MORPHOLOGICAL IMPACT OF BRIDGE CONSTRUCTION ON SUNSARI MORANG IRRIGATION INTAKE

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ABSTRACT

In this paper, we present the results of a morphological study revealing the impacts of river intervention during bridge construction phase in Koshi River near Chatara (Nepal). We demonstrate how such intervention in the river reach resulted in morphological changes that subsequently had an impact on the intake of Sunsari-Morang Irrigation Project (SMIP), located downstream of the bridge. We carried out image analysis to detect the problem and attempted to replicate it using a two-dimensional morphological model (Delft3D). The study revealed how flow and geomorphological feature and processes as well as intervention on these processes lead to adverse impacts on the river system on one hand, and safety and functionality of water infrastructures on the other. The paper demonstrates how a process-based modelling tool can be useful for a rapid assessment of morphological impacts caused by interventions in highly dynamic and sediment-laden river like Koshi.

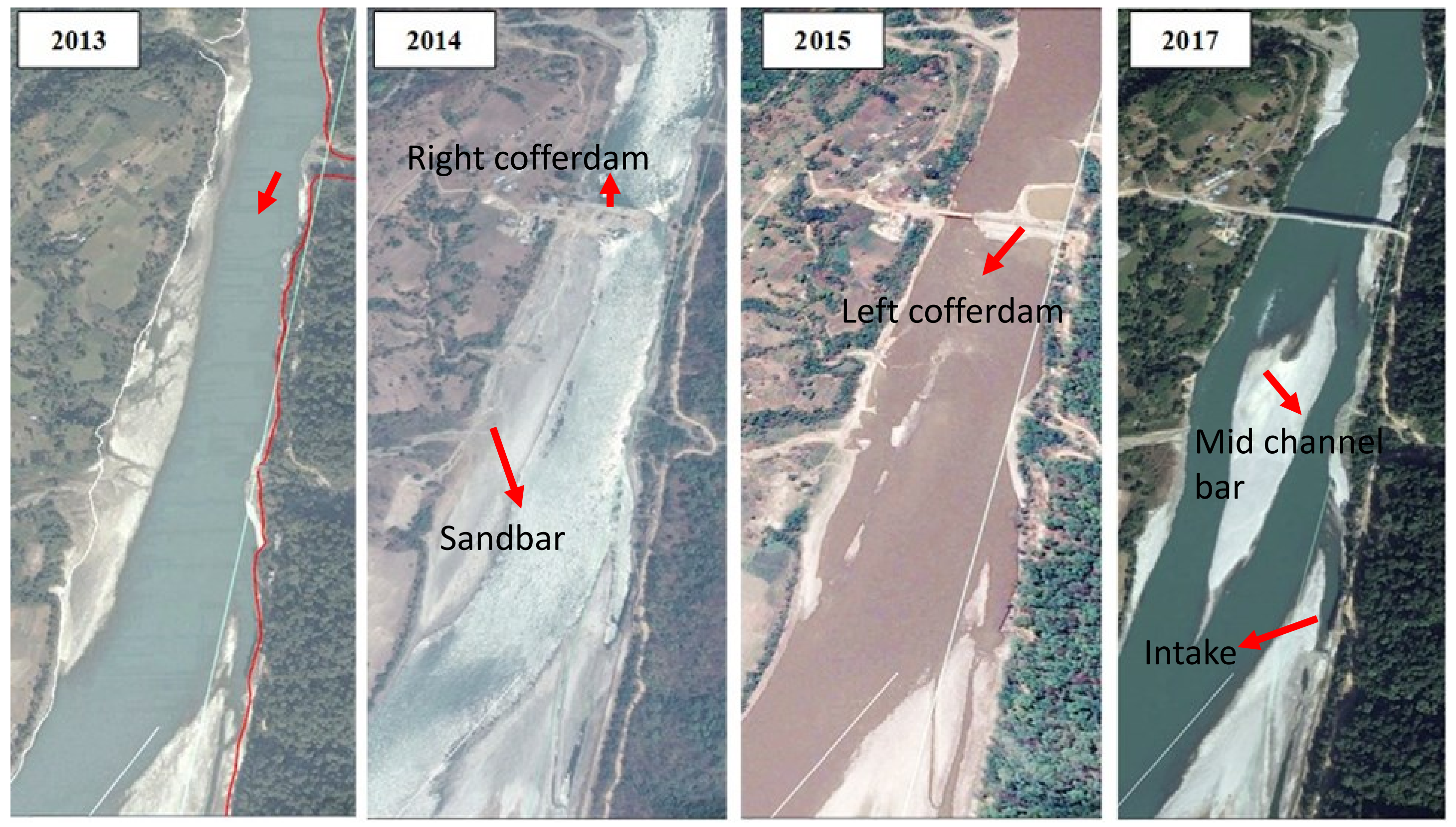

Figure 1. Google earth images showing the evolution of mid-channel bar as an effect of cofferdam

Google earth images as depicted in Figure 1, which clearly shows the formation of mid-channel bar after the construction of the cofferdams. It can also be seen that the bank and sandbar at the right side was eroded, apparently as an impact of the left cofferdam. In fact, this was a major reason for the formation of the mid-channel bar.

