Central Water Commission

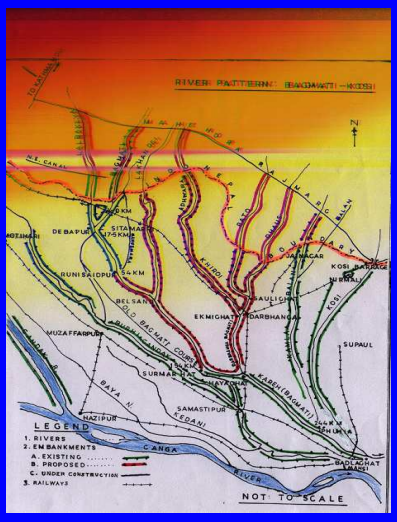
# FLOOD MANAGEMENT IN BAGMATI BASIN

BY

S.K.AGRAWAL
A.K.KHARYA
R.KHATTAR

# BAGMATI RIVER BASIN

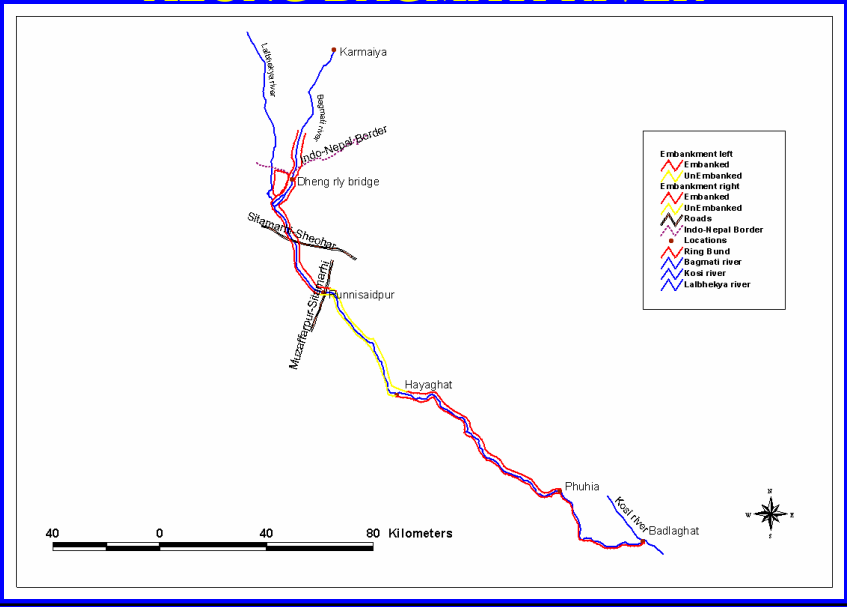
- Total catchment area is 14384 sq km
- One of the perennial rivers of North Bihar & rises in the Shivpuri range of hills in Nepal near Kathmandu
- Enters North Bihar about 2.5 km north of Dheng Railway Bridge
- Meets Kosi river at Khormaghat in north Bihar
- Main tributaries are Lalbhekya, Lakhandei & Adhwara group of rivers



## Past Measures for Flood Control

- BAGMATI FLOOD CONTROL PROJECT, 1965 & BAGMATI IRRIGATION PROJECT, 1969 (Rev. cost Rs.3620 lakh)
- BAGMATI MULTIPURPOSE PROJECT, 1984 (Flood component cost Rs.6050 lakh)
  - Above schemes implemented partially

## EXISTING EMBANKMENTS ALONG BAGMATI RIVER



# EXISTING EMBANKMENTS

- Embankments above Sitamarhi –Sheohar road crossing upto Indo-Nepal border were constructed in 1979-80 and are known as Bagmati afflux bund. The left afflux bund is around 50.5 km, right afflux bund is around 32.8 km and Bargania ring bund is 7.2 km
- Embankments below Sitamarhi –Sheohar road crossing and just upstream of Muzaffarpur-Sitamarhi road crossing have also been constructed. The length of left and right embankments is around 24 km
- Left embankment from Hayaghat to Phuhia (around 73 km) and the right embankment from Surmarhat to Badlaghat (around 145 km) on river Kareh were constructed in 1956 for a design discharge of 1416 cumec. Later on these embankments were strengthened in 1981 for a design discharge of 3695 cumec

# INTERNATIONAL DIMENSIONS

- The river originates in Nepal and then enters India in Bihar, the works executed on the river in Nepal have impact in India and similarly works in the border area in India influences river regime in Nepal.
- In the year 1991, a Joint Team of Experts (JTE) was constituted in the year 1991 for the purpose of arriving at the criteria and design standards for finalizing the project for construction of embankments along the common rivers Lalbakeya, Bagmati, Kamla and Khando

