BOOK REVIEW

WATER AND ITS SUSTAINABILITY IN MINING AND OTHER ENVIRONMENT: VISION 2050 (WSME 2014) 28-29 March 2014, ISM Dhanbad.

The volume under review is a logical outcome of a National Conference on 'Water and its Sustainability in Mining and other Environment (WSM-2014): Vision 2050' held during March 28-29, 2014 at Indian School of Mines, Dhanbad (ISMD). It contains 9 keynote papers and 31 contributory papers covering Mine Water Management, Aquifer Modeling, River Basin Studies, Rainwater Harvesting, Ground Water in Alluvial terrains, Climate and Groundwater, Water use in Agriculture and Waste Water Treatment and Reuse.

Keynote Papers

(i) N.C. Saxena presented a paper on the "*Post Mining Water Management*", and pointed out that there is a need for developing integrated mine planning and design system involving utilization and management of all resources. Water is one of the most important resource which has to be given due importance as it is needed not only during mining but also after closure of mines. The ways in which surface and underground water bodies can be developed in open cast and underground mines were also described.

(ii) P.K. Sikdar presented a paper on "*New resources of groundwater for safe drinking water supply in semi-arid and fluoride affected areas: The example of River Ajay, Birbhum District, West Bengal*". Study area covers a total length of 36 km on River Ajay. Geologically, the area comprises of different rock types ranging from Archean to Quaternary. Based on the study of 247 boreholes, the author suggested construction of ground-water obstruction structures such as infiltration gallery or collector wells with radials, so that sustainable water supply to all villages in the basin can be achieved with a care to see that the base flow of the river is maintained to avoid adverse effect on river regime.

(iii) Dipankar Saha presented a paper on "*Impact of Coal Mining Activity on Ground Water Regime – A Review on Jharkhand State*". Author mentions that groundwater is a key component of socio-economic development of Jharkhand. It caters to rural drinking water and about 1/4th of urban drinking water needs. A significant amount of irrigation demand is also met from groundwater. The replenishable groundwater resource of the state has been worked as 5.96 bcm as per the estimate in 2009 with a stage of development as 30%. Gondwana sediments rich in coal deposits covers about 4% of the total area of the state. Though they are not widespread, the mining for coal, both open cast and underground, cause intervention in groundwater regime both in terms of physical and chemical aspects. The mining activity alters the groundwater flow regime of the shallow and also deeper aquifer in the multi-layered aquifer system within the Gondwana sediments and continuous dewatering of the mine water creates decline in water level. However, other than Jharia, no other block, partially or fully covered by Gondwana deposits, has been overexploited. The aquifers in the areas under mining activity and in surrounding areas should be understood in detail for its hydraulic parameters, resource availability, flow regime, temporal and spatial behavior of water levels and chemical quality. A sustainable aquifer management plan should be adopted to minimize the adverse effect on groundwater regime due to mining, backed by artificial recharge and rainwater harvesting.

(iv) Arvind Kumar contributed a paper on "*Civil Society Stewardship in water conservation in Industry and Mining Sectors*" and suggested that the civil society should be a link between general public and corporate sector and play crucial role in implementation of water conservation measures. Financial resources with corporate sector in tandem with trained human capital of local people can facilitate capacity building of the corporate sector which can be instrumental in attaining the desired results of water conservation and water audit. Civil society should elicit technical expertise from CGWB, State Government Departments and International Agencies in this regards.

(v) Mamta Bose presented a paper on "*Role of Human Face in Safeguard of our Environment with Special Reference to Water*". The author highlighted that mining is environmentally unfriendly but at the same time minerals are backbone for industrial and social development. Indian mining sector is facing severe criticism on several issues relating to its development and suggested as to how responsible mining can be carried out with the use of good technology to save water and handle waste material. Author had given examples of Relegaon Siddhi in Maharashtra and Bhikampur in Rajasthan and suggested that NGOs should take up further studies.

