Beyond the Infrastructure. Sustainable Landscape Regeneration Through Greenways: Towards Project Guidelines for the Sardinia Island (Italy)

Valeria Saiu(✉) and Francesco Pinna

University of Cagliari, 09124 Cagliari, Italy
{v.saiu,fpinna}@unica.it

Abstract. In the context of the challenges posed by development models based on overconsumption of natural resources, the paradigm of sustainability defines a new orientation for territorial planning and design. In this regard, greenways play a key role, contributing to safeguard the environment, rehabilitate the fragmented habitats, connect urban and rural areas, revitalize peripheral and degraded areas, and balancing economic growth needs with equal distribution of opportunities and resources. However, the prevailing technical and sectoral approach with which these issues are still addressed – reflecting the fragmentation of instruments and expertises involved in the territorial project – hinder the intervention's long-term effectiveness. Starting from the critical analysis of the most significant experiences of greenways, this paper highlights the prevailing strategies and actions, in order to build a catalog of good practices transferable to the Sardinian regional context. Sardinia, in fact, represents a potential laboratory for the study of an innovative approach to sustainable territorial regeneration, conceived as an opportunity for local development starting from the networking of the resources – environmental, cultural, economic and social – that compose its complex landscape palimpsest.

Keywords: Sustainable urbanism · Landscape regeneration · Green infrastructures · Greenways · Active mobility

1 Introduction

In the context of policies aimed at the sustainable development of the urban environment, the Greenways project is gaining great interest from national Governments and local Administrations. The greenways, in fact, represent a potentially "low cost" strategy to promote environmental protection and the socio-economic valorization of the territory. Moreover, the Region of Sardinia (Italy) is showing a growing commitment in the implementation of soft mobility networks. In December 2018, the Regional Plan for Cycling Mobility of Sardinia was approved. This Plan provides for the construction of a cycle network of over 2,000 km, developed on 52 itineraries covering the whole island. The Region sees in these systems the opportunity to develop integrated projects capable to transform the project of a mere infrastructure into a landscape

© Springer Nature Switzerland AG 2020
O. Gervasi et al. (Eds.): ICCSA 2020, LNCS 12255, pp. 321–336, 2020.
https://doi.org/10.1007/978-3-030-58820-5_25

project. This objective appears particularly relevant in relation to the opportunities offered by the great variety of landscapes and of the natural and anthropic elements that favor the territorial connectivity: the network of forsaken railway routes, the system of rural roads and flat and mountain paths, but also the dense hydrographic network, can be part of a capillary network of paths with which to make accessible the conspicuous regional heritage – historical, archaeological and environmental – still scarcely valued. In this context, authors have been developed a study aimed to build a system of guidelines for the design of greenways in Sardinia. The work was carried out by the University of Cagliari in collaboration with several offices of the Sardinia Region, responsible for the management of local authorities and finance, public works, transport, state property and heritage, hydraulic works.

As emerged in the interdisciplinary working groups organized by the regional administration, the realization of this project implies the construction of programming, planning and design tools capable to build a holistic vision of the territory, overcoming sectoral approaches. In particular, the plurality of constraints on the environmental, architectural and archaeological heritage, and the numerous levels and regulatory instruments still represent today a strong limit to the effectiveness of public action. The lack of a direction able to guide the work of the various public offices, linking the various involved figures, in fact, translates into a sectoral and vertical approach that tends to fragment knowledge and skills at the expense of an integrated territorial project, essential for the realization of these complex infrastructures.

These are some of the problems that were analyzed during the research work, briefly presented in this text, which, starting from the study of the most interesting international experiences, led to the development of a system of guidelines, aimed to summarize applicable strategies and objectives in the regional context. In this way, an operating framework has been defined which is useful to provide a common reference for all actors – technicians, administrators, citizens, economic subjects, etc. – involved in various capacities in the planning, and to put the existing sectoral initiatives online. From a more specifically operational point of view, through the guidelines it is possible to highlight the potential that the greenways project can have in terms of feasibility and economic enhancement of the territory. On the one hand, in fact, this project appears strategic and transversal to many European Community policies – in particular with regard to territorial cohesion, biodiversity conservation, soil conservation, fight against climate change [1–4] – allowing to intercept important European funding for various sectors. On the other hand, it allows developing new local economies, by re-centralizing peripheral territories.

This paper is divided into three main sections. The first present a literature review on greenways that provides the conceptual framework in which this study is conducted, focusing on the complexities of the concept and on the multiple application potentialities, particularly with regard to the economic and social value (Sect. 2); the second section describes the transition from the conceptual framework to field application: through nine selected case studies, we have highlighted the main programmatic points and design actions, useful for identifying a set of guidelines (Sect. 3); at last the third section proposes the application of the concepts and design guidelines, described in the previous sections, to an demonstration project in Sardinia (Sect. 4).

