Effect analysis of transient scenarios for successful water management strategies

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Abstract

Recent scenario studies on water management focus on one or two projection years and the effects on the water system and functions. The future is however more complex and dynamic. Therefore, we analyse transient scenarios in order to evaluate the performance of water management strategies. Current available simulation tools are not suitable for this purpose. Therefore, we have developed and used a tool to simulate 50-100 year long time series and that is good and fast enough to simulate the effects of these scenarios and strategies on the water system and the interaction with the human system. We present the first step by means of a case study.

Introduction

Successful water management involves defining strategies that are not very sensitive to unanticipated changes in pressures (i.e. robust) and do not a-priori exclude alternative strategies (i.e. flexible). Recent scenario studies on water management in the Netherlands were mainly ‘What-if’ assessments, based on comparing the state of socio-economic and ecological functions of the water systems in one or two future situations with the current situation. The future is however more complex and dynamic. For the identification of robust and flexible strategies we explore a range of possible futures with transient scenarios, thereby considering the interaction between pressures, impacts and management responses in a dynamic way (Figure 1).

Transient scenarios are integrated scenarios which describe time series that include trends, unexpected events, floods and droughts and the interaction between water system and society.

Objective

The objective of this study is to develop a method to identify robust and flexible adaptation strategies in river deltas under uncertainty, by exploring integrated transient scenarios for the physical, socio-economic and social system.

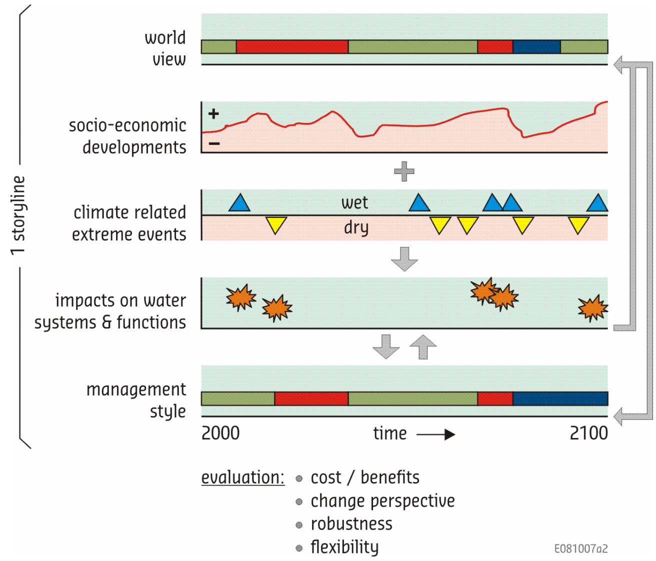

Figure 1 Flow diagram for the effect analysis of transient scenarios.

This study is part of the project Perspectives in Integrated Water Resources Management (Haasnoot et al. 2008).

Method

Most of current available simulation tools require a very long calculation time in case of long time-series or they are unable to run time-series, or they do not consider the society-water interaction involved. Therefore, we developed a Rapid Assessment Model (RAM) that is able to run many long time series and that is adequate to simulate the effects of these scenarios and strategies on the water system as well as the interaction with the human system. This allows for determining transition pathways towards new water management strategies.

The core of this RAM comprises a rule-base of cause-effect relations, describing the physical system, and response curves, describing the world view dynamics and (changes in) management style. The knowledge rules will be based on a vulnerability analysis, results of detailed hydrological and impact models, and understanding of the dynamics in water management perspectives. The latter will be derived from different methods including desk research and participatory stakeholder workshops (Offermans et al. 2007).

Results

To elaborate the method we first applied to an imaginary case inspired by the river Waal. The transient climate scenarios are based on simulations with the KNMI Rainfall Generator coupled to a hydrological model for the Rhine (Te Linde, 2007) in which the KNMI'06 climate scenarios are incorporated as a linear change up to 2100 (Figure 2). However, the events experienced by society are stochastic in nature.

