Chapter 10
From Knowledge to Land-Use Planning: Local Resilient Experience in the Territory of the Municipality of Mappano

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Abstract The chapter illustrates the result of the analysis on the municipality of Mappano, located in northern Turin (Italy). The studies were carried out as part of the collaboration between the Municipality of Mappano and the Inter-University Department of Territorial and Urban Studies and Planning (DIST) of the Politecnico di Torino, for the preparation of the first Municipal Urban Plan. The main goal was to contribute to this local planning tool by introducing innovative analyses, descriptions and elaborations which were useful in structuring planning choices. In particular, various data sources were systematized, integrated and coordinated to represent the territory from the point of view of both environmental phenomena and landscape in order to provide sustainability and resilience.

Keyword Landscape resilience · Mappano · Local ecological network · Viewshed analysis · Walkability · People-centred planning · Transformative resilience

10.1 A Landscape Resilience Perspective

Landscape resilience is "the process of transforming and designing the landscape to improve its quality, while also addressing adaptation and risk control needs (…) by putting the aspirations of the people at the centre" of the planning perspective (Voghera and Aimar 2022), and by bringing the environmental dimension into a dialogue with the landscape demands of the communities (EC, European Landscape

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G. Brunetta et al. (eds.), *Post Un-Lock*, The Urban Book Series,
https://doi.org/10.1007/978-3-031-33894-6_10

Convention, Florence, 2000). Indeed, landscape resilience in urban planning requires identifying "…priority places and modes for actions that foster new balances, with an attitude that has been appropriately called place-oriented and people-oriented" (Gabellini 2018, p. 96). Landscape resilience requires a place-centred approach and community empowerment, operating at the local scale and with attention to biodiversity and ecological networks, historical permanencies and perceptions. Looking forward, the approach to landscape resilience involves the maintenance and rehabilitation of cultural and environmental values (Winter et al. 2018), grounding conservation on "territorial governance" (Brunetta et al. 2019, p. 8) and social responsibility (Voghera 2015), by integrating landscape planning with local planning and design. Assumptions reaffirmed by the Peccioli Charter (2021), which establishes the "trans-scalar perspective" (Art. 10) of landscape resilience and the key role of "common territorial identity" (Art. 10).

Landscape planning and design must therefore be able to identify and to succeed in ensuring the quality of life, through an integrated landscape approach (Gambino and Peano 2015), which is crucial for interpreting the territory holistically, from a socio-economic, environmental and perceptual perspective, creating synergies between adaptation, and landscape and biodiversity policies.

10.2 A Case Study of Local Resilience

The community of Mappano has recently been recognized as a municipality by the Piedmont Region (Law No. 1/2013, entitled "Establishment of the Municipality of Mappano"; B.U.R. Piedmont—No. 5 of 31.01.2013). Since this is the urban plan of a newly formed municipality, the analyses carried out call for a historical reconstruction of the transformations of the territory with particular attention to the process of formation of the village settlement of Mappano as an unplanned sedimentation of fragmented and contradictory settlement choices. In fact, this aspect can be traced to not only by the effects of the diverse urban planning tools of the neighbouring municipalities of Caselle Torinese, Borgaro Torinese, Leinì and Settimo Torinese but also by the population's aspirations and community identity (Traore 2021).

Considering these aspects, Mappano cannot be interpreted, for the purpose of drafting the first urban plan, within the limits of its administrative boundaries, but in its location in a complex node (Lanzo and Canavese Valleys, the urban metropolitan area along the Stura River). Besides, Mappano is an environmental area of great biodiversity and landscape richness for the green and blue infrastructure policy at metropolitan scale, considering the Corona Verde Project (Green Crown) and the Tangenziale Verde Strategy of the General Metropolitan Regional Plan of Turin (PGTM).

Considering the community aspirations, Mappano is characterized to be redefined in terms of socio-economic, cultural possibilities and public services (structure of the population, intergenerational relations, the structure of the family, school, leisure, education, location of sports centres). The housing system is weak and with limited quality and needs diversification of the inhabited area (sub-services) and agricultural systems in relation to their quality and maintenance and visual perceptual aspects.

Why is Mappano an interesting case study? The case study of Mappano is emblematic in demonstrating the role played by the supremacy of local identity or local interests despite the recognized importance of the key role played by land everywhere (Pileri and Scalenghe 2016). The contradiction highlighted by this case raises the discussion of some crucial issues related to the role of local urban planning and soil protection, which cannot be fragmented or subject to short-term local interests. Mappano experienced strong demographic and economic growth in line with other municipalities in north-western Italy participating in the broader process of suburbanization of Turin during the '80s. The availability of large open areas allowed for the programming of important land conservation linked to the creation of a large local and broader regional park that extends from the towns of Borgaro and Settimo and is part of the larger project of the Corona Verde of the metropolitan area of Turin. At the same time, various infrastructure interventions and urban areas regeneration were programmed. This area is located nearby to the strategic infrastructures serving the entire Turin metropolitan area: the A4 motorway, the airport of Caselle, the high-speed railway to Milan and the Canavesana railway line. In addition, the construction of line 2 of the Turin subway towards Settimo Torinese and the valorization of the Turin–Ceres railway, connecting the airport to Turin's city centre, are planned.

