Interlinking of river basins in India - Alternative layout

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Abstract

Interlinking of river basins in India, has been discussed over the years but could not be given a proper shape due to lack of financial resources, or lack of will for implementation. Basically three important alternative proposals were considered- the Dastur's Plan, Dr. K.L.Rao's Plan for linking of Ganga and Cauvery and a proposal of NWDA, for linking various river systems for irrigation. This paper, while dwelling upon these alternatives briefly, discusses the pros and cons with respect to topography, hydrology and geotechnical aspects. Transfer of very large amount of water from Ganga and Brahmputra by having major link canals would require consumption of Hydroelectric power for stage pumping from El. 250m to 500m.

Through this paper, the author proposes a Mega Project, having major link canals from Ghaghra to Ganga, Ganga to Chambal, Brahmputra to Cauvery, and a Garland canal linking various parts of U.P., Bihar, West Bengal, Orissa, for irrigating central and southern parts of India. He also indicates possibilities of creating number of dams and reservoirs enroute so that additional storage capacity and hydroelectric potential could be generated from within the system, through a number of powerhouses located south of the Vindhyans, in order to compensate loss of stage uplifting of water at Rana-Pratap sagar and Gandhisagar Dams on river Chambal. An additional link from Ootacmund to Raichur is also proposed to augment supply to southern link canal from Pandurna to Dundigal.

Introduction

Interlinking of river basins in India, has remained an unresolved issue over decades either due to lack of financial resources or lack of will for implementation; this issue has been debated upon in various fora and a number of approaches and schemes have been formulated from time to time.

After its initial conception as visualized by Sir, Arthur Cotton of the then British Rajya in India, primarily as a navigation scheme, the project was reconsidered in mid seventies, under the National Water policy –NWG, by learned Dr. K.L.Rao, the then Chairman, CWPC (Rao, 1975) wherein the idea limited to linking of Brahmputra and the Ganga with Cauvery, was mooted to provide irrigable water to the water deficient regions of Southern India. Earlier to this, a scheme was put forwarded by captain M.N. Dastur, an airlines pilot that mainly comprised:

(a) 4200 Km long 300m wide Himalayan Canal at el. between 457 m and 335m above MSL, aligned along the southern slope of Himalayas running from Ravi in the west and Brahmputra and beyond in the east, with pondage created in the form of some 90 lakes.

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(b) The southern and central region was covered by a garland canal which was 9300 km in length 300m wide. These two canal systems were suggested to be connected at two points one near Delhi the other near Patna.

Implementation of this Mega Project, ever-since, had remained in the mindset of our National Water Development Agency under whose direction the proposal of interlinking of river basins is contemplated in India. Various alternative schemes are under consideration of the NWDA, who is working with other nodal agencies like the Geological Survey of India, etc. in carrying out different stages of feasibility studies. (Srivastava et. al.,2002).

Under the National Perspective Policy two main components viz. a) the Himalayan Component with 19 links and b) a Peninsular Component with 17 links were defined. The NWDA in 1991-92 made headway when it identified besides the above links, 49 diversion points and 55 storage reservoirs after topographical studies. The details of the link schemes are as under:

a. Himalayan Development Component

1. Brahmputra-Ganga Link (Manas-Sankosh-Tista-Ganga) Link.
2. Kosi – Ghagra Link.
3. Gandak –Ghagra Link.
4. Ghagra – Yamuna Link.
5. Sarda –Yamuna Link.
6. Yamuna Rajasthan Link.
7. Chunar –Sone Barrage Link.
8. Son Dam-Southern tributaries of Ganga link.
9. Ganga –Damodar –Subernarehka Link.
10. Subernrekha –Mahanadi Link.
11. Kosi-Machi Link.
12. Farakka. Bramputra – Ganga Link (Jogigopa –Tista –Farakka Link)

b. Peninsular River Development Component

1. Mahanadi (Manibhadra)-Godavari (Dowlaiswaram) Link.
2. Godavari (Inchumpalli Low Dam)-Krishna (Nagarjunasagar Tail Pond) Link.
3. Godavari (Polavaram) – Krishna (Vijaywada) Link.
4. Krishna (Almatti) –Pennar Link.
5. Krishna (Srisailam) – Pennar Link.
6. Krishna (Nagarjunasagar) –Pennar (Somasila) Link.
7. Pennar (Somasila) –Cauvery (Grand anicut) Link.
8. Cauvery-(Kattalai)-Vagai-Gundar-Link.
9. Ken –Betwa Link.
10. Parbati-Kalsindhi –Chambal Link.
11. Par-Tapi-Narmada Link.
12. Damanganga –Pinjal Link.
13. Bedthi-Vardha Link.
14. Netravati –Hemavati Link.
15. Pamba -Achankovil