2 Greenways: From Infrastructure to Landscape

Despite the wide use of the term, there is no clear definition of Greenway [5]. This concept, in fact, has assumed and still assumes multiple meanings, in relation to the different context – political, economic, socio-cultural – where it is applied from time to time. Very often, moreover, this term has been used as a mere synonym of a green path or cycle path, severely limiting the design potential inherent in the articulated and complex conception of the territorial network that substantiates the Greenway concept. In the Italian context, this is the case of Law 11/01/2018, n.2 "*Disposizioni per lo sviluppodellamobilità in bicicletta e la realizzazionedella rete nazionale di percorribilitàciclistica*" (Orders for the development of bicycle mobility and the creation of the national cycling network). It defines as "green bike path" or "green-way" *a track or cycle path on which motorized traffic is not allowed* (art. 2).

Compared to this partial and reductive concept, the definition adopted in 1998 by the Italian Greenways Association is still current today and represents an important reference [6]. Indeed, it effectively summarizes the most significant characteristics of the Greenways, underlining the idea of "system" and "connection" between different territories. This idea was already present in the concepts of Greenbelt (green belt) and Parkway (park road) developed between the late nineteenth and early twentieth century, respectively in Europe and America thanks to the work of E. Howard [7] and F.L. Olmsted [8], as well as "multifunctionality". This takes up the definition of Ahern [9] and leads the greenways to be configured as territorial networks designed for multiple purposes: ecological, recreational, cultural, aesthetic or other, compatible with sustainable land use. In fact, the concept of greenway develops in parallel with a new sensibility for the environment and the increasingly widespread adoption of the principles of sustainable development in urban and territorial policies [10–17].

This sensibility fits within an integrated and holistic vision of spatial planning that definitively shifts the attention from the single element to the system. In this perspective, the networking of local resources [18] through the design of new multifunctional ways that exploit the advantages derived from the connections between spaces [11, 19, 20], represents a key action for the efficient management of complex territories such as contemporary ones. The concept of greenway as "linear multifunctional green areas" sanctions the transition from the route project to the landscape project, intended as an interpretative and operational tool in the dynamics of territorial transformation, following the definition introduced by the European Landscape Convention adopted on 20 October 2000 in Florence (Italy) [21].

2.1 Building New Human-Nature Interactions: The Social Value of Greenways

There is a large literature on the social and cultural benefits derived from nature [22–25]. The search for a new relationship between mankind and nature and the abandonment of an constraining approach to environmental protection has led to the interpretation of ecosystem goods and services as potential support elements for human well-being [26–34] or, vice versa, as elements potentially negative for the quality of life, so much to configure them as "ecosystem disservices" [35–37]. This aspect shows

as places are intertwined with ecological and social networks, and as the flows and inter-changes between natural processes and human decisions are crucial for the quality of the living environment [38]. Green infrastructures, in fact, are configured not only as elements capable to promote the conservation and protection of biodiversity [39, 40], ensuring the right to environment healthiness, but as a collective resource to promote the socio-economic development of the territory and to improve social exchanges [41–43]. For this reason, the greenways project represents an opportunity – as well as for the protection, for the enhancement of green areas – to connect existing public spaces and to create new ones. They are "devices" for the development of places which contribute to the creation of new identities through the recognition and re-signification of environmental and cultural historical values. In this context, the components of "everyday life" play a decisive role for the success of a project that intends to integrate environment, economy, society and therefore culture as fundamental aspects in the planning and design processes of the landscape. In fact, new cultural and social values can be assigned to these. An example of this approach is the Greenway of the Battle of Pavia (Italia), an itinerary of about 26 km that connects different "everyday landscapes" – the agricultural reality of farmed fields divided by a network of historical irrigation ditches; the urban-agricultural reality, marked by the presence of disordered urban-ization and numerous unfarmed land; the consolidated urban reality, the city of Pavia; the fluvial reality of Ticino and other waterways – whose protection, recovery and development rotate around the historical event.

In accordance with this vision, greenways are configured as potentials cultural and ecological landscape corridors [44]. Many studies, in fact, highlight the social value of greenways, considered as an instrument of cultural landscape design [45], expression of cultural values linked to biodiversity [46] able to improve community attachment [47]. As Little claims «to make a greenway is to make a community» [48]. It is indicative of this that the wide adhesion to the greenways project by public administrations and local populations that have formed various forms of associations to promote their spread. Created in 1998, the European Greenways Association (1998) brings together over 50 associations, active in several EU Countries.

3 Recompose Landscapes Through the Greenway Project: A Design and Regulatory Approach

The greenway planning, design and implementation process allows to operate on different levels, giving to the landscape three main functions: (1) Structural, a guide for the transformations; (2) Ecological, the guarantor of the correct environ-mental functioning (e.g. reduction of air and water pollution, improvement of micro-climatic conditions, mitigation of the impacts of human activities); (3) Socio-relational, the connector of services, resources and soft mobility forms.

The design of these complex landscape networks, therefore, plays a decisive role in the contemporary project, especially within the policies of sustainable regeneration of the territory. Through the greenways, in fact, strategic elements for the urban growth control, the soil consumption and degradation, and the consequently landscape fragmentation can be introduced. For this reason, they are particularly useful for deal with

problems of degrading and degraded areas, and more in general of territorial contexts in which the landscape re-composition – carried out starting from the anthropic and environmental resources of the territory enhancement – allows to attribute new economic and social uses and meanings also to the residual patches. In this context, we need to know what relationships exist or can be established between fragmented landscapes and environmental corridors [49, 50]. To this end, it can learn to recognize the main elements that compose the territory – existing resources and constraints – in order to establish new spatial and functional relationships between different areas. An issue already highlighted in Seventies by G. Angus Hills, Philip H. Lewis and Ian L. McHarg [see: 51] who were among the first to claim that the project (and optimal locations) should derive from the spatial overlapping of multiple thematic maps, elaborated through the recognition of the different resources of the territory.

