CLIMATE CHANGE AND IMPACTS ON THE QUALITY OF LIFE IN URBAN SYSTEMS

Marek Smid
NOVA IMS, Universidade Nova de Lisboa

Context

Urbanization and Population Boom
In parallel with climate change, we are witnessing a population boom and the vast majority will concentrate in large metropolitan agglomerations. In 2007, first time in history, the urban population exceeded the rural one. Therefore, the human kind became predominantly urban based. The number of rural dwellers has been growing since 1950 and it is projected to reach its peak in near future (UN, 2014). In 2014, about 3.9 billion people, representing 54% of global population, were urban dwellers. Half of the urban population resides in small agglomerations up to half million inhabitants. Roughly one of eight urban dwellers is an inhabitant of a megacity (settlements with population of 10 million or more). The number of megacities nearly tripled since 1990. Currently, we have 28 megacities on the planet, and they are home to 453 millions of people. It is projected that by year 2030 there will be 41 megacities on the Earth. The projections say that by 2050 the urban systems will be home to 66% of global population, representing 6.3 billon urban dwellers (UN, 2014).

Climate change and cities
Urban systems act as important economic hubs and, as such, they are very demanding on resources. Globally, the energy consumption of urban agglomerations is up to 80% of the total energy production, which represents approximately 71–76% of global CO2 emissions (UN, 2014). This illustrates the important role of urban areas as drivers of global warming. The urbanized areas are not only major drivers of climate change, but simultaneously they are hot spots of various disaster risks, which make them especially vulnerable to chain reactions (WEF, 2015). Climate change has major economic consequences in form of reduction in labour productivity, disruption of transport systems and significant losses in energy production and its supply chains (Confalonieri et al., 2007).

Challenges

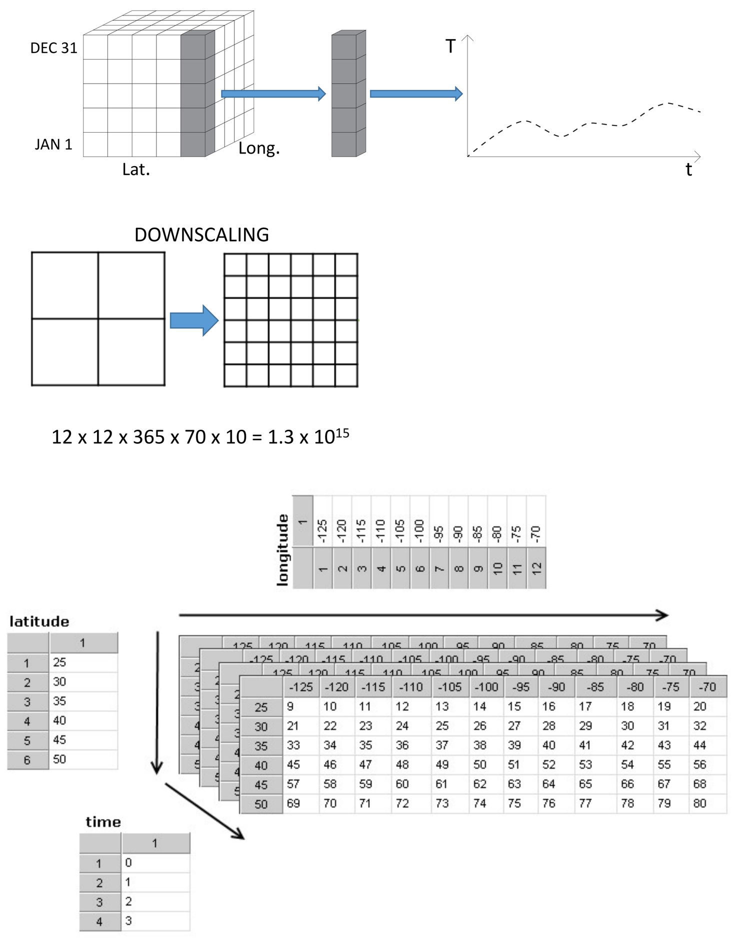
Geomatics' challenge:
"Many climate impact modellers are simply not able to handle the amount of data generated by GCM-RCM simulations (Wilcke & Lars, 2016)."

Data format:
NetCDF-4 Files with HDF5
NetCDF is a set of SW libraries and machine-independent data formats that support the creation, access and sharing of array-oriented scientific data. Uses HD5F as data storage layer.

