GreenFORCE

Torino Summer School

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SOCIAL IMPLICATIONS OF THE URBAN HEAT ISLAND EFFECT
Just and Green Transitions

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1 ABSTRACT

This research project undertakes an in-depth examination of the social implications arising from Turin's Urban Heat Island (UHI) effect, with a specific focus on its impact on marginalized communities, addressing challenges posed by rising temperatures and prioritizing community well-being. The main strategy involves boosting Turin's green infrastructure, creating connected spaces, ecological corridors, and community centers to mitigate the UHI effect on marginalized communities and promote social equality. The cost-benefit analysis evaluates economic, social, and environmental impacts, emphasizing potential benefits like reduced heat stress, improved air quality, water management, community well-being, increased property values, and business attraction. The literature review explores Just Green Transitions, focusing on environmental justice and community participation. The methodology combines literature review, policy analysis, and data collection to understand UHI's social implications. Maps and data analysis reveal correlations between UHI risk, greenery, income, and foreigner concentration. Focusing on the neighborhoods of Aurora and Barriera di Milano, the case study proposes a strategy to enhance green infrastructure, reduce heat stress, and improve the well-being of the 90,197 inhabitants. Furthermore, the study challenges Turin's post-industrial narrative, emphasizing the need for green transitions in industrial areas. The policy recommendations advocate for inclusive green infrastructure development, considering economic impacts, and preventing gentrification through measures like rent control and just-cause evictions.

2 THEORETICAL AND METHODOLOGICAL FRAMEWORK

2.1 Aim of the project

The aim of this report is to analyze the social implications of Turin's Urban Heat Island (UHI) effect on marginalized communities. The main problem at hand is the heat island effect, which refers to the phenomenon where urban areas experience higher temperatures compared to their surrounding rural areas due to human activities and infrastructure. This poses one of many challenges for Turin, a city that is already facing an increase in average temperatures and extreme heat events.

Our primary objective is to develop comprehensive strategies that address the social consequences of the UHI effect in Turin, while prioritizing the well-being of marginalized communities. We aim to explore the complex web of issues tied to this problem, including health disparities, access to cooling resources, and economic vulnerabilities, and propose effective solutions.

One key strategy involves enhancing Turin's urban green infrastructure in close collaboration with local communities. This involves the creation of connected green spaces, ecological corridors, and green community centers. By promoting such green initiatives, we seek to mitigate the UHI effect's impacts on marginalized populations, improve overall urban livability, and contribute to social equality in Turin. This report aims to provide valuable insights and recommendations that can inform policymakers, urban planners, and community leaders in their efforts to create a more resilient and inclusive city.

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2.2 Literature review on Just Green Transitions

A just green transition, according to the UN, means moving toward sustainable and eco-friendly practices that prioritize fairness, inclusiveness, and the well-being of all. The concept of "Just Green Transitions" holds significant importance in the discussions of sustainable development and environmental justice. It revolves around the notion of transitioning to a more environmentally friendly society while ensuring that the benefits and burdens of this shift are distributed fairly among all members of society. This literature review explores the key themes and frameworks surrounding the concept of Just Green Transitions.

Key theme: Environment & Society

1. Environmental Justice and Just Green Transitions

One of Just Green Transitions' principles is environmental justice, which emphasizes fair treatment and meaningful involvement of all people, regardless of race, income, or social status, in environmental decision-making. This concept is foundational to the pursuit of Just Green Transitions, which aim to harmonize environmental sustainability with social justice. Scholars like Bullard (1990) have argued that marginalized communities often bear a disproportionate burden of environmental hazards, making it crucial to address environmental injustices in the transition towards a more sustainable future. Just Green Transitions take this idea further by not only focusing on preventing harm but also making sure that environmental benefits are shared fairly.

2. Community Participation and Governance

Effective Just Green Transitions require active community participation and inclusive governance structures. Research by Agyeman and Evans (2003) underlines the importance of involving local communities in decision-making processes related to environmental and sustainability initiatives. Ensuring that marginalized communities have a voice in shaping green policies and projects is essential to avoid reinforcing existing inequalities.

3. Environmental Racism and Inequities

The intersection of race and environmental justice is a central theme in Just Green Transitions. Environmental racism refers to the discriminatory practices and policies that result in the disproportionate exposure of communities of color to environmental hazards (Bullard, 1993). Just Green Transitions must address and rectify these historic and ongoing environmental inequities to achieve environmental justice.

Key theme: Economy

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4. Green Jobs and Economic Equity

Another important part of Just Green Transitions involves the idea of generating green jobs, which researchers like Pollin et al. (2008) have brought attention to. They emphasize that green sectors, such as renewable energy and energy efficiency, offer opportunities for employment. These jobs not only bring economic advantages to disadvantaged communities but also contribute to a cleaner environment. Nonetheless, it's crucial to make sure that everyone, including historically marginalized groups, has access to these green job opportunities.

Policy & Frameworks

In line with the Agenda 2030 and the commitments made with the Paris Agreement, several countries and regions have developed policies and institutional frameworks aimed at advancing Just Green Transitions. The European Green Deal, for instance, emphasizes a fair and inclusive transition to a sustainable economy, with a particular focus on addressing social and economic disparities (European Commission, 2019). These policy initiatives show the growing recognition of the need for justice in green transitions.

2.3 Mapping Turin's Strategic Development Priorities

To inform our analysis, we have consulted three key documents:

The National Recovery and Resilience Plan:

Under the framework of the National Recovery and Resilience Plan Torino will be implementing several physical and immaterial projects in the following years. These projects are organized in seven areas of action that seek to build a more robust local economy, and a more sustainable, cohesive, and inclusive city. One of the areas of action focuses specifically on building a city of networks and social impact. Therefore, Torino is working on projects in cooperation with the third sector to support people under extreme marginalization, and to promote social, economic, and employment recovery. Moreover, it is working on engaging people in the implementation of the Plan to decrease material and social vulnerabilities, eliminate physical and socio-cultural barriers, and improve the accessibility and quality of public spaces.
The city of networks and social impact area also includes projects on specific buildings and areas of some of the most deprived neighborhoods. These projects include urban regeneration to improve market areas, social buildings, and libraries, and to enhance the public spaces that surround these buildings. These projects are expected to have a direct impact on the improvement of life quality in the neighborhoods.

Climate Resilience Plan:

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This document outlines Turin's strategies and policies for enhancing the city's resilience to climate change. It provides insights into the city's broader approach to addressing climate-related challenges. In our analysis, we explored how this plan addresses the specific needs of marginalized communities affected by the UHI effect. Flat areas are the parts of the city with the densest buildings and therefore the most concentrated urban heat island phenomena. The most important areas are industrial areas, which are generally large areas without green space and large impervious areas.

Piano Strategico dell'Infrastruttura verde:

The "Green Infrastructure Strategic Plan" focuses on the development of green spaces and urban nature. We examined this document to understand how the creation of green spaces can mitigate the UHI effect and benefit marginalized communities. We assessed whether the plan considers the equitable distribution of green infrastructure to ensure that vulnerable populations receive adequate access and relief from extreme urban heat.

