Human dimension of environmental change with special reference to water system and river restoration

Srikumar Chattopadhyay, Trivandrum

Prof. Mridul Hazarika, hon'ble Vice Chancellor, Gauhati University, Professor Hermann Kreutzmann, Director, Centre for Development Studies, Institute of Geographic Sciences, Freie University, Berlin, hon'ble Chief Guest of 36IIG Meet and International seminar, Prof . Abani Bhagabati, President of the Organising Committee, 36 IIG Meet, Prof. Ashok Kumar Bora, Vice President, Organising Committee, Prof. Bimal Kumar Kar, Head of the Department of Geography and Convenor of the Meet, Prof. A Saikia, Dr. D Sahariah, Dr. M Das and Dr. Jayashree Borah, Organising Secretaries of the Meet , Prof. R G Jaybhaye , Secretary, IIG, Senior Geographers and fellow participants.

At the outset let me express my deep sense of gratitude to all the members of IIG and particularly the members of governing council of IIG for their magnanimity in choosing me as the President of the Institute for the year 2014-15. I feel deeply honoured and humbled. It is a great responsibility. Senior professors, well known for their scholarship and authority, have graced this office in the previous years. I am well aware about my limitation to do justice to this office. Nevertheless, it is only the good wishes of all of you and blessings of senior geographers that have encouraged me to accept this responsibility and stand in front of this august gathering to share some of my thoughts with you.

The focal theme of 36th IIG meet and International seminar, 'Environmental Changes and Challenges: Local, Regional and Global Perspectives' is one of the most contemporary topics discussed across the World. I take this opportunity to congratulate the organizers for selecting this topic. I propose to speak on human dimension of environmental change in general. Some specific reference will be made for surface water system and river restoration activities across the world. Finally I shall trace research traditions of geography in studying human dimension of environmental change and urge for continued engagement.

I.1 The Context

The Club of Rome drew our attention to the impending ecological crisis through its publication 'Limits to Growth" in 1972. The Thirty Year Update of Limits to Growth discussed key environment-development issues and provided a guideline for transition to sustainability (Meadows et al, 2004). Our Common Future (WCED, 1987) and Agenda 21 (Rio Summit, 1992) raised the concern and agenda for action, respectively. Subsequently, there had been World Summit on Sustainable Development

(WSSD) in 2002 and Rio + 20 in Rio De Genero in 2012 and a host of other conferences, symposia and deliberations addressing global environmental change, climate change, sustainable development and sustainability organized by scientific community, International agencies, UN, Government and NGOs. All echoing the same concern-the civilization is at cross roads. It is a common responsibility. We must act and act faster.

It is a matter of great concern that the earth system is being stressed beyond its resilience limit and many of its components show symptoms of irreversible changes (Brown, 2006, MEA, 2005, UNEP, undated). There is a general consensus in both science and policy that the present economic and social development paths are not sustainable in the long run. Rockstrom and his colleagues (2009) of the Stockholm Resilience Centre conducted a study to assess safe operating space for humanity. This study identified nine indicators like, climate change, rate of biodiversity loss, nitrogen cycle, phosphorus cycle, stratospheric ozone depletion, ocean acidification, global freshwater use, change in land use, atmospheric aerosol loading and chemical pollution for analysis. Out of these nine, three systems (climate change, rate of biodiversity loss and human interference with the nitrogen cycle) have already crossed their respective boundary limits. Planetary boundaries are tightly coupled and not mutually exclusive, therefore transgression in one boundary may lead to serious risk in case of other boundaries.

Millennium ecosystem assessment report (2005) has indicated that 15 out of 24 ecosystem services examined are being degraded or used unsustainably. The apparent gains in economic development and growth have been achieved at the growing costs in the form of degradation of many ecosystem services, increased risk of non linear changes and the exacerbation of poverty of some groups of people. This report has underlined the role of human activities as principal drivers of change.

Around two decades before, in a joint statement, fifty eight World Academy of Sciences, congregated for the 'Science Summit on World Population' held at New Delhi in October, 1993, observed that 'the magnitude of threat to the ecosystem is linked to human population size and resource use per person'. Following this Science Summit on World Population in New Delhi, three Science Academies, namely India, China and USA collaborated for a tri-academy study on population growth and landscape change (INSA, CAS and USNAS, 2001). Six case study sites, two in each country, were selected for detailed analysis. The States of Kerala and Haryana were taken up for Indian case study sites (George and Chattopadhyay, 2001). It emerged from the case studies that landscape change is linked to intertwined-effects of population, consumption and technology and its effect differs regionally and among social groups. Government policy plays a major role in the changing landscape. It further concluded that any understanding of the interactions between land use and population in any place will depend on taking into account external and global forces. The true drivers of local environmental change must be identified and policies intended to foster more sustainable development must be carried out in recognition of the larger context.

I.2 Human - Nature Dialectics

According importance to human as a part of nature and at the same time recognizing human's role as principal drivers of earth's changing surface have important philosophical connotation in scientific pursuit of Knowledge. Role of human being as free thinking entity, capable of taking independent decisions, and creator of built-in environment by modifying the existing system and contributing to the processes governing geo-system is well recognized. People not only form part of the ecosystem, but are also continuously engaged to deliberately alter the environment. By acting on the external world and changing it, humans at the same time change its own nature. The dialectical relationship or to and fro, by which the human species creates nature, is created by nature, shapes tools and is shaped by tools and by tool making, cannot be studied as a universal process, fixed for all times, but in its historically concrete forms along with their development and change (Wisner, 1978). With progress of human society, concentration of large number of people/activities in certain places, and technological advancement, the human-nature interaction frame has just not widened, but it has become nonlinear, complex and multi dimensional and is making profound changes in the ecosystem.

