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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Environmental impacts of human action in watercourses" *by* J. S. Antunes do Carmo

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INTRODUCTORY REMARKS

This manuscript aims to alert for activities that customarily are developed in watercourses without regard to the consequences that such interventions can have up to very considerable distances, both upstream and downstream of the disturbed areas.

Examples are: the construction of dams, installation of bridge piers, sand extractions, and other installations like groins, dikes and small dams for purposes of protection and/or exploitations of watercourses with multiple purposes.

Therefore, this paper presents a purely morphodynamic approach (morphological

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Interactive Discussion

Discussion Paper

changes in/of the riverbed). Under this context, studies on other impacts are unjustified, namely on water quality, on riparian ecosystems, on flora and fauna, among others.

I understand that the title is very general and that some content may not be clear enough, making it vague and not fully reflecting the objectives. The added subtitle reflects more accurately the manuscript content.

Figure 10 should be interpreted in a qualitative way. On this basis, it seems clear enough.

Accordingly, some material has been added (see below): - a subtitle; - few corrections (3) in the Abstract; - new text added at the beginning (first paragraph) and before the last paragraph of Section 1, and two new citations; - new paragraph in Section 2; - new paragraph and three new citations in Section 3; - few corrections in a paragraph of the Conclusions; - new paragraph in the Conclusions; - six new references in the List of References.

Firstly, my response to the reviewer's comments.

RESPONSE TO REVIEWER COMMENTS

I would like to thank the reviewer for some valuable suggestions which have contributed to enhance the manuscript.

(1) The title promises to address environmental impacts, however, the manuscript is solely focused on...

The title was changed in order to better reflect the contents of the paper.

(2) Most of the problems of the manuscript originate in the large lack of relevant citations,...

I agree that should be added recent references on the latest developments of the relationship (1). In this regard, two references have been added. Three other references

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were added because they are important contributions to the impacts evaluation of hydraulic structures built on riverbeds.

In this context, five citations are added throughout the text and six references are also added to the previous References List (one already mentioned but not included in this List). Three of these references were suggested by the reviewer, to whom I address my thanks.

(3) The manuscript fails to reflect the state of science in the field...

This manuscript does not aim to contribute to the discussion about the relationship (1).

This manuscript intends to retake the 'classic' concept translated by (1) and to invoke its validity for preliminary analysis of morphodynamic processes in the cases under consideration (particularly related to sand extractions in watercourses and sand retention in dams, with consequences in overall behavior of fluvial systems due to changes in the riverbeds slopes).

For this purpose, the relationship (1) is valid and sufficiently clear, since cross sectional measures are not concerned.

Validation or assessment of the application conditions of the classical model of Lane is not the goal of this manuscript.

Therefore, a thorough discussion around the relationship (1) is not justified because it would be relatively marginal to the focus of the manuscript.

(4) The discussion is too short, disconnected from the result section and remains generic.

This paper describes two very serious accidents that occurred in Portugal, both of which happened as a result of interventions, human activities and inadequate management in two watercourses, as a result of lack of knowledge of the fluvial processes in question.

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This paper also presents a morphodynamic model whose mathematical and numerical formulations of the solid phase present several improvements over other versions of this and other numerical models in this area. The application and results are clear examples of this.

The guidelines proposed in the discussion/Conclusions are drawn as a result of the experience gained from the accidents (section 1) and the analyzes made (section 3). A new paragraph/contribution was added in the Conclusions.

(5) In order to publish this manuscript, the author would have to modify it fundamentally.

ADDED MATERIAL (with yellow background in the uploaded PDF file)

The following changes were considered.

- Title "Environmental impacts of human action in watercourses: Responses to changes in morphodynamic processes"

- In the Abstract

Few changes/corrections (3) in the last two paragraphs: "A thorough understanding of the morphodynamic processes and new strategies are needed to develop a multifunctional use structure, which must take into account the many-faceted aims of sustainable development. This paper provides a brief description of the nature and distribution of the direct and indirect types of impacts on the river morphology arising out of building and operating large dams, as well as some specific points that should be taken into consideration. It also reflects on the way in which the problem of extracting inert material from water environments has been dealt with in Portugal, leading to serious accidents. A brief technical contribution is offered, which although qualitative provides a basic record and explanation of the consequences of significant interventions in water environments that have not been properly assessed or have not taken other mitigating circumstances into consideration."

- In Section 1 - Introduction

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First paragraph added (before "Few rivers in Portugal retain ..."):

"Erosion in rivers is not a serious problem so far as no human action is present. But this natural hazard becomes a disaster when riparian buffers are not maintained, and human actions are felt in the bed and on river banks. Anthropogenic activities along the river stretch disturb the equilibrium of the river dynamics and accelerate the rate of bank erosion. Anthropogenic activities like gravel mining, sand extraction, construction of dams and bridges, artificial cut offs, bank revetment, deforestation and land use alterations change the morphology and natural dynamics of rivers (Kondolf, 1997). Human activities are stronger with respect to changing river dynamics than natural events as floods, droughts and landslides (Yamani et al., 2011)."

