickness of alluvium upto 200 m bgl and specific yield as 10%. On the basis of this the, Static Resources of fresh water in alluvium is calculated as 1866 MCM and hard rock quartzite as 28 MCM. Thus the

total fresh Static Ground Water Resource is estimate as 1894 MCM. It is estimated these fresh static resources will be exhausted within 10 years period, if about 2650 moderate to high yielding tubewells are constructed. Effective management tools have been recommended for sustainability of ground water resources of NCT, Delhi making the ground water development as the best option for solving the water supply problems of Delhi.

GROUND WATER POLLUTION MANAGEMENT IN COASTAL TRACT

S.K. Sinha and S.K. Swaroop

Central Ground Water Board, Jamnagar House,
Mansingh Road, New Delhi -110 011

The high productivity of the rich coastal Eco-system has attracted development and high population density. The anthropogenic influences on the coastal geomorphology is large, particularly near the development centers. The rivers contributes to coastal pollution by transporting a wide range of pollutants through land drainage. Ground water is one vital component of coastal zone resources, which provides fresh water flow to sustain ecology, agriculture, development and urbanization.

The river water in coastal areas acts as one of the major source for ground water recharge. Sea water is the major pollutant of groundwater in the coastal tract. The influence of sea water reduces with distance from the coast. The natural recharge water contains some major ions like Na, Ca, Mg, HCO_3, Cl and SO_4. The quality of ground water evolves through interaction with the host sediments and the residence time in the aquifers. The cation exchange process in the clayey sediments, Sulphate reduction by Sulphate reducing bacteria, and sea water contamination are the various factors influencing the quality of ground water. While fresh Na-HCO_3 waters are obtained in tubewells close to the coast, Na-Cl waters are obtained in cases far inland. All saline waters in coastal area are of Na-Cl type.

Ground water in the coastal tract varies widely from fresh to saline. In general, the shallow ground water varies from fresh to saline while the deeper aquifers are saline. There is a lot of heterogeneity in distribution of quality both vertically and spatially. Three of the country's four largest metropolitan cities with burgeoning population are situated along the coast. Besides the nine coastal states; Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal the three union teritories; Pondicherry, Andaman and Nicobar Islands have significant coastal stretches. There are varying degrees of pollutants added to the coastal areas because of the multiple variety of effluents flowing into the sea.

Coastal Ground water quality management comprises the whole set of technical institutional, legal and operational activities. "Groundwater pollution" is the key word in ground water quality management. Assessment and prediction of a ground water pollution situation, ground water protection from pollution and remediation of polluted ground water are the main ground water quality management

task. Among various methods used to assess and predict ground water pollution, solute transport modeling and ground water vulnerability assessment can be distinguished as being the most important.

Solute transport models in ground water is largely governed by the parameters, which also shape the flow equation. In addition, it is governed by the factors: (i) advection of the constituent with the water flowing through the aquifer, (ii) dispersion of the constituents, and (iii) sources and sinks of the constituents within the volume. Without solving ground water flow equation, the contaminant transport equation cannot be solved. The most general classification of Vulnerability assessment approaches includes methods employing process- based simulation models, Statistical / Stochastic methods and overlay and index methods. DRASTIC models is one of the system models based on the index methods which is widely used in the vulnerability assessment of the coastal aquifers.

Coastal Ground water problems are by definition hydrogeological problems. Various software tool have been developed to assist in decision making which works in isolation. However, Integration of software tool speeds up processing of quantitative (numerical) information, but complementary qualitative information (Knowledge) is needs to enhance analysis, processing and interpretation. In an ideal case, the user would posses all the knowledge required, but even then knowledge integrated into Decisions Support System (DSS) would be a much useful tool. The type of quality management problem defines substantially the requirement for the analysis, processing and presentation of the information and therefore the various software tools that might be required to be integrated into DSS for quality management.

NEED FOR AWARENESS TO PROTECT GROUND WATER – A CASE STUDY

Uma Kapoor, S.K. Mohiddin and K.J. Anandha kumar

Central Ground Water Board, Jamnagar House,

Mansingh Road, New Delhi - 110 011

A study was carried out in an area of 2 Sq. Km, in parts of Ghaziabad town, on the reported ground water pollution in that area, with a view to demarcate the extent of ground water pollution. The area is predominantly underlain by older alluvium comprising of clay and sand mixed with kankar and gravel. Medium to coarse sand mixed with gravel serve this area as very good aquifer system. Most of the tube wells located in the area are withdrawing the ground water from the coarse sand and gravel bed situated between 40 and 75 metres below ground level.

The detailed study, followed by analysis of data and results of the ground water samples collected indicated that Para-nitrophenol, an intermediate product during the synthesis of paracetamol may be the cause of yellow colour of the water being pumped out by the tube well, which is tapping the aquifer zone between 45 to 55 metres below ground level.

This study has highlighted the need of awareness to use safer disposal methods especially when industrial effluents are to be disposed off. Several other suspected cases of injection of industrial effluents in the ground water were reported

earlier also. It is more important to make people or industries aware about this way of ground water contamination because ground water contamination, hidden from the direct view can go undetected for years until the particular aquifer is tapped. Further the reclamation and remediation of the contaminated aquifer or cleaning ground water by pumping out and treating before use or in the worst case abandoning the aquifer and location of alternate aquifer to supply water to the area where the contaminated aquifer was supplying water are all very costly and not at all economical especially considering the economic status of our country.

It is also important that the study for location or relocation of industries should include hydrogeological studies of the area. Heavy amount of withdrawal of ground water in the towns where habitation is more, tend to change the ground water flow towards it. This ground water flow will also result in contamination of ground water being used, by public, if effluents discharged from the industries in and around the town have already polluted the ground water.

There may be need for regulation on development and management of ground water resources in areas prone to ground water contamination. Need of the hour is to study the data and reports of various agencies to locate the areas prone to such ground water pollution, so that the ground water is protected and developed in a sustainable way to serve the coming generation also.

