A multi-criteria approach supporting the investigation of a floodplain potentially contaminated by pesticides

L. Ziliani[1], B. Groppelli[1], S. Ceccon[1], F. Colombo[1], D. Bocchiola[2], M. C. Rulli[2], G. Ravazzani[2], R.Rosso[2], M. Marangon[4], C. Presutti[4], L. Conti[4], A. Basciu[4].

[1]Ramboll Environ Italy, V. Vincenzo Lancetti 43, Milan, Italy; [2]Politecnico di Milano, Dept. ICA, Piazza Leonardo da Vinci 32, Milan, Italy; [3]Syndial Spa, Piazza Boldrini 1, San Donato Milanese, Italy

Phone: +39-02 0063091
E-mail: lziliani@ramboll.com

Introduction: It is widely recognized in literature that the dispersal, storage and remobilization of sediment-associated organic and inorganic contaminants in the fluvial system can be directly related to sediment transport processes, river channel adjustments and flooding regime. This study shows how a multi-criteria approach combining historical, geomorphological, hydraulic and hydrological methods can help river basin decision makers to more effectively investigate and control fluvial corridor areas potentially affected by historical pesticide dispersal. The approach was adopted along a 23 km-long reach of the Toce River (Italy) downstream a DDT manufacturing facility operating in 1948-1996 period. The scope of the study was to identify the floodplain areas most probably affected by historical sedimentation, assumed to be the proxy of potential DDT contamination.

Methods: As part of the geomorphological study a multitemporal analysis of historical maps, aerial photographs and topographic surveys allowed to *(i)* document and quantify channel adjustments, and *(ii)* set up a conceptual model of the long-term sedimentation in floodplain. These outcomes supported the following application of the *CAESAR-LISFLOOD* model [1] carried out to reproduce the main historical flood events occurred between 1948 and 2010. A detailed historical research was conducted to *(i)* map the flood marks along the river reach, and *(ii)* organize a geographical datasets of the infrastructures that historically influenced flooding. Such data were than used to set-up and calibrate the numerical model. The hydro-sedimentological models *FEST-WB* and *ERODE* were also applied to investigate the sediment yield processes at the basin scale. The coupled implementation of these models provided several insights about the short-term (2000-2010) depositional trends including all sediment related processes on hillslope and in river channel network. The outcomes of every single approach were summarized in a layer of "sedimentation tendency", overlaid to the others (Fig. 1).

Results: The geomorphological analysis showed a modest reduction of channel width and a significant bed level incision interpreted as a result of the combination of several human pressures. The morphological units having the highest tendency to sediment storage are the "recent terraces" formed after 1950s (Layer 1, Fig. 1). The *CAESAR-LISFLOOD* model allowed reproducing n. 21 historical flood events using n. 109 flood marks for both calibration and model reliability assessment. The effects due to the historical floods were evaluated as frequency of inundation (Layer 2) and frequency of sediment deposition (Layer 3). The coupled FEST-WB and ERODE models provided further results in terms of short-term sedimentation tendency (Layer 4). To complete such findings, the official flood risk zones were also considered because of the inherently associated probability of flooding (Layer 5).

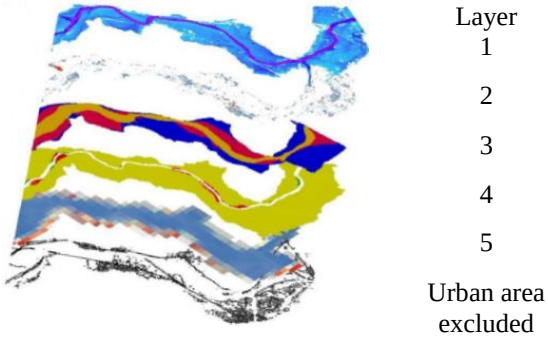

Fig. 1: *Layers used for the multi-criteria approach*

All attribute layers were combined in a Weighted Linear Combination (WLC) to identify the areas with the highest historical sedimentation tendency. This outcome addressed the 2014-2015 soil sampling campaign that fully validated the study outcomes.

Discussion: This study confirmed the strength and the effectiveness of the multi-criteria approach here adopted. To the author knowledge, this is one of the most extensive combined application of geomorphological and numerical modeling approaches in the literature to date.

References: [1] Coulthard, T.J., J.C. Neal, P.D. Bates, J. Ramirez, G.A.M. de Almeida, G.R. Hancock (2013), Integrating the LISFLOOD-FP 2D hydrodynamic model with the CAESAR model: Implications for modelling landscape evolution, Earth Surf. Process. Landforms, 38(15), 1897-1906.