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RECOGNIZING AVULSION EVENTS IN THE ADIGE RIVER ALLUVIAL SYSTEM

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ABSTRACT: Piovan S. & Mozzi P., *Recognizing avulsion events in the Adige River alluvial system.*
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Palaeohydrographical reconstructions of the Adige River alluvial system has recently begun to exploit chronostratigraphy and detailed geomorphological analysis focused on the role of major avulsive events. Following this research line, this work sums up the state of the art and discusses new data at a comprehensive scale.

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La ricostruzione della paleoidrografia del sistema fluviale dell'Adige ha iniziato a sfruttare, in tempi recenti, analisi geomorfologiche e cronostratigrafiche di dettaglio indirizzate a riconoscere i maggiori eventi avulsivi. Seguendo tale linea di ricerca, questo lavoro sintetizza lo stato dell'arte e discute nuovi dati in una scala regionale.

Key words: Adige River, Holocene, alluvial plain, avulsion

Parole chiave: F. Adige, Olocene, pianura alluvionale, avulsione

This work is an attempt to discuss the comprehensive palaeohydrographical reconstructions and stratigraphy of the Adige River alluvial system, with a specific focus on the role of avulsive events. The study area ranges from Roverchiara-Legnago to the Venice Lagoon and the present coastline (from west to east), and from Montagnana-Este to Rovigo-Adria (from north to south). The area is characterized by a dense network of alluvial ridges formed by the Adige River and, locally, by the Po River through the aggradation of sandy and silty channel deposits, natural levees, and minor, proximal crevasse splays. These evidences suggest that alluvial plain formation has been mainly driven by avulsion, defined as the abandonment of all or part of a channel belt in favor of a new course (ALLEN, 1965), rather than lateral migration of channel belts. This sedimentary process is prevailing in other alluvial settings, such as the Rhine-Meuse delta (STOUTHAMER & BERENDSEN, 2007) and the Saskatchewan River (MOROZOVA & SMITH, 2000).

The Adige River is the second longest Italian river (410 km) and the third in terms of catchment area (12,200 km^2). The Adige "high plain", corresponding to the piedmont portion of the Adige sedimentary system, is characterized by gravels and a braided river course. Downstream, in the "low plain," the sediments become sandy and silty-clayey and the river turns to a single-channel, meandering type. The Adige River reaches the Adriatic Sea a few kilometers south of the Lagoon of Venice, through a cuspate delta mouth. The Brenta River megafan and the Po sedimentary system (MURST, 1997; FONTANA *et al.*, 2008) bound the late Holocene Adige sedimentary system to the north and to the south, respectively.

In the distal portion of the alluvial plain, the boundary between Adige and Po alluvial systems is not well defined as branches of the Po River have occasionally intersected the Adige alluvial plain and vice versa.

Studies on the late Holocene geomorphological evolution of the distal tract of the Adige alluvial plain started in the 1970s, concurrent with an increase of archaeological surveys and excavations, given the relationship through time between important ancient settlements and the changing of river courses. Regional reconstructions of the late Holocene paleohydrography, such as those of PERETTO (1986), MARCOLONGO & ZAFFANELLA (1987), mostly relied on remote sensing data. Hence, the times of activity of the different branches of the Adige River and their relations with the northernmost branches of the Po River were largely hypothetical and commonly based only on the interpretation of landforms and their association with surface archaeological remains. Detailed geoarchaeological and palaeoenvironmental investigations provided valuable data but were limited to few excavated sites, e.g., BALLOTTA (1993) and BALISTA (2004). Seminal work of CASTIGLIONI (1978) provided some preliminary indications on the activity of different river branches, later supported by few radiocarbon datings (CASTIGLIONI, 1995). Recently published works (e.g., AMOROSI *et al.*, 2008; PIOVAN *et al.*, 2010), as well as ongoing geological surveys