(vi) Arijit Bagchi presented a paper on "*Mineral Sand Mining below fresh water Coastal Aquifers - An Attempt towards removing Myths and Apprehensions*". Author explains that India has large reserves of mineral sands in 6000 km east and west coasts. Mineral sand mining is an important economic event and mineral sand along coast can be mined without ill effects on coastal aquifers. Author suggested that saline water intrusion into dug wells or dredge ponds adjacent to the coast is reversible and saline water can be eradicated by adding fresh water from river into the dug wells or dredge ponds.

(vii) B.C. Sarkar in his paper on "*Aquifer Modeling-A Geostatistical Approach*" explained how geostatistics aids in modeling spatial variability and thereby used for characterization

of aquifers in terms of hydrogeological parameters. Considerable problems in the formulation and application of aquifer models that are likely to be present in the treatment of the uncertainty of the parameter values, the initial and boundary conditions, or even in the formulation of the relevant processes themselves were discussed. The author described in detail the principles underlying the geostatistical technique, modeling procedure and the advantages of its applications in aquifer modelling.

(viii) S.C. Dhiman presented a paper on "*Impact of Iron ore mining on water resources in Goa*". He explained the task of assessment of ore and its sustainability in a mineral deposit are being carried out from the stage of planning of mining activities for exploration, exploitation and closure of the mines. Water, which is becoming scarce, necessitates to be assessed as a resource along with the minerals for its sustainability and conservation. Aquifer mapping programme needs to be taken up to understand and to develop a relationship with land and water resources for assessment, conservation and sustainable management. Sustainable management of mine water resource can be the alternate source of the socio-economy in the mining belts.

(ix) R.H. Sawkar in his paper on "*Groundwater Development and Rainwater Harvesting in Greater Bengaluru*" explained about the water supply problems of growing Bengaluru city where piped water supply was planned by Sir M. Vishweswaraiah in the year 1933 for seven lakh people in 70 sq km area which has now grown to 1250 sq km with a population of more than 90 lakhs consuming 1460 mld of water from Cauvery river. To meet the growing demand for water, the author suggested rainwater harvesting for domestic use and waste water for non-domestic use. Based on geomorphological study, drainage pattern, weathering character of rocks, he suggested sinking of 10m dia shafts and galleries at selected point to store harvested rain water for recharging over-exploited vadose and phreatic zones. The author further suggests that a National scheme for sustainable supply of domestic water should be drawn to identify Panchayats with population of 10,000 people, municipalities having population upto 2 lakh people, corporations up to 10 lakh people and metro cities with the population exceeding 50 lakhs. Solution to problems of sustainable supply of domestic water to panchayats and metro cities does not lie in bringing water from long distance streams and rivers but can be solved by wise use of local resources. The author also suggested that sustainable supply can be achieved by adopting stoppage of current leakage in piped water supply, use of uncontaminated rain water harvested for charging over exploited vadose and phreatic zones and collection of sewage water in decentralized locations for treatment and reuse.

Mining

Five contributory papers were presented.

(i) Pragati Rai and Santosh Kumar presented a review paper on "*Environmental impact on water regime due to coal mining effects*" and said that both surface and underground water regimes severely get affected though mining is beneficial to the Society. They suggested that there should be a balance between mineral developments on one hand and restoration of the environment on the other.

(ii) D.C. Jha, E.V.R. Raju, and Kumar Ranjeev presented a paper on "*Surplus Mine Water Utilization: An initiative for sustainability by BCCL*". They explained that mines are discharging water which after meeting the requirement of mines and domestic requirements of BCCL colonies, the surplus mine water is being supplied to Khonathi and Behrakudar towns, as an initiative under its corporate responsibility. They further suggested that mine surplus water can be accumulated in non-coal baring zone in points and can be utilized for community use. They divided the study area into 3 layers and have used hydraulic conductivity, groundwater heads, specific yield and recharge areas for model calibration.

(iii) "*Ground Water Flow Modeling applications to mining regions of Kobra district, Chattisgarh*" with 530 sq km coal field area covering 8 open cast and underground mines were studied by S. Sudhakar, C.P. Davata and S. Soumya by using visual MOD Flow finite difference code with hydraulic conductivity, ground water head, specific yield and recharge area as parameters for model calibration. The water balance study shows that high dewatering leads to aquifer over-exploitation in which hydraulic conductivity is an important component for lowering the water table.