In the course of shaping and reshaping the nature humankind continues to superimpose an anthropogenic landscape on the natural landscape. Human activities are so intense, penetrating and materially voluminous that the recent years, more particularly the period beginning with industrial revolution in the latter part of eighteenth century is considered as 'Anthropocene' (Crutzen and Stoermer, 2000). Clearly the landscape that we see today was not the same that people knew even fifty years back and it is changing faster than what earth system can assimilate resulting in increasing ecological foot print, overshoot and endangered earth. In this era of anthropocene human dimension of global environmental change is emerging as a separate field of study to provide an understanding of social science knowledge in global environmental change, and positioned it in the science society interface (Stern, Young & Druckman, 1992, Griffith, 2009).

I.3 Coevolving landscape

The anthropogenic and natural landscapes are coevolving. The ecological sciences and social sciences are interlinked which has been conceptualized as Coupled Human and Natural Systems or CHANS (Rosa and Dietz, 2010). A comprehensive understanding of linked social systems and natural systems require synthesis of several conceptual frameworks. A major step in this direction has been the integration of ecological and economic thinking (Berkes and Falke, 1998). The interface between science and society is also referred as Sustainability Science by International Human Dimension Programme (IHDP). The sustainability science poses a special challenge since it will require new advances in knowledge about human societies-knowledge about the social causes that affect environmental change and lead to unsustainable production systems, knowledge about the characteristics of the earth system, and the likely consequences of global environmental change, and knowledge about policy options, that allow

human society to achieve transition to sustainability (Biermann, 2004).

I.4 Global Environment Change Studies

Worldwide concern about environmental impacts has been conceptualized under the topic of 'Global Environmental Change' (GEC). The fundamental processes leading to GEC can be viewed under three broad groups: autocatalysis, globalization and interconnectedness of ecosystems (Rosa and Dietz, 2010). Autocatalysis refers to a process in which a system catalyses itself in a positive feedback cycle going faster and faster once it has started (Diamond, 1997). The ongoing development process, be it agriculture, industry, population or urbanization follow this route. The globalization has initiated a process of widening, deepening and speeding up of worldwide interconnectedness in all aspects of contemporary social life. It has also decoupled the decision making process from the local needs. Ecological interconnectedness comprises ecological connections and interdependencies on a global scale. It underscores symbiotic linkages of various components of ecosystem, where intervention in one sector will automatically trigger changes in other sectors.

Understanding the cause of GEC is a function of understanding the range of choices and actions humans undertake (Rosa et al, 2010). This issue of GEC was so overwhelming that global institutions were established to study the subject and provide guidelines. Inter-Government Panel on Climate Change (IPCC) came into existence in 1988 and it started assimilating worldwide data and bringing out reports at regular intervals. International Social Science Council established Human Dimension Programme of GEC in 1990 as a global framework for interdisciplinary international research on global change. By 1996, it was renamed as International Human Dimension Programme (IHDP). The core research projects of IHDP covered Global environmental change and human security, Institutional dimensions of global environmental change, Industrial transformation and Land use Land-cover change (LUCC). The LUCC programme was one of the first attempts to study human dimension of environmental change. Changes in utilization pattern of land and resulting change in landscape cover and ecology are most profound of the human influences on the earth and are major drivers of climate change, deforestation, biodiversity loss and alteration of biogeochemical cycles. The notion of human dimensions of global environmental change views societies as both cause and effect, as the drivers of global environmental change and as victims of global change impairing livelihood opportunities and very survival of human beings. The new IHDP core projects include Urbanisation, Global land project (IHDP/IGBP) and Land and ocean interactions in the coastal zone (IHDP/IGBP).

The US National Research Council and National Academy of Sciences (NRC/NAS) standing committee on Human Dimension of Global Change published the report on 'Global Environmental Change: Understanding the Human Dimensions' in 1992 (Stern, Young and Druckman, 1992). This report stressed on the importance of studying human dimension as a separate

field to provide an understanding of social science knowledge in global environmental change, and positioned it in the science society interface with a research agenda. It identified five social variables as key drivers of environmental change. These are population change, economic growth, technological change, political economic institutions and attitudes and beliefs. The 7th open meeting of the International Human Dimension Programme (IHDP) on Global environmental change held at Bonn, Germany showed the increasing role of humans in global environmental change research which is also acknowledged by IPCC AR4 (Griffith, 2009). UNDP(undated) documents stressed on analysis of human dimension of environmental change and linked it with vulnerability, as environmental changes are linked across scales and between geographical regions through both biophysical and social processes.

