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Editorial

GIS Application in Fluvial Geomorphology and Landscape Changes

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1. Introduction to the Special Issue

The main purpose of this Special Issue of Water is to propose on overview of studies and researches, in which the use of GIS is functional to the representation of fluvial geomorphology and river dynamics, linear erosion processes, erosion rates, ancient landscapes reshaped by the fluvial action, flooding areas, and historical anthropic changes of the river landscape and land use. In particular, the use of GIS has for many years been widely applied in various disciplinary fields, serving as an important support to scientific activity and, in the planning field, to the decisional and programmatic phase. GIS applications permit to solve many geomorphic and Quaternary geology research problems are often gained through preliminary map analysis.

Some morphological and environmental contexts, such as the fluvial one, are particularly suitable for reconstructing the historical transformations of fluvial landscape and dynamics [1], experimenting with new tools, useful for constructing detailed geomorphological maps, also through the semi-automatic extraction of the main landforms [2], or for applying morpho-evolutionary models of the river landscape, or to define the erosion rates [3] and areal erosion models.

As concerns the areas at risk of flooding, integrated GIS-based hydro-geomorphological approaches allow overcoming difficulties and uncertainties in simulating floods and flooded areas and in monitoring river channel dynamics, helpful in the prevention and mitigation of floods [4]. They provide, in fact, excellent tools for river channel spatial data extraction, processing, storage, visualization, and analysis [5].

The Special Issue comprises six original papers divided into two main categories: Experimental [6] and field survey [7–11] studies. Overall, the authors focused on different topics, such as the use of digital terrain models for the definition of the sedimentary budget into reservoirs, the evaluation of river short term erosion rates, on the geomorphological mapping of river terraces, floodplains and potential flood areas, and on the geometry and variation of river channels in relation to river management and restoration.

2. Overview of the Contributions of the Special Issue

2.1. *Testing the Prediction Ability of LEM-Derived Sedimentary Budget in an Upland Catchment of the Southern Apennines, Italy: A Source to Sink Approach (Gioia and Lazzari, 2019)*

In this study, the authors focus on the landscape evolution models (LEMs) which represent one of the most promising approaches to evaluate sedimentary budget, although factors such as the high number of parameters or the difficulty evaluating the robustness of the results can represent a limitation in their application in natural landscapes. In this paper, the Caesar–Lisflood LEM has been applied in a small catchment (i.e., about 9 km^2), located in the southern sector of the Ofanto Basin (southern Italy), draining the artificial Saetta-Ficocchia reservoir in order to test its ability to predict sediment flux and erosion rate. Short-term (i.e., about 20 years) estimation of the sediment volumes accumulated in the reservoir has been reconstructed by a bathymetric survey and compared to the results coming from the coeval LEM simulations. The results indicate a good accordance between LEM-based erosion volume estimations and the direct sedimentation assessment, thus testifying to the high potential of such models to solve issues of sedimentary budget and short-term landscape modification.

2.2. Development of Pleistocene Fluvial Terraces on the Eastern Frontal Sector of the Southern Apennines Chain, Italy (Giannandrea et al., 2019)

This paper aims to investigate the Pleistocene fluvial terraces in the small river valley of the Pescogrosso Stream, a left tributary of the Sinni River (Basilicata, southern Italy), placed on the eastern front of the fold-and-thrust belt of the southern Apennine chain. It has shown a complex and positive location for the study of a fluvial catchment development. Sedimentological and geomorphological analyses of eight fluvial terraced units revealed that their formation and evolution were strictly controlled by regional tectonic uplift of the Ionian arc, by climatic changes, and by sea-level variations. In particular, the Ionian sea-level oscillation, as a factor in controlling the short-term fluvial terrace development, was the main factor responsible for the three older terraces' evolutions. Conversely, the evolution of the five younger terraces seems to have been controlled by the base-level variations of the Sinni River.