In our analysis, we expected to find a range of potential solutions and recommendations within these documents. These solutions included initiatives such as increasing tree canopy cover in marginalized neighborhoods, improving access to cooling centers. We will also look for evidence of community engagement and participation in decision-making processes to ensure that the strategies align with the needs and aspirations of the affected communities.

2.4 Methods

The methodology for this report combines a comprehensive literature review, policy analysis, data collection, and analysis. This mixed-methods approach is designed to provide a better understanding of the UHI effect's social implications in Turin and to propose evidence-based solutions that prioritize the well-being of marginalized communities while enhancing the city's overall urban livability and sustainability.

Literature Review:

The literature review process begins with the identification of the problem, which is the UHI effect in Turin and its social consequences, particularly on marginalized communities, and about Just Green Transitions. Systematic desk research is conducted across various academic databases, such as JSTOR, Google Scholar, and documents provided during the Turin Summer School. Key information, including authors, publication dates, and main findings, was extracted from the selected articles.

Data Collection:

Quantitative Data:

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- Temperature Data: Collecting temperature records from maps within Turin to identify UHI-affected areas.
- Socioeconomic Data: Collecting demographic and economic data to identify marginalized communities.

Qualitative Data:

1. Document Review:

A comprehensive review of local, regional, and national policies, regulations, and urban planning documents relevant to Turin, such as "The National Recovery and Resilience Plan", "Climate Resilience Plan," and "Piano Strategico dell'Infrastruttura verde," was conducted.

2. Geographic Information System (GIS) Analysis:

Using the collected quantitative data, maps are generated that include:

- Overlaid demographic and temperature data to identify areas with the highest vulnerability.
- Analysis of the spatial distribution of green infrastructure and identifying gaps in access

Analysis

The collected data will be analyzed using statistical and geospatial techniques to identify trends, correlations, and patterns related to the UHI effect's social consequences. The data will be analyzed at the neighborhood level to use the same aggregation level of the sources from which the socio-economic data is retrieved. This analysis will inform the development of recommendations and strategies and also generate the Cost-Benefit Analysis outlined in the report.

Cost-Benefit Analysis: Comparing total project costs with estimated annual benefits, calculating the benefit-cost ratio (BCR) by dividing the total benefits by the total costs. A BCR greater than 1 suggests that the project is expected to generate more benefits than it costs.

- *Cost and Benefit Estimation:* Including direct costs such as costs for land acquisition, community engagement, design, construction, and project management, as well as indirect costs like environmental and social impacts.

3 CASE STUDY ANALYSIS

3.1 Thematic Study Selection

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In our case study analysis, we focused on the social implications of Turin's Urban Heat Island (UHI) effect on marginalized communities. This thematic study is driven by the need to understand and address the challenges faced by vulnerable populations in the context of climate change and urban development. We believe this theme holds significant relevance in relation to Just Green Transitions for several reasons.

Turin, like many other urban areas, is experiencing the adverse effects of UHI. This case study evaluates the impact that the urban heat island effect has on different groups of Torino's population and shows that the marginalized communities are strongly impacted. Then, it focuses on some of the most deprived neighborhoods: Aurora and Barriera di Milano, and explores a strategy that implements and enhances green infrastructures that do not only act as climate regulators but offer additional environmental and social benefits.

Urban Heat Island Effect:

The Urban Heat Island Effect (UHI) is a phenomenon where urban areas experience significantly higher temperatures than their surrounding rural areas (See Figure 1). This temperature difference is exacerbated during the summer months and is mostly caused by human activities and the physical characteristics of the urban environments. The main causes of UHI are:

- Impervious surfaces: impervious surfaces made of concrete and asphalt absorb, retain, and release heat causing temperatures to rise.
- Lack of vegetation: urban areas can become hotter if they do not have enough vegetation since it does not only provide shade but also natural cooling through the process of evapotranspiration.
- Human activities: activities such as transportation, industrial processes, and energy consumption release heat into the environment leading to an increase in the local temperature.

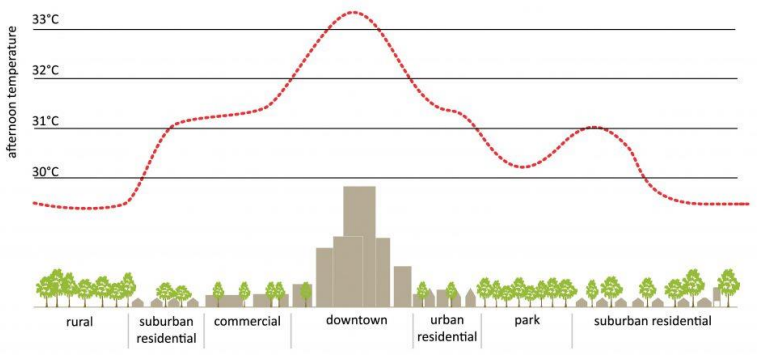

Figure 1: Urban Heat Island Effect

Source: https://urbangreenbluegrids.com/thema/heat/

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Social implications of the UHI:

The UHI causes elevated daytime temperatures, diminishes nighttime cooling, and increases levels of air pollution. Consequently, these factors contribute to heat-related illnesses such as discomfort, respiratory problems, muscle cramps, exhaustion, and non-lethal heat strokes. Moreover, high temperatures limit outdoor activities and recreation, causing social isolation in the most vulnerable people and reducing the overall quality of life.

Low-income neighborhoods where marginalized communities and minority populations live present housing conditions that do not provide cooling resources whether they are passive (e.g., crossed ventilation) or mechanical (e.g., air conditioners). Moreover, these neighborhoods are often characterized by having limited vegetation and poor green areas which aggravates the impacts of high temperatures. When it comes to the UHI marginalized communities carry the burden of climate change which reinforces social injustices.

Green Infrastructures to combat the Urban Heat Island Effect:

An effective strategy to combat the Urban Heat Island Effect is the enhancement and implementation of Green Infrastructures (GI). They are a network of natural and semi-natural areas designed and managed to provide simultaneously a wide range of ecosystem services. Ecosystem services are the benefits that people can get from nature; they have three different functions: provision (e.g., provision of clean air and water), regulation (e.g. water and climate regulation) (see Figure 2), and cultural (e.g. recreation areas). Therefore, GI do not only regulate the climate preventing the UHI, but they also represent an opportunity to provide recreational spaces and improve people's well-being in deprived neighborhoods. Moreover, GI can have a general positive impact on the city, contributing to the improvement of air quality, increasing water resilience, and enhancing biodiversity. Networked and interconnected green areas offer several advantages like Biodiversity Conservation, Ecosystem Services, Resilience, Recreation and Connectivity and Urban Heat Island Mitigation. Some examples of GI are green corridors, urban forests, community gardens, parks, green roofs and walls, etc. These infrastructures can be complemented with environmental education and awareness.

