Preparing urban climate maps using the LCZ methodology improving communication with urban planners: the case of Tandil city, Argentina

Picone, Natasha[1], Campo, Alicia María[2]

[1] *IGEHCS – CONICET/UNCPBA, Pinto 399, Tandil, Argentina, natashapicone@gmail.com*
2 Departamento de Geografía y Turismo - UNS, 12 de octubre 1098, Bahía Blanca, Argentina, amcampo@uns.edu.ar

dated : 15 Jun 2015

1. Introduction

The Local Climate Zones (LCZ) is a new methodology to improve the characterization of urban station localization (Steward and Oke, 2012). The preparation of urban climate maps with this methodology is a new use of it. There are several studies that have applied LCZ to build-up maps. One of them is the one presented by Alexander and Mills (2014) for Dublin, Ireland, where they have merged the LCZ map with the urban heat island of the city. The latest development is the methodology presented by Bechtel et al., (2015) in which they presented the WUDAPT protocol based on the LCZ classification system to gather information from around the world and make it comparable.

The maps obtained using this methodology have great potential to improve the way of communicating the results to urban climate researchers, urban planners and people in general. These kinds of maps have special potential to inform the application of new mitigation strategies related to the climatic and construction characteristics of a city.

This work present the results of three years of study of a middle temperate city of Argentina. The final map of this research has been really helpful for communicate to urban planners and people in general the results obtained in the investigation.

2. Methodology

2.1. Study area

Tandil is a middle city located in the southeast of Buenos Aires province, Argentina. It has a transition temperate climate. The city is surrounded by the center of Tandilia Hills system from west to south and this has defined its growth. The urban area occupies the top and middle basin of Langueyú river, which has been modified to improve water runoff.

The city has 116.916 inhabitants and centralizes 94 % of the total population. It has a diversified economy with a well developed service sector.

2.2. Method

To build-up the LCZ map for Tandil city, climatic and land use information was used (Fig. 1). The climatic information was obtained throughout three years. The humidity and temperature data were acquired by transect measurements during typical seasonal days. With that information, comfort conditions were calculated using several comfort indexes such us HUMIDEX and Wind Chill Factor. Precipitation data was obtained by 11 gauge rain stations. Wind direction, wind frequency and pressure were obtained using two meteorological stations: one located in LCZ 34 and the other one in LCZ D.

The land use information has three mayor components. First, the vegetation that was acquired using NDVI derived from satellite images. Second, the construction density was obtained with current information from the city hall as regards square meters constructed per block. Finally, the population density was gotten using the last census information (INDEC, 2010).

In addition to all this data, a location map was built-up to show the influence of the natural environment in the city settlement. It should be noted that the hills and their characteristics together with the hydrography influence the development of the urban area.

The final map was presented in a formal meeting to a city hall official regarding urban planning. The map has also been presented to people with diverse occupations.

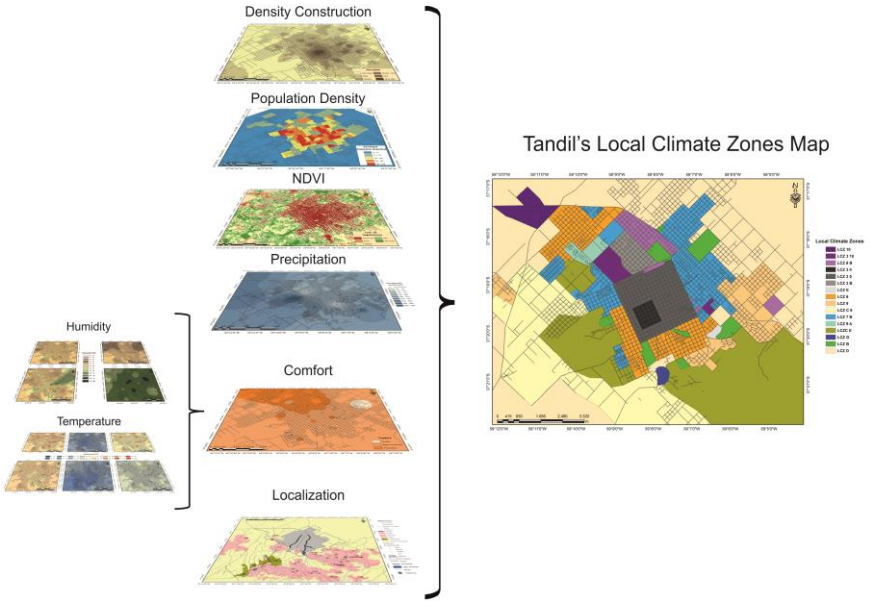

Fig. 1. Methodology summary

3. Results

As a result, a 16 LCZ was determined in Tandil (Fig. 2). The map comes with a table where each zone has its name, a picture showing what it looks like, a description of the construction properties and the climatic characteristics regarding temperature (daily, seasonal and annual behavior), precipitation and comfort (Table 1).

