Limiting Soil Sealing and Depaving: Local Actions for Regenerating Public Spaces to Build Green Infrastructures

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ISSN 2365-757X ISSN 2365-7588 (electronic)
The Urban Book Series
ISBN 978-3-031-28771-8 ISBN 978-3-031-28772-5 (eBook)
https://doi.org/10.1007/978-3-031-28772-5

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Chapter 11
Limiting Soil Sealing and Depaving: Local Actions for Regenerating Public Spaces to Build Green Infrastructures

Fabrizio Aimar

Abstract Green Infrastructure (GI) is part of nature-based solutions to mitigate and adapt the local microclimate and climate of urban areas to climate change. In Italy, the lack of green elements in urban spaces of medium-sized cities calls for improvement of the urban ecological network due to citizens' demands for better well-being and health. This chapter indicates the need to launch a national campaign to deseal over-paved public urban spaces and plant new green elements by 2030 as public space design actions. Limiting and then stopping soil sealing is the first condition to rethink public spaces in Italian, and even European, cities in a more holistic and resilient way. Secondly, encouraging citizen activism towards urban GI is strategic in resilient policies to improve connectivity and networking of the social fabric, as confirmed by the reported international and national cases. In this regard, GI is considered a multi-benefit solution that should be planned according to new digital tools in planning and architecture. The aim is to identify the most critical areas within the urban context that need to be depaved to accommodate green canopies, trees, green roofs, and other solutions with an approach potentially replicable in Italian and European cities.

Keywords Depaving · Heat island effects · Soil sealing · Nature-based solutions · Urban resilience

11.1 Introduction

"Green infrastructure is a planned network of natural and semi-natural areas in urban areas strategically designed to solve problems with storm water management, heat stress, air quality, and biodiversity, to name just a few examples. Urban trees, green roofs and facades, and constructed wetlands are some common examples." according to Johnson's definition (2019).

To support this description, semi-natural and artificial surfaces contribute significantly to higher summer temperatures in cities caused by their low albedo. This

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B. Giudice et al. (eds.), *Green Infrastructure*, The Urban Book Series,
https://doi.org/10.1007/978-3-031-28772-5_11

issue, known as the 'urban heat island effect', can produce "a monthly maximum UHI intensity varying from 1.7 to 4.5 °C" (Currà et al. 2019, p. 731), where "the temperature increase is more evident in the densest urban areas, near street level" (ibid., p. 731). Consequently, higher electricity supplies are becoming more and more necessary for air-conditioning work and living spaces "from 20 to 45% in the Mediterranean climate" (ibid., p. 731), with peak quantities and costs that could, however, be avoidable. Moreover, the rise in temperatures and sunlight contribute to the formation of tropospheric ozone, combined with "chemical reactions between oxides of nitrogen (NO_x) and volatile organic compounds (VOC)." (EPA 2021). All these factors are just some of those related to the Mediterranean region due to the impacts of climate change in Europe, according to Fig. 11.1 of the 2018 European Commission Communication (European Commission 2018, p. 3) (Fig. 11.1).

As a consequence, depave can promote the removal of unnecessary pavement from urban areas (e.g., asphalt and concrete) to recreate green spaces to host new green elements and vegetation (i.e., trees and shrubs) with the aim of mitigating the multiple and interrelated impacts of climate change.

Although the discourse around soil sealing seems more interrelated to ensuring food security (FAO, IFAD, UNICEF, WFP, & WHO 2021) in the framework of continued population growth (JRC-ESDAC 2014; Gardi et al. 2015) and limiting hydrogeological risk (D'Ambrosio et al. 2021) under the main challenge of climate change (Aimar & Repetto, in press) also health care and the quality of public spaces should be more considered in the coming city of the future.

