



Monitoring of **Mediterranean** **Coastal Areas**

PROBLEMS AND MEASUREMENT TECHNIQUES

EIGHTH INTERNATIONAL SYMPOSIUM
Livorno (Italy) June 2020



edited by

Laura Bonora, Donatella Carboni,
Matteo De Vincenzi



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PROBLEMS AND MEASUREMENT TECHNIQUES**

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Organizing secretariat:

CNR-IBE Area di Ricerca di Firenze
Via Madonna del Piano 10,
50019 Sesto Fiorentino (Florence - Italy)
Phone +390555226557
e-mail: segr.org@ibe.cnr.it

Scientific Secretariat:

CNR-IBE Area di Ricerca di Firenze
Via Madonna del Piano 10,
50019 Sesto Fiorentino (Florence - Italy)
Phone +390555226060-6030
e-mail: simposio@ibe.cnr.it

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Preface

2019 was the 250th year since the birth of Alexander von Humboldt, a nature scholar. He was born in Germany and lived in many parts of the world, giving a unified vision of this, where organic and inorganic nature form a single system, whose manifestations are all connected to each other.

Since our Symposium, with its interdisciplinarity, intends to demonstrate, edition after edition, this thesis we seemed appropriate to remember the theorist of this holistic view of Nature. Since the Symposium is held in even years, and in 2019 it was not foreseen, we intended to take the occasion to celebrate Humboldt in 2020 edition.

It would have been interesting to remember him during the traditional three days of Symposium but unfortunately could not be carried out due to the COVID-19 pandemic restrictions. The pandemic also led to a reduction of the works; from the approximately 150 works selected by the Scientific Committee, in these Proceedings only half of them are present for obvious reasons. In any case, it seemed appropriate, giving a clear sign of continuity, to publish the works that the authors were able to complete in this difficult period.

In this reduced edition, the celebration of Humboldt was ensured by F. Benincasa, M. De Vincenzi, G. Fasano with a note that we place before the works of the different Sessions.

The Editors

SESSION

**COASTLINE GEOGRAPHY AND
COASTAL LANDSCAPES:
TERRITORIAL DYNAMICS AND
INTEGRATED PROTECTION**

Chairman: Gloria Pungetti
Department of Humanities and Social Sciences
University of Sassari

tourism and economy. Moreover, to succeed, stakeholders must be involved in actions for waterflow recovery, nature conservation and landscape restoration.

4. Scenario for development and planning

Scenarios are the foundations for coastal development and planning. Hydrological scenarios, for example, have been elaborated by Venudo, Rodani and Devescovi to explore potential design strategies for the Low Friulian Plain. Aiming at investigating the complex territorial transformation, the morphological history of a landscape unit has been described as a blend of biological deserts and wrecks of endangered landscapes. On the basis that hydrological risk represents an intrinsic and retroactive vulnerability of the area which could be adapted and mitigated, there is a need to recover, restore and monitor the water margin continuity through flooding strategies able to prevent future fluctuations. The foreseen scenario can therefore form the base for an overall masterplan for the Friulian “deserts”, aiming at its renaturalisation by means of preserving biodiversity and reducing fragmentation. A new landscape, finally, can take shape, reconstructing the environmental continuity and configuring the watershape within an ecological network for the Friulian deserts.

Development between infrastructures and innovation has always been a challenge in coastal areas. An attempt to create scenarios of the port area of Trieste, seen as an incubator of innovations, has been made by Bisiani and Savron with the objective to define a new landscape able to enhance activities that can provide quality of life and employment opportunities. In particular, a new landscape can be designed with modern technology, where infrastructure and storage space, both physical and digital, minimize the presence of man, configuring the logics of a new artificial living.

Scenarios for planning, moreover, are crucial in regional and local governance. The theoretical scenario implemented by the municipal plans of the Romagna coast has been recently analysed and discussed by Zullo, Fiorini, Marucci and Romano with the aim to highlight how their forecasts can change the future settlement structure, especially in highly urbanized coastal strip next to extremely fragile environments. New tools necessary for future developments are indicated in a technological platform linked with the environmental assessment procedures of plans for the optimised location of new settlements. Such optimisation would provide afterwards a balance between tourist economy and ecosystem preservation along the shores, with a strategically driven vision capable of directing territorial policies, environmental regeneration and sustainable transformation in the long run.