(iv) R. Someswaran and Suresh A. Kartha in their paper on "*Analysis of Effects of heterogeneity on transport of Acid and Mine Drainage*" have explained that mining processes expose minerals such as pyrite, pyrhotite and chalcopyrite etc to atmospheric oxygen leading to formation of low ph or acidified water zones in the unsaturated soils which leach surrounding heavy metals and minerals and transport them to ground water aquifers. Authors have demonstrated that the clay layer can potentially be used as containment layer to absorb harmful chemicals.

(v) Mrinal Kanti Mukherjee and Vasundara Sarkar contributed a paper on "*A Firsthand Prediction of Water Ingress in the Proposed Open Cast Coal Mine for GarePalma IV/5 coal block Mand Raigarah Coal Fields, Chattisgarh, India*". Based on the studies of hydrological and geomorphological setup of the area, hydraulic conductivity of different litho-components and mechanics of ground water movement, prediction of water inflow has been carried out for an open cast coal mine that is planned to be developed.

Water Quality

Nine contributory papers were presented

(i) "*Multi-objective approach for in-situ Bioremediation of Petroleum Contaminated Groundwater using particle swarm optimization*" Deepak Kumar, Sudheerch, Brijesh Kumar Yadav and Sashi Mathur states that groundwater is contaminated due to

leakage of petroleum. A set of injection and extraction wells are used to enhance biodegradation processes of containment in groundwater. The results suggest that by adopting an optimal pumping strategy, groundwater can be remediated with desirable limits of concentration of contaminate.

(ii) "*A case study on* "*Sustainability of conservation measures on water quality of Bhoj wet land*" was presented by Kaushik Majumdar and Subrata Pani. Rs. 247/- crores project implemented from 1995-2004 under external funding of JBIC Japan is of special significance since it has been a source of piped water supply to the city of Bhopal besides being a rich source of Biodiversity and accounts for 35 to 40% of the city's water supply. The authors conclude that the effectiveness of the conservation measures implemented in 10 years back has reduced pollution load and further suggest appropriate conservation and management program for long term sustainability of wet land.

(iii) Sukha Ranjan Samadder and Chillara Subba Rao presented a paper on "*Effects of Arsenic Pollution in Ground water on Life Expectancy"*. By using GIS technique spatial distribution of arsenic pollution in Lalgola and Nawda blocks is computed and life expectancy using Newel's method was calculated. They concluded that in Lalgola block where arsenic value is high ranging between 0 to 0.314 mg/L averaging more than 0.05 mg/l, the life expectancy varied from 65.67 years to 47.24 years whereas in Nawada block where arsenic value range between 0 to 0.15 mg/L averaging less that 0.05 mg/L, the life expectancy varied from 65.69 years to 54.44 years.

(iv) Sangeeta Verma, Anju Singh and Raghavendra Kumar Verma presented a paper on "*Monthly Variation of Water Quality Characteristics and Morphometric Analysis of Viharlake, Mumbai-India*". They have classified Mumbai lakes by taking 10 parameters and using WQI for computation of quality of water. They have found that the WQI varies from 90 to 98.42 and is found within the desirable limits of WHO and BIS (IS-10500) except for total coliform concentration. Their study suggest that water quality of Vihar lake is free from any kind of point pollution sources due to its location within the Sanjay National Park where no anthropogenic activities are allowed. It has higher potential for drinking water compared to other lakes.

(v) Tanmoy Hazra, Md. Hamjala Alam and Brijesh Kumar Mishra in their paper on "*Assessment on Organic Carbon Pollution Load of Surface and Groundwater in Rajrappa area, Jharkhand*" have used the TOC (Total Organic Carbon) in water sample for environmental monitoring. Parameters like TOCK, UV_{254} and COD of ground water and surface water of Rajrappa area, indicate that inorganic matter of ground water samples are below permissible limit of the IS:10500 drinking water standard. But the organic carbon pollution load of water samples are high because of surface water runoff from nearby polluted area. They have determined the chlorine dose for disinfection of the sample. SUVA value of Damodar river water exceeds 2, which indicate that the water has higher chlorine demand and higher THM (Tri Halo Methane) potential.