At the COVID-19 time, Mappano redefines its role within the first town plan process overcoming the crisis; this process requires reflection on the interpretation of the territory as a synthesis of the relationship between community and environment.

The following paragraphs describe the elaborations carried out in the framework of the collaboration agreement signed between the Politecnico di Torino[1] (DIST and DIATI Departments and the Responsible Risk Resilience R3C Interdepartmental Centre) and the Municipality of Mappano, which is aimed at strengthening the definition of studies for the urban plan role through a multidisciplinary approach for sustainable and resilience development.

10.3 Analysing and Understanding the Environmental and Landscape System

Attributing an ecological and ecosystemic role to the territory means considering a general renewal of urban planning paradigms, taking into account the importance of rural production and entrepreneurial and political interests. In line with these objectives, the new ecological corridors should not be "spatial schemes", perhaps excellent in aesthetic terms, but lacking in biodiversity operability (Voghera and La

[1] Departmental agreement among Politecnico di Torino (Departments: DIATI and DIST and R3C) and the Municipality of Mappano (2021–2023), responsible: Lingua A. and Voghera A. Research group: DIST-R3C: Grazia Brunetta, Ombretta Caldarice, Luigi La Riccia, Ammj Traore, Giulia Matteucci, Mattia Scalas; DIATI: Stefano Angeli, Valeria De Ruvo, Paolo Maschio, Marco Piras.

Riccia 2019). For this reason, when investigating the state of naturalness and diversity at different scales, it is necessary to go further in order to prioritize the proposal of ecological coherence: to consider the network in the context of the impacts of human activities and, more generally, in urban planning processes with reference to their operability (La Riccia 2015b).

In this context, several interesting studies on this topic have been launched in the Piedmont region (Italy), with the aim of improving the overall ecological quality of natural and landscape areas and specifically indicating how to avoid ecological fragmentation and strengthen biodiversity (Voghera and La Riccia 2016, 2019). In recent years, specific research has been conducted by the Polytechnic of Turin in collaboration with the Metropolitan City of Turin and ENEA with the aim of defining a proposal for the implementation of the ecological network at a local level in some areas of the territory.[2]

In the last two years, other experimentations have been conducted in other municipalities (Mappano, Alpignano and Moncalieri) following the developed methodology, adapting it to different geographical contexts and taking into account new perspectives in relation to post-pandemic needs. In Italy, the PNRR (Italian Next Generation EU Plan, 2021) is contributing to pushing local governments to prepare new projects for the country's economic recovery. The goal is the ecological transition but also digitization, competitiveness, training and social, territorial and gender inclusion.[3]

In line with PNRR, the proposed approach was to guide local governments with specific measures to limit anthropogenic land use and, where possible, to promote the conservation of ecosystem services. Habitats, natural areas and landscapes were not only interpreted from an exclusively ecological point of view (a mosaic of ecosystems) but also considering a broader perspective that embraces the cultural, social and economic values of the territory. The proposed methodology identifies the ecological character of the territory and defines criteria for the evaluation of the different land-use types: in Piedmont, 97 land-use types were identified, according to the Corine Land Cover database. Subsequently, six key indicators (Voghera and La Riccia 2016, 2019) were applied to assess ecological status (see Fig. 10.1):

- *Naturalness*: land-use types are classified into five levels of naturalness, considering the proximity to formations that would be present in the absence of disturbance (climax). Thus, the levels of naturalness range from level 1, which includes all natural formations, to a maximum of level 4, which considers land-use types

[2] Between 2014 and 2016 the research "Guidelines for the Green System of PTC2" (convention between Metropolitan City of Turin, ENEA and Polytechnic of Turin) and the "Operational proposals for the ecological network of Chieri" (Polytechnic of Turin and Comune di Chieri, Turin) were conducted with the objective of defining a proposal for the implementation of the ecological network at the local level firstly in two municipalities of Turin (Ivrea and Chieri).

[3] The six major areas of intervention (pillars) on which the PNRR focuses are: (1) Green Transition, (2) Digital Transformation, (3) Smart, Sustainable and Inclusive Growth, (4) Social and Territorial Cohesion, (5) Health and Economic, Social and Institutional Resilience, (6) Policies for the new generations, children and young people.

