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Flow and sediment processes in a cutoff meander of the Danube Delta during 100-year recurrent flood

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River training operations, such as meander cutoff, initiated for navigational purposes often lead to dramatic changes in the streamwise profiles (Hooke, 1986, Kesel, 2003; Kiss et al., 2007). Meander correction affects both the hydraulic and morphodynamical behavior of the modified branches that sedimentation occurs in time, while newly built canals usually experience degradation (Jugaru et. al, 2006).
This study reports and analyzes new data on the hydrological and sedimentary processes at work during a morphogenic flood in a large modified meander (the Mahmudia meander) of the St. George branch, the southern branch of the Danube Delta. The 100-year recurrent flood that occurred in 2006 offered an exceptional opportunity for scanning different cross sections of the Mahmudia meander system by means of the emerging Doppler profiler (aDcp) technology in order to analyze the impact on sedimentation and dynamic processes in the study area.
The Mahmudia study site corresponds to a vast natural meander which was cut off in 1984-1988 by an artificial canal opened to shipping. The meander correction accelerated fluxes through the artificial canal and dramatically enhanced deposition in the former meander. After his formation, the cutoff meander acted as sediment storage locations, essentially removing channel and point bar sediments from the active sediment budget of the main channel (Popa, 1997). During the one-hundred-year recurrent flood in April 2006, bathymetry, flow velocity and discharge data were acquired across several sections of both natural and artificial channels with an acoustic Doppler current profiler (aDcp Workhorse Sentinel 600 kHz, Teledyne RDI) in order to investigate the distribution of the flow and sediment and his impact on sedimentation in a channelized reach and its adjacent cutoff. The contrasting hydro-sedimentary processes at work in both channels and bifurcation/confluence nodal points are analyzed from the measured flux distribution, morphological profiles and velocity and concentration patterns. In the cutoff, a diminishing of the intensity of the flow velocity (c. 50%) and of the SSC was observed correlated with the aggradation of the river bed. In the bifurcation/confluence nodal points and in the artificial canal were observed the most intensive hydrodynamic activity (high flow velocity, suspended sediment concentration, degradation of the river bad). The water flow acceleration in the artificial canal (from 1.8 m3.s-1 upstream the bifurcation to 2.3 m3.s-1) enhances incision processes in the artificial canal (gravitationally related sedimentary flow), while the liquid and solid fluxes through the former meander are greatly reduced (from 338 kg.s-1 upstream the bifurcation to 73 kg.s-1 even 8 kg.s-1). Excess boundary shear stress in the sub-reaches directly affected by cutoffs resulted in scour that increased downstream bed material load. These high sediment loads play a key role in driving morphological adjustments towards equilibrium in the cutoff channel.

Keywords: sediment fluxes; flow velocity, acoustic Doppler current profiler (aDcp); former meander; Danube Delta; St. George branch

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