Approach and Objective

In the initial proposal the desired scheme was planned mainly for navigation but subsequently under the Nation Water Policy, the main approach was diverted to provide surplus water to deficient areas. Transferring of about 1680 cumecs of this vital resource would require uplifting by pumping to the order of 50-550m in height, and would require a huge amount of energy intake. The country's power resources are already very less and the requirement will increase manifold in the years to come. As such the power required for this project shall have to be drawn from within the system. It would also be very important to harness the hydro potential thus generated within the system is to be distributed as a regulated supply for irrigation besides power generation throughout the year. Hence, the Mega Project shall have to be a multipurpose scheme, for navigation, to provide irrigation in water scarcity areas, power generation, flood control in surplus areas and also supply water for domestic & industrial needs. In order to fulfil the above

objective our goal should therefore be:

- Diversion of surplus discharge of Indo-Gangetic-Brahmputra basins into river basins of Maharastra, Gujarat, Andhra Karnataka and other states south of the Vindhyans.
- Examine status of existing projects
- Review status of projects under construction
- Inter relationship with other projects, highways, railways, etc.
- Future planning: Review capacity, power generation, yield/ fetch and discharges, their distributaries systems, command areas of existing Irrigation and Power Projects and plan them as part of the Mega scheme, with up-gradation and modifications.
- Review possibilities of interlinking routes, reservoirs, diversion points and power generation points, etc.
- Plan phasing out of the Mega Project into executable smaller units.

All the above alternative proposals have their own benefits and limitations. It should be our effort to foresee that an optimised blueprint of this Mega Project is finalised after deliberations and thorough studies, taking all the pros and cons in the wider perspective, before taking up the components schemes, for feasibility studies and execution, individually.

Construction of a *Himalayan Canal* as suggested by M.N. Dastur, would have been a possibility in the pre-independence period. Diversion of Brahmputra linked with Manas, Tista, Sankosh, and Gandak to the western section (i.e. west of Delhi), may be a difficult proposition due to our territorial boundaries with Bhutan, Bangladesh, and Nepal. Further, with a Diversion Structure somewhere near Dibrugarh (el.150m) on the right bank of Brahmputra, a canal via Dhekachuli, Jalpaiguri and Kishanganj etc., may be viable at El. 100m ± only, and unduly extending it upto either Patna or Kanpur (El.138m) would not be economical.

Geologically, the canal route from Dibrugarh to Munger lies in the Quaternary sediments mainly comprising assorted coarse sands, fine sands and silt occurring as high level terrace deposits of the Brahmputra and Ganga Plains. As one comes down towards the west the grain size reduces. In the Bihar Plains the ground water levels are shallow, as such, problems of slope failures in the soft unconsolidated deposits and marshy ground conditions would be encountered during excavation of the canal.

Moreover, a Right Bank Canal linking Ganga –Son, etc, off-taking from Kanpur or Patna at an elevation of 100 m± would considerably reduce the hydrological regime of the Indo-Gangetic system as the Ganga and its tributaries would have already been diverted to the western sector. Instead, it would be prudent to restrict the diversion of Brahmputra for basinal transfer to Southern Sector at Munger, and cross it over Ganga, by constructing an aqueduct over Ganga (as discussed in suggested scheme, Fig.1). The layout would be more or less similar to that proposed by NWDA, except that no water from Ganga would be added to the lower canal system. A suitable bed gradient need to be given to this East Coast Canal with enroute augmentations from Mahanadi, Godavari, Krishna, Cauvery and other rivers.

Geologically, the southern banks of Ganga form terraces with assorted riverine sediments and residual soils derived from the rock of Bundelkhand Granite, the Vindhyans, Gondwana and other Groups and the pediplains of Mahanadi, Godavari deltas, Krishna delta, etc.

