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Effect of valley shape on temporal change characteristics of bars under unsteady flow condition

○Mauricio Andrades PAIXAO, Hiroshi TAKEBAYASHI, Masaharu FUJITA, Masato KOBIYAMA

Introduction

Bars units are sediment accumulations in channel scale which represent an important role for bedload storage. They are characterized by an elevated region in the river channel where the sediments, that used to be finer than others that compound the reach, are deposited. Bar units are observed in a large range of rivers worldwide. Such structure represents an important role in flow resistance and it is related to short-term response to flow variation and sediment transport.

Some studies have achieved to reproduce the morphology and dynamics characteristics of bars however, in general, the results are insufficient for long-term modeling, as demonstrated by Edmonds and Slingerland (2007). Thus, it is considered that bank erosion process, enforced fluctuations in boundary conditions and spatial-temporal variation in flow discharge have an important role for describing temporal changes in bars.

In order to fill this gap, the present study aimed to preliminary describe the effect of valley shape on temporal change characteristics of bars under unsteady flow condition. Detailed topographic data from two different periods (Jul-18 and Dec-18) were used to evaluate the width/depth relation and the entrenchment ratio. As another step of this research, computational modeling by Morpho2DH will be used to predict temporal changes characteristics of bars in the Boi river.

Material and Methods

The study area is the Boi River Watershed (128 sq km), located in the South of Brazil (Fig. 1), in a typical mountain environment with canyon landscape.

Detailed topographical data were obtained by field survey in two different periods (July 18 and December 2018) for the three reaches considered in this analysis (Fig.1). Each reach has approximately 100 m of length, being composed by bar sequences and distinct gradient and valley shapes. Reaches A, B and C have 0.03 m/m, 0.015 m/m and 0.014 m/m of gradient, respectively.

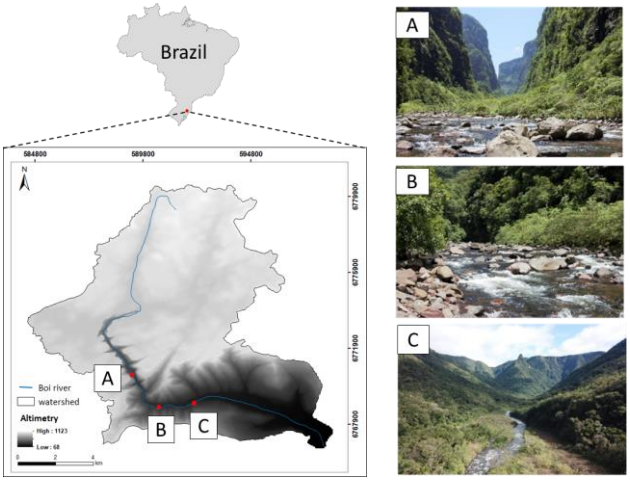

Fig 1. Study area – Boi River Watershed and selected reaches

Hydrological data from a fluviometric station in the downstream were used to identify runoff condition. The most extreme event between the two field survey is considered responsible for the changes in the channel. This event has a duration of 7 days between July 24 and July 30, and peak discharge of 152 m³/s (Fig. 2).

For the next step of the present study, computational modeling with Morpho2DH will be performed to verify the changes in bars during floods.

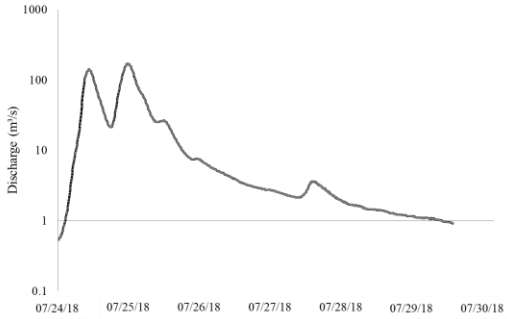

Fig 2. Flow discharge of considered event

Results and Discussion

Alterations in the channel morphology are shown in Fig 3. It is possible to observe that lateral bars were moved in the three reaches although these changes seems to be more pronounced in the cross-section at reach C.

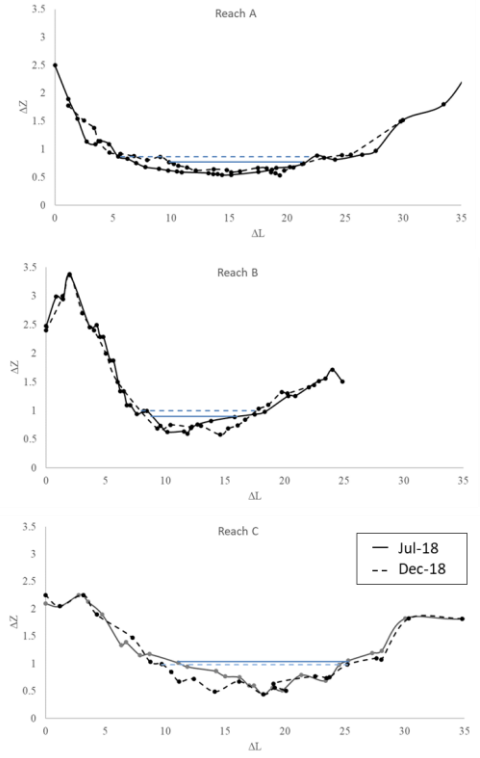

Fig 3. Changes in channel morphology

Summarized results for measured and calculated parameters are shown in Table 1. Field data demonstrate that the reach A has the largest ER and WD relation for both times, Jul-18 and Dec-18, meanwhile reach C has the smallest values for these parameters. Although ER and W/D reduces for reaches A and C, these parameters became wider from Jul-18 to Dec-18 in reach B. Is possible to observe a consistent change in the right bar in reach B with lateral migration of sediments, allowing the reach to become more entrenched.

Table 1 – Summarized parameters

	Jul-18			Dec-18		
	A	**B**	**C**	**A**	**B**	**C**
W	11.45	7.2	14.20	16.35	9.50	15.54
FW	17.65	9.8	18.30	23.96	13.79	20.35
D	0.18	0.30	0.60	0.32	0.35	0.54
ER	1.54	1.36	1.28	1.46	1.45	1.31
W/D	62.21	23.84	23.8	50.77	27.14	25.56

where W is width (m); FW is floodplain width (m); D is depth (m); and ER is entrenchment ratio.

Field data indicate that reach C, which has the smallest gradient, transports the largest amount of sediments. Although more detailed investigation will be performed in the next steps of the present research, it is possible to verify that the absent of complex association of different channel morphologies and larger discharge due to hydrograph convolution associated with its contribution area may influence on sediment movement in reach C.

Next steps of the present research include detection of changes in geomorphology in the analyzed period and modeling with Morpho2DH to evaluate and quantify the temporal changes of these bars.

Conclusions

Analyzing topographical data from different reaches in the Boi river, the present study investigated the effect of valley shape on temporal changes of bars under unsteady flow. The analysis of field data suggests that large W/D values may not strongly affect the temporal changes in bar units.

References

Edmonds, D. A., and R. L. Slingerland (2007), Mechanics of river mouth bar formation: Implications for the morphodynamics of delta distributary networks, J. Geophys.Res., 112, F02034, doi:10.1029/2006JF000574.