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Figure 2: Comparison of temperature between a street with tees and a street without trees

Source:https://tiranapost.al/english/stil-jete/pemet-mund-te-ulin-temperaturen-e-ajrit-me-8-grade-celsius-neper-qytet-i527237

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3.2 Spatialization of Just Green Transition Impacts

Urban Heat Island Risk:

Large areas of the city, especially those with a high density of buildings are exposed to the urban heat island effect. Most of these areas present medium risk and the most critical ones present high risk. "Map 1" shows the risk level of the Urban Heat Island effect in Turin, it ranges from zero risk (green) to high risk (red). The map shows clear differences between the flat area, which is at generally medium risk, and the hill area presents zero and low risk. Moreover, when comparing "Map 1" and "Map 2" it becomes evident that there is a direct relation between UHI risk and green spaces. The areas at zero and low risk are the greener areas of the city (forests, parks, streets with tree lines, and private gardens), whereas the areas at medium and high risk are dense residential areas or industrial sites.

Map 1: Urban Heat Island Risk in Turin

Source: http://www.comune.torino.it/ambiente/bm~doc/resilienza-climatica_en.pdf

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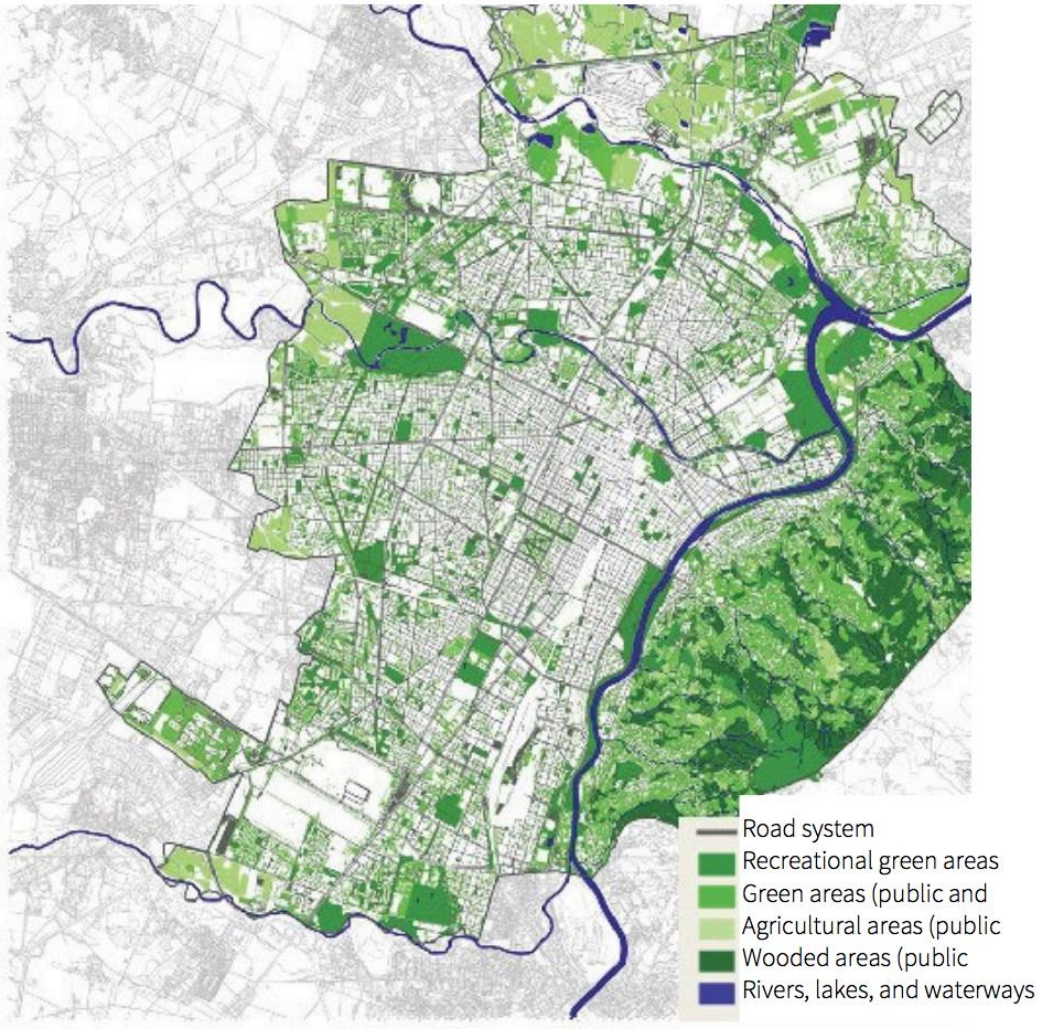

Map 2: Green Spaces in Turin
Source: http://www.comune.torino.it/ambiente/bm~doc/resilienza-climatica_en.pdf

Greenery per inhabitant:

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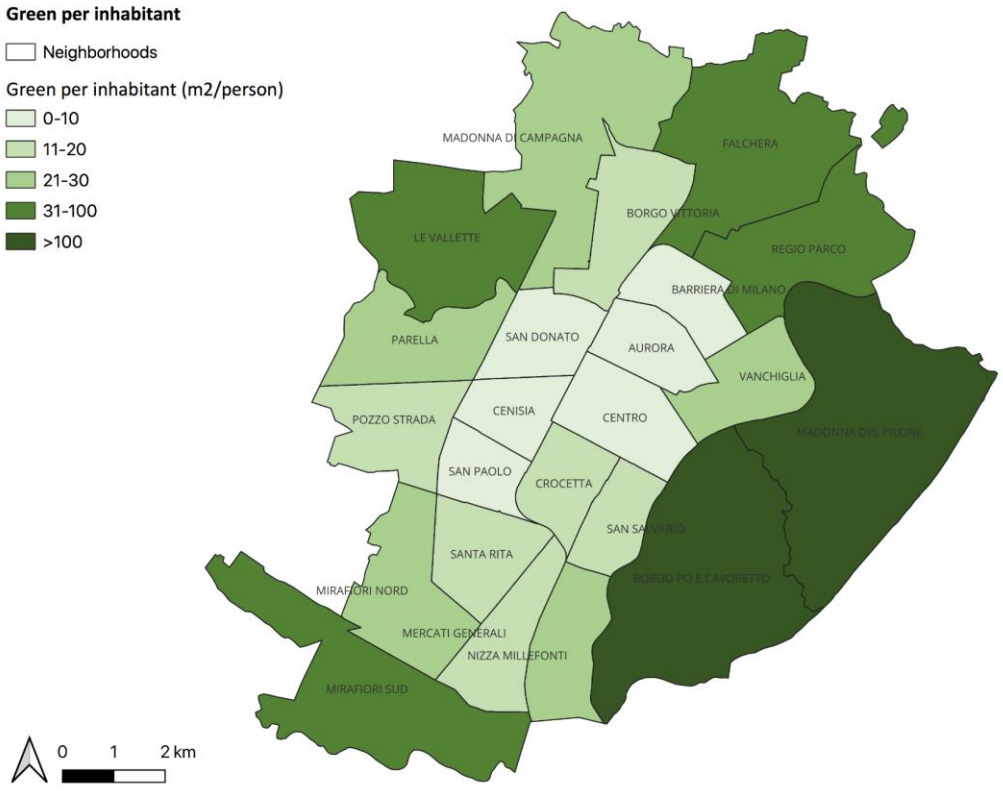
"Map 3" shows that the amount of greenery (public and private) per inhabitant varies through the different neighborhoods of the city. The neighborhoods that present low levels of greenery ranging from 0 to 10 m2 per person (light green) are concentrated in the flat central area that is characterized by a very dense fabric. These neighborhoods are Centro, Aurora, Barriera di Milano, San Paolo, Cenisia, and San Donato. In contrast, the greenest neighborhoods, that offer more than a hundred square meters of green area per person (dark green), are located on the east hill of the city. These neighborhoods are Madonna del Pilone and Borgo Po e Cavoretto and are characterized by scattered houses surrounded by forests and green recreational areas.