I.5 Need for regional and local studies

As most of the environmental problems are of societal origin (Peet, 1985), there is a clear need to understand the type and nature of interventions, direct or indirect, their spatial dynamics and underlying causes, so that ameliorative and adaptive mechanisms could be worked out. The interactions and synergies of ecological, economic, and social processes are scale dependent (Gibson et al, 2000). They change from the local to the regional, national and global levels. Spatial scale analysis is thus important to understand change dynamics. In this context, local level studies assume greater significance in environmental governance to redeem the situation. The global assessment conducted under UNDP has also stressed on sub-global, regional and local level investigations. Millennium Ecosystem Assessment report suggested such assessments to be attempted at the sub national level and International Human Dimension Programme (IHDP) envisaged regional level information as part of international process on cultural and behavioural drivers of global environmental change as well as likely and preferred cultural and behavioural responses.

The IHDP also seeks to outline best practices for transition to sustainability by improving the information and initiating multi level assessment. The Berlin Conference on Human Dimensions of Global Environment Change (2002) also reported inadequacy of macro scale approach and existing studies. It was observed that despite all efforts and existing knowledge base and its political implementation, our activities remain insufficient for a worldwide transition to sustainability. Perhaps there is a need for new kinds of knowledge or new ways to generate knowledge, redesigning of social and scientific institutions to generate sustainability-relevant knowledge and assessment of implications of the current knowledge base, and the ways it is generated and distributed on societal decision making for global environmental protection (Biermann, 2004). Nature and degree of human interventions vary across geographic regions and therefore region specific spatial scale analysis is necessary for designing proper intervention/ adaptive measures. Another issue in this context is about scale coordination. Most of the studies in ecology and social science refer to local condition. Understanding of local change provides key to global dimension of change.

Studies on impact of human pressure, more particularly land use change on water quality and related issues attempted both in global scale and in local scale have highlighted complexities at local scale, site specificity of drivers of environmental control and importance of undertaking local level studies (Jennerjahn, 2012).

Responding to the international initiatives, particularly in the context of IPCC, Government of India initiated mission mode programme and presented National Action Plan on Climate Change (NAPCC) in 2008. The objective of NAPCC was "To establish an effective, cooperative and equitable global approach based on the principle of common but differentiated responsibilities and relative capabilities. We must not only promote sustainable production process, but equally sustainable life styles across the globe'. There were eight missions, namely, (i) National Solar Mission, (ii) The National Mission for Enhanced Energy Efficiency, (iii) National Mission on Sustainable Habitat, (iv) National Water Mission, (v) National Mission for Sustaining the Himalayan Ecosystem, (vi) National Mission for a Green India, (vii) National Mission for Sustainable Agriculture and (viii) National Mission of Strategic Knowledge for Climate Change. Thirteenth Finance commission deliberated on these issues with the State Governments and all State Governments were advised to chalk out their own agenda.

II. 1 The Case of Water system

Water connects everybody. Being one of the important components of earth system machinery it plays an important role in all walks of human life. Water constitutes the largest flow of any material through the biosphere and serves as the primary vehicle for erosion and dissolution of the continents (Vorosmarty et al., 2004). Fresh water is fundamental for food security, industrial development, economic growth, human well being and human development. There is almost no other ecosystem type that offers such a remarkable variety of goods and services to humans like rivers, their flood plains, aquifers and wetlands. However, they can provide the ecosystem services only if their ecological integrity is sustained (Follner et al., 2010). Human activities have largely impaired the aquatic system, worldwide (Gleick, 2003). Maybeck and Vorosmarty (2004) indicated that the global impact of direct human intervention in terrestrial water cycle may surpass that of the recent or anticipated climate change, at least over decadal time scale.

Concern about water, particularly fresh water, came into focus with the United Nations Water Conference held in Mar del Plata, Argentina in March, 1977. The thirteenth Stockholm Water Symposium in 2003 deliberated on various issues related to water management and focused on drainage basin security. It was pointed out that drainage basin security would be a key to reach the Millennium Development Goals, most of which are directly or indirectly water-related. The Post 2015 development debate articulated in Rio+20 conference, the UN development agenda beyond 2015 and revised Millennium Development Goal stressed on water resource management and sustainability in water governance. The Geneva meet during 27th and 28th February, 2013 to discuss Post

2015 development agenda identified water resources management and water quality as important streams of activities under the theme of water (Baillat and Schmitz, 2013).

The challenges for water management are to understand the nature of human activities and the natural forces that generate pressures influencing our planet's water system. Many of these are highly dynamic; they change at a faster pace influencing water management strategies and policies (UNEP, undated-2). The Global Water System (GWS) Project raised three thematic questions: (i) the magnitude of anthropogenic and environmental changes in global water system and the key mechanism by which they were induced, (ii) the main linkages and feed backs within the earth system arising out of changing GWS and (iii) resilience and adaptability of GWS to the change and strategy for sustainable development (Vorosmarty et al., 2004).

Apart from spatial and seasonal variations in water distribution the emergent problem is increasing deterioration of water qualities, which impact water availability, human and animal health, contaminate ground water and elevate cost. Water management is as much as technical as managerial. Therefore we propose to deliberate on two issues of water management here: human intervention in surface water and water governance.