Extreme littoralisation, furthermore, is a common trend of contemporary seashores. The RE.CO.RD. project - Recycling strategies for the coastal sustainable waste management towards E&D innovation - of the EC Interreg Programme, aims to develop new strategies to arrest the environmental impact of economic activities linked to tourism in coastal areas. As outlined by Epifania and Pollice, networking and governance play key roles in the sustainability of coastline, and accordingly coastal developers have an active role for environmental qualification, and at the same time for the sustainable development of coastal tourism. Hence a multifunctional approach must be applied to coastal management of touristic areas.

It is not unusual to note indiscriminate soil and resources exploitation in favour of land use, threatening very fertile coastlines. The paradox, as Mazzeo points out, consists not of the lack of legislative or planning instruments for the regeneration of natural and agricultural sites, but of the poor results they produce, the uncontrolled urban expansion, and a management

completely indifferent to territorial risks. Despite this, possible intervention policies have been proposed in the Domitian coast in north Campania to redevelop this territory.

A different planning experience is described for the Tuscan coast by Saragosa and Chiti. With the objective of outlining the flows of energy in relation to the territorial structure, a cross scale survey methodology has been applied to analyse which settlement configurations can support quality of life. Future research development is however required to explore how the designed solutions support resilience. Hence it would be useful to evaluate the degree of adaptation and survival of species, and to find ways to manage through spatial configurations the ecological flows within the morphogenetic processes of settlements.

Territorial planning is often implemented at two levels: strategic with guidelines, and operational with plans. In harbour regions, the Strategic System Planning Document belongs to the first, and the Port Regulatory Plan to the second. A methodology to identify the port areas which influence the city has been proposed by Palano, Del Corona, Montioni, Pichi and Scamporrino, measuring the degree of such interaction through indicators. The study has formed the basis for the perimeter of the new port-city interaction areas within a Strategic System Planning Document for the North Tyrrhenian Sea.

5. Tools for monitoring and management

Before embracing any territorial management process, monitoring is essential to gather the necessary information on the state of the art of the territory involved. In turn, monitoring and management require tools to carry out the process. Among these are data bases, the foundation of any investigation. On this line, Esposito and Bosi have proposed a database to support sustainable coastal zone management, namely the LaCoast Atlas. This lays in the context of the LaCoast Project on land cover changes in coastal zones, i.e. a geo-referenced database that constitutes a tool for integrated spatial analysis of policies. The LaCoast Atlas database, built from Corine Land Cover database, Landsat images and desk teamwork, has investigated coastline changes, meant to provide indicators for European coastal zones management in order to support land use decision-making.

Mediterranean coasts, as well known, are under increasing human pressure, which has degraded ecosystems and landscapes. A particular challenge is the control of marine litter, which is causing increasing plastic pollution in our seas. Accordingly, a study aimed to analyse and to quantify the abundance, weight and compositions of marine litter has been carried out by a large research group (Corbau et al.) along two beaches of the Asinara Island in Sardinia. Analysing the marine litter, it has emerged that plastic fragments, lolly sticks and string are the most frequent type of debris.

The management of degraded material is doubtless a priority in the Mediterranean Basin. Lolli, for example, has clearly highlighted how our seabed is full of debris. Their removal from the seabed is imperative to maintain downflow conditions and land reclamation, to guarantee coastal protection, and to ensure navigability and port accessibility. Nevertheless, the fragile marine ecosystems are under threat by unsustainable dredging and management operations. Dredged material, in fact, should not be considered just waste, but in some cases it could be considered a resource. Further research and work, however, should be put forward to develop this resilient concept.

