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A US - INDIA EXAMPLE IN CASE HISTORY USE IN LEVEE SAFETY - A MULTI-CULTURAL PERCEPTION OF WHAT IT IS, AND HOW SHOULD IT BE APPLIED

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ABSTRACT

The State of Bihar, India experienced substantial flooding in the Ganges Basin as a result of levee (embankment) non performance. As a result of the 2008 failures the Bihar Water Resources Department is examining, as a programmatic model, the US experience in establishing and conducting the United States Army Corps of Engineers (USACE) Levee Safety Program. This case model examination is intended to structure a new program for managing the Bihari embankment infrastructure. Similar to many historical flood control initiatives throughout the world, India's embankment infrastructure shows the effects of aging and multi-purpose use of the facilities. To examine what practices that could be employed to increase the reliable performance of the embankment system; the World Bank facilitated a detailed case history examination of the USACE Levee Safety Program. The case study included a trial application of elements of the US approach to Indian Levee systems in order to stimulate discussion of what elements could be and should be incorporated into the Indian embankment management system. Elements of the levee safety program examined in this case study include the development of a comprehensive database of features and information on the embankments, a data viewer, areas of maintenance issues and corrective maintenance management activities.

Bihar, the 12th largest state in area and 3rd largest by population, is located in Eastern India. Bihar is most flood-prone State in the country. Approximately 76% of the north Bihar population lives under the recurring threat of flood devastation. In 1987 alone, approximately 1,400 human and 5,300 animal lives were lost due to flooding.

In the year 2011 World Bank (WB) signed an agreement with the Bihar Government for a soft loan of $220 million to rebuild areas devastated by the River Kosi floods of 2008.

WB, made up of 188 member countries, is a vital source of financial and technical assistance to developing countries around the world.

Bihar, at present has more than 2,254 miles (3,627 kilometers) of levee embankment.

The one-week-duration conference, held from October 15 to 22 in the year 2011, was organized by the World Bank and Water Resources Department (WRD) of Patna, Bihar. From the USA two members from the United States Army Corps of Engineers (USACE) – the two authors of this paper, together with four members from members of the World Bank participated in the conference. From WRD several members, including the Principal Secretary, Director, and others were present.

The main objective of the meeting was to learn how the Indian counterpart does their business, and in turn, to inform them how USACE conducts their business.

The International Approaches to Manage and Plan Embankment Assets workshop was designed by the WB and the USACE to share information about the agency Levee Safety Program and the tools and procedures the USACE uses for levee management.

The World Bank's anticipated outcome was that using the tools presented would allow the levees in India to be operated and maintained with a greater degree of performance assurance, thereby, protecting their critical infrastructure and saving lives.

First two days were spent in observing the levee system on Baghmati River in Sitamarhi, adjoining the border of Nepal. The main observations are summarized in the text below.

The existing levee geometry does not meet the US standards. The side slopes were steeper than 1V:3H. Occasionally, the side slopes were as steep as 1V:1H. It should be noted, that, as per the conversation with an Indian official during the site visit, the design levee side slopes are 3H:1V, same as in the US.

Most of the side slopes and levee top were without grass cover. The levee top was observed to have deep ruts.

In several reaches there was a thick forestation consisting of approximately 40 to 50-foot-tall trees with diameter exceeding 18 inches. In USACE, woody vegetation is not permitted due to its adverse impact on accessibility for inspections and floodfighting, and the uncertainty it introduces in structural performance. The writers were informed by the Indian officials that these trees were cultivated by the Forest Department and cannot be removed without their permission. The writer was further informed that in India it is preferable to plant trees on the land side of the levees.

With a few exceptions, the side slope at the river side did not have riprap revetment.

In some reach of the levee, an approximately 10-foot-wide and 30-foot-long brick weir was provided. It was reported that the weir is for the protection of surface erosion. However, in the writers' opinion, it would provide river training rather than the protection against surface erosion.

