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Time series analysis in hydrology

Guest Editors: Salvatore Grimaldi, Demetris Koutsoyiannis, Domenico Piccolo, Francesco Napolitano

PREFACE

Time series methods for analysis of hydrological data has a history of about half a century and continues to be an intense research topic. Based on the theory of probability and stochastic processes and more recently complemented by advances on the study of chaotic nonlinear dynamical systems, time series analysis provides a repertoire of mathematical tools for the modelling of hydrological systems. Such tools have proved very effective and useful in numerous applications and case studies. The effectiveness of stochastic descriptions of hydrological processes may reflect the enormous complexity of the hydrological systems, which makes a purely deterministic description ineffective.

Stochastic approaches in analysis of observed time series have considered by many as "black box" approaches that do not help understanding of the system at hand. In this respect, they have been contrasted to deterministic approaches, which reveal the causative mechanisms of the natural processes. Such criticism of stochastic approaches may be valid in several cases, in which the focus was on the algorithmic details of the analyses. However, in their generality, stochastic approaches and tools are not "black boxes" and blind recipes.

In fact, stochastic processes have provided the only reliable way to link probability, uncertainty and randomness with causal dynamics as well as to incorporate the deterministic controls with random components. In addition, the theory of probability and stochastic processes has provided such tools as spectral analysis, analysis of information and uncertainty, and many others to explore and analyze data, and identify the deterministic controls from the data. Stochastic processes have provided such tools as stochastic (Monte Carlo) simulation, stochastic forecasting, stochastic integration (effective and efficient even for "purely deterministic" problems such as the numerical calculation of an integral), stochastic optimization and others which enable

us to get insight into complex systems and solve difficult problems.

With these ideas we organized a conference session entitled "Time series analysis in hydrology" (HS27) in the frame of the Scientific Assembly of European Geosciences Union, Vienna April 24th-29th, 2005. This special issue includes selected contributions from this session.

From the 35 submitted abstracts (oral and poster presentations) we collected 16 papers. The topics mainly analysed by the authors are:

- conventional (ARMA type) and long-range dependence linear models
- models implementing ideas from non-linear time series analysis (such as artificial neural networks)
- statistical trend detection methods,
- scale recursive estimation,
- space-time stochastic models,
- principal component and wavelet analysis.

In the 16 papers it is possible to read studies on rainfall and runoff forecasting and simulation, drought, sediment transport and soil wetness.

We strongly believe that the development and application of time series methods and the theory of stochastic processes have enabled views of the world – and hydrology in particular – that are much richer that mechanistic views. We also believe that this scientific area has much more to say about hydrology. Thus, with this special issue we wish to further stimulate this research area and to encourage the discussion and dissemination of research results through events, workshops and publications related to both theory and practical application.

Salvatore Grimaldi
GEMINI Department
University of Tuscia
Via San Camillo De Lellis,
01100 Viterbo, Italy
Tel. +39 0761 357326- Fax +39 0761 357356
salvatore.grimaldi@unitus.it
&
H2CU - Honors Center of Italian Universities
University of Rome 'La Sapienza'
Via Eudossiana, 18 - 0184 Rome, Italy

Demetris Koutsoyiannis
Department of Water Resources, Faculty of Civil Engineering
National Technical University of Athens
Heroon Polytechneiou 5, GR 157 80 Zographou, Greece
Tel. +30(210)772 2831, Fax +30(210) 772 2832
dk@itia.ntua.gr - http://www.itia.ntua.gr/dk

Domenico Piccolo
Department of Statistical Sciences
University of Napoli Federico II
Via Leopoldo Rodino', 22 80138 Napoli, Italy
Tel.+ 39 0812537461- Fax + 39 081 2537466
dopiccol@unina.it

Francesco Napolitano
Department of Hydraulic, Transportation and Roads
University of Roma "La Sapienza"
Via Eudossiana, 18 – 00184 Roma
Tel. + 39 06 44585058 -Fax + 39 06 44585065
francesco.napolitano@uniroma1.it