According to the results obtained in each zone, some of them presented problems concerning their climatic behavior in relation to the population that lives in each one. Therefore, proposals were made to mitigate the problems and the current urban development plan. The mitigation strategies were carried out basically in three types of interventions: gas emission control, improvement of the urban vegetation and some construction restrictions.

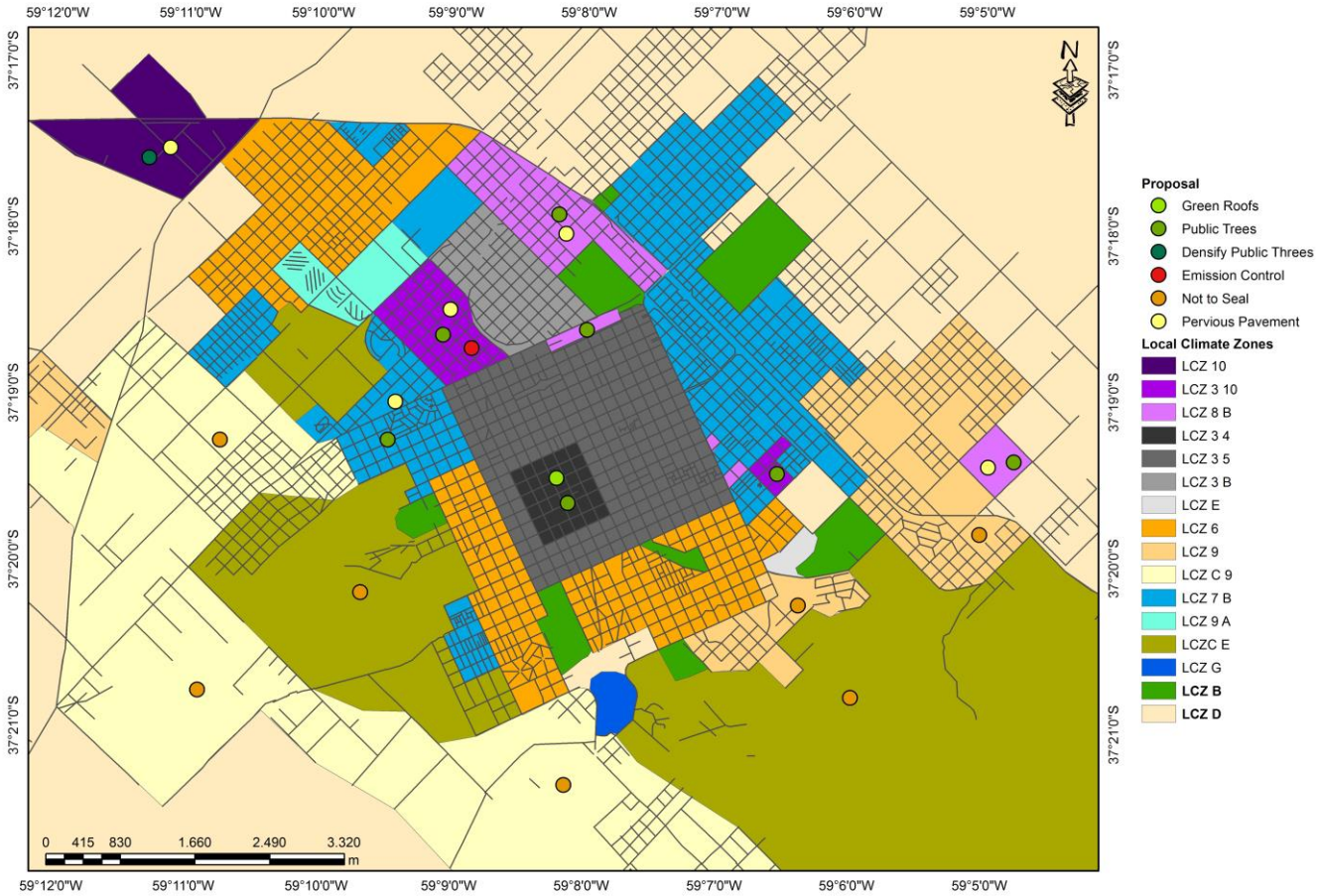

Fig. 2. Tandil's Local Climate Zones Map and the proposal for improving urban development.