## INTERNATIONAL DIMENSIONS

- In Phase-I, the construction of embankment on Bagmati river for the reach from Indo-Nepal border to 20 km upstream in Nepal was taken up for the design discharge of 7000 cumec
- It is proposed by the GoN to embank the river upto Mahendra Rajmarg so as to arrest any flood spillage in the plains in Nepal
- As a result impact will be higher discharge at the border due to denial of moderation of flood peak as result of cutting off the valley storage

## FLOOD PROBLEM

- topography of the catchment in India is very flat and the river carries heavy sediment load particularly in monsoon season thereby resulting in deposition thereof in the bed & flood plains of the river which results in spillage of flood waters in large areas even in case of moderate floods
- entire length of the river in India is not embanked thus quantum of flood water reaching the un-embanked reaches will be more and also time of travel will be less

# FLOOD PROBLEM

- rain water and the flood waters that spill in the country side will not drain back quickly into the river due to embankments resulting in inundation of the areas for longer period and disruption of communication and transportation links for long periods increasing agony of the inhabitants
- flood water that used to spill in flood plains in the U/S in Nepal (pre-embankment time) will also reach India resulting in higher flood level in the river in India. This will threaten the existing embankments in India and more severe flooding in unembanked areas

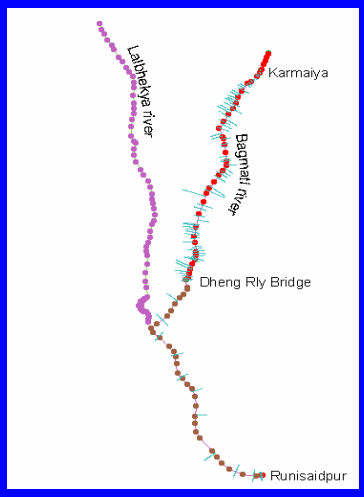
# MATHEMATICAL MODEL

MIKE 11 Model was applied to simulate flows in river system. It is a one dimensional, Implicit & finite difference model.

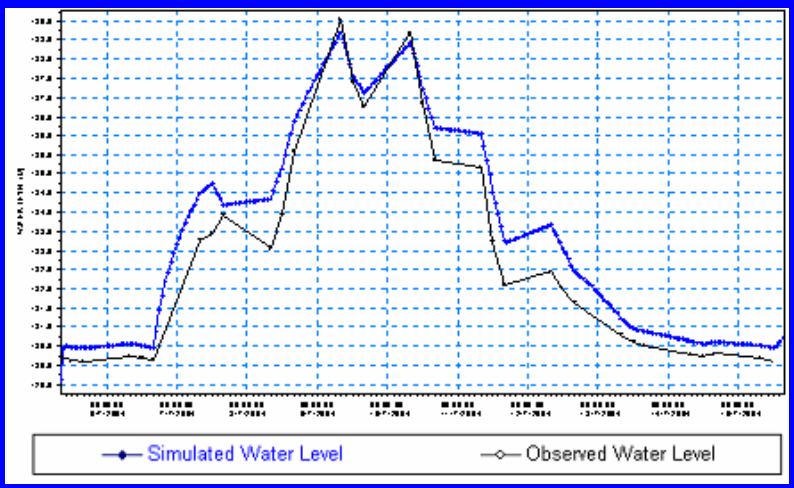
- To Estimate flood levels in the Indian Portion due to construction of embankments in Nepal Portion
- Flood levels were achieved by routing 25- year Design Flood from Karmaiya in Nepal to Runnisaidpur in India

# MODEL SETUP

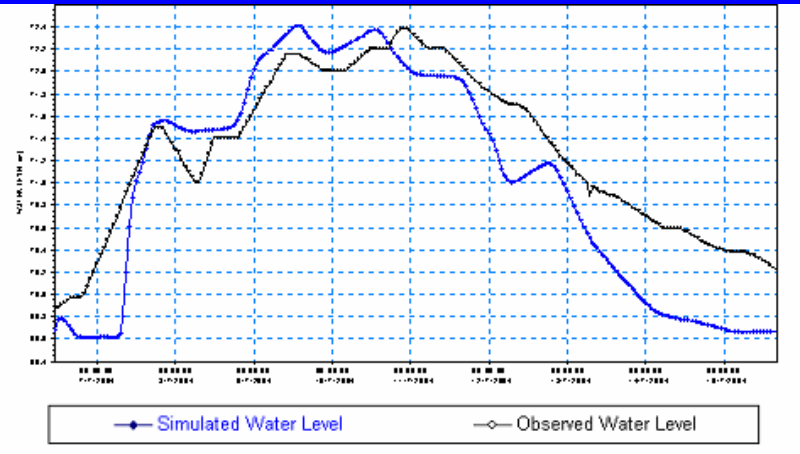
- Digitization of river network
- Specification of X-sections
- Fixing of upstream and downstream boundary
- Preparation of time series data