Map 3: Neighborhood's levels of greenery per inhabitant
Source: group elaboration based on data from: geoportale.piemonte.it

Average income rate:

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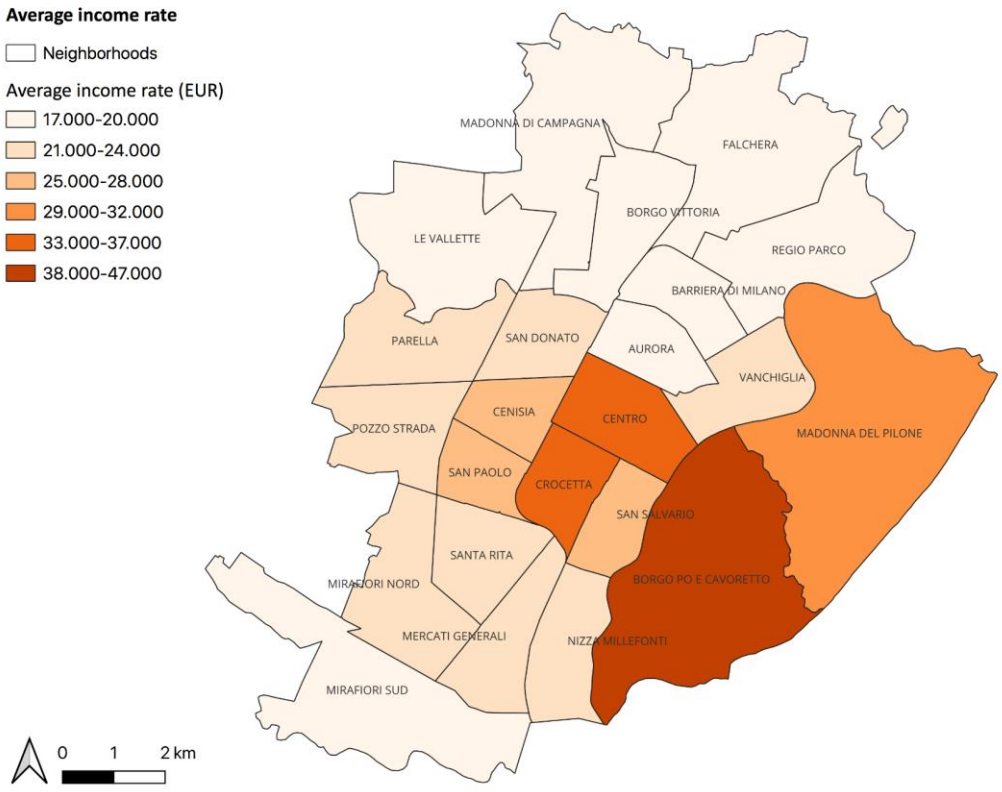
"Map 4" shows that the poorest neighborhoods of the city, with yearly incomes ranging from 17.000 to 18.000 euros per year (light orange), are located in the north part: Aurora, Barriera di Milano and Falchera. On the other hand, the richest neighborhoods, with a yearly income that can reach 47.000 euros (dark orange), are located in the central area and in the east hill of the city: Crocetta, Centro, Borgo Po e Cavoretto and Madonna del Pilone.



Map 4: Neighborhood's average income rate
Source: group elaboration based on data from: geoportale.comune.torino.it

Concentration of foreigners:

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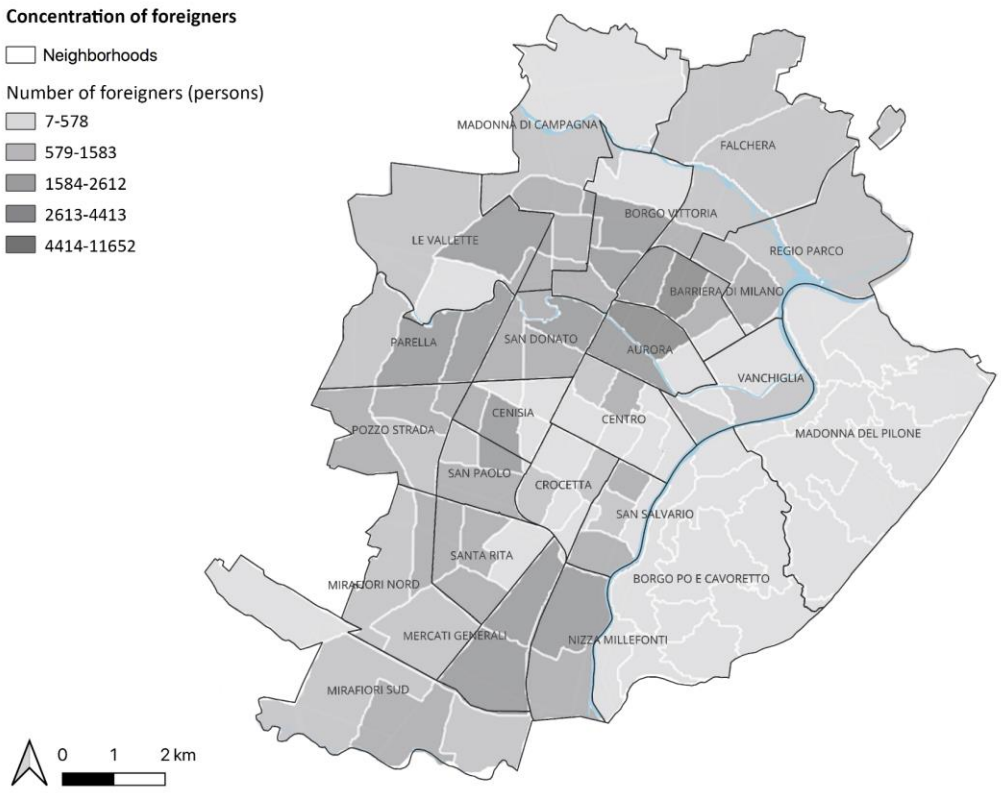
"Map 5" shows that there are many neighborhoods in the city that present a medium concentration of foreigners ranging between 1500 and 2600 people (medium tone grays), such as Mercati Generalli, Parella, and San Donato. However, there are contrasting areas that have either a high (dark gray) or low (light gray) concentration of foreigners. When overlapping "Map 4" and "Map 5" it is possible to observe that some of the low-income neighborhoods such as Aurora and Barriera di Milano are the ones with areas that have the highest concentration of foreigners, ranging from 4000 to 11600 (dark gray). In contrast, the richest neighborhoods such as Borgo Po e Cavoretto are the ones that accommodate a low number of foreigners, ranging from 7 to 600 (light gray).



