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The dynamics of cultivation and floods in arable lands of Central Argentina

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Abstract. Although floods in watersheds have been associated with land-use change since ancient times, the dynamics of flooding is still incompletely understood. In this paper we explored the relations between rainfall, groundwater level, and cultivation to explain the dynamics of floods in the extremely flat and valuable arable lands of the Quinto river watershed, in central Argentina. The analysis involved an area of 12.4 million hectare during a 26-year period (1978 – 2003), which comprised two extensive flooding episodes in 1983 – 1988 and 1996 – 2003. Supported by information from surveys as well as field and remote sensing measurements, we explored the correlation among precipitation, groundwater levels, flooded area and land use. Flood extension was associated to the dynamics of groundwater level. While no correlation with rainfall was recorded in lowlands, a significant correlation ($P<0.01$) between groundwater and rainfall in highlands was found when estimations comprise a time lag of one year. Correlations between groundwater level and flood extension were positive in all cases, but while highly significant relations ($P<0.01$) were found in highlands, non significant relations ($P>0.05$) predominate in lowlands. Our analysis supports the existence of a cyclic mechanism driven by the reciprocal influence between cultivation and groundwater in highlands. This cycle would involve the following stages: (a) cultivation boosts the elevation of groundwater levels through decreased evapotranspiration; (b) as groundwater level rises, floods spread causing a decline of land cultivation; (c) flooding propitiates higher evapotranspiration favouring its own retraction; (d) cultivation expands again following the retreat of floods. Thus, cultivation would trigger a destabilizing feedback self affecting future cultivation in the highlands. It is unlikely that such sequence can work in lowlands. The results suggest that rather than responding directly and solely to the same mechanism, floods in lowlands may be the combined result of various factors like local rainfall, groundwater level fluctuations, surface and subsurface lateral flow, and water-body interlinking. Although the hypothetical mechanisms proposed here require additional understanding efforts, they suggest a promising avenue of environmental management in which cultivation could be steered in the region to smooth the undesirable impacts of floods.

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