A landscape project for the coexistence of agriculture and nature: a proposal for the coastal area of a *Natura 2000* site in Sicily (Italy)

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Abstract

Many rural coastal Mediterranean areas suffer from great anthropomorphic pressure. This is due to intensive agriculture, and construction for residential, tourism and industrial uses.

The present work investigates the idea of using a landscape project in the Gulf of Gela in South Sicily to recover the dunes and the area behind them. The method used is based on the literature and will evaluate and interpret the dynamics of the landscape, so as to draw up a landscape plan, which can be used to help sustain the assets of the area, in a way, which is compatible with conserving nature. This method was tested in the *LIFE11-Leopoldia project*, funded by the European Union. The results of the study form part of the landscape project. This project is aimed at connecting the different productive zones in the area, protecting the natural environments and the rural historical patrimony, through combining the modern road networks with the older slower, historic infrastructure. Three different levels of landscape management are proposed: total protection (the dunes), high-level protection (the area behind the dunes where traditional agriculture is practised, buffer areas and ecological connecting areas), medium levels of protection (sustainable agriculture, *green* connections and ecological corridors). The key aims of the project are as follows: *transversality* - repairing the agricultural fabric and the relationship between the land and the sea; *sustainability* - recovering the environmental system and traditional activities; *flexibility* - agriculture with only minor environmental impact.

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Introduction

Those rural landscapes that have lost their original character (*i.e.*, those functional characteristics linked to maintaining biodiversity and agricultural production of food for humans) are among those, which require planned interventions (Brooker, 2002; Gabellini *et al.,* 2007; Rechtman, 2013). Many of these are on the outskirts of urban areas. They are areas where planning permission has been granted for urban buildings or which have been used for agriculture which is incompatible with the original agricultural environment (*i.e.*, intensive agriculture which puts biodiversity at risk) (Olea and Mateo-Tomás, 2009; Sciandrello *et al*., 2015) even though they are in areas which are part of the *Natura 2000 network* (European Ecological Network).

In Sicily the most striking example of a compromised landscape in the area of the ecological network is on the south coast, where, inside the larger area of the sites of community importance and *special protection area* of the region, important dune systems are used for greenhouses, with no long-term solutions being offered for these sites.

Important projects have been prepared for this area, in order to resolve the present contradictions in their use, and to reduce the risk of losing the remaining biodiversity. These activities began in December 2007, when the Sicilian Regional Authority for the Landscape and Environment, in order to create ecological networks, started redrafting the *management plan* for three sites. The task was given to the Italian League for Birds Protection (LIPU), the managing authority for *Biviera di Gela*, which coordinated the plan inside the site. Many of the actions in the management plan were related to requalifying the coastal landscape, seen as a specific *unified landscape,* where most of the previously mentioned ecological, structural and cultural imbalances were present. The many actions taken under aegis of the management plan in this area were designed to protect and connect the remaining natural areas, through actions aimed at creating new landscapes, which took into consideration the natural resources the historical agriculture and culture of the sites.

In the ambit of the LIFE Leopoldia project [LIFE is the European Union (EU) financial instrument supporting environmental, nature conservation and climate action projects throughout the EU] some of the initiatives planned had to be carried out over a period of three and a half years, from October 2012 to the end of April 2016.

The A2 action of the Leopoldia project is called: *Preliminary environmental, ecological and nature studies and research into the state of the dune habitat in the intervention area and identification of the pilot area*. At present a *master plan* has been produced which outlines a new way of identifying the landscape assets of the area. This takes into consideration the need to manage the biodiversity of the area, while

not excluding the possibility of using it for ecologically compatible agriculture. In this case the master plan is a landscape macro-project, and contains strategic suggestions that can be implemented over time through more detailed projects.

The pilot area was used in the past for typical agriculture and contained large unspoiled natural areas, but today there is a great deal of erosion of the soil and along the coast due to the creation of greenhouses, which are highly visible and have a great negative impact on the environment. In many cases this has resulted in the loss of the social and cultural values of the local population, through the abandonment of traditional agriculture and the resulting changes in the social and economic structure. Nature has also suffered, because the dunes and the areas behind them have been covered by greenhouses. Today activities are in operation, which are designed to recover the traditional agriculture and increase awareness of the local natural resources (Council of Europe, 2000; De Montis, 2014; Nassauer, 2012). Clearly all landscape projects need to pay great attention to these values (Riguccio *et al.,* 2015b; Russo *et al.,* 2014).

Many experts maintain that landscape projects are useful instruments for maintaining and giving added value to the specific environments, for re-qualifying degraded environments and for recovering ancient values and creating new ones (Leger *et al*. 2013; Von Haaren *et al.,* 2014). It must be mentioned that in the academic world landscape projects are seen as a process of scientific research in which multi-disciplinary fields work together in synergy to create the basis for giving form to the landscape, and that the method of research and the rigour with which it is employed in the project becomes itself a form of research into its effectiveness (Milburn and Brown, 2003; Lenzholzer *et al.,* 2013). Lenzholzer *et al*. (2013) state: *By* designing*, we mean the process of giving form to objects or space on diverse levels of scale and when we speak about 'design', we mean the results of a design process*.

According to Zagari (2006), the landscape project *…interprets and translates a context. Various interrelated and overlapping layers, each with their own structure and lifespan, are used in combination to define what, at a specific time and in a specific place, may be identified as a landscape. The planning contexts are increasingly hybrid and on different scales and represent all the aspects of a place, or part of it, and how it is identified and perceived by the local population. What is important is to know how to recognise and evaluate its potential, through the use of refined diagnostic and planning tools*.

This statement is in agreement with the role that the International Federation of Landscape Architects (IFLA) assigns to the landscape, and reconfirms that all those who plan and design urban and rural landscape projects at different times and in different places must base these on the natural characteristics of the areas and their historic and cultural value. To do this one must use aesthetic, functional and scientific methods and principles of management, with the appropriate use of both natural and artificial techniques and materials (Von Haaren *et al.,* 2014). The research is part of the LIFE Leopoldia project and is designed to offer government bodies responsible for the management of the area and landscape a body of knowledge and a strategic instrument, which will help them to develop policies for managing a sensitive rural area. This paper illustrates the method used to plan the landscape when drawing up the master plan. The method used could be a useful reference point, and applied in similar cases.