In terms of health care and climate change-related issues, "mortality for populations in the EU has been estimated to increase by 1–4% for each degree of increase in temperature above a (locally specific) threshold." (European Commission 2014, p. 56). For instance, in Turin, Italy, "considering the period from 15 May to 15 July, again for the over-65 age group, the excess mortality observed over that expected is approximately 6 deaths per day on heatwave days. The overall excess mortality [...] was 155 (an increase of about 33%) in the presence of a heat wave, while it was

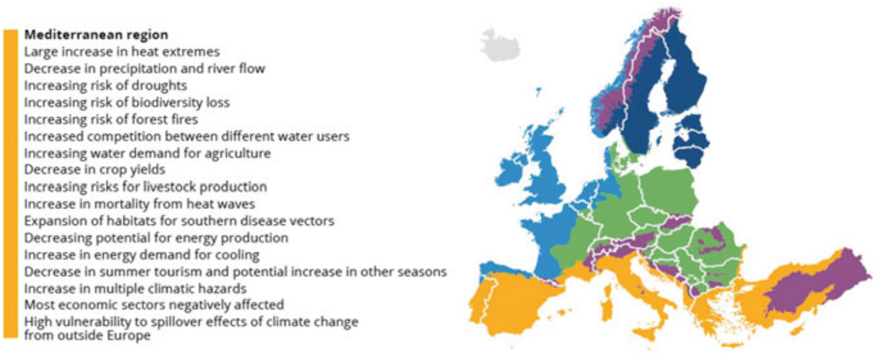

Fig. 11.1 Climate change impacts in the Mediterranean region of Europe. *Source* http://eur-lex.europa.eu, © European Union, 1998–2022

zero in the absence of a heat wave." (ARPA Piemonte 2015). Even when death does not occur, heat-associated pathologies may occur, such as dehydration and hypernatremia, heat-related cutaneous eruption, cramps, oedema, lipotimia, stress, and burn (Ministero della Salute, CCM 2019, pp. 11–16).

In addition, Italy is the second country in the European Union (EU) to record the risk of more premature deaths associated with exposure to PM2.5 and O_3 concentration levels in 2019, raising first in the rank of those attributable to NO_2 exposure (EEA 2021a). 63,710 deaths are estimated out of 364,200 in the EU-27 (i.e., 17.5% of the total) (ibid.). The worst affected area is confirmed to be the Po Valley, with the highest concentrations of particulate matter with a diameter below 2.5 and 10 μm, as well as ozone (EEA 2021b). PM10 concentrations are hazardous to health and cause decreased lung function (De Donno et al. 2018), while PM2.5 causes reddening of the eyes and skin, tumours, cardiovascular and human respiratory system dysfunctions (Xing et al. 2016).

In light of the above, the Guidelines on best practices to limit, mitigate, or compensate soil sealing by the European Commission (2014) propose a connection between health and the quality of public spaces. They mention that "the temperature under a tree is an average of 3 °C lower than the temperature of a pavement exposed to direct sunshine when the ambient temperature is around 30 °C." (European Commission 2014, p. 55). Specifically, they highlight how "a tree with a crown of 10 m in diameter evaporates 400 l/day, consumes 280 kWh of solar energy, and cools with a power comparable to that of more than 10 air conditioners." (ibid. 2014, p. 56). Moreover, "a tree captures an estimated 100 g net of fine dust per year (average value)." (ibid. 2014, p. 16).

Green Infrastructure (GI) would provide several other physical, psychological, aesthetic, and social benefits associated with vegetation. These include shading from the sun's rays in the summertime, protection against strong winds, evapotranspiration of rain on leaves, restoration of local habitat for the urban wildlife (small amphibians, reptiles, birds, and mammals), and reduction of road noise.

In a practical way, the abovementioned Guidelines continue stating that the "calculations for the city of Valencia indicate that 10 ha of vegetation are required to generate a drop in temperature of 1 °C; 50 ha and 200 ha of vegetation are required to reduce the temperature by 2 °C or 3 °C, respectively. With a size of some 135 km^2, approximately 1.5% of the city should be turned green in order to reduce the temperature by 3 °C (Van Zoest and Melchers 2006)." (European Commission 2014, p. 56). It follows that 2 km^2 of new green is needed to reduce the temperature by 3 °C for the city of Valencia, Spain.

What is mentioned above clarifies the need to act on the local scale to provide effective measures to counter these pathologies and limit the impacts of climate change in urban areas. Amongst those, this paper wants to propose an extensive depave of public spaces to create new areas useable for GI through their redesign. This project-based process needs to be based on urban planning measures in order to limit, mitigate, or compensate for the extreme effects of solar irradiance through new digital approaches.

11.2 Depaving as a Strategy to Implement GI in Urban Spaces

Land consumption occurs by artificial land cover due to buildings, infrastructures, solar parks, caves, and landfill areas, for instance. In Italy, the Italian Institute for Environmental Protection and Research (ISPRA) reported that about 64% of land consumption between 2012 and 2020 took place in a context of medium/low artificial density and 21.6% in a predominantly artificial context (Munafò 2021). Therefore, prevention measures seem necessary to avoid fragmented landscapes as well as residual urban areas.

