RESOLVING WATER CRISIS BY INTERLINKING RIVERS AND CLOUD SEEDING

The basic foundation of Indian economy is agriculture on which more than two thirds of the population depend for their livelihood and two-thirds of the labour force are employed in it. Although there was a drought in 1987 , there was food production of 135 million tonnes (M.T.) of which 50 M.T. was due to irrigation under the major reservoirs completed in the post independent era. Although the country was importing food grains till the mid 1960s food security was achieved later due to introduction of high yielding seed varieties for wheat, rice and other cereals and application of fertilisers and crop protection technologies.

Food grain production increased four-fold from 50 M.T. in 1950-51 to about 200 M.T. today, leading to augmentation of per capita availability of food grains from 400 to about 500 grams and during the period while the land under agriculture rose from 50 million hectares (M.ha) to about 128 million hectares. With the same acreage under wheat as in USA, India emerged as the second largest after China with 72 M.T. In 1995 World Watch Institute warned that population rich but land-hundry countries like China and India will have to resort to substantial food impor in another 30 years mainly due to fast decreasing per capita availability of arable land and irrigation water. China, USA and India are producing nearly 400, 320, an 200 million tons of food grains by utilising about 90, 190 and 188 million hectares of land. It clearly shows that Indian agriculture has great scope for development and for this purpose irrigation facilities must be created on large scale and new varieties of high yielding crops must be developed by utilising the advances in Biotechnology.

Our population has already touched 1000 billions and it is going to touch 1350 billions by 2025 AD and 1650 billions by 2050 AD. In order to feed this exploding population we have to increase the food production to 325 million tonnes by 2025 AD and 450 million tonnes by 2050 AD. In particular the production of rice must b increased from the present annual production of 85 million tonnes to 135 million tonnes by 2025 AD and 200 million tonnes by 2050 AD.
http://www.geocities.com/jvmnaidu/cloudseeding.html

The water use for different purposes upto 2050 AD are estimated as follows.(Tabl –1)
The present utilisable surface and ground water is estimated at 1122 billion cu.m. and consequently there is bound to be a water deficit of 126 billion cu.m. by 2025 AD and 534 billion cu.m. by 2050 AD River water storages must be increased to overcome the difficulties caused by frequent failures of monsoons and also to mee the ever growing demands of summer seasons. The present live storages of about 174 billion cu.m. constitute about 10%. Of the total water potential available in th country. Even if a low estimate of future water requirements of 1300 billion cu.m. is to be met, a storage of 600 billion cu.m. is required. (See Table 2 and 3). In order to maintain minimum summer flows to dilute the impact of treated waste

water discharges from municipalities and industries, additional storage is needed. Further 50 billion cu.m. is needed to maintain ecological balances in water courses In addition to the above mentioned live storage the projects under construction and those under consideration envisage additional storages of 75 billion cu.m. and 130 billion cu.m. respectively. Thus there is an urgent need to conserve river waters by transferring the surplus flows from rivers like Ganges, Mahanadi and Godavari to water deficit rivers like Krishna, Pennar and Cauvery.Environmentalist predict that unless more land is brought under agriculture and more reservoirs are constructed across the rivers to store water that is wasted into the sea there will be water famine and food famine in India in general and the Southern states in particular. (See Table 4)
http://www.geocities.com/jvmnaidu/cloudseeding.html

GANGA-CAUVERY WATER LINK:
http://www.indianest.com/voices/v002.htm
http://www.tribuneindia.com/2003/20030313/science.htm#1
http://www.ficci.com/ficci/march5-rivers-goswami.htm
http://rrtd.nic.in/LINKING%20RIVERS.htm
According to the Indian Water Resources Society “A note on the National Water Grdi prepared byu the then Central Water Commission with 3 possible alignments for Ganga-Cauvery links along with other links were brought out. Further studies were made by Dr.K.L.Rao who advocated one of the alignemtns fo Ganga-Cauvery Link along with a few sother links including the Brahmaputra and Ganga Link. The 2640 km long Ganga-Cauvery link essentially envisaged the withdrawal of 1680 cumecs (60,000 cusescs) of the flood flows of the Gangha near Patna for about 150 days in a year and pumping about 1400 cumecs (50,000cusecs) of this water over a head of 5409 meters(1800ft) for transfer to the Peninsular region and utilising the remaining 280 cumecs (10,000 cusecs) in the Ganga basin itself. The proposal envisaged utilisation of 2.59 million hectare meters of Ganga waters to bring under irrigation and additional area of 4 M.Ha. Dr.Rao had also proposed a few additional links like (a) Brahmaputra-Ganga link t transfer 1800 to 3000 cumecs with a lift of 12 to 15m (b) Link transfering 300 cumecs of Mahanadi waters southwards (c) Canal from Narmada to Gujarat and Western Rajasthan with a lift of 275 m and (d) links from rivers of the Western ghats towards East. Dr.Rao had estimated his proposals to cost about Rs.12,500 crores. Very roughly at 1995 prices the Ganga Cauvery link alone would amount t about Rs.70,000 crores (capital cost). The annual costs including cost of power dould be around Rs.30,000 per ha. As further seen, the present NWDA proposals for inter linking river between Ganga and Cauvery at present prices would cost on around Rs.15,000 per ha. Annually. The proposals were examined by the Central Water Commission and found to be groslly under-estimated. It was also observed that the scheme would requisre large blocks of power (5 to 7 million kw) for lifting water. It will also have no flood control benefits. Therefore, the proposal was not pursued as such.

