

# INITIAL STUDY ON GANGA RIVER HARNESSING – FINDINGS

By

- Nayan Sharma, Professor, IIT Roorkee
- Ritesh Kumar Jaiswal, M. Tech Student, IIT Roorkee

## **1. SUMMARY OF INITIAL WORK PERFORMED ON GANGA RIVER MODELLING FOR HARNESSING THE WATER RESOURCES:**

An initial Mathematical model is recently developed by the authors for a selected approx 700Km long reach of the Ganga River from around Varanasi to Bhagalpur (Azmadabad / Bateshwarsthan) in India for appraisal of harnessing the water resources.

SRTM DEM was downloaded and used to generate the cross-sections of the Ganga River using HEC-Geo RAS in Arc-GIS 10.1 Software.

HEC-RAS 4.1 software of US Army Corps of Engineers (USACE) is used for developing the preliminary model which is operated with different limited discharges (since very scanty data are available on discharges in public domain, as most of the Ganga data are “classified”).

Based on the model developed, six different locations about 100 Km apart are identified falling between around Varanasi (UP) and Azmadabad / Bateshwarsthan (Bihar) in India. These locations are chosen based on the available reduced river width.

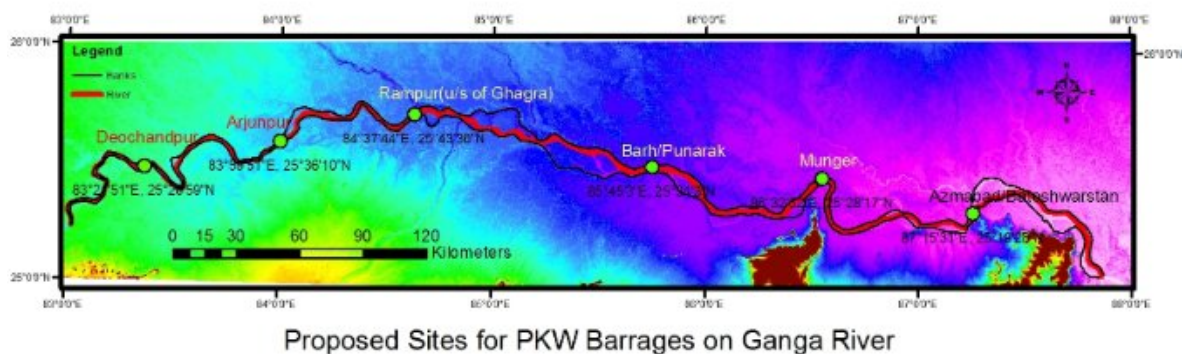
A cascade of Piano Key Weir (PKW) type barrages with varying configuration is simulated in the numerical model such that the creation of backwater storage ponds (river canalization) of adjacent PKW reaches to the successive upstream one.

The above proposed development is investigated to promote inland navigation along the 700 km stretch of the Ganga along with incidental power, environmental flow, drinking water and possible irrigation.

The initially identified six PKW sites are indicated below and also shown in the attached map below:

a) Azmabad / Bateshwarsthan b) d/s of Munger, c) Barh (u/s of Punarak),

d) Rampur (u/s of Ghagra) e) Arjunpur f) Deochandpur



## **2. STATUS OF INLAND NAVIGATION PROBLEMS & TARGETS AS PER IWAI:**

14,500 Km of navigable inland waterways exists in India out of which Ganga- Bhagirathi- Hooghly river (NW-1) from Haldia to Allahabad is 1620 km.

