Co-funded by the Erasmus+ Programme of the European Union

Patronage
Parco Regionale
di Migliarino San Rossore
Massaciuccoli

Fieldtrip guide

LAND DEGRADATION AND REHABILITATION IN MEDITERRANEAN ENVIRONMENTS

Editors

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Serena Doni

Cristina Macci

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International Course

Pisa, Tuscany, Italy

11-23 March 2018

Co-funded by the Erasmus+ Programme of the European Union

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Preface

This field trip guide was developed for the needs of the training school in the framework of the ERASMUS+ LANDCARE project "LAND DEGRADATION AND REHABILITATION IN MEDITERRANEAN ENVIRONMENTS", which will take place inside the Natural Reserve of San Rossore, Pisa, Tuscany, Italy, from the 11 to 23 of March 2018.

The overall objective of the LANDCARE project is to improve training capacities in relation to Land Degradation and Rehabilitation (LD&R) in Southern Europe, in order to fulfill the demands of an emerging labour market and contribute to the green economy. LD&R is a field that requires training involving real study cases and hands-on experience. For this reason, the education path proposed in the project combines short-term international mobility and innovative online learning (PLEs, SPOCs).

The project is cofounded by the ERASMUS+ programme of the European Union.

Partnership: University of Santiago de Compostela (Spain); University of Athens (Greece); University of Lisbon (Portugal); Institute of Ecosystem Study-CNR (Italy); Centro invest. Forestales-Xunta Galicia (Spain); Archipelago (Greece); Empresa de Deselvolvimento e Infra-estruturas do Alqueva (Portugal); West Systems (Italy).

Program of the lectures and other activities

Time	Topic	Teacher
Sunday 11/03/2018	**DAY 1**	
	Arrival to Pisa- All students	
	Welcome and practical information	
19:00	Dinner at the restaurant "La Sterpaia"	
Monday 12/03/2018	**DAY 2**	
9:00-10:00	Presentation of the project and course	Roberto Pini (Director of CNR-ISE Pisa) Local organizer, Grazia Masciandaro (CNR-ISE) Antonio Perfetti (San Rossore Park)
10.00-11:00	Experiences from participant students of the training school in Spain and Greece	Pietro Bertolotto (course 2016) Cosimo Righini (course 2017)
11:00-11:30	break	
11:30-13:00	Student's presentations	
13:00-14:00	Lunch break	
14:00-17:00	Employability in Landcare (CV writing, Personal Branding, social media networking for career opportunities)	Antonella Magliocchi (UniPI)
19:00	Dinner	
Session: Contaminated areas		
Tuesday 13/03/2018	**DAY 3**	
9:00-9:30	Soil Contamination	Grazia Masciandaro (CNR-ISE)
9:30-10:00	Soil rehabilitation technologies	
10.00-11:00	The student's groups work together	Students
11:00-11:30	break	
11:30-13:00	Interactive teaching: Case studies on contamination and decontamination technologies	Students
13:00-14:00	Lunch break	

14:00-17:00	Practical activity outside	Serena Doni (CNR-ISE), Eleonora Peruzzi (CNR-ISE), Cristina Macci (CNR-ISE)
19:00	Dinner	
Wednesday 14/03/2018	**DAY 4**	
8:30-13:00	Fieldwork: Waste management company	Grazia Masciandaro (CNR-ISE), Ilaria Minardi (West Systems)
13:00-14:00	Lunch break	
14:00-17:00	Gas emission	Giorgio Virgili and Ilaria Minardi (West Systems)
19:00	Dinner	
Session: Wildfire		
Thursday 15/03/2018	**DAY 5**	
9:00-11:00	Wildfire: degradation processes and rehabilitation techniques	Agustin Merino (USC)
10.00-11:00	Interactive teaching: Case studies from your own country (wildfires)	Students
11:00-11:30	break	
11:30-13:00	Interactive teaching: Case studies from your own country (wildfires)	Students
13:00-14:00	Lunch	
14:00-17:00	Tour in San Rossore (bicycle)	Agustin Merino (USC) Antonio Perfetti (San Rossore Park)
19:00	Dinner	
Friday 16/03/2018	**DAY 6**	
9:00-12:00	Fieldwork: Wildfire (Monti Pisani)	Agustin Merino (USC) Andrea Bertacchi (UniPI)
12:00-13:00	Lunch break	
13:00-17:00	Fieldwork: Wildfire (Monti Pisani)	
19:00	Dinner	
Session: Coastal Erosion		

Saturday 17/03/2018	**DAY 7**	
9:00-10:00	Coastal systems	Anna Karkani and Nikolaos Sakellariou (NKUA)
10:00-11:30	The student's groups work together	Students
11:00-11:30	break	
11:30-13:00	Interactive teaching: Case studies from your own country (coastal degradation)	Students
13:00-14:00	Lunch break	
14:00-17:00	Laboratory: coastal erosion modeling	Anna Karkani and Nikolaos Sakellariou (NKUA)
19:00	Dinner	
Sunday 18/03/2018		
Teacher & Student interaction		
Monday 19/03/2018	**DAY 9**	
9:00-12:00	Fieldwork: Coastal erosion (Torre del Lago)	Anna Karkani and Nikolaos Sakellariou (NKUA)
12:00-13:00	Lunch break	
13:00-17:00	Fieldwork: Wetlands systems (San Niccolò)	Teresa Ferreira and Patricia Rodriguez-Gonzalez (Ulisboa), Nicola Silvestri (UniPI), Vittoria Giannini (SSSUP)
19:00	Dinner	
Session: Wetlands		
Tuesday 20/03/2018	**DAY 10**	
9:00-10:00	Degradation processes and rehabilitation of wetland ecosystems	Teresa Ferreira and Patricia Rodriguez-Gonzalez (ULisboa)
10.00-13:00	Interacte teaching: Case studies from your own country	
13:00-14:00	Lunch break	
14:00-17:00	Practical activity outside	Teresa Ferreira and Patricia Rodriguez-Gonzalez (ULisboa), Antonio Perfetti (San Rossore Park)
17:00-18:00	Project meeting	
19:00	Dinner	

Wednesday 21/03/2018	**DAY 11**	
9:00-17:00	**Invited speakers**	
19:00	Dinner	
Thursday 22/03/2018	**DAY 12**	
9:00-12:00	Entrepreneurship in land rehabilitation	Giorgio Virgili (West Systems, Italy)
	Student Experience	Pietro Bertolotto (EDIA, Portugal)
12:00-13:00	Lunch break	
13:00-17:00	Goodbye activity	
19:00	Dinner	
Friday 23/03/2018	**DAY 13**	
9:00-12:00	Conclusions and Diplomas of attendance	
	Travel back	

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Workshop
March 21, 2018

9:30 "Improving Resilience of Small Farmers in coastal Mediterranean marginal environments through sustainable use of saline water and plant resources"
Vincenzo Longo
Istituto di Biologia e Biotecnologia Agraria (IBBA)-CNR of Pisa

10:00 "Land degradation caused by wild boar (Sus scrofa) in the Cinque Terre National Park".
Alessandro Pistoia
Department of Agriculture, Food and Environment, University of Pisa

10:30 coffee break

11:00 "LIFE+ SEKRET Project"
Renato Iannelli
Dipartimento di Ingegneria dell'Energia, dei Sistemi, del Territorio e delle Costruzioni University of Pisa

12:00 "Green energy within Bioterra University students centres"
Nicole Livia Atudosiei
Bioterra University, Bucharest (Romania)

12:30 Discussion

13:00 Lunch

14:30 "HORIZON 2020 ECOPOTENTIAL Project"
Ilaria Baneschi
Istituto di Geoscienze e Georisorse (IGG)-CNR of Pisa

15:00 "LIFE+ Hortised Project"
Simona Pecchioli
Department of Agri-Food Production and Environmental Science - Section of Woody Plants University of Florence

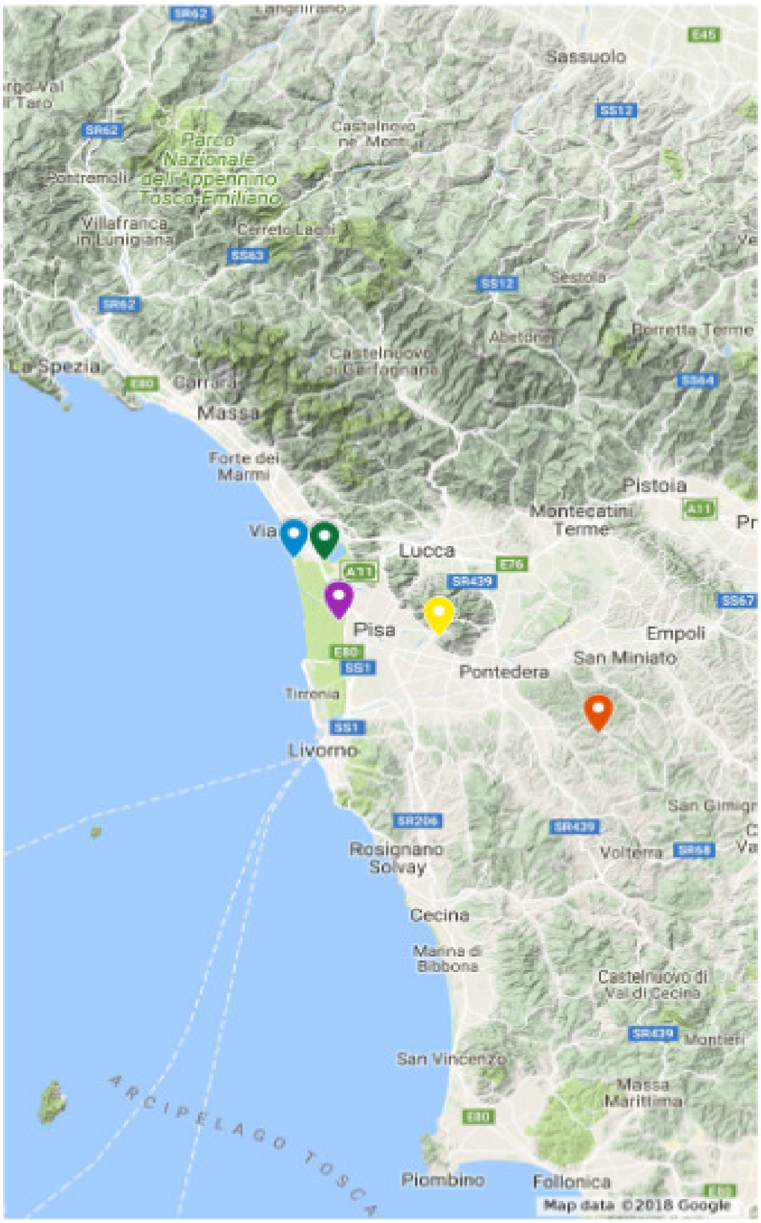
15:30 "Ongoing activities for the Massaciuccoli Lake restoration (IT)"
Vittoria Giannini[1] e Nicola Silvestri[2]
[1] Institute of Life Sciences, Scuola Superiore Sant'Anna di Studi Universitari e di Perfezionamento, Pisa
[2] Department of Agriculture, Food and Environment, University of Pisa

16:00 **Discussion and Conclusions**

field trip locations in Tuscany, Italy

field trip guide

- Vegetation at river
- Costal area
- Wetlands
- Wildfire
- Waste management



Introduction

Migliarino San Rossore Massaciuccoli Park

Migliarino San Rossore Massaciuccoli Park represents a unique environment for its charm and importance. Considering the growing demand for knowledge and natural life, it offers a quantity of information and didactic potentialities which is difficult to find in other places. With its 23,000 hectares, the protected area represents an important classroom in the open air characterized by the great variety of places among nature, art, and history.

According to the Park regulations for the so-called "Tenute storiche" (Historical Estates), a series of limited and specific sections have been set, to which it is possible to refer the whole territorial organization. As a matter of fact, each Estate is characterized by unique natural and architectural features, and for this reason it represents an aspect of the Park. Considered one by one, these aspects express a specific feature of the territory, but if you consider them on the whole, they form a "dialog" demonstrating that it is possible to find a number of diversities living together in an environment covering a rather limited surface.

The Park Authority feels the responsibility to play its own role within a pedagogic activity promoting continuous training: knowing what to do and how to relate to the environment and to others by the consolidation of values, emotions, and knowledge inspired by this territory.

Migliarino, San Rossore, Massaciuccoli Regional Park Authority

Migliarino, San Rossore, Massaciuccoli Park, after ups and downs and a long political, social, and cultural elaboration process (similar to the one of other national realities) was established with Legge Regionale Toscana n° 61 on 13th December 1979. It was one of the first regional parks to be established and the second in Tuscany after Maremma Park (established in 1975). The Regional Law L.R. n. 61/79 established that the Nature Park enclosed the territory and area under its jurisdiction, setting the aims and marking its borders (art. 1 and 2). Art. 3 determined and established the Park Authority: in this way the Consortium "Consorzio del Parco Naturale Migliarino, San Rossore, Massaciuccoli" was born, with the aim to temporarily manage and administer the Park.

San Rossore Estate

The Estate covers an area of 4,800 hectares. It represents the heart of the Park not only for its geographical position, but also for the richness of its environments and for its beautiful landscapes. It is delimited in the north by the river Serchio, in the east by Fossa Cuccia, in the south by the river Arno, and in the west by the Tyrrheanian Sea.