The above validates the importance of a vision for the future management of Mediterranean coastal settlements and landscapes. A synthesis among database, analysis,

LAGOON SCENARIOS FOR THE BASSA FRIULANA PLAIN: A FLOODING ARCHIPELAGO

Adriano Venudo¹, Valentina Rodani², Valentina Devescovi³

¹DIA, Department of Engineering and Architecture University of Trieste (Italy)
phone: +39 3472921588, email: avenudo@units.it

²DIA, Department of Engineering and Architecture – University of Trieste (Italy)
e-mail: valentina.rodani@phd.units.it

³ DIA, Department of Engineering and Architecture – University of Trieste (Italy)
e-mail: valentina@devescovi.it

Abstract – The territory of the Bassa Friulana plain has been the arena of constant adaptation and alteration between lands and waters over the centuries. The matrix of geomorphological features characterized by the alluvial origin of the Tagliamento river artery and by the presence of *risorgive* expound an emblematic case of the landscape of flux. Moreover, the socio-economical conditions incessantly adapted through the assortment of landscapes: forestry (from the ancestral *silva lupanica* to the exploited pine forest), both extensive and intensive farming (from the *agro-centuriatio* to the *manso*, then the great land reclamation and urbanization), energy and tourism (as in the seaside town of Grado or in the fishing Marano Lagunare which pressurize the lagoon). Indeed, par excellence is a landscape of transition and a fragile subject to climate change, albeit an extreme laboratory to cope with its multidimensional impacts. The research aims to investigate the complexity and uncertainty related to the transformation of this territory, through the connection between retro-coastal morphological evidence and embedded resilience. The paper first focuses on the morphological history of a landscape unit, consisting of biological deserts and wrecks of the endangered landscape. Secondly, it analyzes and elaborates hydrological scenarios to explore and discuss potential design strategies. The research hypothesis advances that the hydrological risk represents an intrinsic and retroactive vulnerability of the area that, if recognized, could be adapted and mitigated. The water margin continuity could be recovered, restored and monitored through the development of flooding strategies to respond to possible future fluctuations. In conclusion, the form of the archipelago emerges as a specificity of the landscape unit. More than a metaphor but as a conceptual and programmatic dispositive, the archipelago can inform on the dynamic structure of the Bassa Friulana complex system within an ecological framework.

Introduction. Coast and lagoon territories: Friulian deserts

A drifting landscape of flux – The Bassa Friulana plain is a territory in the north-east of Italy that extends from the easternmost edge of the Po Valley to the karst plateau of the Monfalconese area, within a strip of land between the *risorgive* and the lagoon edge of Marano and Grado, where the distance between the Alpine belt and the Adriatic coast compresses almost to disappear. It is historically and culturally marked by the combination of lands and waters. On the one hand, the former's settlement and development were subordinated to the control of the latter. On the other, the different degrees of resistance between anthropic action

and environmental pre-existences gave shape to such heterogeneity, a compendium of the universe [1], or a mosaic of landscapes. The matrix of geomorphological features characterized by the alluvial origin of the artery of the Tagliamento river and by the presence of springs make this territory an emblematic case of transition landscape. The waters of normal flow sink into the more permeable and gravelly soils like the *magredi* in the high plain; once they resurface from the clayey and sandy soils of the lower plain, giving rise to the phenomenon of *risorgive*. Land depressions and elevations decline several water shapes, from natural springs such as the *olle* (catiniform) and *fontanai* (irregular in shape) to low bogs and wet meadows, swamps and waterways, nearly the lagoon. The *risorgive* belt embodies the watershed between the most refractory dry plain and the humid one. The latter was once a highly differentiated riparian and plain woods, a habitat of meadows, such as the ancient *magna silva* (or *silva lupanica*, localized between the river Isonzo and Livenza, *phaetontea*, from Livenza towards the west, and the *silva diomedea*, from the Isonzo towards the karst) [2], whose permanence has been questioned continuously by the action of man, resulting today in scarce wrecks.

