

Morphological evolution of the Middle Loire River (France): Definition of geomorphic homogeneous river reaches

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ABSTRACT: Since the 12th century, the Loire River (France) has been intensively modified by the construction of flood embankments, navigation structures and the exploitation of sediments in the main channel. Those anthropogenic actions have considerably accelerated the incision of the riverbed. In 1995, granular extractions in the main channel stopped; a different morphodynamic behaviour of the Loire is suspected, which may have a strong impact on some infrastructures such as nuclear power plants and bridges located along the river.

The purpose of this study is to better understand the morphological evolution of the “Middle Loire” River, which represents a linear section of about 450 km. Herein we present the definition of homogeneous reaches used to characterize the morphological evolution since the 1950s. For each reach defined evolution in plan, in length and cross sectionnal data are analyzed. The Middle Loire has been partitioned into 174 reaches with an average length of 2.5 km. Albeit the general trend observed over the last 50 years is a narrowing of the channel active width and an incision of the river bed, the morphological evolution of some reaches appears to decelerate since granular extractions stopped in 1995.

1 INTRODUCTION

Over the past two hundreds years, river dynamics have been significantly affected by human disturbances. The construction of flood embankments, navigation structures (groynes), dams, the extraction of sand and gravel in the main channel have led to considerable channel adjustments. Although channel evolutions are expected in time under natural conditions, the trend is increased by human disturbances. The most common morphological changes identified are: river bed incision, channel narrowing and changes in channel pattern.

Numerous morphological studies have examined those changes associated with human actions over time in European and American rivers. Surian and Rinaldi (2003) summarise the main type of adjustments observed on Italian rivers; incision of more than 10 m, channel narrowing to 50% and changes in channel patterns are reported in the past 100 years. The Loire River, the longest river in France, is no exception; channel narrowing and deepening have been reported since the 1970s.

Since channel adjustments can have detrimental effects, by affecting groundwater recharge, structure's stability and impact ecology (wetland deprivation), a better understanding is crucial to predict future evolution and thus improve river management. In order to characterize channel adjustments, various methodologies of river reach classification have been previously defined. The most widely accepted methodologies have been developed by Leopold and Wolman (1957), Schumm (1977), and Rosgen 1994 Rosgen (1994). However, the criteria for any one classification scheme are unlikely to be generally applicable to other uses. Classification tends to be specific for the intended objectives of its author. From these previous studies, our objective is to propose a more complete definition of homogeneous reaches that could be applied to any river. The proposed methodology has been developed on a long reach of the Loire River (450 km), prone to incision and combining different river styles (meandering, straight, single and multiple channels configuration).

This paper first presents the Loire River, the definition and characteristics of homogeneous reaches