The coastal strip of San Rossore, in particular the central and northern area, houses the typical vegetal species of the Italian coasts, like the sea bindweed, the sea urchin, etc. The European beechgrass is particularly important: it is a plant of the Graminae family, necessary to the formation of the high coastal dunes. In this environment it is also possible to observe Oystercatchers, Curlews, Eurasian Rollers, and some species of Ducks, Gullies, and Solan Geese. In the adjacent areas it is possible to see fallow deer and wild boars, two typical species of ungulates living in the Estate.

The so-called "lame" (marshes) are situated in the southern part of the Estate, in the north of the river Arno. They lie in an area of about 400 hectares whose mainly herbaceous and shrubby covering gives tourists the possibility to enjoy a view going from the coast to the most inner woods and to the natural frame of Alpi Apuane. This coastal area is subject to seasonal floods and for this reason, except in summer, it houses thousands of birds, above all Ducks and Stilts, but also Cormorants, Gullies, and Herons. In this area it is possible to observe the unusual landscape while approaching rest areas provided with some observation huts for bird watching activities. The territory presents very different kinds of vegetation and soil. Depressed areas (such as the so-called "lame") and higher ones (the dunes) alternate up to the coast, and each of them has its own vegetation. The typical trees of the wetlands are English-oaks, poplars, ash trees, and alders, which often root directly in the water. Holm-oaks and stone pines can be found on the dunes. While you are visiting the woods, you may sight the Spotted Woodpecker and the Red Woodpecker.

Massaciuccoli Lake and Padule

The Massaciuccoli Lake and the surrounding swamplands, extending over more than 2,000 square kilometers, compose the widest wetland in Tuscany which originated in the area behind the dunes. Today the lake does not look as the ancient salty lagoon it was in the past, and it is considered a typical lake-pond due to its average depth of 2 m (the highest depth is 4.40 m) and the salinity lower than 500 mg/l. The lake bottom is situated below the sea level. It has a roughly circular shape with a perimeter of more than 10 km. The basin's surface has severely decreased in the last centuries due to the continuous reclamation works especially carried out in the 20th century.

Macchia Lucchese

In Macchia Lucchese there are several easily accessible roads and trails. The itineraries created in Macchia Lucchese give the opportunity to cross and discover two very significant environments of the Park of great naturalistic interest: the woodland and the coast. In the woodland, walking in silence among ilex trees, alders, ashes, English oaks, and stone pines, it will be possible to hear the pounding work of the woodpecker looking for food on the old pines and, crossing the backdune woodland areas, rich in maritime pines, phyllirea, strawberry trees, and juniper trees, we will reach the dune areas representing the largest, most complete and best preserved example of coastal vegetation. Thanks to the project "Life Natura Dune Tosca", backdune wetlands have been re-created: they are very important areas for migratory birds and for the reproduction of many species of amphibians. Moreover, exotic species and weeds, damaging the balance and biodiversity of this extremely delicate environment, have been eradicated.

Tombolo Estate

The Tombolo Estate, extending over about 5,000 ha, covers the southern coast of the Park, between the river Arno and the Calambrone area. For centuries it was property of the Church, and until the late 19th century it was characterized by high and dry areas alternating with low and swampy ones. With the arrival of the Savoy's family the necessary reclamation works were implemented, the pine forests were planted and the road system was fixed. The **trail of the three pines** in San Piero a Grado allows visitors to understand the different typologies of woody areas within the Park, both from the naturalistic point of view and through the memory of the ancient professions that for centuries have shaped the forest and allowed the locals to live, contributing to safeguard these environments until the present days.

WWF Oasis Cornacchiaia and Tirrenia Dunes

In the territory of Migliarino San Rossore Massaciuccoli Park there are two areas managed by the WWF Committee Oasi Litorale Pisano: **Cornacchiaia Woodland** and **Tirrenia Dunes**. They are two interesting sites both from a botanical and wildlife point of view: as a matter of fact, they both house the characteristic species of the Park, like the wild boar, the fox, the badger, the squirrel, the dormouse, the porcupine, the European pond turtle, the woodpecker, the jay, the bee eater, and several other birds. The **WWF Nature Sanctuary "Bosco di Cornacchiaia"** (Cornacchiaia Woodland) presents the classical vegetation distribution on the alluvial soils generated by river Arno. These soils present the characteristic alternation of "tomboli" and "lame", that is strips of sandy dunes separated one from the other by wetland depressions. The **WWF Oasis "Dune di Tirrenia"** (Tirrenia Dunes) was born in 1997 in collaboration with the Park, the Municipality and the Province of Pisa in a coastal area characterized by a luxuriant development of the Mediterranean maquis. In the strip next to the sea, it is possible to find the characteristic psammophilous species, including the particularly abundant and precious *Solidago litoralis*, endemic of the coast of upper Tuscany, while the backdune area is characterized by the rare silk vine, a plant very similar to the tropical lianas.

Coltano Estate

It is situated in the small rural village of Coltano, in the southernmost section of the Park, born from the great reclamation measures carried out over the years. It has an interesting geological formation and a rich history linked to the Medici family, the Lorena family, the Savoy family, and to Guglielmo Marconi. The whole area of Coltano offers a great variety of ideas to develop and thoroughly discover thematic didactic routes. Geology, history, nature, culture, and production activities represent the thread of the projects for the various school levels in the territory of Migliarino San Rossore Massaciuccoli Park.

Technical card of the Regional Park Migliarino San Rossore Massaciuccoli[1]

Antonio Perfetti – Regional Park MSRM

1. Land

The Park consists of the distal part of the Pisana - Versiliese plain (Tuscany, Central Italy). It is extended to about 23,000 ha (internal areas plus buffer zones) of which about 10,000 are forests, as many are farmland, about 2,500 are open wetlands, 350 are recent sandy beaches and dunes, then follow by the urbanized areas. It is a coast that is a daughter of the continuous supply of sediments by the rivers Arno and Serchio that in the historical times have guaranteed a coastline progression up to the half of the 800. After that period the coast was in erosion due mainly to the lower contribution of sediments from the Arno and Serchio basins. Broadly speaking, it can be said that the soils are mainly sandy (from neo and paleodune) and along the rivers are silty, clay or peaty (organic) in lowland of reclamation zones. It is perhaps today in Italy the greatest area of uninterrupted extension of dunes and paleodune.

2. Human history

Its most extensive hills (Isola di Coltano and Palazzetto paleodune) have been inhabited since prehistoric times, while the remaining territory, formed by lagoons with many tombolo, spits, sand islands and marshes, has not been inhabited until recent historical times. In fact, the coast was considered insecure due to malaria and floods. This allowed the development of a wild land up to the Middle Ages, when only in more internal land and at higher altitudes there was important settlements (eg Roman Pisa and Massaciuccoli). Afterwards the territory has been subdivided into large land properties, the estates, belonging to the church, to the family of the Medici first and then to the Lorena, the Borbone and the Salviati. Finally, only the land reclamation of the 30s of the last century lead to a marked increase in the number of inhabited settlements (eg Palazzi di Coltano and Torre del Lago) and the road infrastructures are likewise increased and paved.

3. Climate

The climate is Mediterranean: essentially hot and dry in summer and rainy and mild in winter. However, there is a marked decreasing gradient of rainfall from north to south due to the barrier effect of Apuan Alps in the northeast of the Park against the marine wet winds. Moreover, the slight slope of the plain and the recharge due to the mountain ranges of the Monte Pisano, the Monti d'Oltre Serchio and the Apuan Alps, makes the plain very rich in fresh water. These characteristics increase the contrast in terms of biodiversity (several warm-wet relicts of tertiary live together with quaternary - boreal and Atlantic climate species) and tree strong growth, compared to the usual Mediterranean biomes where dry summer create the conditions for slow growth of trees and for ecosystems with prevalence of sclerophyll shrubs.

4. Ecosystems

There are a few dozen habitats of conservation importance in the Protected Area. In an ideal transept between the sea, the beaches and the sand dunes, passing through the back-dune

[1] Natural Park in laws: Protected Area *sensu* L.N. 394/91 and L.R. 30/2015. ZSC sites of Natura 2000 network for habitat and species of priority and European concern for Habitat 92/43/CEE and Bird directives 147/2009/ECC, DPR 357/97 and DPR 120/2003.

wetlands and then arriving to the flooded forests and the arid ones placed on the dunal top, the main habitats include:

Tidal environments, beaches, Mediterranean and thermo-Atlantic flooded marshes, pastures and M. maritime dunes, halophile internal steppes and lagoon

1150*: Coastal lagoons
1210: Annual vegetation of drift lines
1310: Salicornia and other annuals colonizing mud and sand
1410: Mediterranean salt meadows (Juncetalia maritimi)
1420: Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetiea fruticosi)
1510*: Mediterranean salt steppes (Limonietalia)
2110: Embryonic shifting dunes
2120: Shifting dunes along the shoreline with Ammophila arenaria (white dunes)
2210: Crucianellion maritimae fixed beach dunes
2230: Malcolmietalia dune grasslands
2240: Brachypodietalia dune grasslands with annuals
2250: Coastal dunes with Juniperus spp.

Lentic water, acid peat bogs, limestone low marshes

3140: Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.
3150: Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation
3170*: Mediterranean temporary ponds
7140: Transition mires and quaking bogs
7150: Depressions on peat substrates of the Rhynchosporion
Reedbed (*Phragmition*)
7210*: Calcareous fens with Cladium mariscus and species of the Caricion davallianae

Forests of temperate Europe, Mediterranean deciduous and sclerophyll forests

91E0*: Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)
91F0: Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris)
92A0: Salix alba and Populus alba galleries
2260: Cisto-Lavanduletalia dune sclerophyllous scrubs
9340: Quercus ilex and Quercus rotundifolia forests
2270*: Wooded dunes with Pinus pinea and/or Pinus pinaster

5. Plants

There are numerous important species of plants that have viable populations in the protected area. Among them in the dunal habitats live Tyrrhenian endemisms: *Centaurea paniculata* Jersey knapweed, and the *Solidago litoralis* golden rod.

In the forests there are microthermal relict species such as the *Hypericum elodes* marsh St John's-wort together with wet-warm climate species of tertiary origin such as *Osmunda regalis* royal fern and *Periploca graeca* silkvine. In the wetlands boreal relict such as the *Sphagnum* spp. moss and *Drosera rotundifolia* round-leaved sundew share sites with the euro Siberian species such as the *Symphytum tanaicense* comfrey.

6. Animals

Among the animals there are over 1300 cited species of invertebrates and over 300 species of vertebrates. E.g. among the seabirds along the coast migrate the *Haematopus ostralegus* oystercatcher and winter the *Melanitta fusca* orco marino, the *Morus bassanus* northern gannet and the *Gavia stellata* red-throated diver while in the dunal habitats there are some specialized birds of the open areas such as the *Merops apiaster* bee-eater that nests in the prairies on compact sandy soils, the *Calandrella brachydactyla* greater short-toed lark, the *Burhinus oedicnemus* stone-curlew, the *Caprimulgus europaeus* nightjar that nest in back dunes habitats and the *Charadrius alexandrinus* kentish plover, that is a shorebird that nests on the beaches (fore-dunes). Among typical birds of the forests there are the *Sitta europaea* wood nuthatch, the *Dryobates minor* lesser spotted woodpecker, the *Accipiter nisus* sparrowhawk and the *Strix aluco* tawny owl. Between the groups that characterize the wetlands there are amphibian such as the *Bufo viridis* green toad, birds of reeds like the *Acrocephalus melanopogon* moustached warbler, the *Emberiza schoeniclus* common reed bunting and the *Circus aeruginosus* marsh harrier as well as the migrating terns, the wintering *Podiceps cristatus* great crested grebes, the ducks and the waders. Finally, in the agricultural areas spend most of the time the *Bubulcus ibis* cattle egrets, the *Pica pica* common magpie, the hooded crow *Corvus cornix*, but also the *Grus grus* common crane and the *Anser anser* greylag goose, divide their daily winter routine between the wetlands and the agricultural areas.