3.1 Towards Decision and Design Guidelines: The Case Study Analysis

The considerations set out in the previous paragraphs summarize central themes and issues related to the greenways project. In order to verify how these theoretical concepts are applied and transferred into planning strategies and design principles – useful for coding a replicable model of good practices – some of the most interesting experiences put in place so far have been selected (Fig. 1, Table 1).

The selected projects allow to analyze a wide range of significant projects which refer to different contexts such as United States, Canada, Belgium, France, United Kingdom and Italy. These projects include networks located within internal to densely urbanized areas (1, 4, 5), between urban and rural areas (2, 3) and within dispersed settlements (6–9). The latter scenario characterizes Italian projects that aim at the protection, safeguard, and enhancement of environment and historical-cultural resources, which are recognized as useful devices to reduce the fragmentation caused by the widespread construction of infrastructures and settlements. The Italian greenways, in fact, are not configured as single routes, but rather as complex connectivity structures. The choice of these case studies is based on the fact that these are completed or ongoing projects for which studies and data exist, useful to document objectives, actions and results in a sufficiently exhaustive way.

The analysis of the selected case studies allows to summarize in seven points the main objectives pursued and the results obtained by almost all the projects (Table 2):

1. Re-assemble Landscapes. The project originates from resources and critical elements of territory, conceived as a driver for development strategies, aimed at establishing new links between natural and cultural heritage, promoting to this end the reuse of existing infrastructures (e.g. disused railway lines, river towpaths, urban and rural paths);

2. Promote Soft Mobility. The project discourages the use of private cars and promotes transit and non-motorized transports that use only the "human energy" such as walking and cycling, encouraging public intermodal and multi-modal transport services;

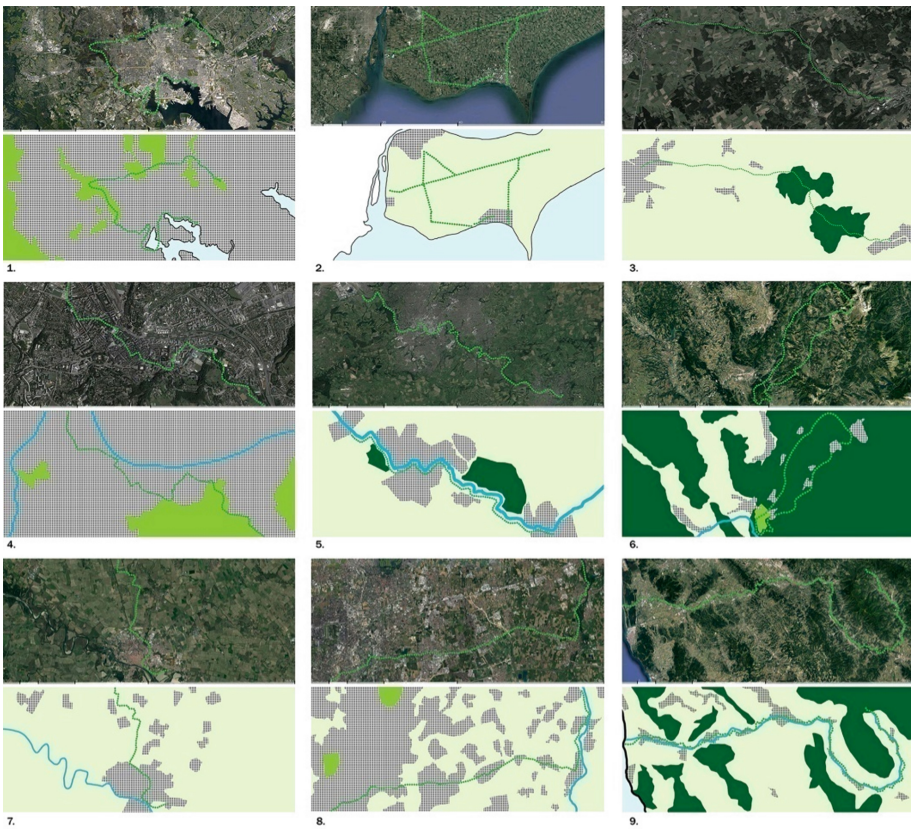

Fig. 1. The nine selected case studies: (1) Baltimore Greenway Trails Network; (2) Chrysler Canada Greenway; (3) Vèloroutes & Voies Vertes (Chambery); (5) Greenways and Quiet roads (Bristol-Bath); (6) Greenway of Nera; (7) Battle of Pavia Greenway; (8) Greenway of Martesana; (9) Greenway of Arno.

Table 1. Data from nine selected case studies.

