Urban surface use optimization for climate resilience improvement

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Synopsis

In the current scenario of massive urbanization and global climate change, the urban surfaces and their characteristics have a key role in pursuing resiliency and sustainability objectives at the city scale. This paper discusses the potential uses of urban surfaces and proposes a systemic approach aimed at their optimization. The methodology, which is customizable for different climates, is tested in a residential district of Bolzano (Italy), which is taking part to the European project SINFONIA. In the case study area, several solutions have been systematically applied and integrated, demonstrating the potentialities of such an holistic approach.

1. Introduction

The massive urbanization and the rapid grow of urban population worldwide, estimated to result in more than 6 billion inhabitants by 2050 (United Nations, 2015), are accentuating various energy and environmental issues clearly related to anthropogenic causes. In this scenario, cities are receiving increasing attention; several mitigation and adaptation strategies are proposed to tackle issues related to urbanization and the correlated effects of climate change (Moraci *et al.*, 2018). Green building solutions, water surfaces, and solar active energy systems are just some of the strategies that are being developed and tested to increase the resiliency and sustainability of cities. However, these are often applied as single and sectorial solutions, impeding their integration and the creation of synergies. As a result, the urban surface is becoming a scattered patchwork of solutions, which reduces the capability of cities in responding and adapting to external environmental pressures, and in mitigating the effects of climate change. Furthermore, the lack of a systemic approach generates disharmonized policies and conflicts in the urban surface usage, which prevent the creation of resilient and sustainable urban areas.

This paper aims to propose a systemic approach to the optimization of the urban surface use, and to demonstrate its relevancy in the maximization of urban resiliency and sustainability. The methodology presented contributes to the debate on resilient cities by answering to the following questions: a) What are the best uses for specific surfaces in a city? b) How can different surface usages be integrated to maximize the throughput avoiding conflicts? c) Which criteria should be considered to optimize the urban surface usage?

2. Background

Several studies have demonstrated the link between urban development and climate change, and the unique climate risks, such as urban heat island and flooding, faced by urban areas (Doherty, Klima and Hellmann, 2016; Wang and Wang, 2017). In this scenario, the urban surfaces and their characteristics have a key role. Indeed, the replacement of natural, permeable surfaces, with mineral materials is responsible of the significant increase of air temperature in urban areas compared to the surrounding environment (i.e. urban heat island effect), and of the land sealing resulting in surface storm-water runoff problems (Tsoka, Tsikaloudaki and Theodosiou, 2017). Furthermore, the low albedo (i.e. reflectance to solar radiation) of materials applied on the majority of the urban surfaces is cause of the increase of solar radiation absorption and of the consequent high surface temperatures observed in cities. The territorial expansion caused by the urbanization increased the land consumption and caused relevant changes in the land use. Therefore, the reduction of green spaces produces a serious environmental degradation, and a decrease of latent heat emission. The latter is cause of the reduction of cooling and further raise of air temperature (Taha, 1997). Heat removal through convection is also prevented by the increase of building heights in urban areas that is responsible for low induced wind velocities. The raise of air temperatures in cities does not only worsen outdoor thermal comfort conditions, but has also negative impacts of human health. Furthermore, it increases the energy consumption for cooling, causing peaks in the electricity demand in hot climate conditions (Santamouris *et al.*, 2016).

2.1 Urban surface uses

In this scenario of increased urbanization and global climate change, it is becoming crucial the capability of cities to: (i) protect people and infrastructures from extreme events like heat waves and floods, and (ii) use their resources efficiently by being self-reliant on energy, food, and water. The use and characteristics of urban surfaces play a key role in addressing these resiliency and sustainability objectives. Five major clusters of surfaces uses are identified as the most promising:

1. Smart coats: consist mainly in solutions aimed at decreasing the absorption of solar radiation in the urban environment. They can be subdivided in two groups. a) Finishing materials or paintings characterized by highly reflectivity to solar radiation and by a high emissivity factor, known as cool materials. These characteristics help decreasing urban surface temperature and minimizing the corresponding release of sensible heat to the atmosphere. Cool materials can be used either on the building envelope or on pavements and other urban structures. The use of reflective materials is associated also to important energy benefits as the cooling load of buildings is reduced (Santamouris *et al.*, 2012). b) Water retentive or porous pavements are applied on ground surfaces to increase evapotranspiration (i.e. water transfer from the land to the atmosphere through the combined processes of plant transpiration and evaporation) and to avoid storm-water runoff.
2. Green: urban greenery contributes to the improvement of urban environmental conditions through different processes: i) direct sun shading, ii) evapotranspiration, iii) mitigation of air movement, and iv) regulation of the heat exchange through the building envelope. In this view, urban greenery solutions can be classified as: a) trees, grass, and vegetation applied in outdoor areas, and b) green building elements (i.e. green roofs and façades). The latter may also produce direct benefits on indoor comfort conditions (Coma *et al.*, 2017).
3. Water: the main purposes of natural water retention measures and artificial water surfaces are to: (i) reduce the impact of urban development by restoring the natural water cycle, (ii) promote in-situ management of storm-water runoff through infiltration (Bortolini and Zanin, 2018), and (iii) remove summer urban heat through evapotranspiration (Santamouris *et al.*, 2016).
4. Urban agriculture: aimed at the production of food, urban agriculture play an important role in the food security and environmental sustainability of a city. As a form of green infrastructure, urban farms and rooftop food gardens contribute to reduce urban heat island effects, mitigate storm-water impacts, and decrease the energy embodied in food transportation (Ackerman *et al.*, 2014).
5. Solar energy systems: within cities, renewable energy can be generated by means of active solar systems, i.e. solar thermal (ST) and photovoltaics (PV), using the surfaces of the building envelope or other elements of the urban landscape (Kanters, Wall and Dubois, 2014).

For each cluster of urban surface use, the main solutions are listed in Table 1, together with the main and secondary objective targeted.

Table 1: Main solutions for each cluster of surface uses. The main (dark green) and secondary (light green) objectives pursued.

USES	SOLUTIONS	OBJECTIVES					
		Resiliency			Sustainability		
		Urban climate optimization	Urban habitats and biodiversity improvement	Urban hydrology and storm-water management	Self-reliance on energy	Self-reliance on food	Self-reliance on water
Smart coats	Cool finishing materials applied on buildings' vertical surfaces	●			○		
	Cool roofing systems	●			○		
	Cool/reflective pavements	●			○		
	Use of finishing materials with different albedo	○			●		
	Water retentive paving systems	●			○		○
	Porous ground materials	○		●			○
Green	Vertical greening systems	●	●	○			
	Horizontal greening systems	●	●	●			
	Planting and greenery	○	●	○			
	Urban parks	○	●	○			
Water	Sprinklers and water curtains	●		○	○		
	Natural water bodies	●	○	○	○		●
	Artificial water surfaces, fountains	●	○	○	○		●
	De-paving	○	○	●			○
	Rain gardens	○	○	●			○
	Water squares			●			
	Aquaculture	○				●	
	Aquaponics	○				●	
Urban agriculture	Rooftop agriculture	○	○	○		●	
	Urban farming	●	○	○		●	
	Vertical farming	○	○	○		●	
Solar energy systems	Photovoltaic panels	○			●		
	Building integrated photovoltaic systems (BIPV)	○			●		
	Photovoltaic application in landscape and urban furniture				●		
	Photovoltaic road pavements	○			●		
	Solar thermal panels				●		
	Road pavement solar collector systems	○			●		
	Shelter design	●			○		

2.2 Conflicts and integration

The majority of the uses and solutions discussed in Section 2.1 are applied independently one from another, highlighting the lack of a systemic view inclusive of synergies and hybridization.

This trend is causing inefficiencies, competition in the use of urban surfaces, and the diffusion of scattered intervention characterized by the absence of a general planning framework. In this scenario, the individuation of the main conflicts and possibilities of integration between different uses is an important step toward the definition of a systemic approach to the optimization of urban surface uses. Table 2 considers the integration of the five surface use clusters discussed in Section 2.1.

Table 2: Conflicts and potential integrations between different surface uses. Rows: main uses; columns: potential secondary uses.

