National Workshop on Developing Comprehensive and Scientific Mechanism/model for Forecasting of Hydrology for Hydro Electric Project

Mainstreaming of
Integrated Flood Management under Climate Change

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Mainstreaming of Integrated Flood Management under Climate Change

- **An integrated approach is advocated.**
- **Using river basins in Bihar and Odhisa as case studies, provides clear insights intobottlenecks as well as promising interventions that would reduce the losses and burdens of millions of people currently affected by floods.**
- **Mathematical modelling as well as social surveys proved to be key to unravel the intricacies of the problem: to quantify what needs to be quantified and to qualify the needs from the grassroots level.**
- **Major conclusions can be drawn from these basins which in many ways can be regarded representative.**

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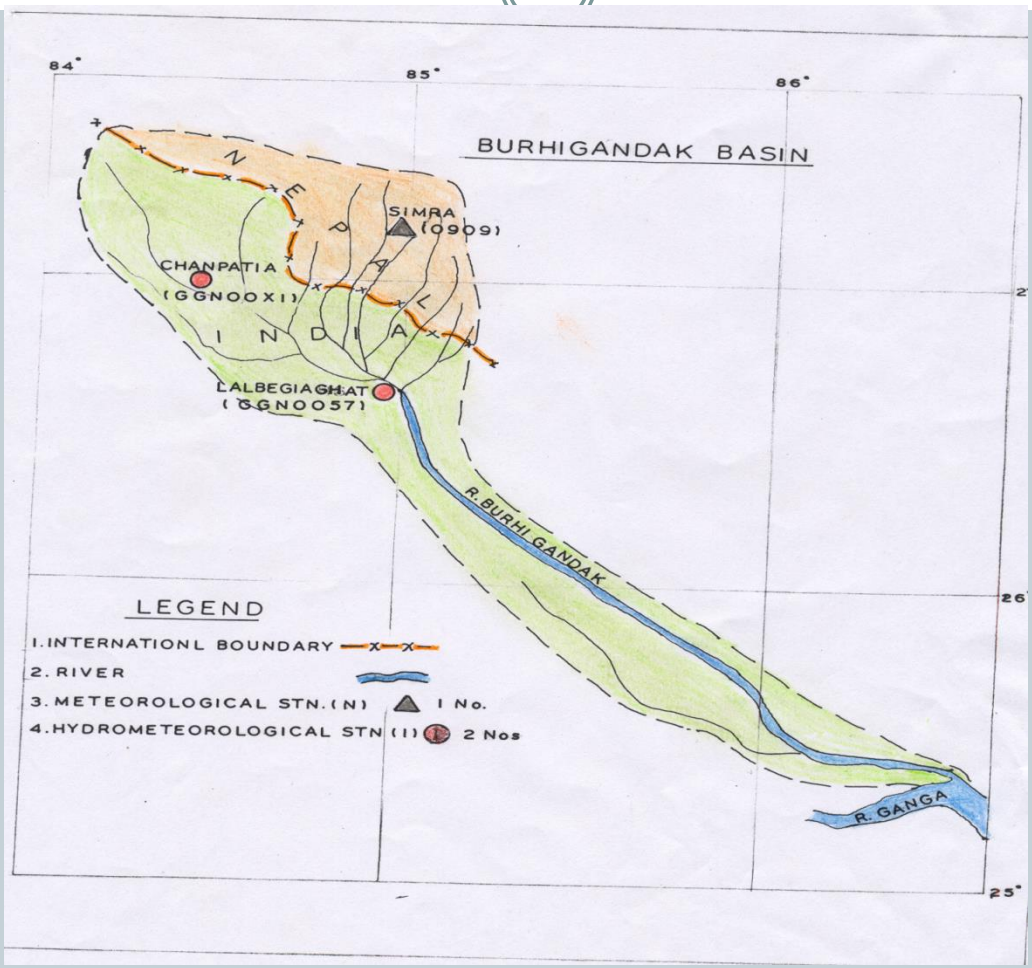
- **It was found that by providing the 1:25 safety standard for rural areas around 90% of the average annual damage could be avoided. This implies that the marginal extra benefits quickly diminish beyond this safety standard.**
- **In terms of flood hazards, climate change is expected to cause heavier rainfall events and can lead to significant increases in flood extent (in the order of 25% in 2040 and perhaps 30% in 2080 in the case of the Brahmani-Baitarani).**
- **To maintain present flood safety standards, embankments should be raised in the order of 80 cm in 2080. Still, most interventions do not take such increase in flood hazard into account.**
- **Upstream structural flood control measures, such as dams and river diversions, would lead to a significant reduction in flood hazard. Typical reduction factors in flood extent for new upstream projects in the two study basins are in the order of 5 to 10%. Complete flood control is not feasible.**