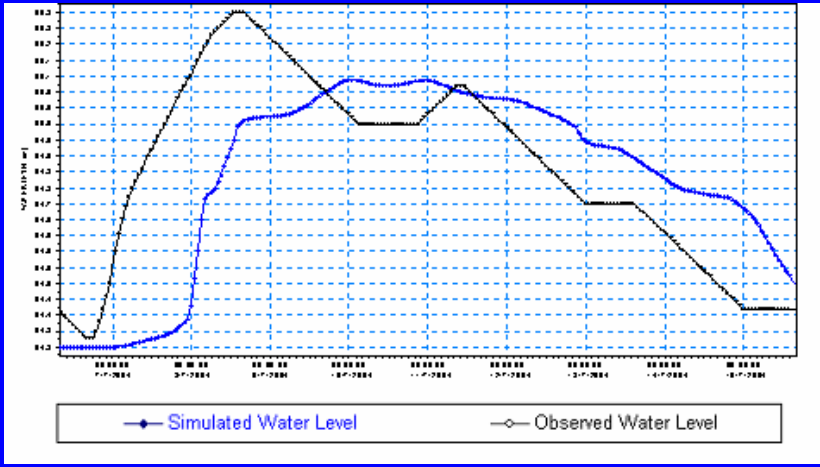

# MODEL CALIBRATION AT PANDRA DHOBAN



# MODEL CALIBRATION AT DHENG RAILWAY BRIDGE




# MODEL CALIBRATION AT RUNISAIDPUR



# CALIBRATION STATATICS

| Location | Simulated Discharge Peak (m3/sec) | Observed Discharge Peak (m3/sec) | Simulated volume (MCM) | Observed volume (MCM) | Simulated Water Level Peak (m) | Observed Water Level Peak (m) | Error (Cm) |
|---|---|---|---|---|---|---|---|
| PANDHERA DHOBAN | 6850 | 6850 | 1622 | 1622 | 138.689 | 139.05 | 36.10 |
| DHENG RLY BRIDGE | 3035 | 2635 | 1040 | 1300 | 72.413 | 72.380 | -3.30 |
| RUNISAIDPUR | 435 | 506 | 253 | 275 | 55.087 | 55.070 | -1.70 |

# MODEL RESULTS

| *Location* | *Chainage from Karmaiya (m)* | *Discharge (cumec)* | *Water Level (m)* |
|---|---|---|---|
| Pandhera Dhoban | -1000 | 8306 | 139.655 |
| Karmaiya | 0 | 8301 | 130.934 |
| Indo Nepal Border | 48873 | 8246 | 75.604 |
| Dheng Railway Bridge | 51373 | 8246 | 74.003 |
| Runisaidpur | 105373 | 8126 | 59.009 |

# LIMITATIONS

- Inadequate frequency of observation of gauge data at Karmaiya
- Insufficient of data – details of gaps/breaches in existing embankments, hydrological data observations on tributaries, extent of flooding and volume of water escaping the channel through gaps/breaches were not available
- Model simulated for fixed bed condition only ie. sediment transport effect has not been considered.

# LIMITATIONS

- Effect of operation of regulators/sluices has been neglected
- Assumptions in extrapolating the rating curve generated for higher flows at Runisaidpur as the observed data was available for much lower discharge values
- Sub-optimal Model Parameters
- Observational errors
- Topographical errors

# DATA REQUIREMENT FOR FURTHER STUDIES

- Topographical survey using latest survey equipments like Total Station, Geographical Positioning System (GPS) or Air-borne Laser Terrain Mapping (ALTM) to produce high resolution, accurate and close contour maps
- Hydrographic survey using high accuracy echo-sounders and GPS.
- Hydro-meteorological data (water level, discharge and silt) in the main river and in the major tributaries