Theme - Drinking Water Quality

WATER QUALITY: GUIDELINES AND ASSESSMENT OF RISK

AL. Ramanathan

School of Environmental Sciences, JNU, New Delhi – 110 067

The quality of water, whether it is used for drinking, irrigation or recreational purposes is significant for Health in both developing and developed countries worldwide. Water quality can have a major impact on health, both through outbreaks of waterborne diseases and by contributing to the background rates of the diseases. Accordingly, countries develop water quality standards to protect public health. The WHO has developed a series of normative guidelines for assessment of health risk and hazards through water. These principal guidelines are intended to assist countries in establishing effective national or regional strategies and standards. These guidelines should be updated as scientific and managerial developments to ensure that they continue to be based on the best available evidence in each country based on their climate, geography, topography and customs.

STUDY OF GROUND WATER QUALITY IN THE PERIYAR DISTRICT OF TAMILNADU, INDIA

AL. Ramanathan,

School of Environmental Sciences, JNU, New Delhi – 110 067

The study evaluates the water quality of the Periyar district in Tamilnadu. Systematic sampling of groundwater has been carried out in different seasons from

1997 to 1999 in the entire Periyar district of Tamilnadu. Groundwater is colorless, odorless and are alkaline in nature. EC and TDS shows are god to moderate in nature. The water chemistry shows distinct variation in space and time. Na+K-Ca-Mg-Cl+ SO_4-HCO_3 is the dominant hydrogeochemical facies. SO_4, NO_3 and PO_4 concentration are higher showing the influence of the anthropogenic sources. SAR, RSC, Na%, CR, TH etc shows that the water is generally good for domestic, agricultural purpose and are not good for long distance transport. Geochemical studies reveal the variation in the (H_4SiO_4/ HCO_3), (F/Alkali) and (F/Ca+Mg) molal ratios and the ionic strength of the groundwater in the aquifer. Here the Fluoride concentration is generally lower than prescribed limit except few areas where the concentration exceeds 1.5ppm.

TECHNOLOGICAL ADVANCEMENTS IN ENVIRONMENTAL BIOTECHNOLOGY TO ASSESS WATER QUALITY

Rita Kumar and Shikha Rastogi

Centre for Biochemical Technology, Delhi University Campus, Mall Road, Delhi – 110 007

Water flows are not steady or uniform, but vary from one hour to another, from day to day, from month to month and from year to year. One major culprit responsible for this is the discharge of pollutants from a variety of sources into the water streams. The discharge of oxygen consuming materials, deplete the dissolved oxygen (DO) of receiving waste-waters. Marked depletions in DO levels can cause major changes in the aquatic flora/fauna in water bodies. Therefore, all the industrial discharges (major quenchers of 'DO') need to be monitored before their release into the flowing water bodies. Biochemical Oxygen Demand (BOD) is one such method for predicting the rate of consumption of DO by microorganisms in a water body. This test is an essential part of assessing the potential for deoxygenation of the receiving waters. The conventional BOD test performed world wide as per the guideline of American Public Health Association (APHA, 1998) is a cumbersome technique having some major disadvantages. First and foremost amongst them is the use of non-standard seeding material (i.e. the microorganisms which are procured from sewage). We have successfully overcome this problem by formulating a uniform, dehydrated microbial mixture to be used as seeding material in BOD analysis. This product named as BODSEED has been successfully launched in the marked. To add here, the Bureau of Indian Standards (BIS) has approved the use of synthetic seeds in BOD analysis. This product is first of its kind in the Indian market. Though this microbial composition reduces the possibility of controversy in BOD results and makes BOD analysis an easy, clean and conventional laboratory test, it needs to be revived a day before conducting the experiment. An endeavour to develop a ready-to-use seeding material for BOD analysis resulted in the development of BODBEADS. This product is first of its kind in the global market and an International patent has been granted for this technological outcome. Another major drawback of the conventional BOD test is that it requires 3-5 days to arrive at a plausible conclusion. The test is too slow to provide timely information to the operator for control purpose. Therefore, for real time monitoring

of the BOD load in waste-waters, we are in the process of developing a mixed culture based versatile BOD biosensor.

Once, we have an insight into the waste-water in terms of its oxygen requirement, we need to treat/control it. Presently, chemical treatment methods are utilized to control waste-waters. But, the agony of this method is that the chemicals used for treatment purposes also add to the pollution load. Biological treatment of wastes is an alternate approach relying on some basic microbial metabolic fundamentals. Collectively, microbes exhibit unparalleled metabolic diversity and adaptability, allowing them to survive in environment incompatible with large life forms. Microbes produce energy and carry out metabolism from a tremendous variety of organic materials. Several viable technologies for the efficient and effective treatment of waste-waters have been developed by our group. Out of these, two technologies viz., ALKANEUTRI and PHENOTREAT are ready for up scaling followed by commercialization. We are also heading towards the development of a few more tailor made microbial packages for treatment of untackled organic wastes.

GROUND WATER QUALITY ON EITHER SIDES OF THE RIVER PONNAIYAR, TAMIL NADU

S.Chidambaram[1], L. Ragunathan[2], K. Srinivasamoorthy[1], P. Anandhan[1] and S.Vasudevan[1]

[1] Department of Geology, Annamalai University, Chidambaram.

[2] Water testing lab, PWD, Pondicherry

Settlements and civilizations of mankind started on the river banks. This was due to the fact that water played a key role in their day-to-day needs, for domestic and agricultural. The excess extraction of water for the industries and the development of aquaculture along the coast has lead to the deterioration of water quality. To study the nature of such affect along the river course on its either sides, a study was conducted along the river Ponniyar located along the east coast of Tamil nadu. Total of twenty groundwater samples were collected ten on the north bank and ten in the southern bank of the river. The samples collected were analysed for different parameters like major and minor ions along EC, TDS and pH. The ratios like Cl/HCO_3 and Na/Cl were calculated to find out the influence of sea water and the weathering in the water samples. Standard plots of USSL, Gibbs and Johnson were used to find out the agricultural utility, factor controlling water chemistry and the facies of the water. It was found that the northern part of the bank was more contaminated than the southern region. This was due to the influence of agriculture, tributaries back waters and to certain extent lithology.