Project	Location	Path length	Infrastructures	Involved actors	Fundings
P1. Baltimore Greenway Trails Network	Baltimora, Maryland	56 km	Urban and rural paths	Municipality, Citizen Associations	State
P2. Chrysler Canada Greenway	Essex County, Canada	50 km	Disused railway network	Conservation Authorities	Donations

(*continued*)

Table 1. (*continued*)

Project	Location	Path length	Infrastructures	Involved actors	Fundings
P3. Reseau Autonome des Voies Lentes (RAVeL)	Wallonie, Belgium	19 km	Disused railway network, canal and river towpaths, country roads	Regions, Municipalities, Local Associations, Minister for Public Works	EU, State
P4. Vèloroutes & Voies Vertes	Chambery, France	45 km	Disused railway network, canal and river towpaths, country and forestry roads	Minister for Land Planning and Environment, Minister for Transport, Minister for Youth and Sport, Associations	EU, State
P5. Greenways and Quiet roads	Bristol-Bath, Great Britain	20 km	Disused railway network, canal and river towpaths, forestry roads, urban parks	Minister for Transport and Health, Associations, government organizations of citizens	State, Private, Tourism Companies
P6. Greenway of Nera	Umbria, Italy	180 km	Canal and river towpaths, forestry roads, urban parks	Region, Provinces, Municipalities	EU
P7. Battle of Pavia Greenway	Pavia, Italia	26 km	Canal and river towpaths, forestry roads, urban parks	Region, Provinces, Municipalities	Regional
P8. Greenway of Martesana	Lombardia, Italy	35 km	Canal and river towpaths, forestry roads, urban parks	Provinces, Municipalities Milan's local public transport company, Associations	State, Local Associations
P9. Greenway of Arno	Toscana, Italy	350 km	Canal and river towpaths, forestry roads, urban parks	State "Genio Civile", Region, Provinces, Municipalities	EU, State, Local Administrations, Private

3. Improve Environmental Quality. The project safeguards natural habitats and their biodiversity and contributes to create new ecosystems through the connection between diversified natural environments and the facilitation of fauna movements;
4. Enhance the Historical-Cultural Heritage. The project makes accessible the historical and cultural heritage, promoting its protection and enhancement, and increasing the sense of identity and community;
5. Include Different Social Categories. The project encourages multiple soft travel modes in relation to different types of users (pedestrians, cyclists, etc.), facilitating movements of people with reduced motor skills, compatibly with the territory morphology.
6. Promote Social Participation. The project promotes a bottom-up approach based on participation processes and encourages public-private partnerships, in order to respond to the needs of all the actors involved.

Table 2. Case studies: consistency with the identified objectives.

Case study	Project objectives						
	1.	2.	3.	4.	5.	6.	7.
P1.	x	x	x	x	x	–	x
P2.	x	x	x	x	x	–	–
P3.	x	x	x	x	x	x	x
P4.	x	x	x	x	x	–	x
P5.	x	x	x	x	x	–	x
P6.	x	x	x	x	x	x	x
P7.	x	x	x	x	x	x	x
P8.	x	x	x	x	x	x	x
P9.	x	x	x	x	x	x	x

7. Know and Make Known the Territory. The project must become part of the collective imagination. To this end, it is necessary to promote large-scale dissemination and information initiatives, aimed at a broad audience, such as websites, educational and didactic projects.

Starting from these points, a series of successful actions, which are believed to be replicable in other contexts and in particular in the Sardinian Region, have been highlighted. These actions were divided into three categories according to the three main dimensions of the sustainable project: social well-being, environmental protection and economic development (Table 3).

Table 3. Project actions.

1. Social well-being	2. Environmental protection	3. Economic development
1.1. Encourage the active involvement of all interested parties in planning and design processes	2.1. Safeguard and enhance environmental resources	3.1. Improve the local tourism economy through the relaunch of the traditional economic resources
1.2. Promote educational paths, awareness campaigns and cultural events	2.2 Define new uses of space according to resources, limits and constraints of different ecosystems	3.2 Equip the territory in order to guarantee services for its optimal use
1.3. Design accessible paths for different users, with regard to people with reduced motor ability	2.3 Decrease investments in new buildings and infrastructures, in favor of the reuse of unused or underused spaces and settlement structures	3.3. Promote specific local economic activities, strengthening traditional materials and products
1.4. Create safe connections between places of interest and places of everyday life (home-school-work)	2.4 Ameliorate the quality of the peripheral areas, improving their environmental value	3.4. Promote local private entrepreneurship at the service of public interest
1.5. Create new public spaces and recreational areas in order to enhance the sense of community, and the sense of belonging to the place	2.5 Secure the territory, improving risk management	3.5. Narrate the territory, using different media and languages

Table 4 summarizes the schedule of project actions, assigning to each one a "weight" calculated on the basis of the sampling frequencies. The table highlights how some actions are very common, while others are less used because they respond to critical issues for specific the territory.

Table 4. Evaluation of the frequency of the identified project actions.

Sustainability goal	Project actions				
1. Social well-being	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
	+8	+9	+9	+9	+6
2. Environmental protection	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**
	+9	+9	+9	+8	+6
3. Economic development	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	+5	+8	+4	+3	+6

4 Greenways in Sardinia

The operating framework previously described, allows us to identify a series of key actions for the construction of greenways network in the Sardinia Island (Italy). In this context, it is important to consider that the regional cycle mobility network is currently being planned and in part it has already been completed (Deliberazione N. 6/22 of 31.1.2017) through a project that foresees the reuse of disused infrastructure networks, especially railway routes.

