CLIM-RUN Product Information Sheet: March 2014

Projections of change in precipitation for hydro energy in Croatia:

Ivan Güttler, Čedo Branković (DHMZ),
Robert Pašičko (UNDP Croatia)

Keywords: Hydro, Renewable energy, Climate change

Target groups

- **Energy**
- **Grid operators, power planners and managers, potential investors**
- **Water authorities**

Relevance to the case-study requirements

In the period 2000-2007 about a half of the total electricity production in Croatia was generated from hydro power plants and about 50% of the total installed power capacities are in hydro. Hydro-power system planning requires a long-term approach because planning and construction of power plants take a long period of time and they usually have a long operation life time (80-100 years). For such a long time spans, it is important to consider the information about climate change.

The approach

We estimate potential climate change over Croatia and the neighbouring countries for the period 2011-2040 from 18 simulations by 13 regional climate models (RCMs) which participated in the ENSEMBLES project (van der Linden and Mitchell 2009). Climate changes for the shorter (10-year) periods are also discussed revealing that important variations within the given 30-year period may also exist. At the boundaries, the RCMs were forced by different global climate models under the IPCC A1B emission scenario. The RCMs horizontal resolution of 25 km enables a reasonably well-defined insight of future change of the seasonally-averaged precipitation climate patterns. The spatial distribution of seasonal precipitation is well reproduced (e.g. Rauscher et al. 2010); however, in the regions with high or complex orography, simulations of precipitation amounts might be less successful.

We focus on the region of Dalmatia where many of Croatia's hydro power plants are located and some of them depend on the water inflow from the neighbouring Bosnia and Herzegovina. The spread of the RCM results over the selected region is also analysed. Assuming that modelling errors are not large, it facilitates the estimate of uncertainties in climate change projections.

References:
Branković Č., Güttler I., Gajić-Čapka M. (2013) Evaluating climate change at the Croatian Adriatic from observations and regional climate models' simulations, Climate Dynamics 41:2353–2373
Rauscher S.A., Coppola E., Piani C., Giorgi F. (2010) Resolution effects on regional climate model simulations of seasonal precipitation over Europe, Climate Dynamics 35:685–711
van der Linden P., and J.F.B. Mitchell, (2009) ENSEMBLES: Climate Change and its Impacts: Summary of research and results from the ENSEMBLES project. Met Office Hadley Centre, FitzRoy Road, Exeter EX1 3PB, UK. 160pp.

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The product

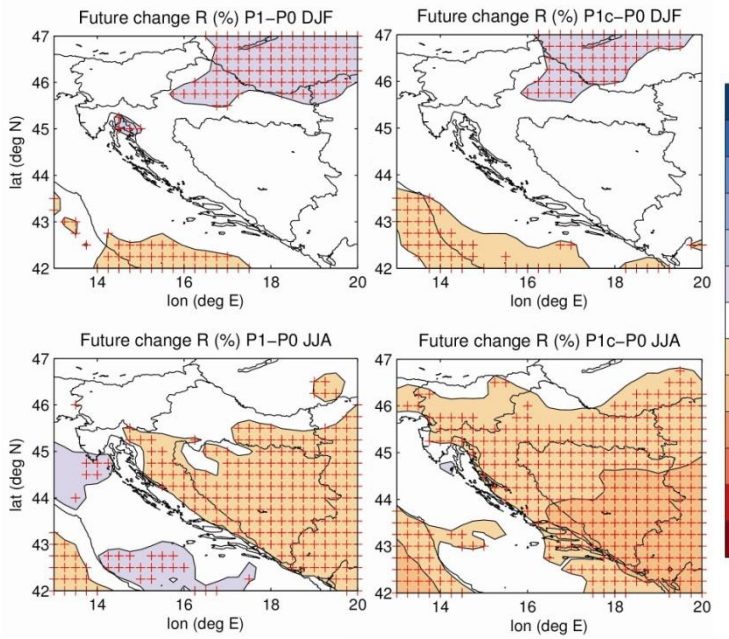

Fig. 1 Relative change (in %) with respect to the reference period 1961-1990 (P0) of seasonal precipitation for winter (top panels) and summer (bottom) in the period 2011-2040 (P1; left) and 2031-2040 (P1c; right). Crosses indicate that 66% of the 18 RCMs agree in the sign of change.