The shape of water: from the agro-centuriatio to the manso – To inhabit this plain, the man had to deal with the absence at least as much as with the multifaceted presence, sometimes generating but sometimes destructive, of the waters. There are two settlement structures that, declined in a great variety of morphologies, have stratified over time: the first, in the plain close to the springs, confirms the matrix of the road and hydraulic infrastructure of the *agro-centuriatio*, forming a network of rural and close-knit villages, where the population was mainly peasant. Instead, the second, found in the lower plain, develops in a more dilated network of villages integrated with the *mansi*. Wetlands guarded vast, empty and cultivated fallows, alternated with grasslands and forests inhabited mostly by shepherds or cattle breeders and with roads branching out in all directions. Both configurations are supported by a vibrant hydrological network which, starting from the river arteries, crucial for commercial exchanges, has fed open-air aqueducts, such as the irrigation ditches, flanked to a greater extent by other forms for the collection of rainwater, such as wells, ponds, cisterns, and tanks. However, none of these solutions has ever been sufficient to solve the problem of conserving water for periods of drought in the most permeable plain just north of the springs, nor to regulate its vast presence to make all the lands in the plains humid and productive. The lowland forest played a vital role in the territory's fluctuating development; it represented the margin between these two forms of settlement, never precise but extremely manipulated by anthropic action. In fact, the forest undergoes the Roman settlement logic, as a precious resource of wood and game, with radical interventions of selective reclamation, deforestation and tillage of the lands. However, it also becomes a refuge from incursions and gradually recovers only with the abandonment of the countryside and the swamp during the Lombard occupation to then reach maximum expansion with the Hungarians' invasions. The subsequent repopulation of the plain through the Slavic colonization is partial to the disadvantage of the forest mantle. This collective heritage will be very slowly incorporated into the villages, partly protected with the regulations of the Serenissima Republic but, since the end of the 19th century, progressively annihilated.

The shape of the city: from the manso to the metropolis – At the beginning of the nineteenth century, the Bassa Friulana landscape was rich of hygrophilous scrub, woods of hard essences, shrubs combined with meadows and wet meadows that, according to historical cartography, extended for about 5000 ha. Nevertheless, thanks to the increase in agricultural activity and the land reorganization of the large agricultural villas, which partially eroded the forest heritage, but above all starting from the significant reclamation works on the plain, it

takes less than a century to halve them. Massive deforestation combined with necessary interventions on several stages of construction of the network of reclamation canals, which govern the *risorgive* waters, those of meteoric origin and the floating ones of the lagoon with the embankments, rationalize the waters by converting the lands into surfaces for production and consumption. After World War II, the surviving forest heritage corresponds to 700 ha [3] fragmented in islands surrounded by extensive agricultural fields and intensive fish farms, only half of which has survived. It is a profound and rapid transformation of the meaning attributed by the population to waters and lands. That persistent element, not traceable in the building constructions but the totality of the settlement structure of a rural metropolis, historically very differentiated, that is the shape of the city [4], almost automatically undergoes the tyranny of the right angle giving rise to a physical and social structure summed up in the word Los Angeles [5]. The result and assiduity of the recent urbanization process, of which man began to be globally aware in the early 1960s but locally only in recent decades, is apocalyptic and configures a permanent emergency condition. Suffice it to say that in the post-lagoon zone, the drainage of wetlands, the depletion of groundwater, and soil loss have reduced natural geomorphology to a minimum. It accelerated the phenomenon of subsidence structuring a substantial hydraulic instability. 12300 ha of land (equal to approximately 18.6 % of the area) are below sea level and the 566 km of the surface hydrographic network is joined by 698 km of canals that require continuous maintenance with defense and safeguard works. In three-quarters of the lands, the intensive and semi-intensive rural landscape dominates (50600 ha, equal to 76.5 % of the area). It consists of extensive crops, only in microscopic part, together with the anthropic areas, which fragment and isolate the 4996 ha of natural environments and wrecks (of which approximately 1900 ha of floodplain and riparian forests, 645 ha of lowland oak forest, 428 ha of stable meadows of anthropogenic origin, 82 ha of wet herbaceous environments, 50 ha of peat bogs low alkaline, 54 ha of small strips of dry grasslands and about 123 ha of fertilized grasslands) [6].