II.2 Human intervention in surface water

Apart from natural forces like seasonality, cyclic draught and flood, spatial differentiation in availability of water and climate change, the human factors like population growth, urbanization, economic development and resultant increased use of water tend to affect water system of our planet. Rivers, lakes, wetland and estuaries considered part of surface water are under stress. A broad array of anthropogenic factors like large scale land use / land cover changes, engineering modifications of channels, in stream resource extraction, consumptive use, other similar interventions causing disappearance of habitats and pollution, singularly and in combination have resulted in serious perturbations and in many places the fluvial system is disturbed beyond resilience limit. In case of agricultural settings, river ecosystems are experiencing increased nutrient and sediment loads, altered flows, and habitat degradation, whereas in urban dominated areas, there are municipal drainage, increased impervious surfaces and infrastructural constraints on rivers channels which have led to the injection of chemical pollutants, river flow modification, and system instability. Continental discharges are major contributors in threatening biodiversity and associated habitats in river system. Fragmentations of river ecosystems by dams have further degraded biotic environments.

Human interventions can be categoriesd into two: (i) direct and (ii) indirect intervention (Chattopadhyay and Mahamaya, 2014). Construction of dams and impounding of reservoirs in the upstream sections for irrigation and hydroelectric projects are most common human interventions on river systems. Water is diverted through main and branch canals impacting larger areas in the case of irrigation projects. Encroachment on river bank, flood plain occupancy, removal of floodplain materials, river bed mining, cutting down riparian vegetation, check dams and similar activities altering

the configuration of land along the river corridor and surroundings are some of the direct interventions. Discharge of domestic solid and liquid wastes in the river, industrial effluents, excessive use of fertilizer and pesticides in agriculture and other such activities causing water quality problem also fall under the category of direct intervention. It has been brought out that land use change in the catchment area impacts water quality (Chattopadhyay, et al, 2005). Indirect interventions include population growth, urbanization, socio-political and socio-religious activities. Impact of globalization is also considered as indirect intervention.

Degradation of water quality due to direct or indirect human interventions has long term impact on economy and ecology. For example, benthic invertebrates are important prey resources for fishes and they promote nutrient cycling and oxygenation of soils through their feeding and burrowing activities. Furthermore, mussels, crabs and shrimps are fishery resources and are used for income generation of local communities. Hence, reduced biodiversity of invertebrates can negatively affect both the functioning of ecosystems and local economies. Because of their limited mobility, benthic organisms are exposed to local disturbances and cannot avoid deteriorating conditions within the water or sediment. Many species are known to react sensitive to organic pollutants or heavy metals. Furthermore, benthic organisms may accumulate such pollutants in their tissue over long time periods which can lead to their biomagnification within food webs. Previous studies showed the presence of heavy metals and organic pollutants from industrial wastewaters, municipal sewage or agriculture in sediment and water samples. It was concluded that the reduction of species numbers in the industrialised area is related to pollution.

The riverine nitrogen and phosphorus inputs into the ocean have tripled from the 1970s to the 1990s whereas the input of dissolved silicate was significantly reduced during that time. These changes were attributed to changes in land use/cover and disposal of industrial and urban wastewater in combination with hydrological alterations. Such kind of information is scarce from coastal regions of tropical South and Southeast Asia which are among the regions most heavily modified by human activities worldwide and its rivers transport a major part of the annual global input of water, sediment, carbon and nutrients to the ocean. Compilation of available studies on these issues will be important to understand the ecosystem dynamics, existing data gap, and future study requirements.

The main research questions can be: What are the nature of these interventions, change therein and impacts? How do these interventions and impacts vary spatially? What are the drivers of these interventions/ change? Is there a commonality or pattern in these interventions across the country/ globe and what lessons can be drawn? How can the negative impact of human intervention be minimized?

II.3 Water Governance

Over the years, there had been change in concept and content of water management. The thrust was on quality analysis of river water in 1950s when water was considered merely as a commodity and it was available in abundance. However, by 2000 there had

been a gradual change in outlook and rivers are considered part of an ecosystem and the thrust has been to improve the relationship between rivers and human beings within the larger frame of human environment relationship. The enabling conditions for water management are implementation of an effective integrated water resource management plan to handle increasing sectoral competitions, better information, long term plan, reliance on demand side economic solutions, documentation and communication, setting up regulatory framework, better governance aimed at balancing ecologic, economic and social dimensions, people's participation and use of social capitals. It is suggested to recognize non technical side of water management or water governance to give water its place in society. Water governance primarily focuses on multiple actors, processes, structures and instruments at different levels that influence and are influenced by water management. Hofstra (2013) proposed three layers in analyzing governance. These are (i) content layer (information, knowledge, skills, strategies/ policies), (ii) institution layer (Organisation, financing, legislation and instruments) and (iii) relational layer (Cooperation, participation, culture, integrity, transparency and communication). A systematic analysis of these issues at different geo-environmental and human ecological context can provide the required insights to understand the problems and potentials of governance in water management.

The research question of this water governance theme focus upon the analysis of long term transition to water governance system towards more sustainable water management solutions, What is the nature of evolution of water governance in the country and changing perspective? How are the laws/ rules/ regulations implemented? What are the roles of different tiers of governance? What is the role of markets and forms of public-private partnership as coordinating mechanism. How do the activities of NGOs internalized? What is the nature of people's participation? What are the processes that can be mutually beneficial?

