Royal Netherlands
Meteorological Institute
Ministry of Infrastructure
and Water Management

Final assessment KNMI'23 scenarios

B. van den Hurk, A. Klein Tank, N. van Lipzig, D. Salas, A. Fischer, J. Aerts, C. Dalelane

De Bilt, 2023 | Scientific report; WR-23-02a

Final assessment KNMI'23 scenarios

Bart van den Hurk, Albert Klein Tank, Nicole van Lipzig, David Salas, Andreas Fischer, Jeroen Aerts, Clementine Dalelane

29 sep 2023

Introduction

Climate change is increasingly witnessed by the general public and professional stakeholders in the real world. The large number of climatic events that have captured headline news reports in the past summer testify on this notion, and one may thus argue that the release of the KNMI'23 scenarios is very well timed. However, the current display of extremes fits in an observable long-term trend of increasing intensities of extreme events such as heatwaves or extreme precipitation. As such the release of a new national climate change scenario product will continue to be synchronized to recorded and witnessed climate change features at any moment in the nearby future, even when global society will succeed in a widespread reduction of greenhouse gas emissions at short notice.

As such the Scientific Advisory Board of the KNMI'23 scenario program greatly supports the continuity of the climate change research program and its frequent synthesis by means of climate change scenarios and related products. We see KNMI'23 as an element in a chain of releases that have been and will continue to be needed to inform and guide citizens and professionals in their efforts to make sense of the implications of climate change for our country. We see this continuity both in the referencing of earlier KNMI scenario outcomes (giving societal partners an indication of the need to retune efforts to make the Netherlands resilient to the impacts of climate change; see e.g. Tables 11.2 and 11.3 in the Scientific Report), and the forward referencing of the KNMI'23 products and outreach activities that are yet to be released.

In this general assessment we contribute to this continuity in the scenario product line by not only addressing our findings on the *scientific soundness* and *innovation compared to earlier scenario releases* of KNMI'23, but also to include a *look ahead*, directed at a next "mindset" for scenario development that has the potential to bring climate change features and its associated decisions even closer to the hearts and minds of the affected people.

Scientific soundness

A lot of work has gone into the scenario production and scientific documentation. Important storyline concepts with a clear user orientation were retained, which already has been reported in the scientific literature as a sound methodology to generate confidence in the scenarios by providing a layer of physical understanding of spread in regional climate change projections. This rationale is reinforced by adopting wet and dry subsets of projections that clearly distinguish between climate change impacts and policy interventions required to deal with these varying features.

Similar to other national climate change programs, the KNMI'23 products rely on well-documented and globally acknowledged CMIP and CORDEX climate change projections, which provides a contribution to the scientific soundness. A large number of partial studies is dedicated to specific climate processes, model behavior, consistence with observed evidence and physical interpretation. Some of these studies find their way to the scientific literature, which is an important element of assuring the scientific quality of the products.

The combination of scientific rigor and the ambition to provide a physically understandable narrative to public and professional recipients of the climate scenarios "could be considered a standard for scenario production in other countries", as stated by one of our Scientific Advisory Board members.

Innovation compared to the previous set of KNMI Climate Change Scenarios

A self-assessment employed by the KNMI scenario production teams mentions a list of innovations in KNMI'23 compared to its predecessor KNMI'14: the explicit separation of wet/dry scenarios, more information on probabilities associated to sea level rise, a stronger underpinning of changes in summer precipitation and temperature extremes, inclusion of scenarios for the Caribbean, a coupling to SSP/RCP scenarios, longer time horizons and a number of technical innovations.

Although not a plain innovation relative to KNMI'14, the stakeholder engagement process has seen a considerable upgrade as well. In an early stage prime stakeholders were placed on the driver seat by requesting an explicit link between the KNMI scenarios and Shared Socioeconomic Pathways used worldwide. This led to among others a choice to include a low-emission scenario in the core set of scenarios, thereby extending the range of KNMI'23 scenarios compared to the previous generation. The overall change in terms of key climate change characteristics was relatively modest, given the fair scaling of many climate change indicators with (regional) mean temperature change, and the application of the "matched warming" approach adopted in some crucial steps in the workflow. Additional stakeholder requests to provide also scenarios between the chosen upper and lower pathways did generate a conceptual break with the 4-scenario structure of KNMI'14, but did increase the potential contribution to the interpretation of climate change in many practical decision making processes.

The strong reliance on (ensemble) model experiments is, however, similar to KNMI'14, and some (persistent) questions on model's ability to describe or explain real world features still remain relatively poorly understood and somewhat underexplored. Prominent features that the methodological and conceptual innovations did not resolve are for instance the model failure to capture the rapid Western Europe warming, or biases in cloud cover and radiation. Suggestions for further innovations increasing the link to the observed phenomena and actual decision contexts are given below.

Potential directions for future development

A future generation of climate scenarios would preferably make an explicit reference to the ongoing experiences of citizens and professionals with climate extremes and their impacts. These extremes raise concerns, provide incentives for action, and give illustrations of potential future conditions, which is a key purpose for practice-oriented climate change scenarios. Some ingestion of event attribution, event storylines and their counterfactuals, and guidance on recent exposures of (compounding) extreme conditions is recommended.

When relying on climate projection ensembles, outstanding systematic biases and limitations should be overcome. Persistent unresolvable but relevant issues should lead to downscaled use of these resources, and replaced by innovations on e.g. combined use of prognostic, statistical and machine learning modelling and observational analyses (hybrid modelling), citizen science, and storyline approaches. Newly developed evaluation frameworks reaching well beyond traditional bias

assessment can help to improve the plausibility of climatic change features projected by earth system models.

A clear analysis of the added-value of convection-permitting models to the quality or representativity of future climate projections should be undertaken. The constraints on affordable time windows or representation of climatic characteristics (such as land/sea contrasts or interaction between atmosphere and urban areas) should be the point of departure when defining the potential use case of these (expensive) activities, and not be added as a disclaimer for their interpretation.

Being embedded in a stakeholder driven request, presentations of new scenario products should include a structured review of societal uptake of the previous scenario release. This uptake will expand over time, and may extend well beyond the primary governmental policy domains, including private industry, education, contribution to international (European) climate missions etc.

Some development could be initiated to develop scenarios designed for adaptative decision frameworks, by making conditional statements on likelihood of a future development given past developments at various future times for various future scenarios. Projections of land use change (particularly urbanization and (de)forestation) and other socio-economic features may become more relevant when moving increasingly to climate impact scenarios. Extended collaboration with experts on risk assessments, societal uptake processes and policy transitions will continuously remain a crucial element of future scenario programs.

These suggestions are generally aimed at increasing the recognition of the scenarios for “human-experienced” circumstances, which is a central purpose of such a highly tailored and society relevant product.

Royal Netherlands Meteorological Institute

PO Box 201 | NL-3730 AE De Bilt
Netherlands | www.knmi.nl