Map 5: Concentration of foreigners
Source: http://geografiemetropolitane.it/ (modified)

Social implications of the UHI:

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When overlapping the information of the three indicators presented above it is possible to identify that the neighborhoods Aurora and Barriera di Milano are the ones with less amount of greenery per inhabitant, with the lowest average income, and with the highest concentration of foreigners. In contrast, the greenest and richest neighborhood with the lowest concentration of foreigners is Borgo Po e Cavoretto.

	Inhabitants	Green areas (m2)	Green per inhabitant (m2/person)	Average income (EUR/year)	Neighborhoods with areas with high concentration of foreigners
1. Centro	42244,00	365605,18	8,65	35000,00	
2. San Salvario	34977,00	418610,63	11,97	25000,00	
3. Crocetta	34009,00	374831,73	11,02	37000,00	
4. San Paolo	33352,00	310980,17	9,32	25000,00	
5. Cenisia	36856,00	220419,63	5,98	26000,00	
6. San Donato	49381,00	404916,44	8,20	24000,00	
7. Aurora	39692,00	290897,35	7,33	17000,00	
8. Vanchiglia	29935,00	722280,64	24,13	23000,00	
9. Nizza millefonti	27762,00	639573,97	23,04	23000,00	
10. Mercati generali	47124,00	685789,79	14,55	21000,00	
11. Santa Rita	55185,00	815658,37	14,78	23000,00	
12. Mirafiori Nord	42030,00	1290311,32	30,70	23000,00	
13. Pozzo Strada	55759,00	703612,40	12,62	22000,00	
14. Parella	47185,00	1205907,99	25,56	23000,00	
15. Le Vallette	40717,00	2438701,04	59,89	18000,00	
16. Madonna di Campagna	41605,00	1068261,27	25,68	18000,00	
17. Borgata Vittoria	40500,00	740249,43	18,28	18000,00	
18. Barriera di Milano	50505,00	453628,77	8,98	17000,00	
19. Falchera	25970,00	2089357,30	80,45	17000,00	
20. Regio Parco	28799,00	1880004,42	65,28	18000,00	
21. Madonna del Pilone	14594,00	3042547,44	208,48	32000,00	
22. Borgo Po e Cavoretto	19947,00	4848240,74	243,06	47000,00	
23. Mirafiori Sud	34188,00	2912964,21	85,20	20000,00	

Table 1: Summary of green per inhabitant, average income, and concentration of foreigners
Source: group elaboration based on information from Torino Urban Lab, Torino Geoportale and Piemonte Geoportale.

The neighborhoods Aurora and Barriera di Milano are known for accommodating low-income foreigners, they have an average income of 17.000 EUR/year and the availability of greenery per person is between 7,33 and 8,98 m2. "Picture 1" shows two average streets of the neighborhoods, they are car oriented, present concrete surfaces and no trees or other types of vegetation. The surfaces of these streets are impermeable and there are no trees to provide shadow, therefore they absorb and release heat contributing to rising the temperature during summer, which decreases the livability of the streets.

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Picture 1: Barriera di Milano streets

Source: pictures taken by Amirmehdi Nazari

In contrast, the neighborhood Borgo Po e Cavoretto, which has very few foreigners, is one of the richest areas of the city with an average income of 47.000 EUR/year. Moreover, it is the greenest neighborhood with 243,06 m2 per inhabitant. "Picture 2" shows some of the streets of this area that, although car-oriented, present tree lines, some bushes, and some permeable surfaces. During summer these streets benefit from the shadow that the trees provide, which helps to keep the surfaces relatively cool.

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Picture 2: Borgo Po e Cavoretto streets
Source: Google Street

"Map 5" shows the green areas of the neighborhoods Borgo Po e Cavoretto (on the left) and Aurora and Barriera di Milano (on the right). The first one is characterized by mostly scattered buildings surrounded by green areas, whereas the second ones are densely built areas with scattered tree lines and green areas.

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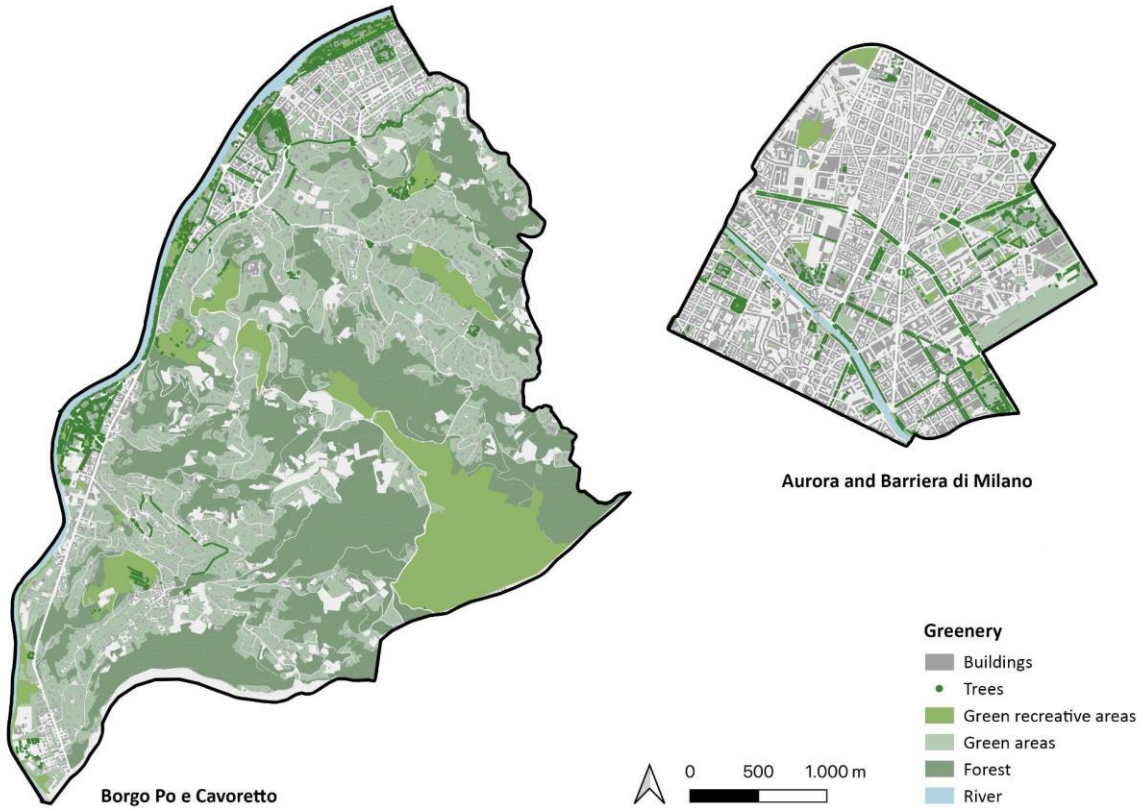

Map 6: Comparison between Borgo Po e Cavoreto, and Aurora and Barriera di Milano
Source: group elaboration based on data from: geoportale.piemonte.it

The maps and the pictures show the differences in terms of greenery between contrasting neighborhoods. High-income neighborhoods benefit from tree lines on streets, green recreational areas, private gardens, and forest areas. On the contrary, low-income neighborhoods barely have these green resources that regulate temperatures and provide comfortable recreational areas, which contributes to the general well-being of people during hot months. Therefore, the people who live in the poorest areas of the city are the ones mostly impacted by the Urban Heat Island effect.