In the Western Sector, the diversion of surplus waters of Ghagra, Sarda, and Ramganga rivers through a common canal, could be diverted to Bhimgoda Headworks (existing) on Ganga and then transfer it to the Main Western Yamuna Canal and the *Main Link Canal systems* for transfer of Ganga to Chambal, that could be planned

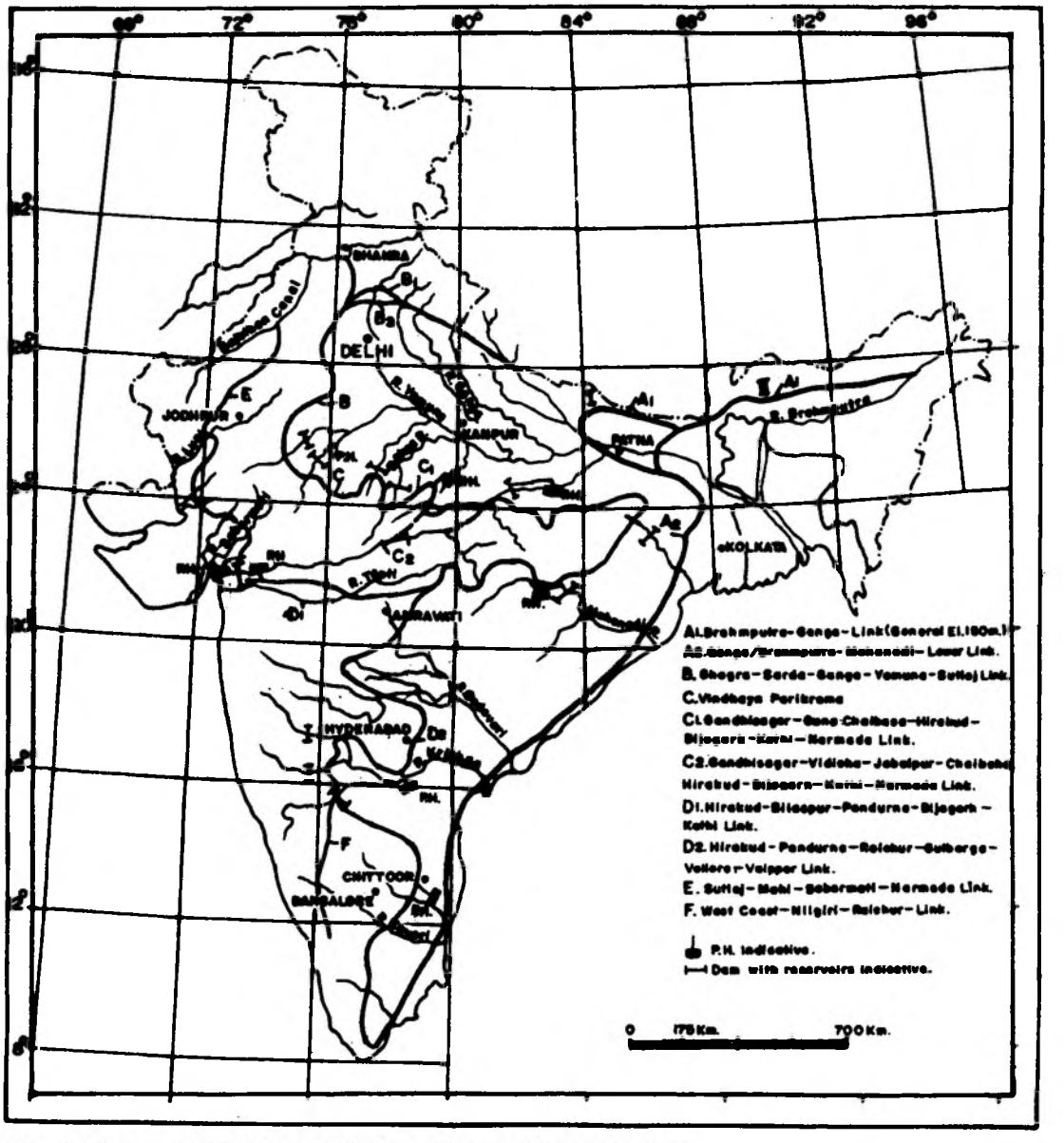

Fig. 4: Suggested Layout of Various Links of Mega Project.

as described in suggested Scheme at item B (Fig.1c). This diversion canal linked with the Narwara Branch canal of Bhakra Main Canal could be possible at an elevation of about El. ±250m. The *Main Link Canal* extending upto Bagwantnagar would transfer the water to Kota Dam reservoir on Chambal; thereafter, water has to be pumped upto Gandhi Sagar Dam from elevations 250m to 306m and from 306m to 507m in two stages, after suitable remodelling of additional capacity at Gandhisagar, if finally found feasible.

