2D numerical flow modelling of a river reach in order to assess results of the backwater effect

Martí Ribé (1), F. Xavier Castelltort (2), Ernest Bladé (1), J. Carles Balasch (2), J. Lluís Ruiz-Bellet (2), JordiTuset (3), Mariano Barriendos (4), David Pino (5), and Jordi Mazón (5)

(1) Flumen Research Group, Dept. of Hydraulic, Maritime and Environmental Eng., Universitat Politècnica de Catalunya, Barcelona, Spain (marti.ribe@upc.edu), (2) Universitat de Lleida, ETSEA, Environment and Soil Sciences, Lleida, Spain, (3)RIUS Fluvial Dynamics Research Group, Universitat de Lleida, Lleida, Spain, (4) Department of Modern History, University of Barcelona, Barcelona, Spain, (5) Department of Applied Physics, Universitat Politècnica de Catalunya, BarcelonaTech, Barcelona, Spain

INTRODUCTION

The Ebro River is one of the main rivers in the Iberian Peninsula. It drains into the Mediterranean Sea an area of 85,000 km^2. Its mean flow is 428 m^3·s^{-1} and the runoff coefficient is 25.8%.

The aim of this study is to assess the results of the backwater effect in two different situations. Firstly, the effect produced by a channel constriction. Secondly, the effect produced by a temporary or permanent rise in sea level.

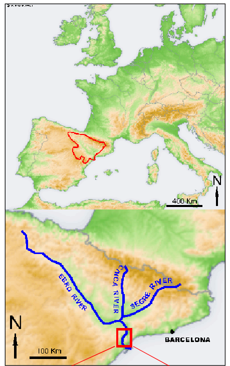

Fig. 1

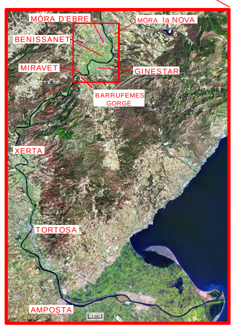

Fig. 2

THE BACKWATER EFFECT CAUSED BY A LITHOLOGIC CONSTRICTION

The backwater effect influences the flood routing in a significant way by introducing water storage upstream from a channel disturbance. Water storage attenuates the peak of the flood wave. The backwater effect forces the stream to create room for the backing up water. This process can be formative. The end point of the backwater effect is the place where the rise in water begins to cause damage. A lithologic constriction into the channel is one of the cases of backwater effect occurrence. This effect has been studied in the Barrufemes Gorge, in the Ebro River, just few kilometers before its flowing into the Mediterranean Sea.

In Fig. 3 a plot of eight 2D modelled synthetic floods is shown. Results of the backwater effect can be seen in the ground plan from minor to large floods, as well as the upstream shifting of the end point of the backwater effect as the flood discharge increases.

