Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04858, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04858
EGU General Assembly 2008

Least action principle, equilibrium states, iterative adjustment and the stability of meandering channels

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The energy based least action principle (LAP) has proven to be very successful for explaining natural phenomena in both classical and modern physics. This presentation briefly reviews its historical development and details how, in three ways, it governs the behaviour and stability of alluvial rivers. First, LAP embodies the special stationary equilibrium state of motion and so its incorporation with the principle of energy conservation explains why so many optimising hypotheses have been proposed in fluvial geomorphology. Second, the variational approach underlying LAP provides a more straightforward and simpler fuzzy-object orientated method for solving river regime problems than do the various complex Newtonian formulations. Third, it is shown that in fluvial systems with surplus energy, the surplus can be expended with slope and/or channel geometry adjustments, with the degree of channel geometry adjustment quantified by the dimensionless numbers F for depth dominated adjustment and H for width/depth dominated adjustment. Different planforms are preferred at different energy levels. Step-pool mountain streams and high energy braided rivers are shown to have considerable surplus energy that must be expended before equilibrium can be achieved. Meandering rivers are shown to be those with modest amounts of surplus energy such that meandering can both reduce their gradient and increase frictional losses. In rivers with insufficient energy, the interactions of endogenous and exogenous factors are shown to be capable, in certain circumstances, of achieving a stationary equilibrium condition which acts as the attractor state. Importantly this study describes how iterative changes enable systems to achieve stable equilibrium by

directing otherwise random system changes in the most probable direction.