

## **Towards risk-based drought management in the Netherlands: quantifying the welfare effects of water shortage**

Marnix van der Vat (1), Schasfoort Femke (1), Van Rhee Gigi (2), Wienhoven Manfred (2), Polman Nico (3), Delsman Joost (1), Van den Hoek Paul (4), Ter Maat Judith (1), and Mens Marjolein (1)

(1) Deltares, Delft, the Netherlands (marjolein.mens@deltares.nl), (2) Stratelligence, Leiden, the Netherlands, (3) LEI, Wageningen University, Den Haag, the Netherlands, (4) Rijkswaterstaat, Ministry of Infrastructure and the Environment, Lelystad, the Netherlands

It is widely acknowledged that drought management should move from a crisis to a risk-based approach. A risk-based approach to managing water resources requires a sound drought risk analysis, quantifying the probability and impacts of water shortage due to droughts. Impacts of droughts are for example crop yield losses, hydropower production losses, and water shortage for municipal and industrial use. Many studies analyse the balance between supply and demand, but there is little experience in translating this into economic metrics that can be used in a decision-making process on investments to reduce drought risk. We will present a drought risk analysis method for the Netherlands, with a focus on the underlying economic method to quantify the welfare effects of water shortage for different water users.

Both the risk-based approach as well as the economic valuation of water shortage for various water users was explored in a study for the Dutch Government. First, an historic analysis of the effects of droughts on revenues and prices in agriculture as well as on shipping and nature was carried out. Second, a drought risk analysis method was developed that combines drought hazard and drought impact analysis in a probabilistic way for various sectors. This consists of a stepwise approach, from water availability through water shortage to economic impact, for a range of drought events with a certain return period. Finally, a local case study was conducted to test the applicability of the drought risk analysis method. Through the study, experience was gained into integrating hydrological and economic analyses, which is a prerequisite for drought risk analysis. Results indicate that the risk analysis method is promising and applicable for various sectors. However, it was also found that quantification of economic impacts from droughts is time-consuming, because location- and sector-specific data is needed, which is not always readily available. Furthermore, for some sectors hydrological data was lacking to make a reliable estimate of drought return periods.

By 2021, the Netherlands Government aims to agree on the water supply service levels, which should describe water availability and quality that can be delivered with a certain return period. The Netherlands' Ministry of Infrastructure and the Environment, representatives of the regional water boards and Rijkswaterstaat (operating the main water system) as well as several consultants and research institutes are important stakeholders for further development of the method, evaluation of cases and the development of a quantitative risk-informed decision-making tool.