Friulian deserts: biological non-place and wrecks – This landscape of transition has been the stage of constant and mutual adaptation over the centuries. The socio-economical transformations gave shape to the waters through the agro-pastoral development of the territory. However, this relation reached a breaking point since man destroyed the shape of the city through extensive, invasive and rapid urbanization. The aqueduct solved the problem of drought where waters were once collected by the bronze fabric dotted with mills, wells and cisterns. While the network of canals and the land reclamation rationalized terrains, which became productive and attractive, ready for use as well as abuse, where the abundant waters nourished once dynamically humid grasslands and forests. That territory characterized by the presence of springs and the lagoon has been subject to more than a century of invasive anthropic transformations and the evident effects of climate change. These changing and adaptable margins are the most fragile landscape, today in crisis. The exploitation and reclamation of lands and the development of mass tourism, at least as much as the implementation of monocultural and intensive farming, have produced a systemic environmental upheaval, enabling the manufacture of a new landscape: the deserts of Friuli. Comparable to metropolitan non-places [7], these surfaces of biological desertification are landscapes of production, which, in addition to being the cause, amplify the effects of climate change in recent decades, such as the intensification of abundant rainfall, the rise of temperature and sea level, and subsidence. These phenomena represent agents of fragmentation of habitats and of the collective landscapes mosaic plain which risks, and it currently is to a certain degree, the irreversible and unavoidable conversion into an archipelago of wrecks. Indeed, it suggests a

landscape of transition extremely fragile to climate change, but also a radical laboratory to experiment with its multidimensional impacts. The recognition of morphological evidence indicates a history of adaptability and constant landscape combination, so it is possible to hypothesize that the margin between land and waters acted as a dynamic network, both self-regulatory distance and dispositive of differentiation as well. Furthermore, the hydrogeological risk can be investigated as a structural vulnerability of the landscape unit, exploring its resilience potential through the analysis of lagoon-based scenarios. This indicates that starting from the acknowledgment of past, present and projected water margins it is possible to explore strategies of recovery, restoration or transformation of the landscape. Whether as a result of anthropic pressure on the lagoon or its inherent structure, the Bassa Friulana plain is clearly sinking. That is to say, what if the Bassa Friulana plain would be transformed into a floodscape [8]?



Figure 1 - Friulian deserts: biological non-place and wrecks. Photograph of a portion of the "reclamation campaign" near the Marano Lagoon, between Latisana and Lignano Sabbiadoro (Udine).

Materials and Methods. The square and the hexagon

The landscape unit consists of a coastal strip ranging from 2 km to 8 km of the Bassa Friuliana plain, which surrounds Marano and Grado's natural lagoon reserves, extending from the Tagliamento river near Latisana [9] to the Monfalconese karst near Aquileia¹. The case

¹ The landscape unit has been recently investigated in the *Green Plan of the Municipality of Latisana* (Environmental Plan L.10/2013) by the *Integrated design laboratory of city, territory and landscape* (a.y. 2019-20 Master degree in Architecture of the Department of Engineering and Architecture, University of Trieste); Venudo A., Ceschin, E., Del Fabbro Machado, L. (2020) - *laboratorio PAESAGGIO LATISANA*, EUT, Trieste.

study is investigated through quantitative and qualitative data analysis, then processed through a landscape mapping and scenario analyses. Firstly, the data collection reviewed the cartographic materials retrieved from historical and land use sources, with a specific focus on landscape morphology, for instance, the evolution of plain woods, the transformation of historical wetlands due to the great reclamation and the changes related to waterscapes (as waterways and coastlines). Moreover, the consultation of specific literature (as archaeological studies, local history, ethnographic researches) informed the groundwork map, representing the landscape unit state of the art. Successively, the map has been superimposed with the scenario analyses developed by FVG Region in the study and evaluation of the impacts of climate change on coastal areas, then revised with the PAI scenarios which produced comprehensive zoning of the hydrogeological risk for the Marano and Grado lagoon basins [10, 11]. These scenarios consider the components of sea rise and lowering of the soil within a time interval at 2100, corresponding to +54 cm, +94 cm and +134 cm of potential flooding, which in the latter case would imply the doubling of the currently depressed surface. The superimposition of the landscape unit state of the art with the scenario simulations displays a preliminary map (Figure 2), representing the lagoon scenario for the Bassa Friulana plain. Secondly, the mapping process has been informed through morphological analysis. The investigation of landscape matrix and spatial structure (Figure 3), the hydrographic basin (Figure 4), the infrastructural network (Figure 5) highlighted the configuration of a surviving territorial archipelago.