III.1 River Restoration Initiatives –Global scenario

All major countries have undertaken restoration projects. The primary thrust is to create data base. In USA, the National River Restoration Science Synthesis (NRRSS) reported findings from a database of 37,099 stream and river restoration projects from around the nation (Bernhardt et al. 2005). A meta data has been developed and all projects were listed under 13 categories: Bank Stabilization, Storm water Management, Water Quality Management, Flow Modification, Channel Reconfiguration, Fish Passage, Riparian Management, In-Stream Species Management, Dam Removal/Retrofit, Floodplain Reconnection, In-Stream Habitat Improvement, Aesthetics/ Recreation/Education and Land Acquisition. Nationally, the most common goals were to enhance water quality, manage riparian zones, improve in-stream habitat, fish passage and bank stabilization. The River Research Centre in UK. holds information for more than 2000 river projects by 2011. Five key aspirations of the London River Action Plan (2009) include i) improve flood management using more natural processes,

(ii) reduce the likely more negative impact of climate change, (iii) reconnect people to the natural environment through urban regeneration, (iv) gain better access for recreation and improved well being, (v) enhance habitats for wild life. Adopted in the year 2000, the European Union's Water Framework Directive (WFD) is a major driving force influencing water management at the national, regional and local levels in all EU countries. The directive stipulates river basin management, requirements to coordinate water use within river basins and undertake river basin planning, and substantive requirements concerning the "good" ecological and chemical status of European waters. Water Framework Directive (WFD) is often considered the principal driver of recent changes in the scalar organisation of water governance and advocacy in Europe (Commission of the European Community, 2000; 2007).

The profile of the German Water Sector, 2011 listed 17 core issues. One of the core issues is 'Performance characteristics of the German water sector is the long term safety of supply and disposal, high drinking water quality, high waste water disposal standards, high customer satisfaction and sustainable utilization of water resources while paying attention to economic efficiency'. In Germany water law was introduced in 1960 with an aim to protect environment and water quality. Germany now follows Water Framework Directive (WFD) of the European Union adopted in the year 2000 (Thiel, 2012). The directive stipulates river basin management, requirements to coordinate water use within river basins and undertake river basin planning within hydrographic regions. The new law in Germany adopted in 2012 also included provision of ecological status. In some basins, States opted to introduce River Basin Organisations (RBOs) as part of new initiatives. Water management has become more collaborative across scales in Germany and environmental NGOs are now involved in water management.

In Australia, both communities and governments, supported by State and Australian Government funding programs, strive at local, catchment, regional and State levels to rehabilitate natural riverine environments and to sustain agricultural productivity. The background paper on "Protecting Australian rivers, Wetlands and Estuaries" (Kingsford et al., 2005) proposed a national framework of river protection focusing on three main elements:

i) Nationally consistent collection of information on rivers, wetlands and estuaries, which will entail agreement on spatial scale and classification and evaluation systems for identification of rivers and dependent ecosystems of high conservation value

ii) Protection schemes that operate at different scales such as:

   – a 'whole-of-river' approach that could include establishment of an 'Australian Heritage Rivers' system

   – protection of high-conservation-value rivers, river segments and dependent ecosystems (floodplains, wetlands, estuaries) in a national, State, regional and local context (using current legislative and policy tools; i.e. environmental flows, protected areas, natural resource planning and management, and incentives) and

iii) Operational and institutional arrangements— coordinated programs involving jurisdictions in implementation of a national framework.

Japan is one of the countries practicing river management for a very long time, however river restoration has been booming since the beginning of 1990 when the River Bureau (MLIT) launched the initiative of "Nature-oriented River Works"(Nakamura et al, 2006). The major aim was to conserve and restore river corridors and their rich biodiversity. Between 1990 and 2004, >23,000 "Nature-oriented River Works" projects were realized throughout Japan. Over the years, ecological integrity became the key objective in place of simple flood defence measures. It is a clear shift from projects at the habitat scale to integrated projects of entire corridors. The present agenda of Japan stresses on river management by classifying rivers as Class A, Class B, Secondary, and Regular Rivers based on their importance. Activities cover flood control, environmental issues, conservation of aquatic ecosystem, restoration of longitudinal continuity facilitating free movement of fishes and other aquatic life along the rivers and bringing back flood plain dynamics. Booming restoration activities stimulated the formation of new academic societies and encouraged small NGO activities.

Asian River Restoration Network (ARRN), Japan River Restoration Network (JRRN) and Foundation for Riverfront Improvement and Restoration (FRIR), Japan have documented river restoration works in various Asian countries, particularly in Japan, Malaysia, China, Tiwan, Korea, Combodia, Phillipines and Singapore. All countries emphasised on restoration activities with various measures of success. ARRN attempted to link Integrated Water Resource Management (IWRM) and River Restoration. It has been observed that river restoration is of vital importance to socio-economic sustainable development in parallel with flood and water use management and that it (river restoration) warrants a new methodology compared to flood control and water utilisation. Considering specific characteristics of monsoon Asia it is urged to establish a river restoration guideline suitable for Asian monsoon region for countries with similar social and natural conditions.

III.2 River restoration Initiatives in India

India is well endowed with water resources however there are several problems due to natural variability compounded by intense human intervention. The Water mission set up by the Government of India in 2008 was one of the eight missions under NAPCC. India receives 4000 billion m3 of precipitation, of which only 1/4th is available for use. This is around 1000m3/person/.year. Population growth, intensive agriculture, increasing urbanization, industrialization and improvement in quality of life are going to increase water demand. It is projected that by 2050, India may turn into a water scarce country. Therefore the national mission gives high priority to water resource management. UNICEF (2013) in its review identified couple of key elements to tackle India's water problem. These are related to data base, gender, pollution control and reorientation of managers for a new vision of water management. Country's comprehensive water policy was formulated

in 1987 and was revised in 2002. Another revision was proposed in 2012. This is being criticized due to absence of commitments towards water right and growing dependence to market mechanism for solving water problem.