GROUND WATER QUALITY IN THE COASTAL TRACT FROM PUDUCHATIRAM TO CHIDAMBARAM, EAST COAST OF INDIA

P. Anadhan, R. Manivannan, V. Mala and N.Ganesh

Department of Geology, Anna Malai University, Annamalai Nagar - 608 002.

The concentration of the ions in the water determines the quality and its utility Higher concentration of the dissolved ions affects the potability, palatability drinking and the irrigation needs of the dependent society especially in the coastal

tracts. The hydrogeochemical studies carried out in the study area in two seasons reveals the dominance of ions in the following order CleS04~HC03 and Na<Mg<Ca<K. Ground water is colorless with slight odour and are alkaline in nature. The abnormal concentrations of Cl, SO_4 and Na are observed in the entire study area m different seasons as well as in two different aquifers. The spatial distribution of hydrogeochemical facies indicates the predominance of Cl and SO_4 in all the high salinity ground water in both the seasons. Predominant geochemical water type here is Na-Cl and Na+K-SO_4. The ground water in these areas are Saline, having permanent hardness, low Na%, RSC and SAR and high C.I. The secondary leaching process from the precipitated leachates, fertilizer and anthropogenic impacts clue to recycling of agriculturally used water and return flow controls the chemistry of the ground water. Nutrients levels are with in the limit and are increasing in the post-monsoon season. Sea water intrusion is suspected to have a partial impact in the ground water chemistry in this region. Hence the abnormally higher concentration of TDS, Cl, SO_4 and Na caused due to anthropogenic impacts made these water unsuitable for drinking water purpose except for irrigation and industrial purpose (WHO 1992). So it is essential to evolve a suitable precautionary methods to avoid the deterioration of the water quality which may not be even useful for irrigation purpose if this situation continues.

HYDROGEOCHEMICAL SURVEY DATA: UTILITY IN WATER QUALITY ASSESSMENT

K. Bheemalingeswara

Geology Department, Delhi University, Delhi - 110 007

Water forms an important commodity for the very survival of humanity. It has no replacement for drinking and agricultural food production. In natural condition, water exists in different types as fresh water, brackish water, saline water, brine water etc. The nature of water molecule though simple, provides enough scope for different elements including toxic, under suitable pH and Eh conditions, to go into solution in various quantities. Water contamination being one of the problems, takes place in surface environment mainly due to the anthropogenic input and subsurface environment due to the interaction with different types of rocks, metallic ores or toxic metal rich sediment layers. So, water whether on surface or subsurface may become unusable for drinking and other purposes due to these reasons.

This change in the quality if due to the dominant ions, may be perceived easily on the basis of taste or odor etc. But the subtle changes in the concentration of different trace elements, which may become toxic, may not be easily perceived. This is one of the problems being faced by the vast majority of the population in the form of fluoride, arsenic, lead etc. The source for such toxic levels may be natural or anthropogenic (particularly in urban areas). Irrespective of the source, the effects will remains the same that is the human health. Many treatment plants are in operation in urban areas to overcome this problem but in rural areas it (particularly natural contamination) remains a problem.

Present paper tries to utilise the data generated during geochemical survey in parts of Rajasthan to assess the water quality. The survey has successfully demarcated the areas, potential for base metal deposits particularly low grade in many cases on the basis of soil or stream sediment data. The ground water samples collected in addition to soil, stream sediment and rock during these surveys were analysed for Cu, Pb, Zn, Mn, Fe, Co, Cr, Ni etc. The data shows fairly high values for base metals and also Mn & Fe in certain areas. The contribution is assumed to be from the low-grade deposits. Since major part of the population in these areas are dependent on ground water for drinking and agricultural purposes and the recorded concentrations are much above the prescribed limits, a proper survey is suggested to be carried out to assess the water quality in terms of human health.

TEMPORAL VARIATION OF GROUNDWATER QUALITY IN AND AROUND THE TANKS OF PALAR BASIN, TAMIL NADU

G. Ravikumar and P. Srinivasagopalan

Centre for Water Resources, Anna University, Chennai

The water quality studies plays important role in the usage of the water. The irrigation being the lifeline of our country. The water used for irrigation purpose Stored in the tanks and regional ground water level is there by increased and it also serves for the direct usage of the water for irrigation. An attempt has been made in this study to know the ground water quality around the system tanks in Palar basin in North Arcot, Tamil nadu. 10 samples were collected in each season pre and post monsoon in the Ayacut area of Palar river basin studied for its temporal variation. The water collected were analysed for Ca, Mg, HCO_3, SO_4, Cl, PO_4 and NO_3. The parameters like EC, pH and TDS were also studied. it revels that premonsoon samples in groundwater shows higher concentration which was displayed by EC and TDS. The tanks contain water only in the monsoon season. In order to get an idea of the surface water quality and know their relationship. 14 surface water samples were collected and analysed.

GROUNDWATER QUALITY AND HYDROCHEMICAL FACIES IN RELATION TO THE TERRAIN MORPHOLOGY AND WATER TABLE SITUATION – A CASE STUDY FROM FIROZPUR JHIRKA – NAGINA REGION, GURGAON, HARYANA

V.N. Bajpai and S. Nayyar

Department of Geology, University of Delhi, Delhi – 110 007.