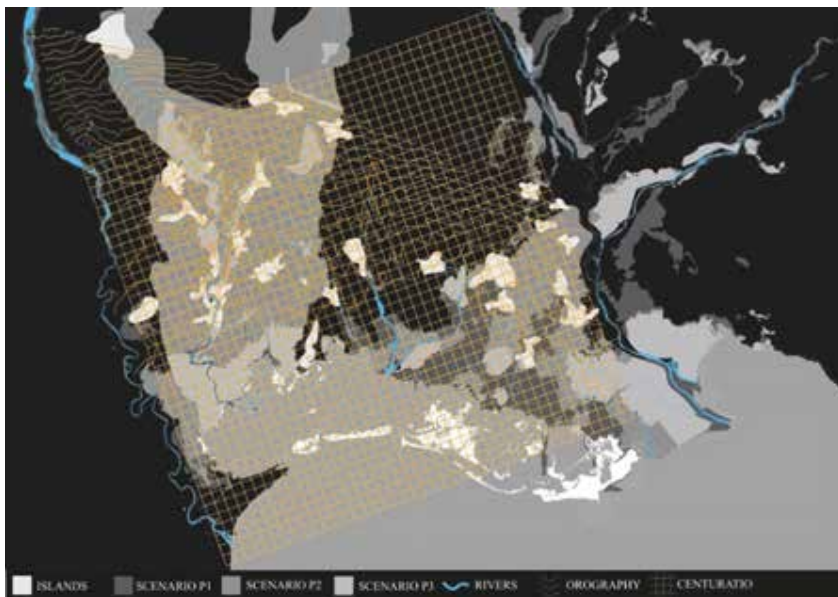


Figure 2 - The spatial matrix of the territory is generated by the grid, which abstracts the ancient Roman *centuriatio*, and by the orographic structure. Given the close relationship between the elements, it follows that the most populated areas are those with the most significant hydrogeological risk.



Figure 3 - The hydrographic basin evidences the anthropic pressure on waters control, as in the isotropic and vast network of embankments.

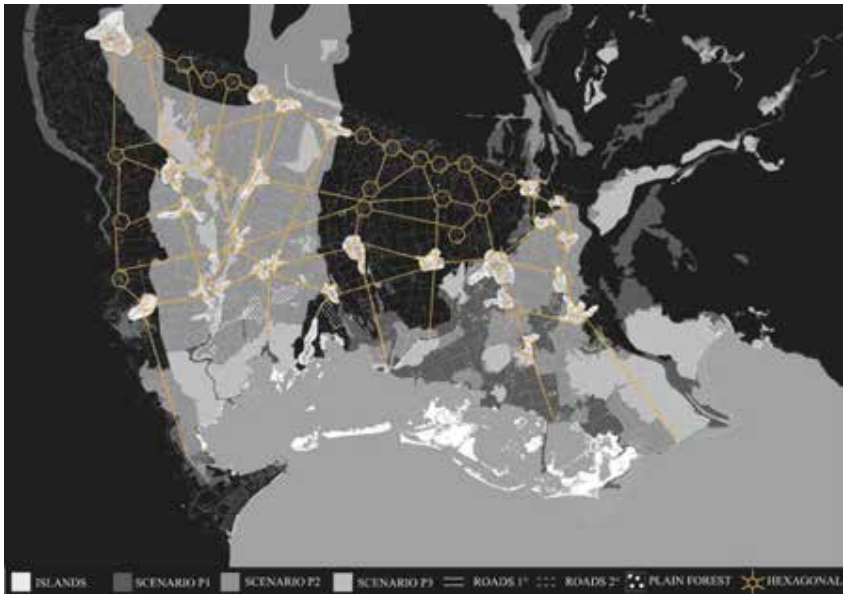


Figure 4 - The hexagonal mesh characterizes the settlements' spatial structure and its infrastructural network, which connects the territory in a capillary way.