India has a long history of river management for flood control and irrigation development. The Damodar Valley Corporation (DVC) in the pattern of TVA of USA was a coordinated effort both technically and in the matter of governance. There are several multi purpose river valley projects taken up in various parts of India. All the States in India introduced Command Area Development (CAD) programme. Many of these projects brought good results, but there are also instances where desired results could not be achieved.Government level initiatives for river restoration started with Clean Ganga project taken up during 1980s. National Ganga River Basin Authority (NGRBA) has been established to spearhead the activities. The principal aim is to i) prepare a river basin management plan and ii) Regulation of activities aimed at prevention, control and abatement of pollution in Ganga to maintain its water quality and to take measures relevant to river ecology and management in the Ganga basin States. Restoration of Yamuna river is another programme being initiated involving Central and State Governments. Thames River Restoration Trust (TRRT) of UK is extending help to restore Yamuna river.

Besides, there are several other attempts undertaken by Government Departments and NGOs. The Tarun Bharat Sanga in Rajasthan has rejuvenated seven streams in Rajasthan. This is one of the most demonstrative examples of river rejuvenation by people's active participation at the grass root level. Restoration of Nagpur rivers was taken up by Nagpur Municipal Corporation in 2013 (Puranik and Kulkarni, 2014) after preparation of a detailed restoration plan at the instance of the Nagpur Municipal Corporation (Anon., 2012). Chennai River Restoration Trust under Government of Tamil Nadu has initiated ecorestoration of Adyar Creek, Adyar creek estuary and Cooum river. Detailed project report (DPR) for restoration of Cooum river is underway (The Hindu, Feb., 14, 2014). The Sabarmati river front project, executed by the Ahmedabad Municipal Corporation in 1997, concentrated on beautification of river front with little care for the restoration of river ecology.

III. 3 River restoration in Kerala: A new initiative

The State of Kerala has drawn global attention due to its spectacular achievement in human development. It is rich in water resources and perhaps the only State in India where hydro-electric power meets 80% of the electrical energy requirements and surface water provides bulk of its fresh water demand. However environmental degradation due to various human interventions is a matter of great concern (Chattopadhyay and Franke, 2006). Water bodies in Kerala are highly affected both in their physical dimension and in quality of water (Nair and Chattopadhyay, 2005). Kerala rivers are under stress due to excessive resource extraction in one hand on the other hand river waters are increasingly getting polluted (Chattopadhyay and Mahamaya, 2014). Waters of all major rivers are not potable for most part of the year. Besides there are water conflicts at

various levels (Dwivedi, 2011). Sand mining from the river bed is widely practised in Kerala. This generates revenue for the local Panchayat and State. All districts have river management fund (RMF) administered by the District Collector. District authorities, Block office and Panchayats prepare projects to be funded under RMF. A high level committee under the Revenue Department oversees these projects and accord sanctions. All these projects hardly contribute to river restoration. The State has adopted water policy for the year 2003 and 2008; however, there is hardly any concrete action to address the problems faced by the water bodies, whose management is still department centric following commodity approach. Although local self government institutions are active under decentralized development, their roles in water management are yet to be defined.

Considering the problems of rivers and urgent need to restore them, the Revenue Department, in 2010, took an unprecedented initiative that has long term implications in river restoration. Through series of discussion at different levels and from the experience that it had already gained for the works under RMF the revenue department proposed a programme consisting of two activities: (i) Mapping of the river bank covering land use, manmade features and physical features and developing a data base and (ii) Assessment of sediment deposits in the river bed. In fact, Government order envisages river bed sediment assessment once in every three years. Uniqueness of this programme is in the involvement of S & T departments, Engineering Colleges, University Departments and NGOs. At present work is being executed in 20 rivers of Kerala. This is considered as the first step in rive restoration. River Bank atlases are being prepared. The River Management Cell under the Revenue Department and Centre for Earth Science Studies (CESS) is helping the revenue department to coordinate this activity. The methodology has been developed by CESS. There are different voluntary organisations across the State working for river protection. Chalakudy puzha Samrakshana Samiti and River Research Centre, one of them, has developed an action plan for protection of Chalakudy and also prepared a draft river policy for Kerala (Chalakudy Puzha Samrakshana Samiti, 2013). The State Planning Board, Kerala State Biodiversity Board and KSCSTE are involved in river restoration in one way or other. The programme envisages detailed analysis of basin characteristics, internalize river bank information and prepare basin-wise rejuvenation and management plan. River is a part of the environmental resources and its management cannot be delinked from total management of the catchment. Demand, supply, availability and distribution of river resources are all part of this integrated management paradigm. Understanding of this reality forms the base for future action.