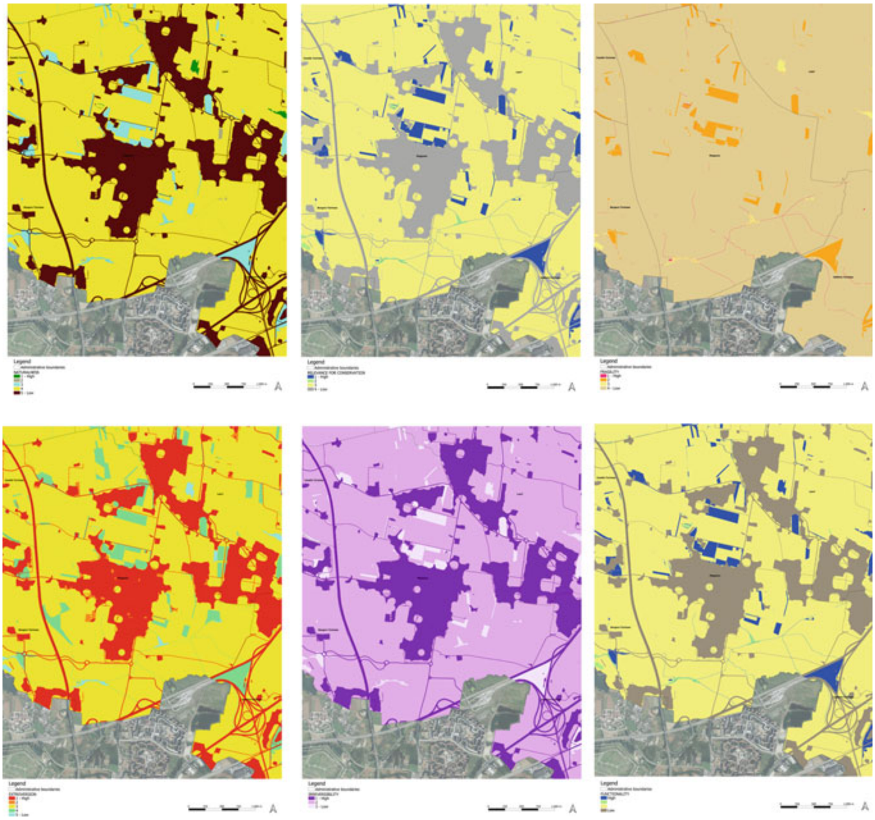

Fig. 10.1 Maps of Mappano territory according to the considered indicators (in the order of appearance): naturalness, relevance for the conservation, fragility, extroversion, irreversibility, functionality. *Source* Voghera and La Riccia

that are fully anthropogenically determined but not artificial (such as almost all cultivated land) and level 5, which includes land-use types corresponding to artificial areas.

- *Relevance for conservation*: land-use types are classified into four levels of relevance according to the relevance/suitability of the land use for the conservation of biodiversity, while considering the importance for habitats and species. The concept of habitats of interest for Natura 2000 Network species is introduced, which includes not only habitats of Community interest, but also complex habitats whose conservation is necessary for the protection of Natura 2000 Network species.
- *Fragility*: land-use types are classified in terms of their intrinsic fragility due to pressures such as pollution, exotic and invasive species entry, and anthropogenic disturbance in general. Level 1 includes land-use types that define both natural

environments with very low resilience such as rocky fields or glaciers, and semi-natural areas with significant anthropogenic determinism but easily fragile for both land-use types and low resilience such as reservoirs or areas of sparse vegetation.
- *Extroversion*: land-use types are classified according to their potential “capacity” for pressure in relation to neighbouring patches. We have considered pressures in an integrated way ranging from pollution of production to the spread of invasive alien species. These range from Level 1, which includes land-use types that coincide with the areas of highest human settlement and capacity to exert pressure, to Level 5, which contains natural land-use types.
- *Irreversibility*: land-use types are classified according to their potential for change of use. Level 1 includes all artificial land-use types that are totally characterized by irreversible land use (e.g. urban, commercial industrial).
- *Functionality*: the combination of patches characterized by different levels of naturalness and conservation relevance leads to a zoning of the territory in terms of network value and ecological functionality. The fundamental attributes that can lead to a reading of the current network are naturalness and relevance for conservation.

For the creation of a local ecological network, it is necessary not only to analyse the current geometry of the elements of naturalness capable of constituting an ecological network, but also their location within the transformation forecasts related to the territory in question, both as a consequence of the inertial processes underway (e.g. advancement of urbanization fronts, changes in prevailing crops, phenomena of abandonment of hill–mountainous areas), and those consequent to the programmatic choices expressed by the various levels of territorial government (general planning or sectoral and programmed interventions). Only in this way will it be possible to prefigure an overall design of the ecological network capable of achieving the set objectives, demonstrating compatibility with the objectives of the various sectors.