Projection:
False North Pole Rotated Grid

CF-1.4 convention

Data volume and large # of files:
4 variables: 900 GB in form of 1200 files
(each one contains entire domain,
5 years – daily data)

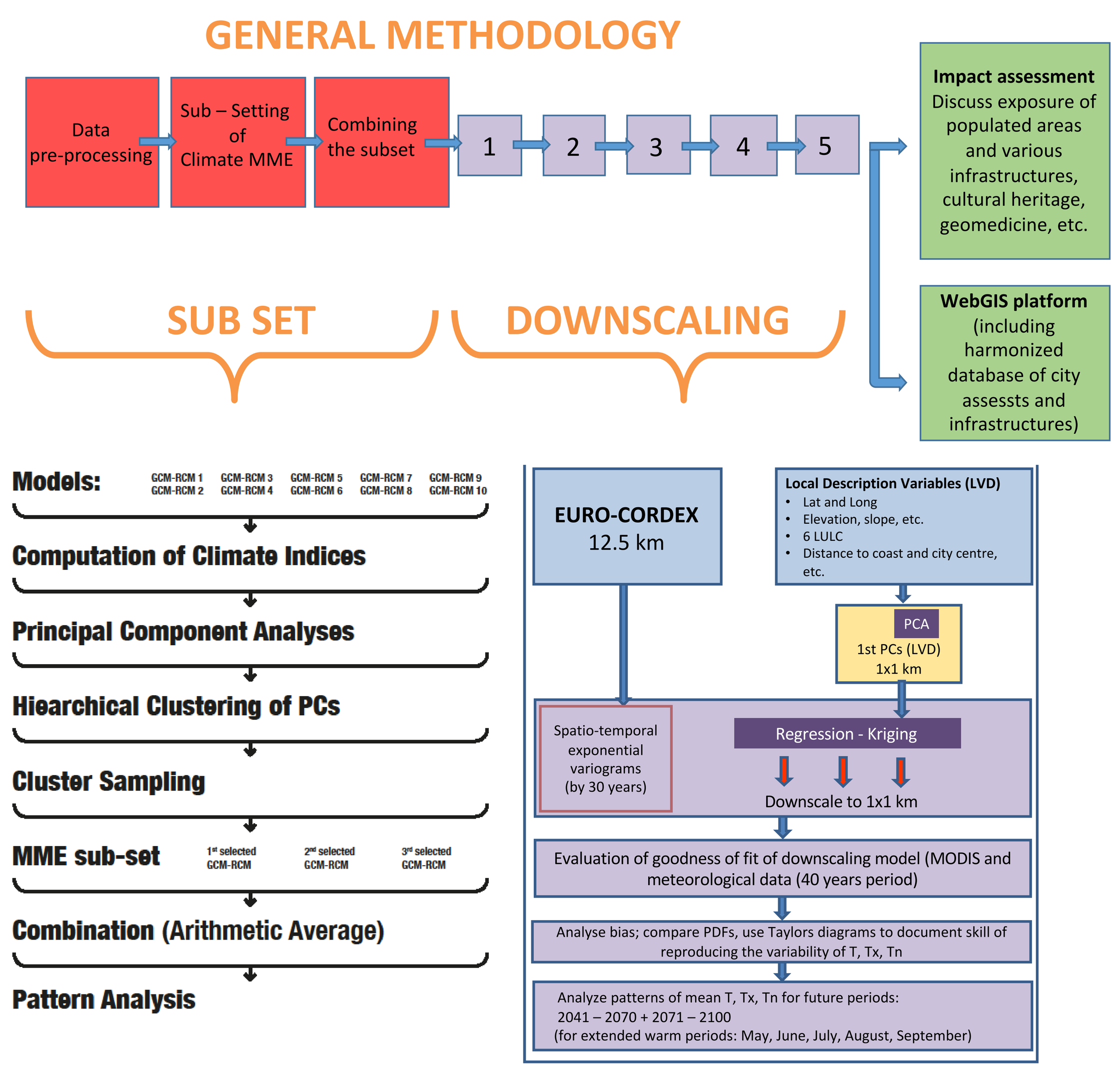


Actions

METHODOLOGY

Sub set:
This procedure leads to sub select of the models from ensemble of simulations. The resulting subset maintains the model spread regarding the variability present in entire input ensemble. The method enhances the quality of the ensemble by reducing the possible bias in the original full set of simulations. The other main advantage of applying such a methodology represents the reduction of the computational cost of all the following operations
In nutshell, the method utilizes the index of inner variability. The subsequent cluster analysis classifies each member of the original ensemble into groups based on their similarity. In final step, those groups are sampled in order to obtain subset of the full set of simulations.

Downscaling:
In the attempt to contribute on assessment of future climate change at city level this study explores downscaling techniques. From two wide families, the statistical downscaling is preferred due to constraints on time and financial resources of dynamical models. Among available groups of statistical downscaling procedures, the regression methods were selected mainly for their ability to employ the full range of available predictor variables.