(vi) Md. Hamjala Alam, Tanny Hazra, Bhupendra Singh Ken and Alok Sinha presented a review paper on "I*mpact of coal based thermal power plant on water*". They have indicated that about 58.75% of India's power is produced from coal based thermal power plants. Using 258 million tonnes of coal with an ash content of 35-40% generating 190 million tonnes of coal ash per annum, require 630 million m^3 water for disposal of coal ash in slurry form per annum. Chemical quality of water and temperature of water alter aquatic plant and animal communities. Authors have suggested implementation of zero ash discharge by utilizing fly ash for making cement, ceramics and construction of roads and bricks for buildings.

(vii) Pradeep Kumar G.N., Janardhan Swami, Y.C. and Srinivas, P. in their paper on "*Logarithmic Methods of Rating Water Quality*" have presented results of an experimental study on Ground Water quality in Kondagattu Catchment of Greater Visakapatnam Municipal Corporation for its use for internal purpose. Groundwater Quality Index (GWQI) for drinking purpose is computed using logarithmic method. Their study has revealed that generation of GWQI helps in categorizing various water quality parameters into a common scale and could be useful for planning and decision making.

(viii) Utsab Ghosal et al. in their paper on "*Hydrology and preliminary results of groundwater flow Modeling to understand Arsenic migration in the Aquifer of Jamuna Sub-basin*" have developed a preliminary ground water flow model to evaluate spatial distribution of hydraulic heads under two development scenarios: Pre-pumping and current pumping for Jamuna sub-basin. They have concluded that pumping of groundwater will modify sub-surface hydrological system of the sub-basin with a low topographic gradient. Newly formed ground water troughs and mounds, will control the ground water flow of the area. Pumping will result in migration of arsenic from the shallow aquifer to the deep aquifer up to a depth of 182 meters. Aquifer below 200m may remain arsenic free. Hence, they have suggested pumping of As-free water 200m bgl for drinking purpose with a caution that irrigation pumps should not lower shallow aquifer levels to contaminate deep aquifers.

(ix) Prasoon Kumar Singh et al. in their paper on "*Hydro chemical investigation and quantitative assessment of surface water resource in west Bokara Coalfields, Jharkhand*" have given details of the 14 water samples collected from the west Bokara coal field, their analysis and evaluation of chemical characteristics and its sustainability for drinking water. Samples are slightly alkaline in nature, and are dominated by Ca^2 and Na^+ and HCO and SiO_{24}. Analyzed parameters are well within the desired limits for drinking purpose. However, in few sites the concentration of TDS, TH, Ca^{2+} and Mg^{2+} exceed the desirable limits.

Aquifer Modelling

Four contributory papers were presented.

(i) Paulami Sahu and P. K. Sikdar presented a paper on "*Groundwater flow model to understand water level variations under different pumping conditions in the Quaternary Aquifer of an upcoming Urban Centre in south Bengal Basi*n". Authors have developed a groundwater flow model to evaluate the spatial distribution of hydraulic heads under three scenarios: pre-pumping, current pumping, and possible future pumping for the newly developed urban centre of Rajarhat New Town (RNT) located in the north eastern fringes of the megacity of Kolkata. Pumping of groundwater beneath this newly developed town with low topographic gradients will modify the sub-surface hydrologic system. New groundwater troughs and mounds will be formed which will control the groundwater flow of the area, thereby increasing the risk of groundwater contamination. They have suggested that further modeling studies are required to locate the new recharge areas and preferential flow paths of contaminants which would help to establish observations stations for regular water level and water quality monitoring.

(ii) S.N. Dwivedi presented a paper on "*Need for model assisted groundwater recharge plan in stressed alluvial aquifers with good recharge prospects*". He states that the artificial recharge to groundwater is steadily assuming importance in the wake of the local and regional scale depletion of water level in several parts of the country. India, which has high overall dependence on ground-water resource to meet the requirements of the agriculture, industry and drinking water sectors, is projected to face water scarcity in large parts the country in the coming decades. Adding to woes is the projected climate change and the associated concerns likely to adversely impact the prevailing natural recharge regime. Artificial groundwater recharge is thus important so as to replenish the aquifers facing storage depletion which is manifested through long term water level decline in certain areas. However, recharge plans need to be conceived holistically. Preparation of artificial recharge plans for stressed alluvial aquifers with adequate recharge prospects and source water availability need to be based on the maximum improvement in water level desired in any given area. To this end, it is argued that the maximum improvement of water level targeted in a given area should be guided by the water levels that existed in the area prior to the onset of groundwater development i.e., the pre-development condition. Groundwater modeling studies can provide valuable inputs on the desired volume of recharge so that the aquifers are brought back to the pre-development condition. Based on the output of such studies particularly the mass balance, the number of different types of recharge structures can be planned for the aquifers under stressed condition.