The first part of the paper, in *Materials and methods* section, describes the area, and highlights the areas, which form part of both the management plan and the LIFE Leopoldia project. The same section also describes the information used and where the data came from. It also outlines the steps of the method used. The results describe the master plan and the strategic guidelines of the actions to be taken. The last section is discussions and conclusions. Here the strong and weak points of the method, and the results obtained, are described.

Materials and methods

Study area

The area of the study, some 13 km^2, is in the south of Sicily, overlooking the Gulf of Gela. It is part of the *Natura 2000* site with the code ITA050012 and called *Torre Manfria, Biviere di Gela, Gela plain and the neighbouring marine area*. It includes an internationally important RAMSAR wetland, the *Biviere di Gela*, where various resident or migratory species live, nest, or pass the winter (Figure 1).

The area, although greatly affected by human activities, is a fundamentally important ecological unit because of the flora and vegetation found there (Brullo and Sciandrello, 2006) and also because of the fauna, which live there (Mascara and Sarà, 2007). *Leopoldia gussonei* grows in the area behind the dunes in the gulf of Gela. This endemic species is in danger of extinction and is included in Appendix II of the 92/43/EEC Habitat Directive, in the Red List of the International Union for Conservation of Nature (IUCN), and in the list of protected species of the *Convention on the Conservation of European Wildlife and Natural Habitats*, also known as Bern Convention (Council of Europe, 1979; European Commission, 1992; IUCN, 1994).

The dune area overlooking the sandy coast was entirely covered by Mediterranean maquis (shrubland) until the 1950s. It has been greatly interfered with and overgrown with exotic and other Mediterranean species from outside the area. Almost all of the native maquis species are extinct, especially near the coast. The dunes themselves have been affected by this and also suffer from the effects of human activities.

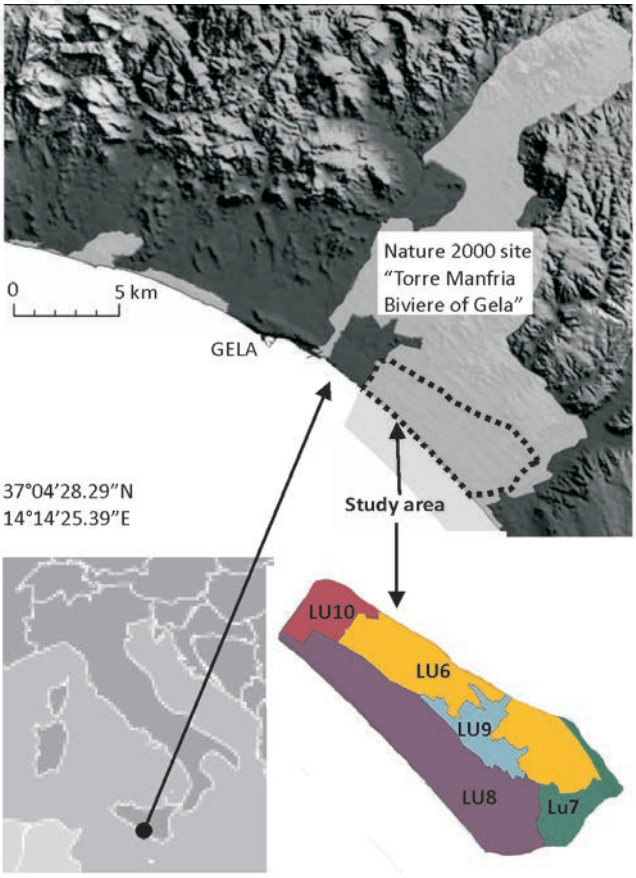

Figure 1. Identification of the area of the study.

Until the 1950s traditional agriculture was practised in the area behind the dunes but this has now changed to more intensive forms (greenhouses) and this is putting the remaining habitats at risk. It has also impoverishing the aquifer, endangering species hydrologically linked to the fragile system of the wetlands, and is also responsible for increased pollution with hazardous wastes (abandoned sheets of polyethylene).

There are highly visible and environmentally damaging human activities on the fringes of the area (industrial sites, oil wells, greenhouses illegal buildings, *etc*.). However there are also elements of notable historical and archaeological value (medieval monuments and villages, as well as many Greek and Roman archaeological sites), as well as agriculture (arable farming and artichokes on the Plain of Gela, the greenhouses and typical agricultural activities on the hills). Today, despite the widespread awareness of the environmental value of the area, human activities are increasing and it is possible that after a short time the remaining environmental assets may be lost.

The actions of the management plan and the LIFE Leopoldia project

Management plan

The management plan is a planning tool as described in Article 6 of the 92/43/EEC Habitat Directive (European Commission, 1992). The plan for the site was ready at the end of 2009, and was drafted in accordance with European, national and regional guidelines. The many actions laid out in the plan (199) are for the 15 land units (LU) (Russo *et al.,* 2011; Carullo *et al.,* 2013a) described in the plan itself. The actions are classified according to codes based on regional technical assessments. There are different numbers of actions in each class, identified by a number at the end of the code. Table 1 shows the actions considered necessary for redrafting the master plan (LIPU, 2009).

LIFE Leopoldia

The project was approved and financed by the European Commission in 2011. It was valid for a period of 42 months. The title of the project is: *Recovery of the dune environment in the greenhouse area of the Gulf of Gela, in order to protect* Leopoldia gussonei. The main objective is to recover and protect the local dune environment. The reference codes to *Leopoldia gussonei* are shown in Appendix A of the 92/43/EEC Habitat Directive (2110 embryonic mobile dunes, 2120 mobile dunes in the littoral corridor containing *Ammophila arenaria*, 2210 stable dunes along the coast containing *Crucianella maritima*, 2230 dunes with areas of Malcolmietalia, 2250* coastal dunes with Junipers) (European Commission, 1992). The specific objectives are to: i) increase the *Leopoldia gussonei* population and its habitat (2110, 2120, 2210, 2230, 2250*); ii) increase the ecological connections of the area; iii) improve the management of the dune environment and the area behind it; iv) recover the morphological system of the dunes; v) encourage the presence and nesting of birds and other protected species (the loggerhead sea turtle); vi) reduce the pressure of human activities on the dunes and encourage the development of sustainable agriculture.

The project is divided into 6 preliminary actions:
- *A*: these include *A2*, the redrafting of the landscape master plan;
- *B*: 2 actions, which investigate the availability of the land in the plan;
- *C*: 7 concrete actions;
- *D*: 3 monitoring actions;
- *E*: 10 actions to publicise the information;
- *F*: 4 project management actions.