IV. Let us continue

Man nature interaction formed one of the core research themes of modern geography. As early as 1864, G.P Marsh drew our attention to the environmental change as related to human actions or human dimension of environmental change through his publication of 'Man and Nature or Physical Geography as Modified by Human Action'. Another seminal work 'Man's role

in changing the face of the Earth' (Thomas, et al 1956) dealt with human impact on physical and cultural alterations of the earth surface. Since then, Geographers have contributed in this subject individually and also as part of the working groups at the national and international levels (HDGC Speciality Group, 2004). Geography, as a discipline, strives to integrate social systems and natural systems. It is geographic tradition to view human being as part of nature and undertake integrated studies on human environment relationship (HER) (Turner II, 2002). Geographers' focus on space and emphasis on location have equipped them to view the processes and phenomena quite differently from other disciplines. Their approach to understand the reality from an interdisciplinary perspective combining physical and social sciences is significant. It is noted that 'across science today, much of the excitement of discovery ignites at the interface of the discipline' (Colwell, 2004) and as Wilson (1998) noted 'the world henceforth will be run by the synthesizers'. It is important to relate environment and development issues focusing on human dimensions of change and transition to sustainability.

Geographers are equipped conceptually and also technologically with necessary GIS application for spatial analysis to follow social ecological analytical frame for integrated research. The DPSIR (Driver-Pressure-State-Impact-Response) frame being used by the LOICZ (II), one of the core projects of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimension Programme (IHDP) is one such methodology that helps to visualize the processes operative in any area systematically. Study of specific human drivers responsible for change under each ecosystem is important to understand which disruptions/ changes make human society most vulnerable and where, so that proper measures can be devised for transition to sustainability. Human induced modification and consequent change can be the focus of such studies. These changes are manifested through land use and also on water bodies.

Analyses of 2286 publications appeared between 1967 and 2005 related to the knowledge domains of resilience, vulnerability and adaptation within the research activities of human dimension of global environment change have brought out some interesting results (Janseen et al, 2006). Number of publications in the three domains increased rapidly between 1995 and 2005. The resilience knowledge domain has a background of ecology and mathematics, whereas the vulnerability and adaptation knowledge domain have a background of geography and natural hazards research with a focus on case study and climate change research. There is an increasing number of cross citation and papers classified in multiple knowledge domains. This seems to indicate an increasing integration of the different knowledge domain.

In India we are yet to take up these studies systematically in the domain of geography. I do hope that geographers will engage themselves to take advantage of emergent scenario and redirect their research activities accordingly.

References

Anonymous, 2009: The London Rivers Action Plan- A tool to help restore rivers for people and nature, www.therrc.co.uk/Irap.php

Anonymous, 2012: Rejuvenation of Nag River and its tributaries in Nagpur city- Detailed Project Report, Vol. III. Nagpur Municipal Corporation

Baillat A and T. Schmitz (2013) Towards a human rights based water governance: Challenges for the post 2015thematic consultations on water. Waterlex, Geneva. pp 1-14.

Berkes F and Folke, C., (ed) 1998: Linking Social and Ecological Systems- Management

Practices and Social mechanisms for Building Resilience. Cambridge University Press.

Brown L. R., 2006: Plan B 2.0., Rescuing A Planet under Stress and A Civilization in Trouble. Earth Policy Institute, W W Norton and Co. New York

Biermann F., 2004: Knowledge for the sustainability transition and the challenge for social science- An introduction. In Proceedings of the 2002 Berlin Conference on Human Dimension of Global Environmental Change, Ed. Biermann F, Campe S and Jacob K. Global Governance Project, Amsterdam, pp 1-12.

Bernhardt, E. S., Palmer, M. A., Allan, J. D., Alexander, G., Barnas, K., Brooks, S. et. al. (2005) Restoration of U.S. rivers—a national synthesis. Science, v.308, pp. 636–637.

Centre for Earth Science Studies (2013) River Bank Atlas of Ithikkara. Thirvananthapuram, Vol.1 and 2, I-IV + 82 plates + 37p.

Chattopadhyay S., Asa Rani L. and Sangeetha, P. V. (2005) Water quality variations as linked to land use pattern: A case study in Chalakudy river basin, Kerala. Current Science. v. 89, pp. 2163-2169.

Chattopadhyay S and R. W. Franke (2006) Striving for Sustainability: Environmental Stress and Democratic Initiatives in Kerala. Concept Pub. Co., New Delhi.

Chattopadhyay, S., and Mahamaya Chattopadhyay (2014) Rejuvenation of Kerala rivers: Geoenvironmental setting, potentials, problems and recent initiatives. Special Publicatin No 3, Ed, R. Vaidyanadhan, Geological Society of India, pp 1-12

Colwell, R., 2004: The new landscape of science: a geographic portal. Annals of the Association of American Geographers, 94 (4) 703-708.

Crutzen, P.J.and E. F. Stoermer (2000) The Anthropocene, IGBP News Letter, 41 (May): 17-18

Diamond, J. 1997: Guns, germs and steel: The fate of human societies, New York. W. W. Norton.

Dwivedi G (2011): Revisiting important water conflicts in Kerala. Chalakudy Puzha Samrakshana Samithi, Chalakudy , Forum for Policy Dialogue on water conflicts in India, Pune

Follner K., T. Ehlert and B. Neukirchen (2010) The status report on German floodplains. 38 IAD Conference, June, 2010 Dresden, pp1-5.

George,P.S., and Chattopadhyay, S., 2001: Population and Land use in Kerala. In Growing Populations, Changing Landscapes – Studies from India, China and the United States, Indian National Science Academy, Chinese Academy of Sciences and U.S.

National Academy of Sciences, National Academy Press, Washington D C, pp 79 – 106.

