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Jump-Diffusion models and structural changes for asset forecasting in hydrology

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Impacts of climate change on surface water and groundwater are of concern in many regions of the world since water is an essential natural resource. Jump-Diffusion models are generally used in economics and other related fields but not in hydrology. The potential application could be made for hydrologic data series analysis and forecast.

The present study uses Jump-Diffusion models by adding structural changes to detect fluctuations in hydrologic processes in relationship with climate change. The model implicitly assumes that modifications in rivers' flowrates can be divided into three categories: (a) normal changes due to irregular precipitation events especially in tropical regions causing major disturbance in hydrologic processes (this component is modelled by a discrete Brownian motion); (b) abnormal, sudden and non-persistent modifications in hydrologic proceedings are handled by Poisson processes; (c) the persistence of hydrologic fluctuations characterized by structural changes in hydrological data related to climate variability.

The objective of this paper is to add structural changes in diffusion models with jumps, in order to capture the persistence of hydrologic fluctuations. Indirectly, the idea is to observe if there are structural changes of discharge/recharge over the study area, and to find an efficient and flexible model able of capturing a wide variety of hydrologic processes.

Structural changes in hydrological data are estimated using the method of nonlinear discrete filters via Method of Simulated Moments (MSM). An application is given using sensitive parameters such as baseflow index and recession coefficient to capture discharge/recharge.

Historical dataset are examined by the Volume Spread Analysis (VSA) to detect real time and random perturbations in hydrologic processes. The application of the method allows establishing more accurate hydrologic parameters. The impact of this study is perceptible in forecasting floods and groundwater recession.

Keywords: hydrologic processes, Jump-Diffusion models, structural changes, forecast, climate change