

# **Global Warming, Eco-refugees and Sustainability:**

## **Inferences from the Bihar Floods**

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The Sorrow of Bihar, Kosi, has once again unleashed its fury. On 18 August, River Kosi broke free of its embankments in much the same manner as the law and order of the state it navigates through, and assumed a course it had flown more than two hundred years ago. Hundreds have drowned, while more than 250,000 people have been reported displaced, their property and source of livelihood submerged below deep waters.

And even as the waters of the Kosi recede, there is news of flooding in Assam where more than 19 of the 27 districts have been flooded after the mighty Brahmaputra burst its banks. Waters have also been flowing above the danger line in Orissa. A tragedy of massive proportions has unfolded as the BBC reported that nearly one-third of the country was affected by unseasonal rains and river bank breaching.

### **A pattern to be recognized:**

There is evidently a pattern to the flooding that needs to be recognized. According to the Sierra Mountain Club of the USA, precipitation on the planet has been up by nearly 20%. The simple reason they say is that the air is getting warmer and warmer air holds more moisture - so when the warmer winds sweep across wet farmlands, they suck up more moisture drying the farms out. And when the winds finally dump that moisture out as rain, the downpours are much heavier. The ocean currents and the corresponding wind currents which regulate the planet's climate system have been undergoing drastic changes over the past several years. Ice melt in the Arctic, the Antarctic and Greenland are changing the flow of hot and cold currents bringing storms and hurricanes in the wake. The US has witnessed more than 3 storms in the last 2 months as the most volatile churning of currents occur in the Gulf Stream and the region best known as the 'Triangle

of Bermuda'. This is reason enough why the Bihar floods need to be reviewed with a fresh insight and a far-sighted view.

### **What the Global Warming Scientists predict:**

Atmospheric scientists at the Intergovernmental Panel on Climate Change (IPCC) predicted that the global warming is expected to increase between 1990 and 2100 by from 1.4°C to 5.8°C. This projection is without precedent in the last 10,000 years. The rise in ocean level during this period is projected at from 0.09 to 0.88 meters. The 2003 UNESCO Report on Natural Water Systems explains that this will lead to moderate to severe changes in the global hydrological cycle. In fact, the warming of the earth's atmosphere is occurring far more rapidly than was predicted, forcing scientists to go back to the drawing table to revise their calculations. Changes in the precipitation, distribution, evapo-transpiration are already significant. Floods, droughts, cyclones and hurricanes are occurring with near unprecedented frequency and intensity, which is affecting both surface and ground water supplies. The Bay of Bengal already exhibits this problem. In the Bay of Bengal, mangrove trees that previously protected the land from the violent onslaughts of hurricanes and cyclones were removed to make way for shrimp fisheries along the coast.

### **The hydrology of Bihar:**

The state of Bihar is exceptional in its proportion of water and land. There are more than 19 major rivers with their innumerable tributaries which drain their waters through this land. It is not surprising that the land was known in Hindu mythology as Mithila or wonderland, the name that is also given to the art that developed from this place. A network of tributaries from the north and south join the mighty Ganges as it winds to its destination along a 2500 km long path. The Ganges and its tributaries encompass half the state's districts. The Ghagra, one of the main tributaries of the Ganges itself has some 7 tributaries including rivers such as Gandaki and Mahi. The river basin map of Bihar indicates the various rivers and their basins. In all nearly 70% of the state is susceptible to floods.

### **Sequence of Bihar Flood 2008:**

A study of Flood Inundation Maps based on daily satellite images from Radarsat 2 obtained from the Flood Management Information System Cell of the Government of Bihar for the months of July and August are revealing. It appears that much of the state was already under threat from the Ganges and its tributaries. Until July 24, the threat of floods lay in the districts of West Champaran, Darbhanga, Muzaffarpur and Nalanda – with water flowing above danger line in several places in north-west, south-west and south center of the state. Most of these districts are affected by the tributaries of the Ganges. What unfolded, however, on 18 August 2008 took everyone by surprise. The Radarsat images show the breaching of the Kosi's embankments transforming it into a massive sea – 38 km wide.

### **Kosi – The Sorrow of Bihar:**

The Kosi, emanating in the Himalayas, is part of the Ganges, Brahmaputra, Meghna riverine system, holding within its fold a population of nearly 1.3 billion spread across five countries – China, India, Nepal, Tibet and Bangladesh – with some of the world's poorest settled in its vast and unpredictable basin. Traversing a distance of 729 km (453 miles), majority of the Kosi's watershed lies in Nepal and Tibet. Steep ridges separate the river's path from other major water streams including the Brahmaputra in the north, Gandaki in the west, Mahananda in the east and Ganges in the south. The river finds its mention in the Hindu epic Mahabharata ( named after sage Vishwamitra's teacher, sage Kusika), as Kusika or Saptakoshi – after the seven major tributaries that drain into it - the Sun Koshi, the Tama Koshi or Tamba Koshi, the Dudh Koshi, the Indravati, the Likhu, the Arun and the Tamur.