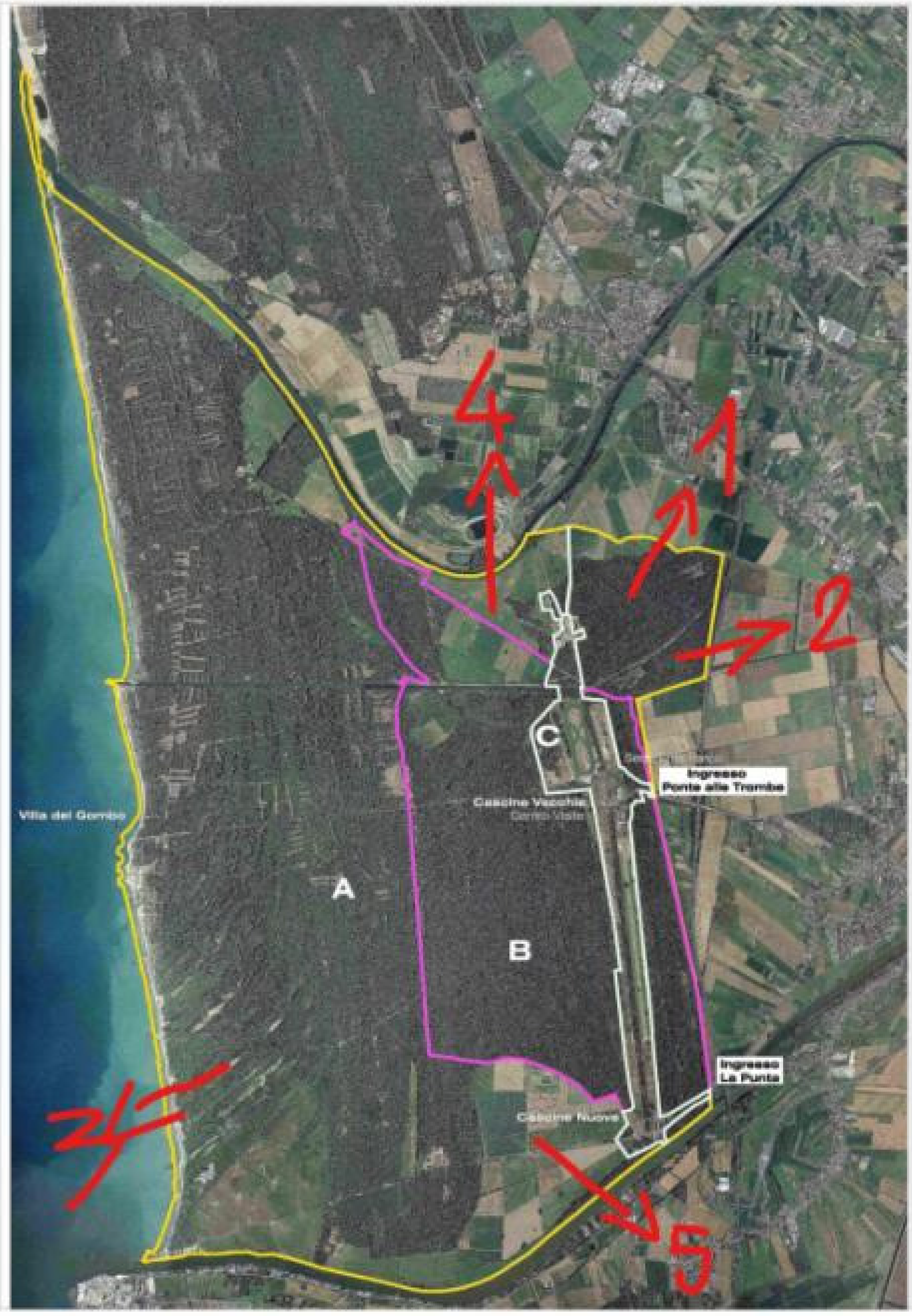
7. Conservation objectives

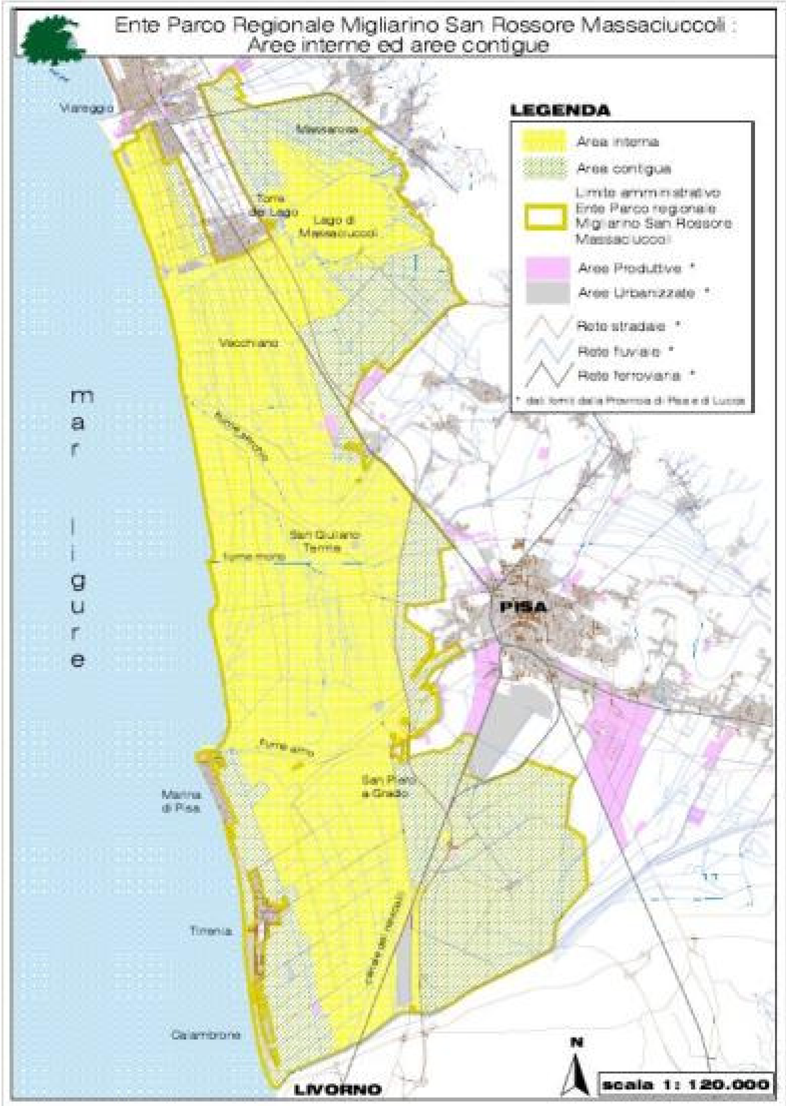
Among the main conservation objectives there are:
Maintenance of mature plain forests of oaks.
Preservation of the flooded forests of alders.
Preservation of reeds, calcareous fens, floating bogs of Sphagnum moss and free-floating communities of hydrophytes.
Conservation of back-dune, dunal and beach habitats.
Conservation of perennial vegetation of marine saline muds, and Limonium spp. steppes, and Mediterranean salt meadows.
Maintenance of domestic and maritime pine forest in semi-natural conditions for the conservation of an historical cultural landscape.

8. Main Threats

Overpopulation of fallow deer and wild boar.
Spread of exotic species.
Eutrophication of water due to agriculture in peaty areas (oxidation of organic matter), use of fertilizers and missing or ineffective water civil use treatments.
Habitat fragmentation and ecological barriers.
Erosion of the coast.
Salinization of the superficial water table.
Desiccation due to water deficit.
Land subsidence.
Wetland siltation, soil erosion.
Waste diffusion and chemical water pollution.
Over-trampling of dunes and beaches.
Mass tourism and military activities.
Tourist, sporting, military, technological and transport infrastructures.
Mechanized cleaning of the beaches.
Alteration of dune morphology for mechanized intensive silvicultural operations.
Mechanized cutting for the management of the vegetation of the channels.

Map 1. San Rossore Estate. Number show field trips and practical activities.

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Aree interne ed aree contigue
LEGENDA
Area interna
Area contigua
Limite amministrativo Ente Parco regionale Migliarino San Rossore Massaciuccoli
Aree Produttive *
Aree Urbanizzate *
Rete stradale *
Rete fluviale *
Rete ferroviaria *
Viareggio
Massarosa
Torre del Lago
Lago di Massaciuccoli
Vecchiano
San Giuliano Terme
PISA
San Piero a Grado
Marina di Pisa
Tirrenia
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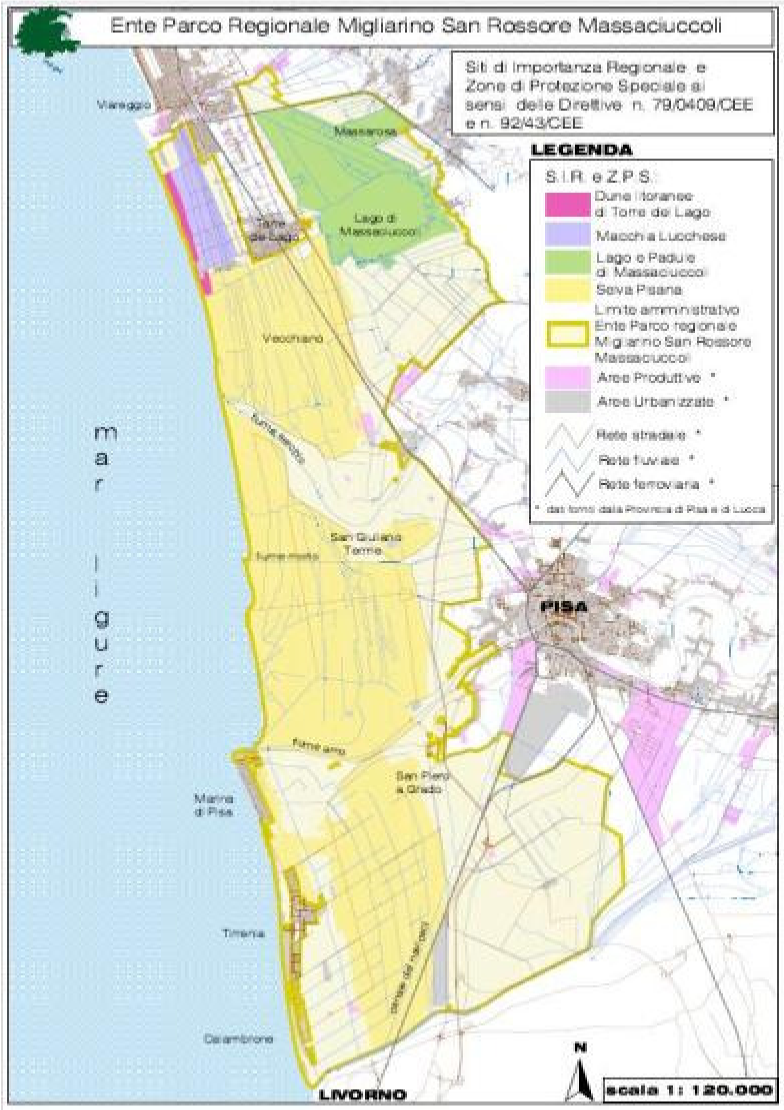
Ente Parco Regionale Migliarino San Rossore Massaciuccoli
Siti di Importanza Regionale e Zone di Protezione Speciale ai sensi delle Direttive n. 79/0409/CEE e n. 92/43/CEE
LEGENDA
S.I.R. e Z.P.S.
Dune litoranee di Torre del Lago
Macchia Lucchese
Lago e Padule di Massaciuccoli
Selva Pisana
Limite amministrativo Ente Parco regionale Migliarino San Rossore Massaciuccoli
Aree Produttive *
Aree Urbanizzate *
Rete stradale *
Rete fluviale *
Rete ferroviaria *
* dati forniti dalla Provincia di Pisa e di Lucca
Viareggio
Massarosa
Torre del Lago
Lago di Massaciuccoli
Vecchiano
mar ligure
San Giuliano Terme
PISA
San Piero a Grado
Marina di Pisa
Tirrenia
Calambrone
LIVORNO
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scala 1: 120.000

Practical activity outside 13/03/2018

Number 4 in map 1

Soil sampling in agricultural areas

Serena Doni, Eleonora Peruzzi, Cristina Macci

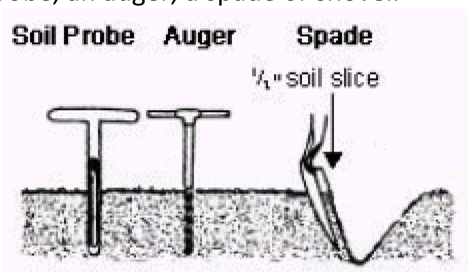
A large agricultural area along the Serchio (north border of San Rossore estate) of some hundreds of hectares maintain a large free grazing livestock populations of about 200-300 specimens. There are three breeds of Tuscan cattle: the Mucco Pisano, the Chianina and the Maremma cow; and two breeds of horses, one Tuscan, the Monterufolino and one Italian, the Tiro Pesante Rapido (TPR), both work breeds. The breeding has an organic address for some decades, aims at a complete self-sufficiency (closed cycle), and since last year is planned to arrive in the coming years to a natural diet for the whole year (grass fed) improving management of pastures. In this way, in addition to preserving these five rare local breeds of cattle and horses, we also aim to achieve the maximum environmental benefits such as: increasing biodiversity, better animal welfare, reduction of human work input, increase the store of soil carbon. In this way, free grazing breeding and grass feed livestock provides a concrete example of alternative techniques with low environmental impact for extensive farming.

Soil sampling

Beneficial results of a soil test depend on the availability of a good sample. The sample should represent the area from which it is taken from. A soil sample must be taken at the right time and in the right way. The tools used, area sampled, depth and uniformity of the sampling, information provided, and packaging are all factors influencing the quality of the sample.

How to Take Samples

- Use a soil-sampling probe, an auger, a spade or shovel.



- Tools should be either stainless steel or chrome-plated. Do not use brass, bronze, or galvanized tools because they will contaminate samples with copper and/or zinc.
- Mix soil cores for each sample in a clean, plastic bucket. If the bucket has been used to hold fertilizer or other chemicals, wash it thoroughly before using it for soil samples.

The advantage of the use of the corer is the fact that the user can sample a representative composite soil sample with a minimum soil disturbance. The user applies a pressure to the corer lower handle which penetrates the soil profile and upon collection; the removal of the core sample is done by pushing the plunger, releasing the content of the corer into the sampling bag.
This coring device allows to collect soil samples at various depths in sufficient quantity to perform an adequate analysis (a quantity varying between 1 and 2 kg is recommended).

The corer is almost mandatory in vegetation covered soils, as the spoons are highly not recommended in such situations. The corer cuts through the vegetation and reaches the soil with a minimum vegetation cover disturbance.

Sampling Depth

Collect samples to the same depth considered for plowed (usually about 30 cm) because this is the zone in which fertilizers have been incorporated.