N.W.D.A.PROPOSAL: National Water Development Agency Proposes
1. To provide terminal storages on Mahanadi and Godvari to transfer a surplus water by gravity and lift to the drought-prone areas of Andhra Pradesh, Tamil Nad and other states.
2. To plan for diversion of water from the West flowing rivers of Kerala and the East flowing rivers of Tamil Nadu.
3. To plan for construction of small storage dams and to inter link the rivers flowir on the west coast for transferring water to the East of the Western ghats through small tunnels or mountain passes and thereby augment the water yield in the rivers of the Southern states.

Surplus in Mahanadi is 22000 Mm3 (770 TMC) and Godavari is 28000 Mm3 (1000 TMC) against the present assessment of 11500Mm3(400 TMC) and 15000 Mm3 (530 TMC) respectively.
I. From Manibhadra dam on Mahanadi 8000 Mm3 equivalent to 280 TMC is proposed to be transferred through Mahanadi-Godavari link to deliver 6500 Mm3 (230TMC) into Godavari at Rajahmundry.
II. GODAVARI TO KRISHNA: Surplus in Godavari is calculated at 21500 Mm3 (15000+6500) (760 TMC) and this is proposed for transfer into Krishna through 3 links.
(a)1200 Mm3 (42 TMC) will be diverted through Polavaram-Vijayawada link to supplement needs of the delta.
(b) 4370 Mm3 (154 TMC) is proposed to be transferred through Inchampalli-Pulichintala link totake over part of the command under Nagarjuna Sagar left and right bank canals as exchange.
(c) 14000 Mm3 (500 TMC) of water is proposed to be discharge into Nagarjuna Sagar reservoir after considering needs of enroute irrigation and transmission losses. The electrical power requirements for lifting the water to Pulichintala and Nagarjuna Sagar will be about 110 MW and 1650 MW respectively.
III. KRISHNA TO PENNAR: Out of 14000 Mm3 discharged into Nagarjuna Sagar 12000 Mm3 (420 TMC) is proposed for diversion through Nagarjuna Sagar-Somasila link and the balance is utilized under part command of sagar left canal in exchange. After considering enroute irrigation under Sagar right canal in exchange and irrigation under other canals about 9800 Mm3 (346 TMC) reaches Somasila. Since this link provides water on exchange basis to Sagar canals an equivalent quantity of water may be diverted from Srisailam and Alamatti to other needy areas. 2300 Mm3 (80 TMC) is proposed to be diverted from Srisailam through Srisailam-Prodduturlink to reach the barrage at Proddutur. About 2000 Mm3 (70 TMC) is proposed for diversion from Alamatti through Alamatti-Pennar link to cate for enroute irrigation under Krishna and Pennar basins.
IV. PENNAR TO CAUVERY: About 9500 Mm3 (335 TMC) of water is proposed to be transferred through Pennar-Cauvery link into Grand Anicut deducting for enroute irrigation and Madras water supply about 5000Mm3 (176 TMC) will reach Grand Anicut and out of this water about 3000 Mm3 (106 TMC) will be used in Cauvery delta.
V. CAUVERY TO VAIGAI: Out of 5000Mm3 reaching Upper Anicut, about 2000 Mm (70 TMC) is proposed to be diverted through Cauvery-Vaigai link for utilization in Cauvery, Vaigai and other stream in between Vaigai and Vaippar.
ECONOMICS : Peninsular link project from Mahanadi to Cauvery costs Rs.50,000 crores for main works and additional amount of Rs.30,000 crores will be needed fo branchcanals, field channels.

AUGMENTING ANNUAL YIELD IN RIVERS AND LAKES BY CLOUD SEEDING
The water droplets in the clouds are so small (10 micro-meters in radius) that the cannot reach the earth without evaporating. Hence if large rain drops (500 micro-meters in radius) tht fall on the earth without evaporating are to be formed, about a million small cloud droplets must coagulate since mere adhesion and condensation are not enough. There are 2 theories about the mechanics of rain-drop formation, each of which is valid under different climates.

The first theory of rain-drop formation in warm clouds (do not reach freezing levels) is based on "Langmuir chain-reaction" that mostly occurs in the hot, humic atmosphere of the tropics. In a rising cloud, the up-currents hold the big-drops in suspension while the smalle ones are caught up and merge with the big ones. If the large drops become too big, they burst into fragments that again collide and coalesce with small droplets and ultimtely fall to earth as rain-drops.The second theory for cold clouds (tops touch freezing levels) is based on "Bergeron chain-reaction". The clouds that precipitate consist at the higher levels, of ice crystals. For the formation of big droplets in the cloud an ice-phase is a precondition. For transition from the liquid to solid phase a freezing nucleus is essential. The freezin nuclei allow supercooling of water droplets upto 15o C before ice-formation occurs Infact pure water suspended in air does not freze until it touches about minus 40o C temperature. The ice-crystals grow rapidly by absorbing all the supercooled droplets on their way down and unwiedly lumps of ice are formed and they melt a about zero degree centigrade to become rain-drops that fall on earth.