	Smart coats	Green	Water	Urban agriculture	Solar energy systems
Smart coats		? May be used in combination	✗ Impervious surfaces	✗ Use of the same surfaces	? Higher reflected radiation
Green	✗ Use of same surfaces		✓ Increase of permeability	✓ Compatibility	? Research on-going
Water	✗ Conflicting solutions	✓ Microclimate regulation		✓ Compatibility	? Non-conflicting surfaces
Urban agriculture	✗ Use of the same surfaces	✓ Compatibility	✓ Aquaculture and aquaponics		? Use of PV as shading system
Solar energy systems	✗ Use of the same surfaces	? Research on-going	? Non-conflicting surfaces	✗ Use of the same surfaces	

The application of smart coats, mainly highly reflective materials, increase the sealing of urban land; therefore, it conflicts with the surface use for urban agriculture and water systems, which require the presence of permeable soils. In addition, the integration of smart coats with greening or solar energy systems is not possible on the same surface. However, the conflict between the solutions may be avoided when applied on different domains. As an example, cool asphalt applied on ground surfaces is compatible with greening at the building envelope scale. While the increased solar reflection due to the application of cool materials may be beneficial for the energy production of nearby active solar systems (Lobaccaro *et al.*, 2017). Green surfaces are fully compatible with water solutions, as they imply the same heat mitigation processes, and with urban agriculture, while they conflict with solar energy systems. However, recent studies are focusing on the integration of the latter through the application of photovoltaic systems on green roofs (Chemisana and Lamnatou, 2014), and the creation of a multifunctional system integrating building greening and PV (Penaranda Moren and Korjenic, 2017). Water surfaces are compatible with urban agriculture, as they can be used for aquaculture or aquaponics (Al-Kodmany, 2018), and with green solutions. On the contrary, they are not compatible with solar energy production. However, water solutions are mainly applied at ground level, where the shadow casted by buildings and trees reduces consistently the amount of solar irradiation, making these surfaces unsuitable for the installation of solar active systems. Therefore, in the majority of cases, there is no direct conflict. Urban agriculture and solar energy systems are conflicting, since they both aim at using surfaces with good solar exposure. A recent study has conducted a comparison between rooftop food production and energy generation, highlighting the benefits and costs produced by the two solutions applied in Mediterranean climates. The results have shown that, under the modeled conditions, food production is more beneficial than energy production in terms of financial return and local job creation (Benis *et al.*, 2018). Integration between solar energy systems and urban agriculture may be obtained through the application of semi-transparent PV modules on greenhouses roof (Cossu *et al.*, 2016).

3. Methodology

The methodology proposed in this study implies sequential and logical steps to address local climate and morphological aspects for the urban surface use optimization in consolidated urban areas.

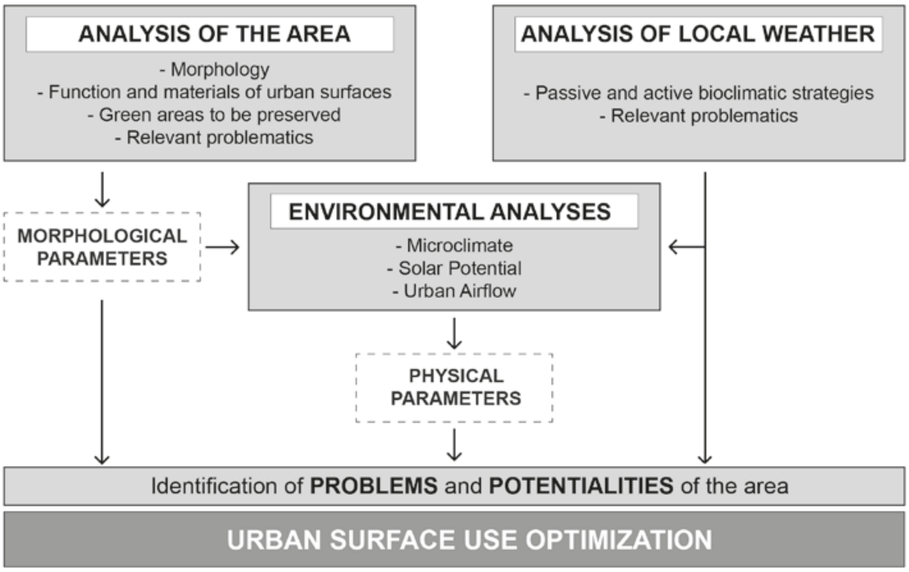

Figure 1: Workflow of the presented methodology.