In fact, the Sardinia Region is investing huge resources to encourage the development of bicycle mobility. The Regional Plan for Cycling Mobility defines a coordinated set of complementary and integrated measures, interventions and activities aimed to promote and to make available a new way of knowing and experiencing Sardinia, with a strong ecological and environmental connotation [52]. Another characteristic of this Plan is that the cycle mobility system is strongly integrated with all other modes of transport and includes actions and interventions aimed at promoting and spreading slow mobility. This network will also represent an important tool of tourist attraction and, consequently, the driving force of a new production system with effects directly visible on the territory [53].

The plan that defines the network of the connections between urban centers and between the main transport exchange nodes (e.g. bus and train stations, ports, airports), could be empowered through others existing paths that characterized the landscapes crossed. In particular, the green and blue infrastructures, described in the previous paragraphs, can therefore be connected to this network, in order to allow a complete use of environmental and historical-cultural assets that connote internal areas, and which are located very far from the regional cycling network.

From this point of view, the reuse of State property, which is in a state of neglect and degradation, is fundamental. On the one hand, these public goods constitute a resource for the network, because they allow it to be equipped with the services, useful to guarantee its full use. On the other, the greenway network creates necessary conditions for their recovery and reuse.

The hydrographic network, which is part of the state property, is characterized by a high degree of capillarity which can be particularly useful for defining privileged access lines to the territory. The dense network of waterways and canals, in fact, guarantees not only the enjoyment of pleasant paths but the effective territorial protection. The water courses, in fact, can be understood as: (1) Structuring axes, systems for reorganization through which to connect different landscapes; (2) Development axes, systems for territorial transformation useful for orienting decision/making processes and the dynamics of local economic development; (3) Discovery axes, systems for the promotion of an articulated and sustainable territorial fruition.

The analysis of the small and main river paths, carried out with the support of the regional databases, allows us to identify the potential landscape elements of a greenway, in order to configure an integrated project at regional scale.

4.1 A Project Hypothesis for the Sulcis Area: The Four Possible Scenarios

In order to verify the applicability of the theoretical and operational considerations made in the previous paragraphs, we propose an explorative project in Sardinia. To that end, we have analyzed and mapped the hydrographic network in order to identify all possible paths that could be part of the greenways network. In a second step, using the GIS tools, we verify the connections between these routes and the points of environmental, historical and archaeological interest, and their connections with the Regional Cycling Mobility Plan. Finally, among all these paths we have selected the most representative for the purpose of this study, because it allows applying the proposed methodological approach at an appropriate scale.

The identified area is located in the Sulcis area of Sardinia, in a territory characterized at the same time by a landscape of great environmental quality and by a complex settlement system, linked to the mining history of the area. The crisis of mining activity, in fact, is one of the main factors of degradation and land abandonment. In this context, the project of greenways represents an opportunity to activate the redevelopment of large areas of the territory. In particular, we propose a greenway that connects the city of Carbonia – the largest foundation city in Sardinia emblem of industrial modernization of the island – with the coast, along the Rio San Milano. The path length is about 8 km and develops mainly along the pre-existing dirt roads, trying to minimize the conflict with vehicular traffic. The greenway crosses different territories: urban areas, countryside, dispersed settlements and scattered buildings, of recent and historical origin. A heterogeneous and articulated set of landscapes which at present which at present is scarcely used and therefore risks being degraded and abandoned. The proposal adopts a strategic approach based on three key actions (Fig. 2):

a) *Connect*: provide users with a wide range of mobility options, alternatives to vehicular transport, through a network of paths that guarantee the safe mobility of pedestrians and cyclists;
b) *Re-sew*: contrast the fragmented status of the territory by connecting different areas and elements, and reduce the soil consumption dynamics through the promotion of the reuse of the existing building stock, with particular regard to degraded and abandoned heritage;

c) *Develop*: enhance policies aiming to increase the environmental and historical/cultural safeguard and development, in order to create new local economic and recreational opportunities.

These actions were applied in four project scenarios that allow showing the flexibility of greenways networks able to adapt to various place. Through these scenarios it is possible to demonstrate the applicability of the greenways project in different territorial contexts, whose peculiarities allow to explore many complementary themes and scales. The potential for landscape regeneration offered by greenways, in fact, is expressed precisely in the possibility to activate an integrated project, fielding a complex of different intersectoral actions, strictly coherent and interconnected, which converge towards a common target of territory development. The four scenarios are briefly described below.

Scenario 1: Urban and Peri-Urban Areas. The greenway starts from the Carbonia intermodal station that connects 24 municipalities. This area is the main interchange node between rail and road transport, from which it develops the cycle path that connects the intermodal station to the city center. This place constitutes a strategic node because the station assumes the role of gateway to the territory and to the greenway. Through the greenway project is possible to strengthen the connections to the internal and coastal areas and consequently favor the activation of territorial regeneration processes. In particular we planned the transformation of some abandoned areas into urban parks the provision of some essential services, such as parking areas for bikes, cycle workshops, bike sharing, etc.