The Least Available Depth (LAD) maintained in National Waterway-1 till March 2014 and that to be maintained by IWAI during 2014-2015 is given below in a tabular form:

Sl. No.	Stretch (In km)	Maintained Depth in 2013-14 (in m)	Target Depth in 2014-15 (in m)	No. of shoals in 2014-15 anticipated
i)	Haldia (Sagar) - Farakka (560)	2.8 - 3.0	3.0	15
ii)	Farakka - Barh (400)	2.1 - 2.5	2.5	60
iii)	Barh - Ghazipur (290)	1.6 - 2.0	2.0	43
iv)	Ghazipur – Chunar/Allahabad (370*)	1.2 - 1.5	1.5	30

### **3. Table Showing Computed Preliminary Potential of Incidental Power with the Proposed PKW Barrage Cascade**

Location of PKW Barrage	Height of PKW Barrage (m)	Storage Volume (MCM)	Firm Power (Mw)	Installed Capacity (Mw)	Approx. Annual Energy Generation (GwH)	Approx. Revenue @Rs. 4.5.(in Million Rupees)
<i>At Azmabad / Bateshwarsthan to Munger (100 Km)</i>	7	813.984	25.39	30.83	246	1107
<i>At Munger to Barh (102.31 Km)</i>	10	1358.13	22.87	37.68	265	1192.5
<i>At Barh (u/s of Punarak) – Rampur (127.04 Km)</i>	10	1904.48	23.90	31.37	241	1084.5
<i>At Rampur (u/s of Ghagra) to Arjunpur (83.2 Km)</i>	8	550.37	7.38	11.21	81	364.5
<i>At Arjunpur to Deochandpur(97.05 Km)</i>	9	438.72	8.15	10.26	80	360
<i>At Deochandpur to upstream</i>	8	466.97*	4.23	5.71	44	198
<i>Total</i>		5532.654	91.92	127.06	957	4306.5

Note: \* Storage volume is greater than 466.97 as back water length is upstream to Varanasi.

### **4. SUMMARY OF POTENTIAL BENEFITS / SUGGESTIONS FROM THE CASCADE OF PKW BARRAGES ON THE GANGA:-**

Based on above preliminary mathematical modelling in the 700 km reach of the Ganga, the potential benefits arising out of the proposed cascade of PKW Barrage structures are enumerated below:

- Least Available Depth (LAD) of 3 m between Barh and Rampur, as well as between Azmabad / Bateshwarsthan and Munger; and LAD of 4 m at all other sites to promote navigation.
- Newly emerging Chevron technique (fruitfully used recently in St. Louis Harbor on the Mississippi river) can promote in fairway development also sustaining inland navigation terminals on the Ganga.

- Incidental Hydropower generation of 92 MW as firm power, 125 MW as total Installed Capacity, Annual Energy Generation 957 GWH with revenue generation of about 4.6 Billion Rupees.
- The ungated PKW barrages will create in-channel water storages of 5533 MCM by maintaining continuous overflow of excess river water in desired “अविल”
- Tentative provision made in modelling for cultural / spiritual, livelihood, biodiversity and hydrogeological integrity of the Ganga River, with 45 % of prevailing inflows.
- Drinking water availability of more than 10-20 million people can be provided from in-channel storages of PKW Barrages.
- Scope of nominal irrigation can be explored in future by further detailed study.
- Channel improvement structures like Trail Dyke System with Jack Jetty & Submerged Vanes (fruitfully deployed at Nakhwa site on the Ganga in 2009-2010) will help in channelization by controlling river bank erosion & improving navigation depth.
- Additional benefit of restricting flood flow within the river channel wherever required, making flood dykes along with trail dyke and jack jetties to prevent flood waters from going to the habitat land.

**Notably -**

- Piano Key Weir (PKW) is hydraulically 2 to 4 times more efficient than conventional barrages / weirs.
- PKW is cost effective (due to absence of expensive steel gates) and requires negligible O&M cost.
- PKW does not obstruct movement of sediment inflows and thus causes relatively less stream bed changes compared to conventional barrages.
- Sawra Kuddu HEP (120 MW) on Pabbar river in Himachal Pradesh is the First Piano Key Weir (PKW) type barrage constructed in India by HPPCL in 2010 - 2015 and this PKW type barrage was comprehensively model tested for its design finalization by Dr. Nayan Sharma in IIT Roorkee during 2009-2010.

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