From the integration of the results of different indicators, the so-called structural map of the ecological network (Voghera and La Riccia 2016, 2019) has been obtained (see Fig. 10.2). This map shows the elements of the local ecological network system, chosen on the basis of the levels of naturalness, ecological functionality, geographical continuity and consists of three main elements:

- *Structural elements of the network* (primary ecological network), i.e. areas with high and moderate ecological functions, as well as areas hosting specific conservation emergencies, i.e. of natural and significant importance for the conservation of biodiversity.
- *Priority Network Expansion areas*, i.e. areas with a residual ecological function in which action to increase the functionality of the primary ecological network is a priority and for which the implementation of protection measures to maintain the primary ecological network is planned. These areas are further subdivided into connection areas and portions contiguous to structural elements.
- *Possible expansion of the network areas*, i.e. areas with residual ecological functionality, but on which it is possible to implement new measures aimed at

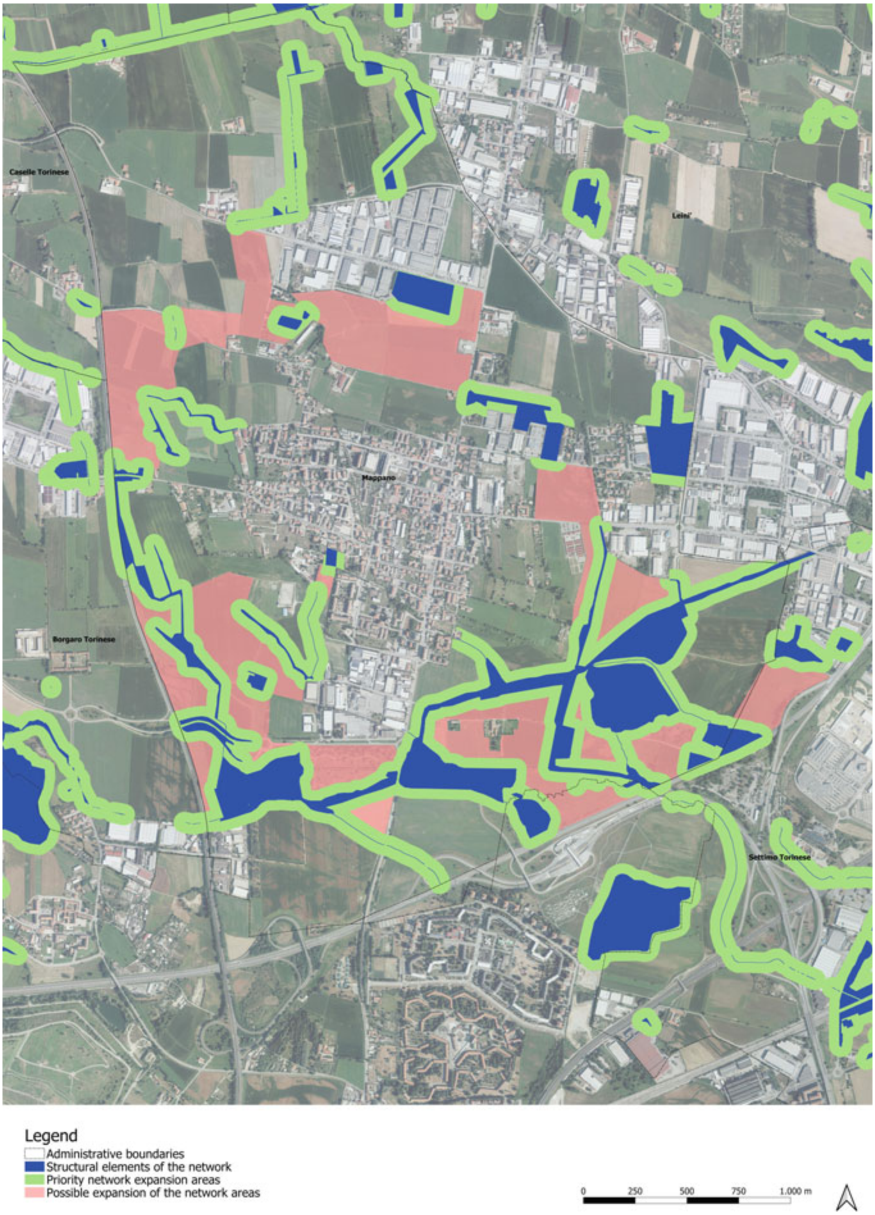

Fig. 10.2 Map of the ecological structurality of Mappano territory. The picture shows the two components of ecological structurality (structural elements and the contiguous portions to the structural elements). *Source* Voghera and La Riccia

increasing naturalness that are useful for protecting the habitat and species of interest for the conservation of biodiversity.