Brief description of different scenarios

S.no.	Scenarios	Conditions	Remarks
1	Simulation of reference case	Initial falt bed	Fig 3(left)
2	Reproducing morphological effect of cofferdams	a) Right bank cofferdam was placed initially. b) Then, left bank cofferdam was placed.	Fig 3(right)
3	Scenario after formation of mid channel bar	Left bank cofferdam not removed	Fig 4(left)
		Groyne at u/s and d/s of Chatara bridge at right bank and left bank cofferdam not removed.	Fig 4(right)
		Groyne at u/s of Chatara bridge at right bank and left bank cofferdam removed.	Fig 5
		Groyne d/s of Chatara bridge at right bank and left bank cofferdam removed	Fig 6

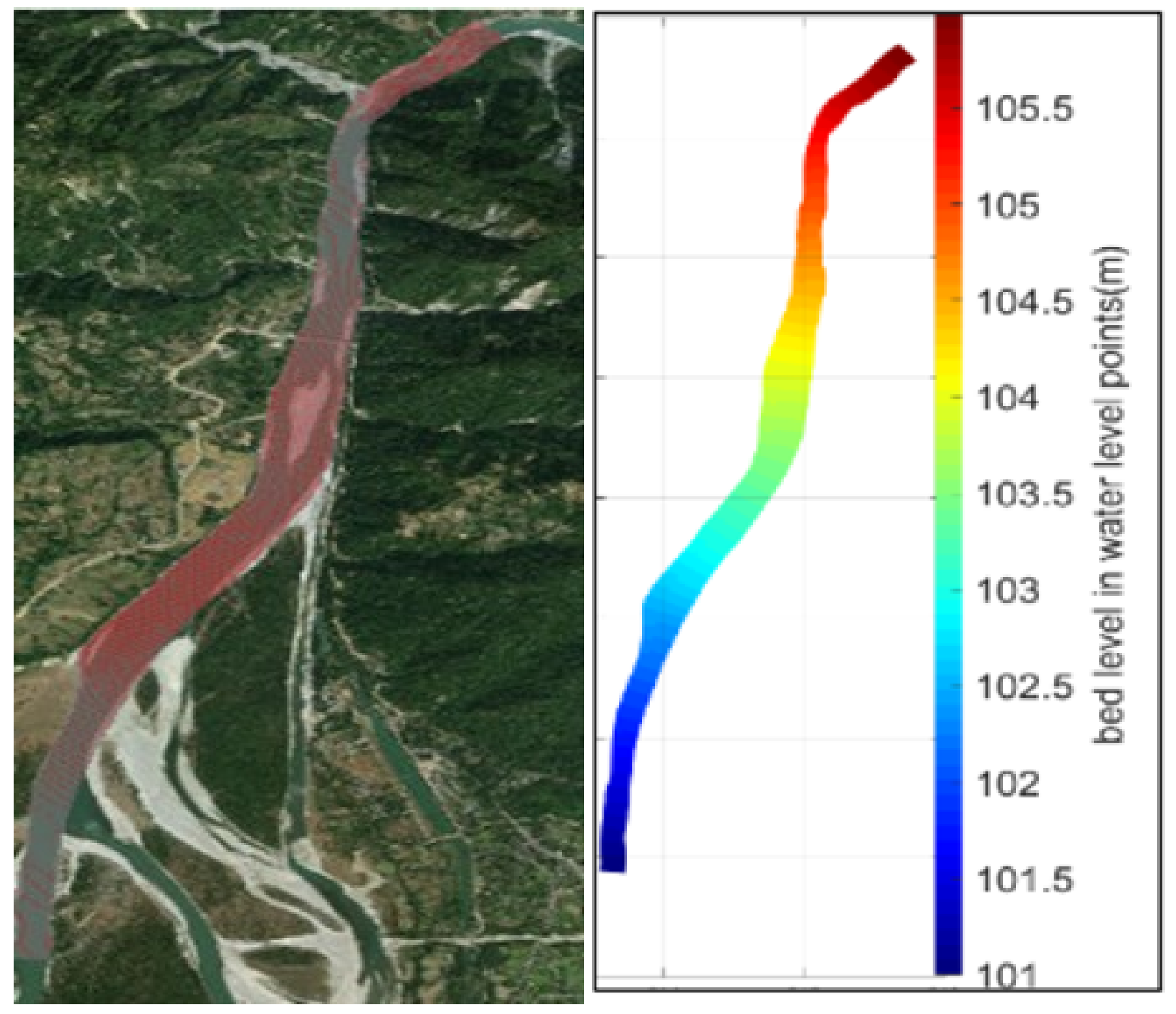

Figure 2. Model domain with computational grid (left) and a flatbed initial bathymetry (right)