Scenario 2: Agricultural Contexts. In this scenario, the greenway crosses fragmented and abandoned agricultural territories. The proposal encourages the shared use of land, also through diversified forms of local economic development. Among these a widespread agricultural market would allow those who travel to the greenway paths to appreciate the typical productions, encouraging the local economy. Further-more, in order to hand down the agricultural tradition to future generations, the commercial areas could be flanked by spaces dedicated to educational laboratories. In this context, some architectures of the historical agricultural landscape are particularly suitable for hosting these functions. Among these the “medaus” and the “furriadroxius”, micro residential and productive settlements dating back to 18th century, that by their scattered and widespread nature, are particularly suitable to become new reception centers, for hospitality and tourism services.

Scenario 3: Historical Sites. The third scenario includes the archaeological site of Locci Santus, one of the most important necropolises of the Sulcis, dating back to the Neolithic age (c 3,000 BC), consisting of 13 burials in Domus de Janas. Through the greenways it allows to highlight how it is possible to make historical and cultural heritage accessible, in order to promote the protection of the existing heritage and increase the sense of belonging of the communities. Following these principles, in addition to safeguarding and managing the asset, it was considered important to realize a service area for full use of the site. As in other contexts, the new network of soft mobility becomes a way to rediscover and enhance the history of places.

Scenario 4: Coastal Areas. The path traced by the greenway ends on the coast, near an area with a strong environmental value but poorly equipped with services and infra-structures. Here the project provides new recreational areas, structures and services for fishing activities, some of which to be built inside the new pier that allows to ex-tend the greenway to the sea. Despite their simplicity, these interventions can be of great importance to incentivize new forms of local economies.



Fig. 2. The four project scenarios: views and maps of intervention areas.

According to the Sect. 3.1, Table 5 summarizes the project actions which can be included in each of the four scenarios presented.

Table 5. Scheme of the actions applied to the definition of each design scenario.

Sustainability goal	Project actions				
1. Social well-being	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
	S1, S2 S3, S4	S1, S2 S3, S4	S1, S2 S3, S4	S1	S1, S2 S3, S4
2. Environmental protection	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**
	S1, S2 S3, S4	S1, S2 S3, S4	S1, S2	S1	S1, S2 S4
3. Economic development	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	S2, S4	S1, S2 S3, S4	S2, S3, S4	S1, S2 S3, S4	S1, S2 S3, S4

5 Discussion and Conclusions

As shown by the literature and case studies examined, the promotion of territorial and urban regeneration strategies through the creation of green systems is now shared by researchers and administrators of many cities. In fact, they see these infrastructures as an important opportunity for sustainable transformation of their territory. In this context, the greenways allow to overcome the binding and sectoral approach characterizing the planning and design logics, and to configure a strategic "tool" useful to simultaneously pursue multiple objectives. Among these, it emerges the promotion of active mobility, the safe-guard of the biodiversity and ecosystem services, the revitalization of local economies, the enhancement of the historical and cultural identity of the territory and the construction of new spaces of social relationship, all capable to promote a new sense of belonging to places and to strengthen the sense of community.

It follows that the greenways project is a complex project that must be built starting from the in-depth knowledge of the characteristics of the territory, the needs and aspirations of the local community and the market analyzes exclusively oriented to generate profit. In fact, the greenways projects require the active involvement of all the potential actors concerned in the project: public administrations, economic operators, associations and individual citizens. For this reason, consistently with the concept of landscape defined by the European Convention of the Council of Europe in 2000, the greenways take on the function of "landscape infrastructures" to try to establish a new balance between population and environment. Beyond these theoretical reflections, the study is propaedeutic to the development of a system of guidelines for the planning and design of a system of greenways in the Sardinian regional territory. In fact, the comparison between case studies has been useful to define recurring themes, objectives and actions allowing to outline a shared strategic framework. In this common frame, it is possible to develop multiple design variations which adhere to the specific features of each different territories, making each project unique. The proposed project exploration addresses the case of the territory of the Sardinia Region, where a greenways project has not yet been undertaken. The article builds a synthetic picture, trying to identify the strategies and the carried-out projects, which, put to system, can contribute to the construction of a system of greenways for Sardinia. Among these, the regional cycle network project is the first strong framework to which a second network could join, made up of more capillary pedestrian paths. As said, the regional hydrographic network could represent suitable reinforcement for this purpose. In this way, the greenways network construction would offer an opportunity to promote the places active protection not reached through the cycle network and the river rods themselves. The presented scenarios are not intended to create solutions. Through the heterogeneity, and therefore the richness, of the landscape, the scenarios show the potentiality of this project which, as underlined several times, will have to be built starting from the knowledge of the ecological and environmental, socio-economic and historical-cultural characteristics of the territory. A potential development of this work is the creation of guide-lines, useful to support the public decision makers in decision-making processes. It is not a question to give strict indications but to guide the project, evaluating the locational, formal and technological choices through a multiscale and multidisciplinary

approach. This method will also allow to share and clearly communicate the reasons of the choices, activating a participatory design process which is crucial for the project outcome. Finally, the guide-lines, as well as for the project, could give indications for the implementation and management of the interventions, that are two critical phases requiring a careful planning of the activities.