10.4 Analysing and Understanding the Environmental and Landscape System: Landscape Sensitivity

With the advent of ICT, the wide use of geospatial data and the creation of Digital Elevation Models (DEM) and Digital Surface Models (DSM), the development and implementation of new GIS methodologies help to determine visible areas more accurately and automatically (Travis et al. 1975; Yoeli 1985; La Riccia 2015a, 2017; Chiesa and La Riccia 2016). The family of GIS software can provide a spatial representation of landscape elements, studying the intervisibility relationship between different points more or less distant from each other, and define the overall sensitivity of the landscape. The aim of this analysis is to contribute to the field of urban planning, taking into consideration the objective conditions and geometries of different points of analysis (formal characteristics of the landscape scene, observation points, radius and depth of view, perceptual reference points), assuming that they can be predictive of a subjective landscape experience, a subjective perception. The viewshed analysis simulates the relationship between landscape morphology and spatial elements and helps to calculate the coverage (visual space) with respect to the position and visual horizon of a specific observer. Based on a model (DTM or DSM), it is possible to perform the analysis from individual positions (viewsheds), paths (incremental viewsheds) or areas (cumulative viewsheds). In all cases, the viewshed defines the assumed view space as the portion of the landscape that an observer can see. This process is not only based on the three-dimensional aspects of the space but also on other conditions such as the position of the observer (altitude, proximity, etc.), the direction of the view (azimuthal and vertical angles) and atmospheric conditions (minimum and maximum visibility radius). The results are based on a Boolean visibility concept and are given in binary code (1 = visible; 0 = not visible). A binary viewshed answers a fundamental question: What portion of the landscape is visible from a given vantage point? When carrying out this analysis, it is important to include all kinds of information about, for example, other scenic elements or particular points of interest (historical buildings, landmarks, natural environment, etc.) in order to assess different intervisibility relationships.

The geometric characteristics of each selected scene are organized within a geographical database that includes various elements: altitude of the selected viewpoint, height of the observer relative to the ground, height of a visual landmark, width of horizontal and vertical angles, depth (radius) of the view horizon. The set of parameters (La Riccia 2017) that can be imported by the GIS software is shown below:

- Spatial coordinates of the viewpoint;
- SPOT: altitude of the viewpoint;

- OFFSET A: height of the observer with respect to the ground;
- OFFSET B: height of a different landmark or another point of interest;
- AZIMUTH 1 and 2: width of the horizontal angle;
- VERT 1 and 2: width of the vertical angle;
- RADIUS 1 and 2: minimum and maximum distances (radius) of the view.

When several viewshed analyses are obtained from several points, it may be possible to superimpose them and create an "absolute visibility" map of the landscape. The result can be a Boolean (raster) image, or even be characterized by a more complex subdivision by incorporating the different viewshed analyses into a single map, generated by superimposing several raster images through the "combine" function of the GIS, and taken as the result of the "landscape sensitivity" index.

Figure 10.3 shows 6 classes of landscape sensitivity and derives from the weighted sum of the individual viewshed analyses, calculated from each of the seven viewpoints selected on Mappano following on-site inspections. The methodology therefore makes it possible to contribute to the drafting of landscape protection indications that can be applied differently, protecting the views on the basis of three distinct levels (foreground, medium-ground, background) or defining specific management plans that include detailed indications, for example the coherence between views, the development of the local ecological network and urban transformations, the requests for environmental mitigation and compensation to overcome the most critical territorial situations.

10.5 Analysing and Understanding the Environmental and Landscape System: Accessibility and Sustainable Mobility

The walkability assessment in Mappano was conducted through the improvement of an analysis methodology that aims to recognize the parts of the city where the actions for the improvement of walkability could be more effective.

The concept of walkability is a way of looking beyond the presence, distribution and simple accessibility of urban facilities (Cittadino et al. 2020; La Riccia et al. 2021): the spatial quality and the ability to accommodate and facilitate pedestrian mobility in the urban environment influence the way in which people perceive and use the city. What the concept of walkability brings with it, in fact, is the quality of accessibility: how and to what extent the urban environment is able to promote walking and offer itself as a platform for a daily life based on pedestrian mobility. But the research we have analysed often describes a path that has led to the construction of walkability indices, taking into consideration density and the urban mix (which brings together possible points of origin and destination of movements), safety (which concerns both intersections between pedestrian paths and vehicular paths, which anthropogenic safety), the pleasantness of the environment (quality of pavements,