BURHIGANDAK BASIN



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- **Flood embankments are currently and will remain the major flood control measure and the preferred option of a majority of the people. Still a large number of people are living in areas between the embankments and the river and are therefore liable to flooding (especially in Bihar).**

- **Technical standards, regulations and design guidelines for embankments are in place, but not always followed up during implementation. Safety standards for embankments (return periods) are still not defined using a genuine risk approach, comparing costs and benefits.**

- **Non-structural measures necessarily complement structural measures, as is well understood by all key stakeholders. However, flood forecasting, early warning and community preparedness are far from satisfactory. Community disaster management plans are still not mainstream practice. Land zoning is not actively implemented as part of flood management as legislation is still not enacted in most States.**

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- **An indispensable tool for such approach is a mathematical model to simulate flood hazards from source (rainfall) via pathway (river and floodplain) to receptor (people and their assets). It is only through such tool that effectiveness of measures can be assessed after which fruitful combinations can be built into a basin wide flood management plan.**
- **It proved to be quite feasible to run a complete 1D/2D hydrodynamic model of the entire lower part of the basins (covering some 25,000 Sq.km).**
- **Estimating the flood extent through GIS.**
- **it is much better to include the storage effect of the flooding itself during a flood event.**

Flood Risk Analysis

- Risk analysis at the basin level produces flood risk maps for different return periods under current conditions and under scenarios of climate change. Such analysis should use a state-of-the-art mathematical model for hydrology and hydraulics. In order to derive validated model results the data on hydrological parameters, elevation, land use and infrastructure should be checked on consistency.
- In many cases a joint probability analysis needs to be performed in order to derive the appropriate return periods. Failure modes of embankments need to be researched and reservoir operation modes studied.

- Exposure and vulnerability data should also be made available and validated with community surveys. Fragility or damage functions for various assets as well as agricultural crops can be used from generic (Indian) sources or should be adapted for local conditions in case of significant deviation from the country average.

- It is recommended to include possible climate change effects on the flood hazard.
- Downscaling of global climate models should be conducted for each basin or state, as has been performed in this study for the two states.

- Performing such a study might not be feasible for each project.

- A factor for quantum of increase could be established so all future projects in that area can use those numbers.

Flood Risk Evaluation

- **The resulting flood risk maps are input for discussions among stakeholders to evaluate the acceptability of the risks and to decide if new measures are needed. Evaluation can be done based on predetermined safety levels (such as 1:25 year return period for agricultural areas and 1:100 year for urban areas), or on a full-fledged economic cost-benefit analysis (CBA).**

- **Also community needs and conditions need to be taken into account because there can be other than purely economic reasons for establishing a safety level.**
- **A pilot CBA exercise in the Brahmani-Baitarani river basin (near Jenapur) revealed high benefit-cost ratios for embankments with a 1:25 year safety level and higher.**

- **These results should be followed up with a more detailed, full fledge CBA.**

Selection of flood mitigation measures

- **Urgent measures first: these include all kinds of repair and emergency measures, in order to avoid major problems in the next flood season.**

- **Short term measures: implementing measures which can reduce flood impacts in the coming years and do not require large investments (such as adjustment of reservoir operation rules, improved flood forecasting and warning and community preparedness plans).**

- **Medium to long term measures, which require some kind of study and /or DPR approvals. This includes upgrading embankments, new dams and diversion projects, watershed improvement, land use zoning etc. For embankments the concept of a dike ring should be adopted, which provides a standard safety for the entire area that is enclosed by the embankment.**

Recommendations to promote River Basin Planning for IFM

- Development of flood models (hydrological/hydraulic) with accurate Digital Elevation Models and appropriate joint probability analysis.
- Preparation of CC downscaling studies for major river basins.
- Preparation of flood risk maps based on the flood model results.

- Organise discussions with stakeholders / communities using flood risk maps.
- Inventory of promising measures .
- Feasibility assessment using economic tools and community surveys.
- Improve economic BC analysis for flood projects
- Update guidelines for DPR.

- Detailed study of river behaviour as a consequence of earthquakes / landslides and morphological changes.

Recommendations on flood risk mitigation measures

- Improvement of hydrological forecasting through automated hydromet stations, improved data transmission and mathematical models (instead of gauge to gauge extrapolations).
- Implementation of advanced technologies such as SMS broadcasting.
- Review the reservoir operation rules for enhanced flood cushioning (15% of live storage is recommended).

- Improve supervision of construction and maintenance
- Review/update criteria for freeboard CWC.
- Realign embankments which do not adhere to 3 times Lacey's wetted perimeter.

- Maintenance and O&M of sluice gates, Construction of drains.
- Promote appropriate land use in the catchment and flood prone areas to reduce rainfall-runoff, Provide incentives for conjunctive use of surface and groundwater.
- Implement Master Plans for vulnerable cities and towns,
- Ensure proper maintenance of drains, culverts etc.

Thank You