Acknowledgments. This work was carried out in collaboration with the technical offices of the Autonomous Region of Sardinia, in particular with the General Directorate for Local Authorities and Finance – State Property and Heritage Service, as part of the curricular training and orientation internship agreement, established between the General Directorate for Local Authorities and Finance, the University of Cagliari – Master of Science in Architecture, and the General Directorate for Public Works, Territorial Service of Cagliari Hydraulic Works (STOICA). The case study data presented in this article were collected by M. Mallus and C. Porcu under the coordination of the authors [54].

References

1. European Commission: The multifunctionality of Green Infrastructure. https://ec.europa.eu/environment/nature/ecosystems/docs/Green_Infrastructure.pdf. Accessed 27 Jan 2020
2. European Commission: The Forms and the Functions of the Green Infrastructures. https://ec.europa.eu/environment/nature/ecosystems/benefits/index_en.htm. Accessed 27 Jan 2020
3. European Environment Agency: Green Infrastructure and Territorial Cohesion. The Concept of Green Infrastructure and its Integration into Policies Using Monitoring Systems. https://www.eea.europa.eu/publications/green-infrastructure-and-territorial-cohesion. Accessed 27 Jan 2020
4. European Environment Agency, Signals 2019 - Land and soil in Europe: Why we need to use these vital and finite resources sustainably. https://www.eea.europa.eu/publications/eea-signals-2019-land. Accessed 27 Jan 2020
5. Flink, C.A., Sears, R.M.: Greenway: a Guide to Planning. Design and Development. Island Press, Washington, D.C (1993)
6. AssociazioneItaliana Greenway: Greenways: Concept and Definitions. http://www.greenways.it/definizioni.php. Accessed 27 Jan 2020
7. Howard, E.: To-Morrow: The Peaceful Path to Social Reform. Swan Sonnenschein & Co., London (1898)
8. Eisemann, T.S.: Frederick law olmsted, green infrastructure, and the evolving city. J. Plan. Hist. **12**(4), 287–311 (2013)
9. Ahern, J.F.: Greenways as a planning strategy. Landsc. Urban Plan. **33**, 131–155 (1995)
10. Lyle, J.T.: Regenerative Design for Sustainable Development. Wiley, New York (1994)
11. Ahern, J.F.: Greenways as a planning strategy. In: Fabos, J., Ahern, J. (eds.) Greenways: the Beginning of an International Movement, pp. 131–155. Elsevier, Amsterdam (1996)
12. Turner, T.: Landscape Planning and Environmental Impact Design. UCL Press, London (1998)
13. Fabos, J.G., Allan, J.J., Ryan, R.L.: Understanding opportunities and challenges for collaborative greenway planning in New England. Landsc. Urban Plan. **76**(1–4), 172–191 (2006)
14. Steadman, P.: The Evolution of Designs. Biological Analogy in Architecture and the Applied Arts, A revised edition. Routledge, New York (2008). (Original edition printed in 1979 by the Syndics of Cambridge University Press)

15. Sharma, A.: Decoding the genotype of greenway design thinking and practice: a steadmanian frame for systematic understanding, synthesis and tracking multidisciplinary discourse. J. Des. Res. **13**(2), 150–166 (2015)
16. Palmisano, G.O., Govindan, K., Loisi, R.V., Sasso, P.D., Roma, R.: Greenways for rural sustainable development: an integration between geographic information systems and group analytic hierarchy process. Land Use Policy **50**, 429–440 (2016)
17. Culligan, P.J.: Green infrastructure and urban sustainability: a discussion of recent advances and future challenges based on multiyear observations in New York City. Sci. Technol. Built Environ. **25**(9), 1113–1120 (2019)
18. Gambino, R.: Oltre la insostenibile periferia. In: Camagni, R. (ed.) La pianificazione sostenibile delle aree periurbane. Il Mulino, Bologna, pp. 179–203 (1999)
19. Checkland, P.: Systems Thinking. Systems Practice. Wiley, Chichester (1989)
20. Zonneveld, W.: Conceptvorming in de Ruimtelijke Planning. Patronenen Processes (vol. 1) and Encyclopedie van Planconcepten (vol. 2). PlanoloaischeStudues 9, Universiteit van Amsterdam, Amsterdam, Netherlands (1991)
21. Council of Europe: The European Landscape Convention. https://www.coe.int/en/web/landscape. Accessed 27 Jan 2020
22. Bull, J., et al.: Strengths, weaknesses, opportunities and threats: a SWOT analysis of the ecosystem services framework. Ecosyst. Serv.s **17**, 99–111 (2016)
23. Chan, K.M.A., et al.: Where are cultural and social in ecosystem services? A framework for constructive engagement. BioScience **62**(8), 744–756 (2012)
24. Daniel, T.C., et al.: Contributions of cultural services to the ecosystem services agenda. Proc. Natl. Acad. Sci. **109**(23), 8812–8819 (2012)
25. Larson, R., Keith, S.J., Fernandez, M., Hallo, J.C., Shafer, C.S.: Ecosystem services and urban greenways: what's the public's perspective? Ecosyst. Serv. **22**, 111–116 (2016)
26. Ehrlich, P.R., Ehrlich, A.H.: Extinction: The Causes and Consequences of the Disappearance of Species. Random House, New York (1981)
27. Ehrlich, P.R., Ehrlich, A.H.: Extinction, substitution, and ecosystem services. Bioscience **33**(4), 248–254 (1983)
28. Odum, E.P.: Ecology and our Endangered Life-Support Systems. Sinuaer Associates, Sunderland (1989)
29. Folke, C., Hammer, M., Jansson, A.M.: The life-support value of ecosystems: a case study of the Baltic Sea Region. Ecol. Econ. **3**, 123–137 (1991)
30. De Groot, R.S., Wilson, M.A., Boumans, R.M.J.: A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. **41**, 393–408 (2002)
31. Daily, G.C. (ed.): Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington D.C. (1997)
32. Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., et al.: The value of the world's ecosystem services and natural capital. Nature **387**, 253–260 (1997)
33. de Groot, R.S.: Functions of nature: evaluation of nature in environmental planning, management and decision making. Wolters-Noordhoff BV, Groningen (1992)
34. Fisher, B., Turner, R.K.: Ecosystem services: classification for valuation. Biol. Cons. **141**, 1167–1169 (2008)
35. Lyytimaki, J., Petersen, L.K., Normander, B., Bezàk, P.: Nature as a nuisance? Ecosystem services and disservices urban lifestyle. Environ. Sci. **5**, 161–172 (2008)
36. Lyytimaki, J., Sipilä, M.: Hopping on one leg. The challenge of ecosystem disservices for urban green management. Urban For Urban Green 8(4), 309–315 (2009)
37. Escobedo, F.J., Kroeger, T., Wagner, J.E.: Urban forests and pollution mitigation: analyzing ecosystem services and disservices. Environ. Pollut. **159**, 2078–2087 (2011)