(iii) Fakhre Alam and Dipankar Saha presented a paper on "*Assessing vulnerability for protection and management of stressed marginal alluvial aquifers*". Central Groundwater Board study aims at estimating vulnerability of aquifer by application of DRASTIC models in the southern part of the Gangetic Plain of Bihar State. The alluvial sediments of Pleistocene age unconformable overlie Precambrian basement in the area. The alternating layers of clay and sandy clay form potential aquifer. The area forms a part of sub-regional aquifer system extending up to the Ganga river. In the study area, 3 to 4 aquifers are encountered within 80 to 110m bgl, which merge towards north and form single thick aquifer down to 250m bgl along the northern border of the study area. The depth to water level ranges from 0.58 to 3.08m bgl. The general groundwater flow direction is southwest to northeast.

The DRASTIC method was used in GIS environment in this study. The parameters like depth to water, net recharge, aquifer media, soil media, and topography, impact of vadose zone and hydraulic conductivity of the aquifer were considered for the preparation of groundwater vulnerability map. The vulnerability index is computed as the sum of the products of weights and rating assigned to each of the input considered. The vulnerability index range from 156 to 172 and it is classified into three categories i.e., <160, 160-170 and> 170 to low, medium and high vulnerability zones, respectively. Using this classification, a groundwater vulnerability potential map is generated which shows that 19% area falls in low vulnerable zone, 63% in medium vulnerable zone and 18% in high vulnerable zone. Major portion of the study area comes under the medium vulnerable zone. The map thus generated can be used as a tool for projects and management of aquifers.

(iv) Dinesh P., Suresh A. Kartha, and Subashis Dutta presented a paper on **"***Ground Water Flow Modelling of Kosi Alluvial Fan in Bihar State using Modflow 3D Grid Approach*". The authors state that transient ground water flow modeling of Kosi alluvial fan in Bihar region of India (180 x 150 km) is studied using MODFLOW 3D GRID approach. The aquifer parameters and depth to water table values are used as inputs and calibrated model is subsequently used to simulate piezometeric heads in the region and predict the groundwater flow directions. The regional aquifer-river interaction like influent and effluent river stretches and marshy land regions has been well observed during transient simulation at different time step using flow budget analysis.

River Basin Studies

Three contributory papers were presented on rivers.

(i) Pradeep K. Naik and Arun K. Awasthi have presented a paper on "*Estimation of Base flow in a River with Modified and/or Regulated Stream flow*". The water use approach discussed in this paper is applicable to the rivers where the stream flow is modified either due to heavy water withdrawal and/or regulated due to reservoir releases from an upstream reservoir or series of reservoirs. The water use approach reveals that if the quantum of water withdrawn artificially from the river is quantified, base flow component could easily be estimated with the help of the reservoir releases in the upstream and the stream flow at the mouth of the river.

(ii) Jaideep Sehrawat, Anurag Sharma, Arvind Kumar and Bimlesh Kumar presented a paper on "*Developing Nomograms for a Tunnel Connecting Two Reservoirs*". The design of the tunnel connecting two reservoirs should depend on the upstream water level or downstream water depth. The discharge characteristics of the tunnel should be such that it should carry a maximum discharge of 34 cumec. The design values of discharges for that maximum upstream depth of 3.5 m obtained for all five different value of 'n' are studied. The value of 'n' may be chosen such that it satisfies the above constraint.