Although the project is large and complex, the philosophy behind it can be summed up as follows: i) preserving the area where *Leopoldia gussonei* is present, identifying other potential areas where the plant can grow and establishing which areas are state owned land, as at present this is uncertain. Increasing the quantity of Leopoldia by establishing nurseries, increased planting and monitoring the effects in the field; ii) reducing the effects of agricultural activities and establishing suitable conditions for the coexistence of agriculture and Leopoldia. In other words, reorganising the agricultural and environmental activities

Table 1. Actions of the management plan included in the master plan.

Action code	Action
FRU_SIT_03_1	Improving the access to the coastal area
FRU_SIT_03_2	Creation of pedestrian paths to provide access to the beaches
NUO_HAB_15	Creation of protected areas along the banks
NUO_HAB_07_1	Insertion of buffer zones of indigenous vegetation in residential and agricultural areas
NUO_HAB_07_2	Creation of strips of vegetation perpendicular to the coastline
NUO_HAB_09_2	Insertion of buffer zones of vegetation along the railway lines
NUO_HAB_14_01	Planning and realisation of increases in temporary wetlands in the special protection area
NUO_HAB_15	Creation of areas to be respected along the banks
REC_PAT_02_1	Recovery of rural architecture
REC_PAT_04_2	Establishment of measures to mitigate the effects of protected agriculture
RIQ_HAB_03_2	Re-qualification of ecological corridors linked to the wetlands
RIQ_HAB_03_5	Creation of buffer zones along water courses
RIQ_HAB_04_01	Recovery of the main dune areas
RIQ_HAB_04_02	Recovery of the dune areas in the critical sites
RIQ_HAB_05	Farms that will be lost for food production
RIQ_HAB_08_3	Environmental recovery of contaminated soils
RIQ_HAB_08_12	Re-qualification and creation of natural environments in the Bivieri reserves (zones A and B)

in a particular lot to show that Leopoldia can coexist with agriculture; iii) ensuring that management and implementation of Leopoldia is based on sustainable social and economic development. Publicising the results of the project to the various agricultural and environmental actors and in schools. Establishing an environmental quality mark, which can be adhered to by farmers who change their activities to conform to the suggestions of the management plan of the LIFE project.

The drafting of the master plan is an essential part of indicating the role that the functional assets of the area must play in the near future, with the Leopoldia project only establishing the minimum necessary, while the much larger transformation of the area can only come about through the use of funds for the recovery of the environment (*environmental recovery plan, reclamation plan, regional operative plan, regional development plan*).

Actions of the management plan and the master plan

The area of the master plan includes all of LUs 8 and 9 and parts of LUs 6, 7 and 10 (Figure 1), laid out in the management plan. The actions of the plan are mainly designed to establish different types of *connectivity* between the remaining natural areas. They include: the establishment of vegetation systems on the margins of agricultural land and along the roads and rivers, the creation of infrastructures which will allow birds, animals and plants to pass artificial barriers such as roads (NUO_HAB_15, NUO_HAB_07_1, NUO_HAB_07_2, NUO_HAB_09_2, NUO_HAB_15); the creation of strips of wooded areas along rivers and roads or the protection of such areas from urban and industrial pressure (NUO_HAB_15, NUO_HAB_07_1, NUO_HAB_07_2, NUO_HAB_15, RIQ_HAB_03_2); the recovery of the original agricultural landscape; the removal or conversion of greenhouses; the recovery of structures, sites of biodiversity (dry stone walls, ruined buildings) (Carullo *et al.,* 2013b) (REC_PAT_02_1, REC_PAT_04_2, RIQ_HAB_03_2, RIQ_HAB_08_3, RIQ_HAB_05); the adaptation of the historic infrastructure to encourage tourism linked to ecologically sustainable agriculture (FRU_SIT_03_1, RIQ_HAB_03_2); the creation of actions to reclaim and recreate the habitats and the dune systems (NUO_HAB_15, NUO_HAB_07_1, NUO_HAB_07_2, NUO_HAB_14_01, RIQ_HAB_03_2, RIQ_HAB_03_5, RIQ_HAB_04_01, RIQ_HAB_04_02, RIQ_HAB_05, RIQ_HAB_08_3, RIQ_HAB_08_12) and the creation of infrastructures to allow access to the beaches (FRU_SIT_03_2).

The actions of the master plan, including the drafting of the project and the different types of actions, are shown in Table 1.

Materials

The *regional technical map* was used for drafting the project. This is from 2007/2008, in digital raster form with a resolution of 300 dpi, at a scale of 1:10,000. Google Earth from 2011 was also used (from the same period as the drafting of the master plan), as were aerial photographs from 2007/2008. The latter came from the WebGis of the Sicilian region, specifically designed by the region (http://www.sitr.regione.sicilia.it/webgisportal/default.aspx) in raster form with a resolution of 300 dpi at a scale of 1:10,000. The analysis of the landscape used information from GIS maps (ArcGis10; Esri, Redlands, CA, USA) for the landscape plan and the management plan for the *Natura 2000* area being studied. Information from field studies conducted in the first half of 2013 were also used. In addition information from historical photographs from 1938 were also used. These were in raster format at a resolution of 200 dpi. They were supplied by the Sicilian region when drafting the master plan, as were the historical Military Geographical Institute maps. These were available for the period 1867 to 1940 in raster format at a resolution of 300 dpi. Of particular relevance were: sheet 272 from 1867 at a scale of 1:50,000; Tables III and II south-east from 1940, both at a scale of 1:25,000. AutoCAD (Autodesk, Inc., San Rafael, CA, USA) and Photoshop (Adobe Systems, Inc., San Jose, CA, USA) were used when drafting the interpretative maps for the project, while ArcGis was used for inserting metric data from the plan into the maps.

Methods

The method used for drafting the landscape project took into consideration the consolidated scientific and technical information available (Countryside Agency and Scottish Natural Heritage, 2002; Mazzino, 2002). It was structured as follows: i) *phase 1*: identification of the problems of the landscape and outlining of the objectives; ii) *phase 2*: analysis; iii) *phase 3*: synthetic interpretation; iv) *phase 4*: drafting of the master plan.

Phase 1

A group of planning experts will be assembled (a landscape agronomist, a botanist, an architect, a group leader specialised in environmental protection who will represent those members of the population who are aware of the environmental aspects of the plan). The first task of the team is to identify the problems of the landscape and to outline the objectives of the project. In this phase the technical and scientific knowledge of each member of the team will enable them to identify the salient features and the landscape issues involved and to establish a preliminary framework of the area.