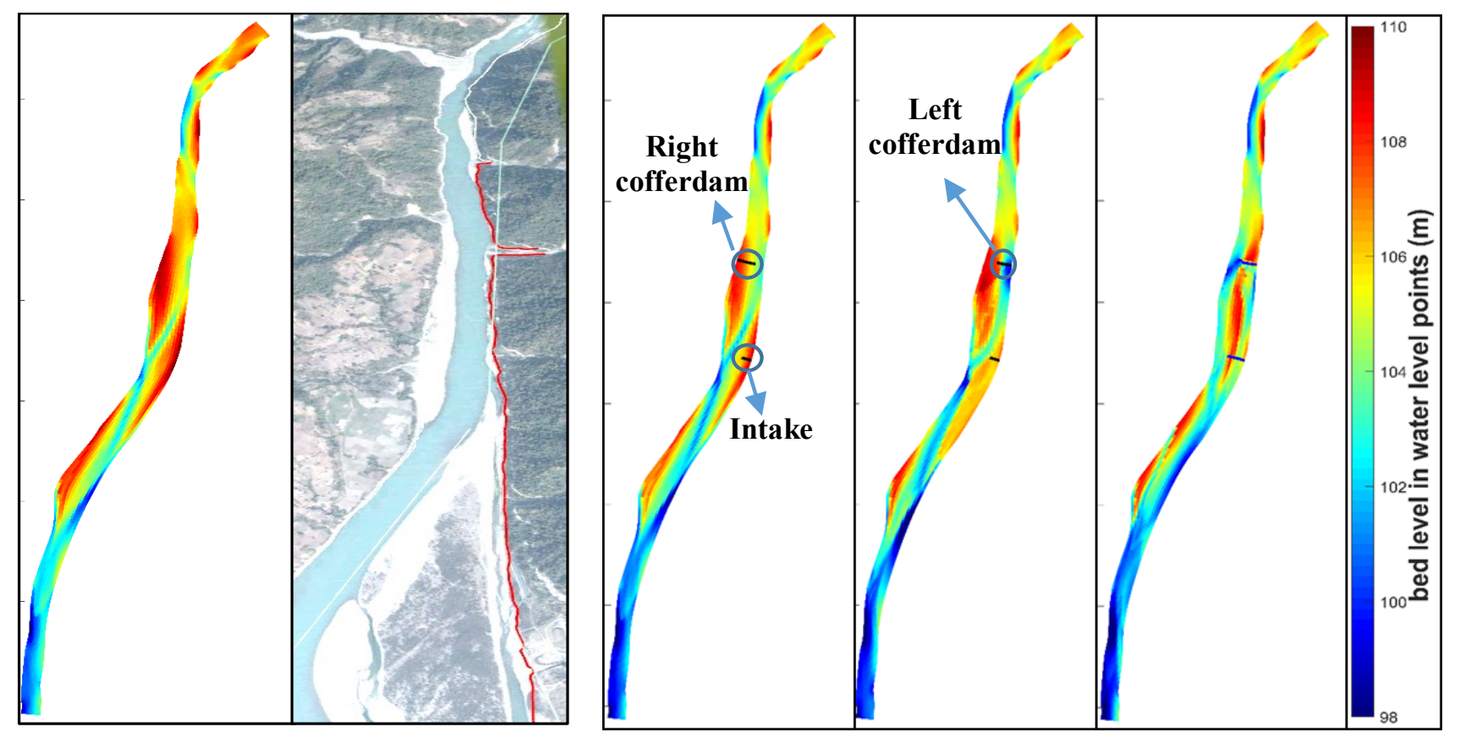

Figure 3. Comparison between the river bed after spin-up simulation (from initial flatbed condition) and Google earth image before the construction of the bridge (left), and simulation result showing impact of construction of right and left cofferdams and eventually formation of a mid-channel bar (right) as shown in Figure 1