New text added before the last paragraph (before "Aiming to help Prevent occurrences ..."):

"In the Hintze Ribeiro Bridge photo, shown in Figure 4, both the geometry and the shape of the cross section of the river bed are clearly visible. The P2 and P3 pillars were the most affected by the river flow. The protections of these pillars existed in 1931 as well as the sandbar at the intrados of the Douro river curve. Figure 4 also shows that the P4 pillar was founded in the sandbar, and with a sand level similar to that of the P5 pillar. With the increase of sand extractions, since the 70's, the sandbar has been decreasing, due to direct extraction, having nearly disappeared in 1982, as stated in a survey carried out that year.

The lowering of the bottom topography in the order of four meters, on average, recorded between 2000 and 2001 in the Hintze Ribeiro Bridge section, was primarily the result of the five major floods observed in the period from December 2000 to March 2001 (Figure 3). As the sand was not sufficient in order to supply the needs created by the five flood waves, the large holes created upstream by sand extraction, over more than two decades, were not able to be silted up, thus restoring the conditions prior to sand extractions.

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A picture taken just a few days after the bridge collapse show that the P4 pillar fell upriver, against the natural effect of the flow, whose strength and resulting impulse would point in the opposite direction. Such behavior can only be explained due to infra-excavation, which was the dominant process at the base of the pillar P4, putting it out of service.

More recently, another bridge situated at approximately 10 km downstream of the Raiva dam, in the Mondego River, and about 20 km upstream of Coimbra, Portugal, collapsed. The scour around one pillar of the bridge, in this case due to lack of sand that is retained in the Aguieira and Raiva dams, led to the lowering of the river bottom about 6 m in relation to the initial level."

- In Section 2 - Background

First paragraph added (before "Over thousands of years an almost natural balance..."):

"In general, all anthropogenic actions that change the river morphology will have regional-scale impacts. Even interventions limited to small areas, as levee construction, linearization of a river stretch, sand extractions and gravel mining, the effects can be felt until long distances downstream and upstream of the affected areas. Other interventions, to an even broader regional-scale, should be considered, such as flow and sediment regulation by large dams and changes caused by groundwater extraction."

- In Section 3 - Responses of the fluvial system to changes in morphodynamic processes

Reference added (before equation (1), along with the two existing references):

(Lane, 1955; Antunes do Carmo,...)

Paragraph added (before "To better understand this type of analysis,..."):

"Expansions of Lane's relation (1) to account for changes in cross-sectional, planform and bedform geometry have been suggested recently (Dust and Wohl, 2012; Huang

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et al, 1014). We recognize that these changes are typically associated with complex channel adjustments, but for the analyzes considered in this work is sufficient to use the classical relation (1)."

- In Conclusions

Few corrections in the paragraph started by "It should be concluded that..."

"It should be concluded that all interventions performed in the fluvial system, including regularization of rivers, rectification of stretches and correction of riverbeds, must always be preceded by environmental impact studies covering large stretches of the river, both upstream and downstream of the area directly affected."

Paragraph added (before "In relation to extraction of inert material in river environments,..."):

"From the hydrological point of view, we highlight the fact that none of the five floods that occurred in three months exceeded half of the local PMF (the flood that can be expected from the most severe combination of meteorological and hydrological conditions possible for the region in a given period, typically a hundred years). This means that security and stability of hydraulic constructions installed in alluvial riverbeds should be evaluated taking into account possible sequences of floods with short intervals of occurrence, even with intensities well below the PMF."

References added (properly placed in alphabetical order):

Dust D. and Wohl E., 2012. Conceptual model for complex river responses using an expanded Lane's relation. Geomorphology 139–140, 109–121.

Huang H.Q., Liu X. and Nanson G.C., 2014. Commentary on a 'Conceptual model for complex river responses using an expanded Lane's relation by David Dust and Ellen Wohl'. Geomorphology 209, 140–142.

Kondolf G.M., 1997. Hungry Water: Effects of dams and gravel mining on river chan-

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Lane E.W., 1955. The importance of fluvial morphology in hydraulic engineering. Proceedings of the American Society of Civil Engineers 81, 1–17.

Rocha J.S., Antunes do Carmo J.S., Lemos L.J.L., Silva V.D. and Rebelo C.A.S., 2008. Bridges built on alluvial beds: The failure of the Hintze Ribeiro Bridge. Portuguese Journal of Water Resources 29, 2, 41-57. ISSN 0870-1741 (in Portuguese).

Yamani M., Goorabi A. and Dowlati J., 2011. The effect of human activities on river bank stability (Case study). American Journal of Environmental Sciences 7(3), 244–247.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C2531/2014/nhessd-2-C2531-2014-supplement.pdf

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 6499, 2014.