Phase 2

The research principally used the data from the landscape maps, integrating it with information from the field studies. The research consisted of: i) *evolutionary and functional analyses, which* were designed to grade the actions and interventions, the changes over time, and their reversibility or permanence in terms of the resources of the area. The information from historical and technical maps was used to do this. The most important information obtained from this was identifying those areas were the same as they were in the maps from 1867 and 1938/1940. The analysis was carried out for two time periods: 1867 to 2013 (data checked by filed studies) and 1938/1940 to 2013; ii) *analyses of the structure of the landscape.* This was done by studying the relationship between the components of the natural system (ecological corridors, value of the fauna and flora, permanence of non-intensive agriculture, habitat) and the *anthropic* one (various examples of the protected ancient historical heritage as defined in the regional territorial plan, use of the soil, settlements, viewing points and panoramic roads, permanent agriculture, biological permeability) (Giacomini and Romani, 2002; Mazzino, 2002); iii) *analyses of the aesthetic and visual characteristics* of the landscape. This was done using photographs and sketches, which conform to the instructions in the manual on landscape character assessment (Countryside Agency and Scottish Natural Heritage, 2002). This method, as well as others (Diti *et al*., 2015; Ramírez *et al*., 2011), are the indisputable reference points for the visual and perceptive analysis of the landscape (Observatoire virtuel du paysage Méditerranéen, 2007). Five viewing points were identified which were on the highest points of the terrain. These are emblematic: the first two face the Biviera and are suitable for observing the most pristine natural area, while the others face the sea and the area behind the dunes used for greenhouses. The following aesthetic aspects were taken into consideration: scale, borders of the various areas, amount of diversity, texture, forms, lines, colours, balance, movement, configuration (Countryside Agency and Scottish Natural Heritage, 2002).

Phase 3

This involved a synthetic interpretation of the results of the second

phase, in order to identify the pressure caused by human activities, and the productive and environmental potential of the area. The valuable elements and the quality of the landscape were identified from the various levels of analysis, in line with the guidelines established by the European Landscape Convention (Council of Europe, 2000), as well as those areas, which are degraded. The particular values were: the historical and cultural elements, deduced from historical investigation and analysis of the anthropic system; biodiversity, deduced from analysis of the natural system; the uniqueness, diversity and recognisability of the landscape, which was inferred from visual analysis.

Degrading elements were those, which affect the environmental integrity of the area and the quality of the landscape. These were: structures used for intensive agriculture (wells, open areas where all grass cover has been removed) and industrial plants, which were included in the area of analysis which considered the landscape from an aesthetic perspective. This allowed us to identify those areas in which the value of elements of the landscape and human activities were in conflict, and were thus areas of critical importance for the landscape (Zheng *et al.,* 2011).

A map, which synthesised this information, was useful for identifying those valuable or degraded areas which may be of importance when planning to recover the landscape and for social and economic development.

Phase 4

The master plan was drafted and the strategies for recovering the landscape were formulated. Based on the present state of the areas and the suggestions which emerged from the interpretative syntheses and the plans in force (general plans of the Gela district, environmental landscape plan, management plan), the functions of different parts of the landscape, and the planning ideas which spring from them, were identified and put into a framework. The form of the landscape (the project) was established by taking into consideration not only aesthetic, functional and management principles but also the need to maintain or establish biodiversity and high-quality agriculture. The latter factors were indispensable if the project was to be coherent with local development policies. The project was elaborated following the appropriate landscape architecture techniques and also the guidelines and strategies for interventions.

Results and discussion

Phase 1: identifying the problems of the landscape and outlining the objectives

The problems, which have already been described above in the description of the area, were caused by the great anthropic pressure in an area of great environmental importance. Without doubt this puts at risk biodiversity and the survival of autochthonous species in danger of extinction, such as *Leopoldia gussonei* (Sciandrello *et al.,* 2015).

The principles can be synthesised as follows: i) intensive agriculture (greenhouses) puts the remaining environmental assets under great pressure, and impoverishes the water resources and pollutes the water table; ii) mining quarrying and industrial activities on the margins of the area have a negative impact on the visual values of the landscape as well as increasing the pressure on the remaining environmental resources; iii) Lake Biviere, while it is still relatively undamaged in landscape and environmental terms, is under anthropic pressure from the construction of greenhouses; iv) although the area is still rich in resources, especially environmental ones, its cultural value and its potential for tourism is not sufficiently appreciated; v) the areas behind the dunes are completely covered by greenhouses, which use land, which are suitable habitat for *Leopoldia*.

Although intensive agriculture is used there are no support structures for marketing and giving value to the produce.

In order to deal with these problems, the project outlines the *future* assets of the landscape. These assets are an expression of the agricultural, cultural and tourist activities developed as part of general management of the environment, and are in particular related to the LIFE11-Leopoldia project. Thus, in order to improve the quality of the site, it is of primary importance to: i) re-establish a balance between human and natural factors; ii) manage the components of the landscape (natural elements, cultural elements, aesthetic and visual elements) so as to reconnect natural coastal areas with inland ones; iii) redefine the local development model so that it conforms with sustainability.

Phase 2: analyses

The cognitive analyses interpret the principal present characteristics of the area, the dynamics of changes, and the importance of the site holistically. They also identify the strong and weak points and areas.

Evolving and functional analyses

Historical analysis shows that in 1867 some 90% of the area was unspoilt nature and 10% was used for agriculture (arable farming and vineyards). In 1938/1940 the unspoilt area covered 60% of the total area and the other 40% was used for agriculture. In 2013 only 13% was unspoilt natural areas. In 2013 farms covered some 11%, or about 1.43 km^2, of the total area. In about 9%, 1.17 km^2, of the area the agriculture did not change from 1867 to 2013 (Figure 2A) (Russo *et al*., 2009).

Before the sudden development of greenhouses, the area consisted of dunes, which were sometimes almost thirty metres high: behind these was an area of Mediterranean maquis interspersed with small farms, which used dry farming techniques. There was also a large area of wetland, and in particular Lake Biviere. Today the area is largely covered by greenhouses (about 7.15 km^2 or some 55% of the area), which run down to the narrow and eroded beaches. This rapid and intense development, beginning in the 1980s, was for economic reasons, and it rapidly replaced other forms of agriculture, including small farms, as well as taking over wooded areas and levelling out most of the dunes. The extraordinary density of the greenhouses has had an increasing impact on the soil. They have not only destroyed the previous agriculture and natural assets, but in certain cases their height has also almost totally blocked views of the coast, which can no longer be seen from the public roads. The few roads leading down to the sea are hidden, difficult to use, and in bad condition.

