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Environmental Geotechnical Issues in River Interlinking Proposal

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Abstract. Water is life! In the Indian scenario, it has estimated that in the near future, there may be an acute shortage of water, due to Climate Change and Global Warming. The issue of water scarcity is in a greater extent in the Southern India in comparison to the Northern part. To counter these problems, proposal of River inter linking became a big debate in India. It became necessary to link the perennial rivers of northern India to the Rivers of southern India. The Inundation Rivers can be smoothed to manage the water so as to control the flood by feeding the dry rivers of another basin. The inter basin flood control can also be possible because of river linking system. Now, it is essential to see the methodology of interlinking of rivers, how best it can be executed at an economical cost. As the construction process is always having an adverse effect on the Environment, similarly issues on Geotechnical engineering also having its own impact in the methodology of river interlinking strategy.

So, this article it has been dedicated to the probability of adverse issues and Socio-environmental apprehensions in relations to the Geotechnical Engineering. With the help of effective planning how best a River inter-link program can be conducted with the application of the latest geotechnical science like, Tunneling, Soil nailing, Reinforced earth technology, Geo environmental engineering protection to the water and ground water with the application of Geo membrane, Geo-synthetic and Geo grids etc.. The effect of River interlinking on Ground water hydrology and combating its contamination has been discussed in this study. The Issues in the planning stages along with the Remedial measures on these problems have been briefly narrated in this article.

Keywords: Ecological and environmental issues, Quality of water and its effect on soil, change in the behavior of soil pattern. Issues and challenges in Geotechnical problems, variations of soil and its impact on environments.

1 Introduction

The interlinking of rivers is very important to combat the draught and flood and it can be executed with the help of lot of activities. But the role of Geotechnics is the prime factor in this contest. The length of top 10 rivers of India is 16253 km and the interlinking can be executed by construction of channel and tunnels for conveyance of water from surplus area to deficiency area. First of all, the idea of

Laxmikanta Tripathy

linking rivers was presented by Sir Arthur Cotton, chief engineer of the Madras Presidency in 1939, 150 years ago. The concept has been developed by Dr. K.L.Rao during 1972 and in 1977 Captain Dinsaw Dastur proposed two canals for 4200km long and 300m wide Himalayan canal and 9300km Galand canal. In 1980 NWDA & MoWR have worked on it.

NWDA carried out Water Balance Studies of 137 basins/sub-basins and 71 diversion points. It also carried out toposheet studies of 74 reservoirs & 37 link alignments. Based on these studies, NWDA identified 30 links (16 under Peninsular Component & 14 under Himalayan Component) for preparation of Feasibility Reports (FRs). Out of these, FR of 14 links under Peninsular Component and FR of 2 links (Indian portion) and Draft FR of 7 links under Himalayan Component have been completed. Field surveys & investigations for the remaining links under Himalayan Component are under progress except one link namely Kosi-Mechi which lies entirely in Nepal.

Under the Ken-Betwa project, additional water from the Madhya Pradesh will be brought to the Betwa River in Uttar Pradesh through a canal of 231 km. This will result in irrigation of one lakh 27 thousand hectares of land in Bundelkhand, as it is the most drought-affected area. In India there are 12 major river basins, 45 medium river basins, 24 of which are east flowing rivers, 17 of west flowing rivers and 4 flowing into neighboring countries in the North-eastern region. Together they contribute over 9-% of the rainfall-runoff occurring in India. But the project is being held up due to Wildlife issues.

The Minor rivers account for about 10% of the runoff. About 62 per cent (1,202 km³) of annual water availability in India generated in the Ganges, Brahmaputra and Meghna river systems, which accounts for 33 per cent of the geographical area of the country. On the other hand, 10 per cent is to be found from the west flowing rivers south of Tapi, which covers only 3 per cent of the area, and the remaining 28 per cent comes from the other river systems distributed over 64 per cent of the land area (Kumar et al., 2005).

Now, it is in need of the time to discuss about the geo-environmental issues for the ILR proposals. The environmental issues, soil erosion and Water conservation issues are more important matters in the river interlinking system.

