Compilation of contributions

Second National Working Group Meeting

IGCP 582

TROPICAL RIVERS

HYDROPHYSICAL PROCESSES, IMPACTS, HAZARDS & MANAGEMENT

Edited by

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Geological Survey of India

DGCO, New Delhi

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Geological Survey of India
DGCO, New Delhi

Indian National Working Group
International Geoscience Programme Project No. 582

SECOND NATIONAL WORKING GROUP MEETING

Tropical Rivers
Hydrophysical Processes, Impacts, Hazards and Management
(2009 - 2013)

AGENDA
3rd August 2011

Opening Session:	
10:30-11:15	Inauguration
11:15-11:30	*Tea break*
Technical session I:	**Status report and key note address**
11:30-11:45	Status report by ***Dr. Snigdha Ghatak, Convener IGCP 582***
11:45-12:30	**Keynote address: "**Avulsion threshold and plan form dynamics in a large Himalayan river: the case of the Kosi" by ***Prof. Rajiv Sinha, INC member and leader IGCP 582 project.***
Technical session II:	**Presentations by National Working Group Members and special invitees**
12:30-13:00	Talk on "Tectono-climatic controls on fluvial sedimentation of upper and middle reaches of Tapi River Basin, Central India" ***by Dr. Snigdha Ghatak, Convener, IGCP 582***
13:00-13:30	Invited lecture on "Understanding Dynamics of the Ganga System in West Bengal" ***by Dr. Kalyan Rudra, West Bengal Pollution Control Board***
13:30- 14:00	*Working lunch*
14:00-14:30	Talk on "Widespread aggradation in the mountainous catchment of the Alaknanda - Ganga River System: timescales and implications to landscape responses to climate change **by" Dr.** ***Pradeep Srivastava, NWG Member, WIHG, Dehradun***
14:30-15:00	Invited lecture on "Role of geoinformatics in river basin management" **by Prof.** ***Vikrant Jain, University of Delhi***
15:00-15:15	Talk on "Spatio temporal variation of sediment loads of Teesta River" ***by Dr. Sreemati Gupta, NWG Member, GSI, New Delhi***
15:15-15:45	Talk on "Climate change and Himalayan water resources" by **Dr.** ***Manohar Arora, NIH, Roorkee***
15:45-16:15	Presentation on "Vulnerability assessment to develop coping mechanism - people based perspective ---a case study of Kosi Region" **by Prof.** ***Ajay K Katuri, NWG, CEPT University, Ahmedabad***
16:15-16:30	Tea break
16:30-16:45	Invited lecture on "River drainage response to active tectonism: evidences from Chaliyar River Basin, Kerala State, India" by **Ms. V Ambili, GSI, Kerala**
Technical Session III**:**	**Future Action plan for IGCP 582 project**
16:45-17:25	Discussions and Summing up of action plan
17:25-17:30	Vote of thanks

FOREWARD

The 2nd meeting of the International Geological Correlation Programme (IGCP) or 'International Geoscience Programme' as is known today is a platform for eminent geoscientists to collaborate exchange ideas and experiences, in the field of earth sciences.

It is a unique collaboration between International Union of Geological Sciences (IUGS) and United Nations Educational, Scientific and Cultural Organisation (UNESCO), for last three decades working in global environment, natural resources, natural hazards etc.

Director General, Geological Survey of India (GSI) heads as ex-officio Chairman of the institution of Indian National Committee, which is the monitoring agency in India overseeing the work of IGCP. INC also has members from ONGC, NGRI, AMD, WIHG, BARC, CGWB, CWC, SINP, etc.

IGCP-582 in particular is a group of professionals to interact on matters related with hydro-physical processes, hazards and management of Tropical Rivers. Other geoscientific organisations like NGRI, NIH, WIHG, ISM and academicians from University of Lucknow and CEPT University are sister organisations of this unified group, i.e. IGCP-582. While working on various aspects of tropical river system, special emphasis would be put on Late Pleistocene to Recent period of earth's history. The combined effort of this expert group, in their respective fields, gives a glimpse of things to be unfolded in identified areas during the course of another four years to come.

I take this opportunity to convey my best wishes to the NWG members and other participants wish IGCP-582 all success in its initiatives and endeavour.

Thanks and best regards

(Dr. V.P. Mishra)
Deputy Director General, PSS
& Chairman IGCP 582
Geological Survey of India
DGCO, New Delhi

INTERNATIONAL GEOSCIENCE PROGRAMME– 582

TROPICAL RIVERS: HYDRO-PHYSICAL PROCESSES, IMPACTS, HAZARDS AND MANAGEMENT (2009 - 2013)

INDIAN NATIONAL WORKING GROUP

Chairman, INC for IGCP:	*Director General, Geological Survey of India*
Member Secretary, INC for IGCP:	*S. Balakrishnan, Director, International Division, Geological Survey of India*
Chairman, IGCP582:	*Dr. V.P. Mishra, Deputy Director General (PSS), DGCO, Geological Survey of India, New Delhi*
Convener:	*Dr. (Mrs.) Snigdha Ghatak, Sr. Geologist, LHIM Division, Geological Survey of India, New Delhi*
Members:	*Dr. Ahmad S. Masood , Scientist - 'G', Head Paleoclimate Group, NGRI*
	Shri N.V. Venkatraman, Senior Geologist, Geological Survey of India, Chennai
	Dr. Rakesh Kumar , Scientist – F, Surface Water Hydrology Division, National Institute of Hydrology, Roorkee
	Dr. M.S. Bodas, Senior Geologist, Project: Landslides, Geological Survey of India, Pune
	Dr. Pradeep Srivastava, Scientist – C, Sedimentology Group, Wadia Institute of Himalayan Geology, Dehradun
	Dr. Sreemati Gupta, Senior Geologist, EPE Division, Geological Survey of India, New Delhi
	Prof. Vinay Kumar Srivastava, Department of Applied Geophysics, Indian School of Mines, Dhanbad

Prof. Rameshwar Bali, Centre of Advanced Study in Geology, University of Lucknow, Lucknow

Dr. Vivek P. Malviya, Mineralogist, Mineral Physics Lab, Geological Survey of India, Nagpur

Prof. Ajay K. Katuri, Faculty of Planning and Technology (CEPT), Centre for Environmental Planning and Technology (CEPT) University, Ahmedabad, Gujarat

Shri Manoj Kumar Shukla, Assistant Geologist, Quaternary Geology Project, Geological Survey of India, Lucknow

Shri Rajesh Kumar Senior Geologist, Geodata Division, Geological Survey of India, Kolkata

Shri N.R. Mohapatra, Op. WB-N, Geological Survey of India, Eastern Region, Kolkata

Aims and Objectives of IGCP-582

Fluvial systems are considered as the economic engine in tropical regions; they have a central role in electricity production, and sustain the bulk of agricultural production and other high-value economical activities based on natural resources extraction (mining, fishing, timber). At the same time they can also be drivers of natural disasters such as floods, bank erosion and rapid channel migration.

The overall scope of this project is to provide an integrated assessment of long-term direct impacts of climate variability and human-induced change and management of tropical rivers basins by identification, quantification and modeling of key hydro-geomorphologic indicators during the past and present times. The potential impacts of global change on fluvial systems and of their socio-economic implications will also be analyzed.

The proposed project would contribute significantly towards understanding of tropical river systems in terms of their societal relevance as this will address the issues of river management and human intervention as well as the flood disasters which are often interconnected. IGCP is a unique platform that permits the interaction among the researchers across the globe. In tropical regions, it is a fact that generalizations are frequently encountered when comparing the different developing countries or "tropical" countries (Latrubesse et al., 2005). The IGCP would facilitate the sharing of experiences of river management among the researchers from different parts of the globe and would therefore contribute directly to the Society.

The project is open to researchers, technicians, students and independent professionals from a variety of disciplines such as geology, geomorphology, hydrology, engineering, ecology, environmental sciences, planners, remote sensing specialist among others, that are devoted to the study of tropical rivers.

Some of the project leaders are:

- *Edgardo M. Latrubesse, Universidad Nacional de La Plata-, Centro de Investigaciones Geológicas-CIG, La Plata, Brazil*
- *Rajiv Sinha, Engineering Geosciences Group, Department of Civil Engineering, Indian Institute of Technology Kanpur, INDIA*
- *Jose C. Stevaux, Universidade Guarulhos-, Pr. Tereza Cristina, 1 – Centro, Guarulhos, SP, Brazil*
- *Zhongyuan Chen, State Key laboratory for Estuarine and Coastal Research,East China Normal University, Shanghai 200062, China*

Oncoming events in 2011

1. IGCP 582 International Symposium, Medellin Colombia; organize a special session on Tropical Rivers during the XIV Geological congress that will be held in Medellin, Colombia from August 29 to September 2nd. Professor Juan Restrepo (EAFIT University) will be the main organizer of this event. See details of the event at http://www.14clg.com/site/index.php?option=com_content&view=article&id=5&Itemid=1&lang=en and contact Edgardo M. Latrubesse *latrubesse@austin.utexas.edu* or Juan Restrepo *jdrestre@eafit.edu.co*

2. The main annual meeting shall be organized by Rajiv Sinha (co-leader of IGCP 582), in Kanpur, India and will have the support of the IITK and the national delegation of IGCP. The tentative date is from December 12th to17th with three days of Symposium and three days of field trip along the Ganges River basin.