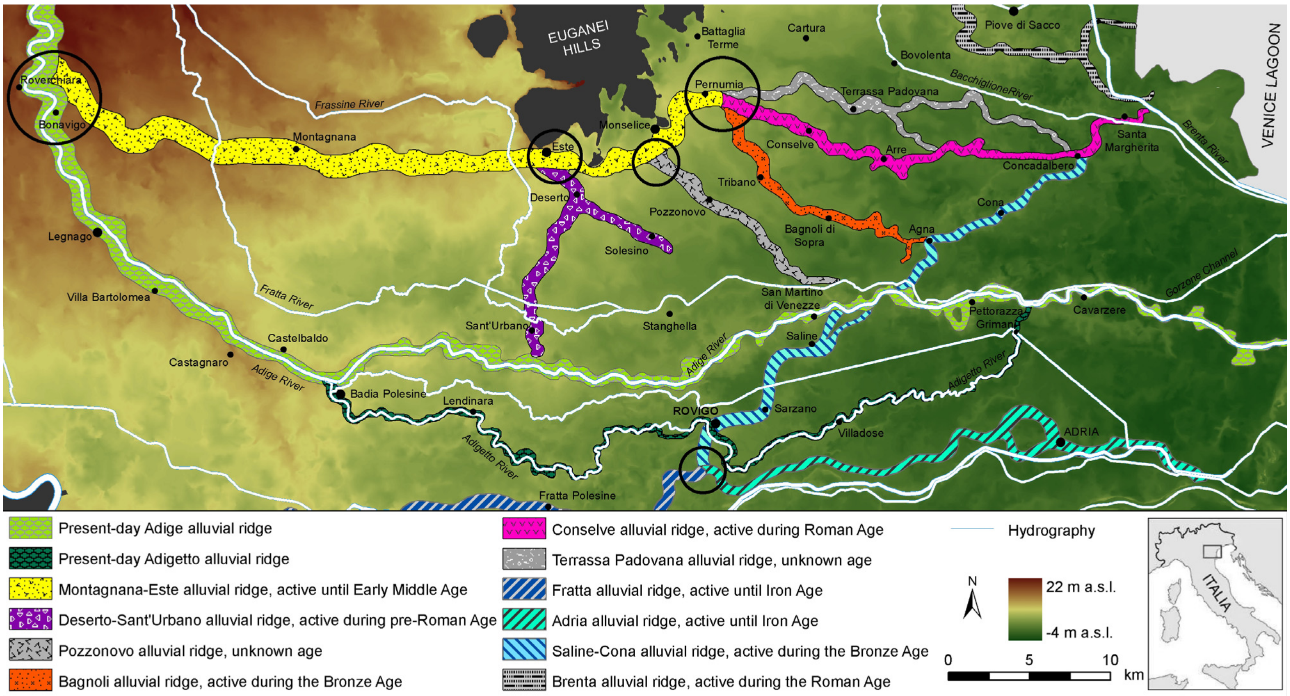

Fig. 1, Geomorphological sketch of the Adige-Po plain. The map shows the main alluvial ridges recognized by DTM (in the background) and remote sensing. The circles indicate the points where the major avulsion occurred.
Schema geomorfologico della pianura dell'Adige-Po. La carta mostra i principali dossi alluvionali riconosciuti mediante DTM (sullo sfondo) e telerilevamento. I cerchi indicano i punti in cui sono avvenute le principali avulsioni.

(sheet 147 "Monselice", CARG Project) provide new detailed geomorphological and stratigraphical data on the distal part of the Adige-Po alluvial plain, allowing for the definition of the activity of some river branches at regional scale.

A Digital Terrain Model based on contour lines with a spacing of 0.5 m derived from "Carta Tecnica Regionale del Veneto" (1:5000 scale), combined with aerial photographs and satellite images, allow to recognize the most important alluvial ridges, as shown in Figure 1.

The Montagnana-Este Adige alluvial ridge, which was active during the Bronze Age and until late Roman times-early Middle Ages (MARCOLONGO & ZAFFANELLA, 1987; BALISTA, 2004), runs from Bonavigo to Monselice where it splits in a number of minor alluvial ridges.

The Bagnoli ridge, which runs from Pernumia to Agna in NW-SE direction, is attributed to a Roman/ pre-Roman Adige palaeochannel according to remote sensing and archaeological evidence (MARCOLONGO, 1987). Calcimetric analysis (ZOLETTO, 1991) and dendrochronological analysis (CASTIGLIONI, 1995) confirm the activity of the Adige River around 1164 BC.

The Conselve ridge runs from Pernumia to Santa Margherita, few kilometres from the inner margin of the Lagoon of Venice. Radiocarbon datings of organic material from manual boreholes in a cross-section through the Conselve alluvial ridge date the local activity of the Adige River to Roman times.

The Deserto-Sant'Urbano was apparently active during the 2nd millennium BC, as from some unpublished radiocarbon datings (CARG Project). No chronological data are available for other alluvial ridges, such as those of Pozzonovo and Terrassa Padovana, which have not yet been studied from a chrono-stratigraphical point of view.

In detail, Bagnoli and Conselve alluvial ridges join the Saline-Cona ridge (also called "Po northernmost branch by CASTIGLIONI, 1978) in Agna and in Concadalbero, respectively. The Saline-Cona alluvial ridge was formed by a Po branch active until Final Bronze Age (about 3000 cal BP) (PIOVAN *et al.*, 2010). It runs from Rovigo through San Martino di Venezze, Anguillara Veneta, Agna and Cona to Concadalbero. Age estimates suggest that Adige palaeochannel in Bagnoli may have been partly contemporary to the Saline-Cona Po branch. CASTIGLIONI (1978), on the basis of P. Jobstraibizer's petrographic analysis of sands, regarded the sands of the Saline-Cona alluvial ridge in Cona, downstream of Agna, as belonging to the Po River but showing a Adige component: this would be consistent with the existence of a junction of the Adige and Po rivers at Agna. Around 3000 BP, the Po River northernmost branch was no more active (PIOVAN *et al.*, 2010); aggradation continued until Roman times due to sedimentation by the Adige River from Concadalbero to Santa Margherita. Here, according to stratigraphical investigations, the Adige River was active during Roman times.

Present-day Adige River alluvial ridge runs from Bonavigo through Legnago, Badia Polesine, San Martino di Venezze and Pettorazza Grimani to Cavanella d'Adige. It formed after an important avulsion, probably occured in Late Roman times-Middle Ages in Bonavigo (La Cucca site), that diverted the course of the Adige River from the northern path of Montagnana-Este (ZAFFANELLA, 1979; ZERBINATI, 2003; BALISTA, 2004).
In Figure 1 the main avulsive nodes are indicated, from which the different alluvial ridges stem out. Future research will be dedicated to developing a more detailed chronostratigraphic framework, with the aim of sorting out the possible allocyclic forcings which may lead to major avulsions, i.e., climate-driven hydrological changes, enhanced sediment yield due to anthropogenic soil erosion in the catchment, relative base level changes.

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