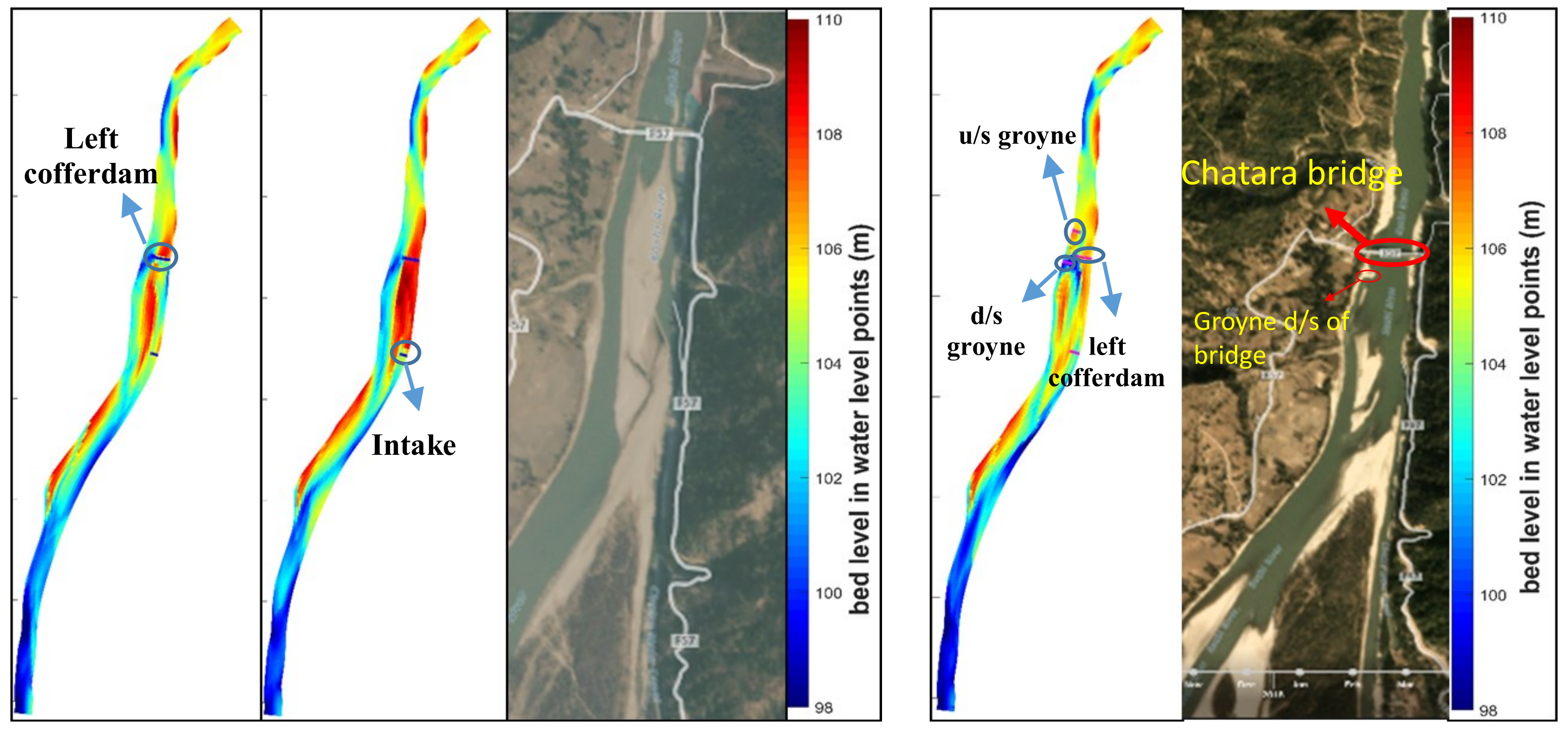

Figure 4. Simulation result for the scenario when left cofferdam was not removed (left) and the scenario showing erosion of mid-channel bar with newly constructed groyne downstream of chatar bridge and comparing to Google Earth image (right) {Google earth images; left: Feb 2016 and right Dec 2018}