3.1 Morphological and climate characterization of the area

The methodology, schematized in Figure 1, starts with the analysis of the selected area. The morphology, the function and materials of the urban surfaces are examined with two objectives: (i) outline the main features of the district, and (ii) collect relevant input data for the environmental models. In this stage, the area is also characterized by the individuation of its relevant problematics (e.g. presence of areas prone to flooding, etc.) and positive features (e.g. green areas to be preserved). In parallel, the local weather is analyzed to clearly understand the local conditions and to determine truly responsive passive and active bioclimatic strategies (Lobaccaro *et al.*, 2018). Successively, sets of environmental analyses are conducted on the three dimensional model of the district to: (i) characterize the local conditions and (ii) test responsive solutions, depending on the resiliency and sustainability objectives set for the area. This step includes:

1. Solar potential analyses: aimed at identify the most irradiated areas and the surfaces most affected by overshadowing;
2. Microclimate analyses: focused on the definition of the local climate conditions, the identification of the main problematics of the area, and the verification of the impact of specific modifications in the urban surfaces use;
3. Urban airflow analyses: to evaluate the natural ventilation in the district.

In the final step, the physical and morphological parameters obtained by the analysis process are used as guidelines to define the optimal usage of each surface in the district. One of the strength of the methodology is its replicability worldwide. Hence, since it is based on the three-dimensional model of the analyzed urban district and on the local weather data, the methodology may be reproduced in every morphological and climate condition.

3.2 Tools and indexes for environmental analyses

Several tools may be used as support during the analysis process. In this study, the three-dimensional model of the district was created using the Windows®-based NURBS modeler *Rhinoceros* (McNeel Robert and Associates, 2015). The solar simulations to evaluate the solar potential of the urban surfaces were run using the solar dynamic simulation tool *DIVA-for-Rhino,* a validated *Radiance*/*Daysim*-based software (McNeil and Lee, 2012). Finally, the numerical model *ENVI-met*, version 4.0, has been used to analyze the microclimate conditions in the district in the different scenarios. *ENVI-met* is a 3D prognostic microclimate model that simulate the surface–vegetation–atmosphere interactions in urban complex environments with spatial resolution of 0.5 to 10 m and temporal resolution of 5 to 10 s (Bruse and Fleer, 1998). The analyses have been conducted for the 29th July 2017, selected as representative of a typical hot summer day. Finally, the human comfort at pedestrian level in the district has been evaluated using the Physiological Equivalent Temperature (PET), a thermal index developed by Höppe to assess the thermal comfort in outdoor environments (Höppe, 1999; Matzarakis, Mayer and Iziomon, 1999). The value of PET identifies the thermal perception by human beings and the correlated grade of physiological stress; the range from 18°C to 23°C corresponds to “comfort”, above 35 °C to “hot”. PET values above 41°C describe a “very hot” thermal perception related to extreme heat stress conditions (Matzarakis, Mayer and Iziomon, 1999).

3.3 Case study area

The proposed methodology is tested for the urban surfaces use optimization in an existing residential district in the city of Bolzano.

Bolzano (UTM 46°29'53.8" N, 11°21'17.1" E) is located in the north-east of Italy, at a height of 265 m above sea level. The city is situated in the center of south-eastern Alps in a basin surrounded by four mountain ranges, whose significant height impedes balancing currents and moisture. As a consequence, the climate in Bolzano is categorized as moist continental (“Dfb”) according to the Köppen-Geiger classification (Kottek *et al.*, 2006), and is characterized by strong seasonal fluctuations. Due to its location and climate characteristics, Bolzano is often affected by high temperature and heat waves during summer (Papathoma-Köhle *et al.*, 2015), when it is ranked often among the hottest Italian cities. In summer, air temperatures (T_{air}) often exceed 35 °C, with maximum peaks up to 40 °C. Furthermore, a significant increase in the number of tropical nights (i.e. nights with a minimum temperature equal or higher than 20 °C) has been observed in recent years. Until 1995 the tropical nights where less than five per summer, while in 2010 have reached the number of 20 (Papathoma-Köhle *et al.*, 2015). The historical meteorological data series show an increase in the mean annual T_{air} of more than 3 °C in the last 30 years (Lobaccaro *et al.*, 2018). In this scenario, the city of Bolzano represents an interesting case study for its location, its climate features, as well as the need to mitigate summer conditions.

The district selected is one of the five areas in Bolzano taking part to the Smart Cities European project SINFONIA *(Smart Initiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy solutions*) (SINFONIA, 2017), and it includes two social housing blocks (i.e. buildings S1 and S2 in Figure 2) and the nearby buildings. The morphology of the area is characterized by the presence of five urban canyons: *Via Milano* and *Via Cagliari* from north to south; *Via Brescia*, *Garden*, and *Via Palermo* from west to east (Figure 2). The latter is one of the main roads connecting the eastern and southern areas of Bolzano, while *Via Milano* and *Via Cagliari* are secondary roads. *Via Brescia* is mainly used by the residents to access the underground parking lots, and present a green area with trees running alongside. *Garden* is the central public area between buildings S1 and S2 and it is characterized by grass surfaces and vegetation of different species and dimensions. In the framework of SINFONIA project, whole-building refurbishment and technological interventions have been undertaken. This work aims to expand the evaluation of SINFONIA's impact at the whole district by considering the urban surfaces in a systemic approach.