Events in 2010

1. The main annual meeting 2010 linked to the **45 Brazilian Congress on Geology**, was held in Belem, Brazil from September 26th to October 1st. The activities were organized by Prof, Jose. C. Stevaux (UEM-Brazil and co-leader of IGCP 582) and Prof. Naziano Filizola (UFAM-Brazil). At total there was more than forty contributions from Argentina, Brazil, Cameroon, Colombia, Germany, Venezuela, China, France, India and Puerto Rico. The total involved participants (authors and co-authors) were eighty eight (88).

2. In India, a Regional meeting was organized by Dr. Snigdha Ghatak, GSI and had the participation of several Indian researchers. IGCP projects in India are closely followed up by the premium geological institution, Geological survey of India. The idea of Indian participants and a main objective of co-leader Prof. Rajiv Sinha, is to evolve a program within the GSI system and relating items of the IGCP 582 project for implementation.

Events in 2009

1. A conference was organized about large rivers in XII Congress of the Brazilian Association for Quaternary Studies (ABEQUA); IV Argentine Quaternary Congress and Geomorphology and Meeting on the Quaternary of South America, in La Plata (Argentina) with exposition of some works related to the large rivers.

2. In 6th Symposium on River, Coastal and Estuarine Morphodynamics (RCEM), a course was organized on Fluvial Geomorphology with Emphasis on Large Alluvial Systems, given by Professor Edgardo Latrubesse and Carlos Ramonel, in Santa Fé city (Argentina).

United Nations
Educational, Scientific and
Cultural Organization

2010 ANNUAL REPORT

In 2010 the Tropical Rivers group advanced in two ways:

a) Increasing the participation of researchers from in developing countries in conferences, training courses and, importantly, favoring the participation of those researchers in special issues of internationally recognized and indexed journals;
b) Trying to identify gaps in knowledge and generating new strategies to fill up the identified gaps with new knowledge through theoretical approaches and increasing international collaboration.

Under this perspective, during the second year of activities the Project was able to generate international meetings, supporting young and seniors researchers from in developing countries and editing special issues of international and regional journals. Additionally, several of the participants also produced interactions with governmental agencies in projects related to river management, planning, hazards, restoration and engineering. We made during 2010 a particular effort to incorporate some African researchers and to generate a front of discussion on the Caribbean region. The meetings during 2010 concentrated in Brazil and India. The countries involved in the project activities during 2010 were: Argentina, Australia, Bolivia, Brazil, Cameroon, Colombia, China, France, Germany, India, Puerto Rico, USA and Venezuela. Researchers from all these countries participated of meetings, contributed for special issues of international journals edited by the IGCP 582 or developed collaborative researches in Tropical rivers.

Groups participating of IGCP 582 that maintain long term research activity in some key tropical regions.

1) BRAZIL. The Brazilian groups of Maringa State University, Federal University of Sergipe, Amazonas State University, Goias State University among others Brazilian participants, produce applied science and transfer results to National and State agencies such as Environmental State Agencies, Water Resources State agencies, PETROBRAS national oil company among others and maintain collaborative research with French institutions. The environmental projects in the San Francisco basin still actives until 2011 funding by Petrobras-Brazil.

2) ARGENTINA. The Argentinean participants also develop projects that produce social benefits. The group of the National University of el Litoral is a constant referent in applied projects in Argentinean rivers and maintain close links with state agencies and private consultancies services. Additionally Argentinean researchers are providing support to the Tri-National Basin committee of the Pilcomayo River (Argentina, Brazil and Bolivia). During 2010 the IGCP 582 participants of Universidad del Litoral Argentina, provided a new set of consultancies as solicited by the Tri-National Commission of the Pilcomayo.
3) VENEZUELA. The group of Universidad Pedagógica el Libertador (UPELD) in Venezuela concentrates the research in the Apure fluvial basin and develops applied research for the national state agency INGEOMIN. One PhD students is developing activities in the Orinoco Llanos (we granted this participant in 2009)
4) GERMAN. The German group of the University of Frankfurt maintains several activities and project in central Africa (Cameroon, Democratic Republic of Congo and Central African Republic) among others.
5) INDIA. The Indian group of IITK is developing a large project with remarkable social relevance on river dynamics and flood risk evaluation in the Kosi River which has been funded by the Ministry of Earth Sciences, Govt. of India.
6) CHINA. In China ECNU develop a long term program of research on the Yang Tze basin transferring results to society and in special to national agencies.
7) USA. Researchers from University of Texas at Austin are producing results on rivers in Mexico and south-west of USA. Several projects are related to applied basin management and supported by Texas State agencies.
8) COLOMBIA. In Colombia the group of EAFIT University maintains research in collaboration with a variety of agencies and with the Colombian Navy surveying rivers delta sand estuaries. The group of research of Prof. Restrepo (EAFIT University) develop environmental surveys in the Pacific fluvial watershed collaborating with the Colombian Navy and transferring results to the government.
9) CAMEROON. This year we had the participation of Dr. Jean Guy Dzana from Cameroon. Had been our intention to include researchers from Africa in the projects but it is not an easy task for several reasons: a) because the scarcity of local professionals working on fluvial processes in equatorial Africa and because of the high cost to support the participation of African professionals who demand practically 100% of economic coverage.
10) PUERTO RICO & CARIBBEAN REGION. The participation of Carlos Scharron of The University of Puerto Rico opened a new perspective in our IGCP project allowing as to cover this year the Caribbean region, once the collaboration with M. Bezada (Venezuela) and Juan Restreppo (Colombia) will be possible in the future.

IGCP 582 meetings with approximate attendance and number of countries

During 2010 the activities of IGCP 582 concentrated in Brazil and India. The main annual meeting happened linked to the 45 Brazilian Congress on Geology, hold in Belem, Brazil from September 26th to October 1st. The activities were organized by Prof, Jose. C. Stevaux (UAM-Brazil and co-leader of IGCP 582) and Prof. Naziano Filizola (UFAM-Brazil). At total we had more than forty contributions (30 in English-see abstracts in appendix and 12 in Portuguese) from Argentina, Brazil, Cameroon, Colombia, Germany, Venezuela, China, France, India and Puerto Rico. The total involved participants (authors and co-authors) were

eighty eight (88). Additionally the representatives of IGCP 582 Prof. Edgardo Latrubesse (UT-Austin-USA) and Jean P. Bravard (Univ. Lyon-France) were invited to offer plenary talks to the general audience of the Brazilian Congress.

In India a Regional meeting was organized by Dr**.** Snigdha Ghatak and had the participation of Indian researchers (see appendix). IGCP projects in India are closely followed up by the premium geological institution, Geological survey of India. The idea of Indian participants and a main objective of our co-leader Prof. Rajiv Sinha, is to evolve a program within the GSI system and relating items of the IGCP 582 project for implementation. Was also decided to have IGCP 582 portal in India linked to the main page of the IGCP 582. This portal will host all kind of data, reports and information related to projects related to the IGCP themes.

Educational, training or capacity building activities

During 2010 the groups were training the young students and favouring exchanges among the different groups. Regional courses were developed in:

a) Federal University of Sergipe, Brazil. Prof. J.C. Stevaux applied the course on Fluvial Dynamics and Sedimentometry;
b) State University of São Paulo at Rio Claro, Brazil. Prof. E.M. Latrubesse applied the course

Participation of scientists from developing countries, and in particular young and women scientists

We maintain a good equilibrium of genera. In relation to the participation of young researchers from developing countries a major support was provided to Jean Guy Dzana from Cameroon. Additionally we supported participants from Latin-American countries such as Argentina, Brazil, Colombia and Venezuela.

List of most important publications (details on contents are described in the Appendix)

Latrubesse, E and Stevaux. (Guest Editors), (2009). Hydro-geomorphology, sediment transport and human impacts in large South American rivers. *Latin American Journal of Sedimentology and Basin analysis*, 16 (2), 77-131. (This issue was printed in February 2010).

CONTRIBUTIONS

Abstracts

AVULSION THRESHOLD AND PLAN FORM DYNAMICS IN A LARGE HIMALAYAN RIVER: THE CASE OF THE KOSI

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Abstract

Avulsion, the relatively rapid shift of a river to a new course on a lower part of a floodplain, is considered as a major fluvial hazard in large population centers such as the north Bihar plains, eastern India and the adjoining areas of Nepal. This region witnessed one of the most recent avulsions of the Kosi River on 18 August, 2008 when the river shifted by ~120 km eastward. The Kosi river draining the parts of Nepal and north Bihar in eastern India avulsed by ~120 kilometers eastward triggered by the breach of the eastern afflux bund at Kusaha in Nepal. The Kosi river originating in high mountains of Nepal is a major tributary to the Ganga river system and has long been considered as a problematic river due to frequent changes in its course and extensive flooding. A preferentially westward movement (150 kms in the last 200 years) has been recorded by the previous workers. However, the August 18, 2008 event was different in two ways. Firstly, the river moved eastward of the modern course – unlike the westward migration trend over the last 200 years, and secondly, the total movement was of the order of ~120 km – an order of magnitude higher than any single movement recorded in historical times. The avulsed channel 'reoccupied' one of the paleochannels of the Kosi and 80-85% of the flow of the river was diverted into the new course. Since the new course had a much lower carrying capacity, the water flowed like a sheet, 15-20 km wide and 150 km long with a velocity of 1m/s at the time of breach. The new course did not join back the Kosi nor did this find any through-drainage into the Ganga as a result of which a very large are remained inundated for more than six months. It is also obvious that such large-scale avulsion would cause extensive inundation, which is different from 'regular' flooding by the river through overbank spilling.