Analyses of the structure of the landscape

The *natural system* describes the remaining natural areas. These are important for both flora and fauna and thus for conserving biodiversity. These strips of natural areas are found along the watercourses and in some small areas no longer used for greenhouses. There are some zones of reforestation with mainly local species. Although the dune area is now much reduced in size (0.65 km^2 or about 5% of the area), in it there are notably important habitats (Minissale and Sciandrello, 2015). The rivers and lakes that occupy 8% of the area (1.04 km^2) are equally important, as are the remaining uncovered areas behind the dunes. The latter provide ecological corridors, which connect different areas. They also cover some 6% of the total area (Figure 2B).

Analysis of the *anthropic system* shows that land is at present mainly covered with greenhouses (Table 2). This is also clear from the biological permeability map which shows how little of the land is suitable for

promoting biodiversity, and this itself is only found in the ecological corridors and uncultivated areas (Figure 2C).

There are still some rural buildings from 1867 and an archaeological site near Lake Biviere. One can still see two historic roads, which wind their way along the coast (Figure 2D).

These can be defined as *historic values* because they form part of the rural landscape and help to define its character. They may be economic resources, which will help environmentally compatible development. They have cultural value as examples of past building techniques and types of lifestyle, even when they are in ruins, and thus are useful elements in a possible ecological network (Jim, 1998; Mazzino, 2002; Riguccio *et al*., 2015a).

Analyses of the aesthetic/perceptive characteristics

The *scale of observation* from the two viewing points, which look over the Bivieri, is *large*, although limited by some dissonant areas

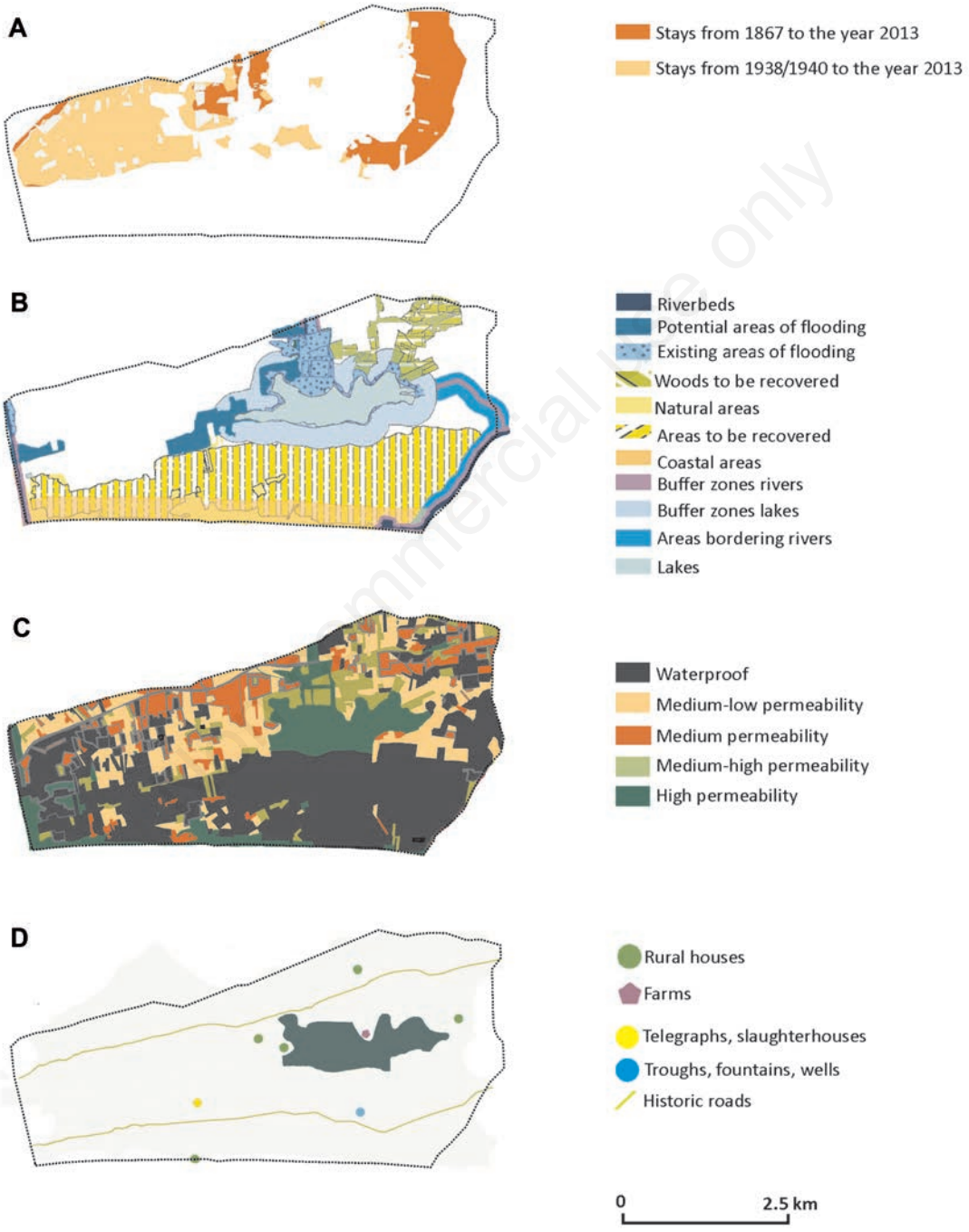

Figure 2. Some analytical maps: A) farm stays; B) ecological corridors; C) biological permeability; D) historic values.

near the edges (greenhouses). The *margins* are not clearly marked and discontinuous, with the exception of the area near water, which is thickly covered with Arundo donax. The *diversity* of the landscape can be categorised as *varied*, because of the richness and variety of the vegetation and as well as the presence of water. The *texture* varies from *uniform*, in the area near water, to *slight damage* in the reedy area, to *rough* in the area covered with Mediterranean maquis. The *form* of the area is determined by the flat sheets of water and the margins. The prevalent *lines* are the *sinuous* ones along the banks of the lake. The *colours* change with the seasons and are the result of the different amounts of sunshine. In general the components of the landscape (water, fields, maquis) are in *harmonious* equilibrium, and this does not change with the seasons. *Movements* are *quiet or calm*. Wind ripples the surface of the lake and ruffles the foliage, while local and migratory birds fly overhead. The *configuration* is *casual*, due to the dominant natural nature of the area (Figure 3A, Table 3).

