Geophysical Research Abstracts
Vol. 14, EGU2012-4119, 2012
EGU General Assembly 2012

Toward a new system approach of complexity in geomorphology

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Since three decades the conceptual vision of catchment and fluvial geomorphology is strongly based on the “fluvial system” (S. A. Schumm, 1977) and the “river continuum system” (R. L. Vannote et al., 1980) concepts that can be embedded in a classical physical “four dimensions system” (C. Amoros and G.-E. Petts, 1993). Catchment and network properties, sediment and water budgets and their time-space variations are playing a major role in this geomorpho-ecological approach of hydro-geomorphosystems in which human impacts are often considered as negative externalities.

The European Water Framework Directive (i.e. WFD, Directive 2000/60/EC) and its objective of good environmental status is addressing the question of fluvial/catchment/landscape geomorphology and its integration into IWRM in such a sustainable way that deeply brings back society and social sciences into the water system analysis. The DPSIR methodology can be seen as an attempt to cope with the analysis of unsustainable consequences of society’s water-sediment-landscape uses, environmental pressures and their consequences on complex fluvial dynamics. Although more and more scientific fields are engaged in this WFD objective there’s still a lack of a global theory that could integrate geomorphology into the multi-disciplinary brainstorming discussion about sustainable use of water resources.

Our proposition is to promote and discuss a trans-disciplinary approach of catchments and fluvial networks in which concepts can be broadly shared across scientific communities. The objective is to define a framework for thinking and analyzing geomorphological issues within a whole “Environmental and Social System” (i.e. ESS, E. Masson 2010) with a common set of concepts and “meta-concepts” that could be declined and adapted in any scientific field for any purpose connected with geomorphology.

We assume that geomorphological research can benefit from a six dynamic dimensions system approach based on structures, functions, connections, phases, topologies and adaptations. By combining these six dimensions one can easily understand that geomorphological features and dynamics are then considered as very complex systems in which hierarchies, information, discontinuities, openness, resilience and self-organized responses are fundamental properties emerging among many others (E. Masson 2010).

This conceptual approach is consistent with many other scientific concepts used in ecological sciences (S-E. Jorgensen et al. 2007, C-S. Holling and al. 2002, I. Prigogine 1997, W-M. Elsasser 1987…) but also in human sciences (A. Dauphiné 2003, Ch.P.Péguy 2001, P. Bourdieu 1987, U. Beck 1986, J. Tricart 1968, C. Levy-Strauss 1958…), in physics (P. Bak, 1996, K-R. Popper 1982, I. Prigogine 1955…) and obviously into systemic science (E. Morin 1977, J-L. Moigne 1977, L. Von Bertalanffy 1968). Our contribution is then an encouraging attempt to expand the frontier of geomorphological theory with a new trans-disciplinary approach that deals with the huge complexity of hydrosystems considered as a whole Environmental and Social System.