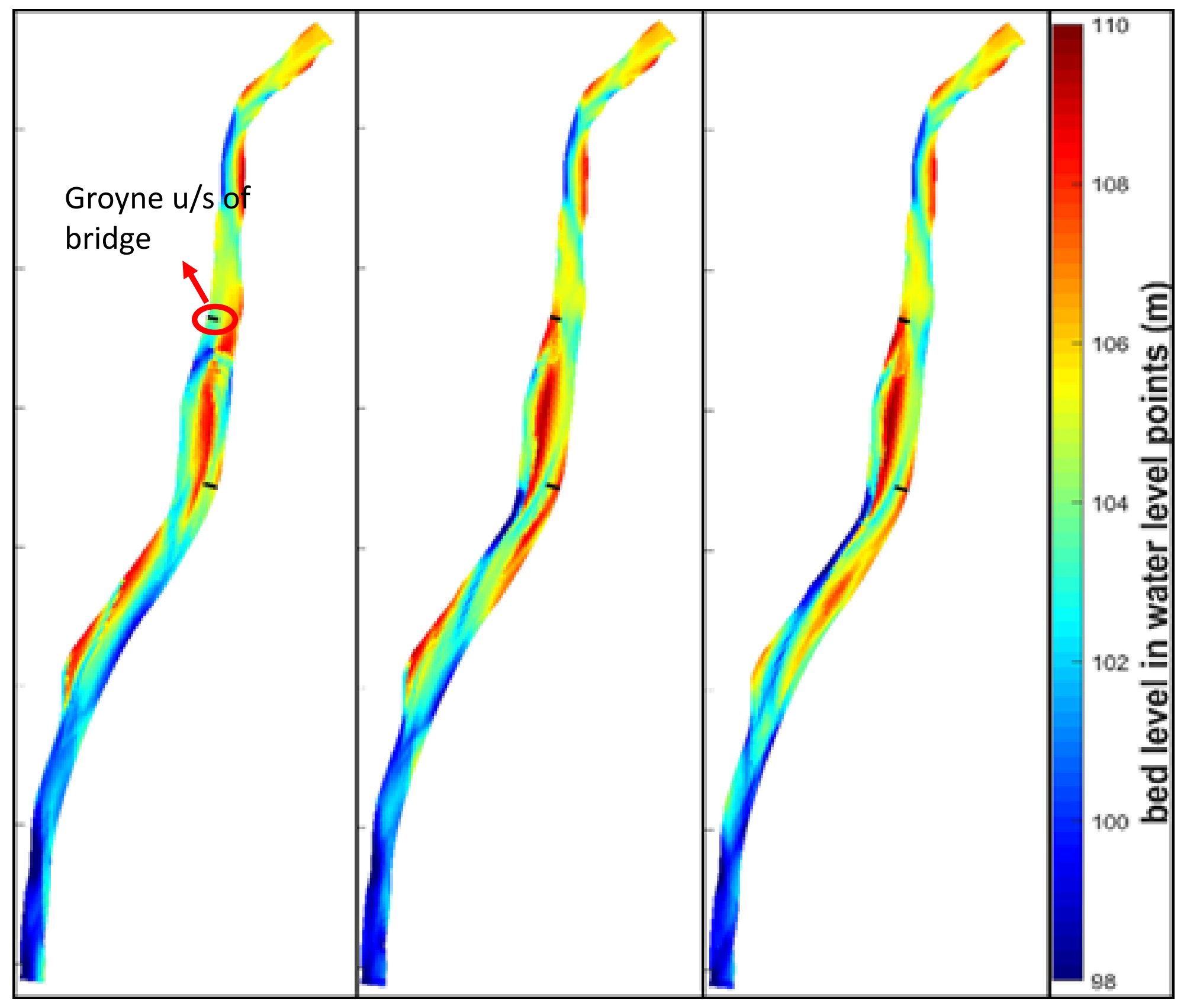

Figure 5. Simulation scenario with the groyne at right bank showing erosion of mid-channel bar and shift of sandbar towards the right bank and the deeper channel along the left bank