The trigger for an avulsion largely depends upon the regional channel-floodplain slope relationships and the lowest elevation available in the region. Most of the available assessments of avulsion threshold have therefore been based on the

examination of channel slopes- longitudinal and cross-sectional. However, planform dynamics in a sediment-charged river such as the Kosi also plays an important role in pushing the river towards threshold for avulsion. The present study has made use of SRTM DEM, temporal satellite images and maps to compute the avulsion threshold for a ~50 km long reach of the Kosi river after incorporating planform dynamics in a GIS environment. Flow accumulation paths generated from the SRTM data match closely with the zones of high avulsion threshold. Not just that the Kusaha plots in a high avulsion threshold zone, we also identify several critical points where breach (avulsion) can occur in near future. This study assumes global significance keeping in view the most recent flooding in the Indus River in Pakistan. Like the Kusaha breach in Kosi in August 2008, the Indus flood trauma started with the breach of the eastern marginal embankment in the upstream of Taunsa barrage and was apparently triggered by rise of bed level due to excessive sediment load. This talk will highlight the causative factors responsible for the avulsive shift of the Kosi river with particular emphasis on the Kusaha breach and will also make a case that such events need an altogether different strategy for river management.

TECTONO-CLIMATIC CONTROLS ON FLUVIAL SEDIMENTATION OF UPPER AND MIDDLE REACHES OF TAPI RIVER BASIN, CENTRAL INDIA

Snigdha Ghatak[a], Mriganka Ghatak[b]

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[b]SAARC Disaster Management Centre, New Delhi

Tapi River is one of the few major rivers of Indian sub continent with a westerly flowing course. The present work discusses the tectonic processes that have played a stellar role in the sedimentation history of the middle reaches of the Tapi basin located at the southern margin of the Satpura ranges in parts of Maharashtra and Madhya Pradesh of Central India. The Tapi in this part is fed solely by monsoonal rains which visit the region between June and October. This period also coincides with the major fluvial activity in this part of the basin. However, in this basin, the fluvial processes and the sedimentation; both past and present have inherited the legacy of the regional tectonic processes. Tapi basin has drawn some attention from researchers in recent times especially from hydrological aspect and Quaternary sedimentation with much work concentrated in the lower reaches. The absence of information in the upper to middle reaches of this basin regarding fluvial and tectonic geomorphology was one of the factors that encouraged the authors to focus their research on the tectono-sedimentary processes of this part. The present work describes the anthology of the Tapi river from east to west direction over a river course length of ~100 kms.

The Late Cenozoic period in the Central Indian Tectonic Zone (CITZ) was marked by several episodes of crustal adjustments which are reflected in terms of various tectonic landforms, repeated adjustments in the drainage systems and sedimentation pattern in the Tapi basin which is a half graben structure. The northern margin of the basin is bound by ENE-WSW trending Tapi Fault Zone (TFZ) while the southern margin gradually merges with the Ajanta-Buldhana plateau.

The Tapi in the eastern part of the studied stretch runs along a narrow intermontane valley carved into the lower middle level plateau of the south Satpuras. The course of the river is dominantly straight to sinuous with resistant channel

boundaries and coarse bed material. Here, majority of the fluvial deposition has been in the form of overbank deposits with restricted flood plain development. Field evidences show that the opening of the basin and consequent sedimentation in this part has been controlled by Tapi River fault set in at a later period as compared to the part of the basin disposed to its west. The river here flows through a fault controlled valley cut into Deccan Traps and the river terraces on either bank are unpaired. The Deccan-Quaternary contact on either banks of Tapi in this area show an elevation difference of 8-10 meters. The episode of faulting appears to have been preceded by a high rainfall phase and development of ash associated red paleosol horizon. Post uplift sedimentation in this part of the basin has been in form of buff coloured slack water deposits, dominantly finer grained during uppermost part of Late Pleistocene. Possible inset of transient arid phase (~LGM) had led to preservation of lithified grit beds. The last phase of sedimentation in this part of the basin is in form of grey silt bearing inset terraces of Holocene period derived from older sediments. This phase appears to have witnessed a major episode of faulting as evident by presence of massive, meter scale bank collapse structures in the sediments. At present the river has set into a denudational phase, engaging into deep incision of its older sediment package and intense undercutting of the exposed sections. Intense vertical erosive activity influenced by slow tectonic uplift is manifest in form of fresh scarp sections, presence of giant pot holes and talus scree and block falls from the sections along the river course. The imprints of ongoing tectonic activity in this part have been in the form of tilting, crushing and brecciation of Deccan Traps and alignment of hot and cold springs along the river course.

The Tapi River after traversing this intermontane valley descends onto the foothills which has a different set up of tectonic landforms and sedimentation history. Here the river course is having dominantly wide and open meander bends with occasional presence of point bars and channel bars. This part represents the deeper part of the basin and sedimentation here has been under the influence of two regional scale faults: Tapi North Fault (TNF) traversing the lower plateau parts of the Satpura ranges and its margin and Tapi River Fault (TRF) which as the name suggests, runs along the course of the Tapi river and has governed the sedimentation pattern in the basin. Several first order transverse tributaries emerge from the Satpura foothills and join the Tapi River course in this stretch. Chronological data supports that the

sedimentation in this part of the basin was initiated at least during middle Pleistocene. Episodic uplift of the reactivated segments of old crustal scale discontinuities has provided loci for sedimentation in the basin. The flood plain (red palaeosol) sediments of this part also show signatures of high rainfall phase caused by intensification of monsoon and episodic uplift of the northern footwall block of TNF. Climatic amelioration caused development of multiple bedded calcrete horizons and flash flood deposit. Rejuvenation of the main river and its tributaries has also introduced channel deposits along the river courses at a later phase possibly during upper part of Late Pleistocene. The youngest Holocene deposit occur as inset terraces along the river course. The sedimentary pile in this part is appreciably thick and the base rock/Quaternary contact is not seen along the river course except for the parts which have witnessed contemporary uplift along TRF.

Both TNF and TRF have been active during the deposition of sediments in this part of the basin. The imprints of TNF activity have been in the form of zones of high geothermal gradient, accelerated denudation even along the juvenile first order streams and deformation of sediments. TRF on the other hand, has preserved the evidences of active tectonic activity in the form of paleoliquefaction features, deformation of sediments, development of coalesced colonies of potholes resulting from intense scouring of the Deccan Trap base rock along the uplifted segments of the TRF and development of alluvial fans. The episodic faulting in the basin created the depocentre for initiation of sedimentation and seismicity in the basin.

In light of the discussion above it may be stated that the sedimentation history in the middle reaches of Tapi basin has gone hand-in-hand with the tectonic activity in the basin and the hinterland immediately north of the basin.

UNDERSTANDING DYNAMICS OF THE GANGA SYSTEM IN WEST BENGAL

Kalyan Rudra

West Bengal Pollution Control Board

Abstract

The river Ganga and the vast and intricate mesh of tributaries and distributaries in its lower deltaic region are characterised by some unique hydrological and morphological features which give rise to certain hydro-geomorphological processes typical in the region. The region has been experiencing difficulties adjusting to the combination of accelerated processes of natural and anthropogenic change owing to which certain human ecological and social problems have emerged.

In the absence of scientific understanding of the geomorphological processes in the Gangetic delta, they continue to be labelled as 'disasters' to be 'controlled' by some structural measures. The major engineering intervention in the Delta was the construction of a barrage on Ganga at Farakka. Increasing structural interventions in the fragile deltaic region has greatly disturbed the natural fluvial, marine and coastal land-building processes leading to ecological consequences like devastating floods, large-scale erosion and an altered coastal ecology.

It is for an open scientific understanding of the land and water interactions in the fragile ecosystem of the Gangetic Delta that an attempt is made in this paper to conscientiously analyse the limitations of traditional hydrological engineering approach to water management. A concentration on purely traditional engineering solutions to augment lean season flows and to combat flood and erosion, continue to imperil the ecological security and delicate hydrological balance of the densely populated Gangetic delta. The paper discusses the changing dynamics of the Ganga at the apex and the estuary.