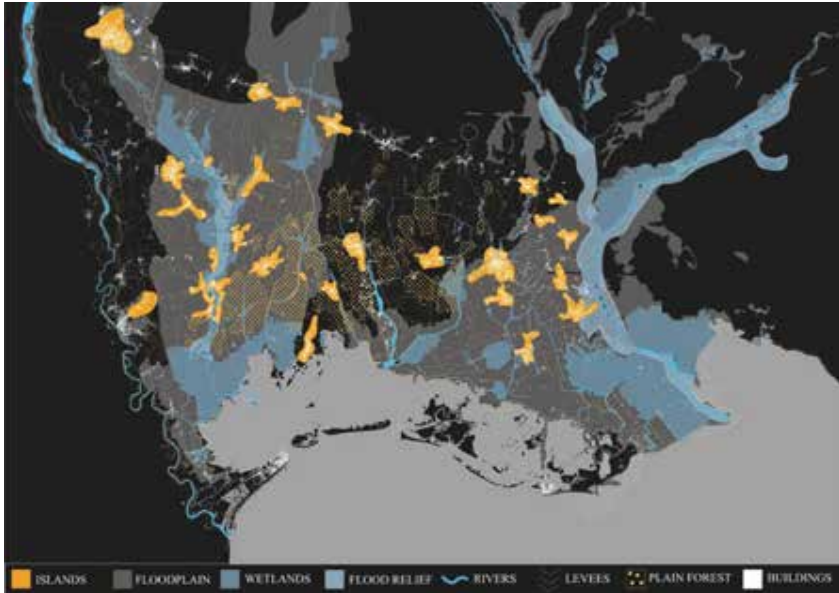


Figure 5 - In the future scenario, maintaining the territory's structural characteristics, the archipelago of the Bassa Friulana plain will be created, making the area habitable, safe and healthy, promoting self-regulation of ecological dynamics, supporting the needs for change.

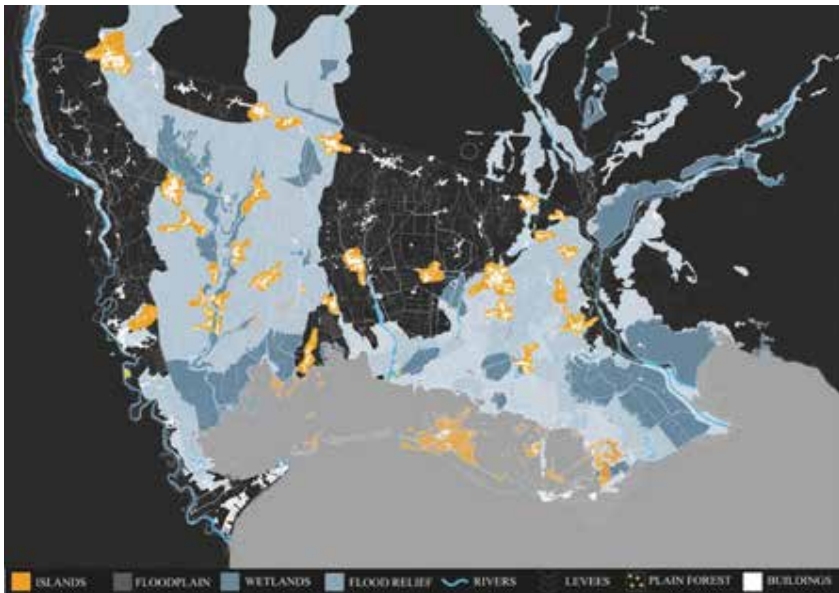


Figure 6 - Lagoons scenarios for the Bassa Friulana plain: a flooding archipelago.

Results. Archipelago e land reclamation: new costal landscapes

The mapping process of the geomorphological structure of the territory and the hydrographic and infrastructural networks on the PAIR scenarios have highlighted some critical issues, but also various potentials. Whether as a result of historical and morphological analyses or projective scenarios, the Bassa Friulana plain has clearly an embedded resilience.