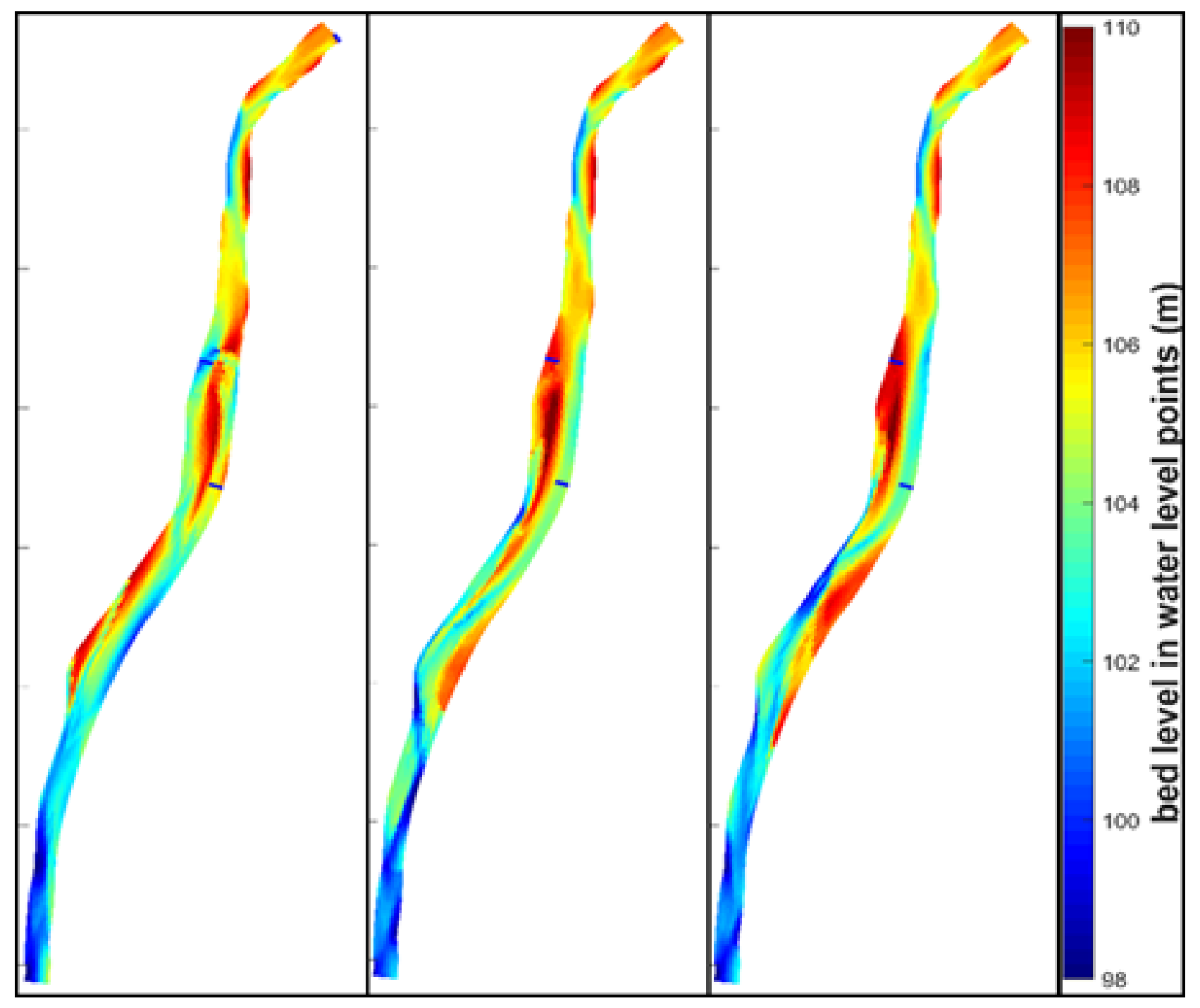

Figure 6. Simulation scenario with the groyne at the right bank d/s of the bridge (cofferdam at the left bank removed) showing erosion of the mid-channel bar and shift of sandbar towards the right bank and deeper channel along the left bank

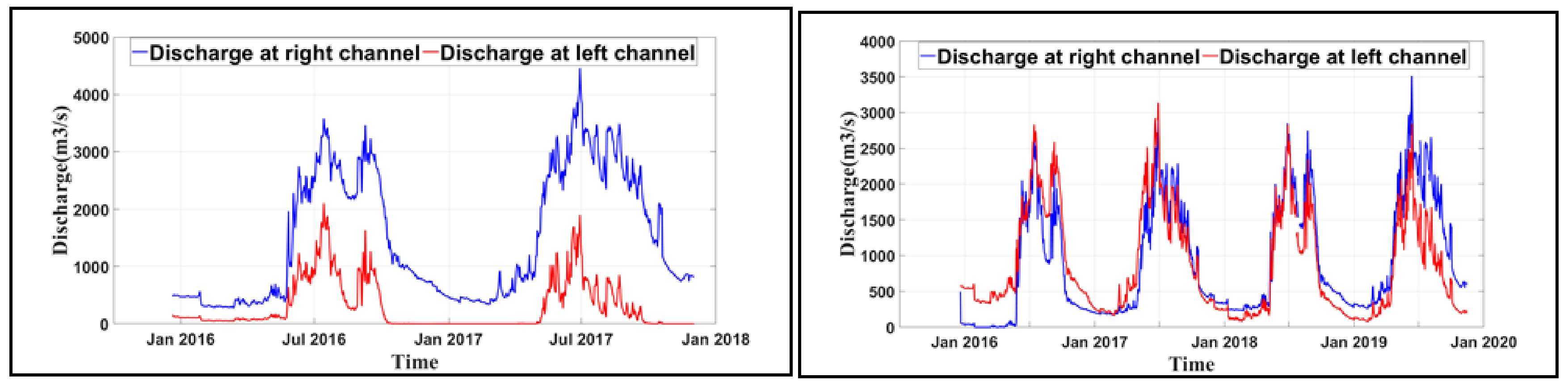

Figure 7. Discharge distribution at the bifurcation after formation of the mid-channel bar showing less discharge towards the left branch where intake is located (indicated by red color line in left plot), and after the erosion of the mid-channel bar showing almost similar amount of discharge flowing through both the branches (right)

