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Climate Change Projections for African Urban Areas

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Mainly driven by changes in the orbital characteristics of Earth around the sun, the planet's climate has been continuously changing over periods of tens of thousands of years. However, the warming that has been detected in the Earth's atmosphere over the last century is occurring at a rate that cannot be explained by any known natural cycle. Main-stream science has indeed reached consensus that the 'enhanced green house effect', caused by the interplay of incoming short-wave irradiation, outgoing long-wave radiation and the absorption of energy by enhanced levels of CO_2 and water vapour in the troposphere, is the main forcing mechanism responsible for the phenomena of global warming. The enhanced greenhouse effect strengthens the 'natural green house effect' that results from the CO_2 and water vapour occurring naturally in the atmosphere. The continuous burning of fossil fuels since the industrial revolution and the simultaneous degradation of large forests, are the main reasons for the increase in CO_2 concentrations in the atmosphere.

The availability of climate change projection data varies considerably for different areas on Earth. Whereas the data centres storing climate change projections for Europe and North America now store petabytes of data, regionally downscaled projections for Africa are rarely available. In the context of the research project CLUVA, (Assessing vulnerability of urban systems, populations and goods in relation to natural and man-made disasters in Africa, co-funded by the European Commission under grant agreement no: 265137), the Council for Industrial and Scientific Research (CSIR) in South Africa and the Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC) in Italy have produced a large set of projections of climate change over Africa, covering the time period 1950 to 2100.

Through the collaboration between CMCC and CSIR, a multi-model ensemble of eight high-resolution simulations of climate change over parts of West and East Africa have been derived (six at CSIR and two at CMCC). That is, a multi-model ensemble of simulations of present-day and future climate has been made available for a number of African regions. This approach is most useful to describe the range of uncertainty associated with future climate.

In order to obtain a set of plausible and physically defensible projections that can be used for a broad range of subsequent research questions, the two partners followed two different modelling approaches. The first approach, (by CMCC) uses a single dynamic climate change model: the model gets executed several times using a number of pertubations, e.g. changing initial conditions to account for the non-linear dynamics, perturbations of the boundary conditions to account for the 'imperfect' characterizations of the non-atmospheric components of the climate system or to handle the uncertainty of the driving global model, or perturbations of the model physics to account for the uncertainties inherent in the parameterizations. The second approach, (by CSIR) keeps the boundary conditions static but downscales a number of different global circulation models to account for the uncertainties inherent in the models themselves. In total, CSIR has run six different dynamic models. All runs have been conducted on super computing clusters to be completed within reasonable timeframes.

The full data set is currently made available on the web. A number of tools is used to provide maximum user experience for climate change experts, social geographers, city planners and policy decision makers.