Adapting to climate change – Keep uncertainty in mind, scientist urges

While many forecasting models predict changes in the global climate with consequences for natural resources such as water, we need to heed the uncertainties of these predictions and structure our adaptation strategies accordingly. So says Vice President of the International Association of Hydrological Sciences, Prof Denis Hughes, Director of the Institute for Water Research at Rhodes University.

There has arguably never been a topic in the natural sciences that has seen as much publicity and discussion in the social and political arenas as that of climate change. Perhaps this is inevitable given the projections of the consequences that are often reported in the popular press and governing briefings or policy documents from countries worldwide.

"It is almost as if the 'science' of climate change has been taken out of the hands of scientists and is now more driven by political agendas," noted Prof Hughes. He was speaking at the 16th National Hydrology Symposium, held in Pretoria, in October.

"One of the consequences is that effective scientific enquiry into an extremely complex issue has been partially suppressed to the extent that many papers submitted to journals start with the assumption that climate change and adverse consequences are known facts. This would have been a totally alien concept in the natural sciences of the past, where any assumptions would have to be clearly demonstrated by hard evidence."

While some scientists conclude that such hard evidence is already available and therefore the assumptions are valid, there is also ample evidence (often ignored) that it is not true for other aspects and there remains a high degree of uncertainty associated with future projections.

Global climate models (GCMs) are used by various climate research centres throughout the world and their outputs downscaled to provide regional or local impact assessments. As Prof Hughes pointed out, models are only mathematical abstractions of reality and depend on a whole range of assumptions about the real processes and boundary conditions and are therefore subject to varying degrees and causes of uncertainty.

"As the scale of modelling increases, so does the uncertainty, regardless of the complexity included in the model – we simply do not have sufficient understanding of complex natural systems (whether of the land surface or of the atmosphere) to be able to construct models that are perfectly reliable."

This is true when scientists use models to simulate historical conditions for which there are some observations that can be used to condition the model outputs. It is even more true when models are used to forecast future conditions of which there is no experience.

For hydrologists dealing with the modelling of an inherently intricate and variable hydrological cycle, the added complexity of climate change brings even more issues of uncertainty. This is especially so for a country such as South Africa which already has an extremely variable climate in time and space and where it is not unheard of to have droughts and floods simultaneously in different parts of the country. Current extreme weather phenomena can thus not necessarily be attributed to a changing climate. In addition, where past assumptions have assumed that, for example, a rise in temperature will necessarily result in a rise in evaporation, new observations are showing this to be not necessarily so.

"At this stage there are far more things that we do not know about the future climate and its impacts on water resources than there are things that we do know."

Inadequate gauging records (of both climate and hydrology variables) make it more difficult to detect changes of time or to condition the outputs from models that are applied to fill in the variability in climate and natural water resource availability. Superimposed on this variability are poorly quantified development impacts related to water use, hydropower generation and land use changes. It is therefore always difficult to separate out these various effects over historical time periods and confidently conclude that trends can be detected.

The variability in rainfall and streamflow that exists in southern Africa has been well documented scientifically. "One of the important questions about possible climate change impacts is whether that variability will be changed, and if so in what direction?" noted Prof Hughes. Further questions relate to whether any changes in variability will make significant differences to the impacts of that variability, whether communities and managers have learnt (or not) to adapt to it and whether we need to change our water resources management practices or infrastructure. It is therefore important to not only look at possible changes in hydrological response, but what these changes mean in terms of real impacts. The only answer at this stage is that we will be faced with more uncertainty.

The fact of the matter is that at this stage there are far more things that we do not know about the future climate and its impacts on water resources than there are things that we do know, noted Prof Hughes. "The danger is that ill-informed policies will be formulated around potential threats of climate change that cannot be adequately justified using scientific analyses. While it is not suggested that there should be no response to potential future threats of climate change, it is recommended that these responses should be considered in a context of existing known variability, as well as the uncertainties of the future. The responses should therefore be informed by the level of risk aversion that can be considered appropriate in different circumstances."

For scientists this means improving their observation networks so that they rely less on uncertain model outputs, or at the very least have more real information to constrain model outputs. "We also need to develop consistent approaches for conveying scientific outputs to non-scientists," said Prof Hughes.

He concluded: "We need to know more about possible changes to the climate before we can make some of the important decisions about how to adapt to them. In the meantime we should develop better ways of managing existing patterns of variability so that our approaches are robust in the face of future uncertainties." ❑