The Western Ganga Main Link Canal lies in the interfluves of Rivers Yamuna and Sutlej, and primarily runs along the higher level terraces of the Indo-Gangetic Plains following the Aravallis, and the Chambal

ravines, partly through the desert area of Kishangarh, adjoining of Badharpur and Rajgarh in Rajasthan.

After stage-lifting from Ganga Main Link Canal upto Gandhisagar, the water could be routed into the Main Garland Canal System from Bhiwani Mandi into a number of reservoirs and interlinking canals (as per suggested Scheme Alternative C, C1 –C2 (Fig 1), that are briefly outlined in the relevant chapter, described below) shall run along the rock formations belonging to Vindhyans, Gondwanas, the Deccan Traps and Peninsular Gneisses etc. The Garland Canal will either fall in Narmada at Kathi where a powerhouse could be contemplated (Canal Route E1, Fig.-1).

Alternatively, the Garland Canal called the Vindhyan Parikrama, could be extended from Pandurna-Amravati, Akola with reservoirs on rivers Penganga/Wainganga, via Nanded (Purna), Gulbarga, Pandharpur, Raichur, (Tungabhadra) down to Seshachalam Hills, Kadiri, and Palkonda – with a P.H. at Kalchasti near Vellore. This link Canal via Mettur Dam, Mettupalaiyam and Dindigul could be finally discharged into Varshalai river with routing to drop into the Brahmputra – Mahanadi Lower Canal System (Canal Route E2, Fig.1). This alternative System would cover a major part of Central and Southern India that could also be used as a navigational canal besides providing irrigation to the water deficient parts of Maharastra, Andhra Pradesh, Karnataka and Tamil Nadu.

Sutlej –Mahi Link Canal is suggested to have its initiation at the Hirake Barrage as part of the Rajasthan (Indira Canal?) that will start from near Jellanabad and would run through Rajasthan via Pokharan, Phalsund, Panchpadra (Luni), Bagota, Dhanera, Deera Palanpur plains of Banas (El. 150m), Saraswati, Mahesana, Rakhail (Mahi), and shall run as Mahi R.B. Canal, to drop in reservoir at Headwork of Sabarmati and may be extended to join Narmada High level Canal. It could finally fall in Narmada at Rajpipla (resevoir at Kathi) via Heran Dam (Canal Route D1, Fig.1).

The Western Ghat has over 2000 m.m. annual rainfall, but the Ghats offers a very rugged topography with very steep slopes drained by a number of rivers like Kalinadi, Bedthi, Varahi, Mahadai, Netravati, Hemavati, etc. that straight away debouch into the Arabian Sea. There are a number of creeks in the Ghat section that offer very good communication links for inland movement from the sea. Regular Steamer service for passengers and transportation of mine ores is in operation since long. All three systems – viz. road, railway and waterway already exist. Moreover, a number of river valley projects are also in various stages of development for utilising the full capacity of the rivers flowing in to the Arabian Sea. As such, a canal system on the western slopes of the Ghat would be uneconomical and unfeasible viewing the constraints.

Geologically, these slopes are also very steep and rugged and topographically do not favour construction of a 100 m wide canal system. These slopes are prone to landslides as well. On the other hand the eastern slope of the Western Ghats have relatively gentler slopes that could offer better conditions for developing a canal system. The ground elevations are higher on the southern side, starting at El. 2670m from Ootuckmond, the slopes fall gradually towards north and east, covering parts of Mysore, Bangalore, Chitradurga, Shimoga and Dharwar at el. around 700 m. A high level canal interconnecting major rivers such as Tungabhadra, Krishna, Koyna, etc. through the existing reservoir and canal network, without disturbing the downstream regime and functions of already existing projects, therefore, could be planned to divert the surplus discharge of the southern rivers toward north and connected to **a canal system,** so that un-irrigated areas of Maharastra, Andhra, Karnataka and Tamil

Nadu could be benefited (suggested Nilgiri – Raichur link – (Canal Route F, Fig.1).