Where to Take Samples

When collecting samples, avoid small areas where the soil conditions are obviously different from those in the rest of the field—for example, wet spots, old manure and urine spots, places where wood piles have been burned, severely eroded areas, old building sites, fence rows, spoil banks, and burn-row areas. Also the fertilizer bands in fields where row crops have been grown should be avoided. Because of the samples taken from these locations could not be typical of the soil in the rest of the field, including them could produce misleading results.

- Areas within a field where different crops have been grown in the past should be sampled separately, even if you now plan to grow the same crop in the whole field. Areas that have been limed and fertilized differently from the rest of the field should also be sampled separately. Each sample should represent only one soil type or area—for example, bare or vegetated area. For each unique area, take at least six to eight samples. Place all the samples for one unique area in a plastic bucket and mix thoroughly. Use the mixture in the bucket to fill a soil sample bag about two-thirds full.
- If the field you are sampling contains areas that are obviously different in slope, color, drainage, and texture, etc. submit separate samples for each area.

Within any soil there is an inherent variability in physical-chemical and biological properties. The degree of variability differs according to numerous factors, including the size of the area, the management and the soil type. These factors can produce spatial variability that is considerably larger than that encountered in other media.

When to Take Samples

Collect samples three to six months before remediation time. You will then have the test report in time to plan your remediation program. If you submit samples immediately after harvest in the fall, you are likely to receive the results promptly because the laboratory workload is lighter at that time than in the spring. If possible, try to collect your samples at the same times every year, or if the samples are taken in different period of the year, please take into account the season effect.

Do not collect samples when the soil is too wet because it will be difficult to mix the cores. As a rule, if the soil is too wet to plow, it is also too wet to sample.

How Often to Sample

Six months are necessary to soil for reaching a new state of equilibrium after a remediation strategy application, so that after the characterization sampling, the first monitoring sampling should be done at least after six months from the beginning of the experimentation.

Submitting the Sample

Procedures for sampling operations will be carefully documented. Careful documentation during sampling is required so that all relevant information on the nature of the sample (when it was taken, where it was taken and under what conditions it was taken) will be clearly recorded on site at the time of sampling by the person conducting the sampling. This is necessary because variations in sampling procedures can have a marked effect on the results of analysis.

Sample receipt, storage and disposal

Almost as important as proper sampling, is the proper storage of samples prior to analysis. It is important to ensure that the passage of a sample through the laboratory's analytical systems is fully documented, and corresponds to the practices laid down in the relevant Standard Operating Procedures. Equally important are the arrangements for disposal of samples. The sample should be logged in and stored in such a way as to minimize its deterioration. The condition of each sample and its storage location should be recorded and, where appropriate, the analyses to which it is to be subjected should also be recorded.

Field trip 14/03/2018

Waste management

Grazia Masciandaro (CNR-ISE), Giorgio Virgili and Ilaria Minardi (West Systems)

Legoli landfill (Belvedere SpA) is the public/private company that since 1997 manages the waste disposal plant in the municipality of Peccioli near Pisa. The core business, in addition to the waste disposal activities, lies in the production of energy from renewable sources, both solar and wind power. Also of interest are the activities of promotion and development of the municipal territory and its economy, including farming and related activities.

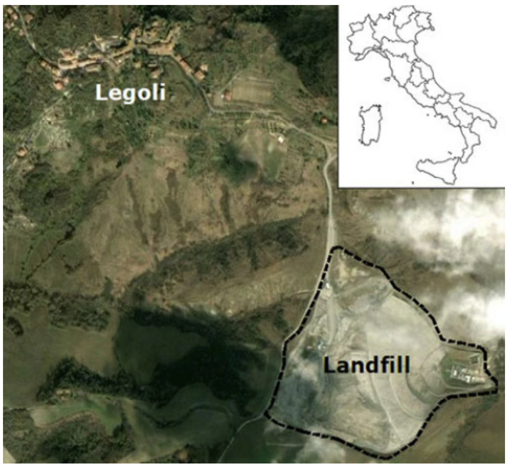


Fig. 1 Ubication of Legoli landfill

Landfill history

From 1988 – In 1988 there was in Peccioli a non-managed landfill receiving waste from six local municipalities. Then, despite the public opinion claiming for the closing of that dump - even if the provincial plan provided for at least one waste disposal plant in one of those municipalities – the

Municipality rejected this protesting attitude and consciously chose the road of environmental protection: decontamination and enlargement of the old dump, putting new volumes in the service of the environmental emergency of the whole Tuscany Region.
In Peccioli the citizens' distrust brought out during the 1980s a real "NIMBY syndrome", which was overcome thanks to a transparent policy of information and administrative responsibility. In the waste disposal plant was installed a system for the reuse of biogas producing **electric power** to be sold to the national grid and **thermal power** to be used both for the treatment of leachate and the **district heating** of the near village of Legoli. During the years Belvedere has been more and more involved in the energy production from renewable sources: an anemometric survey has been in place for some months to ascertain the feasibility of a **wind power plant** upon the waste disposal plant area, while 4 mini wind turbines are already in place and producing electric power.
Thanks to the correct environmental management and the good relationships with the inhabitants and the public opinion, the Province of Pisa's Administration has singled off Peccioli's plant as a pillar of the general plan in the area; that's why a new enlargement of the plant has been completed, in order to fulfil the Province's plan's requirements.
The waste disposal plant has been active for over twenty years; it encompasses an area of about 25 hectares and receives up to 1,000 tonnes of waste each day, 300,000 tonnes a year, from the provinces of Pisa, Florence, Prato, Lucca, Livorno and Massa Carrara. Nowadays the Tuscany Region identifies this plant as of regional interest, providing for it in the regional plan for waste and polluted sites decontamination.

The uninterrupted attention towards the environmental issues, in such a touristic area as this, led up to two important achievements: the Orange Flag – quality trademark assigned by the Italian Touring Club – for the Municipality of Peccioli and the prestigious European EMAS (Eco-Management and Audit Scheme) for Belvedere's plant.
Alongside the care for the environment it has been developed an economic course that enabled first the Municipality of Peccioli and then Belvedere S.p.A. to reinvest on our territory the wealth produced, creating a proper development system under every aspect: economy, innovation, employment, art, culture, solidarity and territory's reclamation.

Landfill economic system – Belvedere S.p.A. is today a company with an estimated value of 60 million euro and a net asset value of about 40 million euro; in over 15 years of activity it produced 200 million euro of sales proceeds and, what is more important, the vast majority of these resources remained in our territory, generating value.
It is relevant, therefore, the role that Belvedere is playing in this moment of severe crisis for both economy and employment. A recent study shows how our system grants, directly or indirectly, jobs for about 290/340 people: of these, we can easily identify and "look in the eye" at least 90 people working in activities that couldn't have existed without the company.
Moreover, Belvedere gave fields for free to 80 families that use them as vegetable gardens: these fields are located partly in the area of the solar power plant "An Hectare of Sky" and partly inside the great farm "Le Serre". To these families we must add 30 other families to which we have given for free 3,000 olive trees inside "Le Serre": they tend the trees and keep their fruits.
The Municipality of Peccioli gains from all these activities a big economic return, so managing to maintain low fiscal charges and giving its citizens many other advantages in services linked with school, entertainment, cultural activities, public works and didactic and formative projects.

Formative partnerships – Since 2011 Belvedere S.p.A. is committed in extra school education for both the young and senior people in the area, through free masters aiming towards the

enhancement and development of the individuals' personal skills, in order to increase their competitiveness and give them useful tools to approach the world of work.
There is a long time standing partnership with the Sant'Anna school in Pisa, started years ago by the Municipality of Peccioli for the project on the automated house and later continued by Belvedere with specific projects such as "DustBot", a robotic system for waste separation, and other robotic systems born from creativity and innovation. Belvedere also partnered with the National Council of Researches in Pisa to promote research and experimentation linked with the waste management chain, particularly thermography of emission areas. Belvedere is in partnership also with Legambiente and the Italian Environment Fund to safeguard the artistic and naturalistic assets in Italy.

An exportable model – This organization is so peculiar that it attracted the attention of international entities such as UN and OECD, which took it as a model of a virtuous experience to be presented to other territories as a repeatable example.
During the years the various **partnerships** helped to give birth to many specific publications:
"The possible utopian" by Antonio Preiti, Stefano Fantacone and Piero Pierotti. Foreword by Giuseppe De Rita. Edizioni Plus (2003).
"Pecciolo Vs. Talquale, the rubbish monster" (2003) and "Pecciolo and Talquale and a flag for the environment" (2007) by Sergio Staino. Panini Editore.
"Waste and development. The virtuous case of the Peccioli System" by Nadio Delai. Foreword by Innocenzo Cipolletta. FrancoAngeli Editore (2009).
"Planning, discussing, doing – the experience of Peccioli, a Tuscan organization creating wealth from the bottom up" by Roberto Sbrana and Alessandro Gandolfo. FrancoAngeli Editore (2012).
"20th Belvedere Spa" by Nomisma Spa (2017). Twenty years of Belvedere's activity.

Practical activity outside 14/03/2018

Gas emission monitoring

Giorgio Virgili, Ilaria Minardi (West Systems) and Grazia Masciandaro (CNR-ISE)

Landfill gas tends to escape from the landfill surface even when gas collecting systems are installed. Since gas leaks are generally a noticeable percentage of the total production of landfill gas, the optimisation of the collection system is a fundamental step for both energy recovery and environmental impact mitigation.

*Studies aimed at obtaining a quantitative estimation of the fluxes of volatile compounds are necessary both to assess a more comprehensive evaluation of the impact of landfill gases on air quality and to better define the environmental risk due to landfill gas production. The lack of data on gas emission rate and composition from landfills also prevents any comparison among different waste management technologies and the related environmental impact (**Raco et al., 2010**).*

The **Westsystems fluxmeter** is a portable instrument for measuring soil fluxes directly on the field. The system is based on the accumulation chamber method.
The instrument allows the evaluation of a wide range of soil gas fluxes: CO_2, CH_4, H_2S, VOC; other gas species can be added to suits the needs of the customer. It's possible to add a soil probe for measuring temperature, humidity and conductivity.

- The Methane Detector, based on the innovative **Tunable Diode Laser Absorption Spectroscopy (TDLAS)** technology combined with a Herriot multi-pass cell, allows a low detection limit (100 ppb).

- **Portability**. The portable fluxmeter is smaller, lighter and has a lower energy consumption than instruments based on FID technology. Furthermore, only one operator is needed for operating our instrument in the field.

- The Infrared analysis does not destroy the sample as the FID Technology does. Therefore, our instrument can re-inject the sample in the accumulation chamber using a smaller accumulation volume, optimizing the measurement time.

- The instrument is able to perform around **80 measurements per day**, which allows to draw a precise and accurate isoflux map by using kriging technique and to estimate the total output of the study area.
- Real-time concentrations reading: this allows the verification of appropriate accumulation and/or measurement optimization time.
- Automatic **georeferencing** of the measures, which accelerates the geostatistics post-process.
- Extreme versatility. The instrument detects diffuse emissions of several gas species.

The portable fluxmeter is able to measure:

- CO_2, CH_4, H_2S, VOC diffuse flux from soil by means of the accumulation chamber method.

- Soil temperature and water content
- Temperature, humidity and barometric pressure inside the accumulation chamber.

Field of application

- Monitoring of CO_2 emissions in Carbon Capture and Storage (CCS) sites

  Carbon capture and storage (CCS) is the process of capturing waste carbon dioxide (CO_2) from large point sources, such as fossil fuel power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation. The aim is to prevent the release of large quantities of CO_2 into the atmosphere (from fossil fuel use in power generation and other industries). It is a potential means of mitigating the contribution of fossil fuel emissions to global warming and ocean acidification.
- Monitoring of natural gas storage sites

  Natural gas storage is principally used to meet load variations. Gas is injected into natural oil reservoirs used as storage during periods of low demand and withdrawn from them during periods of peak demand.
- Survey of landfill biogas emissions;
- Volcanic surveillance;
- Geothermal exploration;
- Evaluation of soil respiration;
- Environmental monitoring.

Case study: Gas emission at the Landfill of Legoli

From May 2004 to January 2009, 11 soil gas emissions surveys have been carried out at the landfill of Legoli (Peccioli municipality, Pisa Province, Italy) (Raco et al., 2010).

The size of the sampling grid is a critical point due to the great spatial variability of gas flux values. The correctness of the sampling grid can be checked only a posteriori on the basis of the spatial structure (variogram) of gas flux data and the analysis of the variation coefficient (ratio between the standard deviation and the mean value). To reconcile data representativeness with the time needed to map the entire landfill, flux measurements were carried out over a regular grid of about 20 × 20 m covering the entire landfill surface, apart from the active disposal area.

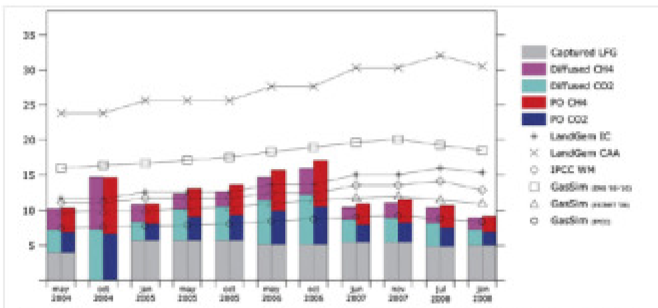


Fig. 4 Comparison among output of numerical production models and results obtained with direct measurements of flux. *PO CO_2* pre-oxidation CO_2, *PO CH_4* pre-oxidation CH_4, *Landgem IC* Inventory Conventional, *Landgem CAA* Clear Air Act, *IPCC WM* waste model, *EN '00–'10* GasSim England 2000/2010 waste fractionation, *EIONET 08* GasSim EIONET 2008 waste fractionation, *GasSim IPCC* GasSim with IPCC WM waste fractionation

The comparison among the outcomes of numerical production models (**LandGem** v3.02, USEPA 2005; **IPCC** waste model IPCC 2006; and **GasSim** Lite 1.54, Gregory et al. 2003) and the results of direct flux measurements highlights that no model can directly respond to any sort of remedial works or waste management changes, whereas direct measurements are sensitive to different kind of operations carried out on the "landfill system" (in October 2004 the capturing system was at rest).

