Final Preport for Project **961**

Project title: **BINGO**

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## Project Overview

The BINGO project (**B**ringing **IN**novation in on**GO**ing water management; www.projectbingo.eu) was an international collaboration involving institutes from Germany, Portugal, the Netherlands, Spain, Norway and Cyprus. The project was funded by the European Commission from 2016 – 2020 under grant agreement 641739; in order to fully exploit the project data, the BINGO project utilised DKRZ resources for a further 12 months. BINGO aimed to provide knowledge and tools to end users affected by climate change, i.e. water managers, decision- and policy-makers, etc., so that they can better plan for regional changes in the hydrological cycle expected in future climate scenarios, such as a changed risk of drought or floods. The BINGO project used six research sites across Europe, located in the aforementioned countries. The main objectives of BINGO were to provide adaptation strategies for climate-change-related challenges, by co-produced tools and methodologies for water and land resources management strategies that are based on an improved understanding of future climate and its impact on the hydrological cycle. BINGO addresses average and extreme conditions of climate, focusing on integrated demand-driven solutions for the six research sites.

## Project Activities

The FU Berlin (FUB) led Work Package 2 in BINGO and was responsible for providing improved and downscaled climate variables, based on the present and future. The work of the FUB was performed using the Mistral supercomputer at the DKRZ, supported under project allocation code bb0961. This dynamical downscaling can be summarized in two parts. Firstly, ERA-Interim reanalysis and MiKliP decadal predictions were dynamically downscaled to 0.11° resolution. Secondly, an event-based dynamical downscaling approach was taken in order to further dynamically downscale the 0.11° simulations to a convection-permitting resolution of 0.02° (2.2 km). The event-based approach had the purpose of identifying weather situations with a higher probability of producing extreme precipitation events so that these episodes can be targeted and downscaled at high resolution, thus saving the prohibitive computational expense which would have been associated with continuous multi-decadal downscaling for all six research sites. To achieve this aim, a classification algorithm was developed for identifying extremal episodes – i.e. weather situations with a high chance of intense precipitation – from low-resolution model data (Meredith et al., 2018).

In addition to the high-resolution dynamical downscaling, the FUB was also responsible for performing bias correction of the model data and the development of a stochastic weather generator which created high spatiotemporal resolution time series for each research site.

The simulation data produced by FUB at DKRZ were used by the project partners (i) for climate-change analyses, (ii) as forcing data for hydrological models, and (iii) as forcing data for wave models (Fortunato et al., 2019). FUB furthermore used convection-permitting models to perform research into intense convective precipitation under present and future climate conditions.

## Project Outcomes

The outcomes of BINGO are provided in detail at the project website

<http://www.projectbingo.eu/>. Here, an abridged account is provided. **Short- and long-term changes in climate** were studied using medium and medium- and high-resolution resolution regional climate model data to force hydrological models at the different research sites. The downscaled data were created at the DKRZ. **Integrated analysis of the water cycle** was performed at all six research sites using hydrological, hydrodynamical and other models in accordance with the specific needs of each research site; in particular, with an emphasis on extremes. Through this work, a detailed hydrological description of each site could be obtained. Additionally, improved assessment of the impacts of hydrological extremes (floods and droughts) in a future climate were produced, including the local processes which contribute to these extremes. **Risk assessments** for different stakeholders and their key activities were made, i.e. with respect to future climate change. This included identification of sector-specific key vulnerabilities and the level of risk tolerance of different stakeholders. With these results, **risk management** strategies and adaptation measures – including recommendations for implementing a transition path – were developed for the research sites. With regard to the interaction between science and stakeholders, "Communities of Practice" were established at each research site, which offered a forum for mutual learning between scientists and non-scientists so that **actionable research solutions** can be developed for addressing the complex problems faced by stakeholders under climate change. At the end of BINGO, all outcomes were described and summarized in a set of **guidelines** for reproducing the BINGO methodologies within other communities.

## Key Publications


Fortunato, A. B., Meredith, E. P., Rodrigues, M., Freire, P. and Feldmann, H.. (2019). Near-future changes in storm surges along the Atlantic Iberian coast. Nat. Hazards 98, 1003–1020. http://dx.doi.org/10.1007/s11069-018-3375-z

Meredith, E. P., Rust, H. W. and Ulbrich, U. (2018). A classification algorithm for selective dynamical downscaling of precipitation extremes, Hydrol. Earth Syst. Sci., 22, 4183–4200. http://dx.doi.org/10.5194/hess-22-4183-2018

Meredith, E. P., Ulbrich, U. and Rust, H. W. (2019). The Diurnal Nature of Future Extreme Precipitation Intensification. Geophysical Research Letters, 46(13):7680–7689, https://dx.doi.org/10.1029/2019GL082385

Meredith, E. P., Ulbrich, U. and Rust, H. W. (2020). Subhourly rainfall in a convection-permitting model, Environmental Research Letters, Volume 15, Number 3. http://dx.doi.org/10.1088/1748-9326/ab6787

Meredith, E. P., Ulbrich, U., Rust, H. W. and Truhetz, H. (2021). Present and future diurnal hourly precipitation in 0.11° EURO-CORDEX models and at convection-permitting resolution. Environ. Res. Commun. 3, 055002. http://dx.doi.org/10.1088/2515-7620/abf15e