Feasibility studies

For carrying out the feasibility of the "Interlinking of River Basins", the following parameters have to be considered:

Hydrological and engineering considerations

Hydrology plays a vital role in the design of River Valley Projects. The monsoon flood and lean season discharge of all major rivers shall have to be assessed and quantified for sustainable routing into the Main Canal System throughout the year. Storage capacity of the various reservoirs and the canal need to be planned for accommodating the available water. Engineering prefeasibility of all major civil structures, viz. dams, reservoirs, Power Houses, stoplog gates, siphons, aqueducts, etc. should be taken up for the entire scheme as a whole.

Geotechnical Considerations

A preliminary Geotechnical assessment of all the major civil structures with regards to foundation conditions, reservoir competency supplemented with aerial photo-interpretation, tunnelling and excavation, quality of ground material and availability of construction material, geo-mechanical studies, should be simultaneously carried out.

Slope stability, Neotectonic and seismic studies

Geo-stability of Dam abutments, slopes of canals, powerhouses and other appurtenant structures should be assessed critically.

Geo-hydrological Considerations; Availability of ground water, level of ground water

Groundwater contour maps may be prepared and groundwater conditions along the entire canal route should be studied so as to record water-logged areas and design the canal lining accordingly.

Environment, forest, fisheries, health

Status of existing environmental setup related to Forest cover, landuse, fauna and flora, impact on reserved sanctuaries, etc. should be assessed, and measures to tackle the situation in the changed scenario should be planned well in advance. Study of any related health hazard should be undertaken.

Detailed surveying, geological mapping and exploration

These studies should follow immediately after preliminary assessment of the Mega Project, so that the layout can be transferred on the ground.

Economic, administrative surveys, rehabilitation and others.

Economic Surveys to assess the costing of the project, assessment of land required to be acquired for the project components and land for rehabilitation, cost of a forestation, reclamation, compensation, etc. should also be made.

It may further be added that the National Water Development Agency should be strengthened on the lines of National Highway Authority of India, to generate its own funds and resources for the implementation of the Mega Project.

It is needless to say that different experts in their respective fields carry out the above studies. However, their interdependency cannot be flouted, as over looking one field of study could alarmingly influence the safety and overall cost of the project and can disrupt the eco-system, scheduling and execution of the project in the long run. There are of course certain ground truths that the planners shall have to bear with and these are the inherent constraints. Some of the technical constraints that need to be considered are:

Constraints

- Diversion of Brahmputra into the main system at elevations above ±150 m not possible due to territorial boundaries with Bhutan, Bangla Desh and Nepal.
- Diversion either at Monghyr or Patna likely into Ganga for lower system may influence settlements on the banks of major rivers
- Maximum Ground elevation for northern river system in the western sector is constraint at elevation 250m (approx) for main canal upto Chambal along Arvallies, west of Delhi.
- Transfer of Ganga water into the lower canal system to Mahanadi, Godavari , Krishna, Cauvery, etc. would also require uplifting by pumping, instead simply transferring of Brahmputra across the Ganga by an aqueduct may be an economical proposition and this would not greatly effect the regime of the Ganga in areas in the downstream.
- Steep slopes along the Western Ghats experience heavy rainfall.
- A good network of road and railway route already exists, besides there are already a number of hydroelectric projects under operation and in progress.
- The Ghat is thickly forested and does not require additional irrigation facilities.
- The steep slopes do not offer suitable ground conditions for construction of wide canals (at El. 500m) as these are prone to landslide problems.

Proposed Scheme

In view of the above constraints and many other related unforeseen conditions, a proposal, based of studies made by the author after consultation of maps and literature (Anon. 1971, 2000) that could optimize the implementation and feasibility with certain modifications are proposed as follows:

A1. Brahmputra - Ganga – Link (General El. 150 m)

In this part of the proposal the main Brahmputra-Ganga Link Canal takes off on the right bank of Brahmputra at Dibrugarh. A diversion structure is suggested for the canal. The proposed canal shall run from Dibrugarh via Dhekajuli, Tamalpur, Longa, Alipur-Daur and Siliguri, etc. to joinn Ganga near Munger/ Jamalpur. The canal will collect water from Subansiri, Kameng, Manas, Jaldhaka, Tista. Mahananda and Kosi (Bihar) at suitable points

