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A cellular-automaton model of wide rivers, and discussion about the basic processes required to braiding

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Braiding as well as meandering is an instability that results from the coupling between hydrodynamics and erosion/deposition processes. Its physical nature is still an issue 1) because of the complexity of basic processes, and 2) because of the lack of heuristic models capable of generating river-like dynamics in a realistic way. Such models would help to gain understanding of the causal relationships between boundary conditions, processes and emerging dynamics. The difficulty with river modeling at geological (or geomorphological) time scales stays is the 10^7 (and even more) difference between the time scales of hydrodynamics and erosion.

A significant step forward has been obtained with cellular automaton methods where water volumes (called precipitons thereafter) are moving on and interacting with topography. Modeling river dynamics over very long time scales was made possible by simplifying, or neglecting, the interactions between precipitons. This comes to considered highly simplified hydrodynamics, where turbulence effects due to small eddies (typically smaller than the precipiton size) are parameterized, and where large eddies are not represented. The method is thus restricted to phenomena mostly triggered by erosion/deposition processes, and is not adapted to model complex hydrodynamic effects such as secondary flow structure in channel (that is proposed to be responsible of meandering) .

We present a cellular-automaton program (EURos) that, in particular, incorporates non-linear erosion, out-of-equilibrium sediment transport, and lateral erosion. All the basic ingredients are likely to occur in rivers, and have been extensively described, measured and parameterized. The program successfully produces forms encountered in rivers such as (wide) straight channels, braiding rivers, even incipient meandering, as well as most of the complex river processes encountered in deltas. It allows one to discuss the basic processes/parameters that trigger the braiding instability and control the straight-to-braided transition. The three phenomena cited above are critical for developing braiding. Their role is physically identified and numerically illustrated.