2.3. GIS-Based Geomorphological Map of the Calore River Floodplain Near Benevento (Southern Italy) Overflooded by the 15th October 2015 Event (Magliulo and Valente, 2020)

In this paper, the authors describe the GIS-based geomorphological map of the overflooded sectors of the Calore River floodplain near Benevento, starting from the destructive flood of 15 October 2015, when the floodplain of the Calore River recorded a stream stage increase up to 10 m. The map graphically represents the field-checked results of a detailed geomorphological study carried out by means of GIS analysis of historical and topographic maps and orthophotos. Particular attention was devoted to the analysis of the channel adjustments experienced by the Calore River since the end of the 19th century, which shaped most of the landforms in the floodplain. The results showed that the investigated floodplain is characterized by abandoned channels, anthropogenic landforms, and five orders of recent river terraces separated by gently-sloping inactive fluvial scarps, less than 2 m high. On the oldest and/or more distal sectors of the floodplain, landforms are badly preserved, probably due to the more prolonged reshaping by natural erosional processes and anthropogenic activities, and to the high erodibility of the loose sediments in which they are shaped.

2.4. Channel Changes and Controlling Factors over the Past 150 Years in the Basento River (De Musso et al., 2020)

The authors focused on the channel changes in relation to the relevant implications for river management and restoration. This paper investigates the channel dynamics in the Basento River (Basilicata, southern Italy) over the past 150 years, when the river was heavily affected by human activities (e.g., hydraulic interventions and gravel mining) and climate changes. Channel adjustments were analyzed with historical maps, aerial photos, and geomorphological surveys. The results show that the channel underwent a strong narrowing during the twentieth century, similar to many rivers in Italy, with the most intense phase from the 1950s to the 1990s (with the width varying from –30% to –80%). The morphology pattern remained almost completely unchanged, apart from a few reaches located in the hilly area that were affected by intense modifications before the 1940s. The causes of channel adjustments were identified as human disturbances (land use variations, channel interventions at the reach scale, sediment mining) from the end of the 1800s to present, as well as natural factors (changes in frequency, duration, and intensity of flood events), whose effects have intensified since the late 1990s.

2.5. Short-Term GIS Analysis for the Assessment of the Recent Active-Channel Planform Adjustments in a Widening, Highly Altered River: The Scrivia River, Italy (Mandarino et al., 2020)

This paper focused on the active-channel planform changes that occurred along the Scrivia River floodplain reach (NW Italy) over the period 1999–2019 and it aims at investigating in detail the ongoing geomorphological processes under the river management perspective. The study is based on a quantitative multitemporal analysis of aerial photographs and satellite images performed in a GIS environment and supported by field surveys. The outcomes revealed a generalized trend of gentle active-channel widening together with widespread bank instability and several (26% of total banks) intense and localized bank retreats involving both the modern floodplain and the recent terrace. In the investigated 20-year period, the active-channel area has increased by 22.7% (from 613.6 to 753.0 ha), its mean width by 25% (from 151.5 to 189.3 m), whereas no relevant length variations have been noticed. These morphological dynamics have been more or less pronounced both at reach scale and over time. The extreme floods occurred in the investigated period can be considered the most important triggering factor of the active-channel planform changes, most probably together with an increase of the reach-scale unit stream power due to changes in the channel geometry that occurred over the 20th century.

2.6. Geomorphic Approaches to Estimate Short-Term Erosion Rates: An Example from Valmarecchia River System (Northern Apennines, Italy) (Guerra and Lazzari, 2020)

In this final paper, the authors discuss about GIS-based analyses to evaluate the fluvial network geometry and possible anomalies, particularly useful to estimate modifications in processes and erosion rates. The aim of this paper is to estimate short-term erosion rates attributable to fluvial processes in two sample catchment sub-basins of the Marecchia river valley (Senatello river, 49 km^2 and Mazzocco river, 47 km^2), by conducting quantitative morphometric analyses in order to calculate various descriptive parameters of the hierarchisation of the river networks and the mean turbid transport of streams (Tu). Sediment yield transported by streams can in fact partially express the amount of erosional processes acting within the drainage basin. Starting from geomorphological maps of the two river basins, the Tu parameter has been calculated and converted in short-term rate (average value 0.21 mm/year). Moreover, the comparison of these short-term mean data with the uplift rates calculated on a regional scale (0.41 ± 0.26 mm/year) in the Marecchia valley confirms that the northern Apennines may represent a non-steady state system.

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