Proposed response to the implications of the UHI in Aurora and Barriera di Milano:

To reduce heat stress and provide a better life quality to the inhabitants of Aurora and Barriera di Milano the group proposes four main actions that focus on the implementation and enhancement of green infrastructures:

- **Regeneration of underutilized areas and improvement of already existing green areas with the engagement of the community:** this action will not only provide good quality and

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enjoyable green recreational spaces but, since the process will include the collaboration of neighbors, it can also help to strengthen the ties within the community.

- **Provide community centers and green enclaves:** some projects of the municipality propose the improvement of social buildings and libraries, and the public spaces that surround them. These projects could serve as community centers and green enclaves in the dense urban fabric.
- **Creation of green and permeable streets:** some wide streets can be redesigned to implement tree lines and permeable surfaces transforming them into narrow linear parks. These actions will improve the livability of some streets during summer, will generate ecological connections, and will provide additional green recreational areas.
- **Knit Aurora and Barriera di Milano to the surrounding neighborhoods:** the green and permeable streets could reach the river bank, surrounding parks, and green streets which could help to connect Aurora and Barriera di Milano to the surrounding neighborhoods, and in that way contribute to breaking physical and virtual barriers.

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3.3 Cost-Benefit Analyses to measure Just Green Transitions

Aurora and Barriera di Milano, with a combined area of 5,871 square kilometers and a population of 90,197 inhabitants, are facing urban challenges related to heat stress and quality of life. In response, a proposed project aims to implement and enhance green infrastructures to mitigate heat stress and improve residents' well-being. This cost-benefit analysis (CBA) evaluates the economic, social, and environmental impacts of the proposed green infrastructure project in these areas.

Project Description: The project focuses on enhancing green infrastructure in Aurora and Barriera di Milano to reduce heat stress and improve the quality of life for its 90,197 inhabitants. It includes two main actions: the regeneration of underutilized areas and the creation of green and permeable streets.

Costs:

1. **Regeneration of Underutilized Areas:**
   - Planning
   - Land Acquisition and Preparation:
   - Design (with Community Engagement):
   - Construction:
   - Project Management /Operation and maintenance
2. **Creation of Green and Permeable Streets:**
   - Planning
   - Street Redesign:
   - Implementation of Permeable Surfaces and Tree Planting
   - Project Management /Operation and maintenance

Benefits:

1. **Environmental Benefits:**
   - **Reduced Heat Stress:** The implementation of green spaces and permeable surfaces is expected to reduce heat stress in plants and animals, which helps to preserve local flora and fauna.
   - **Improved Air Quality:** Enhanced greenery and vegetation improve air quality. High temperatures cause smog levels to rise, and vegetation can reduce smog by reducing air temperatures, reducing the emissions of pollutants related to air conditioners, and removing air pollutants.
   - **Enhanced Water Management:** Green infrastructures can serve to manage stormwater which helps to avoid polluted stormwater runoff being deposited in water bodies.
2. **Social Benefits:**
   - **Improved Community Well-Being:** The presence of green spaces is anticipated to lead to improved mental and physical health among residents, and avoid heat-related health problems.

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- **Increased Community Cohesion:** The project's focus on community engagement and shared green spaces is expected to reduce social issues, resulting in estimated annual savings of (?).

3. **Economic Benefits:**
   - **Increased Property Values:** The project is likely to enhance property values. Urban green infrastructures are estimated to increase property values by 4% to 12%, depending on the location of the home and the quality of the nearby green public areas. Moreover, higher property values mean higher taxes which lead to more income for the municipality.
   - **Attraction of Businesses:** Green areas within a neighborhood make it more attractive, and therefore appealing for businesses and tourists, which could bring capital to the area.
   - **Reduction of loss of labour productivity:** studies have shown high temperatures (above 25°C) can reduce labour productivity from 3% up to 50%, depending on the type of work. Therefore, maintaining reasonable temperatures through green areas in the urban space can help to avoid economic losses caused by labour productivity.

3.4 Land-Based financing for Climate Solutions

(Financial) benefits of Green investments:

The urban environment now hosts over 50% of the world's population, with urban areas continuously expanding in both population and size (Sandström, 2009). Human settlements, intricate social-ecological systems, rely on the health of their associated natural environments for ongoing sustainability. This underscores the complexity of planning for sustainable cities, addressing environmental aspects as one of the fundamentals in achieving socially equitable sustainability (Ahern, 2007; Jackson, 2007).

Green Infrastructure has emerged as a vital policy initiative worldwide, effectively tackling various environmental and social concerns (Barnhill and Smardon, 2012). Investing in Green Infrastructure can draw high-value industries, entrepreneurs, and skilled workers to a region by creating high-quality, environmentally friendly living and working environments. This not only enhances local economies but also generates new opportunities in recreation, agriculture, forestry, and public services (EFTEC, 2005; ECOTEC, 2008). Significant number of studies shows that investments in green space can improve a region's image, attracting and retaining high-value industries, new business ventures, entrepreneurs, and workers (ECOTEC, 2008). Given that good quality green infrastructure positively impacts both the environment and society, it logically follows that it also contributes positively to economic performance (RICS, 2011).

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Assessing the local or regional economy involves recognizing the value of green infrastructure in offering local economic opportunities. This is particularly relevant to communities and regions transitioning from "old" to "new" economies, influencing population and income growth. Nelson and Stynes (2003) also found that GI generates direct and indirect economic impacts through visitor spending in the local economy. Consequently, local economic regeneration is closely linked to improved quality of place, recreation, leisure, and tourism (Ely and Pitman, 2013).

Furthermore, there is strong evidence indicating that green spaces increase property values and financial returns for land developers, with estimates ranging from 5% to 15% depending on the type of project (Haq, 2011). This not only aids in urban regeneration and revitalization but also enhances the attractiveness of locations for business investments, fosters community enterprises, and creates new employment opportunities (Wodarczyk, 2007). Urban public parks also play a significant role in increasing property value. Market trends consistently demonstrate that people are willing to pay a premium for properties located near parks or open space areas, compared to those lacking this amenity (Okunlola, 2013).

Due to the multifaceted nature of various forms of green infrastructure, quantifying the benefits they provide has proven challenging. Different functions necessitate distinct measurement methods (EC, 2012). Nevertheless, numerous approaches have been developed in recent decades to assign a monetary value to the functions performed by GI. This is justified by the fact that monetary values are easily comprehensible to stakeholders and the community, serving as a universal unit of measurement across a range of factors (Symons et al., 2015). It's also worth noting that evidence of the benefits of GI is often more qualitative and less straightforward to quantify than costs (Naumann and McKenna, 2011).