The Farakka Barrage on the river Ganga (Ganges) is located about 40 km. upstream of the point where the river branches into two major distributaries, the Hugli-Bhagirathi that flows through India and the Ganges-Padma that flows through Bangladesh before meeting the Bay of Bengal. With historic decline in the flow of the

Hugli-Bhagirathi, the barrage was contemplated with the objective of improving the status of the navigation channel in Hugli-Bhagirathi to the port of Kolkata. However, the basic objective of the project has remained largely frustrating as the problem of siltation in the Hugli estuary has been unsolved and port of Kolkata is not yet easily accessible to the large sea-going vessels. On the contrary, the engineering intervention in the Ganga at Farakka has impaired the dynamic equilibrium of the river. The recurrent bank failure and consequent change in the course of the Ganga upstream and downstream of the Farakka barrage continues. This has resulted in many problems like land reallocation causing border dispute between Jharkhand and West Bengal and created a class of environmental refugees. The politicians and the governmental engineers are addressing the problem as a 'natural disaster', while the basic geomorphological processes remain relatively ill-researched. While the course of the Ganga continues to change unabated in the northern front of the delta, the sea encroaches inland in the southern front of the littoral tract. There is a major tragedy connected with the limitations of sectoral approach to the management of river systems.

WIDESPREAD AGGRADATION IN THE MOUNTAINOUS CATCHMENT OF THE ALAKNANDA-GANGA RIVER SYSTEM: TIMESCALES AND IMPLICATIONS TO LANDSCAPE RESPONSES TO CLIMATE CHANGE

Pradeep Srivastava

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Abstract

Himalaya, the expression of continent-continent collision and related thrust tectonics, shows highest continental relief, experiences a significant E-W rainfall gradient and variations in surface processes. In an active orogen of such a kind, mass distribution, erosion, intensity of rainfall and their interaction decides upon its large-scale morphotectonic evolution. The river systems such as Ganga that drain through these neotectonically active thrusts bear potential to unravel the past climatic as well tectonic evolutionary history of Himalaya. Fluvial terraces are often used to decipher controlling factors like varying climate and tectonic pulses and time scales of river aggradation and incision in such a tectonically active setting. The researches suggest that the valley scale aggradations may represent the climatic impact while the fluvial incision into the bedrock equals the long-term uplift rate and thus the local rise of the incision rate can be interpreted as an effect of vertical motion along the active tectonic discontinuities and/or increased hydraulic efficiency.

Cut-and-fill type fluvial terraces are ubiquitous in the Lesser Himalayan zone of the Alaknanda-Ganga (Ganges) rivers system, which flows perpendicular to Himalayan litho-tectonic units and traverses a steep climatic gradient. The lithofacies analysis of the sedimentary sequences of cut-and-fill terraces indicated that the valley aggradation took place via (1) channel bar development, (2) debris flows composed of mixed rounded to sub-rounded lithoclasts, resulting from episodic high intensity rainfalls in the upper catchment or (3) debris flows or rockfalls generated by local landslides. The luminescence chronology indicates that valley aggradation took place in two phases of ~49–25 ka and 18–11 ka. The incision of the fill started soon after 11 ka. Paleoclimatic records from marine sediments indicated that the aggradation and incision in the Alaknanda-Ganga River has oscillated in-phase with global climatic variations. Glaciation–deglaciation processes in the upper catchment produced huge

amounts of sediment between 63 and 11 ka, which was fluvially transferred to the lower valley via several cycles of erosion and deposition, leading to extensive aggradation. The climatic amelioration at ~11 ka and the completion of deglaciation processes led to increased fluvial discharge and decreased sediment supply, conditions conducive for incision of the alluvial fills. Records from the Indo-Gangetic plain and the Ganga Delta demonstrate that the phase of aggradation was regional but that incision in the foreland started at least 2–3 ka later, after 7 ka.

TERRAIN, GEOMORPHIC FEATURES AND MORPHODYNAMICS STUDY OF KOSI RIVER AND MEGAFAN (BIHAR), INDIA IN PARTICULAR WITH REFRENCE TO MAJOR FLOOD OF AUG 2008 USING REMOTE SENSING AND GIS TECHNIQUES

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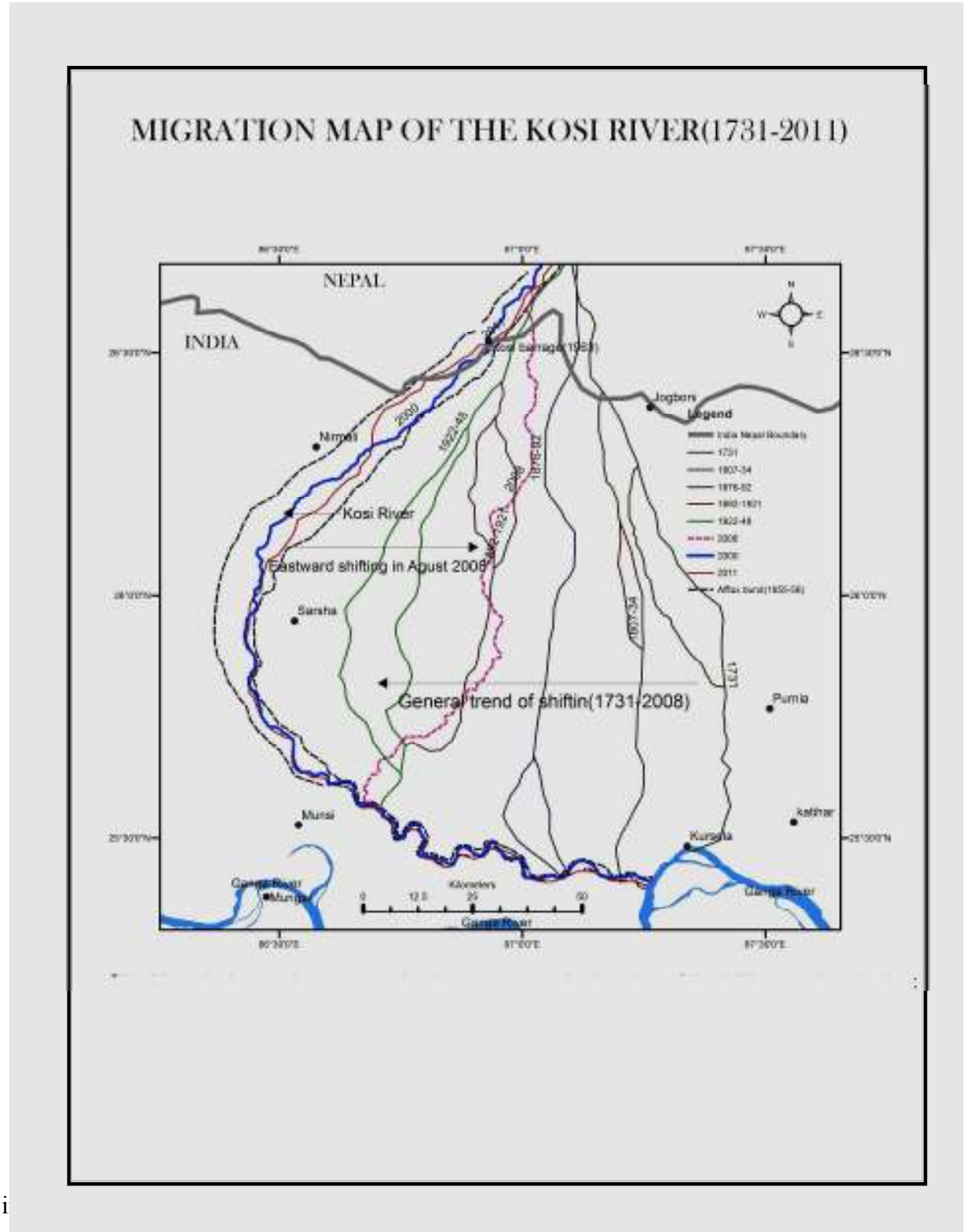
Abstract

The Kosi River is one of the major tributaries of the Ganga River which emerges out at Tribenighat in Nepal (26054'47"N, 87009'25"E) and enters Bihar plain near Bhimnagar. This is a mountain fed river having a large catchment area of high relief containing the highest mountain peaks of the world such as Mt Everest (8848 Mt) , Kanchenjhangha (8598 mt) with comparatively small flood plain (U/p=5.3)of low relief. After flowing for about 320 km through the Gangetic plane of North Bihar it ultimately joins the River Ganga (25024'43"N,87015'32"E) near Kursela village, Katihar Distrcts, Bihar.The river basin is surrounded by the ridges separating it from the Brahmaputra in the north, the Gandak in the west, the Mahananda in the east, and by the Ganga in the south.

The river is a typically braided in nature and has formed a very large alluvial fan (Megafan) in plain due to discharge of large volume of sediments from the Himalayas and generally aggradational regime combined with very high rainfall in the catchment area (average rainfall 1200-2000 mm). Further frequent occurrence of earthquake and related neo tectonic activities in Himalayan region trigger landslides and produce a large amount of sediments which eventually fill up the basin. This excess amount of lodes, which river unables to carry in plain area results in deposition , frequent changes in drainage lines causing floods in the lower plain. However Wells and Dorr (1987) are of the opinion that the frequent migrations of the Kosi river channels have been stochastic and auto cyclic , and are not related with any type of catastrophic events, such as high-magnitude floods or severe earthquakes. From historical data as well as from the analysis of present space images of recent period it is observed that the river had moved westward laterally by about 200 km through more than 12 distinct channels during the last 280 years since 1731 but on 18th Aug 2008 due to sudden breach in embankment near Kusaha, the river avulsed

eastward to about 60 km (see fig no.1). In between the 18 August 2008 to 26 January 2009 the river had flown in central part of the mega fan along various paleo channels near the Rampur and then the Kosi river was diverted back into the old river course through the barrage on 26 January 2009 after restoring about 2 km long embankment (Sinha, 2009)



elevation value around 70 mt and of peripheral elevations ranging from 35 mt to 50 mt as obtained from SRTM DEM data where as there is a gradual variation in elevation from 90 mt. at north exit point to about 30 mt. at south end.