Groundwater quality and hydrochemical facies have been determined for the shallow groundwaters in the Firozpur Jhirka – Nagina region of Gurgaon district. The region has been morphologically classified on Landsat images into rocky tract (structural ridges of quartzite), pediment (weathered rock in foothill region covered with alluvium) and valley fill (alluvium). The groundwater quality has been assessed on the basis of chemical analysis of 32 samples presented on the trilinear diagrams and on the cantour maps of specific electrical conductance, sodium and chloride. Four major hydrochemical facies – calcium bicarbonate type, sodium bicarbonate

type, calcium chloride type and sodium chloride type are indicated on trilinear diagram. Out of these, the sodium carbonate and sodium chloride are the dominant facies. In general, the water quality is fresh and potable in quartzite ridges and pediments. The specific electrical conductance, sodium and chloride values range as 500 – 2000 microsiemens, 17 – 375 ppm, and 280 –760 ppm respectively. The higher values are towards the pediment – valley fill contact. In valley fill, the water is saline to very saline, indicated by the ranges of specific electrical conductance, sodium and chloride as 4000 – 16,000 microsiemens, 300 – 6300 ppm, and 300 – 10,000 ppm respectively. Saturation indices of calcite, halite and gypsum are low in ridge and pediment areas. However, they are high in valley fill zone. Two distinct pockets of oversaturation in valley fill zone are noticed in all the saturation index contour maps – one in the north (NE of Nagina in Muhamadnagar – Hasanpur Nuh region) and the other in the south (S of Firozpur Jhirka in Jormalbas – Raoli region). These zones are in conformity to those noticed in the specific electrical conductance, sodium and chloride contour maps. Electrical resistivity plots also indicate the fresh water in the quartzite ridge – pediment region (resistivity=50-80 Ohm.m) and highly saline water in the valley fill region (resistivity=3-6 Ohm.m). The water quality and oversaturated mineral zones have been found not only related to morphological variations but also to water table gradient. The fresh water in the rocky tract – pediment region is because of recharge waters (bicarbonate waters), flushing the region due to their flow with high gradient towards the valley fill. The regional water flow in the valley fill initially towards NE and finally towards the Kotladhar water body 2 in the NW also gets sluggish, giving rise to stagnant and water-logged conditions. This has further resulted into location of high salinity (sulphate and chloride waters) and oversaturated mineral zones. More ion exchange between clays and groundwater has also contributed to concentration of sodium in valley fill waters. The waters have thus hydrochemically evolved towards very saline following Chebotarev sequence. It is therefore suggested that the maximum water may be pumped out through battery of wells installed in the ridge – pediment region in order to have fresh water supply and avoid the flow of water towards the valley fill zone.

Theme - Modeling

A COMPUTER PROGRAM FOR WATER QUALITY STUDIES

S. Chidambaram[1], AL. Ramanathan[2], K. Srinivasamoorthy[1],
P. Ananadhan[1] and S. Vasudevan[1]
[1]*Department of Geology, Annamalai University, Chidambaram*
[2] *School of Environmental Sciences, JNU, New Delhi*

The chemical constituents present in the water determine the quality. The water quality studies have become essential to delineate the utility criteria. The study on the quality needs certain constituents like major cations and anions. Some of the parameters like Sodium Absorption ratio, Hardness, Corrosivity index, sodium

percentage, index to the base exchange, permeability index, etc., and certain ionic ratios like Na/Ca, Cl/HCO_3, Na/Cl, etc., will help to determine certain process like nature of weathering and saltwater intrusion studies. Moreover the classification of water using the standards available like. Wilcox classification (EC), Eaton's (Na%), Richards (SAR), USGS hardness classification, Styfzands classification, chemical facies and Schollers water type. It becomes a tedious and time-consuming process to calculate all these parameters. So in order to over come this difficulty a computer program was made in C++ using turbo C compiler. The data input requires ppm values of ions like Ca, Mg, Na, K, Cl, HCO_3, SO_4, H_4SiO_4, PO_4, NO_3, F, and parameters like pH, EC and TDS. The program first converts these data fed to epm values and checks for the ionic balance. Large set of data can be fed in and the individual ionic ratios and chemical parameters of the sample can be obtained and also it groups the sample fed into against the above said standard classifications. One of the preliminary and essential need of water is for agriculture. The USSL classification has been used for several years for the same and the plot has also been included in the program along with Doneen's permeability index plot, Johnson's water facies plot, Gibbs water chemistry plot and certain standard graphs to establish the linear relationship of the ions. This program substitutes the manual calculation and immediate grouping of the entire data set.

AN APPROACH TO SELECT, BUILD AND DECIDE THE GROUND WATER MODEL

Deeksha and H.S. Bhatia

Civil engineering, Delhi College of Engineering, New Delhi - 110 042

Ground water flow and transport modeling can be useful in making informed and defensible remedial decision. This paper describes method for selecting ground water flow and contaminant transport models. This selection process starts with conceptualisation , which takes in account modeling objectives , environmental characteristic of the site and the phase of remedial process . Parameter estimation describes the various parameters of ground water flow and contaminant transport, which is followed by review and evaluation process that includes calibration and validation mainly done for screening the model. The best suited model that meet site specific modeling are finally used.

Water both groundwater and surface water is the most vital resource, which is contributing a major share in meeting the requirements of domestic, industrial and agricultural needs. Ramanathapuram coast is a semi-arid region, which receives a annual average rainfall of 980 mm. The Northeast monsoon contributes 70 % of rainfall. Nearly 900 naturally formed rainfed tanks in geological past of the study area holds the rainwater during the monsoon and for a short while in the post monsoon too. Twenty-eight samples have been collected during monsoon period of year 2000 from the surface tanks of the study area and analyzed. With the analyzed results, the surface water has been classified using HYCH program. The following thematic maps have been prepared Viz. Total Dissolved Solids, Salinity and Sodium Hazard, Hardness,

Chloride / Bi-carbonate ratio and Water Classification using GIS. From these, it is inferred that water resources are affected by the saline water encroachment along the northeastern and Southern coastal regions. Interior parts fall under fresh water having some intermediate water quality. C5S4 type water, which type water having very high Sodium and high Salinity is observed along the above mentioned coastal regions. Similarly brackish salt and permanent hard water have been identified along the same coastal locations. Groundwater is being pumped near Uppur and Valinokkam (Loc.s 9 & 26) for the saltpans and these development activities may enhance the salinity water encroachment of this area.