Financing Green investments:

Much of the success of GI projects is likely to depend upon financing and understanding the circumstances under which different types of funding are used. Financing tools for GI are currently very diversified and widely dispersed. Some basic tools and methods of financing GI are (Kaminker, 2013; Koh, 2018; Zimmerman et al., 2019):

- Public Funds and Grants: State and local governments may provide financial support for Green Infrastructure projects through budget allocations, grants, and subsidies. These grants may be directly accessible to cities, municipalities, or environmental conservation organizations.
- Private Financing: Private investors can invest in Green Infrastructure projects to generate profit or contribute to environmental conservation efforts. This may involve investments in the construction of sustainable residential and commercial buildings, renewable energy sources, or other environmental projects.
- Loans and Borrowing: Organizations and local authorities may take out loans from banks or financial institutions to finance Green Infrastructure projects. These loans can be tailored specifically for environmental initiatives.

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- Public-Private Partnerships (PPP): The PPP model involves collaboration between the public sector (e.g., government) and private companies or investors to finance, build, and manage Green Infrastructure projects.
- Donations and Philanthropic Funds: There is a significant number of organizations, foundations, and non-governmental organizations that offer donations for Green Infrastructure projects.
- Innovative Financial Instruments: This includes various innovative approaches to financing, such as green bonds, green mortgages, or revenue from environmental taxes used to finance Green Infrastructure projects.
- Crowdfunding: Crowdfunding is a platform that allows individuals and organizations to gather small amounts of money from a large number of people to fund projects, including those related to Green Infrastructure.

These various financing methods can be combined and adapted to suit the specific needs and characteristics of each Green Infrastructure project.

3.5 Just Green Transition: between carbon-neutrality and re-industrialization

Despite the overwhelming narrative, heard from Turin public administration, planners, architects, etc., describing Turin as post-industrial, the present economic structure of the city challenges this vision. Understandably the city is focused on giving old and unused industrial sites a new life, mostly for non-industrial purposes. Yet, at the same time Turin administration recognizes that the remaining industrial or manufacturing sectors are still today a major driver of the city's economy and a major industrial hub at national level.

The website of Turino Municipality states that: "the city maintains its great specialization in manufacturing, particularly linked to traditional sectors in the territory — automotive and aerospace — with expertise excellence in design and engineering"

Furthermore, manufacturing generates 22,1% of the value added in the broader region of Piemonte (See Figure 3), and 40% of regional value added comes from services purchased by manufacturing companies (e.g., consultancy, research, ICT, design, etc.)

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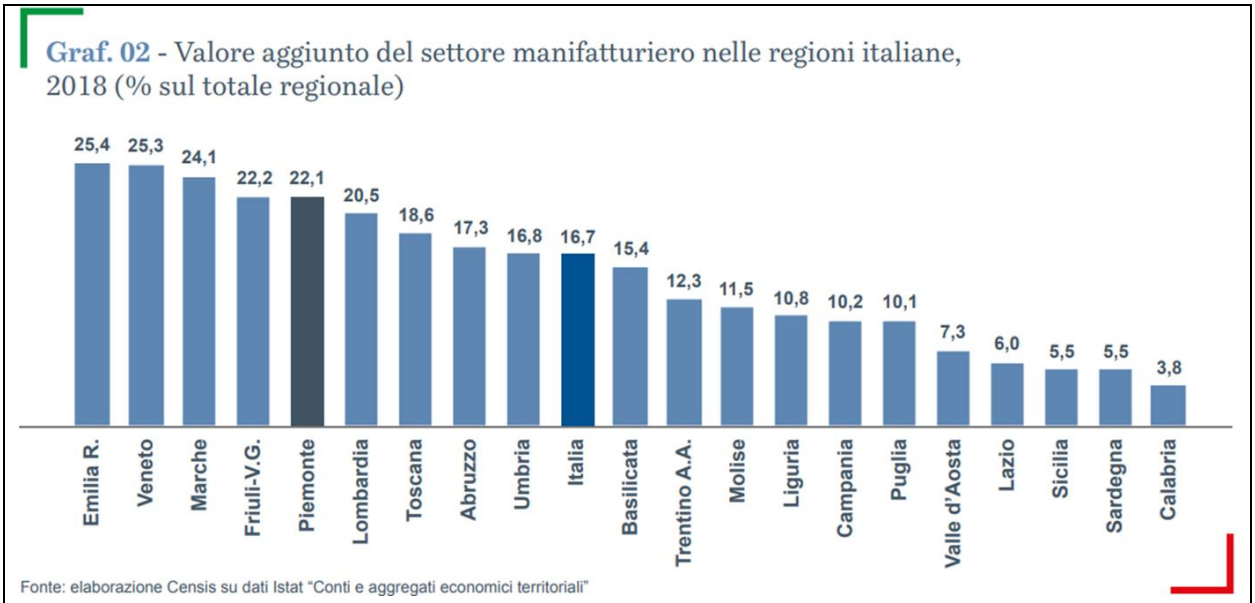

Figure 3: Added value of the manufacturing sector in the Italian regions, 2018 (% of regional total)

Source:(https://www.cdp.it/resources/cms/documents/L'economia_piemontese_le_5_eccellenze_da_cui_ripartire.pdf)

In addition, the city and region are putting significant efforts to secure industrial development via innovation (R&D&I) and other specific initiatives to support industrial adaptation to a green economy. Piemonte spends over 2% of GDP in innovation, which is well above the Italian average (1.3%). Indeed, there are dozens of private and public R&D centers in Turin and Piemonte. Turin city has also established the Manufacturing Technology Center to support knowledge exchange and develop programmes of competence development surrounding the principles of Industry 4.0. In addition, it was announced that Turin will be the home for the new Italian Institute for Artificial Intelligence (I3A) to coordinate 600' actors and research activities around several focus areas, from manufacturing and robotics, to IoT, health, mobility, food/agriculture and energy, public administration, culture and digital humanities, and aerospace.

All of this is to say that the industry is not the past, but also the present and future of the city of Turin, and therefore planners should challenge the imprecise or incomplete narrative of the 'post-industrial city' to consider the future industrial developments, including repurposing existing infrastructures towards new industrial uses, ideally of 'new green industries.

Linking this to UHI, city planners should consider ways for increasing the tree coverage and permeable surfaces in existing and new industrial sites. There should be dialogue with stakeholders in existing industrial parks, complexes, and new developments, to enable interventions such as the implementation of green roofs on industrial buildings, the creation of green buffer zones around manufacturing facilities, and the establishment of community gardens within or adjacent to industrial areas. These initiatives would contribute not only to mitigating the Urban Heat Island

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effect but also to fostering a more sustainable and resilient industrial landscape, aligning with the goals of Just Green Transitions.