A2.Ganga/Brahmputra- Mahanadi – Lower Link (General El. 100m)

Alternatively an aqueduct over Ganga for crossing the Brahmputra Main Canal at Monger could be designed and layout the Main canal along the right bank of Ganga and take it via, Dumka, Asansol, Bankura, Dhalbhum, enroute augmenting its supply from Subernrekha, Mahanadi, Godavari through Baripada, Palasuni, Talcher Daspalla, Ganjam, Udaigiri, Vizainagram, Narsipatnam, Nagavaram, Visanapeta, Guntur, Viunkonda, Darsi, Podili, Udayagiri in A.P. It shall continue to Pallempet, Chandragiri, Vellore, joining Cheyyar, following a route from Gingee, Villupuram, (Ponnaaiyar) Chinna Salem, Perambelur, (Cauvery) Tirichchirapalli, Pudukkottai, Madurai, (Vaigai) Virudhanagar, to finally meet river Vayappar, for irrigation and serve as inland water communication route.

B.Ghaghra-Sarda-Ganga–Yamuna–Sutlej Link

Alternative B1: In the western sector, the diversion of the Main Ganga – Chambai link Canal augmented with supply of rivers; Kauriala, Ghaghra, Ramganga and Sarda interconnecting existing reservoirs on these rivers at suitable locations through a canal

link via Ghaghra Barrage, creating a Reservoir on Sarda), going over to Bilauri, Deoha (Raise Dam Height) Kichha, Haripura, Baur, and Kalluwala, (Umaria Dam), Ramganga Dam, , Khoh Dam, to Kotdwar, and finally transferring their water into Ganga at Bhimgoda Headwork, (Ganga) near Haridwar.The Ganga Main Link canal shall run as Upper Ganga Canal via Jhinjhana , Panipat (Create Barrage) Karnal, Rohtak (as W.Y Canal), then as Sutlej-Yamuna Canal, it could be routed from Kalanaur, Beri Khas, Farukhnagar, Pataudi Kishangarh, Bahadurpur, Rajgarh joining river Banganga (after creating a reservoir), Toda Bhim, Karauli, Morel Tank, Dhil Tank (Banas), Bagwant nagar (Create a High Dam on Banas), Galwa, Bundika Godhra, to finally drop into the Kota Dam (Ranapratap Sagar) (el.306m),from where the canal water shall have to be pumped to Gandhisagar Dam (Chambal Stage –II, el. 507m Reversible Pumped Storage) constructed across river Chambal .The off-take of Main Garland Canal –I may be located at Bhiwanimandi.

Alternative B2: In the second alternative to proposal **B1,** rest of the system remaining same, it is suggested to construct a barrage on Ganga near Bijnor and off-take the Main Link canal via Jalalabad, Jhinjhana (As Upper Ganga Canal), Panipat (Create Barrage) Karnal, Rohtak (as W.Y Canal), then as Sutlej-Yamuna Canal, Kalanaur, via Beri Khas, Farukhnagar, Pataudi Kishangarh, Bahadurpur, Rajgarh (Banganga), Toda Bhim, Karauli, Morel Tank, Dhil Tank to drop into a reservoir formed near Bagwant nagar (Create a High Dam on Banas, Galwa , Bundika Godhra, to Kota Dam (Ranapratap Sagar at El.306m), Gandhisagar Dam (Chambal Stage –II, El. 507m, with a Reversible Pumped Storage on Chambal. The off-take of Main Garland Canal –I may start at Bhiwanimandi,

C. Vindhayn Parikrama

Main Garland Canal –I : The main Garland Canal suggested at a general ground El. 500 m MSL can be planned under two alternative schemes (Anon. 1971, 2002). One of the proposal under C1 starting from Gandhisagar reservoir shall follow a route from Jhalawar crossing river Ahu to Sunel Choti joining Kalisindh with Manpura dam reservoir, via Guna will cross over into Damodar valley with creation of intermittent reservoirs on Barakar, and Damodar taking cognizance of the already existing DVC project shall further cross over into Mahanadi basin via N. Puralia, Chaibasa, Lodhani, Deogarh, etc. to fall into Hirakud Resevoir on Mahanadi river, whereafter it can follow a route from north of Bilaspur via Ratanpur, Rajnandagaon, Katangi, Achalpur via Burhanpur and Bijagarh to Kathi, where a fall of about 300m could be utilized to generate power before falling into a reservoir formed with a dam at Kathi on river Narmada. The waters of Tapti could be transferred into the Narmada through a tunnel or a high level canal (Proposal C1, Fig 1.).