Figure 2: a) Top view of the case study district. Highlighted in red the two SINFONIA building blocks (source: Google Earth); b) Aerial view.

3.3.1. Scenarios of urban surface use

In this study, five different scenarios of urban surface use have been simulated (Table 3). In the *Baseline* scenario, the morphological characteristics and the albedo of the urban surfaces were maintained unvaried from the actual situation in order to characterize the microclimate and environmental features of the district. Successively, three new scenarios have been modeled to address the main needs of the area, each considering a single use of the urban surfaces. In the *Cool* scenario, materials with higher albedo have been applied on roads and pedestrian paving, at the ground level, and on the roof surfaces, at the building envelope scale (Maleki and Mahdavi, 2016). The *Greenification* scenario implies the modification of the building envelopes, with the application of vertical and horizontal greening systems (Jänicke *et al.*, 2015). While in the *BIPV* scenario, the effect of solar active systems applied on façades and roof surfaces with suitable solar potential has been investigated. The results obtained from the *Baseline* scenario were used as reference values for comparison with the others. Finally, based on the outcomes of the previous scenarios, a final configuration of the district has been outlined. In this *Integrated* scenario, the systemic application and integration of several solutions has been addressed to demonstrate the potentialities of a holistic approach to the urban surface use optimization.

Table 3: Characteristics of the scenarios of urban surface use simulated in the study.

Scenario	Surface	Solutions
Baseline	Roads	-
	Public areas	-
	Buildings	-
Cool	Roads	Cool grey asphalt with albedo 0.40
	Public areas	Cool pavement with albedo 0.50
	Buildings	Cool paint with albedo 0.80 on the roof
Greenification	Roads	-
	Public areas	-
	Buildings	Façades: vertical greening systems Roof: horizontal greening system with grass
BIPV	Roads	-
	Public areas	-
	Buildings	Façades: BIPV on surfaces with suitable solar potential Roof: PV panels
Integrated	Roads	Cool grey asphalt with albedo of 0.40 on the main roads (i.e. *Via Palermo*, *Via Milano* and *Via Cagliari*).
	Public areas	Increase of green areas of 10%
	Buildings	

	Façades: vertical greening systems on (i) surfaces exposed at south, (ii) façades along the roads with higher T_{air}; BIPV on the surfaces with suitable solar potential. Roof: PV panels on the most irradiated surfaces; cool paint with albedo 0.80 on the remaining areas.

4. Results

In this section, the relevant results related to the five simulated scenarios are discussed along with the significance of addressing the use of urban surfaces through a systemic and holistic approach.

4.1 Microclimate conditions in the district

The microclimate analysis of the *Baseline* scenario has been focused on the evaluation of the main climate parameters. Air temperature (T_{air}, Figure 3a), surface temperature (T_s), mean radiant temperature (T_{mrt}, Figure 3b), global shortwave solar radiation (Irr_{SW}), and wind speed (W_s, Figure 3c) have been assessed in selected points for each urban canyon. Finally, solar analyses (Figure 3d) led to the identification of the most irradiated building envelope surfaces potentially suitable for the installation of solar active systems.