In w arm clouds to be seeded there is a serious shortage of large wt er droplets over 20 microns in diameter and this reduces the efficiency of the cloud to give rain. In order to induce such clouds to give rain the coalescence mechanisms have to be stimulated by injecting the clouds withs the hydgroscopic sodium chloride particles from a small aircraft. The Langmuir chain-reaction gets a boost and the clouds which were formerly unproductive become productive. Similarly the dearth of ice-crystals in cold clouds is removed by seeding them with silver iodide to ensure one nucleus per litre of cloud air so that such seeding generates additional ice-crystals and thereby accelerates the rain-forming processess.

CLOUD SEEDING FOR ARTIFICIAL RAINS:Since salt crystals are abundant in oceanic regions they favour larger cloud droplets that collide and coalessscence to initiate rain fall with in the life time of the clouds. But the atmosphere over continental regions contain much smaller and more numerous condensation nuclei and hence the medium sized clouds formed in such regions usually dissipiate before coalescence mechanism has had a chance to initiate rain. When right conditions exist, the cumulus clouds can be stimulated to grow larger and last longer. The freezing of millions of droplets in the cloud release enomous latent hea energy and that makes the cloud buoyant, causing it to grow larger, thereby efficiently processing more wter for a longer time period than would have occurrec without the cloud-seeding process.

COLD-CLOUD SEEDING:Introduction of massive dosages of silver iodide into the clouds at minus10o C at the rate of 100 to 1000 nuclei per liter of cloud air is known as dynamic seeding. In this process the conversion of super-cooled water i the cloud into ice-crystals (though Bergeron-Findesen reaction mechanism) releas latent heat that increases buoyancy, thereby increasing the size of the cloud with better organisation of low level inlows with the probability of cloud-merger and area wise enhancement of rain-fall. Dynamic seeding of individual clouds on a random basis in USA, indicated significant increase in rain-fall by a factor of three.

REFERENCES – WEB SITES ON CLOUD SEEDING

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TABLE-1: WATER USE FOR DIFFERENT PURPOSES (in billion cu.m.)

S.No. Purpose 2000 AD 2025 AD 2050 AD
1. Drinking Water 44 77 93
2. Irrigated Agriculture 520 909 1072
3. Hydro power 27 70 212
4. Industries 30 120 200
5. Ecology, Recreation etc. 41 72 80
TOTAL 662 1248 1656

TABLE-2: PRODUCTION OF FOOD GRAINS IN INDIA
Crop 1950-‘51 ‘60-61 ’70-71 ’80-81 ’90
91 ’97-98 2010 2025 2050 Annual growth rate
’94-2010 2010-2025 2025-2050
Rice 20 34 42 54 74 82 104 134 198 2.2 1.7 1.6
Wheat 7 11 24 37 55 66 80 110 170 2.6 2.1 1.8
Coarse cereals 15 24 31 29 33 34
Pulses 8 13 12 11 15 13 15 21 40 3.0 2.6 2.6
Total food grains 50 80 110 130 177 193 220 287 435 2.2 1.8 1.8
All the figures are in Million tons.

TABLE: 3 FOOD-SHORTAGE FORECAST IN INDIA FOR “2025 A.D. AND 2050 A.D.

S.No. Particulars 1950 1975 2000 2025 2050
1. Population,m. 360 640 1000 1350 1650
2. Land Area, M.ha. 22 55 90 150 200
3. Food grains, M.t. 50 120 195 325 450
4. Rice, M.t. 22 50 85 135 200
5. Wheat,M.t. 7 28 66 110 170
6. Irrigation water B.cum 100 250 400 640 900

TABLE:4 FOOD SHORTAGE IN SOUTH INDIAN STATES (1991-2050)
Population, Rice Demand, Production and Deficit

State 1991 2000 2025 2050
Pop dem Prod def Pop dem Prod def Pop dem Prod Def Pop dem Prod def
Andhra Pradesh 66 13 11 2 80 16 13 3 110 22 12 10 140 28 10 18
Tamil Nadu 55 11 5.5 5.5 68 14 6 8 95 19 6 13 120 24 6 18
Karna-taka 49 10 2.5 7.5 60 12 3 9 80 16 5 11 100 20 8 12
Kerala 30 6 1 5 32 6 1 5 35 7 1 6 40 8 1 7
Total 200 40 20 20 240 48 23 25 320 64 24 40 400 80 25 55

NOTE: Population (in Millions)
Rice production, Demand and shortages (in Million tons).
Pop(Population), dem(Demand), Prod(Production), def(Deficit)

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