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On classification of hydrologic connectivity indexes, their descriptive adequacy and predictive power

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In the last several decades a considerable number of hydrologic connectivity indexes have been suggested both in surface and subsurface hydrology. The hydrologic connectivity indexes can be classified according e.g. to the following criteria:

- Argumentation – if the index formula is based on a strict theoretical derivation, intuitive assumptions, empiric data, or some combination of the above?
- Range of applicability – only a very few indexes have been suggested as the universal ones, i.e. applicable on various scales, while the great majority of indexes have been designed exclusively for specific scales and environments.
- Flow model – even at the same scales and environments the various types of flow may have considerably different morphologies. For instance, in the subsurface hydrology the saturated pressurized flows may have the morphology that is notably different from that of unpressurised flows. Consequently, for the suggested connectivity indexes the addressed flow model should be properly specified.
- Descriptive adequacy – to what extent the index describes the hydrologic connectivity, and whether its value can be strongly affected by the factors unrelated (at least directly) to the connectivity?
- Predictive power – what is typical accuracy of the index value (or set of values) and if the index value alterations may predict important changes in the hydrologic connectivity of addressed environments?

Several examples of the suggested classification are provided. We further compare two of the powerful connectivity approaches, such as the percolation theory approach and method of random graphs and consider some of the indexes based on these approaches. It can be shown that although both approaches can hardly lead to accurate description of connectivity in real hydrologic systems, they nevertheless may provide theoretical explanation of critical changes in connectivity. The percolation theory, especially its directional modifications, are more applicable for systems consisting of great number of similar elements, connected via their close neighbors. In turn, the approach of random graphs is preferable for systems having moderate number of elements which are connected not necessarily through their neighbors. The mentioned approaches seem to be the most adequate ones for exploring the sharp changes in the hydrologic connectivity but should be further rectified by considering realistic flow processes and their

interactions.