(iii) Pankaj Kumar Sharma presented a paper on "*Study on Environmental Impacts of Tehri Dam*". Dam is essentially an artificial wall constructed across a river which converts a running water ecosystem into a lake type ecosystem. This causes some changes in basic riverine ecosystem. The author states that studies were conducted through expert agencies for the likely negative impacts of dam and its reservoir. Mitigating measures, where necessary, were taken on the likely negative impacts.

Rainwater Harvesting; Groundwater Flow in Aluvial Tracts; Groundwater in Agriculture and Climate Change & Water:

(i) Ankit Kothari et al., presented a paper on "Implementing rain water harvesting scheme in every household – An urgent need for the city of Bangalore". Authors have suggested a dire need to match growth in urban population with adequate water supply. Rain water harvesting by individual households and property owners can be a cheap, reliable and near adequate source of water to areas with good rain fall periods. This paper deals with the water demand efforts made through several projects to meet the increasing water demand, need for supplementing these efforts with suitable rain water harvesting schemes to ensure total availability of water to the individual houses.

(ii) Neeraj Balot presented a paper on "*Resistance Relationship for Alluvial Channel*". The author mentioned that the flow boundary in alluvial channels is not fixed but continually undergoes changes in its characteristic geometry and dimensions through mutual interaction between the flow and bed. In the present work, a resistance equation has been developed empirically for the alluvial channel by using a large database of flume and field experimental observations. Advantage of the present model is that it includes the effect of Froude number, Reynolds number and particle relative roughness parameter on friction factor. In case of alluvial channel, Reynolds number and Froude number along with particle relative roughness affect the friction factor. Present equation developed includes the effects of all the three parameters on friction factor in alluvial channel comprising of all types of bed forms. Error in friction factor prediction from the present equation has been found much lesser than the equations available in the literature.

(iii) Rutuja Chavan and Bimlesh Kumar presented a paper on "*Development of Incipient Motion Criteria for Alluvial Channel*". Authors state that the major limitation of existing incipient motion criteria is that the particle diameter should be known to evaluate the bed shear stress. This paper presents a resistance equation at incipient motion of plane bed channel under uniform flow condition. Analytical equation for shields functional relationship is also presented and from this equation one can compute shields parameter by taking the value of Q=0.58. The performance of the present model can be said satisfactory considering the complexity of the incipient motion.

(iv) Thokchom Bebina Devi and Bimlesh Kumar presented a paper on "*Near Bed Hydrodynamics of Vegetative Channel with Seepage*". Authors conducted experiments to study the change in flow characteristics in a flexible vegetated channel with suction. Different percentage (10% and 15%) of seepage was applied. From the study, it is found that when vegetation is introduced in a threshold channel or at incipient motion condition, then sediment particles around the vegetation started its movement but not in bulk. An S-curve velocity profile is achieved at no-seepage condition. A high velocity zone occurs near the bed with suction and it increases with increase in suction rate. Deflected plant height decreases with increase in suction rate because the downward force drags the vegetation towards the bed. The maximum Reynolds stress occurs near the top of the deflected vegetation height. It also indicates that the Reynolds stress follows the linear law and reaches its maximum near the top of the vegetation. The sharp decrease in the Reynolds stress within the vegetation is caused by the drag due to vegetation. In other words, the vertical momentum transfer from the upper layer towards the lower or vegetation layer is obstructed by the vegetation stems. The inflection point in the velocity profile and the turbulent Reynolds stress lie close proximity to each other. From the Reynolds stress diagram, the shear velocity for each case was found by extrapolating the measured Reynolds stress towards the bed. It is found that the shear velocity increases with increase in the percentage of seepage.

(v) Abhirup Basu et al., presented a review paper on "*Hydroponic Systems and Future Agriculture*". The authors state that the huge fresh water requirement for agricultural and industry is causing water stress in various countries. According to Organization for Economic Cooperation and Development projections, 47% of the world's population could be living under severe water stress by 2050. The rate at which rain forests are removed for new pastures of fertile lands all over the planet is alarming. Old agricultural lands are fast becoming infertile and barren due to over exploitation of ground water and application of excess fertilizers. Also, harmful pesticides are being used to combat pests, which by bio-magnification and bio-accumulation are finding their ways into the human body, causing all sorts of health concerns. Agricultural runoff, which contains fertilizers and pesticides are contaminating fresh water and groundwater sources. The need of the hour is to find a more sustainable alternative which will not only satisfy our food requirements but also lower the impact on environmental and health and also reduce the stress of global water demand. Hydroponics has developed,

over the years, into a viable alternative to the conventional methods. Added with the knowledge of state of the art biotechnological techniques, hydroponics has the capability of changing the scenario of agriculture and horticulture in the coming years.