Starting from a literature review (e.g., Taylor & Francis, Elsevier, and Springer journals and books, etc.), the early goal should evaluate how to manage the transiency of the soil sealing, from “zero balance” to its permanent arrest. Indicators for territorial evaluations would be individuated into a multicriteria spatial decision support system. Organising land use in the next planning policies could be carried out with big data and spatial analysis led by simulation tools. Investigations could involve several city plans, using high-resolution layers/CORINE to define sealed soil levels, as well as existing databases and GIS/web-GIS tools to explore geomatics, spatial analysis, and urban/land morphology, amongst others. A Geographic Information System can help map the solar irradiation potential by processing a digital elevation model (DEM) of the area under analysis, as well as the variations. Moreover, the urban traffic plans and maps, as well as changes in land surface temperature measured by the Copernicus Sentinel-3 satellite over the short to mid-term, should be consulted to better calibrate potential strategies and related actions.

One of the possible research outcomes concerns the creation of a software tool useful to determine a ‘zero balance’ between urban/periurban transformation areas and the re-naturalised ones, both at the municipal and provincial scale. This one would also help to determine a precise ratio between permeable/sealed areas and suggest measures as depave of the over-paved areas to be included in the local policies. Areas that could potentially be suitable for this are portions of churchyards, public schoolyards, market spaces, redundant parking spaces for vehicles, and existing avenues. The action will aid the increasing and/or creation of Green and Blue Infrastructures and their sustainable planning and management, mapping and protecting existing lands with high-production capacity (Land Capability Classification—classes I, II, and III). It could be a possible upgrade of two ongoing projects: the LIFE SAM4CP one, when combined with the existing Playsol simulator, and the SOS4LIFE project, to specify programs of urban soil desealing with analytic data.

According to the National System for Environmental Protection (SNPA) data, the 2019 report still confirms “a low incidence of public green areas on the municipal territory: if we consider the municipalities with two-thirds of the provincial capitals, the percentage value is lower than the average of the 109 municipalities (3.03%), and […] in 82 cities, this indicator does not reach 4%. In as many as 32 provincial capitals, the percentage is less than or equal to 1%” (Chiesura et al. 2020, p. 7). In particular, the report affirms that “particularly low values (less than or equal to

0.5%) are concentrated in the South and the Islands, and some cities in the Centre" of Italy (ibid.). Among this group, there are Genoa, Imperia, Belluno, Lucca, Pistoia, Massa, Grosseto, Arezzo, Viterbo, Teramo, Foggia, Lecce, Brindisi, Crotone, Enna, Syracuse, Nuoro, and Sassari (ibid., p. 8).

Consequently, a large campaign of depaving, combined with the plantation of new green elements, could be planned for the public spaces of most relevant cities and towns in Italy (e.g., regional and provincial capitals), according to the ongoing modifications imposed by the global climate change. As pointed out by Bastin et al. (2019), Turin will, in fact, suffer from an annual temperature increase of 2.1 °C by 2050, where its increase during the warmest month will be 7.7 °C, while that of the coldest month will be 1.7 °C of 2.5 °C by 2050, where the warmest month's temperature gain will be 7.2 °C and that of the coldest month 3.6 °C. Finally, Rome will undergo an annual temperature increase of 2.5 °C by 2050, where the temperature growth of the warmest month is 5.5 °C and that of the coldest month is 2.8 °C. In a nutshell, Turin and Milan will experience the current climate of Dallas, Texas (U.S.A.), while Rome that of Adana (Turkey).

All these data are to be understood and used as design inputs for more resilient cities, whose ultimate goal is the well-being of citizens and communities rather the merely GDP growth (Ripple et al. 2020). These objectives refer to the United Nations Sustainable Development Goals, in particular to the targets 3.9, 11.3.1, and 15.3 (UN 2015).

11.3 Best Practices and Community-Based Approaches in Depaving Private and Semi-public Urban Spaces

The community-based approach to depaving is already widespread in Anglo-Saxon countries such as Great Britain, the U.S.A., Australia, and Canada, and in Europe in France and Germany. For instance, the Depave association, based in Portland, Oregon (U.S.A.), "empowers disenfranchised communities to overcome social and environmental injustices and adapt to climate change through urban re-greening. Depave transforms over-paved places and creates resilient community greenspaces […]" (Depave n.d.).