The three viewing points, which face the sea, have a *vast scale of observation*. They look over a continuous expanse of polyethylene sheets from the greenhouses, which in certain places stand out against the remaining high dunes and can be confused with the sky or sea. The *margins* of the lots are tight but not clearly defined, as they are entirely covered by greenhouses. There is no *diversity* in the landscape and thus it is *uniform*. The prevalent *texture* is due to the slightly damaged fabric around the greenhouses. The *form* is *horizontal*. The prevalent *lines* are the straight ones of the greenhouses. The *colours* are *monochrome* clear grey because the greenhouses extend to the horizon. The *equilibrium* of the landscape is *dissonant* because the great contrast between the artificial greenhouses and the naturalness of the biviere and the remaining dunes is clearly evident. Movements are *calm* and in certain moments *absent* and are due to the occasional presence of vehicles. The *configuration* is the result of the *regular geometry* of the greenhouses (Figure 3B, Table 3).

Phase 3: synthetic interpretation

Evaluation of the landscape has identified the strong and weak points of the present assets of the countryside and the most sensitive and threatened areas.

The main strong points are: i) - there is still significant biodiversity and areas where Leopoldia is present, as well as other areas which may be suitable for planting it. These areas include the banks of Lake Biviere, and a few abandoned areas, where traditional agriculture is still practiced; ii) the nature reserve of the Biviere di Gela; iii) there is a dense infrastructure of secondary roads; iv) the greenhouses are only temporary structures; v) the dunes stretch continuously along long parts of the coast; vi) greenhouse use is in continuous decline, as can be seen from the great number of abandoned greenhouses.

The main weak points are: i) erosion of the dunes. The coastline has been eroded some 250 m in the last 50 years (LIPU, 2009); ii) the pressure of human activities on the habitat and on Leopoldia in particular; iii) absence of green areas among the greenhouses, given that at present the only areas not covered by greenhouses are the roads leading into the area and temporarily un-used lots; iv) the dune areas covered by greenhouses have become impermeable; v) pollution of the soil and air because of the use of chemical products and the presence of industrial plants nearby; vi) agricultural activities which are incompatible with the need to recover the natural state of the environment. These put pressure on the area by reducing the available water resources and contaminate the water and soil through the use of chemical products. There is also contamination from the plastic waste from the greenhouses, as well as the polyethylene containers used for vegetable growing. The most sensitive areas where human activities put the environment at risk and the others, where, by contrast, development might be possible are shown in Figure 4A. The areas at most critical risk are the massive spaces covered by greenhouses behind the dunes. The reasons for optimism are the survival of significant chains of dunes, the decline in greenhouse farming and the presence of Lake Biviere and other temporary wetlands, which are important sites of biodiversity.

Phase 4: project

The project proposes continuing agricultural activities, but in a form which is compatible with conservation, balancing production and protection (protection of the area, the values of the agrarian landscape

Table 2. Current land use, agricultural and natural historic stays.

	Land use		Historic stays (2013)	
	km²	%	km²	%
Greenhouses	7.15	55	-	-
Arable crops, olive groves, vineyards	3.38	26	2.60	20
Uncultivated lands, woods	0.78	6	-	-
Lake, water courses	1.04	8	1.04	8
Dunes	0.65	5	0.65	5
	13.00	100	4.29	33

Table 3. Aesthetic and perceptive characteristics of the landscape.

Parameters	Quality of the parameters				Viewing points	
					1-2 Lake Biviere	3-4-5 Sea
Scale	Very small	Small	Large	Vast	Large	Vast
Margins of the areas	Tight	Closed	Open	Uncovered	Open	Constricted
Amount of diversity	Uniform	Simple	Varied	Complex	Varied	Uniform
Texture	Smooth/Uniform	Slight damage	Rough	Very rough	Uniform, slight damage, rough	Slight damage
Form	Vertical	Inclined	Rolling	Horizontal	Horizontal	Horizontal
Lines	Straight	Angular	Wavy	Sinuous	Sinuous	Straight
Colours	Monochrome	Shimmering	Colourful	Gaudy	Shimmering	Monochrome
Equilibrium	Harmonious	Balanced	Dissonant	Chaotic	Harmonious	Dissonant
Movements	Absent	Quiet	Calm	Frenetic	Calm	Absent, calm
Configuration	Casual	Organised	Regular	Geometric	Casual	Geometric

and the peasant traditions, conservation of the soil) in such a way as to create a landscape which the local population can identify with.

Thus the strategies for achieving these objectives are essentially aimed at defining a landscape, which will break the impermeable barrier formed by the greenhouses parallel to the coastline, by creating corridors of vegetation at right angles to the coast. These will improve the natural resources and connect green areas and thus mitigate the loss of biodiversity and ensure that the visual aspects of the landscape improve (Fry and Sarlöv-Herlin, 1997; Arendt, 2004).

Recovering the green corridors which run along the watercourses are thus part of the project, as these are sites of remaining natural vegetation and potential replanting, and their development will eliminate the barriers which run along the coast and block the connections between the most pristine areas (*i.e.*, Lake Biviere and the sea).

The vegetation is important aesthetically and visually, provides biological connections and mitigates the impact of human activities (Junge *et al.,* 2015). Creating a network of vegetation is an efficient way of responding to the progressive reduction in biodiversity and the consequent degradation of the landscape (Klein *et al.,* 2015).

The vegetation system, both linear (strips of woodland, buffer zones, vegetation cover, rows of trees, hedges) and in blocks (agricultural areas, wooded maquis, isolated trees), can reinforce biological permeability and may improve the following aspects (Torreggiani *et al.,* 2014; Klein *et al.,* 2015): i) scenic - perceptive; ii) connectivity; iii) resilience; iv) protection of the most valuable habitats.

The ecological network overlaps others which are also involved in creating the landscape: historical and cultural networks, aesthetic and visual networks, productive networks.

Each of these is useful, but a stable situation can only be created if they are used together in an integrated way. This will result in an improvement in the quality of the landscape and the initiation of a virtuous circle of recovery and conservation (De Montis *et al.,* 2014a, 2014b; Riguccio *et al.,* 2015a).