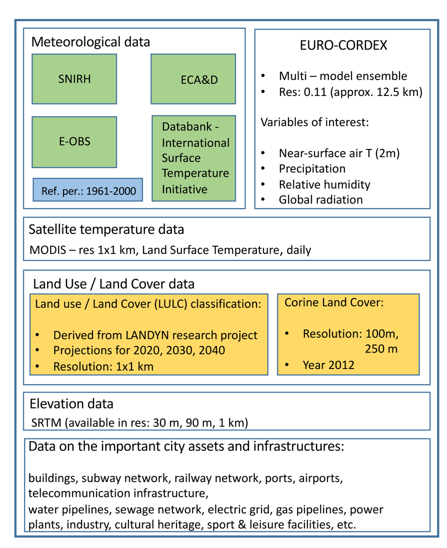


Climate indices:
Furthermore, we propose to compute several climatic indices providing the information related extreme temperature and precipitation events occurrence, such as those proposed by the Expert Team on Climate Change Detection and Indices (ETCCDI). Furthermore, we propose to compute several climatic indices providing the information related extreme temperature and precipitation events occurrence, such as those proposed by the Expert Team on Climate Change Detection and Indices (ETCCDI). Those indices represent the tool to better quantify observed change in climate, particularly of its more extreme aspects. Hence, climate indices allow us to build a clear picture of long-term variability of extremes (Donat et al., 2013).

CLIMATE INDICES

Index	Description	Units
HWMId	Heat Wave Magnitude Index Daily	ranking
Intensity category:		
DTR – Diurnal temperature range	Mean difference between daily maximum and daily minimum temperature	°C
Duration category:		
ECAHWFI (WSDI)	Warm spell days index wrt 90th percentile of reference period	# of days
Frequency category:		
TX90p - Warm days	Share of days when Tmax > 90th percentile	% of days
TN90p - Warm nights	Share of days when Tmin > 90 percentile	% of days

DATA



Scaling Up

The resulting method is adjustable to any urban system and for the wide range of climate change induced natural hazards. Due to its low computational cost and only moderate requirements in terms of scientific and technological expertise the method, when applied in other metropolitan areas, may serve as a basis for comparisons. Hence allows for judgments at higher (e.g. state or regional) scale. By incorporating the other variables and indices many other aspects of future climate behaviours can be assessed. The WebGIS platform can be linked to Early Warning Systems (EWSs) if those would be available in the particular municipality. The value of the tool can be enhanced by deeper integration with ESR08, particularly by fusion of the thermal and the air quality information.

Impact

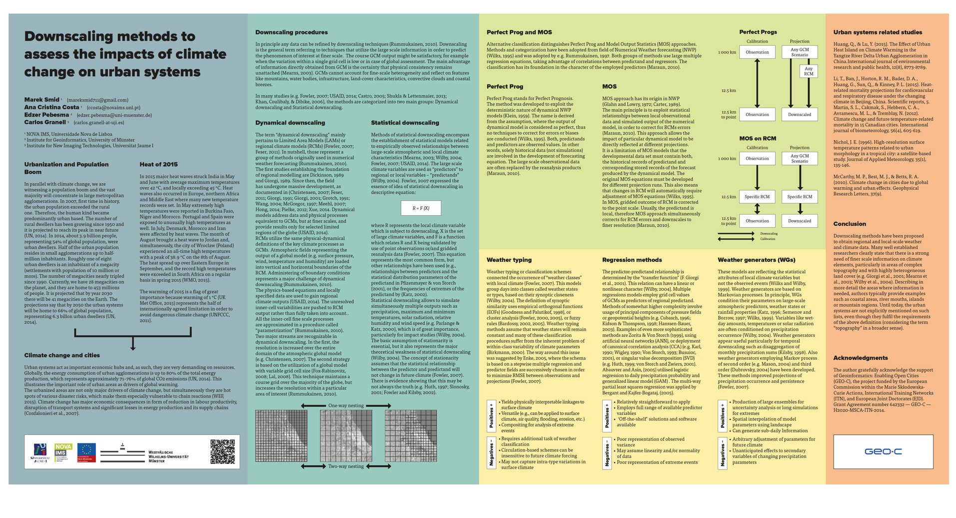
The urban planners represent the primary user group of the results of this project. The foreseen deliverables will serve as a decision making support material in fields of urban planning, CC impact adaptation and mitigation strategies, public health, energy sector and preservation of cultural heritage. Not only the stakeholders from private sector (e.g. insurance companies, developers or real estate entrepreneurs), but the individual citizens as well, will be able to benefit from this research. At last but not at least, also the scientific community, namely the urban climate modellers can use this study as a basis for their own further research.

Results

Scientific publications:
1. Downscaling climate projections: a discussion of techniques for impact studies in urban areas
2. Climate change patterns of extreme precipitation and temperature from EURO-CORDEX subset
3. Extreme heat related CC impact assessment based on statistically downscaled climate indices

The main scientific contribution is the development of a new downscaling climate model, specifically tailored for urban environment, providing future climate scenarios (with focus on projections of extreme events) in fine (city-level) spatial-temporal scale. This model will be developed fully with open source technology and complemented with documentation in order to be integrated into the Open City Toolkit.

Another expected result is an inventory of important infrastructures and assets of the target area of the case study (Lisbon metropolitan area) in form of a detailed harmonized database. Furthermore, the catalogued infrastructures and assets together with the exposure maps will be published via a WebGIS platform, thus available for all the stakeholders and general public.



Consortium

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