In general the relief of the mega fan is smooth and gentle with presence of several longitudinal dunes and bars , 3- d dunes (see north –south elongated light toned striated features in image) particularly in northern central part of the fan where water course has gone wide and braided where as in southern lower part, the river channel has gone thin and shows sever meandering and also presence of several ox-bow lakes.

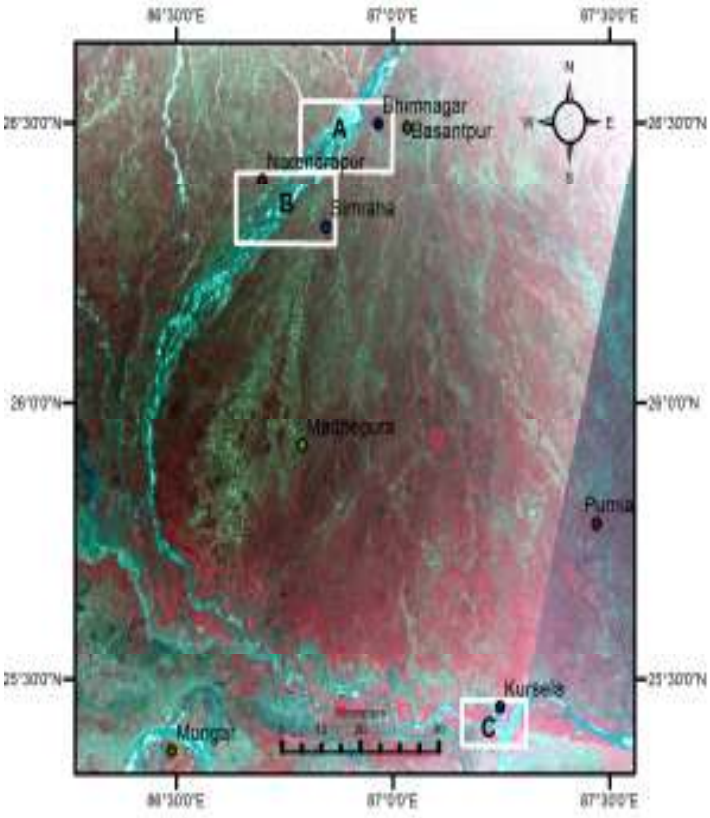


Fig 2a: Satellite (FCC) over view of Kosi Megafan. Box shows the area where changes in fluvial features studied (Parker 2007)

Fig 2b: Artistic (resembling) View of Inverted Fan

The channel pattern is a dynamic manifestation of the bed slope discharge, load, velocity and cross section geometry and results in formation of various fluvial features along the river courses (Parker 2007) and here the Kosi River channel pattern has also changed due to changes in controlling factors as mentioned and results in changing fluvial deposits/ formation Changes in fluvial features both before and

after the major flood of 2008 have been studied at three locations along the river as shown in the fig 2a (see boxes) in FCC image of Kosi fan.

From the present study it is established that the Kosi river is a dynamic river and shifts its course episodically and periodically as compared to other Himalayan rivers which is controlled by auto cyclic processes. However it is difficult to predict its future trends as because the recent major shifting of about 60 km has been seen from west to east during August 2008 against the previous general shifting of river towards west amounting 200km during the last 280 years.

ROLE OF GEOINFORMATICS IN RIVER BASIN MANAGEMENT

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Application of geoinformatics has been traditionally limited towards mapping related applications, for e.g. mapping of flood hazard area or channel morphological changes etc. However, recently the availability of Digital Elevation model (DEM) has provided a new tool to analyse the fluvial processes and to develop explanation for physical changes in a river system. This process-based understanding of fluvial systems provides an essential platform to develop stream management programme, as meaningful river management strategy requires an explanation for river appearance, behaviour and its nature of adjustment to external changes occurring within a catchment. In this abstract two applications of geoinformatics has been discussed, i.e. process based understanding of (1) spatial variation in river processes and morphology and (2) dynamic nature of unstable channels.

The process-based understanding of fluvial system could be achieved by analysing the driving and resisting force in a system. Driving force in a fluvial system is expressed as stream power, which is a fundamental property to analyse fluvial processes. It is defined by the liberation rate of kinetic energy from potential energy and is a function of unit weight of water (γ), discharge (Q) and channel slope (s) (Bagnold, 1966). Distribution pattern of stream power was generated for different rivers through extraction of long profile from Digital Elevation Model (DEM) using ArcGIS. The DEM data was clipped to each river basin area and then filled to remove the sinks in the data. Subsequently, flow direction and flow accumulation grids were produced in the GRID module of ArcGIS. A long profile was prepared through export of database file-containing x, y coordinates, height and contributing area (flow accumulation area), which were plotted using Microsoft Excel. The long profile pattern was converted into a mathematical expression and was merged with discharge variability to generate the downstream stream power distribution pattern. The stream

power pattern provides an opportunity to analyse geomorphic processes at basin scale. The resultant bimodal distribution pattern successfully explains the higher erosion in upstream (hilly) catchment area and helps to define catchment to reach scale thresholds in geomorphic system. This identification and characterization of threshold for geomorphic changes will further help to define sensitivity of river channel against any external causes like climate change or anthropogenic activities.

Further, DEM data is also very helpful in analyzing the dynamic nature of rivers, which is a major concern in stream management planning of the rivers in the Bihar plains. Channel shifting in the Bihar plains is associated with avulsion process. SRTM DEM data based mapping and reach scale classification was followed by kinematic GPS/Total Station based fieldwork to understand avulsion mechanism and to define the avulsion threshold in the area. Avulsion process is governed by variation in channel gradient. Avulsion occurs due to increase in Sa/Se ratio (Sa-slope of potential avulsion course, Se-slope of the existing channel) (Jones and Schumm, 1999). This ratio may increase either due to decrease in Se or due to increase in Sa (Jones and Schumm, 1999, Jain and Sinha, 2003, 2004). In the field area, high-resolution digital surfaces were generated, which will be used to estimate gradient of main channel and avulsed channel. The data will be used to compute the avulsion threshold. Identification and computation of avulsion threshold will help to develop the prediction capability for this highly dynamic river system.

SPATIO TEMPORAL VARIATION OF SEDIMENT LOADS OF TEESTA RIVER

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Abstract

River Teesta, like any other Himalayan Rivers, carries voluminous sediment load, which plays an important role in carving out the geomorphology of the basin. Geology of the catchment area, drainage pattern, river water discharge, magnitude and intensity of rainfall, natural calamities like; landslide and anthropogenic activities are the broad factors that influence the sediment load carried by the river. River Teesta, one of the major tributaries of Brahmaputra, in Eastern India, flows in a narrow steep valley in the mountainous terrain along the entire State of Sikkim and debouches into the plains near Sevoke in West Bengal. Geologically, it drains through a gamut of lithounits belonging to Gondwana Supergroup, Siwalik Group, Quaternary sediments and present day formations. This seismically active zone is traversed by two major tectonic discontinuities, viz., Main Boundary Thrust (MBT) and Main Central Thrust (MCT). While the mountainous part of the river has number of landslide incidences, in the frontal foreland part, this flood prone river, known for its dynamic nature has been changing its course, which in turn impacts on the sediment load of the river.

To understand the influence of river discharge and sediment yield on fluvial geomorphology spanning through time, information on river discharge and sediment yield data (on 10 daily basis) from Gauge and Discharge (G&D) stations along Teesta river for a period of twelve years have been obtained from Central Water Commission, Ministry of Water Resources, Govt of India. The present work aims to analyse this 10 daily sediment load data along the course of the Teesta River on three sites (Chungthang, Sankalan, Khanitar) in the mountainous terrain, during monsoon and non-monsoon period to bring out the spatio-temporal variation in pattern of sediment load, relationship with river water discharge, factors controlling sediment loads and correlate them with different geological & geomorphological, natural and manmade factors and vice versa.

CLIMATE CHANGE AND HIMALAYAN WATER RESOURCES

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Abstract

The concentration of several greenhouse gases has increased over time. Human activity increases the greenhouse gases effect primarily through release of carbon dioxide, but human influences on other greenhouse gases is also important. The ongoing accumulation of greenhouse gases causes increasing global warming. The recent IPCC (Intergovernmental Panel on Climate Change) 2007 shows that global average air temperature near Earth's surface rose 0.74±0.18°C in the last century and report concluded "most of the observed increase in globally averaged temperatures since mid – 20th century is very likely due to the observed increase in the concentration of anthropogenic greenhouse gases. Trends of increase in temperature and changes in precipitation over India/Indian sub-continent with global trends are compared. It is found that the changes in temperature in India/India-subcontinent over last century are broadly consistent with global trend of increase in temperature.