38. Malcevschi, S.: Appunti di viaggio nell'interregno. Parole-chiave per non soccombere. StreetLib (2015)
39. Bryant, M.M.: Urban landscape conservation and the role of ecological greenways at local and metropolitan scales. Landsc. Urban Plan. **76**, 23–44 (2006)
40. Ahern, J.: Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design. Landscape Ecol. **28**, 1203–1212 (2013)
41. Lindesy, G., Maraj, M., Kuan, S.: Access, equity, and urban greenways: an exploratory investigation. Prof. Geogr. **53**(3), 332–346 (2001)
42. Larson, L.R., Keith, S.J., Fernandez, M., Hallo, J.C., Shafer, C.S., Jennings, V.: Ecosystem services and urban greenways: what's the public's perspective? Ecosyst. Serv. **22**, 111–116 (2011)
43. Paneerchelvam, P.T., Maruthaveeran, S., Maulan, S., Shukor, S.F.A.: The use and associated constraints of urban greenway from a socioecological perspective: a systematic review. Urban For. Urban Green. **47**, 1–20 (2020)
44. Xu, H., Plieninger, T., Primdahl, J.: A systematic comparison of cultural and ecological landscape corridors in Europe. Land **8**(3), 1–32 (2019)
45. Ryan, R.L., Eisenman, T.S.: Building connections to the minute man national historic park: greenway planning and cultural landscape design. In: Proceedings of the Fábos Conference on Landscape and Greenway Planning, vol. 6, no. 1, Art. 25 (2019)
46. Clark, N.E., Lovell, R., Wheeler, B.W., Higgins, S.L., Depledge, M.H., Norris, K.: Biodiversity, cultural pathways, and human health: a framework. Trends Ecol. Evol. **29**(4), 198–204 (2014)
47. Arneberger, A., Eder, R.: The influence of green space on community attachment of urban and suburban residents. Urban For. Urban Green. **11**(1), 41–49 (2012)
48. Little, C.: Greenways for American. Johns Hopkins University Press, Baltimore (1990)
49. Dunning, J.B., Borgella, R., Clements, K., Meffe, G.K.: Patch isolation, corridor effects, and colonization by a resident sparrow in a managed pine woodland. Conserv. Biol. **9**, 542–550 (1995)
50. Henein, K., Merriam, G.: The elements of connectivity where corridor quality is variable. Landsc. Ecol. **4**(2–3), 157–170 (1990)
51. Belknap, R.K., Furtado, J.G.: Three approaches to environment resource analyses. In: Angus Hills, G., Lewis, P.H., McHarg, I.L. (eds.) The Conservation Foundation, Washington DC (1967)
52. Meloni, I., Saba, C., Scappini, B., Zucca, V.: Improving regional accessibility through planning a comprehensive cycle network: the case of Sardinia (Italy). In: Gargiulo, C., Zoppi, C. (eds.) Planning, Nature and Ecosystem Services, pp. 859–868. FedOAPress, Napoli (2019)
53. Regione Autonoma della Sardegna: Rete ciclabile della Sardegna. https://www.sardegnaciclabile.it/. Accessed 27 Jan 2020
54. Mallus, M., Porcu, C.: Greenway guidelines. Master's Thesis, University of Cagliari, Faculty of Engineering and Architecture, Cagliari (Italy) (2017)