Geophysical Research Abstracts,
Vol. 11, EGU2009-12797, 2009
EGU General Assembly 2009

Quantitative regularities in floodplain formation

O. Nevidimova
Institute for monitoring of climatic and ecological systems SB RAS, Tomsk, Russian Federation (olga-nevidimova@mail.ru)

Quantitative regularities in floodplain formation

Modern methods of the theory of complex systems allow to build mathematical models of complex systems where self-organizing processes are largely determined by nonlinear effects and feedback. However, there exist some factors that exert significant influence on the dynamics of geomorphosystems, but hardly can be adequately expressed in the language of mathematical models. Conceptual modeling allows us to overcome this difficulty. It is based on the methods of synergetic, which, together with the theory of dynamic systems and classical geomorphology, enable to display the dynamics of geomorphological systems.
The most adequate for mathematical modeling of complex systems is the concept of model dynamics based on equilibrium. This concept is based on dynamic equilibrium, the tendency to which is observed in the evolution of all geomorphosystems. As an objective law, it is revealed in the evolution of fluvial relief in general, and in river channel processes in particular, demonstrating the ability of these systems to self-organization.
Channel process is expressed in the formation of river reaches, rifts, meanders and floodplain. As floodplain is a periodically flooded surface during high waters, it naturally connects river channel with slopes, being one of boundary expressions of the water stream activity. Floodplain dynamics is inseparable from the channel dynamics. It is formed at simultaneous horizontal and vertical displacement of the river channel, that is at Y=Y(x, y), where , y - horizontal and vertical coordinates, Y – floodplain height. When d/dt=0 (for not lowering river channel), the river, being displaced in a horizontal plane, leaves behind a low surface, which flooding during high waters (total duration of flooding) changes from the maximum during the initial moment of time t0 to zero in the moment tn. In a similar manner changed is the total amount of accumulated material on the floodplain surface.
Thus, the floodplain dynamics is determined by the amount of material Q(t), left as sediment (amount of warp on a unit of area) during the period of flooding, and the amount of material q(t), removed during the time between floods. With the floodplain height approaching some limit height Yl, which equals the maximal height of floods, [U+F044]Q(t) [U+F0AE] 0, q(t) [U+F0AE] max. From here, we can build a functional diagram of the floodplain height change depending on time:
dY/dt=Q (t) - q (t) (1)
This equation allows us to describe non-monotonous behavior of different floodplain massifs. As floodplain systems, like all geomorphosystems, are dissipative structures, they should eventually come to a stable condition: dY/dt=0. This mode is possible in cases: Q=q=0 and Q=q=const.
In the first case, the floodplain level would reach the maximum height of flooding and would not be flooded any more. It would cause significant decrease in the amount of material left on its surface as sediments and the system would start to degrade. This variant is purely theoretical, as such conditions, where the streams of matter are absent, can appear only in a homogeneous environment.
The second case characterizes the final stage in the formation of floodplain system as an integral unity in concrete external conditions and determines its dynamic equilibrium. In terms of the theory of dynamic systems, this condition corresponds to the limit cycle. Real floodplain systems never achieve it, but approach to it indefinitely closely, repeating themselves and not changing essentially in their basic morphological parameters. Thus, a high floodplain, approaching its limit height, shows morphological completeness. If for any reasons the floodplain surface becomes higher than the limit height Yl, it will not be flooded any more and will become a terrace, which means that the limit cycle of the floodplain system will be destroyed, as well as the system itself.
The equation (1) allows to take into account the river incision, accumulation of material onto the floodplain from slopes and denudation from the floodplain surface, also the dynamics of mobile inundated islands and vegetative

communities on them.
It is known, that $Y(t)=Y0+N \times m$ and thus, with the increase in height, the amount of flooding is changed proportionally to the difference of the floodplain limit height (Yl) and its height at the present time Y(t).
Using this formula, it is possible to calculate the duration of flooding at a set moment of time at any point of the floodplain surface and to determine the increase of the floodplain height, which surface is complicated with former river-bed depressions or banks.
In summary, we can say that dynamic equilibrium can be established in a wide range of hierarchical levels of river channel relief. Floodplain systems, being a part of fluvial geomorphosystems, show structural time-space orderliness in the process of self-organization. Despite the fact, that floodplain is under the stochastic influence of water stream, the floodplain dynamics fits a deterministic scenario.