Griffith, C (2009) Introduction to the Issue. Urbanisation and Global Environmental Change Programme (UGEC) Viewpoints, No. 2, September, 2009, pp 4-5

Gibson, C. C., E. Ostram, and T. K. Ahn (2000) The concept of scale and the human dimension of global change: A survey. Ecological Economics, 32 (1) 217-239

Gleick, P.H (2003) Global freshwater resources: Soft-path solutions for the 21st century. Science, 302, 1524–1528.

Government of Tamil Nadu (2010): Chennai Rivers Restoration Trust, tnuifsl.com/crrt/crrt.asp

Hofstra M, (2013) Water governance- a framework for better communication. Water Governance Journal 01/2013. online

Indian National Science Academy, Chinese Academy of Sciences and U.S. National Academy of Sciences, (INSA, CAS, USNSA), 2001: Growing Populations, Changing Landscapes – Studies from India, China and the United States, National Academy Press, Washington D C.

International Human Dimension Programme, (2004) Human Dimensions of Global Change Speciality Group, UNEP

Jennerjahn, T.C.(2012) Biogeochemical response of tropical coastal systems to present and past environmental change. Earth Sci. Rev., 114 (1)19-41.

Janseen M A, Schoon M L, Ke W and Borner K (2006): Scholarly network on resilience, vulnerability and adaptationnwithin the human dimension of global environmental change. Global Environmental Change. doi: 10.1016/ j.gloenvcha.2006.04.001

Kingsford, R.T., Dunn, H., Love, D., Nevill, J., Stein, J. and Tait, L. (2005) Protecting Australia's rivers, wetlands and estuaries of high conservation value, Department of the Environment and Heritage, Australia, 100p.

Meadows, D., Randers, J. and Meadows, D., 2004: Limits to Growth The 30-year Update. White River Junction, Vermont: Chelsea Green Publishing Co.

Meybeck M. and C J Vorosmarty (Eds) (2004) The integrity of rivers and drainage basin systems: Challenges from environmental change. In Vegetation, Water, Human and the Climate-A new perspective on an interactive system edited by P kambat et al, part D, pp 297-479 Springer-Verlag, New York.

Millennium Ecosystem Assessment, (2005) Millennium Ecosystem Assessment Report-Pre publication final draft. www.millenniumassessment.org.

Nakumura, K., Tockner, K., and Amano, K. (2006) River and wetland restoration: Lessons from Japan. Bioscience v. 56, pp. 419-429.

Nair K N and S Chattopadhyay (2005) Water Resources of Kerala: Issues and Case Studies. Centre for Development Studies, Thiruvananthapuram, 125p.

Peet R.,1985: The social origins of environmental determinism, Annals of the Association of American Geographers, 75 (3) 309-333

Puranik V. and Kulkarni A., 2014: Study of rejuvenation and restoration aspects of Nag river. Int. J. Applied Research and Studies. V. 3, Issue no. 9 pp 1-7.

Rockstrom J, 2009: A safe operating space for humanity. Nature, September, 24, 2009, pp 472-475.

Rosa EA and Dietz T, 2010: Global Transformations: PaSSAGE to a New Ecological Era.

In Human Footprints on the Global Environment-Threats to Sustainability, Ed by Rosa E A., Diekmann A, Dietz, T and Jaeger C, MIT press, Cambridge. Pp 1-45.

Rosa E A., Diekmann A, Dietz, T and Jaeger C, 2010: Human Footprints on the Global Environment-Threats to Sustainability, by MIT press, Cambridge. Pp 1-45.

Stern, P.C., O. R. Young, and D. Druckman, (1992) Global environmental Change: Understanding the human dimension, Washington, D.C: National Academy Press

Thomas W L, Mumford L and Sauer Carl O, 1956: Man's Role in Changing the Face of Earth. University of Chicago, USA

Turner II, B L (2002): Contested identities: Human-environmnet geography and disciplinary implications in a restructuring academy. Annals of the Association of American Geographers, 92 (1)52-74

The Hindu, 2014: DPR for Cooum restoration by this month end. 14 February 2014. (Chennai Edition)

Thiel, A. (2012) The politics of problem solving: a co-evolutionary perspective in the recent scalar reorganization of water governance in Germany. Discussion Paper 09/2012, Department of Economics, Humboldt-University of Berlin, Berlin, 22p.

United Nations Environment Programme,(undated) Water in The Transition to Green Economy- A UNEP Brief. www.unep.org/greeneconomy

UNICEF (2013) Water in India: Situation and Prospects. UNICEF, FAO and SaciWaters, UNICEF India Country Office, New Delhi

Vorosmarty, C.J,. D. Lettenmaier, C. Leveque, M. Meybeck, C. Pahl-wostl, J. Alcamo, W. Cosgrove, H. Grassi, H. Hoff, R. Kambat, F. Lansigan, R. Lawford, and R. Naiman (2004) Humans transforming the global water system. EOS, Transactions, American Geophysical Union, 85 (48) 509, 513-514.

Wisner, B., 1978: Does radical geography lack an approach to environmental relations. Antipode, v.10 (1) 84-95.

Wilson, E.O., 1998: Consilience: The Unity of Knowledge, New York: Knopf.

World Commission on Environment and Development, WCED, 1987: Our Common Future, Oxford University Press, New Delhi.

Srikumar Chattopadhyay
CESS
Trivnedraum