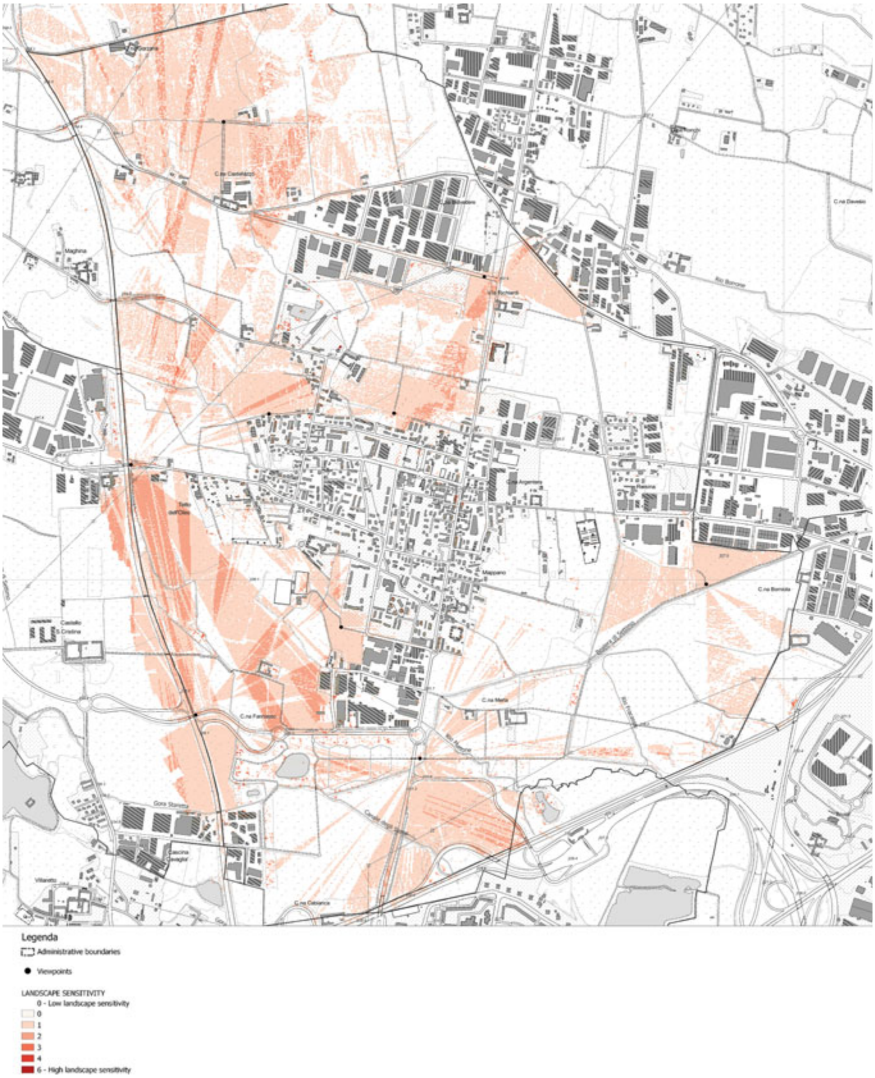

Fig. 10.3 Landscape sensitivity map from predetermined observation points (cumulative viewshed). *Source* Voghera and La Riccia

presence of shops and other activities along pedestrian paths, presence of greenery, low level of pollution and noise, etc.).

An analysis of accessibility is almost always present, expressed as the distance to be covered on foot to reach certain services, which however is calculated on the road network, that is, using the data and tools developed for vehicular traffic. This is obviously due to the unavailability of pedestrian path graphs. But this introduces significant distortions. In Mappano, however, the “walkable” space was modelled through a raster with a resolution of 1 m × 1 m: each cell of the raster was assigned an "impedance to be walked" value (cost raster, "local cost" of QGIS). The cost raster was then used to calculate the accessibility to some walking mobility destinations, such as the cumulative weighted distance (cost distance).

With this goal in mind, criteria were focused and indexes were constructed to make them operable. All data was checked and rasterized with 1 × 1 m cells. The other data, of a point nature, have been spatialized using the kernel density estimation (KDE) which, given the value of a phenomenon in a point, represents its diffusion and attenuation in a circular neighbourhood, with a radius suitably defined in relation to the phenomenon represented.

All the maps were produced as rasters with cells of equal size: the different rasters were then simply added up with the Map Algebra method, giving each a suitable weight (Table 10.1; Fig. 10.4). The use of the weighted sum, avoiding more complex algorithms, is functional to maintain a certain control over the meaning of the results, very appropriate because these results derive from a procedure of a certain complexity, which contains several critical steps inside. In identifying the criteria at the neighbourhood level, the starting point was the "Walkability Hierarchy of Needs Pyramid" (ITDP 2018, p. 13–14). The six proposed criteria have been compacted into three: practicability, safety (physical safety and anthropogenic safety) and comfort/ pleasantness.

The weighted sum of the macro-indices relating to these three criteria constitutes the cost raster, readable as a detailed representation of the walkability (Fig. 10.5). High values of the macro-indices mean high practicability, high safety, high pleasantness, while the values of the raster cost represent a cost, an impedance to walk the cell. The values of the cost raster were then calculated as a complement to 100 of the normalized sum of the macro-indices.

Improving walkability therefore means intervening on those extrinsic characteristics to people that favour full individual expression. Our research therefore proposes a two-level reasoning: walkability has been assumed as a complex indicator for assessing the state of places (at the neighbourhood level) and becomes a tool for orienting the design action aimed at improving livability (at the city level), with the aim of recognizing the parts where actions aimed at improving walkability can be most effective.

10.6 Conclusion: Reasoning in an Integrated Perspective

The set of analyses produced based on consolidated methodologies involves rules, models and criteria for solving common problems for planning requiring reasoning in an integrated perspective.