However, Depave Paradise is operating as a project of Green Communities Canada, which was established in Peterborough in 2012. During this period, it has desealed 14,565 m^2 in 28 cities, with a benefit of 5485 m^3 of stormwater diverted annually (Depave Paradise 2022). In the same line, the Mayor of London in the UK provided "A Guide to Community-Led Depaving Projects" entitled "Grey to Green" (Mayor of London 2019), which refers that "a community planting event is a great way to involve the local community in the fun parts of the project." (ibid., p. 10).

In Italy, the option of depaving "and planting trees on grey areas" (Pastore et al. 2020, pp. 90–91) is envisaged by the project 'ForestaMi' by the Metropolitan City of Milan, the Municipality of Milan, Parco Nord, Parco Agricolo Sud, and ERSAF.

It asserted that “21% of new trees will instead be housed in grey areas, i.e. on paved soils” (ibid., p. 116), in which “a ‘top-down’ quantitative estimation work” is to be placed side by side with a “bottom-up listening and mapping work of the Milan Metropolitan City territory.” (ibid., p. 112). The numbers of the pilot project mention “130,407 square metres of car parks and squares to be depaved” in “19 Areas for forestation measures on impermeable soil” by 2030 (ibid. p. 225).

Before planting, an analysis of the soil after the depaving process should be carried out to check for the presence of pollutants such as lead or hexavalent chromium. Using native plants is recommended in order to create an urban habitat for native plant and animal species that can reduce water volumes for irrigation and fertiliser quantities. Such low-cost measures would allow the implementation of ecological infrastructures aimed at increasing biodiversity in the urban environment.

As recommended by The Nature Conservancy, “finance and policy to enable tree planting for public health” should be developed more to sustain this practice (McDonald et al. 2017).

In terms of policies, these bottom-up approaches could be part of the studies and analyses includable in the amendments to the clauses of the bill DDL S.2383, “Limiting land consumption and reuse of the built-up land” [“Contenimento del consumo di suolo e riuso del suolo edificato”] (Senato della Repubblica 2017), in particular to the article 2.1, point g. It suggests, concerning environmental compensation, “the adoption [...] of measures to recover, restore, or improve, [...] the functions of already sealed soil through its de-permeabilisation and to restore the natural condition of the soil.” (ibid., p. 5). The bill is still being examined by Commissions no. 9 ‘Agriculture and agri-food production’ and 13 ‘Territory, environment, environmental goods’ of the Senate of the Italian Republic as of 2017. Likewise, the development of new Green Infrastructures “... could also be considered in the revision of Interministerial Decree 1444/68 on urban standards.” (Munafò 2021, p. 40).

In terms of funding, more studies should be carried out to understand the costs of the correct management of these urban GI. Planting has to be followed by proper management of the plant elements, ensuring appropriate pruning, health treatments and replacement of dead, felled, or decaying ones. The management is a sensitive issue, both in terms of funds and workforce available to municipalities. By the way, the white paper issued by The Nature Conservancy estimated that “spending just $8 per person per year, on average, in an American city could meet the funding gap and stop the loss of urban trees and all their potential benefits.” (McDonald et al. 2017).

For instance, in Asti, Piedmont, Italy, joint surveys carried out by the Landscape Observatory, together with Legambiente Asti and Valtriversa, highlighted the occurrence of a good number of dead/felled or decaying trees in two local avenues in March 2019. In Corso Torino avenue, 42 out of a total of 203 specimens need to be replaced in about 900 m (Osservatorio del Paesaggio per il Monferrato e l’Astigiano 2019a), while out of a total of 204 trees in the 720-m-long Corso Matteotti avenue, as many as 84 were found to be dead, absent, and/or in a serious condition of decay (Osservatorio del Paesaggio per il Monferrato e l’Astigiano 2019b) (Fig. 11.2).

Appropriate replanting will be carried out by the Municipality of Asti in participation with the retailers of the two avenues to remedy this situation through “concrete

Fig. 11.2 Some photos of the arboreal surveys in the tree-lined avenues of Asti in March 2019. From left to right, a missing tree (Maple negundo) in a plot later cemented over or left green, while on the right, a felled flowering cherry tree. *Photos courtesy* Osservatorio del Paesaggio per il Monferrato e l'Astigiano

actions of sharing management activities to achieve effective rooting and development of the trees over time." (Osservatorio del Paesaggio per il Monferrato e l'Astigiano 2019a).