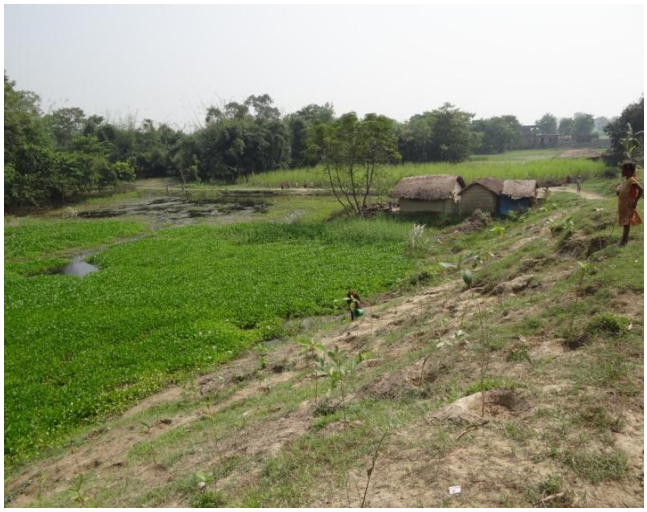

Photo 1. Lack of grass cover and intentional planting of trees on the levee side slopes

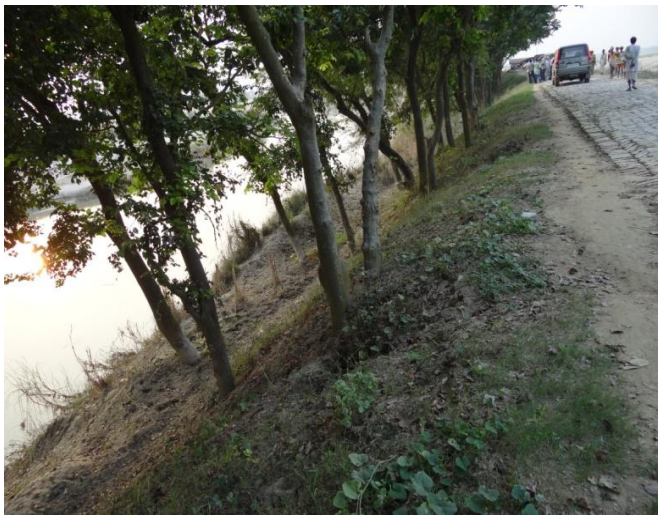

Photo 2. Trees growing on the water side slope of the levee

No pump stations were observed on the land side of the levee. It was learned that it is not a customary to provide pump stations in Indian levee system. The seeping water from the levee embankment and the foundation spreads on the land side and is used for irrigation in the adjoining farmland.

Most of the side slopes were populated with huts in which people were living.

Periodic Inspection (PI) and Annual Inspection (AI) are not performed. However, levees are inspected before the monsoon season during the period from June to September. Levees are also inspected during the flood event. The results of the inspection are reported in a notebook in Hindi, one of the two Indian official languages. The other official Indian language is English.

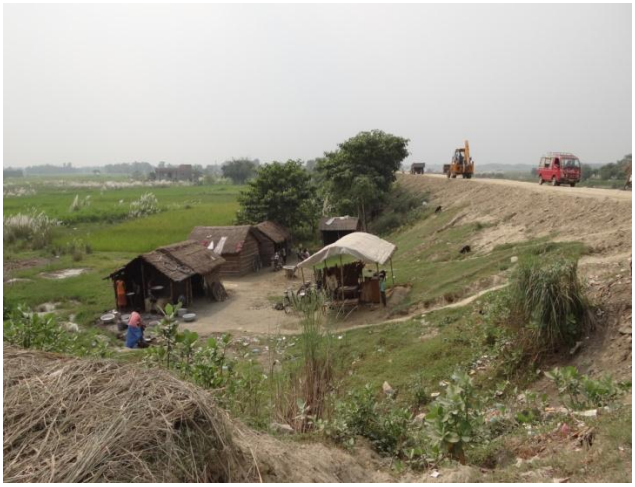

Photo 3. People living within the Right-of-way of levee

Levee checklist is not standardized. The items to be checked depends upon the experience of the inspector and vary from person to person. The USACE team helped their Indian counterpart develop a preliminary levee checklist.

Inspection is performed by a single person, in contrast to the PI in US which is performed by a team of a many as six persons – levee sponsor, civil engineer, geotechnical engineer, hydraulics and hydrologic engineer, electrical engineer and mechanical engineer.

It is interesting to note that the WRD does not have any geotechnical engineer on their staff. This is in stark contrast to the USACE, where the geotechnical engineer is involved right from the inception of the levee's feasibility study and during the design and construction of the project. However, it should be noted that this is not typical in India.