The work carried out is based on the idea of outlining a shared theoretical perspective, because it is based on theoretical acquisitions already given, but which required measuring oneself with the territorial dimension of Mappano to guide them towards new hypotheses, methodologies and application directions. By dealing with urban

Table 10.1 Set of indicators (at city level and at neighbourhood level) for evaluating walkability in Mappano

Macro-indexes		Indicators	
Weight attributed in the weighed sum (%)	Description	Weight attributed in the weighed sum (%)	Description
Walkability at city level			
40	Population density	30	Density of children 0–14 years old, inhab/ha, by census sections
		50	Population density 15–64 years old, inhab/ha, by census sections
		20	Population density over 65 years old, inhab/ha, for census sections
20	Density of economic activities	60	Local unit density, LU/ha, by census section
		40	Density of employees, employees/ha, by census section
20	Urban form	50	Block density per sqm/km, by statistical area
		50	Density of public pedestrian circulation areas (by census section) sqm/sqm
20	Attractive activities for services, leisure, intermodality	30	Number of Public Facilities (e.g. security, administrative offices, social welfare services)
		20	Number of Schools (Schools, Kindergartens, Universities)
		20	Number of leisure places (cinemas, sports facilities, thematic markets, museums, tourism offices, theatres)
		30	Number of Intermodal nodes (taxi stations, car sharing, bike sharing, stalls of disabled people, parking areas, metro, bus and train stations and stops)
Walkability at neigh-bourhood level			
40	Accessibility	50	Presence of sidewalks, pedestrian crossings, paths, slides, stairs…
		50	Population density 15–64 years old, inhab/ha, by census sections
20	Security	10	Presence of activities at the sidewalk level: shops, stalls
		20	Presence of intersections with vehicular traffic regulated by traffic lights
		20	Separation of pedestrian/vehicular routes
		10	Number of accidents involving pedestrians

(continued)

Table 10.1 (continued)

Macro-indexes		Indicators	
Weight attributed in the weighed sum (%)	Description	Weight attributed in the weighed sum (%)	Description
		15	Presence of areas and intersections with controlled vehicular traffic
		20	Adequate lighting levels
		5	Social control by the people of the houses overlooking the lower floors
20	Comfort/ pleasure	15	Presence of trees
		5	Presence of street furniture
		10	Presence of attractive activities at the sidewalk level (shops)
		5	Presence of covered paths
		5	Presence of water points
		15	Sidewalk quality
		5	Low noise level
		20	Path contiguous to green areas
		5	Presence of "buildings of particular historical interest"
		5	Presence of works of art
		10	Presence of landscape visuals and panoramic points

Source Voghera and La Riccia

planning, in particular, such an approach helps us to abandon the idea of relegating this activity within a single disciplinary area and to acquire the conviction of taking a look "beyond the borders", under penalty of reductivism and, consequently, of not being able to grasp the relevant threats on the territory due to the global changes in progress.

A people-centred and place-based approach for urban planning that starts from ecological and landscape perspective can contribute to make operational the concept of transformative resilience, proposing solutions for the ecological and landscape quality needed for the coevolution of the territories (Folke 2016). The Mappano experience enforces the community aspiration to construct new development path based on shared visions about landscape and nature preservation, making effective the "nature-based recovery" or "nature positive economy" (IUCN Marsiglia 2020) towards a landscape resilience.