Not all possible consequences of climate change are yet fully understood, but the three main 'categories' of impacts are those on agriculture, sea level rise leading to submergence of coastal areas, as well as increased frequency of extreme events. All the three impacts would have serious impact on Indian economy. In India, demand for water has increased manifold in recent years. At present, changes in cropping pattern and land use pattern, over exploitation of ground water storage and changes in irrigation and drainage pattern are modifying the hydrological cycle in many river basins. An assessment of the water resources in changing climate and its variability is essential for relevant national and regional long-term development strategies and sustainable development. This paper highlights various issues related to the impact of climate change on water resources of India for evolving the suitable adaptation strategies in the water resources sector.

VULNERABILITY ASSESSMENT TO DEVELOP COPING MECHANISM - PEOPLE BASED PERSPECTIVE ---*A CASE STUDY OF KOSI REGION*

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Disaster vulnerability is socially constructed, i.e. it arises out of the social and economic circumstances of everyday living. The study starts with an assessment of trend of Disaster and damages faced by it in and then narrowed down to Flood events in India and Kosi Region in particular. Among all the main tenets of vulnerability research this study basically focuses on the approach which came into existence in late 1990's where vulnerability is seen both as biophysical risk (Extrinsic vulnerability) as well as a social response (Intrinsic vulnerability) but within a specific area or geographic domain. Taking into account the above approach the study attempts to establish the hazard of place Model of vulnerability to identify the overall vulnerability of the place towards flood and then analyze the role of autonomous as well planned coping in reducing the vulnerability due to flood .

Compared to the Cutter's SOVI (2006), the result of this study is based on the assessment of vulnerability of selected villages at HH level of most vulnerable block in Kosi region instead of county, and the place vulnerability is easy to identify precisely. For the assessment of the extrinsic vulnerability depth of the flood water and inundation time has been taken. Similarly for the assessment of the intrinsic vulnerability variables under social, economic & well being has been taken and these are literacy, minority population, income, access to basic amenities and family structure. Different scores of Extrinsic & Intrinsic vulnerability were divided into different ranks describing different intensity of vulnerability.

This method will be applicable for other hazards and places too, but variables of extrinsic vulnerabilities need to be reconsidered and recalculated to meet the need.

RIVER DRAINAGE RESPONSE TO ACTIVE TECTONISM: EVIDENCES FROM CHALIYAR RIVER BASIN, KERALA STATE, INDIA

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Thiruvananthapuram

Abstract

Geomorphological analysis is a powerful tool for unravelling the tectonics and fluvial dynamics that control directly or indirectly the evolution of a drainage basin. The evaluation of stream profile analysis, morphometry, morphostructural analysis, geomorphic indices and geomorphic markers of active tectonism are used to appraise the influence of active tectonism in the hydrographic network of Chaliyar River basin, Kerala State. The tributaries of Chaliyar River display uneven longitudinal profiles with a number of knick points along the profiles. Analysis of concavity, steepness and deviation of the profiles points towards the influence of tectonism and rock upliftment in the basin. Morphostructural analysis in the study area exhibits two phases of tectonic activity. The first phase is compressive in nature and has occurred on a regional scale and is responsible for the development of folded structures, reverse and strike slip faults. The second phase is a neotectonic phase which caused general uplift which displaced the structures developed during the first phase. This phase has also displaced the fluvial terraces and is responsible for the sharp fluvial deviation in the basin. Based on geomorphic indices, the sub-basins of Chaliyar River are classified as Class II of the Relative tectonic activity classification, which represents a tectonically active zone but less active than Class I. Relative tectonic activity index (Iat) for the sub-basins are 2 and 3 which represent zones of high and moderate tectonic activity respectively. Detection and characterization of geomorphic anomalies (markers) in the Chaliyar River drainage basin have provided an additional tool for recognizing the subtle tectonic movements in the region. The morphology of the Chaliyar River basin bears the imprints of recent morphological and structural adjustment of the stream channels due its location in a zone of moderate to high tectonic activity.

INTERNATIONAL GEOSCIENCE PROGRAMME (IGCP)

MINUTES OF THE FIRST MEETING OF NATIONAL WORKING GROUP FOR IGCP 582 ON "TROPICAL RIVERS, HYDRO PHYSICAL PROCESSES, IMPACTS, HAZARDS AND MANAGEMENT"

1.0.0

The first meeting of National Working Group of IGCP 582: Tropical Rivers, Hydro Physical Processes, Impacts, Hazards and Management was held on 4-5 October 2010 in Fermor Hall, Geological Survey of India (GSI), Central Region, Nagpur. Dr. K Rajaram, Deputy Director General, Op. Maharashtra, GSI, Nagpur and Chairman, IGCP 582 chaired the meeting. The list of NWG members and special invitees who attended the meeting is given in annexure-I.

Amongst the NWG members Dr. Ahmad S Masood, NGRI, Hyderabad, Dr. Rakesh kumar, IIH, Dehradun, Dr. Pradeep Srivastava, WIHG, Dehradun, Dr. Sreemati Gupta, GSI, New Delhi, Dr. M. S Bodas, GSI, CR, Pune, Shri. Rajesh Kumar, GSI, CHQ, Shri. N. R Mohapatra, GSI, ER could not attend the meeting.

1.0.1 Welcome address by the Convener

Dr. Snigdha Ghatak, Convener, IGCP 582 welcomed the Chairman IGCP 582, International leader and INC member of IGCP 582, Prof. Rajiv Sinha, IIT, Kanpur, NWG members, invited speakers, guests and members of the organizing committee. She dwelt upon the constitution of IGCP 582, brief introduction on the objectives of the IGCP 582 project, the profound effects the study would impact upon the societal issues and the socio economic relevance it is likely to usher in. She also emphasized the importance of inter and multidisciplinary research in this area of research. She informed that although the tenure of the IGCP 582 is between 2009 & 2014, the actual groundwork has started only since October 2010. She therefore requested the NWG members to put in focused efforts to compensate for the time lost. The constitution of NWG is enclosed as annexure- II.

1.0.2 Self introduction by the NWG members and special invitees

Prof. Rameshwar Bali, Prof. Ajay K Katuri, Shri. Manoj Kumar Shukla, Shri. N. V. Venkataraman, Dr. V. P. Malaviya, Prof. Vinay Kumar Srivastava, Dr. N. R Ramesh. Dr. D. K. Pal, Dr. H.S. Saini, Shri. M Chandradas gave a brief introduction about their respective research fields.

1.0.3 Opening remarks and welcome address by the Chairman IGCP 582

Dr. K Rajaram Dy. DG, Op. Maharashtra, GSI, Nagpur and Chairman, IGCP 582 welcomed the INC member and project leader Prof. Rajiv Sinha, NWG members and other distinguished scientists and guests. He suggested to have constant interaction within the IGCP 582 group and other experts till the completion of the projects for the benefit of the society at large. Citing an example of hazards caused by unplanned human intervention in Una River in Umaria Coal Fields, M P, he emphasized the societal relevance of the project and how important it is to take up multi- and inter-disciplinary activities. He also expressed his confidence that IGCP 582 will be a nodal group for other agencies in carrying out premier scientific studies. He concluded the speech by thanking the organizers.

1.0.4 Release of base document of IGCP 582

Dr. K. Rajaram, Chairman IGCP 582 and Prof. Rajiv Sinha jointly inaugurated the base document consisting of the research papers/abstracts submitted by NWG members and special invitees. Prof. Rajiv Sinha congratulated the convening group in producing the document in a limited time in a good quality.

1.0.5 Vote of Thanks

Shri. N.V. Venkataraman proposed vote of thanks to the Chairman IGCP582 and the NWG members for participating in the inaugural session and concluded it by wishing good deliberations in the meeting.

1.1.0 Technical session I: Key note address

1.1.1 Keynote Address and invited lecture by Professor Rajiv Sinha, Member, INC and Team Leader for IGCP 582

Professor Rajiv Sinha delivered the Keynote Address on "Tropical Rivers: Hydro Physical Processes, Impacts, Hazards and Management". He dwelt on the ten large tropical rivers, their varied tectonic settings, channel patterns, sediment transport, river dynamics, floods, bank erosion, hydro-geomorphic processes, anthropogenic impacts, ecosystem based management and reconstruction of Quaternary palaeo climates. The address covered the impact of floods in Kosi river, the recent floods in Pakistan and in the western and the eastern Ganga basins, the rainfall patterns and the consequences of rainfall in the evolution of the hydro-physical processes. His speech covered the major objectives, the important projects, expected output from the IGCP 582 group and publication of special issues from time to time. At the end, he expressed the hope that the IGCP 582 would facilitate sharing of experiences on river management amongst the researchers world over and therefore contributes directly to the society at large.

1.1.2

Dr. Snigdha Ghatak, Convener, IGCP 582 delivered a talk on Morphological Modeling within the Hooghly estuary, Indian Sunderbans: A framework for coastal zone management. The talk centered around the potential hazard in the southern sea facing islands of the Ganga –Brahmaputra delta and the need to adopt a scientifically evolved management plan to mitigate the threat potential. In this context, she presented her studies and stressed upon the new approach of study to evolve GIS based coastal area morphological modeling within Hoogly estuary as a blue print for coastal management plans. This, she said was a contribution to IGCP 582 work.