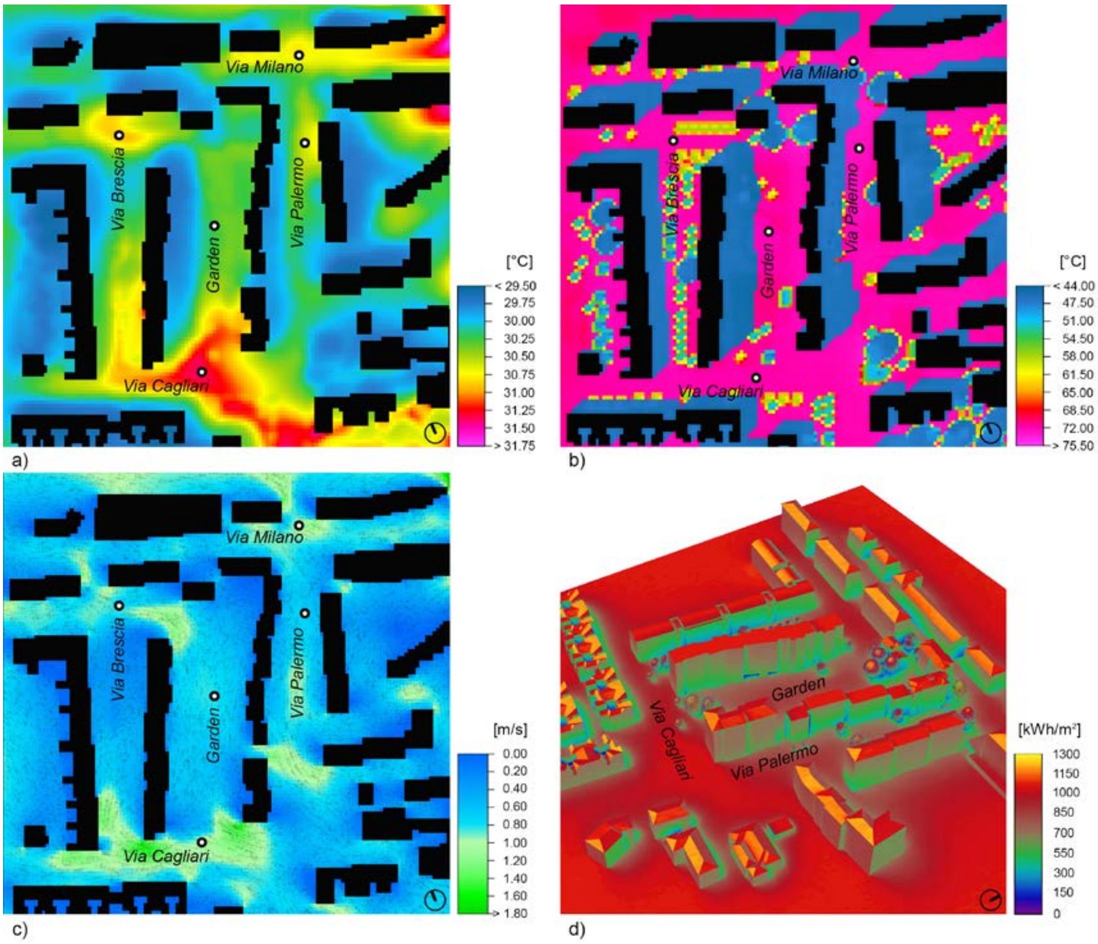

Figure 3: *Baseline* Scenario: a) Air temperature; b) Mean radiant temperature; c) Wind speed and direction vectors; d) Average annual global solar radiation.

The results show that the main problem to be addressed in the area is summer overheating, which is exacerbated by the frequent heat waves, as discussed in Section 5.3. In the analyzed day (i.e. 29th July 2017), the peak of the thermal stress is achieved at 15:00. The hot spots (i.e. areas with high level of thermal stress) are localized in *Via Palermo* and *Via Cagliari*, where T_{air} reaches 30.8 °C and 31.4 °C respectively (Table 4). In both the urban canyons, the T_{mrt} is higher than 70 °C and the PET higher than 50 °C, corresponding to a high level of human thermal stress. The wind flow pattern around buildings (Figure 3c) ensure comfortable and safe wind conditions for pedestrians (Blocken and Carmeliet, 2004).

Table 4: Microclimatic characteristics of significant spots in the urban canyons.

Urban canyon	H/W	Ground material	T_{air} [°C]	W_s [m/s]	T_s [°C]	T_{mrt} [°C]	Irr_{SW} [W/m^2]	PET [°C]
Via Palermo	0.60	Asphalt	30.73	0.63	47.62	72.95	990	52.00
Garden	0.56	Loamy	30.27	0.80	42.17	72.34	1 004	50.20
Via Brescia	0.84	Asphalt	30.93	0.77	44.00	63.23	1 006	45.70
Via Milano	1.36	Asphalt	30.77	0.68	47.52	72.24	1 012	51.10
Via Cagliari	0.78	Asphalt	31.38	0.83	44.10	71.43	1 020	50.50

