Variability of the Senegal River floodplain under climate change scenarios

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Abstract :

In West Africa, the annual flood of the Senegal river floodplain is essential for numerous ecosystem services, including flood recession farming, biodiversity, groundwater recharge etc. Remote sensing provides increased opportunities to monitor surface water dynamics across large floodplains which are currently poorly captured by local hydrological monitoring and modelling due to data scarcity and the flat, heterogeneous topography. Landsat, MODIS and Sentinel-2 (S2) imagery are used to represent surface water variations across this 2250 km^2 floodplain. Cloud computing (Google Earth Engines) allows the automation of the classification and extraction of flooded areas over 1999-2020. Daily stage and flow values from Bakel gauging station on the Senegal river are then analysed to derive relationships between the flooded areas in the floodplain and upstream flow data over 1999-2020. Finally, the impact of climate change on the flooded areas are simulated using GR4J rainfall-runoff models fed with projections from 7 Cordex RCM models under RCP 4.5 and RCP8.5. Flooded areas are shown to reach a maximum of 450 000 ha with MODIS during the large 2003 flood. Flood peaks with S2, MODIS and Landsat reach around 300 000 ha during high years and reduce to 150 000 ha or less during low flood years. Correlations derived between the monthly maximum flow and maximum flooded areas is high (coefficient of determination $R^2 = 0.87$). Results from climate change projections highlight the significant divergence between scenarios, however results concur towards a decline in the peak flooded areas of 60 000 ha over 2020-2065 compared to 1999-2020. Outputs from this research are essential to help understand the variability experienced by farmers in flood recession farming, and consider the impact of future changes. The extent of the annual flood will be further influenced by rising anthropic pressures (dams, withdrawals, etc.) in the basin which must be better understood.

Keywords: Remote sensing; Cloud computing; Floodplain; GR4J modelling; Senegal