Name	Picture	Description	Climatic Characteristics
LCZ 10 Heavy Industrial		Low-rise and midrise industrial structure. Few or no trees. Land cover mostly paved or hard-packed.	High temperature all year. Normal rain. Summer discomfort.
LCZ 3 $_{10}$ Compact low-rise with industrial		Dense mix of low-rise buildings with industrial structures.	High temperature all year. Precipitation lower than normal and pH lower than normal. Summer discomfort.
LCZ 8 $_{B}$ Large low-rise with scattered trees		Open arrangement of large low-rise buildings with lightly wooded landscape of deciduous and/or evergreen trees.	High temperature with mean variability. Lower precipitation. Summer discomfort.
LCZ 3 $_{4}$ Compact low-rise with highrise		Dense mix low-rise buildings with arregenment of tall buildings to ten of stories.	Variable temperature with great daily and seasonal variability. Low precipitation. Summer discomfort.
LCZ 3 $_{5}$ Compact low-rise with midrise		Dense mix of low-rise buildings with arregement of mid-rise buildings. Scaterred trees.	High temperature with high seasonal variability. High precipitation in the west and low values in the rest of the area. Comfortable.
LCZ 3 $_{B}$ Compact low-rise with scattered trees		Dense mix of low-rise buildings with lightly wooded landscape of deciduous and/or evergreen trees.	Seasonal temperature variability. Low precipitation. Summer discomfort.
LCZ E Paved surface		Featureless landscape of rock or paved cover.	High temperature during day and low values at night. Normal precipitation values. Comfortable.

Name	Picture	Description	Climatic Characteristics
LCZ 9 Sparsely built		Sparse arrangement of small or medium-sized buildings in a natural setting.	Low temperature variability. High precipitation. Comfortable.
LCZ C $_{9}$ Bush with sparsely built		Open arragement of bushes, shrubs and short, woody trees. Sparse arragement of small or medium sized buildings in natural settings.	Daily temperature variability. High precipitation values. Comfortable.
LCZ 7 $_{B}$ Lightweight low-rise with scattered trees		Dense mix of single-story buildings with lightly wooded landscape of deciduoues and/or evergreen trees.	Light high temperature. Normal precipitation. Summer discomfort.
LCZ 9 $_{A}$ Sparsely built with dense trees		Sparse arrangement of small or medium-sized buildings with havealy wooded landsacape of deciduous and/or evergreen trees.	Low temperature variability. Low precipitation. Comfortable.
LCZ C $_{E}$ Bush with bare rock		Open arrangement of bushes, shrubs and short, woody trees with landscape of rock.	Great daily temperature variability. Precipitation higher than normal. Variable comfort.
LCZ G Water		Large, open water bodies such as seas and lakes, or small bodies such as rivers, reservoirs and lagoons.	Low tempertature variability. Normal precipitation. Comfortable.
LCZ B Scattered trees		Lightly wooded landscape of deciduous and/or evergreen trees.	Low temperature variability. Normal precipitation. Summer comfortable and winter discomfort.
LCZ D Low plants		Featureless landscape of grass or herbaceous plant cover.	Variable temperature according with type of crops.Normal precipitation. Comfortable.

Table 1. Description of each Local Climate Zone.

The presentation to the city hall official on urban planning proved that the map helps in the communication process. First, it was recognized that the map and table were simply for understanding, taking into account all the data in the summary. Second, the way it shows the proposal makes it easier for the urban planner to interpret why they have been aimed at and why they are necessary. Besides this good impression, the results have not been taken into account as to improve the current urban development plan.

On the other hand, the experience of communicating the results to people with different occupations has been quite surprising. People related their home or workplaces to the things presented in the table as accurately as they could describe. In all the cases, the people tried to know what they could do to improve their own environment asking what each of the proposals means and how they can put it into practice.

4. Conclusion

The map served to improve the communication of the results to the urban planner and people in general. The simple way in which the map and table present the climatic and construction characteristics of each zone, the relation between both and the mitigation strategies that should be implemented to improve the problems make it easier to understand them.

Although the urban planner did not use the information to improve the current urban development plan, the positive attitude of regular people for making changes to enhance their own environment can change things from bottom to top. This makes it more necessary for us to broadcast the results of the research using the map and table as tools to make people aware of our current situation and the ways to improve our environment.

Acknowledgment

This work is part of Natasha Picone's PhD thesis “Clima Urbano de la ciudad de Tandil” (Urban climate of Tandil city) and was financed by CONICET, Argentina.

References

Alexander and Mills, 2014: Locate Climate Classification and Dublin's Urban Heat Island, *Atmosphere*, **5**, 755 – 774.

Bechtel, Alexander, Böhner, Ching, Conrad, Feddeman, Mills, See and Steward, 2015: Mapping Local Climate Zones for the Worldwide Database of the Form and Funtion of cities, *GeoInformation*, **4**, 199 – 219.

INDEC (2010). Censo Nacional de 2010*. Instituto Nacional de Estadística y Censos*. Buenos Aires, Argentina.

Steward and Oke, 2012: Local Climate Zones for urban temperature studies, *Bull. American Meteorological Society, **93***, 1879 – 1900.