# APPROACH FOR FLOOD MANAGMENT

- Identification of major issues for flood management
  1. Increased flood in India due to construction of embankments in Nepal along river Bagmati
  2. Fear of avulsion of Bagmati river into Manusmara near India-Nepal border
  3. Inadequacy of embankments for draining the flood water from Dheng bridge to Runisaidpur for passing the increased flood due to jacketing of the river in Nepal
  4. Fear of more flooding and inundation of the area between Runisaidpur to Hayaghat where river is not embanked.
  5. Erosion of banks or embankments due to meandering of the river
  6. Inadequate waterway below road/rail bridges constructed over the river/ tributaries

# APPROACH FOR FLOOD MANAGMENT

- Identification of distinct reaches for flood management
  1. From Kathmandu (origin) to Mahendra Rajmarg (Karmaiya Barrage)
  2. From Mahendra Rajmarg in Nepal to Dheng bridge
  3. From Dheng bridge to Runisaidpur
  4. From Runisaidpur to Hayaghat
  5. From Hayaghat to confluence with Kosi

# REACH-WISE RECCOMENDATIONS

- From Mahendra Rajmarg in Nepal to Dheng Bridge in India
  - Left embankment in Nepal be tied with left afflux bund in India and adjustment in the alignment of the bund taking into account the present bank line of the river (length 1.5-2 km) in order to avoid feared avulsion of Bagmati in Manusmara river
  - The gaps in right & left embankments in Nepal be plugged to prevent flooding in Nepal and India simultaneously with the works of raising & strengthening of embankments in India
  - Appropriate anti erosion measures in the form of low level bed bars with every alternate bar extending upto left afflux bund u/s of Dheng bridge be taken to prevent avulsion of river Bagmati

# REACH-WISE RECCOMENDATIONS

- From Dheng Bridge to Runisaidpur
  - The gap on right embankments at Belwadhar be closed with an appropriately designed ungated regulator to allow a maximum discharge of 1500 cumec (subject to safe carrying capacity of Belwadhar)
  - Raising & strengthening of embankments for design discharge and water levels at various places should be according to the water levels 74.003m at Dheng Bridge and 59.009m at Runisaidpur worked out by mathematical model studies
  - Properly designed anti flood sluice may be provided for facilitating country side drainage
  - The waterway under Dheng bridge, Railway Bridge at Hayaghat and other road bridges be appropriately increased by adding a few spans after conducting proper study

# REACH-WISE RECCOMENDATIONS

- From Runisaidpur to Hayaghat
  - Spacing between the embankments is kept so as to ensure flood moderation from the routed flood discharge at Runisaidpur to safe carrying capacity below Hayaghat and in no case it should be less than 3 km. However, mathematical model study must be undertaken to determine suitable alignment, design flood and top level of embankments Raising & strengthening of embankments for design discharge and water levels at various places should be according to the water levels 74m at Dheng Bridge and 59m at Runisaidpur worked out by mathematical model studies
  - Properly designed anti flood sluice may be provided for facilitating country side drainage
  - Wherever major tributaries join the river, the embankments should be carried along these tributaries to join road/railway embankments to prevent flooding due to back water whenever Bagmati is in high spate

# REACH-WISE RECCOMENDATIONS

- From Hayaghat to confluence with Kosi
  - Raising & strengthening of Embankments of Bagmati river should be taken up for the discharge and water levels at various places worked out by mathematical model studies right from Karmaiya barrage in Nepal to Hayaghat after collection of required hydro-meteorological and topographical data. If the works recommended above are executed properly, raising of embankments may not be required and only restoration of the embankments would be sufficient Properly designed anti flood sluice may be provided for facilitating country side drainage
  - The right Kamla embankment, which terminates abruptly and as a result of which water flows back and inundate a large number of villages, be tied to the left embankment of Bagmati with sufficient provision of anti flood sluices. This work be taken up simultaneously with extension of embankments of Kamla to high ground in Nepal.

# SUMMARRY AND CONCLUSION

Structural measures for flood management are capital intensive therefore, need more time and effort during planning stage. A reliable data base is a prerequisite for any optimal and successful planning. Mathematical model studies are the widely accepted quick methods for understanding behaviour of such complex systems provided the input data are adequate and accurate. An attempt for mathematical model studies for the river from Karmaiya barrage in Nepal to Runisaidpur in India using MIKE-11 model has been made and considering limitations on availability of data, results are considered reasonably accurate and acceptable. Here what is important is the approach to flood problem keeping in view the limitations imposed by international aspects.

# Thank you