(vi) Bijendra Kumar et al., presented a paper on "*Global Climate Change: - A review on impact on world resources*". Climate change is due to natural internal processes or external force, or to persistent anthropogenic changes in the composition of the atmosphere. The Third Assessment Report on climate change of the Inter-governmental Panel on climate change, the atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased by about 31%, 151% and 17%, respectively. The changes in the atmospheric concentrations of GHGs and aerosols, land cover and solar radiation alter the energy balance of the climate system which are drivers of climate change. They affect the absorption, scattering and emission of radiation within the atmosphere and at the Earth's surface. Human activities result in emissions of four long-lived GHGs. Climate change will alter the current situation of the hydrological cycle, evaporation, runoff and solid humidity and cause redistribution of water resources in space and time which results in drought and flood conditions in different parts of the world and it indirectly affects the crop production, fresh water availability, forest damage, erosion problems and different resource crisis all over the world. Warming of climate due to global warming rises the global mean surface temperature by 0.6°C over last 100 years which results in melting of ice sheets in Polar regions, increase in the level of sea and salinization of coastal aquifers due to intrusion of sea water. Increase in concentration of various gases in atmosphere alters the radiation budget of the earth which in turn affects the hydrological cycle, precipitation and evaporation rate. These variations affect the recharge rate of groundwater and flow rate of water in river basins. Changes in atmospheric concentration changes the atmospheric chemistry which causes variation in the rate of reaction leading to the formations of secondary pollutants in troposphere and changes in the air quality which are harmful to human beings. Climate change also increases the rate of natural emissions and increases the tendency of forest fire which ultimately results in the destruction of natural habitat and threat to the biodiversity. Climate change affects the evapotranspiration of soil moisture and variations in organic matter, organic carbon and nitrogen of soil by alteration in biochemical cycles. Thus, changes in climatic system ultimately cause large scale damage to the world resources which are essential for the growth of human beings.

Water Treatments

Rakesh Kumar et al., presented a paper on "*Indian Water Scenario and Waste Water Treatment in India*". Present scenario of over exploitation of ground water shows that the water level is going down. Domestic and industrial waste water is causing water pollution. This ground water level depression and pollution is affecting the whole hydrosphere which is directly affecting the eco-system. Water consumption in industry, livelihood and agriculture is increasing day by day. One can utilize the water which is going waste in the industries, agriculture and as municipal waste, by adopting some technologically feasible and economically acceptable processes to recycle this waste water. Government and number of industries are working on the waste water treatment but some scope for improvement still prevails.

Vishakha Kaushika and M. Pandit in their paper on "*Decolorization of Acid Orange II Dye by Fenton Reagent: Optimization of Parameters and Kinetic Study*". The authors expressed that waste water generated from dyes and textile industries have high concentration of chemical oxygen. They conducted experiments in a batch reactor. The effects of different reaction parameters such as hydrogen peroxide concentration, ferrous ion concentration, pH of solution and initial dye concentration were investigated. In this study, the experimental ranges for H_2O_2 dose varied from 50 mg/l to 500 mg/l and Fe^2 ion was 10-40 mg/l. All experiments were carried out at temperature of 38°C. The optimized dose of H_2O_2 and Fe^2 were 250 mg/l and 30 mg/l. The optimum pH condition was found to be 3.07. Under optimum conditions, the initial 300 ppm dye solution was completely decolorized within 12 minutes at 38°C and 87% chemical oxygen demand (COD) was removed which proves that the dye was not only decolorized but mineralization also took place. A pseudo first-order reaction rate with respect to Acid Orange II concentration was found. The results show that Fenton's processes not only decolorize the dye solution but it can also oxidize the by-products leading to mineralization and 87% COD reduction was achieved within 30 minutes.

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