1.2.0 Technical Session II: Invited lectures and presentation by the National Working Group members

1.2.1

Shri M.P. Tiwari, GSI (retd.) shared his experiences on the Quaternary deposits of Central India. He covered the Quaternary litho and morpho stratigraphic classification of the Narmada, Tapi-Purna-Wardha, Wainganga-Pranhita River valleys and spoke about the tectonogenic and climatogenic riverine Quaternary sedimentation in these basins.

1.2.2

Dr D.K. Pal, renowned soil scientist from ICRISAT, Hyderabad delivered an invited lecture on soil and their mineral formation as a tool in provenance, climate change and geomorphological research. He elaborated upon pedogenic minerals like di- and tri-octahedral smectite, smectite-kaolin interstratified mineral, hydroxyl inter-layered vermiculite and smectite and pedogenic calcium carbonate as tools of palaeo-environmental indicators. His talk covered his vast research experiences in the Ganga plains.

1.2.3

The presentation entitled: Flood hazard modeling and flood risk assessment for a river basin by Dr. Rakesh Kumar of NIH, Roorkee and member, NWG was distributed amongst the participants of the meeting. The paper introduced a procedure for flood hazard modeling and flood risk zoning for a river basin.

1.2.4

The invited lecture by Shri. M. Chandradas, Sr. Geologist, GSI, CR was an interesting study on the disaster caused by the

Mumbai floods due to human intervention and greed. He cited the example of Mithi River and how ill and unplanned growth could lead to recurring flood hazards.

1.3.0 Technical Session III: Invited lectures and presentation by the National Working Group members

1.3.1

Prof. Vinay Shrivastava, ISM, Dhanbad and member, NWG presented his observations on the drainage patterns in Jharia-Raniganj coal fields using remote sensing images.

1.3.2

Dr H.S. Saini, Superintending Geologist, GSI, Faridabad spoke on the geological signatures of past rivers in the NW Himalaya and adjoining fore deep. His talk covered the recent Leh mudslide disaster of Ladakh and the pattern of river behavior at the foothills of the Himalayas, leading to lost channels and palaeo channel patterns. He elaborated about certain channel migration aspects in Ghaggar River in Haryana.

1.3.3

Prof. Ajay Katuri, CEPT, Ahmedabad and member, NWG spoke about human intervention on flood situation for the Sabarmati River in Ahmedabad city. Anthropogenic intervention has lead to reduction in river section, leading to flood hazard. The study covered flood simulation by using SOBEK to assess flood extent for different return periods of the floods.

1.3.4

Dr. N.R. Ramesh, Director, GSI, Bengaluru presented the work carried out by him in the Brahmaputra basin in the North-East India. He presented evidences of Late Quaternary changes in the river regimes, possibly as a sequel to global climatic changes and neotectonic movements. Observations on river metamorphosis, unilateral channel migration, bank erosion and related flood hazards were also brought out.

1.3.5

Dr. Rameshwar Bali, Lucknow University and member, NWG presented his work on climate change on Siachin and the Gangotri glaciers, which is a source for some of the tropical rivers.

1.4.0 Technical Session IV: Action Plan for implementation of IGCP 582 project

1.4.1

Dr. Snigdha Ghatak initiated the discussions for implementation of the action plan and presented the guidelines of IGCP projects in India and the time frame for different activities viz. holding workshops/seminars, annual report submission, paper publications, project finalisation etc. for IGCP 582.

Dr. K. Rajaram suggested to frame and focus on a few selected topics based on the capabilities of NWG members and available infrastructure. He also advised to put up proposals for requirements of new equipments for IGCP 582.

(Action: all NWG members)

After an elaborate discussion on various aspects (Urban flooding, flash floods, river dynamics of flooding, fluvio dynamic processes, glacio-marine processes, coastal processes) and feasibility issues for taking up projects by the participants, the gap areas were identified and three different tentative activities for IGCP 582 in India were planned. The activities/themes, sub themes were addressed basin wise for a time frame of Late Pleistocene to Holocene and the scientists from NWG members and additional contributors for these projects were decided which is enumerated below.

Sl.	Activity	River Basin/study area	Contributors (NWG)	Contributors (Non NWG)	Data and work components/ Lab inputs required	Remarks
I.	**Multidisciplinary Data Base on Tropical Rivers: Reports, data and spatial information collection**					
	Compilation of database (for IGCP 582, India chapter website)	Narmada – Tapi-Purna (flooding and draught)	Shri N V. Venkataraman Dr. Snigdha Ghatak Dr. V P Malviya Dr. M.S.Bodas	M Chandradas Dr D K Pal		-
		Sabarmati (Urban planning)	Prof. Ajay Kumar Katuri Dr. Pradeep Srivastava Dr. Snigdha Ghatak Dr. V P Malviya			-
		Ganga-Yamuna	Shri Manoj Kumar Shukla Dr. Pradeep Srivastava Prof. Rameshwar Bali Shri Rajesh Kumar	Dr. H.S Saini Vikrant Jain Dr. D K Pal		-
		Kaveri	Dr. V P Malviya	Dr. N R Ramesh Dr. J K Tripathi Prof. Balakrishnan		--
		Khowai – Haora (NE)		Dr. N R Ramesh		-
		Teesta	Dr. Sreemati Gupta Dr. Snigdha Ghatak Prof. Ajay K Katuri			-
II.	**Analysis and compilation of recent flood disasters, investigation of the causative factors and debate on the efficacy of the existing flood control measures**					
	a. Basin scale analysis	Narmada – Tapi (flooding and draught)	Dr. Snigdha Ghatak Shri N V Venkataraman Prof. Ajay K Katuri Dr. V P Malaviya Dr. M.S.Bodas	Shri M Chandradas Dr. D K Pal	Hydrology and hydraulic , geology-geomorphology	-
		Kosi	Prof. Vinay Kumar Srivastava			-
		Ghaghra	Shri Manoj Shukla			-
		Teesta	Dr. Sreemati Gupta Dr. Snigdha Ghatak Prof. Ajay K Katuri			-
	b. Urban floods	Ahmedabad	Prof. Ajay K Katuri		Hydrology, geology-geomorphology, soil, landuse-landcover, census data etc.	-
		Mumbai	Dr. M S Bodas Prof. Ajay K Katuri	Shri M Chandradas		**FSP item:** New Project proposal to be formulated. **(Action:** Dr. M.S Bodas & Shri M Chandradas)

Sl.	Activity	River Basin/study area	Contributors (NWG)	Contributors (Non NWG)	Data and work components/ Lab inputs required	Remarks
III.	**Analysis of hydro-geomorphologic parameters of Global change and anthropogenic impacts on river systems**					
	Holocene palaeoclimatic reconstruction using multi proxy approaches & Impact of human intervention on river form and processes	Narmada	Dr. Snigdha Ghatak Shri N V Venkataraman Prof. A K Katuri Dr. V P Malaviya	Dr. M Shareef Dr. Pitambar Pati Ms. Manju S	Multidated maps and imagery, Hydro-meteorological data, Dating-OSL/cosmogenic radio nuclide/ ESR, MMA, micromorphol-ogical studies etc..	**FSP Item:** New Project proposal to be formulated from GSI, CR **Action :** Convener, IGCP 582, Shri N V Venkataraman, Dr. V P Malviya
		Lower Ganga	Shri Rajesh Kumar Shri N R Mahapatra			**Action :** Shri Rajesh Kumar Shri N R Mohapatra
		Kosi	Prof. Ajay K Katuri Prof. V K Srivastava	Arvind Singh Atul Pandey Tapan Chakraborty		**Action :** Prof. Ajay K Katuri Prof. V K Srivastava
		Sabarmati	Dr. Snigdha Ghatak Prof A K Katuri Dr. V P Malaviya			Request for additional data will be forwarded to GSI, WR through Chairman, IGCP 582 **Action :** Dr. Snigdha Ghatak Prof Ajay K Katuri Dr. V P Malaviya
		Kali Basin, Eastern Kumaun	Shri Manoj Shukla			**FSP Item:** Data generation can be carried out simultaneously with current FSP Project/new FSP of Quaternary Geology Division Lucknow. Request will be sent through Chairman IGCP 582. (**Action**: Convener, IGCP 582 & Shri. Manoj Shukla, NWG member)

1.4.2

Apart from identifying the project framework, the house conceded upon the following points.

i) One website of IGCP 582 India chapter is to be launched either as part of GSI portal or as a separate web page with its hyperlink/ external link reflected in GSI portal as well as IGCP 582 main website. Proposal for this will be put up to DG, GSI.

(Action: Convener)

ii) The international event/ seminar of IGCP 582 is going to be organized at Kanpur in 2011. It was decided by the house to tie up IGCP 582, India chapter activity with that of the proposed International event in 2011. For this a proposal will be placed to DG, GSI for hosting the event partially. Secretary, MoM could be invited for the proposed IGCP meeting at Kanpur. Proposal of the same will be put up to Chairman, IGCP 582.

(Action: Convenor)

iii) The Bombay and Ahmedabad urban flood history and predictions to be put up to portal as a sequel of IGCP 582 meeting. It was decided that the base document inaugurated during the meeting can also be uploaded in GSI portal.

