HYDROLOGICAL AND SEDIMENTOLOGICAL BEHAVIOR OF THE CATALAN RIVERS. COMPARISON WITH A MEDITERRANEAN NATURAL SEDIMENT FLUX MODEL

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Abstract

The Inner Catalan river basins (NW Mediterranean) have been analysed from two different perspectives. The first analysis deals with the long-term hydrological evolution of the studied watersheds and its relation with global and regional climatic factors. The second analysis integrates the available sediment load data with lithologic, climatic, land-use, and geomorphic parameters in order to develop a reliable model of river influx under natural and human impacted conditions. This second analysis is reinforced by a similar study involving other 79 Mediterranean river basins.

Keywords : Gis, Hydrology, River Input.

Introduction

The pressure over fluvial systems is especially intense in the Mediterranean region mainly due to the rising human population and the agricultural needs. Mediterranean rivers are not only important as fresh-water sources, but also as nutrient and sediment suppliers to the marine environment. A significant scientific effort is underway to understand the hydrological and sedimentary behavior of Mediterranean rivers in order to ensure their sustainability and that of the Mediterranean Sea and its shorelines.

Catalonia is in the western part of the NW Mediterranean Basin. As in many other Mediterranean regions, fluvial solid discharge has not been regularly and historically monitored. The challenge is, therefore, to achieve a reliable model of river input under natural and human impacted conditions.

Analysis of long-term hydrological and climatic time series

Long-term water discharge (Q) data series have been gathered from the Catalan watersheds, 10 fluvial systems ranging between 70 and 5,000 km^2. Various global datasets compiled into a GIS allowed extracting lithologic, climatic, land-use, and geomorphic parameters for each watershed.

Q was essentially homogeneous in the Catalan rivers along the 20^{th} century, with slightly increasing or decreasing long-term trends. Mean values for all rivers ranged from 0.3 to 11 m^3/s. Precipitation (P) decreased in all the watersheds at a rate of about 0.33 mm/yr, while temperature (T) increased nearly 0.02° C/yr. This is in agreement with the mean P and T trends on the NW Mediterranean Basin, although in Catalonia these climatic changes are larger in land than above the sea. However, these P drop and T rise do not directly translate into river flow reduction.

Hydrological periodicity has been also analysed. A negative relationship between the Q data series and the NAO index has been observed, i.e. maximum discharge events often fit with the most negative NAO values, and vice versa. The frequency and magnitude of droughts (flow below the 15^{th} percentile) and floods (flow exceeding more than 10 times the average Q) were very irregular during the last decades, a period during which most of the Catalan watersheds showed a slight increase in the magnitude of these extreme events.

Sediment load analysis: From the Catalan to the Mediterranean case

Total suspended sediment (TSS) field data from the Catalan basins are limited to 6 years of punctual uneven measurements. The recorded values (average 9-209 mg/l equivalent to 0.4-15 t/km^{2}yr) show that sediment flux is relatively low in Catalan rivers compared with other Mediterranean rivers [1].

River regulation in the form of dam construction and water extraction concentrates in 2 of the 10 studied basins. Residence times on reservoirs range from one day to more than one year, causing variable impacts on sediment transport. 10 over the existing 16 dams retain more than 90% of the suspended material. The overflow rate indicates that only 4 dams allow bypassing medium silt sized sediment.

All the parameters collected from the Catalan basins were used to develop a TSS multiple regression model (R^2=0.87) that involved Q, slope, the Fournier index, the percentage of agricultural land, and the percentage of outcropping hard rocks. We also compiled all the available Mediterranean natural (before human regulation) water and solid discharge values and the same lithologic, climatic, land-use, and geomorphic parameters used for the Catalan case in order to analyse a larger number of Mediterranean rivers on the same basis and compare the resulting models. 79 Mediterranean river basins ranging from 300 to 90,000 km^2 were considered. The highest correlation indexes (r>0.6) are found between Q, P and 1/T, while TSS is best correlated with the inverse of the basin area and with the percentage of outcropping sedimentary rocks. The best multiple regression models between TSS and the available parameters come to light after classifying river basins by their temperature-precipitation relationship, obtaining 4 sets of rivers with significative regression models (R^2=0.42-0.99) based on slope, basin area, P, T, lithology and land-use. Our first results show that most of the Catalan rivers are part of the driest Mediterranean groups whose sediment flux depends largely on terrain characteristics such as lithology, land-use and slope.

Reference

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