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DYKE BREACHING AND CREVASSE-SPLAY SEDIMENTARY SEQUENCES OF THE RHÔNE DELTA, FRANCE, CAUSED BY EXTREME RIVER-FLOOD OF DECEMBER 2003

ABSTRACT: ARNAUD-FASSETTA G., *Dyke breaching and crevasse-splay sedimentary sequences of the Rhône Delta, France, caused by extreme river-flood of December 2003*. (IT ISSN 0391-9838, 2013).

Crevasse splays caused by the flood event of December 2003 in the Rhône Delta (Mediterranean France) offered the opportunity to study the «stage I» of Smith & alii (1989), as contemporary analogues for quantifying lateral erosion and overbank deposition in the flood plain. From two study cases («Petit Argence» and «Claire Farine»), main hydrogeomorphological impacts of December 2003 flood event and sedimentary facies associated with each crevasse-splay sub-environment (crevasse channel, crevasse-splay lobe, proximal and distal flood basin) are detailed. Fluvial landforms, sediment-body geometries and sedimentary-facies characteristics are determined using a combination of topographic maps, remote sensing data, field measurements, and laboratory analyses. Spatial distribution of hydraulic parameters such as mean flow velocity, bed shear stress, and specific stream power is derived from relationship with mean flow depth, sediment structure, sediment grain size, sediment thickness, and distance from the Petit Rhône channel/dyke breach. Sedimentological analysis highlights different gradients of downstream thickness, fining, and sorting of sediments. The 3-D geometry of crevasse splays is reconstructed with calculation of the sedimentary volume deposited or eroded in the delta-plain area. Sediment balance ($674,227 \pm 33,711 \text{ m}^3$) derived from December 2003 crevasse splays is correlated with the delta-plain sediment balance.

KEY WORDS: Rhône Delta, Rare flood, Fluvial geomorphology, Crevasse splay, Flood-plain deposition, Sediment balance, Hydrological risk.

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INTRODUCTION

Many papers were published dealing with hydromorphological, sedimentological, and geochemical impacts of the flood of December 2003 in the Rhône Delta (Mediterranean France) nine years after the event. Publications have focused on the following, from upstream to downstream: (i) Variations of dissolved major and trace element concentrations in the lower Rhône River (Ollivier & alii, 2006); (ii) Radiological consequences in the flood plains both of the Rhône River upstream of Arles and the Petit Rhône River (Eyrolle & alii, 2006); (iii) Suspended sediment and ^{137}Cs fluxes in the Grand Rhône River (Antonelli & alii, 2008); (iv) Morphological changes and sedimentary processes at the mouth of the Grand Rhône River (Maillet & alii, 2006); (v) Stratigraphic signatures due to flood deposition near the Grand Rhône mouth (Drexler & Nitrouer, 2008); (vi) Radionuclide deposition in the Grand Rhône prodelta (Miralles & alii, 2006); and (vi) Dilution zone of the Rhône River in the Mediterranean (Gatti & alii, 2006). Only the thematic focal point (ii) focused on «crevasse splays» but little has been said about the sedimentation processes, and protocols based both on field measurement and mapping methods were different.

Crevasse splays are recognised to have an important impact in the sedimentary construction (*i.e.*, by aggradation and/or progradation processes; Galloway & Hobday, 1996, p. 74) of both alluvial plains (Allen, 1964; Coleman, 1969; Bridge, 1984; O'Brien & Wells, 1986; Smith, 1986; Smith & alii, 1989; Mjos & alii, 1993; Smith & Pérez-Arlucea, 1994; Gomez & alii, 1997; Kraus & Gwinn, 1997; Bristow & alii, 1999; Ethridge & alii, 1999; Krauss & Wells, 1999; Pérez-Arlucea & Smith, 1999; Davies-Vollum & Kraus, 2001; Farrell, 2001; Makaske & alii, 2002; Kraus & Davies-Vollum, 2004; Slingerland & Smith, 2004; Sihna & alii, 2005; Stouthamer & Berendsen, 2007) and delta/