1.1 Major river basins in India

Sl. No.	Name of River	Catchment area in India, Km ²	Catchment area outside India, Km ²
1	Indus (Sindhu)	3,21,289	1,46,779
2	Ganga	8,61,404	1,88,569
	Brahmaputra	1,87,113	3,92,887
	Barak & rivers flowing into Meghna	70,895	
3	Sabaramati	21,674	
4	Mahi	34,842	
5	Narmada	98,796	
6	Tapi	65,145	
7	Brahmani	39,033	
8	Mahanadi	1,41,589	
9	Godavari	3,12,812	
10	Krishna	2,58,948	
11	Pennar	55,213	
12	Kaveri	81,155	
	Total	25,49,905	7,28,235

2 Technical approach for execution of Interlinking of Rivers

a. Strategy of study and analysis :

- *Prefeasibility study, feasibility study and DPR* :-The route map, involvement of forest and Alternative planning and exploring the possibilities of construction of reservoirs, canals, drinking water facilities and other water resources structures are to be included in the study.
- *Hydro Geological studies* : Collection and analysis of data on the local rainfall, soil characteristics, silt calculation, discharge data, ground water flow characteristics, soil moisture and temperature and type of rocks, geological mapping data for making proper analysis and design.
- *Quality of water and soil* :- Checking the quality of water, soil and rocks for the involvement of harmful chemicals and contaminations.

b. Project components :

- *Geographically*, the River Interlinking Projects in India has been categorized in two components 1. Himalayan and 2 Peninsular components. These interlinking works can be taken up in considering with various components as under. It is well known that the rivers can be linked by excavating the lands and construction of channels. During the course of execution for interlinking there will be CD works, Bridge works and other Environmental works are also to be involved. Projects like Dams and barrages can also be constructed for the use of water in the running path of interlinking. Similarly the probability

of Meandering of rivers can also be studied in the existing planning. With the help of Remote Sensing data of the existing rivers of past decades it can be analyzed for the future predictions.

- **Structures to be constructed:**-For these constructions of dam's structures, canals, cross drainage works or bridges, sub soil exploration works and geotechnical and geophysical analysis can be taken up as usual manner. The characteristics of soil, rock and water also to be studied as per standard practices for construction as well as environmental purpose.
- **Area of involvement** :-But, when the linking comes across the industrial area or urban area, there are chances of contamination of flowing water. Environmental issues and its effect on the quality of water, Quality of soil , involvement of habitants and urban areas, requirement of lands for the excavation and distribution of water with the help of rivers and canals also to be taken care of.

3 Environmental issues and challenges

There some environmental issues which are independently influence the project implementation, where as some of the issues which are closely related to the geotechnical part for the executions. Since the water has to flow over the soil and the contaminated water can contaminate the soil, effect of environmental pollution is always has an impact on the geotechnical characteristics.

3.I Environmental features

- **Chemical factors:** The central Indian rivers, which flow through the black cotton soil belt such as Tapti, Narmada, Godavari, Chambal and upper reaches of Krishna have higher *concentration of Soluble salts* in comparison to North Indian Rivers such as Brahmaputra, Gandak, Kosi , Ganga etc., which flow through *alluvium*. Few rivers such as Ravi, Jhelum, Ramganga, Chambal etc. show acidic characteristic for few months during the year.
- **Influence of Urbanization:-** As the channels with flow of water has to connect the rivers, there is a chance of loss of land, habitant, forest area and influence of urbanization during the course of connection, so the issues of Ecology, solid wastage, land area utilization, increase in habitation & population are to be taken care of .
- **Chemical contamination of water due to Industry:-**Contamination and toxicity due to Industrial wastage which can effect on the quality of ground water, effect on foundation & strength of soils. It has found , during flow of the water through some area, it can engross some of harmful chemicals like fluoride and other items. So, care should be taken and the water to be tested, if required it needs disinfection at the spot itself.
- **Chemical effect of Rocks** :-During the connection it may contact various types of rocks. As the rocks contain water physically and chemically, it can easily mix with water along with its other chemical properties like Sulphur, Florine, Chlorine, Bromine and Iodine etc. The types of rock their chemical composition can effect to the linking of water and the change in the chemical property of water⁹.

- **Afforestation along with the suitable ecological balances** :- Taking the water of Ganga above the Vindhya towards Cauvery, will cost a lot more and for this, large diesel pumps will be used, more than 4.5 lakhs people will be almost displaced, 79,292 forests will also be submerged in water. The afforestation along with the suitable ecological balances can be made in the adjacent area to the river interlinking. Suppose the width of channel is 150m another 150m width in the both side of the interlinking area is to be developed for ecological balances.
- **Alternative proposals for linking** :- If we are finding an alternative way to connect the rivers through tunnels for saving the surface ecology, then it may create some new geotechnical issues like settlement of tunnels etc. For this numerical modeling and construction simulations may also be required.