Picture 3: Fiat's old factory in Turin,1982
Source: twitter

Picture 4&5: Fiat's old factory in Turin, now
Source: (https://www.expedia.co.uk/Turin-Lingotto.dx6055016)

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4 POLICY ADVICE AND RECOMMENDATIONS

Main Challenges

One of the most important environmental challenges that Torino is facing is the Urban Heat Island effect but with variations in the way it may impact the different areas of the city. Areas that lack green spaces are subjected to medium and high risk, in contrast with more vegetated areas that are exposed to low risk. Within this framework, this work identified that the greener neighborhoods are also the wealthiest ones, whereas some of the neighborhoods that lack green private and public spaces are the ones that accommodate migrants and some of the poorest people of the city. This translates into a difference in the vulnerability to the UHI effect between low- and high-income neighborhoods. Low-income communities are more exposed to the effects of the UHI and therefore highly negatively impacted by it. The consequences are elevated temperatures and air pollution that have a direct impact on physical and mental health, and ultimately on the life quality of people.

Objective

The idea of Just and Green Transitions highlights that the pursuit of more environmentally sustainable cities should benefit everyone. Therefore, it is important to pay close attention to marginalized communities that are often forgotten when developing environmental city strategies, and that are usually the most strongly impacted by environmental hazards such as the Urban Heat Island effect. For that reason, the general objective of the proposal is to reduce the effects of the UHI and improve the well-being in the identified deprived neighborhoods: Aurora and Barriera di Milano.

Strategies

To achieve the above-mentioned objective the strategy consists of implementing Green Infrastructures in the selected neighborhoods, that will help to regulate temperatures and reduce air pollution, and additionally provide recreational spaces.

Actions

The strategy proposes four main actions:

- Regenerate underutilized areas and improve existing green areas with the engagement of the community to provide enjoyable green recreational spaces, and help to strengthen the ties within the community.
- Provide community centers and green enclaves using existing municipal social buildings and libraries.
- Create green and permeable streets to improve the livability in the neighborhood during summer, generate ecological connections, and provide additional green recreational areas.

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- Knit Aurora and Barriera di Milano to the surrounding neighborhoods, breaking physical and virtual barriers, through the connection of the green streets of the neighborhood with surrounding green spaces.

Recommendations

When planning the implementation of Green Infrastructures in deprived neighborhoods it is important to take into account the economic effects that this action may have. Building public green areas in a neighborhood might generate an increase of property values and attract higher income residents, which can produce gentrification (the displacement of old residents for higher income new residents). To avoid this side effect, policies should incorporate preventive actions such as rent control, anti-displacement measures, and preservation of traditional business licenses.

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5 REFERENCES

1. Bullard, R. D. (1990). Dumping in Dixie: Race, Class, and Environmental Quality. Westview Press.
2. Bullard, R. D. (1993). Confronting environmental racism: Voices from the grassroots. South End Press.
3. Pollin, R., Heintz, J., & Garrett-Peltier, H. (2008). The Economic Benefits of Investing in Clean Energy: How the Economic Stimulus Program and New Legislation Can Boost U.S. Economic Growth and Employment. Political Economy Research Institute, University of Massachusetts Amherst.
4. Agyeman, J., & Evans, T. (2003). Toward Just Sustainability in Urban Communities: Building Equity Rights with Sustainable Solutions. The Annals of the American Academy of Political and Social Science, 590(1), 35-53.
5. European Commission. (2019). The European Green Deal. Retrieved from [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en]
6. United Nations. (n.d.). Just Transition. United Nations Framework Convention on Climate Change. [https://unfccc.int/topics/just-transition]
7. Symons, J., Jones, R., Young, C., & Rasmussen, B. (2015). Assessing the Economic Value of Green Infrastructure: Literature Review.
8. European Commission (2012). The Multifunctionality of Green Infrastructure. *Science for Environment Policy In-depth Reports*. European Commission's Directorate-General Environment.
9. Naumann, S. & Mckenna, D. (2011). Design, implementation and cost elements of Green Infrastructure projects, Final report Brussels: European Commission.
10. Sandström, G. (2009). 'IAIA09 Conference Proceedings', Impact Assessment and Human Well-Being 29th Annual Conference of the International Association for Impact Assessment, 16-22 May 2009, Accra, Ghana.
11. Ahern, J. (2007). Green infrastructure for cities: The spatial dimension, ISBN: 1843391368. Published by IWA Publishing, London, UK.
12. Jackson, J. (2007). Applying principles of Landscape Ecology to Green Infrastructure planning, Discussion paper.
13. Barnhill, K., & Smardon, R. (2012). Gaining Ground: Green Infrastructure Attitudes and Perceptions from Stakeholders in Syracuse, New York.
14. ECOTEC (2008). The economic benefits of green infrastructure: the public and business case for investing in green infrastructure and a review of the underpinning evidence, Report for Natural Economy Northwest (NENW).
15. EFTEC (2005). Social and Economic Benefits of the Natural Environment: Review of Evidence, GHK Consulting.
16. RICS (2011). Green infrastructure in urban areas, RICS information paper 1st edition.

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17. Nelson, C., & Stynes, D. (2003). "2003-2007 Michigan Comprehensive Outdoor Recreation Plan." Michigan Department of Natural Resources.
18. Ely, M., & Pitman, S. (2013). Green Infrastructure Life support for human habitats; the compelling evidence for incorporating nature into urban environments.
19. Haq, S. M. A. (2011). Urban green spaces and an integrative approach to a sustainable environment. Journal of Environmental Protection, 2(5): 601-608.
20. Wodarczyk, D. (2007). Green Structure in Development of the Sustainable City, the Baltic University Press.
21. Okunlola, A. (2013). Sustainable Environmental Management through Urban Public Park in Southwestern Nigeria, Global Advanced Research Journal of Agricultural Science (ISSN: 2315-5094) Vol. 2(3).
22. Zimmerman, R., Brenner, R., & Llopis Abella, J. (2019). Green infrastructure financing as an imperative to achieve green goals. *Climate*, *7*(3), 39.
23. Myong Koh, J. (2018). Green infrastructure financing. Palgrave Macmillan.
24. Kaminker, C., Kawanishi, O., Stewart, F., Caldecott, B., & Howarth, N. (2013). Institutional investors and green infrastructure investments: selected case studies.
25. *City of Turin. (n.d.). Industry and Research - Open for Business.* [http://www.comune.torino.it/openforbusiness/en/industry-and-research.html]
26. CDP S.p.A. (2021). L'economia piemontese: le 5 eccellenze da cui ripartire.
27. Città Metropolitana di Torino. (2019b). Piano strategico metropolitano 2021-2023-Asse 3.
28. the Department for Environmental Policies with the coordination of the Environment Area. (n.d.). Informambiente. Torna alla pagina iniziale del Comune. [http://www.comune.torino.it/ambiente/cambiamenti_climatici/piano-di-resilienza-della-citta-di-torino.shtml]
29. the Department for Environmental Policies and Public Green with the coordination of the Green Area. (2020). Città di Torino - Servizio Telematico Pubblico. [http://comune.torino.it/torinosostenibile/documenti/piano_strategico_infrastuttura_verde_2021.pdf]

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