Raco Brunella, Battaglini Raffaele and Lelli Matteo. Gas emission into the atmosphere from controlled landfills: an example from Legoli landfill (Tuscany, Italy). Environ Sci Pollut Res (2010) 17:1197–1206

Field trip 15/03/2018

San Rossore park (bicycle)

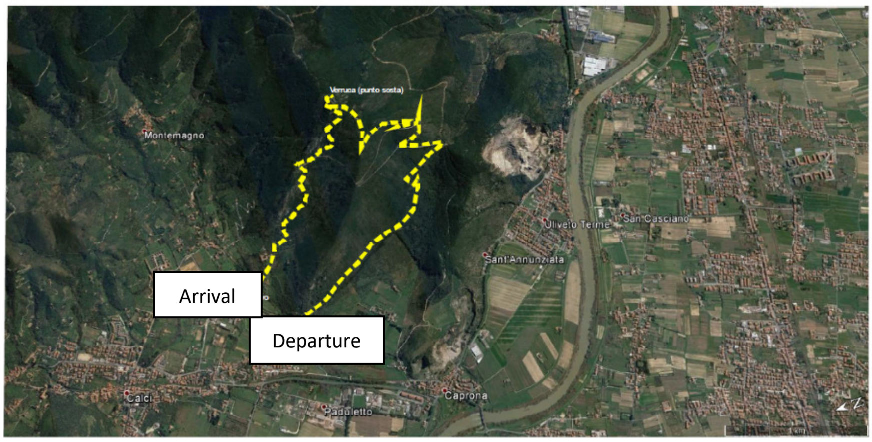
Natural Reserve of Lame di Fuori (see 3 in map 1)
This reserve is what remains of the right side of the Arno delta. It is today a wetland of over 600 hectares composed of an alternation of water blades and herbaceous and shrubby areas in the higher ground. The surface waters are brackish near the sea and freshwater in the internal areas. Being a group of endorheic basins, the conditions of flooding are intermittent and dependent on evo-transpiration and the rainfall regime. Meadows pastures alternate with *Juncus acutus* sharp-pointed rush and *J. maritimus* sea rush, or *Limonium* spp. steppes, *Salicornia* glass worth, *Arthrocnemum* spp. and *Spartina* cordgrass and free waters with *Ranunculus* white water-crowfoot, up to scrublands of elm, and woods of ash and alder. In winter it is an extraordinary reservoir of waterfowl and wader such as *Anas crecca* teal, *A. acuta* pintail, *A. strepera* gadwall, *Tadorna tadorna* shelducks, *Pluvialis apricaria* golden plover, *Numenius arquata* curlew and *Valnellus vanellus* lapwings. During the migrations again the swamp comes alive with *Anas querquedula* garganey, *Sternula albifrons* little tern, *Pernis apivorus* honey buzzard, *Numenius phaeopus* whimbrel, *Recurvirostra avosetta* avocet, and *Himantopus himantopus* black-winged stilt. In summer, on the other hand, with aridity, remain mainly the prairie birds (e.g. *Alauda arvensis* skylark and *Cisticola juncidis* zitting cisticola) and also the scrublands birds (e.g. *Otus scops* scops owl and *Lanius collurio* red-backed shrike).

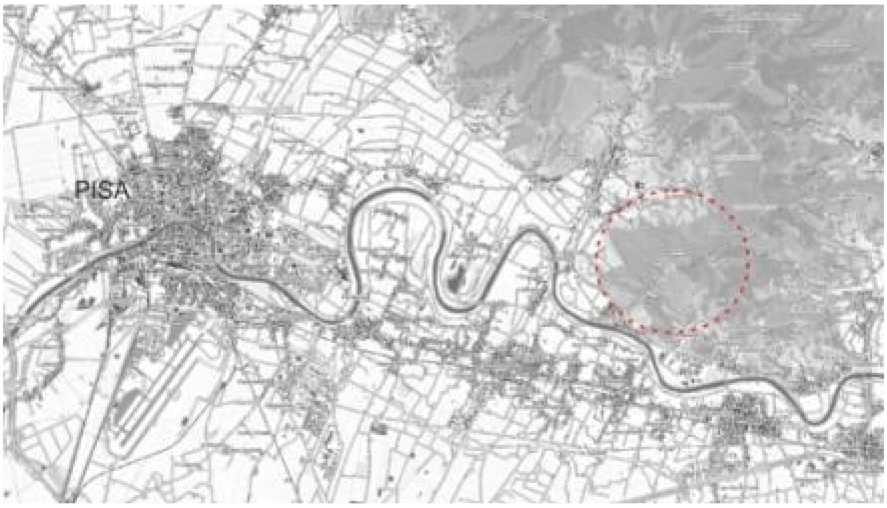
Field trip 16/03/2018

Wildfire

Andrea Bertacchi and Agustin Merino

The field trip concerns a hilly area of Monte Pisano, of the Municipality of Calci (PI).
The excursion will take place along a walking path of about 5 km in the northern side of Monte Verruca, with a difference in height of about 500 meters. There will be a stage with packed lunch at the Fortezza della Verruca (see figure) on the top of peak.
The lower belt is partially cultivated by crops mainly represented by olive groves and, for the remaining part, by forest particularly on steep slopes.
The geo-lithological substratum is partly constituted, in the south-western sector, by carbonatic rocks, for the rest by quartzitic rocks. The path will unfold between what remains of pre-existing *Pinus pinaster* woods, evergreen sclerophyllous woods of *Quercus ilex* and *Quercus suber*, post-fire scrubs and mixed deciduous woods with the presence of *Castanea sativa*, *Quercus pubescens* and *Quercus petrea*.
The area in fact has been subjected to decades of periodic negligent or fraudulent fires, of which the last (2010) that has invested an area of about 200 ha, particularly devastating.
The picture of the primitive or in any case "natural" plant landscape of this hilly area is therefore very conditioned by the age-old anthropic activity.
Leaving aside the traditional cultivation of the olive tree, which here is only carried out in a small sector, the main transformations are due to historical silvicoltural interventions with plantation ("coniferamenti") of *P.pinaster*. Subsequently, the replacement of topsoils potentially characterized by woods of evergreen sclerophyllous and mixed deciduous broad-leaved woods, differently arranged in relation to both the soil and the exposure, and of which there are still numerous examples even if of limited extension. In this context, fires have determined a vegetation landscape very diversified both by potential vegetation and by historical conifers plantations.
Today we can observe a mosaic of differentiated succession of vegetation phases (garrigue - dwarf shrubs -scrubs- woods) of phytocoenosis surviving the fire.
The excursion, crossing all these types, will allow to observe in the field the effects of the passage of the fire on the phytocoenosis, will highlight the aspects of resilience of the different species and phytocenosis to the fire and the aspects related to their flammability.

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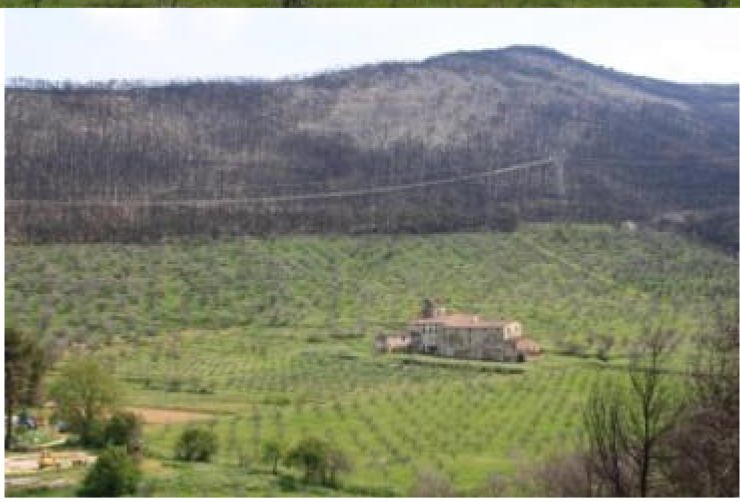

2010

2014

2018

Field trip 19/03/2018

Field trip 1. Wetland systems

Patricia Rodriguez-Gonzalez and Teresa Ferreira (Ulisboa)

GENERAL INFORMATION: WETLAND THREATS IN MEDITERRANEAN REGIONS

Wetlands, landscape features found in almost all parts of the world, are known as “the kidneys of the landscape” and “ecological supermarkets” to bring attention to the important values they provide (Mistch 2007[2]). First, they function as the downstream receivers for water and waste from natural and human sources, they stabilize water supplies, thus ameliorating both floods and drought. Second, they are called “ecological supermarkets” because of the extensive food chain and rich biodiversity that they support, providing unique habitats for flora and fauna. Also they are described as important carbon sinks and climate stabilizers at the global scale.

There are multiple approaches to characterize and classify the large diversity of wetlands existing on Earth. One of the most accepted definitions of wetlands is the one adopted by the Convention on Wetlands (Ramsar, 1971). The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The wetlands definition established by Ramsar Convention includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans (Ramsar 2009[3]).

In spite of their ecological importance, wetlands have suffered intense and long-lasting human pressures since water is one of the most essential natural resources. Until the 1970’s, the drainage and destruction of wetlands were accepted practices around the world and even encouraged by specific government policies (Mitsch & Gosselink 2015[4]). The loss of wetlands in the world is difficult to determine, but recent estimates suggest that we have lost more than half of the world’s wetlands, with much of that occurring in the twentieth century. In Europe, more than 80% of wetlands area has been lost (Verhoeven 2014[5]).

In Mediterranean regions, human activities have impacted wetlands more than their counterparts in more humid or temperate regions because of the severe competition for water that occurs in Mediterranean-climate regions (Gasith and Resh 1999[6]). Under increasing water demand, the Mediterranean region is expected to experience the greatest proportional impact compared to other biomes (Sala et al 2000[7]), making wetland ecosystems particularly fragile in the Mediterranean Region. Wetlands have been destroyed and transformed through widespread land cover change, agriculture intensification, urbanization, industrialization and engineering schemes such as reservoirs, water diversion, groundwater pumping, irrigation and interbasin transfers to maximize human access to water (Vörösmarty et al 2010[8]). These multiple changes have modified natural ecological processes and fragmented the aquatic landscape, increasing the ecosystem vulnerability to the additional stresses associated with climate change and other emerging threats

[2] Mitsch, W.J., & Gosselink, J.G. (2007). *Wetlands*. (Fourth ed.). New Jersey: John Wiley and Sons
[3] Ramsar, (2009). Information Sheet on Ramsar Wetlands (RIS) – 2009-2014 version Available in http://www.ramsar.org/doc/ris/key_ris_e.doc and http://www.ramsar.org/pdf/ris/key_ris_e.pdf. Retrieved 29/03/2016
[4] Mitsch, W.J., & Gosselink, J.G. (2015). Wetlands. (5th ed.). New Jersey: John Wiley & Sons
[5] Verhoeven, J.T.A. (2014). Wetlands in Europe: Perspectives for restoration of a lost paradise. *Ecological Engineering, 66*, 6-9.
[6] Gasith, A., & Resh, V.H. (1999). Streams in Mediterranean Climate Regions: abiotic influences and biotic responses to predictable seasonal events. Annu. Rev. Ecol. Syst., 30, 51-81
[7] Sala, O.E., Chapin III, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F., Jackson, R.B., Kinzig, A., Leemans, R., Lodge, D.M., Mooney, H.A., Oesterheld, M.L.P., N., Sykes, M.T., Walker, B.H., Walker, M., & Wall, D.H. (2000). Global biodiversity scenarios for the year 2100. Science, 287, 1770-1774
[8] Vörösmarty, C.J., McIntyre, P.B., Gessner, M.O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S.E., Sullivan, C.A., Liermann, C.R., & Davies, P.M. (2010). Global threats to human water security and river biodiversity. Nature, 467, 555-561

such as alien species invasions. As a result, conservation, sustainable management and restoration of freshwater and riparian ecosystems is a major challenge for this century.

THE RAMSAR SITE OF THE MASSACIUCCOLI LAKE AND MARSH

In the field trips of this International Course we will explore "The Massaciuccoli lake and marsh" (Lago e Padule di Massaciuccoli - Macchia di Migliarino - Tenuta San Rossore) an area designated in June 2017 as a Ramsar Wetland of International Importance (site number 2311) (Figure 1). The designation of the site responded to its compliance to several Ramsar criteria of importance: 1) Representative, rare or unique natural or near-natural wetland types, providing ecosystem services; 2) Rare species and threatened ecological communities; 3) Biological diversity, particularly high in the EU Mediterranean Region and 4) Support during critical life cycle stage or in adverse conditions.

Figure 1. Boundaries of the Ramsar Site #2311 "The Massaciuccoli lake and marsh".