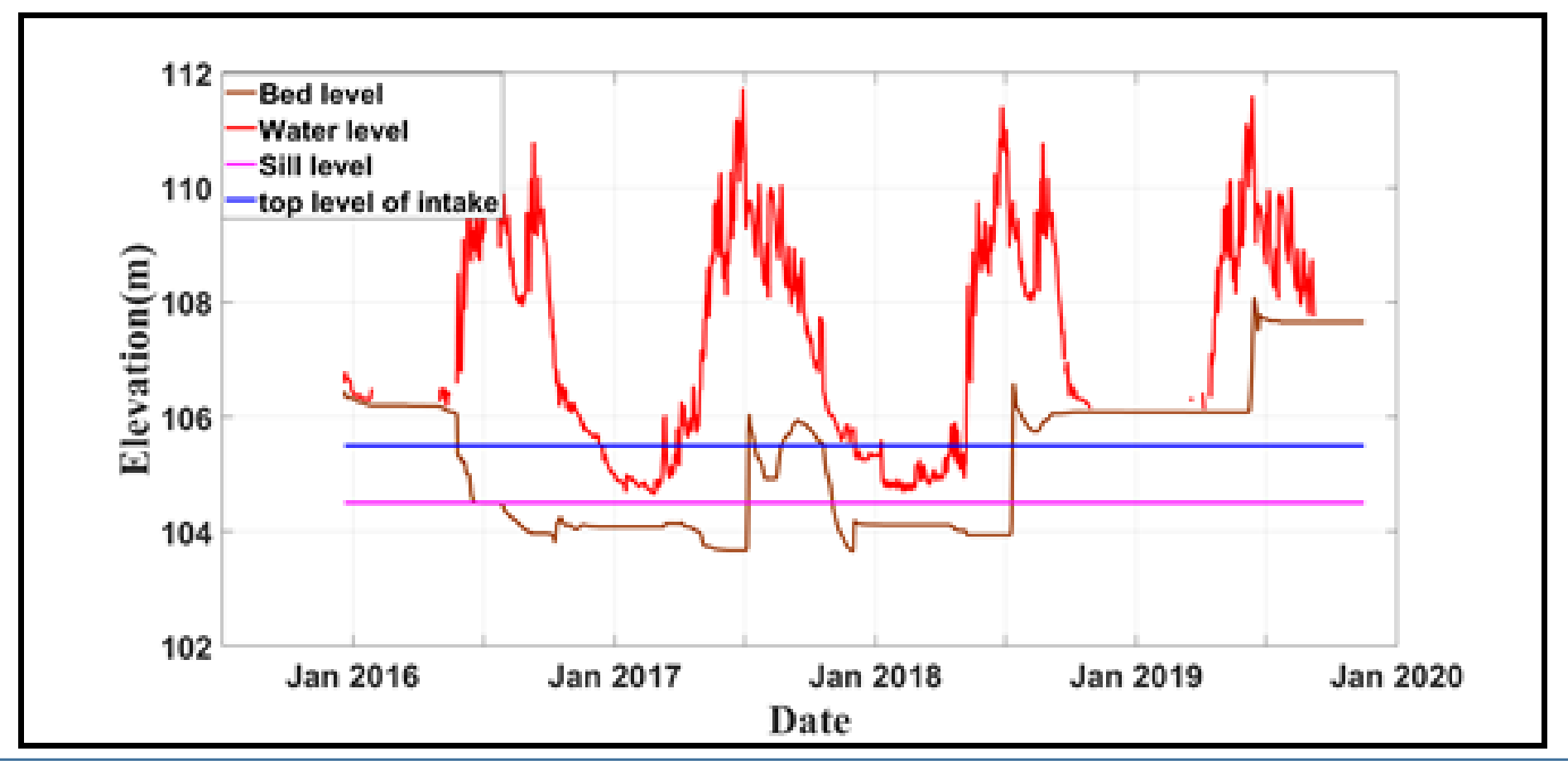

Figure 8. Simulated changes of bed level, water level and sill level at the intake for the scenario shown in Figure 5

Bed level of the river near the intake is 104 m, which stayed below the sill level for two years up to pre-monsoon of 2017 with sufficient water level at the intake. The worst case is when the bed level at the intake increases every year after the monsoon of 2018.

