

## **Adaptation to climate change in urban areas: the use of specific climatology by professionals and local stakeholders involved in urban planning and management**

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What about climate change in Italian urban cities in recent decades? What's possible to do about climate mitigation and adaptation in daily urban design, management and planning activities?

Some answers are expected to come from the Italian project ClimaMi "Climatology for professional activities and adaptation to urban climate change in the Milano area", co-funded by Fondazione Cariplo in 2019. The project aims to involve professionals, such as engineers and architects, who work in public and private organisations concerned with energy, construction and plant design, building renovations, meteoric runoff management, urban planning and regulation. It will provide them with knowledge basis and suitable local data about urban climate to address the problem of climate change in the specific territorial context.

Within the end of 2019, a Climatic Database and its Guidelines will be released in open source as an integrated urban climate information tool (SIC-U). The database is referred to twenty automatic urban meteorological stations (AWSs) belong to Climate Network of Fondazione OMD, that have been monitoring weather since 2011/2012 in Milano (8 stations) and surrounding minor urban centres. Climate Network accounts for 50 AWSs specialised to measures meteorological variables at the top of Urban Canopy Layer in the main Italian cities.

ClimaMi database, beside most of the usual climatological statistics, implements the climate parameters and indicators that can be used directly by professionals in design calculations or as decision support. Most of these parameters are contemplated by sector legislation or technical standards; other climatic parameters introduced are quite new in professional sectors, such as Humidex and Heat Index suitable to quantify both cooling energy demand and outdoor microclimate comfort. Frequency and intensity of extreme events are accounted for: hot heatwaves, Humidex and Heat Index threshold exceeds, heavy precipitations and strong winds. The database includes data uncertainties and AWSs metadata too.

The associated Guideline is intended to give consciousness of local urban climate, its characteristics and phenomena that are going to be exacerbated by climate change, such as Urban Heat Island (UHI). Urban climate change is in fact the sum of global warming and local anthropogenic contributions. The professionals have to pay great attention on interactions between buildings, infrastructure, energy consumption and microclimate of public space: the influences are in both directions. The use of correct climate temporal and spatial scales is fundamental to properly evaluate result performances of projects, urban planning and management in relation to local microclimate comfort and adaptation to urban climate change impacts.

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ClimaMi project includes capacity building courses for professionals, designed to give them the suited climatological bases to understand characteristics and implications of different climate data and statistics, to evaluate associated uncertainties and to choose the data more suitable to their purposes.

ClimaMi project also includes an experimental action: the application of SIC-U to update the Territorial Government Plan (PGT) of Melzo, a little town near Milano where a Climate Network AWS is located. The purpose is to use SIC-U to characterise local climate and to quantify outdoor microclimate comfort, UHI intensity, extreme events frequency and intensity (heatwaves), warming and cooling degree days. All these information will be used as a decision support for regeneration of city districts planning and as a monitoring system of PGT implementation: every year the dashboard of climate indicators will be updated.

ClimaMi has an experimental value in its overall perspective. Firstly a multidisciplinary technical committee was created to bring together climatologists, engineers, architects and urbanists to work on the various issues of urban climate change. A preliminary training on applied climatology and the creation of a common language were necessary inside the technical committee itself. They are the groundwork of the Guidelines and of the Glossary included.

The technical committee had stringent and constant dialogue with the project stakeholders, belonging to public administration, energy and water utilities, Universities, industry. They expressed specific applications, practical needs and a common perception: a significant variation of climatic patterns in the last decade, that make inadequate their usual and consolidated approaches.

Comparison among different CLINOs in Milano Centro AWS, the only weather station in Milano downtown for which pluridecadal data series is available, confirmed stakeholders' perception. Considering yearly mean temperature series since 1900 onwards, performing Thiel-Sen statistic with Mann-Kendall test and asking for three change points, the statistical analysis identifies 1980, 1999 and 2010 as change points with an average annual temperature increase of about 2°C. The last change point makes sense to use the period 2012-2018 in ClimaMi database, i.e. data from Climate Network for application purposes.

Another goal of ClimaMi is the determination of the more useful updating period of a climatological statistic in relation to practical applications: a fixed interval or a variable period function of temperature increase rate?

Another issue could be the choice of the reference period to calculate extreme events occurrences, such as heatwaves as defined by WMO-WHO Guidelines (2015): because of climate instability, the choice of different though close CLINOs as reference (e.g. 1981-2010 instead of 1961-1990) implies different occurrence counting of heatwaves referring to the same period.

Professionals and decision makers have to be able to properly choose climatic statistics in relationships with their usage.

ClimaMi database makes awareness of spatial distribution of climatic parameters in Milano metropolitan area and particularly inside Milano city. Such a distribution will be presented and discussed referring to the following climatic indicators: warming and cooling degree days (Energy sector), Humidex and Heat Index thresholds exceeds (both as counting of moist heatwaves and outdoor microclimate comfort metric - Health, urban planning), dry heatwaves occurrences, frequency/intensity/duration of precipitation events (urban management).

Structure of ClimaMi database and guidelines will be also presented.

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