4.2 Effects of the simulated scenarios

To improve the microclimate of the district, two scenarios have been defined based on the most diffused mitigation technologies (i.e. cool materials and green solutions). A further scenario has focused on the district self-reliance on energy by considering the maximization of the urban surfaces' potential energy production. Figure 4a shows the air temperature difference between the baseline and the *Cool* scenario. The cooling effect of the albedo increase is visible mostly at the center of *Via Palerm*o, *Via Cagliari* and *Via Milano*. The maximum cooling effect of 0.4 °C dissipates by reaching the limits of the roads and the central areas of the district. The increment of the ground surfaces' solar reflectivity produces an average decrease of surface temperature by around 2.6 °C, but causes at the same time an increase of T_{mrt}, which produces a consequent worsening of thermal comfort conditions at pedestrian level. This is demonstrated by an average increase of PET by 0.5 °C. Regarding the *Greenification* scenario, the vertical green façades and vegetated roof does not produce a significant cooling effect in *Via Palermo* and *Via Milano* hot spots, while T_{air} is reduced at the center of *Via Brescia* and *Garden* by up to 1 °C. In *Via Palermo*, the air temperature is slightly increased (i.e. ΔTair = + 0.6 °C) due to the reduction of wind speed caused by the presence of vegetation at both sides of the urban canyon. However, considering the overall effects in the district, this scenario leads to a significant improvement of thermal comfort, reducing PET by around 0.5 °C. Finally, the *BIPV* scenario does not produce relevant modifications in the microclimate conditions of the district; in this scenario, PET is slightly reduced by about 0.3 °C.

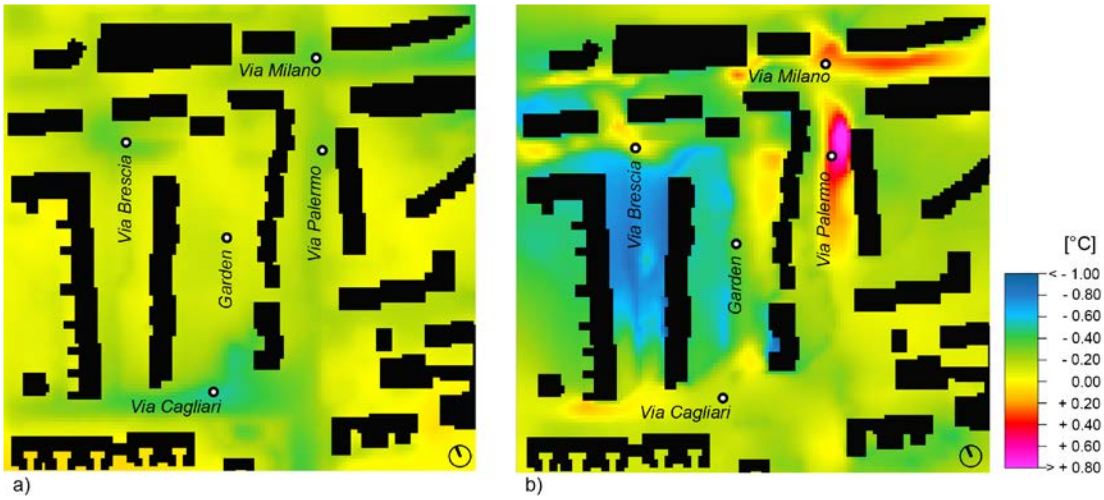

Figure 4: Comparison between *Baseline* and simulated scenarios - Absolute T_{air} difference: a) *Cool* scenario; b) *Greenification* scenario.

4.3 Final scenario of urban surface use optimization

The final configuration of the district (i.e. *Integrated* scenario) has been outlined based on the result of the *Baseline* scenario (Section 4.1) and of the simulated scenarios (Section 4.2). The urban surface use has been defined with a systemic approach. The objective set has been double: (i) to improve the microclimate conditions by combining some of the mitigation strategies previously analyzed and the increment of vegetated areas, and (ii) to increase the energy self-reliance of the district by taking advantage of the surfaces with a good solar exposure (Figure 5a). In terms of microclimate conditions, the air temperature is reduced in all the hot spots (Figure 5b). Furthermore, the combination of increased relative humidity, and decreased surface and mean radiant temperature, produces a reduction of PET in all the urban canyons (Table 5). The more significant improvements in term of outdoor thermal comfort are registered in *Via Palermo* (ΔPET = - 1.4 °C), *Via Milano* (ΔPET = - 2.6 °C), and *Via Cagliari* (ΔPET = - 0.8 °C), which resulted to be the canyons with the higher thermal stress in the *Baseline* scenario. Finally, in the *Integrated* scenario, the installation of solar systems on building envelope surfaces with suitable solar irradiation (i.e. Irr_{SW} ≥ 950 kWh/m²) has been considered. The sum of the suitable areas on façades and roofs covers 6 500 m², with a corresponding annual solar potential of 6 320 MWh/a.