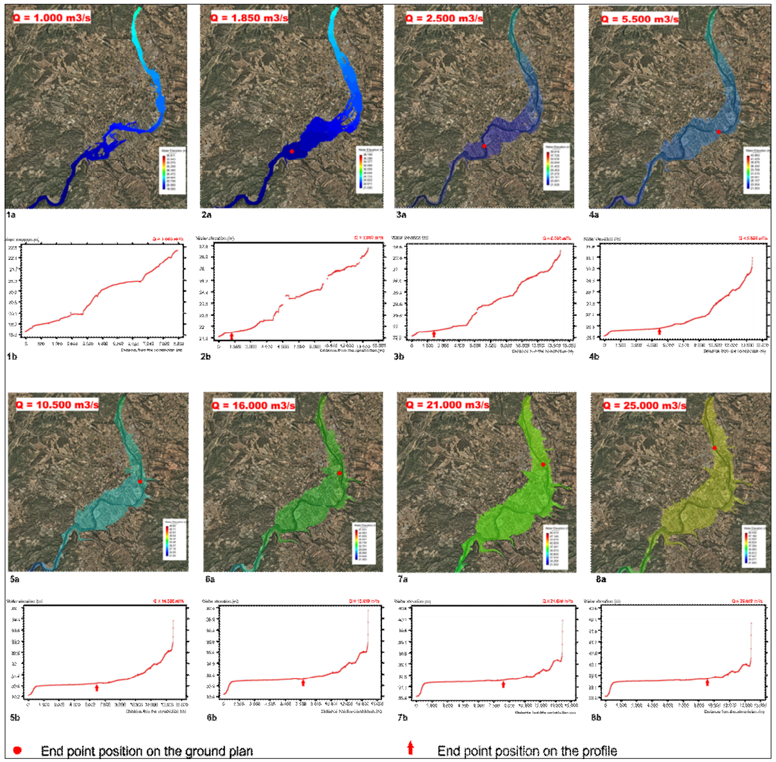

Fig. 3

The upstream reach of the backwater effect can be well recognized from Q=2.500 m^3/s until Q=10.000 m^3/s floods. The profile of these floods show a well defined end point. The end point is difficult to place accurately in floods with large water discharges. The queue of the backwater effect is very similar in major floods. From this point of view, floods arriving this area could be divided into three categories: small scale floods, up to Q=2.500 m^3/s; medium-sized floods, from Q=2.500 m^3/s up to Q=10.000 m^3/s; large-size floods, above Q=10.000 m^3/s.

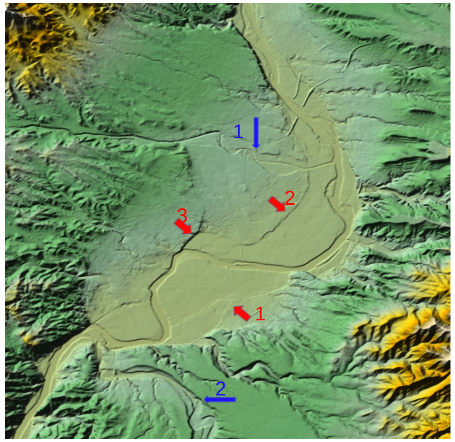

Fig. 4

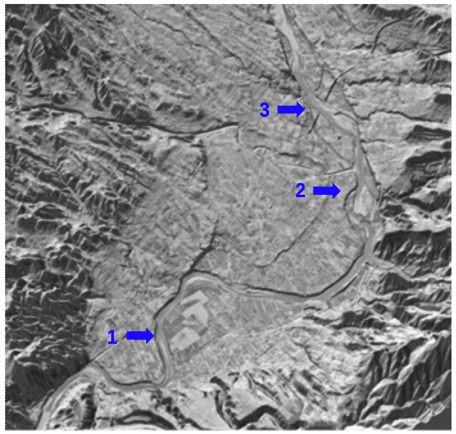

Fig. 5

CONCLUSIONS

- Wide floodplains influenced by backwater effect are formed upstream from a lithologic constriction.
- The backwater effect depends on the magnitude and frequency of floods arriving at the constriction. In other words, the construction is incised by a group of floods recurrent enough and formative.
- Major and extreme events are not enough recurrent to create a channel pattern easily perceptible from a geomorphic point of view as well as hydraulic.
- Determinate bedforms are typical of end point still waters due to rapid vertical accretion. Geomorphic marks allow to recognize the most recurrent flood discharges.
- Tributaries flowing into the backwater effect area are influenced by it

GEOMORPHIC MARKS

There are two sets of geomorphic marks in Fig. 3. Firstly, a group of riverbank erosion marks at different elevations (in red), and secondly, a group of meandering reaches of the tributaries (in blue).

Riverbank marks indicate the uppermost water level of certain formative floods. These have been recurrent enough to leave mark in the riverbank.

The riverbank mark **1** corresponds to a water level of 23 m. A Q=2.500 m^3/s flood fits into this limit. The riverbank mark **2** matches a water level of 25-27 m which is filled with a Q=5.500 m^3/s flood. The riverbank **3** ranges between 22-40 m. This bank is affected by any of the modelled floods over 3.000 m^3/s.

The tributary's meandering reach **1** starts at a water level of 35,8 masl, and the meandering reach **2** starts at a water level of 37.8 masl. These water levels match for a flood of 21.000 m^3/s.

CHANNEL BEDFORMS ANALYSIS

The end point of small scale floods reach the point **1**. Although these floods overflow the main channel, water velocity is larger in channel sections. This results in the formation of channel bedforms, such as gravel bars. The end point of medium-sized floods range from points **1** and **2**. The smallest floods of this group continue developing channel bedforms, but the greatest have created a micro delta in the end point area, where the high-velocity flow reaches still waters and losses the sediment load. The same effect have taken place in point **3** where the large-size floods have developed a bigger micro delta.