3.2 Geotechnical approaches in the execution works:

Execution of work is the most important activities just like planning. There will be lot of difficulties and issues in construction works. These can be listed as follows:

- **Geotechnical planning with investigation**:- There must be proper planning before execution of the works, it must be followed up by proper resilient design basing on the Sub soil data of each structure along with Geotechnical investigation, borrow area survey, construction material survey, testing of soil across the canal alignment and rock samples. Studies on the Seismic zones and its probable effect on the rivers. The behavior of all the parameters through the testing like Mechanical analysis, swelling pressure, Triaxial shear with pore pressure consideration, Standard proctor test and chemical analysis of soil are to be executed.
- **Study on Sedimentation**:- Influence of sediments are playing a major role in the life of flow pattern in the rivers. For this the study on the flow pattern, source and Control of sedimentation deposit in the river and management is to be made properly to find the conclusion on controlling it and combating it.
- **Influence of the Problematic soil** :-Workout on the clayey soils and slushy soils for canal construction and remedial measures like use and application of Cohesive non swelling layers for the same.
- **Flow of water through Seepage and permeable soil zone** :- Some times, it happens the surface flow water is being percolated through Porous soils and then stops surface flow and starts underground water flow, keeping the surface area dry. So, to control and to bring the river/river link/nala live, application of underground check dams / impervious soil barriers can be constructed to control the underground seepage/ flow of water.
- **Meandering of rivers** :- In a meandering river, the soil from the bank is continually eroded from the points where it is concave in shape and is deposited at points where the bank is convex in shape. Meandering of rivers can be controlled with the help of structures like levees and spurs. The work can be executed according to shape and the materials to be used. The shapes can be straight, 'L' shape and 'T' shape and the materials can be Brick, stone or con-

crete spurs. It depends on the design basing on the geometrical property like length, angle of the stream and the discharge in the stream.

- To work in the underwater construction works and to lower the ground water levels for these constructions, technologies like well point systems are to be provided.
- **Construction of Embankment, Dam** :-Embankment, Dam construction and flood protection works with local materials and application of geosynthetics. The dam design provisions are to be made to combat the Hydraulic and structural failures. This can be achieved through Seepage analysis, Stability analysis, Slope protection, Provisions of drainage system in earth dams,

Suitable earth from burrow area : During construction of earthen Dams it is important to have suitable earth in the vicinity of construction area. The types GC in Homogeneous section, SW,GW in pervious section & C in Impervious section are very fine. Similarly C.L, CI are suitable for Homogeneous section and GM is for Pervious section and CL, CI are suitable for Impervious section, whereas SP,SM, SH are suitable for Homogeneous section and SP, GP are for pervious section , whereas ML, MI, MH are for impervious section. But ML,MI, MH are poor for impervious casing and OL,NI and OPHT are not suitable for impervious section. Compaction test with respected to the Optimum Moisture Condition is to be conducted in the laboratory for the Compaction efficiency of the compacted earth at the field.

A soil which has less compressibility and liquid limit, is considered as the best material for core construction. The main function of Cutoff trench in the earth fill dam is to reduce the loss of stored water in the reservoir, from the seepage flow through the foundation and its abutment. Furthermore it also prevents the sub-surface erosion caused by piping action.

- **Erosion control strategy for the banks** :-Soil erosion protection / control with the application of reinforced soil embankment/guard walls/ Soil nailing works etc. Retaining walls (Gravity/ Semi gravity/ Cantilever/ Counterfort), piling with Geotextile fencing/vegetated geo-grid. The medi-clinical vegetation can be helpful in both the way for reducing the erosion and enhancement of water quality.
- The issues and challenges on Geotechnical factors are being summarized as under.

Sl. no.	Issues and challenges	Solutions
1	<i>Planning and design on the problems</i>	Can be executed as per site specific conditions
2	<i>Control of sedimentation deposit in the river</i>	Sedimentation control structures are to be constructed with regular maintenance provision.
3	<i>Workout on the clayey soils and sludgy soils</i>	Application of Cohesive non swelling layers for the same
4	<i>Porous soils and underground water flow</i>	Impervious soil barriers to control the underground seepage/ flow of water.

5	<i>Meandering of rivers and its control</i>	Structures like levees and spurs can help to control the meandering
6	<i>Underwater construction works and to lower the ground water levels</i>	Technologies like well point systems to lower the ground water table
7	<i>Embankment, Dam construction and flood protection works</i>	Selection of suitable type of soils and design provisions to be made to combat the Hydraulic and structural failures.
8	<i>Soil erosion protection / control</i>	Reinforced soil embankment/guard walls/ Soil nailing works/geotextile fencing/

4 Conclusion

Though River interlinking in India is much benefitted to the country, it has some bottlenecks in Environment and water quality during the inter basin transfer of water. New technologies, materials and methodology can be adopted for the benefit of the quality of water to be transferred. The afforestation along with the suitable ecological balances can be made in the adjacent area to the river interlinking. Suppose the width of channel is 150m another 150m width in the both side of the interlinking area is to be developed for ecological balances. The soil properties can be enhanced chemically by keeping the medicinal plants like Neem, Karanja or any other suitable tree and adding the minerals like Calcium, Magnesium and sodium. It can also be understood that without joining rivers, the problem of flood and drought can be solved but ILR can be more benefitted.

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