The Ramsar Site extends over 11135 ha and holds a large ecologically diverse wetland on the coast of northern Tuscany. It is a flat, mixed forest ecosystem, with soils formed by both sedimentation and erosion increased by wind and the hydrological interactions of the Arno and Serchio rivers and the sea. Wetlands of this size are extremely rare in coastal plains of the Mediterranean area. The main ecological systems are represented by the two final parts of Arno and Serchio rivers, with the wetland of the old river Arno delta in the inland (named "Lame di Fuori"), by the wetland of the old back-dune with the Lake of Massaciuccoli, which is surrounded by the fen beds (*Cladium* sp.) mixed with reed beds (*Phragmites* sp.) and *Sphagnum* spp. peatland that floats on root mats islands, and by an extensive hosted paleo-dune system that alternates with dry forests (dune top) and flooded forests (interdunal lowlands), up to the newly formed dunes and the beaches. The Site hosts a great variability of communities and a wealth of species, including endemic subspecies such as *Artemisia caerulescens cretacea*, which is found only in central Italy, and *Centaurea aplolepa subciliata*, which is unique to the Tyrrhenian coast. The lowlands host wetland forest communities especially remarkable in the context of the Mediterranean Region such as such as *Alnus glutinosa* swamp forests exhibiting singular floristic composition (Gellini et al 1986)[9]. The Site is an important migratory and wintering area for hundreds of bird species. It also contributes to carbon retention and is important for sediment retention, fresh water supply, and also recreation and nature-based tourism. Among the main threats, in addition to the impacts associated to the history of agricultural activities, several alien invasive species endanger the ecological integrity of the wetland, especially: *Amorpha fruticosa, Myriophyllum aquaticum* and others such as *Yucca gloriosa, Paspalum boteri, Robinia pseudoacacia, Arundo donax*, (Ramsar Sites Information Services)[10].

RIPARIAN VEGETATION IN MEDITERRANEAN REGIONS

Riparian corridors in Mediterranean-climate regions are resource-rich habitats within water-limited landscapes. Plant species are adapted to multiple abiotic stressors, including dynamic flooding and sediment regimes, seasonal water shortage, and fire. Yet, long term impacts have severely degraded these ecosystems from land-use conversion to agriculture, streamflow regulation, nutrient enrichment, biological invasions and climate change, making them extremely vulnerable (Stella et al 2013[11]).

Riparian vegetation as plant community is the main structural component of riparian ecosystems and thus its structure and change provide useful information on the underlying changes in the fluvial system. For this reason, it is a reliable tool for monitoring riparian ecosystems state and related services (Rivaes et al 2013[12]). Particularly in arid and semi-arid regions, riparian areas host high local plant diversity and a greater proportion of the biome's tree species than their counterparts in temperate or tropical regions. They also host a large proportion of the surrounding biome's wildlife species for some portion of their life history (Stella et al 2013[1]).

Riparian plants display a tight association with fluvial processes and their physical drivers in Mediterranean regions. Riparian physical drivers in Mediterranean regions can be divided into five principal categories: (1) flood magnitude and hydraulics; (2) flood timing; (3) streamflow and water table dynamics; (4) sediment dynamics and texture; and (5) fire. In this association, plants are not only passive but active components as river system engineers (Gurnell 2014[13]). The biogeomorphic role of plants on river systems is significant across spatial scales from individual plants to entire forested river corridors particularly in stabilizing banks, modulating sediment dynamics and through its contribution to hydraulic roughness. These processes in turn affect the rate and spatial pattern of floodplain development, and influence recruitment success of seedling cohorts through seedbed availability, water table depth, and sediment texture.

Recent research is providing increasing understanding over riparian vegetation pattern and functioning as a basis for their rational conservation, restoration and resource management in Mediterranean regions. Yet, multiple historical and current impacts jeopardize riparian ecosystems sustainability. Globally, human pressure will increase in Mediterranean regions and

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climate change is already reducing the water supply in most of them (Underwood et al., 2009[14]). In addition to the described abiotic pressures, these ecosystems are now accumulating multiple biotic pressures such as emerging diseases (Bjelke et al 2016)[15] and invasion by alien species (Stella et al 2013)[16] that constitute a global scale problem. Specific strategies for riverine and riparian management need to take into account projected future changes. For this purpose, a proper assessment of the degradation status, limiting further degradation and developing rehabilitation approaches that increase their resilience are urgently needed.

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Case study: Restoration of a Mediterranean drained peatland: the case study of the Massaciuccoli lake basin (Tuscany, IT)

Vittoria Giannini (SSSUP) and Nicola Silvestri (UniPi)

The Massaciuccoli lake basin, located in Tuscany, is a coastal floodplain that has been largely drained from 1930-1940s to make possible the cultivation of these territories. After almost a century of deep drainage, because of the complex hydrological setting and the high soil organic matter content (up to 50%), a series of problems have arisen in this catchment. The most important environmental priorities to be faced were phosphorus leaching and land subsidence.

In the project that started in 2011, rewetting of a part of the area was identified as a solution for restoring lost ecological functions of this site. In a pilot experimental field of 15 ha, three different management systems, with an increasing anthropogenic impact has been tested: constructed wetland system (CWS), paludicultural system (PCS) and a natural wetland system (NWS).

i) The CWS is composed by a series of 5 treatment cells linked each other among which the drainage water is treated flowing in a serpentine path.

Each treatment cell, with a parallelogram shape, has a surface of about 6200 m^2 and a depth of about 40 cm.

i) The CWS was sized to guarantee a retention time of 1.0-1.5 day. At the end of the construction works lasted two years (up to 2012), the CWS started to operate and the spontaneous vegetation started to develop within it.

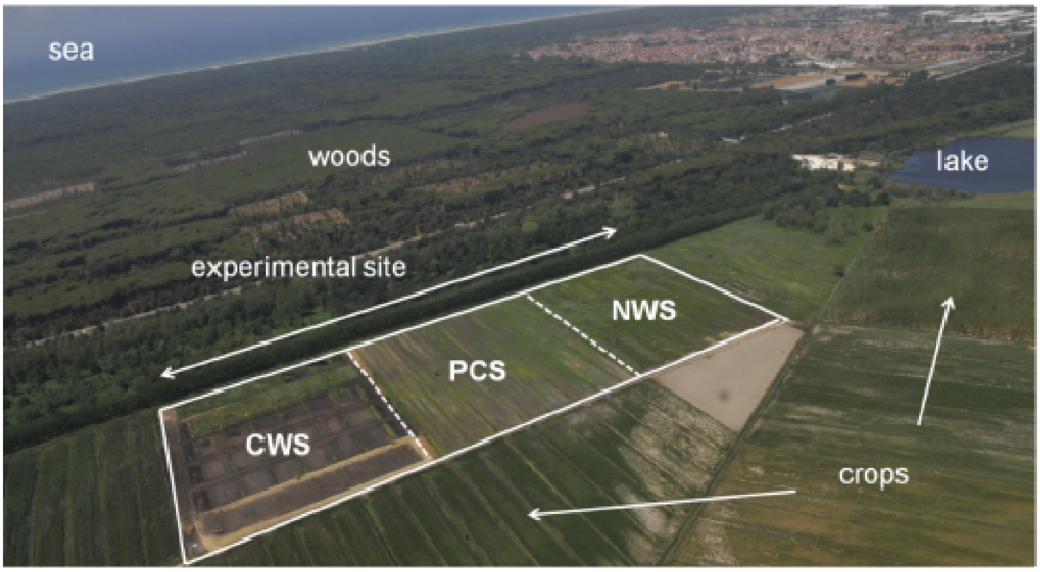
The settlement of the spontaneous vegetation was possible because the area was unvegetated before the construction works, thus some rhizomes, stolons and seeds were still present in the treatment cells.

ii) The PCS was based on growing different no-food crops and harvesting their biomass periodically to ensure nutrient removal from the waters to be treated. The system was not dammed and was crossed by a dense network of small channels (about 8 m apart) that supplied both drainage (in autumn and winter) and irrigation (in spring and summer) for the crops through lateral infiltration. The main difference between the PCS and the surrounding areas concerns the water table level. The water table in the watershed is artificially lowered to allow the farmers to cultivate, with noticeable fluctuations during the year (from −0.10 to −0.60 m) depending also on cultivation practices. In the rewetted PCS, the water table depth is kept higher because of the continuous supply of water to be treated and thanks to the weirs, which are not moved except for management needs (e.g., harvest or maintenance of drainage ditches). Then, in the experimental fields, the water table depth is only dependent on the meteorological conditions (e.g., rainfalls or dry periods), ranging from 0.00 to −0.05 m during the winter and from −0.10 to −0.20 m during the summer (Giannini et al., 2017).

In this system three perennial rhizomatous species (*Arundo donax* L.; *Phragmites australis* (Cav.) Trin ex Steud.; *Miscantus* x *giganteus* Greef et Deuter) and two woody crops managed as short rotation coppice (*Salix alba* ‘Dimitrios’, *Populus* × *canadensis* ‘Oudenberg’) with a biennial turn have been planted.

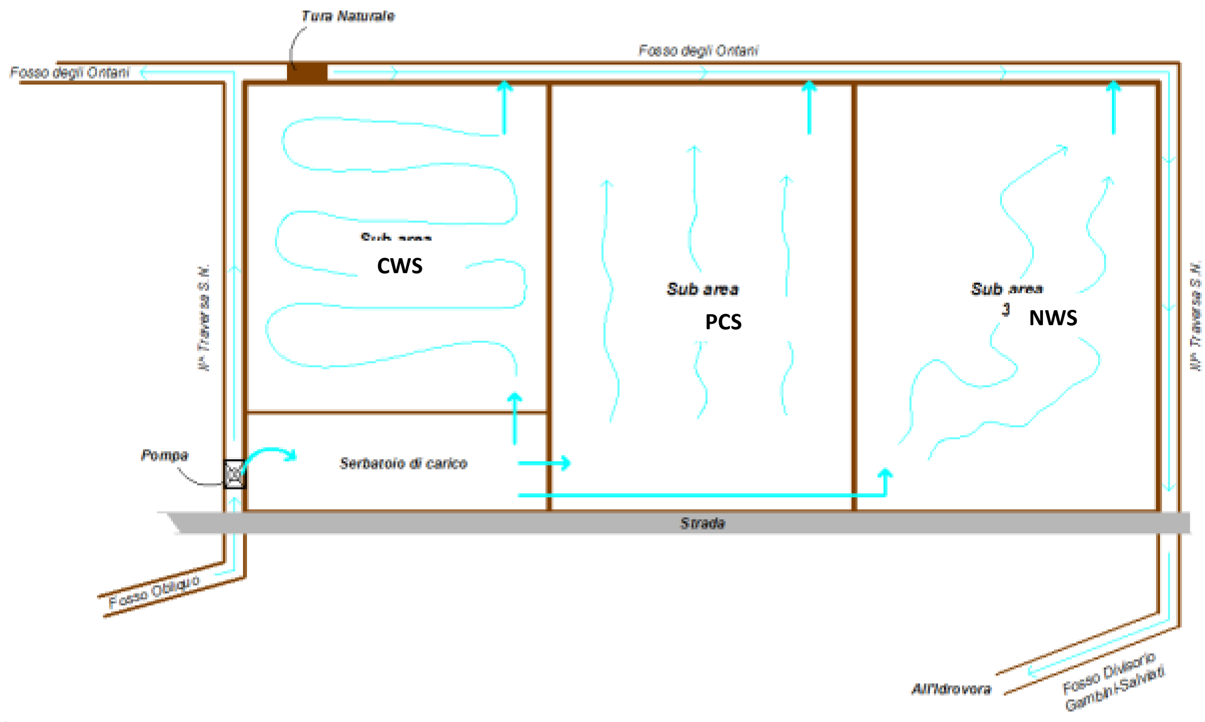
iii) The NWS was set up as natural rewetted area with a surface area of 2.7 ha and surrounded by small embankments built with the top soil (~10 cm) removed long the area's borders. Natural elevation changes within the NWS helped in creating zones with a different bottom height in order to promote the colonization from a large variety of plant species.

The effectiveness of the different systems was determined following a multidisciplinary approach evaluating the status and changes of water, soil and plant communities’ biodiversity. In addition, a conventionally cultivated and an uncultivated drained peat soil, characterized by a natural vegetation succession, were used as controls. Hydrological cycle, surface- and ground-water quality, peat oxidation rate, microbial diversity and functionality, CH_4 and CO_2 emissions, plant nutrient removal, biomass production and energy efficiency have been monitored in order to assess the most effective and sustainable management system.



Aerial view of the experimental pilot field represented by three different management systems: constructed wetland system (CWS), paludiculture system (PCS) and natural wetland system (NWS). The conventionally drained area cultivated with annual crops is near the pilot field.

What is the water flow path in the three systems?



How do we monitor the surface water quality in the three systems?

Three sampling schemes have been planned: 1) **continuous monitoring** with probes placed *in situ*; 2) a **composite sampling** with automatic samplers (one at the inlet and one for each outlet) proportional to the flow pattern; 3) an **instant discrete sampling** for groundwater. The monitored parameters are:

• Continuous: pH, oxygen, temperature, electrical conductivity (EC);

• Composite: EC, total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN, Kjeldahl), nitrates (NO_3^-), ammonium (NH_4^+), dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), anions, cations.

Overview of the sampling station at the inlet of the phyto-treatment area. Details of: (b) the inlet in the CWS, (c) inside the sampling station, (d) the automatic probes and (e) the bottles used for the continuous sampling.

How do we monitor the water inflow/outflow in the three systems?