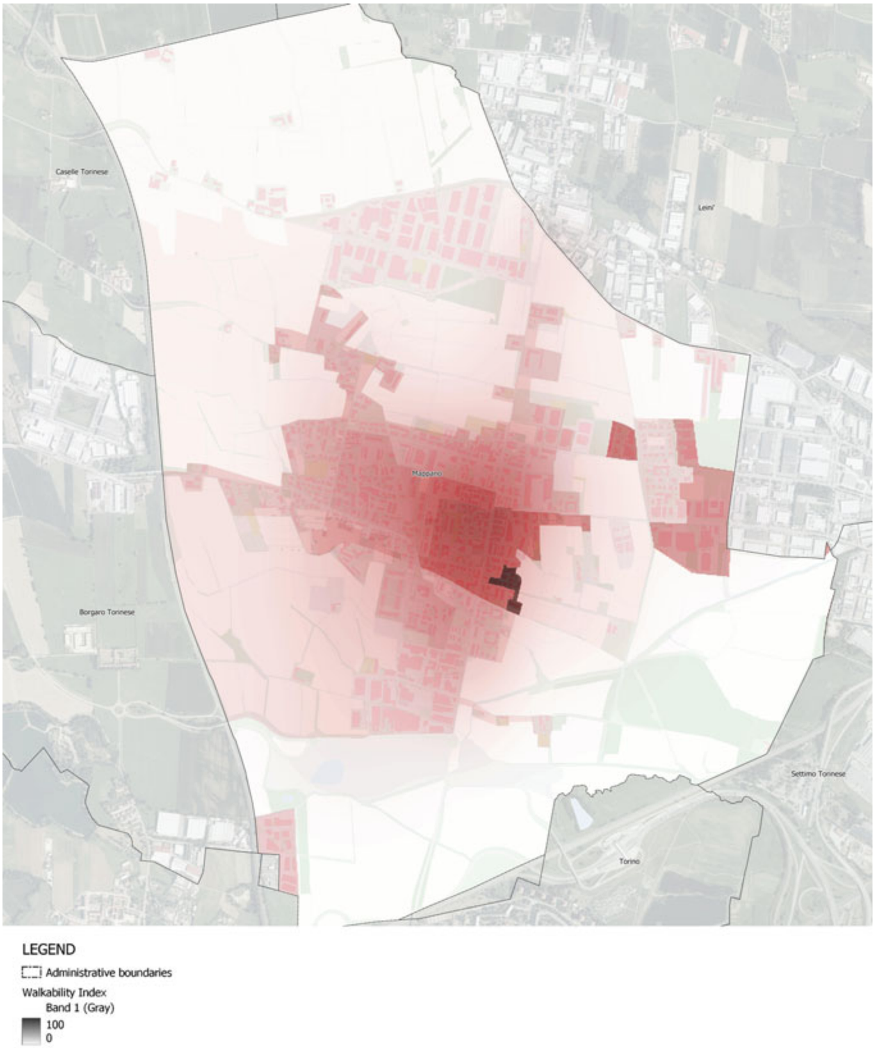

Fig. 10.4 Walkability at city level in Mappano. *Source* Voghera and La Riccia

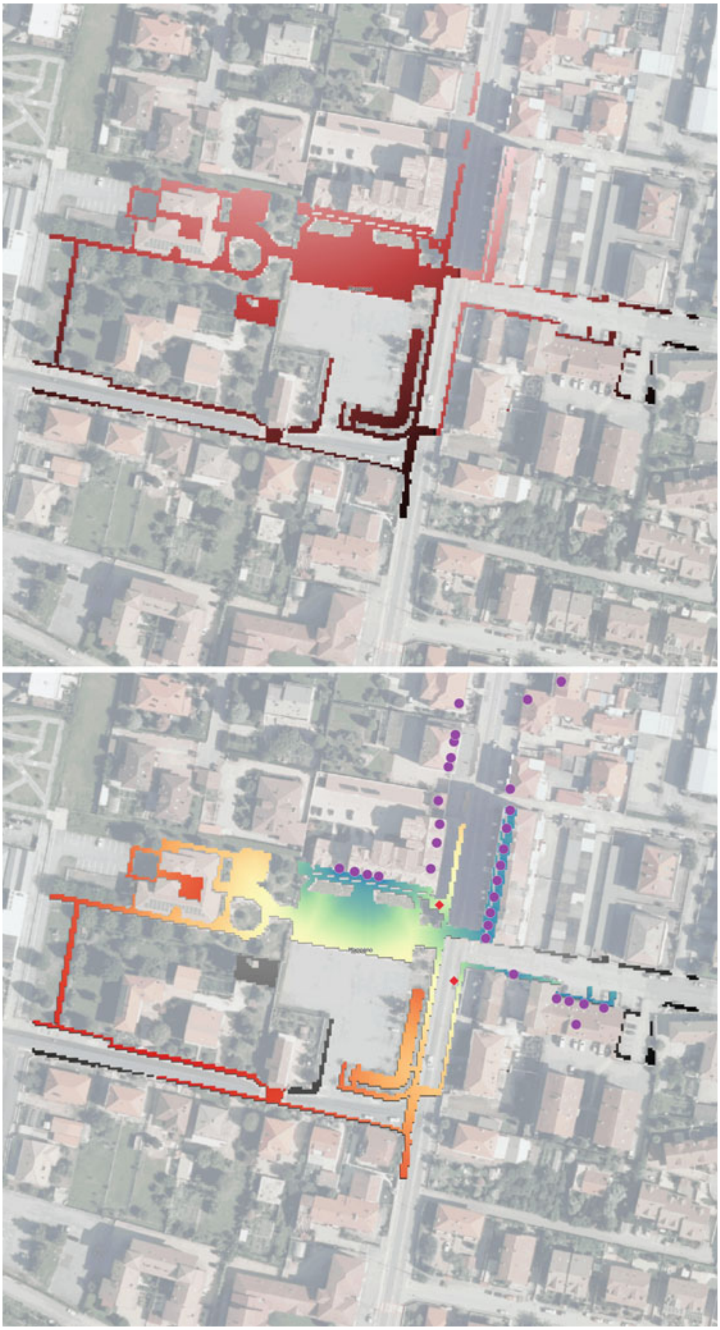

Fig. 10.5 On the left, cost raster: cumulative raster of the cost of walkability. On the right, cost distance: accessibility to shops (weighted distance cumulated on the cost raster). *Source* Voghera and La Riccia

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