Effects of river damming and training on the 2008 Koshi River avulsion, Nepal

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Abstract
Situated in the Nepal’s eastern Ganges region, the braided Koshi River is unique among the other rivers, because of the high frequency of channel avulsion.

Figure 1: 2008 Koshi flooding.

This research studies the role of the Koshi barrage and related embankments, constructed near the border between Nepal and India in 1963 on the channel avulsion that occurred in August 2008. In that occasion, a dike breached at Kusaha (12 km upstream of the barrage) and the river made an eastward jump of around 120 km (Sinha, 2009). During that period, the river flowed through one of its old channels for about 9 months then diverted back into the pre-2008 channel (Regmi, 2011). The resulting flood left thousands of people homeless in Nepal and millions in India (Figure 1). Furthermore, 1,500 km² of farmland was made useless, covered under a thick layer of infertile, dry sand (Hooning, 2011) (Figure 2).

Figure 2: Fine sediment deposits about 2 m thick, 2 km far from the dike breach, East-West Highway, Nepal.

The Koshi Barrage was constructed across the river channel, but all the opening are located near the eastern side, leading to sedimentation in the western side of the channel and forcing the river flow to shift towards the east. Water abstraction structures near the barrage and at Chatara (42 km upstream of the Barrage), were also observed to influence the local river morphodynamics, since they increase local sediment deposition. Average bed level rise of 0.12 m/yr upstream of the barrage brought to the conditions that led to dike breaching in 2008. During that event, huge amounts of sediment were eroded from the river bed (average 4.5 m of sediment over an area of 55 km²) and deposited outside the river channel (Devkota, 2012) (Figure 2). The resulting bed lowering of the river channel means now a gain of time to prevent a similar event in the future, since new space for sediment inside the embankments system has been created. This time, estimated in 40-50 years, can be used to take proper river engineering measures to prevent or mitigate another similar event.

This research includes the development of a 2D morphodynamic model based on the Delft3D code for the analysis of the river response to changes in discharge, longitudinal/transverse slope, bed roughness, sediment grain size, bar position and gate operating mechanism of the barrage. Different scenarios were tested for the river in 1970 and 2010 maps. Model results show that the complex topography of the Koshi River bed causes spatial variations of flow resistance and sediment transport. This, together with barrage and embankments causes in-channel sedimentation and forces the river to shift towards the east. Hence, eastward shifting of the Koshi River is observed due to a combination of all these external (human intervention) as well as internal (bar formation and increase in local roughness) forcing. A transverse slope of the river corridor caused by tectonic activities is not needed to explain the river tendency to shift eastward.

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References