POTENTIAL OF MEMBRANE SEPARATION TECHNOLOGY FOR FLUORIDE REMOVAL FROM UNDERGROUND WATER

Meenakshi Pahwa and R.C. Maheshwari
Centre for Rural Development and Technology
Indian Institute of Technology, New Delhi

Membrane technology has been established as a proven technology for desalination of seawater to provide drinking water in coastal areas. Yet little attention has been given to explore its potential for treatment of groundwater having some inorganic pollutants. In this study, various membranes were tested to select a suitable membrane for this purpose. Initially, experiments were done with nanofiltration membrane and was observed that all the monovalent ions are rejected less as compared to bivalent ions. But fluoride shows exceptional behavior. This may be due to low solubility product of calcium fluoride. Thus fluoride may precipitate out in hard water and so rejected better. But, the problem associated with nanofiltration membranes is the very low recovery.

So, to overcome this problem hyperfiltration membrane was used and experiments were done at varying range of operating pressure, feed flow rate, pH of feed water, temp. of feed water and concentration of feed water, because the membrane separation efficiency depends upon operating conditions and chemical composition of feed water. Thus, optimum conditions for maximum efficiency were selected and the water samples collected from rural areas of district Gurgaon were treated at the optimum operating conditions. The results showed that at high pressure, hyperfiltration membrane rejects almost the all the ions upto 99%, thus leading to need of remineralization and cost is also high due to high pressure requirements. But at low pressure, rejection is in the range of 88% to 93%, which allows some essential minerals to remain in water and also the cost of process is reduced.

ASSESSMENT OF GROUNDWATER POLLUTION THROUGH MASS TRANSPORT MODELING

V.V.S. Gurunadha Rao
National Geophysical Research Institute, Hyderabad - 500 007

Effective management of groundwater requires the ability to predict subsurface flow and transport of solutes, and the response of fluid and solute flux

to changes in natural and man made stresses. One popular tool evolved during last three decades is the deterministic, distributed parameter, computer simulation model for analyzing flow and solute transport in groundwater systems. Recently, the visual MODFLOW and MT3D (Mass transport in three dimensions) models have become popular for groundwater flow and mass transport simulation respectively, with the advantages of pre-processing and post-processing facilities attached to the basic modeling software. The number and types of equations to be solved in flow and mass transport modeling are determined by the concepts of the dominant governing processes. The coefficients of the equations are the parameters that are measures of the properties, boundaries, and stresses of the system; dependent variables of the equation are the measures of the state of the system. These are mathematically determined by the solution of the governing equations. Two case studies have been presented to illustrate the application of mass transport modeling for assessment of groundwater contamination.

First case study deals with likely groundwater contamination from red mud stacking from a proposed allumina plant near Doragarha, Rayagada district, Orissa. The allumina plant produces fine red-mud residue and the liquor contains Sodium Carbonate (Na_2CO_3). The concentration of Na_2CO_3 may be as high as 3500 mg/l. The red mud slurry is pumped to the disposal area where it is spread in layers known as red mud stacking layers. The water drained from the red mud stacking area is collected in two ponds for recycling. Seepage from tanks may carry the effluent to the groundwater regime. The red mud ponds are located in a Khondalitic terrane of Eastern Ghats. Geophysical surveys have been carried out to understand aquifer geometry, identify significant structural features controlling the groundwater flow. A groundwater flow and mass transport model was constructed to analyze likely migration of contaminants from the red mud ponds for 50 years. The predictions showed that the contaminants might take more than 50 years to reach the Baraha nadi, a perennial stream in the area.

Mass transport modeling in the Bolaram Industrial Development area near Hyderabad illustrates the study of groundwater contamination due to discharge of effluents from the pharmaceutical and bulk drug industries in effluent settlement tanks/ponds and stream channels during last 20 years. The seepage from the beds of these tanks/ponds and along the Pamula vagu stream acted as a diffuse source of contamination. The mass transport model has been calibrated for a period of 20 years and later used for assessment of contaminant migration for next 20 years. The contaminant migration is restricted to a narrow patch with elevated TDS concentrations due to low permeability of the aquifer in the granitic terrain.

TRANSPORT OF POLLUTANTS IN OPEN CHANNEL WITH SHORT WAVES

Sandeep Patil and A. K. Rastogi
Dept of Civil Engg., IIT, Bombay - 400 076

Assessment of the surface water quality in open channels is of greater importance today due to the increasing load of pollutants that is diverted to these systems. Computation of dispersion coefficient plays an important role for an adequate

prediction of the pollutants movement in open channels. Apart from the advection dispersion, short period wave on the water surface also contribute to this process, which exists on any water body open to the atmosphere. Effect of ambient wavy environment on the transport of pollutants through open channel is examined in the present study. Equation for the short period surface wave is coupled with the one dimensional dispersion equation to get an accurate and applicable solution of concentration distribution of pollutants. The existing equation of longitudinal dispersion coefficient is modified to consider the short period wave. Initially, experiments were conducted involving non wavy flow in open channel and values of the longitudinal dispersion coefficient were found out by the method of least square. The observed values of longitudinal dispersion coefficient matched closely with the values predicted by the empirical law given by Won Seo II (1998). After verifying the model for non wavy environment short waves of various amplitude and period were generated on the flow with the help of wave generator. Experiments were conducted to note the spread of pollutant values, which were substituted in the analytical solutions to compute the values of wave induced longitudinal dispersion coefficient (WILDC). For non wavy cases, it is well known that the longitudinal dispersion coefficient depends on aspect ratio and friction factor. In case of wavy environment, it was decided to segregate the effect of waves from these parameters. Dimensional analysis was conducted using Buckingham's P theorem and a new parameter (a/TU*) named as wave parameter was found out. The analysis shows that WILDC depends on three parameters instead of two. Outlier in the scatter diagram were detected by Grubb's analysis and discarded. Uncertainty analysis was conducted and confidence interval was calculated which is stated as predicted data ± 0.092043. This is the range in which true value of dimensionless WILDC is lying with high probability. Expression for WILDC was analytically developed by using two-dimensional depth averaged mass transport equation. Longitudinal dispersion coefficient was integrated over depth as well as one wave period for practical consideration. Equation of Won Seo II was modified for wavy environment by adding local depth averaged velocity due to wave in the flow velocity and the vertical water surface displacement in the mean water depth. The equation is then integrated over a wave period by gauss quadrature method to get the final model of WILDC. The model shows that WILDC remains independent of longitudinal distance. It was observed that negative horizontal vector component of orbital velocity due to wave is the governing factor which decided the value of wave induced longitudinal dispersion coefficient. More the magnitude of negative component, more the churning action, which further increases mixing of pollutants and therefore increases the mixing coefficient. Sensitivity analysis suggested that growth in the wave amplitude and wave period increases the magnitude of longitudinal dispersion coefficient. But the effect of amplitude was found to be more intense than wave period. Further, as depth of flow to wave length ratio increases, effect of wave on the mixing reduces. The concentration verses time curves were plotted which shows that the maximum percentage increase in the concentration occurs at a point of inflection attributed to the wave superposition. As particle traveling under the wave follows orbital motion,