The river Kosi is fed by glaciers in the Himalayas which provide perpetual water to the system. In the Arun-Koshi river basin, there are 737 glaciers in Tibet and 229 glacier lakes while the Sun Koshi is fed by 45 glacier lakes. The Kosi has an average water flow (discharge) of 1 564 m<sup>3</sup>/s or 55,000 cu ft/s. During floods, it increases to as much as 18 times the average. The greatest recorded flood was 24,200 m<sup>3</sup>/s (850,000 cu ft/s) on

August 24, 1954. The Kosi Barrage at Hanuman Nagar, Birpur in Nepal has been designed for a peak flood of 27,014 m<sup>3</sup>/s (954,000 cu ft/s).

Among the many reasons for the Kosi's floods is the silt carried by the river. Mainly rocky in nature and largely infertile, this silt is deposited over steep gradients forcing the river to meander along unpredictable paths. Owing to extensive soil erosion and landslides in its upper catchment by factors both natural and human, the silt yield of the Kosi is about 19 m<sup>3</sup>/ha/year (10 cu yd/acre/yr), one of the highest in the world. The Arun Koshi, with its origins in Tibet, brings the greatest amount of coarse silt in proportion to its total sediment load.

#### **The Kosi fan:**

The Kosi river fan located in the northern part of India (in northeast Bihar and eastern Mithila) is one of the largest alluvial cones built by any river in the world. This 180 km (110 mi)-long and 150 km (93 mi)-wide alluvial cone shows evidence of lateral channel shifting exceeding 120 km (75 mi) during the past 250 years through more than 12 distinct channels. The river, which used to flow near Purnea in the 18th century, now flows west of Saharsa. A satellite image shows the old palaeo-channels of the Koshi river with its former (before 1731) confluence with the Mahananda River north of Lava. The river's immense alluvial fan has now grown to an area of about 15 000 km<sup>2</sup>. Instead of a single well-defined channel, the river has numerous interlacing channels that shift laterally over the fan from time to time. Without sufficient channelisation, floods spread out very widely. The record flow of 24 200 m<sup>3</sup>/s is equivalent to water a meter deep and more than 24 kilometers wide, flowing down the slight slope of the alluvial fan at one meter per second.

#### **Glacial Lake Outburst Flood:**

Another major factor overlooked by most analysts is that nearly 34 of the glacier lakes that feed the Kosi have been declared as above the danger line - insecurely damned by ice and moraine. It is believed that many of the Glacier lakes in the Himalayas are causing what is known as GLOF or Glacial Lake Outburst floods leaving behind poor vulnerable

subsistence farmers who have to choose between floods and starvation. The Kosi's alluvial fan brings fertile soil and abundant groundwater into a state where agricultural land is in acutely limited supply in relation to population.

### **Controlling Floods:**

Although floods in Bihar owing to the Kosi river system has led to considerable damage to life and property over decades, attempts to design hydrological systems to reduce the rate of floods are almost negligible. The only barrage that exists is at Hanuman Nagar, Birpur in Nepal. Built in 1956 through a bilateral agreement with Nepal, it was part of a proposal by the Central Water Commission which included a 239 m high dam about 50 km at Barakshetra in Nepal to be backed by a barrage downstream. Due to several reasons including the uncertain political relation with Nepal and the environmental movement against large dams, the dam was never built. However, the Barrage in Birpur was constructed with eastern and western embankments of 105 and 106 km respectively. Mr. K.N. Singh, Deputy Chairman, Planning Commission, Bihar states: "Apart from the multiplier benefits to agriculture, flood protection and livelihood patterns to both people of India and Nepal, a substantial part of the hydro-electricity of 3,000 MW could be sold by Nepal to India to bring about huge improvement in real income of Nepalese and meet the energy deficiencies of the eastern region, failed to carry conviction."

### **Conclusions:**

As a country which has ratified the Kyoto Protocol, it is the abiding duty of the government to prepare its people to face the long and short-term consequences of global warming and rapidly evolve mitigation plans. Every state must develop its own plan of action to deal with effects of uncertain precipitation and sea-level rise. All coastal regions must have a comprehensive and holistic coastal management plan in place.

It must be recognized that Climate has a major effect on ecological systems which are entirely interwoven with precious fresh water supplies. Efforts towards decentralized rainwater harvesting, water conservation techniques such as water efficient faucets and flush tanks, drip irrigation and water recycling must be given priority in any urban or rural community planning.

The river systems of the North-east India have a great potential for generating hydro-electric power – a clean and renewable source of energy. The prospect of constructing small and medium sized dams to generate electricity along these river basins must be considered seriously. This power must be made available to the people of the states in which they are being constructed. Other sustainable means of harnessing the energy from these rivers such as micro-hydel projects must be looked into urgently.

The victims of the Bihar flood as also that of Hurricane Katrina or Iva, are eco-refugees. The increasing influx of Bangladeshis into India is enough evidence of this fact. As low lying coastal regions submerge globally, it is creating a whole population devoid of land and means of livelihood. These eco-refugees must not be considered illegal citizens and therefore, persecuted and left to lead miserable lives. It is imperative that governments everywhere recognize their presence and make provisions to accommodate for their survival for they are, after all, hapless victims of our profligate lifestyles and humanity's irreverent behavior to mother earth.