To calculate the inflows and the outflows from the weirs, the data collected from the water head probes placed at the gauging stations have to be converted into the water level above the sharp-crested rectangular weir (used as flow gauge, see Figure). For each working period, an individual equation should be used formulated as linear regression trend or logarithmic regression trend according to the best fit with the values directly measured on the field.


Sharp-crested rectangular weir used as flow gauge

Then the height values above the weir were transformed in flow rates [mc/s] applying the Bazin equation. A 10 minutes cumulative volumetric flow rate (Q_10) was computed multiplying Q [m^3/s] by 600 (60 seconds and 10 minutes). The Q_10 _ow rates were summed up to obtain cumulative daily flow rate for each gauging stations.

$$Q = h \cdot \mu \cdot b \cdot \sqrt{2 \cdot g \cdot h} = h \cdot 0.415 \cdot 0.6 \cdot \sqrt{2 \cdot 9.81 \cdot h}$$

Where Q is the flow rate [mc/s], h is the water level above the weir [m], μ is an empirical coefficient
[-], b is the width of the weir [m] and g is the gravitational acceleration [m/s^2]. Several values of μ can be found in literature (Arvanaghi & Oskuei, 2011; Bagheri & Heidarpour, 2009), 0.415 was chosen based on direct measurements of the flow from the weirs.

Otherwiswe (for example if the weir is dismantled), we can use the following equation:

$$Q = v \cdot (b \cdot h) = 0.08 \cdot 0.6 \cdot h$$

in which v is the _ow velocity [m/s].

How do we monitor vegetation in the three systems?

CWS and **NWS**: we used a mixed approach merging phytosociological surveys with ortophotos taken by an Unmanned Aerial Vehicle (UAV). After 4 years of observation (2016), we performed destructive sampling by boat on the most widespread plant communities in the areas (NWS: *Phragmites australis* and *Myriophyllum aquaticum* community; CWS: *Phragmites australis* and *Typha latifolia*) to quantify the biomass production and the uptake of nitrogen and phosphorus.
Thus, on harvested biomass we performed analyses to determine the chemical content in C, N, P.
PCS: cropped species were monitored and sampled yearly. For the perennial rhizomatous grasses the sampling was performed in the end of summer while for the woody crops was performed in winter, after the fall of leaves.

Sampling of the spontaneous vegetation (*Myriophyllum aquaticum*) in the NWS

How do we monitor soil in the three systems?

A set of the soil physico-chemical properties (e.g. pH; EC; TN and soluble nitrogen (NO_3^- and NH_4^+); TP and different phosphorus species (P-Fe, P-Al, P-Ca, P-org); C:N ratio; SOM and soil texture) has been measured in order to assess the soil status before rewetting and once per season in each of the three systems

Example of a peat core

Field trip 19/03/2018

Field trip 2. Coastal systems

Anna Karkani, Niki Evelpidou (NKUA)

Coastal erosion constitutes a global issue, as 70% of the shorelines are retreating (Bird, 1985), while in Europe it is estimated that 15 km^2 of shorelines are retreating annually. In Europe, more than 5 million people live in areas threatened by coastal erosion and coastal flooding. According to EUROSION 2004, in 2004 approximately 20.000 km of shorelines faced serious problems, with most of them being eroded (> 15.100 km).

Coastal erosion is observed since the beginning of the creation of a coastal area, and is influencing and shaping its evolution. However, climate change (sea level rise, extreme weather phenomena) and human interventions in the coastal area and inland, have intensified their effects, which are expected to be even more important in the near future (Maglara, 2011).

The risk assessment of a region of rising sea levels can be based on various factors such as (Papanikolaou *et al.*, 2011):

- The rate and extent of rise
- The relationship between tectonics and eustatic in an area: tectonically active regions counteract or reinforce the rise of sea level depending on the movement of pieces
- The relationship between sea level rise and sediment discharge: the change may be a result of climate change (manmade or natural), through which affected the erosion rate as a result of precipitation and vegetation change, or anthropogenic interference, such as the construction of dams, sand extraction, fires, etc.

Furthermore, there are many local factors that affect coastal erosion, such as (Dukakis, 2005; Papanikolaou *et al.*, 2011): a) the topography of the shore (shore in bay or the open sea), b) the lithology of coast (sandy or rocky), c) the morphology of the coast (gentle or steep slope), d) the prevailing climatic century wave conditions (longitudinal currents, winds, typical wave heights), e) the frequency and intensity of extreme weather and wave phenomena, f) the sediments stocks area (coast near the river or not).

Methodology for studying coastal erosion

For the study of coastal erosion in a region, three main stages may be distinguished:

1) The first stage includes the collection and study of bibliographic material on earlier scientific approaches in the region (e.g. hydrographic network, climate, vegetation). The processing of these data will produce valuable conclusions about the evolution of the coast.
2) The second stage includes field research with repeated interceptions. At the field we can join topographic / sedimentological sections from the marine section to the boundaries of the beach, perpendicular to the coastline. These sections are depicting the morphology of the area and, based on the prices of sedimentological analysis, it is possible to identify the mechanisms of action of one or more combined factors (e.g. wave, wind, and river). Moreover, by determining the feed mechanisms (e.g. river) and settlement (e.g. wave)

may be assessed an annual balance sediments that help morpho-dynamics development of the region. Finally, with repeated mapping of the area and the time monitoring, is imprinted a detailed mapping of the area where is recognizing any change of it.

3) The third stage includes the implementation of a standard numerical simulation models which are going to focus at the eroded parts of the field. The composition of thematic maps will lead to that direction.

The equipment to be used is:

- Side scan sonar. This method has the ability to scan large areas of the sea bed, contributing to the mapping of landforms, the background types and marine habitats.
- Sub-bottom profiler. This method determines the geological substructure of the seafloor, while giving information about the physical and geotechnical properties of sediments, the morphology of the bottom along the section.
- GPS. The Global Positioning System (GPS) is a space-based radio-navigation system that determines the precise location in space and time.
- Tape measure/stakes/paint. For the composition of the topographic sections.

Sand dunes

Dunes or sand dunes are small hills of sand, which are usually found in coastal areas. Coastal sand dunes owe their development to the combined action of aeolian transport of sand and the presence of vegetation covering dunes, in contrast with desert dunes, where vegetation is absent. They constitute an important habitat in the transitional zone of land and sea and they are owed to erosion processes and the deposition of sand in the coastal zone. Therefore, the sand of the coastline, which is drifted by the wind, is naturally replaced by the sand, which is brought to the coast by waves and currents. This sand comes from the river basins, from eroded rock sediments or from submarine accumulations of sand.

Because dunes consist of sand, they constitute an unstable, but dynamic geomorphological unit of the coastal zone. Their development and preservation depends on the prevailing winds of the area, the wave regime in the coastal zone and the supply-sorting of erosion materials, as well as the supply of erosion material from nearby streams and rivers bring to the coastal zone.

Dunes along with coastal mudflats, salt marshes and sandy beaches, belong to the coastal habitats, they provide a wide spectrum of important functions and they are invaluable for the protection of wild fauna and flora. Dunes and salt marshes in particular absorb wave energy, thereby preventing the erosion of the coastal zone.

Dunes are sensitive, but dynamically evolving ecosystems that host flora and fauna with a high adaptation to unfavorable environmental conditions. Their ecological importance is great and is mainly attributed to the vegetation, which has a key structural role in the development and preservation of dunes, as this vegetation:

- Holds the sand
- Stabilizes the coastline and the soil from the erosive action of the sea and the wind
- Works protectively as a natural barrier (sea water, winds) for the inland.

Besides, dune systems are sensitive and fragile ecosystems that have adapted to the changes caused by natural causes (wind, wave), while, regardless of the sandy deposits (extent, thickness, height), they play an important part in groundwater hydrology of the wider area. This is owed to their substantial storage capacity, concerning the groundwater hosted in their mass.

Degradation risks and erosion of coastal dunes

The current deterioration of many dune systems is attributed to natural causes (beach width, wind and wave intensity, etc.) and human activities (walking on permanent paths, frequent crossing of vehicles, touristic activities, land reclamation). In addition, the plants that make up the dune systems consist of species restricted to this habitat and therefore, due to the general deterioration of the dune populations, plants have an increasing risk of extinction (e.g. Pancratium maritimum).

The main threats for sand dune ecosystems come from:

- The interruption of their continuity (e.g. road construction, various infrastructures)
- The loss of their habitat, due to touristic or other purposes
- Changes in sand supply (e.g. port or other works in the coastal zone, arrangements of rivers and streams, tree planting on the beach, continuous cleaning by mechanical means, sand extraction)
- disposal of garbage and construction debris
- Multiple activities in a limited area (e.g. tourists, vehicles, campings), which exceed the environmental capacity of the area from an ecological point of view and in terms of the offered facilities.

The threats and degradation risks of sand dunes can be addressed through a good management, rational planning, environmental awareness, social consensus and acceptance. Typically, conservation and protection projects of important dune systems begin with studies on their bearing capacity of human activities, while for the design mild interventions and actions are considered.

In the past, erosion of the coastal zone was treated with “hard” technical solutions, such as the construction of marine protection systems and breakwaters. However, although these systems were able to limit coastal erosion in some areas, they intervened in the natural process of sand transport causing erosion in other locations. Nowadays, “soft” practices are preferred, such as the planting of native plants.

For coastal erosion, Europe has adopted the following recommendations:

- Early warning of risks, environmental impact assessment and restoration of damages in the framework of policies on coastal management.
- Increasing the protection of the coasts by restoring the sediment balance with mild and socially acceptable interventions (e.g. sediment transport from areas that have strategic reserves and as long as the physical balance of the system is not compromised)
- Drastical and scheduled management of coastal erosion (better planning in the long term and a regional plan for the management of coastal sediments, also taking into account risks, costs and effects)
- Implementation of best practices individually for each case, with full knowledge of management of coastal erosion

Finally, a guarantee for the preservation and protection of dune ecosystems is the continuous awareness of the local community and their active participation in the sustainable management of these important ecosystems.

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Conservation of the coastal ecosystems of northern Tuscany (Torre del Lago)

Antonio Perfetti, Grazia Masciandaro, Serena Doni

Since 2002 the MSRM Park Body has underlined the need for a broader strategy for the coastal habitats with respect to the one limited to planning, vigilance, promotion and research followed up to now, in order to more efficiently meet the objectives of conserving biodiversity, resources and services that the coastal ecosystems supply. A preliminary study on the various factors threatening these ecosystems allowed elaboration of a project (**LIFE Nature project DUNETOSCA, http://www.parcosanrossore.org/page.php?id=173)** that covers ecological restoration, direct land management, environmental communication and scientific monitoring, to be presented to the European Commission within the ambit of the LIFE Nature financial programme. The project was approved and began its operative phase in October 2005.

The general objective was to broaden and improve the quality of the dunal and fresh-water habitats of community interest which are under threat from the various above-mentioned factors, and to restore the retrodunal and inland wetlands. Furthermore, given the presence of an important bat colony in the Park, one of the aims was also to maintain suitable environmental conditions for conserving the *Rhinolophus ferrumequinum* and *Myotis emarginatus* breeding/over-wintering populations. All the results to be met in the project would then be maintained, completed and improved in the following years after the interventions had been completed.

In particular, the following actions were therefore carried out:

elimination of the coenoses of the invasive alien species *Yucca gloriosa*
(north Amercian agavacea), by now dominant in many xeric retrodunal areas, by removing the vegetative bodies as deep as 50 cm below ground level and subsequent chemical treatments aimed at new shoots;

maintenance of 20% of the entry paths to the beach and **constructing 19 wooden walkways** which cross the dunal belt and are provided with didactic/information boards;

closing 80% of the pathways (over 4 ha), open to intense and uncontrollable traffic by visitors to the beach, by installing fencing and faggotting, restoration of the filled-in retrodunal wetlands, bringing sand and planting local psammophilous species;

planting approximately 2,000 plants, grown in a special nursery for typical species of the dunal habitats, as part of the project to close the pathways opened up by over-trampling on the dunes;

eliminating the coenoses of the invasive alien species *Amorpha fruticosa* (north American legume) from the retro-dunal wetlands, by directly removing the plants as deep as 50-100 cm and later following on by chemically treating any shoots;

reconstructing an appropriate landscape morphology in the retrodunal wetlands after they were freed from Amorpha, leaving plenty of natural islands and avoiding vast areas of uninterrupted excavations, in order to maintain a mosaic of plant populations and aquatic animals associated to each other and able to recolonize the restored habitats;

restoring two previously reclaimed inland wetlands situated in San Rossore, increasing the depth of the country plain level and, in one case, raising the outflow thresholds of the emissary canal to maintain more fresh water and at the same time avoid entry of polluted water and saline water from the downhill canal;

limiting motorised traffic in the Marina di Vecchiano area to rationalize free use of the beach in the area;

safeguarding the breeding bat colonies, by restructuring the roof of the building where they live which risked collapsing because of water infiltration; an electronic system was later set up to monitor the animals in order to analyse the main behavioural and environmental variables;

monitoring the over-wintering *R. ferrumequinum* colony to check their distribution outside the Park and any further threats to the protected population; moreover a bunker in the Park from the World War II was modified to create suitable environmental conditions to encourage the animals to over-winter in the protected area;

environmental communication campaign accompanying the above mentioned actions, using direct and indirect methods of communication (meetings, seminars, conferences, voluntary activities, articles in the press, educational and divulgative material, etc.).