(Action: Convenor)

iv) A requirement of an application oriented training module for river hazard mitigation was felt under the aegis of IGCP 582. Therefore it was decided that, a training programme on river processes, hydrological understanding, and hazard mitigation needs to be parallely run by GSI and or other organizations in which Prof. Rajiv Sinha, NWG members and other geoscientists will impart training. A proposal for taking up this training module is to be placed to Regional Training Institute, GSI, Nagpur as well as GSI, Training Institute, Hyderabad through the Chairman, IGCP 582. Prof. Ajay Katuri informed the house about the e-module that is going to be announced shortly by CEPT, University on multi hazard risk mitigation and the scope of running the programme as part of IGCP 582 India chapter activity.

(Action: Convener, IGCP 582, M. Chandradas, RTI,Nagpur, Prof. Ajay K Katuri, CEPT University, Ahmedabad)

v) Some of the NWG members have expressed their inability to contribute for the IGCP 582 project. It was decided that the following names would be co-opted as NWG members who have expressed their willingness to help achieve the objectives of the project. Accordingly, the nominations will be forwarded to International Division, Kolkata.

-Ms. Manju Sudevan, Jr. Geologist, GSI, CR

-Prof. S.K Tandon, Retd. Delhi University (recommended by Prof. Rajiv Sinha)

(Action: Convener)

vi) Name of the following geoscientists will be reflected in the field item of IGCP 582 from Central Region for new projects which are to run either as special item of IGCP 582 beyond accredited programme or as part of new FSP.

a. Dr. Pitambar Pati , b. Dr. M Shareef , c. Ms. Manju S

viii) The details of project to be taken up from NR and CR is likely to be finalized by March 2011.

ix) Prof. Rajiv Sinha, project leader IGCP 582 had shown his concurrence to participate in all the activities of IGCP 582, India chapter and extend lab facilities available at IIT, Kanpur.

x) Apart from the NWG members, Dr. N. R Ramesh, Shri. M Chandradas, Dr. D.K Pal, Dr. H.S Saini also volunteered to contribute for the IGCP 582 projects in India.

Xi) Prof. Rajiv Sinha recommended the names of Dr. Vikrant Jain, Delhi University, Dr. J.K Tripathi, Jawaharlal Nehru University, New Delhi, Prof. Balakrishnan, Pondicherry University, Dr. Atul Pandey, Patna University, Prof. Tapan Chakraborty, Indian statistical Institute, Kolkata, Shri. Arvind Singh, Geological Survey of India, Patna as additional non NWG contributors for the project.

1.4.3

Prof. Rajiv Sinha summed up the action plan worked out during the deliberations on equal participation of all the members based on their capabilities and facilities available in their respective organizations.

1.5.0 Vote of thanks

Shri. N.V. Venkatraman, Sr. Geologist, GSI, CR presented vote of thanks to the Chairman, Member Secretary, INC for IGCP, Chairman IGCP 582, Convener and other NWG members and members of the organizing committee and special invitees for their active participation in making the meeting a success.

Annexure- I

INTERNATIONAL GEOSCIENCE CORRELATION PROGRAMME (IGCP)

FIRST MEETING OF NATIONAL WORKING GROUP FOR IGCP 582 ON "TROPICAL RIVERS HYDRO PHYSICAL PROCESSES, IMPACTS, HAZARDS AND MANAGEMENT"

List of NWG members, special invitees & members of the organising committee who attended the meeting held on 4-5 October 2010

1	Dr. K. Rajaram, Dy DG, Op. Maharashtra and Head Mission II	Chairman, IGCP 582
2	Prof. Rajiv Sinha, IIT, Kanpur	Leader, IGCP 582 project
3	Dr. Snigdha Ghatak, Sr. Geologist, Geodata Divn, GSI, CR	Convener, IGCP
4	Shri. M. Mohan, Director PSS I, GSI, CR	Special invitee, Organising Committee
5	Dr. D.M. Mohabey, Director, Palaeontology Division	Special invitee, Organising Committee
6	Shri K. Rao , Director CT, Op. Maharashtra, CR	Special invitee, Organising Committee
7	Shri N.V. Venkatraman, Sr. Geologist, GSI, CR	NWG Member
8	Prof. Rameshwar Bali, Lucknow University	NWG Member
9	Dr.V.K. Srivastava, ISM, Dhanbad	NWG Member
10	Prof. A.K. Katuri, CEPT University	NWG Member
11	Shri M. K. Shukla, Asst. Geologist, GSI, NR, Lucknow	NWG Member
12	Dr. V.P. Malviya, Jr. Mineralogist, GSI, CR	NWG Member
13	Shri M.P. Tiwari, GSI (Retd.)	Special invitee
14	Dr. N. R. Ramesh, Director, GSI, Bangaluru	Special invitee
15	Dr. H.S. Saini, Superintending Geologist, GSI, Faridabad	Special invitee
16	Dr. D.K. Pal, ICRISAT, Hyderabad	Special invitee
17	Shri M. Chandradas, RTI, GSI, CR	Special invitee
18	Ms. Manju S, Jr. Geologist	Organising Committee member
19	Shri M.L Dora,	Organising Committee member
20	Shri S.H Wankhade	Organising Committee member
21	Dr. Mohammad Shareef	Organising Committee member
22	Shri J. Vijay Kumar	Organising Committee member
23	Dr. Pitambar Pati	Organising Committee member
24	Shri A.B. Chatterjee	Organising Committee member

Annexure- II

INTERNATIONAL GEOSCIENCE CORRELATION PROGRAMME (IGCP)

FIRST MEETING OF NATIONAL WORKING GROUP FOR IGCP 582 ON
"TROPICAL RIVERS HYDRO PHYSICAL PROCESSES, IMPACTS, HAZARDS AND MANAGEMENT"

INDIAN NATIONAL WORKING GROUP

Director General, Geological Survey of India	Chairman, INC for IGCP
K. Balasubramaniam, Director, International Division	Member Secretary, INC for IGCP
Dr. K. Rajaram, Deputy Director General, Op.Maharashtra, Head Mission II, Central Region, Geological Survey of India	Chairman, IGCP582
Dr. (Mrs.) Snigdha Ghatak, Sr. Geologist, Geodata Division, GSI, CR	Convener, IGCP 582
Dr. Ahmad S. Masood , Scientist - 'G', Head Paleoclimate Group, NGRI	Member
Shri N.V. Venkatraman, Senior Geologist, Geological Survey of India, Central Region	Member
Dr. Rakesh Kumar , Scientist – F, Surface Water Hydrology Division, National Institute of Hydrology, Roorkee	Member
Dr. M.S. Bodas, Senior Geologist, Project: Landslides, Geological Survey of India, Central Region, Pune	Member
Dr. Pradeep Srivastava, Scientist – C, Sedimentology Group, Wadia Institute of Himalayan Geology, Dehradun	Member
Dr. Sreemati Gupta, Senior Geologist, LHIM & EPE Division, Geological Survey of India, Pushpa Bhavan, New Delhi	Member
Prof. Vinay Kumar Srivastava, Department of Applied Geophysics, Indian School of Mines, Dhanbad	Member
Prof. Rameshwar Bali, Centre of Advanced Study in Geology, University of Lucknow, Lucknow	Member
Dr. V. P. Malviya, Mineralogist, Mineral Physics Lab, Geological Survey of India, Central Region, Nagpur	Member
Prof. Ajay K. Katuri, Faculty of Planning and Technology (CEPT), Center for Environmental Planning and Technology (CEPT) University, Ahmedabad, Gujarat	Member
Shri Manoj Kumar Shukla, Assistant Geologist (Gr.I), Op: UP & UK, Quaternary Geology Project, Geological Survey of India, Lucknow	Member
Shri Rajesh Kumar, Senior Geologist, Geodata Division, Geological Survey of India, CHQ, Kolkata	Member
Shri N.R. Mohapatra, Senior Geologist, Op. WBAN, Geological Survey of India, Eastern Region, Salt Lake, Kolkata	Member

Photographs of IGCP 582 meeting

Dr. K Rajaram (middle), Chairman IGCP 582, Deputy Director General, Op. Maharashtra and Head Mission II presiding over the first NWG meeting. Also seen are Prof. Rajiv Sinha (left), IIT , Kanpur, Leader IGCP 582 and INC member, Dr. D.K Pal (right), ICRISAT, Hyderabad.

Welcome by Dr. Snigdha Ghatak, Convener, IGCP 582. Also seen are Dr. K. Rajaram, Chairman, IGCP 582 and other distinguished scientists attending the meeting.

Release of base document by Dr. K Rajaram, Chairman (right), IGCP 582 and Prof. Rajiv Sinha, Leader IGCP 582 (left).

Participants of IGCP 582 meeting showing their work.

Participants of IGCP 582 project. Front row from left: Prof. Ajay K Katuri, Prof. Vinay Srivastava, Shri. N.V Venkatraman, Dr. N. R ramesh, Prof. Rajiv Sinha, Dr. K Rajaram, Dr. D.K Pal, Dr. Snigdha Ghatak, Dr. H S Saini; Back row from left- Shri. M Chandradas, Prof. Rameshwar Bali, Shri. Manoj Kumar Shukla, Dr. V. P Malaviya