In the US the main purpose of the levee construction is the flood control. However, the writers were informed by the Indian officials that the levees in India serve three purposes:

a. Flood control
b. Transportation, and
c. Shelter

The next five days were spent in delivering USACE presentations on the approaches to levee design and management. Each presentation was followed by discussion facilitated by WB personnel on how these approaches may or may not have applicability in Bihar. USACE introduced the audience to the Flood Risk Management Strategy present in the United States. The USACE described the cultural and political history that developed the levee assisted, flood risk management approach found in the United States. The USACE described how the USACE implements the Levee Safety Program within the context of flood risk management with the objectives being the protection of life and property, to provide national consistency, effectiveness in policy and investment, and delivery of legislatively authorized benefits, the group described their respective universe of levees. Discussions facilitated by the WB provided insights into the similarities and differences between the two programs. Both countries had programmatically and non-programmatically constructed levees. Responsibilities for operation and maintenance were similarly divided between the government and quasi governmental entities. In the US the majority of levees were not covered by standards of construction and maintenance as prescribed in the USACE program while the Indian levee program had a less prescriptive set of inspection criteria. Both Countries had published standards for levees and both countries described their implementation success and limitations with their standards.

Prior to the conference the USACE personnel used Google Earth and Bing web based images to prepare an pseudo inspection select a Bihari levee that appeared similar in features to a USACE constructed levee. Using public domain images analysis was performed by the authors to identify potential departures from the USACE Inspection of Completed Works standards. The selected levees were then pseudo inspected using the criteria present in the USACE Inspection of Completed Works checklist (USACE ER/EP-500-1-1 and USACE (2006) Levee Owners Handbook). The field examination previously described visited the areas on the selected levee to ground truth the pseudo levee inspection. Inspection results of a USACE program levee that was morphologically similar to that observed in Bihar and of the Bihari levee was then presented, compared and contrasted to illustrate the applicability of the inspection standards, the ability to record and communicate the inspection data and the ability to provide a "quick and dirty" GIS technique that would be able to be used to identify departures from a standard.

The WB personnel facilitated discussion on the USACE standards. In these facilitated discussions applicability of each element present in the USACE inspection standard and whether each element was important from an engineering perspective to be included into a Bihari approach was discussed. In addition each rating criteria that determined if the observation required immediate action, action within a specific time frame or was a normal condition was discussed by the WB facilitators and the Bihari engineering team using the USACE as a technical resource to explain rationale and approach present in the USACE rating criterion. The USACE discussed type examples of levee conditions including embankment condition, grass cover and vegetation free zones. These approaches were discussed by the Bihari team as to technical, cultural and societal merit and potential acceptance in their program. The USACE presented demonstration of the use of the inspection program in the fiscal and operational management of the Levees. An example was discussed on developing a scope of work to fill and repair erosion rills in a section of a levee. The inspection program was described as facilitating the determination of the extent of the project, cost estimate,

and provided a definitive methodology of determination of work progress and completion.

The USACE discussed the tools that it had developed to collect, store and manage the data concerning levees. This National Levee Database (NLD) was presented as one of the tools for levee management present in the USACE program. Discussion included the underlying information that populated the tool and the rational for the inspection components and rating system were explored with the Bihari program management and engineers. This discussion illustrated that the data from the inspections, according to a single nationwide standard, provided the opportunity to manage the portfolio of program levees from multiple perspectives. Several of the management approaches could include identification of where rehabilitation work was needed, ability to lump similar tasks for personnel task assignments, verification of work performed, estimation of costs, as well as system programmatic prioritization of funds. In addition the system could be utilized for monitoring of conditions not requiring immediate attention. The discussions also included the interface of the Levee Inspection Tool and supplementary records such as files obtained from geotechnical instrumentation.

Field tools including the GIS based data collection tool originally developed at the USACE Rock Island District and now used as the standard throughout the USACE were demonstrated in tutor and student sessions using the rooftop of the Conference site to illustrate data recording and field inspections. The USACE discussed alternative filed tools including the use of blackberry cell phones and GIS embedded photographs sent as text messages during high water events. Shortly before the meeting the Indian press announced development and deployment of very inexpensive tablets which were discussed as potentially providing a low cost method of levee data acquisition in comparison with the rather expensive field systems utilized by the USACE.

The Bihari personnel expressed significant interest in further development of a uniform inspection standard and incorporating this standardized inspection information into a Database similar to the NLD. At present, NLD and geotechnical instrumentation are not used routinely in India on levee projects. However, Indian counterparts expressed strong interest in these tools and informally discussed assistance from the WB in facilitating additional cooperation with the USACE.

Subsequent to this conference the WB facilitated additional discussion with USACE and provided a closer examination of the applicability of USACE programs by providing funding assistance for visitation to several USACE districts in examination of available tools, techniques, and approaches to river training, levee construction and operation and to flood risk reduction.

The USACE team also met with the officials of the WRD ministry and apprised them of our observations and findings of the Indian levees in Patna, Bihar.

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