Within this setup it is also suggested to benefit the southern parts of Akhajhiri, Lalitpur, SW–Chhattarpur, Panna, Devendranagar, Rewa etc in Uttar Pradesh and Madhya Pradesh, by utilizing additional pondages across rivers Betwa (-U/S of Main Dam at Lalitpur), Dhasan (create reservoir across Dhasan), Ken (create reservoir), and river Son near Sidhi, by constructing a high dam across Son. Likewise the minor canal could extended to Gopad, *Rihand* (Rihand Dam), via Sukhra Tank (Kanhar), to fall into reservoir of N.Koel after creating a High Dam on North Koel, through Daltonganj before it joins the Main Canal after crossing into Damodar Valley. Additional intermittent reservoirs on Barakar, and Damodar have been also taking cognizance of the already existing DVC project. Further this canal will cross over into Mahanadi basin via N. Purulia, Chaibasa, and Lodhani, Deogarh

etc. to fall into Hirakud Resevoir, whereafter it can follow a route from north of Bilaspur as per proposal – C2, (Fig 1).

Alternatively the Garland Canal as per the above suggestion may follow a route from Katanga onwards through Pandurna-Amravati, Akola joining Penganga, Purna Sodawari with reservoirs built for augmenting pondage near Hingoli, Nanded, Parbhani, Paithon (resevoir?), and then led to Gangakher Deglur, Medak, North of Hyderabad. Further south the canal course could be diverted via Tandur, Gulbarga, Akalkote, Barsi, Pandharpur, Sindgi, and Lingsugur, to Raichur .A resevoir at Sandur could be used to include water from Tungabhadra near Sandur. The Garland canal after giving a suitable bed fall if designed along the central part of Andhra and Karnataka states via Anantpur, Pulivendia, Seshachalam Hills, Kadiri, could irrigate a vast dry lands before leading to Palkonda to take advantage of high fall to generate hydro-power at a P.H. at Kalchasti. The canal may be extended further south taking unutilized waters to Vellore, Jolarpettai, Mettur Dam, Andiyur, Mettupalaiyam Dindigul before it is finally discharged into Varshalai for tail routing into the Lower Brahmputra- Mahanadi Canal System at el. 100m ± (Canal Route D2).

Main Garland Canal –II : The Main Garland Canal proposed at a general ground el. 500m can be alternatively planned as proposal under C2, starting from Gandhisagar Reservoir after crossing Kalisindh river. The canal can be routed via Manohar Thana Barsad, Sironj, Sindhana, (Betwa) Vidisha, Bareli, so as to cross into Narmada on Right Bank. It is suggested to construct a high dam at Sobhapur on Narmada river, with an Off-take on Right Bank to proceed from Narsimhapur, Jabalpur, Singwara, Shahdol, Janakpur, Muri (Rehar, Dudhi Dam), Mankheri, Ramgarh, Sonuhata, Chaibasa Torlow, Lodhani, Deogarh. This Garland canal thereafter cross into Mahanadi basin, and joins the main reservoir at Hirakud Dam. Beyond Hirakud reservoir the canal may follow the path of alternative C1 as discussed above.

The Garland canal beyond Hirakud could then be routed under two diversion alternatives as given below:

Alternative D1: The canal is proposed further from Ratanpur, Kawardha, Rajnandgaon, Seoni, Katangi, Deogarh to Kathi via Achalpur, Burhanpur, Asirgarh, Bijagarh, and Pansemal. It is also proposed to generate power, by having a PH and a storage dam at Kathi (el.150m to 200m) on L.B. of Narmada (Anon. 1971, 2000).