One factor to bear in mind is that most of the existing greenhouses are in poor condition and inefficient. As a result they are uneconomic and restructuring of the activity is inevitable. Agriculture in the area is

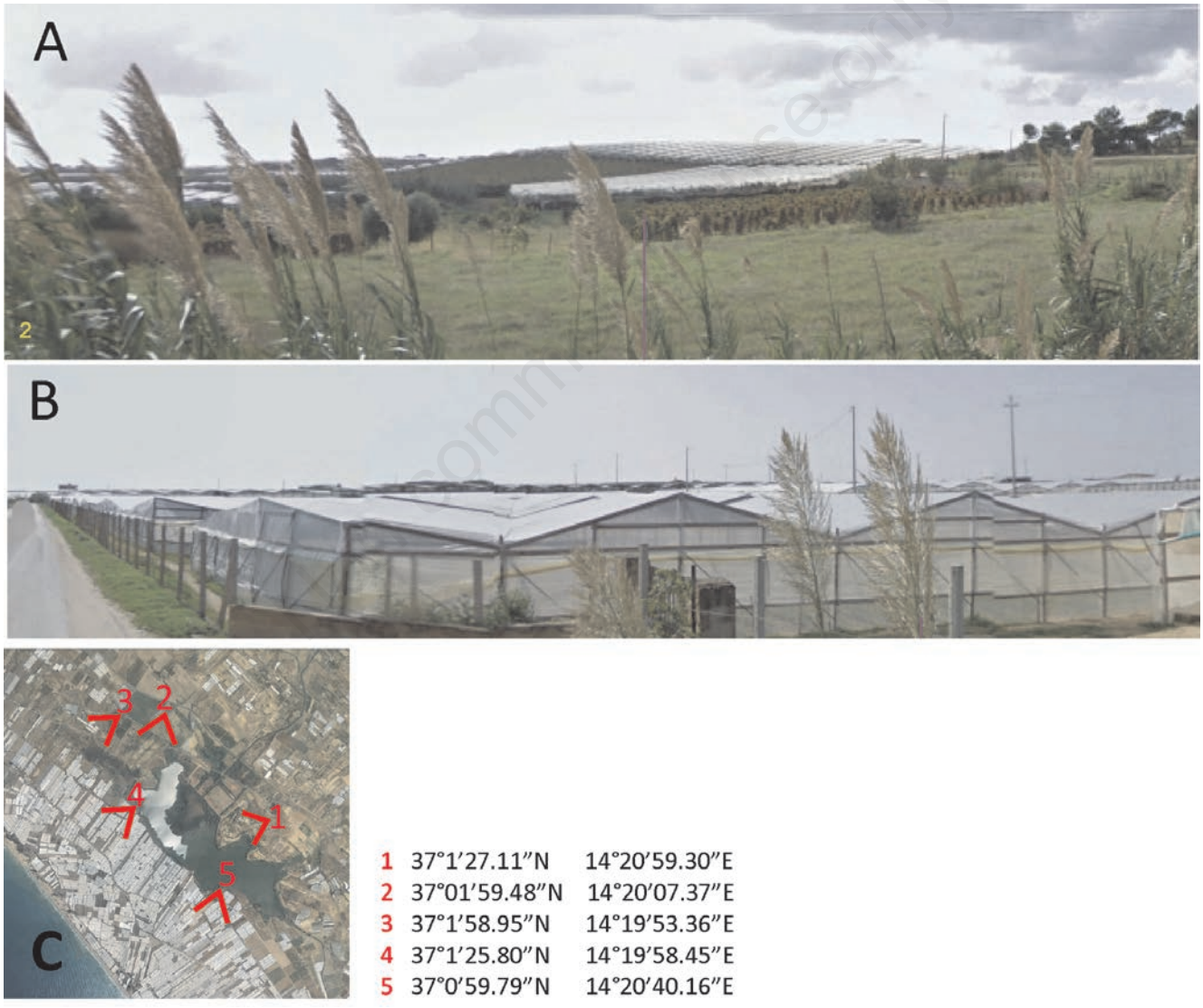

Figure 3. Aesthetic and perceptive analyses: A) one of the two viewing points which face Lake Biviere; B) one of the three viewing points that face the sea; C) viewpoints.

very vulnerable and new management models are required. As a result the present proprietors may be ready to give up their land or think about changing to sustainable agriculture. One can imagine combining such agriculture, aimed at the production of high quality products, with improvements in the environment, landscape and culture. This will increase tourism and recreational, scientific and educational activities in the area (Riguccio *et al.,* 2015b).

The project thus proposes to link together the types of production which form part of the local identity, the natural environments and the historic rural heritage, combining the present road systems with an older and slower system based on paths and trails which are at present not identifiable. This will make the area once more of value to the local population, to be used in different ways, but ones which are compatible with the ecological sensitivity of the area (Figure 4B).

Three different levels of landscape management are proposed (Figure 4C): i) protection-level 1 (absolute). These are the areas where recovery of the dunes is proposed and is already partly in operation under Actions C1, C3, C4 and C5 of the Leopoldia project (about 3.00