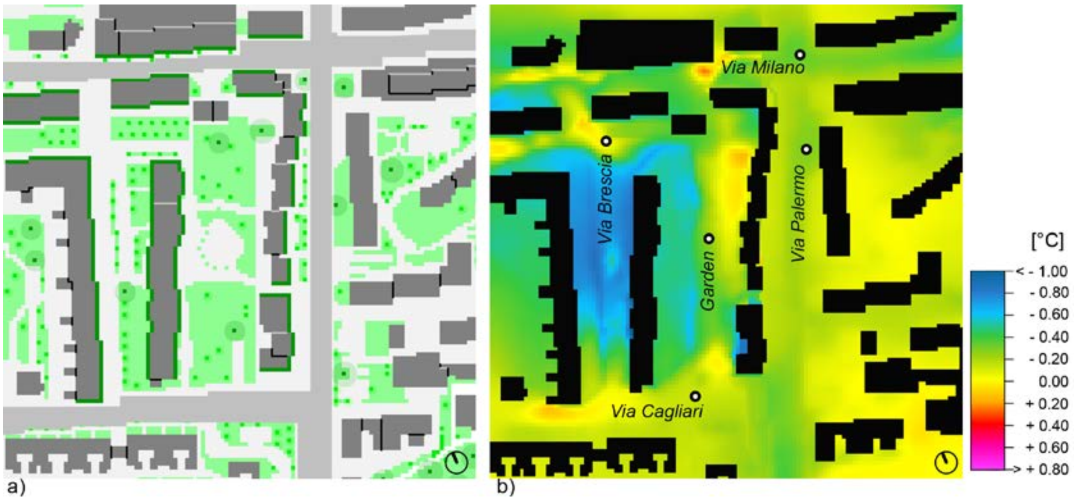

Figure 5: a) Final configuration of the district; b) Comparison between *Baseline* and *Integrated* scenario - Absolute T_{air} difference.

Table 5: Absolute difference of the main microclimatic parameters at 1 m a.g.l. in the *Integrated* scenario compared to the *Baseline* scenario.

Urban canyon	**ΔT_{air}** [°C]	**ΔRH** [%]	**ΔW_s** [m/s]	**ΔT_s** [°C]	**ΔT_{mrt}** [°C]	**ΔIrr_{SW}** [W/m²]	**ΔPET** [°C]
Via Palermo	-0.05	0.56	0.06	-0.65	-1.35	0.23	-1.40
Garden	-0.10	0.70	-0.04	-0.14	-1.40	0.78	-0.70
Via Brescia	-0.13	1.99	-0.21	-1.18	-1.15	-5.12	0.00
Via Milano	-0.33	0.86	0.42	-3.58	-0.78	-2.73	-2.60
Via Cagliari	-0.40	0.83	0.01	0.78	-0.94	1.26	-0.80

5. Conclusions

The main purpose of the study was to develop and test a systemic approach aimed at the optimization of the urban surfaces use in consolidated urban areas. The preliminary discussion on the main uses, their conflicts and potentialities for integration, highlighted the lack of a systemic approach for the optimization of urban surfaces. In this scenario, a methodology is proposed to systematize the results of morphological, climate, and environmental analyses. In the first step, the analysis led to the identification of the main negative and positive features of the district. Successively, the solutions to be applied have been defined based on the main resiliency and sustainability objectives set for the area. Optimal uses of surfaces have been identified in terms of (i) outdoor microclimate and thermal comfort, and (ii) solar active strategies. The final configuration, in which several solutions have been systematically applied and integrated, demonstrate the potentialities of a holistic approach to the urban surface use optimization. The thermal stress in the district is reduced, with PET values up to 2.5 °C lower than in the *Baseline* scenario, and the potentialities of the most irradiated surfaces have been exploited by installing solar systems. Future developments of the study will address (i) the effect of other solutions for surface use and, (ii) the definition of quantitative thresholds and guidelines for the optimization process. Furthermore, the possibilities and potentialities for the inclusion in urban planning instruments of indications on the surfaces uses will be investigated.

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