A reduction in precipitation between 5 to 15% is expected over most of southern Croatia in the summer during the period 2011-2040. In the last decade of this period (years 2031-2040), the projected summer reduction is up to 25% in parts of southern Dalmatia. This indicates that the rate of change is not evenly distributed throughout the 30-year period, but the sign of change (reduction) is consistent in the majority of models. The main climate change impact on the hydro-energy production is a potential reduction in precipitation, especially in the river basins where most of the hydro power plants are located.

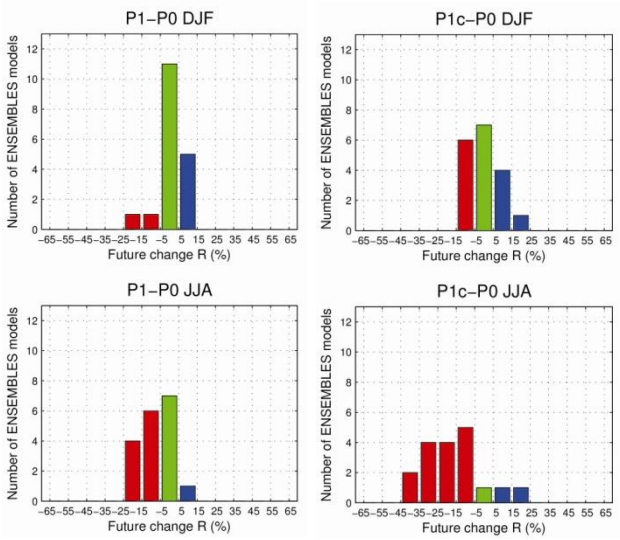

Fig. 2 Bars denote the number of RCMs (out of 18) producing a given change in precipitation in winter (top) and summer (bottom) for the periods 2011-2040 (left) and 2031-2040 (right) for the area of Dalmatia where most of Croatia's hydro plants are located. Clearly, more models "predict" a larger reduction in precipitation in the 10-year period (bottom right panel).

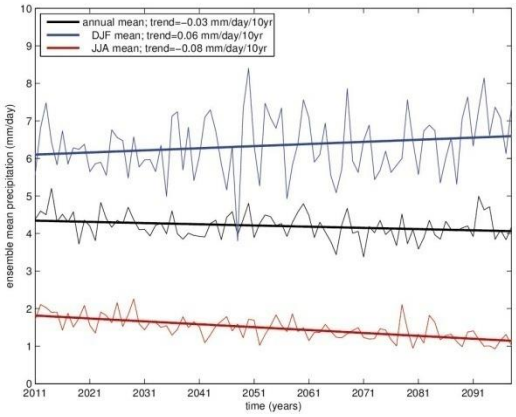

Fig. 3 Trends in precipitation over Dalmatia for annual (black, -0.03 mm/day per decade), winter (blue, 0.06 mm/day per decade) and summer (red, -0.08 mm/day per decade) precipitation as projected for the 21st century. A slight increase in seasonal precipitation is seen only in winter, consistent with the recent observed trend (Branković et al. 2013). The interannual variation is only indicative and should not be regarded as prediction for any specific year.

Making the product usable

The above analysis can be applied for various locations/regions in Croatia. The CLIM-RUN team is seeking collaborations with stakeholders in the energy sector to make climate products usable. The above products could be further tailored according to stakeholders specific needs by providing e.g. analysis of precipitation extremes, critical thresholds and monthly to seasonal forecasts.

This information sheet was developed in the framework of the CLIM-RUN FP7 EU project. The product it describes should not be used without acknowledging the project and, particularly for any operational use, interaction with the authors is welcome and strongly encouraged.

Contact: robert.pasicko@undp.hr **Further information: www.climrun.eu**