11.4 Green Infrastructures Projects

Next, some international design examples of urban greening through the inclusion of Green Infrastructure are proposed. In Tirana, the capital of Albania, the adoption of green specimens when resurfacing driveways is carried out by the goodwill of the municipality as the urban Green Plan is absent. The chosen trees (mostly birches, but also magnolias, maples, sycamores, etc.) are selected on the basis of the available road section and planted usually 6 m apart (Fig. 11.3).

In Italy, Law No. 10 of 14 January 2013, titled 'Rules for the development of urban green spaces', imposes some legal obligations that can be leveraged for the enhancement of Green Infrastructure, synergistically with the design of urban public space. Article 2, in this regard, states that "Two months before the natural expiration of the term of office, the mayor shall make known the arboreal balance of the municipality, indicating the ratio between the number of trees planted in publicly owned urban areas at the beginning and the end of the term of office, respectively, giving an account of the state of consistency and maintenance of the urban green areas under the mayor's jurisdiction" (Italian Parliament 2013).

To cite some Italian examples of mid-sized cities, in Pescara, Marche, the planting of 140 specimens in 14 city streets and squares follows the strategy of "… restoring the failures that have been created, especially on streets and squares, enhancing the greenery in some public areas" (Il Tirreno 2019). In 2019, stone pine, wax-leaf privet,

Fig. 11.3 Project for new Green infrastructure added to the renewal of the road surface and pedestrian pavement in Rruga Dora D'Istria in Tirana, Albania. The width of the pavement is 2 m, while the distance between the two tree boxes is around 5 m. *Source* the author

Callery pear, judas-tree, Carpinus Orientalis, and common Hibiscus were planted, and other specimens of Viburnum Lucidum followed in 2022.

In Novara, Piedmont, "… thousands of new trees were planted, resulting in a very high number of trees in the city, more than 30,000." (Novara Today 2021). In March 2021, 420 more trees were being planted by the Municipality of Novara. Plantings included Norway and field maple, London plane, ash, hackberries, tilia, tulip tree, plum, elm, oak, Aesculus, pear, hawthorns, crepe myrtle, sweetgums, and hornbeam. Furthermore, "In addition to laying, the work also includes triennial maintenance with punctual watering." (ibid.) as a correct ex-post management strategy.

However, despite calls for urban forestation and obvious needs, ISTAT found a modest increase in the urban green/inhabitant ratio, from 31.1 (2011) to 31.7 (2017) (ISTAT 2017).

11.5 Conclusions

As the discussion makes clear, soil plays a central role as a microclimate regulator in urban and suburban areas. Indeed, its virtuous management can mitigate the adverse effects of 'urban heat islands' on human health thanks to the Green Infrastructures deployment (GI). Urban greenery is a bio-compensation measure that also ensures energy saving, reducing energy bills related to heating and cooling during the winter and summer seasons.

Depaving could be a valid project strategy to be implemented in the urban planning agenda to obtain usable land for planting a network of green elements, in addition to the green roofs and vertical gardens; however, the latter are not the subject of this chapter. Moreover, it can be useful for achieving the targets 11.6, 11.7 and 11.b of the Sustainable Development Goal 11 "Make cities and human settlements inclusive, safe, resilient and sustainable" (UN 2015). These scalar measures, therefore, go from the size of the street to the city to add value, creating a better urban dimension thanks to the redesign of public spaces. From this perspective, Green Infrastructures should be considered multi-benefit solutions, instrumental in creating adaptive and resilient thinking through shared outlooks with citizens.

In this regard, ensuring biodiversity through the provision of ecosystem services is fundamental in designing future cities with high population density and low emissivity. Therefore, starting from a census of existing green elements in the urban and peri-urban context, the interdisciplinary collaborative work between architects, planners, and agronomists becomes necessary to intervene in the public space in a conscious and targeted manner through the selection of the most suitable and native plant species.

In addition, other similar cities in Europe can benefit from the study and calculations led by Van Zoest and Melchers (2006) for Valencia, Spain, such as Turin (130.17 km^2) and Rimini, in Italy (135.79 km^2), Seville, in Spain (140 km^2) and Nîmes, in France (161.85 km^2), amongst others.

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