Alternative D2: A second alternative starts from Ratanpur, Kawardha, Rajnandgaon, Seoni, Katangi, Pandurna-Amravati, Akola (Penganga) Hingoli, Nanded (Purna), Jintur, Parbhani, Paithon Sodawari, Gangakher Deglur, Medak, North of Hyderabad, Tandur, Gulbarga, Akalkote, Barsi, Pandharpur, Sindgi, Lingsugur, Raichur, (Tungabhadra) Sandur, Anantpur, Pulivendia, Seshachalam Hills, Kadiri, Palkonda – P.H. at Kalchasti, Vellore, Jolarpettai, Mettur Dam, Adieu, Mettupalaiyam Dindigul so as to discharge into Varshalai.

E. Sutlej –Mahi –Sabarmati- Narmada Link

Starting as part of the existing Indira Canal, Rajasthan at Hirke Barrage on Sutlej (el. 210m), the main link canal takes off from the Rajasthan canal, near Manakasar, and runs via Pokharan, Phalsund, to Panchpadra, where it crosses river Luni. It is laid-out through Bagota, Dhanera, Deera to Palanpur plains of Banas (el. 150m), where it meets Saraswati river. Thereafter it runs to Mahesana, Rakhail (Mahi), and joins Mahi R.B. Canal, and again led to drop into a reservoir at Headworks of Sabarmati. Beyond this point, it extend and join Narmada High Level Canal, Heran Dam, Narmada at Rajpipla (Narmada Sagar) and Karjan where a High Dam is recommended to be constructed and it also interconnects'

Tapi and Narmada reservoir by a tunnel and a dam at Kathi (Fig.1).

F. West Coast–Nilgiri- Raichur- Link

This proposed high level canal on the eastern side of the western Ghats starts near Ootacmund from elevation 2637m (Anon. 1971) and gradually falls down to el. 500m towards the north of the peninsula. There are a number of major rivers that flow eastward like, Cauvery, Krishna, Tungabhadra, Malaprabha and Vedavati etc. On which a number of major dams are present. It is quite likely that during monsoon enough run-off would be available even after all these reservoirs are filled up to leave excess water that could be released to the Central India and northern part of the Peninsula.

Keeping this factor in mind a high level canal is proposed from Moyar river and runs via Hassan, Chikmagalur, Arsekere to join Vanivilas Sagar constructed on Vedavati river From Vanivilas Sagar it again follows a route via Tungabhadra dam at Hospet, Kushtagi to join Krishna in the Narayanpur reservoir and is aligned on the right bank of Krishna to finally join the Pandurna Medak, north of Hyderabad, Tandur, Gulbarga branch canal (D2) near Raichur (Fig-1).

Conclusions

After studying the various proposals as described above it is observed that:

1. Inter –Basinal transfer of Brahmputra to Ganga would be restricted to ground El. 100m to 150m, since International boundaries with Bhutan, Nepal and Bangladesh may become major constraints in timely execution of the scheme.
2. Tranfer of Brahmputra to Ganga may be possible either at Munger or Patna but this would submerge habitations on the banks of Ganga.
3. Tranfer of Ganga water to the southern section would mean complete drying out of the river in its downsteam regime.
4. Alternatively, a cross-over of Brahmputra- Mahanadi Link Canal by having an aqueduct over Ganga would be better a preposition.
5. Interbasinal Transfer in the western section i.e. Ghagra-Sarda- Ramganga-Ganga-Yamuna and Sutlej (Joining Narwara branch of Bhakra Main Canal) to Chambal at Kota Barrage via Rohtak, Kishangarh, etc. and having a pumped canal for uplifting of water from the Main Ganga Link Canal into the Gandhisagar upto el. 500 m (+/-) may be considered. The elevation of the Main Ganga Link Canal shall be restricted to el. 250 m to the west of Delhi. This means an uplift of about 250 m by pumping to reach the Gandhisagar reservoir level. This would require huge amount of power for uplifting.
6. The loss of this power should not only be compensated elsewhere within the system but efforts to generate additional power south of the Vindhyans should be planned as the water thus released could be transferred to the desired purpose.
7. A Garland canal linking various parts of southern U.P., Bihar, West Bengal, Orissa, M.P. Maharastra etc as per different alternatives discussed above may also be considered so that the best possible proposal could be adopted. An additional Link from Ootacmund to Raichur is also proposed to augment supply of the southern link canal from Pandurna to Dundigal.
8. Creation of additional reservoirs, power stations, and possibilities of irrigation of the central and southern sectors may be provided besides some amount of navigational facilities could also be looked into.

9. The Northern states that would be providing the excess water should be compensated from the beneficiary states.

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