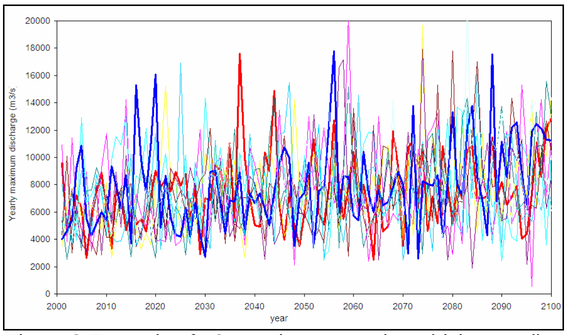

Figure 2 Example of 10 transient scenarios which are all possible realisations of the future. They indicate the maximum yearly discharge of the Rhine at Lobith, based on modelling results under a changing climate (W+ KNMI'06 scenario).

The current version of the RAM is able to analyse the performance of a strategy for a transient climate scenarios and includes the following physical cause-effect relations:

- discharge and water levels along the river,
- water level and probability of dyke failure (based on Van Velzen in prep.),
- water level and shipping costs,
- water level and flooding,
- flooding and damage to houses and agriculture (De Bruijn, 2008),
- flooding and vegetation types (based on Haasnoot and Van der Molen, 2003).

By using transient scenarios, we will be able to evaluate the management response to the occurrence of (extreme) events. For example, a scenario with an extreme flood event around 2040 will have a different impact and response than a scenario with two flood events in 2015 and 2020 (red and blue line in figure 2). The results of the analysis of transient scenarios will be used to evaluate the management strategies and develop possible adaptation paths.

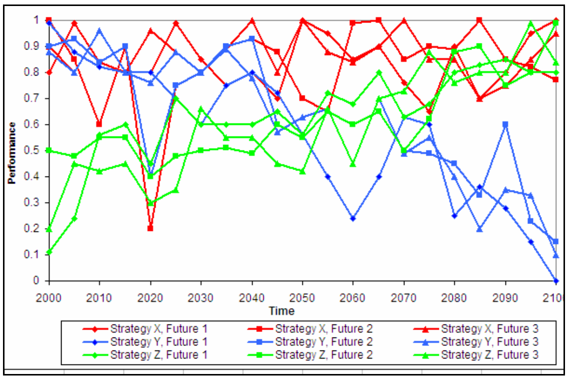

Figure 3 Example of the result of the Rapid Assessment Model. The lines indicate the relative performance of a strategy for different transient scenarios.

An example of a result of the RAM is given in figure 3. The figure presents the performance of three strategies for three different futures. The performance indicates to what extent the objectives are achieved through time. This gives information on the robustness of a strategy and adaptation paths. 'Strategy X' has mostly a good performance considering all possible futures. 'Strategy Y' decreases in performance and it might be worthwhile to change to 'strategy Z' after 2050. If the objectives change the performance changes as well.

Conclusion

The first results of the study are encouraging to elaborate it further in the imaginary case and test the method in different real cases. We plan to extend the number of possible futures with socio-economic scenarios. Furthermore, we will include perspective based evaluation of the performance of a strategy and include the response of society in terms of world view and management style.

References

De Bruijn, K.M. (2008) "Bepalen van schade ten gevolge van overstromingen. Voor verschillende scenario's en bij verschillende beleidsopties." Deltares report Q4345.00. Delft, The Netherlands (In Dutch).

Haasnoot, M. & D.T. van der Molen. (2003) Impact of climate change on ecotopes of the rivers Rhine and Meuse. In: Lowland river rehabilitation.

Haasnoot, M. et al. (2008) Research proposal perspectives in integrated water resource management in river deltas. Vulnerability, robust management strategies and adaptation paths under global change. Deltares.

Offermans, A. (2007) Perspectives in Integrated Water Management. NCR proceedings 2007.

Van Velzen, E. (in prep.) Overstromingskansen in WV21 (in Dutch).