Geophysical Research Abstracts
Vol. 20, EGU2018-11725, 2018
EGU General Assembly 2018

Using Science and Enlightened Modelling to Fight Hydromythology, Zombie Models and Hydrological Indifference in Prediction of Ungauged Basins

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Many hydrological concepts persist despite being conceptually incorrect and after having been dismissed by scientific investigation. Their persistence elevates them to the status of hydromythology. Hydrological models themselves can persist well past the validity of their conceptual framework and they are sometimes called "zombie models" when their behaviour becomes dominated by hydromythology. These zombie models are inconsistent with hydrological understanding and can be dangerous to the advance of hydrological science and to robust prediction. Zombie models persist because of hydrological indifference – streamflow hydrographs themselves are often indifferent to the many combinations of model structures and parameter sets that can be used to mimic them. However, indifference does not convey robustness to model predictions, particularly where non-stationarity occurs. Simulations must embrace full hydrological cycle verification and prediction to have scientific validity and to predict with confidence where there are no gauges and for future conditions. Deriving the physical content of model structure and parameters from integrated observation and prediction programmes can provide opportunities to minimize the series of measurements needed for model calibration and parameter selection. Transferring physically realistic parameters from observations made using remote sensing and research basins surveys improves the scientific basis of hydrological modelling methods, giving confidence that some of these models are getting the right answers for the right reasons. Successful prediction means integration of small-scale physical descriptions into comprehensive systems representing the catchment. Other catchments of functional similarity can inform the development of these systems by an integration of top-down and bottom-up approaches with regionalisation and catchment and landscape classification. Through concomitant improvements to the understanding of process hydrology, catchment hydrology and scale emergence of hydrological phenomena, complex issues in hydrology can be addressed. This often requires development of more robust hydrological models that reflect current scientific understanding, and take advantage of all available atmospheric, ecological and physical catchment information so that prediction in non-stationary and ungauged conditions is credible.