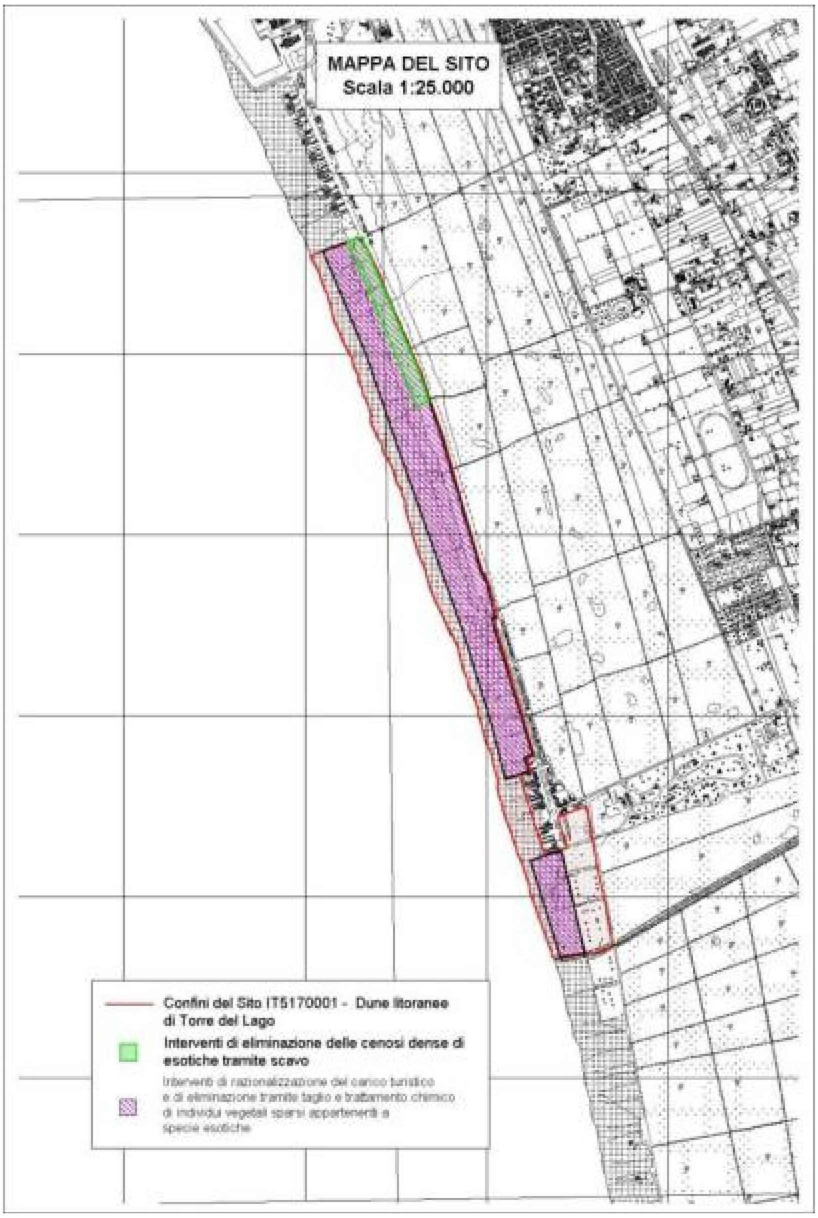
Results and objectives achieved

Regarding the dunes, over-trampling has decreased and the presence of the alien ***Yucca gloriosa*** has fallen in 80 ha of dual habitat; moreover, previously destroyed dunes have been rebuilt. With regard to the retrodunal and inland wetlands, 6 ha of ***Amorpha fruticosa*** have been removed and over 13 ha of coastal wetlands have been restored respectively, increasing, moreover, the annual permanence of fresh-water. Conservation actions regarding the bat colony have allowed keeping suitable environmental conditions in the nesting and over-wintering sites for these animals. The operations performed, and so far described, were accompanied by scientific monitoring actions regarding the key variables of the restored ecosystems (hydro-geological, botanical, zoological and socio-environmental) and by a communications strategy that promoted understanding and sharing conservation objectives through means of direct and indirect participation (over 30,000 illustrated pamphlets, 138 didactic/information boards, an internet website, 44 newspaper articles, 2 television interventions, 479 environmental questionnaires distributed to beach users, 27 public events of which 3 were international meetings.

Without the ecological restoration interventions, the existence of the priority habitats and species of both the dunes and the coastal wetlands would still be at a higher risk because of the increase in fragmentation of natural spaces and increase of vulnerability of many populations.
Indeed, small fragmented areas are far more difficult to preserve in good conservational conditions than large natural areas.
This improvement, however, cannot be considered final because of the short duration of the project compared to the times that characterize ecological processes such as, for example, the diffusion of populations of plant species and changes in vertebrate distribution areals.
Moreover, the marked human presence in the intervention areas still continues, given their tourist/recreation attraction. For the most part, it should be noted that public opinion with regard to understanding the problems so far mentioned is generally low. For example, ecological restoration operations meant using heavy mechanical work means with considerable changes to the landscape, generating conflicts between businessmen in the protected area and the citizens. However, after these operations were carried out, proving how it is possible to achieve positive

results in terms of nature conservation even in areas heavily frequented by man, collaboration has been growing more and more.

This nourishes hopes for even better results than those so far attained, because they would come from the efforts and motivation of all members of society.



Dune habitats restoration

Embryonic shifting dunes with *Agropyron junceum* and *Otanthus maritimus*

The configuration of the dune in February 2016 (A) and in June 2016 (B). The extreme erosion of the frontal portion of the dune is clearly appreciable. The dots point out the position of the same object in each picture.

Practical activity outside 20/03/2018

Fresh water ecosystems

Natural Reserve of Palazzetto (see 1 in map 1) and peninsula of Poggio di Mezzo (see 2 in map 1)

Patricia Rodriguez-Gonzalez and Teresa Ferreira (Ulisboa)

In about 300 ha, 5 km far from the sea coast, there are three large palaeodunes systems up to 20 m a.s.l. arranged orthogonal to the coastline. In the interdunal areas there are extensive biomes with helophytes and hydrophytes with numerous rare species at national level surrounded by large forests flooded with *Ulmus* elms and *Alnus* alders and *Fraxinus angustifolia* ash and *Quercus robur* peduncolate oak in the higher areas. Progressing towards the top of the dunes, the alluvial woods give way to the *Fraxinus ornus* manna ash, *Q. ilex* holm oak woods and the pinewoods. The dry meadows are what remains of the cultivated areas around the ruins of the old farmhouses of the settlers. In these old-growth forests the animal populations are among the most complex of the protected area with species such as the *Dendrocopos major* great spotted woodpecker, the *Anas crecca* teal, the *Columba oenas* stock dove and the *Turdus philomelos* song thrush among birds, the *Martes martes* pine marten and the *Nyctalus noctula* common noctule between the mammals and the *Triturus cristatus* warty newt among the amphibians. Poggio di Mezzo, located between two channels with a serious organic pollution, is a natural experiment site because the peninsula is hydraulically isolated and fed only by meteoric precipitation. This allowed experimentation with the introduction of new population of rare plant species that needed nutrient-poor waters without high peaks in surface water temperatures to live and reproduce.

QBR INDEX FIELD PRACTICE

In this field trip we will go through of the lower part of the Fiume Morto Nouvo, an old drainage channel situated between the river Serchio and the river Arno. In this site, currently inhabited by wetland forest (Figure 2), we will relate riparian structural changes with observed pressures by combining aerial images with field assessment using the QBR index of riparian quality (Munné et al 2003[17]). Among the species present, we will be able to identify trees such *Populus alba, Alnus glutinosa, Fraxinus angustifolia* subsp *oxycarpa*, *Quercus robur*, or *Carpinus betulus* shrubs such as *Frangula alnus, Rubus ulmifolius* (Gellini et al 1986)[18].

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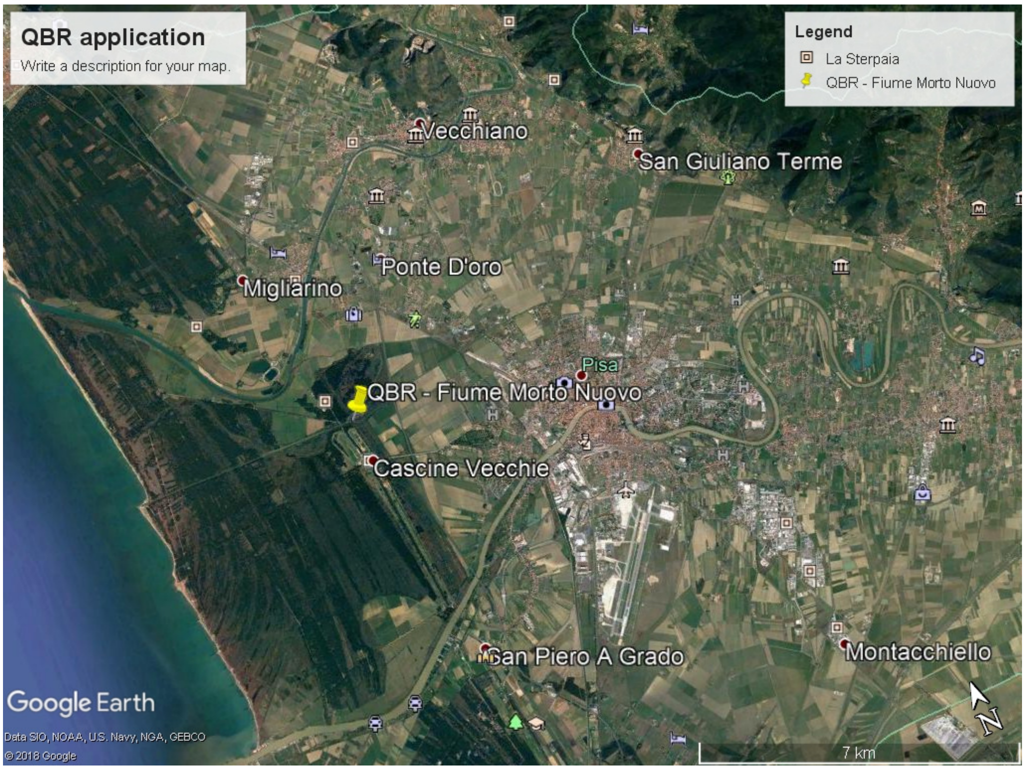

Figure 2. Location of study Site to apply the QBR index at the lower part of Fiume Morto Nuovo and relative position of River Serchio (North) and Arno (South).

Figure 3. Study Site to apply the QBR index at the lower part of Fiume Morto Nuovo

QBR INDEX

The QBR index was developed initially in Mediterranean rivers in Spain (Munné et al 2003[5]), and has been already applied in several countries in the Mediterranean region (Chatzinikolaou et al[19]). Calculation of the QBR index in the field is made using a two-sided sheet which is completed by a field surveyor (ANNEX FIELD SHEET). The index is based on four components of riparian habitat: total riparian vegetation cover, cover structure, cover quality and channel alterations. It also takes into account differences in the geomorphology of the river from its headwaters to the lower reaches. These differences are measured in a simple, quantitative way. The index score varies between 0 and 100 points.

Materials to be used:

-Field sheet (Annex FIELD SHEET)
-pencil
-Measuring tape / GPS to mark the upstream and downstream limits of the study site
-Camera to photograph the study site features

Field site:

Site width: Before the QBR calculation, the main channel and floodplain zone should be differentiated (see the figure at the top of the field sheet) identifying the bankfull zone. Although the delimitation of the riparian zone is not always easy, the observer should use all the available indicators of the riparian area, such as fluvial terraces, presence of riparian vegetation and evidence of the effects of large floods. In highly modified areas, a compromise is made between the true riparian area in the absence of human impact and the present situation where extensive agriculture or forest plantations may exist. For index determination, the river is divided into two sections: the main channel and the riparian area. The former is subdivided into two: the area permanently covered with flowing water (which is not considered in the scoring process), and the channel zone between the permanently flowing reach and the bankfull state (see the figure at the top of the field sheet).

Site length: The index must be calculated in river or stream lengths of 50m (upstream areas) or 100m (middle and lower reaches).

Field sheet structure:

1-Total vegetation cover. This is assessed both for the riparian and channel areas and includes any kind of tree, bush, shrub or helophyte. Grasses are excluded because they are annual plants and their cover may be very variable depending on the year and the hydrological conditions.
2-Vegetation cover structure. An assessment is made of the structural complexity of the riparian environment that may increase the biodiversity of the fluvial ecosystem, both for animals and plants.
3-Cover quality. The number of tree species present in a stream reach will vary depending on river geomorphology and stream type. Three stream types are defined according to the total geomorphological score which depends on the form and slope of the riparian environment (field sheet).
4-River channel alterations. Man-made river channel alterations are included in the index because they are one of the main disturbances to the riparian habitat either (channelization,

[19] Chatzinikolaou, Y, Ntemiri, K, Zogaris, S. 2011. River riparian zone assessment Using a rapid site-based index in Greece, Fresenius Environmental Bulletin, 20: 296-302.

rigid structures, alluvial terraces, embankments, weirs, river crossings, wells for water abstraction…).

Classes of riparian quality.

After completing the analysis, the sum of the four parts gives the final QBR index. The index varies between 0 and 100. There are five quality classes of riparian habitat which broadly correspond to those suggested in the Water Framework Directive (European Commission, 2000).

Table 1. Quality classes according to the QBR index

Riparian habitat quality class	QBR	Colour
Riparian habitat in natural condition	≥95	Blue
Some disturbance, good quality	75–90	Green
Disturbance important, fair quality	55–70	Yellow
Strong alteration, poor quality	30–50	Orange
Extreme degradation, bad quality	≤25	Red

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