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A model for the coupled dynamics between meandering rivers and riparian vegetation

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Riparian vegetation is part of the complex ecosystem living close to the banks of streams and it is strictly interacting with the river. The river supplies water, which transport nutrients and is drawn by plants for their survival, and sediments, to create new sites where germination can take place. In turn, vegetation can modify the river migration, increasing the friction coefficients, trapping sediments carried by the river, varying the bank erodibility and turbulence structure. The present work investigates the interactions between riparian vegetation and meandering rivers dynamics. To this aim, a model coupling river dynamics and riparian vegetation evolution was developed. Meandering dynamics were simulated with a fluid dynamical model using shallow water equations on an erodible bed. The riparian vegetation model takes into account some of the main actions caused by the river, i.e., water table oscillations, floods, and sedimentation. A logistic law and an exponential decay were used to model the increase and decrease in the biomass, respectively, consequent to river migration. Moreover, a linear variation of the erodibility coefficient of the river banks with the biomass density was used in some simulations. Consequently, a comparison of the geometry of the rivers obtained with constant and variable erosibility was carried out. The numerical simulations by the model highlight how river dynamics are able to induce typical vegetation patterns that are similar to some real riparian landscapes (some examples are shown) and how the river geometry can be influenced by the vegetation dynamics. The results also show the role of the temporal scales of vegetation evolution and river migration and the relevant river-vegetation interactions.