Panta Rhei – Everything Flows
Change in Hydrology and Society
IAHS Scientific Decade 2013-2022
www.iahs.info/pantarhei

Details of the Proposal

Title of the Working Group

Natural and man-made control systems in water resources

Abstract of the proposed research activity

Everything changes, this is of course true, but the long term behaviour of the physical world we live in seems remarkably predictable. For several sub-systems this is due to feedback mechanisms that support the current behaviour. To study future behaviour that differs materially from the current behaviour it will be necessary to look for hints in the historical behaviour of possible paths from one stable behaviour to another. It will also be necessary to examine the models in current use to see whether they are approximations valid only for the current behaviour. This leads to three important questions.

1) Do the current measurements of model input and output allow for identification of state, structure and parameters? If not then can this be remedied?
2) Do the current models have multiple stable behaviours (possibly for different parameter sets)?
3) Can strategies be developed to either keep the systems near desirable behaviour or to move system and society gracefully to a new stable behaviour.

It is well known that physical systems that make up our planet have multiple stable states. It is reasonable to assume that non-trivial hydrological models also have multiple stable states, see for example [1]. Even if they do not have multiple stable states then a search of the parameters space for a given set of model inputs and outputs may still yield different parameter sets corresponding to different stable states of the real world hydrological system. Given the multitude of feedback loops in natural systems control theory seems a natural fit to examine stability and parameter identification for hydrological systems and models.

Moreover, it is well known in control theory that the internal state and structure of a

model cannot always be reconstructed from its inputs and outputs.

These two points together suggest that a concerted effort of specialists in hydrological, atmosphere and ocean models and specialists in control theory aimed at a better understanding of stability and identifiability of hydrological systems would be worthwhile.

The same group would also be able to come up with new approaches to system management in a changing environment .

Panta Rhei Research Themes, Targets and Science Questions addressed by the Working Group

Science questions addressed:

(2) How do changes in hydrological systems interact with and feedback on natural and social systems driven by hydrological processes?

(6) How can we support societies to adapt to changing conditions by considering the uncertainties and feedbacks between natural and human-induced hydrologic changes?

Targets addressed:

(1) Understanding

(2) Estimation and prediction

(3) Science in practice

Societal impact of the Working Group activity

A proper understanding of the limits on the capacity of a system to deal with disturbances and changes without materially altering its behavior and of ways to allow gradual movement from one behavior to another are essential to the continued existence of our current society.

List of Participants

Please include at least 6 members from 3 different countries. Make an effort to ensure interdisciplinarity. Add rows at the Table if necessary.

Name of Participant	Affiliation (full address and email)	Role	Main expertise
1 Ronald van Nooijen	Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, Netherlands	Primary contact	Mathematical system analysis applied to water resource systems

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2 Markus Hrachowitz	Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, Netherlands M.Hrachowitz(at)tudelft.nl	Member	Tracer hydrology and conceptual hydrological modeling
3 Alla Kolechkina	Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, Netherlands a.g.kolechkina(at)tudelft.nl	Member	Control theory and optimization for management of water resource systems
4 Renata Romanowicz	Institute of Geophysics Polish Academy of Sciences, ul. Księcia Janusza 64, 01-452 Warszawa, Poland, Romanowicz(at)igf.edu.pl	Member	Hydrology, environmental modelling, uncertainty analysis, climate change impact on hydrological processes
5 Jarosław Napiórkowski	Institute of Geophysics Polish Academy of Sciences, ul. Księcia Janusza 64, 01-452 Warszawa, Poland, J.Napiorkowski(at)igf.edu.pl	Member	Hydrology, multi-objective optimisation, environmental hydraulics, forecasting
6 Niels Schütze	Technische Universität Dresden Bergstr. 66 01069 Dresden, Germany ns1(at)rcs.urz.tu-dresden.de	Member	Inverse modelling of physically-based models, development and application of soft-computing methods
7 Dirk Schwanenberg	Institute of Hydraulic Engineering and Water Resources Management, Universität Duisburg-Essen, Universtitaetsstr. 15, 45141 Essen, Germany, dirk.schwanenberg(at)uni-due.de	Member	Short-term forecasting and optimization of water resources systems
8 Andrea Castelletti	Dept Electronics, Information, and Bioengineering, Politecnico di Milano Piazza Leonardo da Vinci, 32 20133 Milano, ITALY andrea.castelletti(at)polimi.it	Member	Applied systems analysis, Optimal control and decision-making
9 Demetris Koutsoyiannis	Department of Water Resources and Environmental Engineering, School of Civil Engineering, of the National Technical University of Athens, Heroon Polytechneiou 5, GR-157 80 Zographou, Greece dk(at)itia.ntua.gr	Member	Investigation of the nature and properties of hydrological and geophysical processes
10 Taha B. M. J. Ouarda	Masdar Institute, Masdar City,	Member	Hydrometeorology, environmental and public

	Abu Dhabi, United Arab Emirates, touarda(at)masdar.ac.ae		health modeling, and risk analysis
11 Francesca Pianosi	Department of Civil Engineering, University of Bristol, Queen's Building, University Walk, Clifton BS8 1TR, United Kingdom francesca.pianosi(at)bristol.ac.uk	Member	Water resource management
12 Valeriy Khokhlov	Hydrometeorological Institute, Odessa State Environmental University, Lvivska str. 15, 65016 Odessa, Ukraine vkhokhlov(at)ukr.net	Member	Hydrometeorology, Climate Change impacts, Multivariate time series analysis
13 Dmitry Kushnir	Department of Information Technologies, Odessa State Environmental University, Lvivska str. 15, 65016 Odessa, Ukraine kushnir.dmitry23(at)gmail.com	Member	Hydroclimatology, ecological modelling, spatial ecology

References

[1] Peterson, T. P., Argent, R. M. and Chiew, Francis H. S. (2007) Multiple stable hydrological states in models: Implications for water resource management. In Oxley, L. and Kulasiri, D. (eds) MODSIM 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2007, pp. 1457-1463. ISBN : 978-0-9758400-4-7.