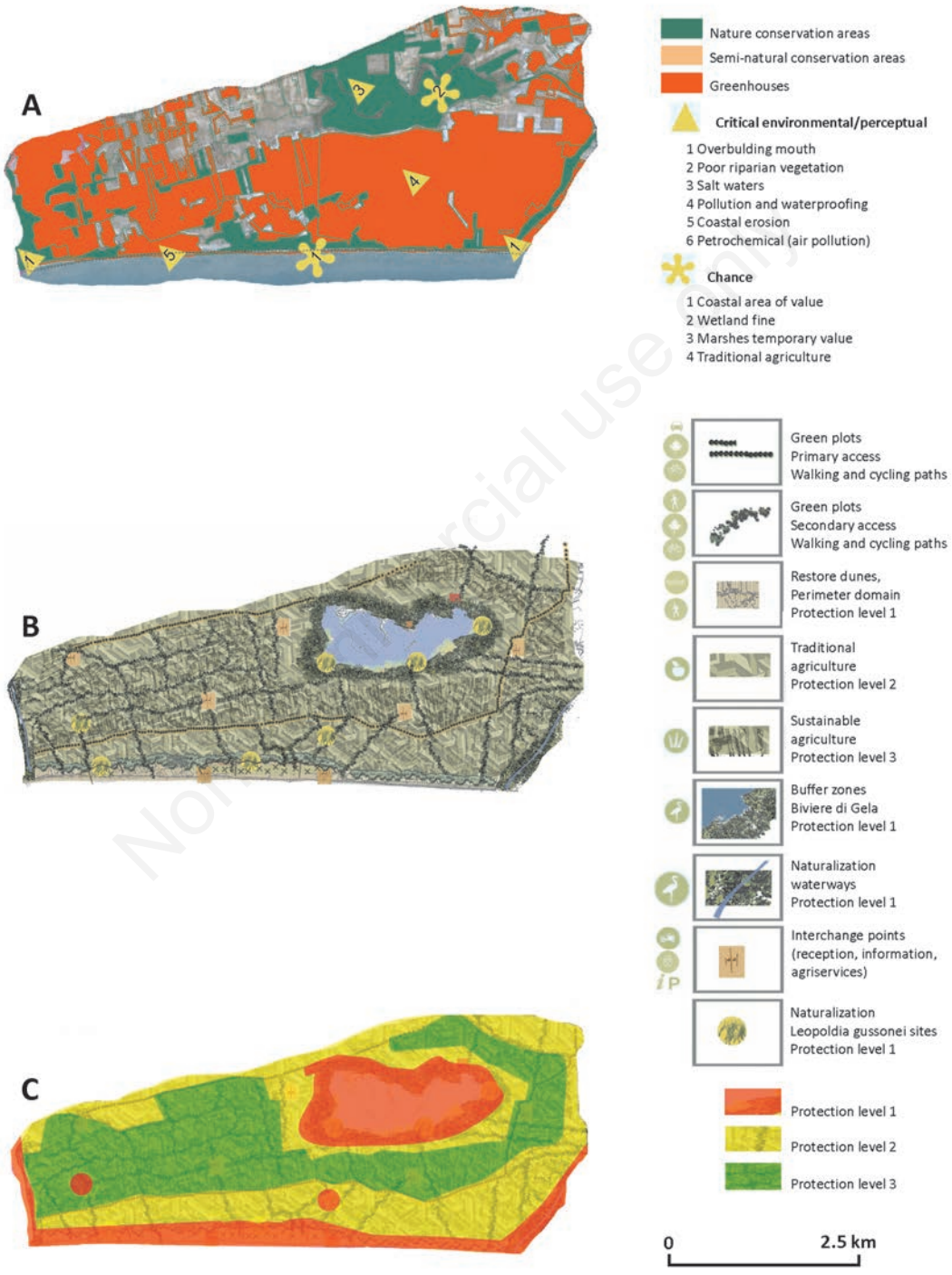

Figure 4. Synthetic interpretation and project: A) areas where human activities and the environment are in conflict and development possibilities; B) master plan; C) identification of the three levels of protection.

km^2); ii) protection-level 2 (high). These are the areas of the dune belt where the original traditional agriculture could be re-established. Action C5 of the Leopoldia project is an example of this (about 5 km^2); iii) protection-level 3 (medium). These are areas further away from the dunes where even greenhouse agriculture could be practised in accordance with the management plan as long as they were also ecological corridors (about 5 km^2).

The project will also allow the reduction of the area covered by greenhouses, eliminating them in protection-band 2 and reducing them in protection-band 3, where they will be reduced to a maximum of 10% of the surface.

Some 65 km of new ecological corridors (20 km parallel to the coast) may be created as part of the various networks, with each being at least 10 m wide. Various areas may be recovered, above all on the banks of Lake Biviere and in the area with protection-level 2, where *Leopoldia gussonei* is present. The guidelines for the master plan include recommendations that the farmers reserve part of their land for *Leopoldia*. This will allow the plant to spread and prevent it from disappearing.

The key words for the project are: *transversality*: re-establishment of the agricultural fabric and the relationship between land and sea; *sustainability*: recovery of the environmental system and of traditional activities; *flexibility*: agriculture with less environmental impact.

Conclusions

In conclusion, this paper has two merits. It presents a methodological approach and also the experience of an actual project.

The methodology has already been widely tested in the field of landscape architecture and has been found suitable. It allowed us to develop the research in the certainty that the proposed objectives would be easily attained. The holistic nature of analyses and the synthetic interpretation (from phase 1 to phase 3) may be a weak point in the method, because the results may be influenced by the subjective views of the planners, who may give more or less importance to the various components, depending on their cultural background and sensitivity to certain aspects of the plan. The project (phase 4) is thus by definition a *personal* processing of the data, which, while it is the result of knowledge and synthetic analysis of the data, has a precise composite form, depending of the subjective views of the planners (Milburn and Brown, 2003). This *subjectivity* is thus inserted into the process and so the quality of the plan depends on the competence and experience of the planners. The landscape architects should have multi-disciplinary skills, in order to reduce possible errors in analysis and evaluation. This is what the professional organisations in this field hope will happen, or else that all phases are dealt with by teams of specialists from different fields (ecology, engineering, architecture, economics, agronomy, *etc*.) (Leger *et al.,* 2013). Another way of reducing the subjectivity of the approach is to involve the local population, above all during the phase, which establishes the values and quality of the landscape (Southern *et al.,* 2011). It is to be hoped that this will emerge from the later detailed project.

The results clearly show that transformation of the landscape in the way suggested is only one possibility. However, given the very stringent surrounding conditions (the need to recover the chain of dunes and their characteristic habitats, re-establish the quality of the area behind the dunes through the use of agricultural techniques with less environmental impact, reconnect the natural areas, develop multi-functional activities in rural areas) (Estrada-Carmona *et al.,* 2014), the solution proposed may be the only one which meets the objectives (phase 1). There may be a certain degree of liberty in the assignation of the tasks, even though these are rigidly defined and greatly influenced by the above-mentioned surrounding conditions.

When the project is completed it will certainly completely change the present landscape, improving its environmental and visual aspects. The agriculture practiced will be compatible with the preservation of the natural landscape in general and of *Leopoldia* in particular.

The decisions taken at landscape level reflect the interaction between the managers and the users, and the particular interaction is directly related to the specific sites and depends on the biophysical and structural conditions and local and global social and economic factors (Pinto-Correia and Kristensen, 2013). All of these connections and interactions are expressed by the form of the landscape as a spatial entity. Thus re-establishing the quality of the landscape through a project means creating the basis for optimising the relationship between two types of *driver* - social, economic and cultural, and natural and structural - as indicated by Pinto-Correia and Kristensen (2013).

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