superposition of wave increases the longitudinal dispersion coefficient. The study suggests that the concentration distribution of pollutants calculated under wavy environment provided more correct and applicable solution to the real phenomena at the river sites.

GIS BASED AUTOCORRELATION ANALYSIS OF GEOCHEMICAL SPECIES PRESENT IN THE GROUNDWATER OF MEHSANA DISTRICT

S. D. Dhiman[1] and Ashok K. Keshari[2]

[1] Department of Civil Engineering, Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar, 388120. [2]Department of Civil Engineering, Indian Institute of Technology, Delhi, New Delhi - 110016

A Geographic Information System (GIS) can be used as an effective tool to manage environmental, climatic, and hydrologic data to support decision making and meet regulatory requirements. GIS based autocorrelation is a statistical technique by which the correlation between pixel values of raster map and pixel values of same raster map with different shifts (lags), k, in horizontal or vertical direction are generated. In this paper, the GIS based autocorrelation analysis is performed for a study area located in the Mehsana district of Gujarat State. In this particular study, the raster-based maps obtained for the geochemical species present in groundwater are used for autocorrelation analysis. The geochemical species considered for analysis are calcium, magnesium, potassium, sodium, chloride, fluoride, sulfate, nitrate, alkalinity, and pH along with other parameters like electrical conductivity and total hardness. The spatial dependence of a geochemical species present in the groundwater is investigated at 5% significance level. The autocorrelation coefficients (r_k,) for each of the geochemical species in horizontal and vertical direction for the rasterized maps are computed at different shifts, and the horizontal and vertical correlograms for these geochemical species are obtained for the area under consideration. The upper and lower tolerance limits for horizontal correlogram at 5% significance level (r_k, ¼ k £ 749) are 0.07 and -0.073, respectively. Results reveal that horizontal correlograms for calcium, chloride, nitrate, sulfate, fluoride and electrical conductivity (EC) have all the autocorrelation coefficients falling outside the tolerance band. A very small number of autocorrelation coefficients for sodium, magnesium, potassium, total hardness, bicarbonate and pH are inside the tolerance band. It is thus evident that the geochemical data analyzed for pixels in horizontal direction are not independent. In case of the vertical correlogram for calcium, fluoride, pH, bicarbonate and magnesium, all the autocorrelation coefficients fall outside the tolerance band. However for EC, nitrate, chloride, potassium, sulfate, sodium and total hardness, very few autocorrelation coefficients fall inside the tolerance band limits (r_k, ¼ k £ 635) of 0.076 and -0.079. This signifies that the pixels of geochemical species analyzed in vertical direction are also not independent. Such studies on testing the hypothesis of the spatial dependence of geochemical species help in understanding the significance of the geochemical reactions controlling the variability of individual species concentration within the groundwater regimes.

National Workshop on
Conservation of Rivers and Floodplains in India
New Delhi, 23-24 November 2001
Recommendations

The participants of the National Workshop on the Conservation of Rivers and Floodplains in India (held in New Delhi during 23-24 November 2001), call upon the Ministry of Environment and Forests, Government of India,

1. To treat all rivers, lakes, reservoirs, wetlands, etc. as integrated components of a river basin, and to develop a mechanism for coordination between all programmes for their conservation and management;
2. To take necessary actions to ensure adequate flow in rivers for maintaining their ecological integrity, water quality and biodiversity;
3. To regulate the abstraction of river/surface water for various uses (including agriculture, industry and domestic supplies) in consonance with the hydrological conditions of the river basin and in a manner that under no circumstances the abstraction exceeds a maximum prescribed proportion of the total flow;
4. To ensure return flow of adequate quality by promoting sustainable land use, and recycling and reuse of wastewater;
5. To take necessary steps towards issuing a notification under the Environment Protection Act, to protect river floodplains, and areas surrounding all inland water bodies, from uncontrolled anthropogenic activities (tentatively called as **River Regulation Zone** notification);
6. To declare certain rivers and/or their reaches as "National-Heritage Rivers" and restore them;
7. To initiate measures, on highest priority, for the **conservation and restoration of floodplains, and protection of upper watersheds** of rivers throughout the country;
8. To establish a network of **Protected Areas of River Systems** for the conservation of riverine biodiversity;
9. To establish a **National Institute for Inland Waters** for research on inland surface waters, focusing especially on rivers and lakes;
10. To set up a **National Authority for the Conservation and Restoration of Inland Waters** which should coordinate between various ministries and departments, and function under the NRCA.
11. To coordinate with the Ministry for Urban Development and other concerned ministries and Departments to take measures on priority to **decentralise treatment of domestic sewage** by requiring the housing boards, housing societies, builders, etc. to treat domestic sewage at their end and to recycle treated water;
12. To promote **alternate energy-efficient technologies for wastewater treatment** (e.g., root zone./ constructed wetlands) that will help reduce costs of both capital and O&M.
13. To promote and support **research on river-floodplain systems** in the following areas of priority for achieving the goals of river conservation: A. adequate flow in various rivers/ stretches of rivers, B. hydrology of rivers in relation to their ecological functioning, C. river-floodplain interactions, emphasising nutrient dynamics, D. biological diversity of freshwater ecosystems, E. relationships between groundwater and river flows, F. biologicaVecological integrity of rivers, monitoring and assessment
14. To establish an **ENVIS Center** exclusively for inland surface waters;
15. To promote and support **socio-economic studies** of communities dependent upon rivers (including floodplains) and lakes;
16. To promote and support detailed studies on **Ecological Economics**, particularly of river-floodplain systems emphasizing water quality, biodiversity and natural resources, and