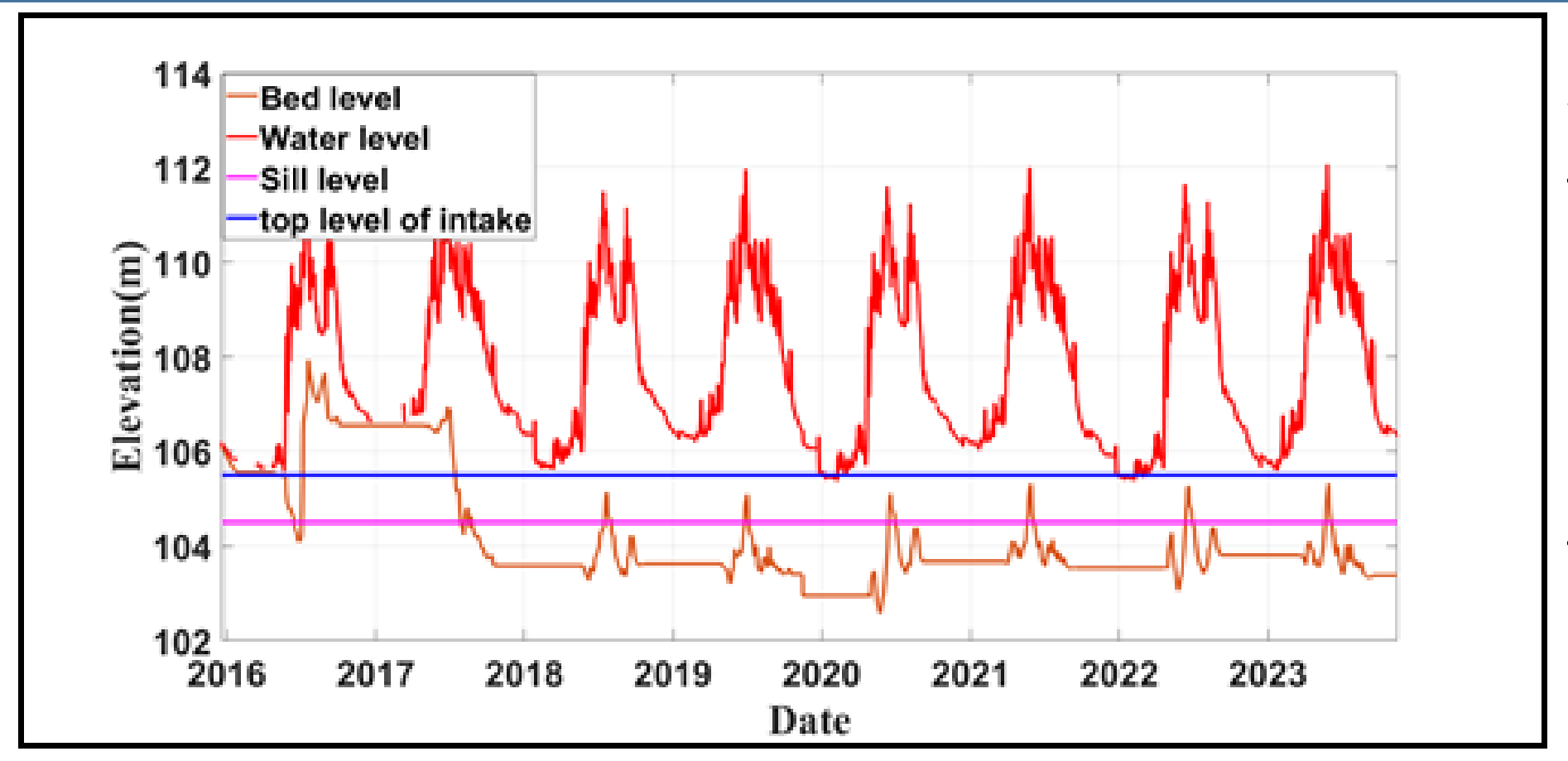

Figure 9. Simulated changes of bed level, water level and sill level at the intake for the scenario shown in Figure 6

When the groyne was constructed at the right bank below the bridge (as shown in fig 6) shows that the bed level has stayed below the sill level for number of consecutive years with sufficient water level at the intake. The bed level rises during the flood period above the sill level of the intake and goes down below the sill level after the flood, thus facilitating the flow of water into the intake.

CONCLUSION AND RECOMMENDATION

The study shows how a morphological model can be useful to simulate hydraulic and morphological impacts of the intervention in a river reach (in this case, the effect of cofferdams during a bridge construction). It is very important to assess such impact before constructing any kind of interventions on a river.

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