17. To promote **Education and Awareness** about river-floodplain systems. Year 2002 is the Year of Mountains. India must focus on mountain rivers. Similarly, Year 2003, the International Year for Water, should be observed in India by the MOEF as the **Year of Flowing Waters.**
18. To adopt a **Vision Statement (motto)** of the National River Conservation Directorate to reflect a holistic integrated approach to the conservation of rivers and other inland surface waters; (suggestion: **Ensuring ecological integrity of inland waters for sustainable development**)

Listed below are some of the recent news items dealing with various aspects of Biogeochemistry and Environmental Law collected from various National newspapers, reports, etc., and the detailed news items are updated on our website on day to day basis and may be browsed at (http://envisjnu.tripod.com/news/prenews-frame.html).

Banned! Pollution Laws in up to Spoil the Party, The Hindustan Times, 23 January, 2002

Toxins Passed on from Mother to Child, The Hindustan Times, 14 January, 2002

Clean Air: Should you trust your Govt? The Times of India, 11 January, 2002

Water Pollution Goes Unchecked: CAG The Times of India, 9 January, 2002

Tap Water Chemical Risky for Pregnant Women: Study. The Times of India 9 January, 2002

Raising of Periyar Dam Level, a Threat to Biodiversity', The Hindu, 8 January, 2002

'A Friend in Roots Down in the Earth' ,The Times of India, 4 January, 2002

Pre-Digested Organic Wastes for High Quality Vermi-Composting, The Hindu, 4 January, 2002

He Made Environment a National Concern, The Hindu, 4 January, 2002

Programme on Disposing Solid Waste, The Times of India, 19 December, 2001

Water Clock Clicks Fast for Rajasthan, The Times of India, 19 December, 2001

Latest Tiger Census Kicks up a Row, The Times of India, 19 December, 2001

Joint Management of Forests only on Paper, The Hindu, 19 December, 2001

HC Order on Dumping of Garbage, The Times of India, 11 December, 2001

Environment Group to File PIL Against Airports Authority, The Hindu, 5 December, 2001

Stringent Action Against Elephant Killers Mooted, The Hindu, 5 December, 2001

PM Urged to Help Stop Felling of Trees, The Times of India, 23 November, 2001

SC Shifts Focus from CNG to Safety, The Times of India, 23 November, 2001

Five Funerals and a Rainforest Festival, The Times of India, 23 November, 2001

Polymers can be used for Road-Laying: Study, The Hindu, 20 November, 2001

Green Corps Soon to Guard Environment, The Times of India, 20 November, 2001

What a Waste! The Hindu, 19 November, 2001

No Takers for Deadline on Cracker-Bursting, The Times of India, 17 November, 2001

Decibels Soared as SC Norms on Divali Were Ignored, The Times of India, 17 November, 2001

SC Directive Goes up in Smoke, The Times of India, 17 November, 2001

Pollution Soared on Diwali Night Thanks to 'Inversion', The Hindustan Times, 16 November, 2001

165 Nations to Take Steps Against Global Warming, The Times of India, 12 November, 2001

Schools Take Pollution Seriously, Kids Say No to Crackers, The Indian Express, 11 November, 2001

Along With Ear Plugs, Get A Gas Mask This Diwali, The Indian Express, 8 November, 2001

Industries Polluting Various Rivers in Tamil Nadu, The Times of India, 5 November, 2001

Winter Cocktail of Dust and Pollution is Here, The Times of India, 1 November, 2001

Power Shortage is Generating Pollution, The Times of India, 3 October, 2001

More Plastic goes into Thicker Bags, The Times of India, 3 October, 2001

The Capital is so Noisy that People are Falling Ill, The Times of India, 3 October, 2001

Some Recently Published Books

SARASWATI – The River that Disappeared by K.S. Valdiya. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/ 3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. ISBN: 81 7371 0945(PB), 168pp., Rs. 280.00.

The Essential Guide to Environmental Chemistry by Georg Schwedt. 2001. Published by John Wiley & Sons Ltd., Baffins Lane, Chichester, West Susses PO19 1UD, UK. National: 01243 779777, International: (+44) 1243 779777. ISBN: 0 471 89954 2.

DYNAMIC HIMALAYA by K.S. Valdiya. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. ISBN: 81 7371 094 5(PB). 168pp, Rs. 280.00

SILENCED RIVERS: The Ecology and Politics of Large Dams by Patrick McCulley. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. Rs. 415.00.

INTER-STATE RIVER WATER DISPUTES IN INDIA by MVV. Ramana. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. HB Rs. 150.00. PB Rs. 75.00.

GANGA by C. Sivaramamurti. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. HB Rs. 115.00. PB Rs. 85.00.

Biocontrol Potential and its Exploitation in Sustainable Agriculture by R.K. Upadhyay. **Volume 1:** Crop Diseases, Weeds and Nematodes. 2000, ISBN 0-306-46460-8. HB, Price: EUR 131.50. **Volume 2:** Insects Pests. 2001. ISBN 0-306-46587-6. HB. Price: EUR 166.75. Published by Wolters Kluwer Academic Publishers, C-16, Qutab Institutional Area, P.O. Box 4612, Hauz Khas, New Delhi – 110 016.

Water Resourecs Management and the Environment by U. Aswathanarayana. 2001. Published by A.A. Balkema Publishers, a member of Swets & Zeitlinger Publishers. www.balkema.ni and www.szp.swets.nl. ISBN: 90 5809 322 0(HB), 90 5809 339 5(PB).

Environmental Education materials for Children's Educators. For further details contact: EDUTECH, Centre for Environment Education, Thaltej Tekra, Ahmedabad – 380054, e-mail: ceeindia@vsnl.com.

HIMALAYA – Emergence and Evolution by K.S. Valdiya. 2002. Published by Orient Longman, 3-6-272, Himayatnagar, Hyderabad – 500 029. Tel: 3224305/3220306, Fax: 3222900. Email: upilco@hd2.dot.net.in. ISBN: 81 7371 397 9(PB), 168pp, Rs. 280.00.

Physiochemical Groundwater Remediation by James A. Smith. 2001. Published by Wolters Kluwer Academic Publishers, C-16, Qutab Institutional Area, P.O. Box 4612, Hauz Khas, New Delhi – 110 016. ISBN: 0-306-46569-8. HB. Price: EUR 104.

Law and Economics of International Climate Change Policy by Reimund Schwarze. 2001. Published by Wolters Kluwer Academic Publishers, C-16, Qutab Institutional Area, P.O. Box 4612, Hauz Khas, New Delhi – 110 016. ISBN: 0-7923-6800-2. HB. Price: EUR 62.50.

Recently held/forthcoming Conferences and Workshops

9th International sysposium on the Interactions between Sediments and Water. At Banff Springs Hotel, Canada, During May 5-10, 2002. Organised by International Association for Sediment Water Science(IASWS). Contact: Dr. Ellen Petticrew, IASWS Symposium Co-ordinator, University of Northern British Columbia, 3333, University Way, Prince George, British Columbia, Canada, V2N 4Z9. Email: iasws@unbc.ca. Ph. 1-250-960-6645. Fax: 1-250-960-5538. Website: www.wsc.monash.edu.au/iasws/ninthconference.html.

XVI National Symposium on an Integrated Approach to Pollution Control and Preservation of Environment, AIA-PPE, 2002. During March 8-9, 2002. in North Eastern Region(NER), Shillong. Organised by Indian Society of Analytical Scientists(ISAS), Head Quarters – Mumbai. Contact: Dr. R. Saran, The Convener, XVI National Symposium, ISAS, AMD Complex, Civil Lines, Nagpur – 440 001. Phone: 91-712-536577(O), 533890®, Fax: 91-712-536 438. Email: rsaranamd@yahoo.com.

Second FICCI-TERI Global Conference 'Green 2002' Agenda for industry. During 7- 8 February 2002 New Delhi. Contact: Ms Dhenuka Srinivasan, Research Associate, TERI, Darbari Seth Block, India Habitat Centre, Lodhi Road, New Delhi 110 003, India. Phone 4682110, 4682111 Extn. 2341, Fax 4682144, 4682145, E-mail: dhenuka@teri.res.in.

Training Workshop on Climate Change: Impact Assessment, Vulnerability and Adaptation Strategies. During December 17-19, 2001 at Jadavpur University, Kolkata - 700 032. Contact: Dr. Joyashree Roy, Programme Coordinator, Jadavpur University, Kolkata - 700 032. Email: jroy@cal2.vsnl.net.in.

Workshop on Greenhouse Gas Inventory Development (Dec 3-5, 2001) and **Future Socio-Economic Scenario** (Dec 6-7, 2001) Organised by Indian Institute of Management. Contact: NATCOM Project Director, Dr. Subodh Sharma, National Project Director, Ministry of Environment and Forests, Govt. of India, Room No. 564, 5th Floor, Paryavaran Bhavan, CGO Complex, New Delhi – 110 003. Ph: 4360861, 4631669. Fax: 4360861. Email: subodh@yahoo.com, ssharma@menf.delhi.nic.in.

Our Recent Publications

(1). Text book on Environmental Sciences by V. Subramanian. 2001. Published by: Narosa Publishing House, 6 Community Centre, Panchsheel Park, New Delhi - 17, Tel: 91 11 649 4818, 649 6423, 649 1765; Fax: 91 11 649 8717; E-mail: narosadl@nda.vsnl.in. Hardback: 1-84265-075-0, Rs.265/-(Indian Edition), viii-240 pages.

(2). Environmental Hazards in South Asia by V. Subramanian. Jan. 2002. Published by Capital Publishing Company, 7/28, Mahaveer Street, Ansari Road, Daryaganj, New Delhi - 2. Tel: 91 11 328 8719, 328 4197, Fax: 91 11 326 5030, E-mail: capub2000@mantramail.com. Hardbound: 81-855 89-05-4, Rs. 695/-, $19.50. Pages: 350app.

(3). Proceedings of the International Workshop on Ecohydrology, Edited by V. Subramanian and AL. Ramanathan, Jawaharlal Nehru University, New Delhi, During November 26-29, 2001. Published by Capital Publishing Company, 7/28, Mahaveer Street, Ansari Road, Daryaganj, New Delhi - 2. Tel: 91 11 328 8719, 328 4197, Fax: 91 11 326 5030, E-mail: capub2000@mantramail.com. Hardbound: Rs. 650/-. Pages: 460app.

(4). Subramanian, V. (2000): Water: Quantity - Quality perspective in South Asia. Kingston International Publication, Surrey, UK. Distributorin India: Capital Book Private Limited, 7/28, Mahaveer Street, Ansari Road, Daryaganj, New Delhi - 110 002. Phone No.: 91-11- 3284 197, 3288 719, Fax: 91-11- 326 5030, Mobile No.: 98101-50806. E-mail: capitalb@mantraonline.com.

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Contact

Prof. V. Subramanian
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi - 110 067 INDIA

Phone : +91-11-6107676 Extn. 2316
Telefax : +91-11-6106501
Fax : +91-11-6165886, 6198234
Email : envis@mail.jnu.ac.in
jnuenvis@yahoo.com

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