The result of the analysis and interpretation work was summarized in the "map of the archipelago" of the Bassa Friulana (Figure 6) shown above. This is an extreme, but not improbable, vision and the case studies analyzed demonstrate it. The rebalancing of man-environment-settlements must inevitably go through a phase of recovery of the "original landscape", which was generated on environmental dynamics of self-regulation, in particular for the management of water cycles, regulation of outflows following of rainfall intense (water-bomb) and of self-containment of possible flooding, which should be remembered that generated, over two thousand years ago, the well-known "flooded forest", which still today is the landscape matrix of the unity of the landscape "Bassa Pianura Friulana e Isontina" (AP10) and the landscape unit "Laguna e Costa" (AP12) [12]. The trend scenarios outline three areas subject to the risk of "hydraulic danger" in a time gap of 100 years. In the archipelago map we recognized the structural areas with which to associate the strategies of self-regulation, controlled flooding, restoration land reclamation (oasification) and migration. These environmental strategies will act on the structural components and territorial dynamics in the short, medium and long term.

These three hydraulic scenarios have been set with a "return time" that is now more than acceptable (100 years), this choice is supported by the results of the rainfall, analyzing the trend of the rainfall curves of the last twenty years of the Osmer FVG [13]. The rainfall monitoring confirms the choices of the time indicators for the scenarios (100 years) and are consistent with the other environmental data collected: temperature trends, progress of desertification processes in agricultural lands, reduction of the level of biodiversity. All this is due to the phenomena of ecological fragmentation. The coincidence of all these environmental data and the overlap with the data on the settlement dynamics lead to a single result: in these perilagunar territories, the "Friulian deserts", the territorial planning must necessarily start from the environmental reorganization, to avoid natural disasters and catastrophes, but above all to be able to manage the territory over time at lower costs, and triggering more natural and spontaneous processes. For these reasons, ecological networks (RER) and landscape systems (Udp) can no longer be only indicators, but will have to become the new vector for territorial and large urban planning. According to this approach, the environmental frame becomes an urban and territorial frame.

Considering all this, we hypothesized environmental dynamics related to water management to achieve these territorial layouts, using some strategies in the project areas, which consider environmental structures and units as settlement figures for urban development and reorganization:

The islands:

- *The settlement islands* reproduce the original matrix, formed by the integration of anthropic dynamics with environmental characteristics, and recover the figures of the "squares and hexagons" as a form of the territorial structure, identified by Francesco Tentori in his essay (1983) "*Living in the Friuli plain: the settlement, the grounds, the house. The square and the hexagon*" [5]. The planning use of islands (squares and hexagons) allows to encapsulate the reclamation land, restoring the water margin, and

proposing a new balance between mechanical drainage and natural drainage. The hydraulic concept merges the settlement concept for all the inhabited territories of the Lower Friuli plain (friulian deserts) in favor of a structure and an overall functioning that regulates itself, and which also provides for flooding (semi-controlled) as a cyclic regeneration event of the environmental system, and not as a catastrophic event to be excluded. The settlement systems, which derive from the redesign in islands "with squares and hexagons" are resistant thanks to their position and their morpho-typological characteristics, because they belong to ancient systems of "territorial wrecks", born from an agriculture of resistance, in these flooded lands, particularly careful to maintain an environmental and landscape structure (necessary for its survival).

- *The islands of the forest* are wetlands, outcrops or semi-emerged lands that function both as a filter and as a containment device for the waters of the lagoon. These outcrop wetlands form rolling basins and contribute to the overall retention during floods. They are therefore "barrier and backward barrier islands". They refer to natural structures already present in lagoon landscapes and marine habitats, the "velme" and the "barene" (sandbanks), performing an important hydraulic function for the self-regulation dynamics (retention, filtration, speed reduction), but also biological (refluxes and oxygenation of the water, but also sedimentation or stagnation of the water) hypothesized by our scenarios, as well as constituting a first habitat for the numerous fish and bird species of the Lagoon of Marano and Grado. The islands of the forest will allow the direct reformation of the lowland forest, which although small at the beginning, will constitute a fundamental engine for the restoration of the wet forest and peat bogs (recovery of the original landscape and return to the flooded forest).

The waterways:

- *The waterways* within the lagoon play an important ecosystem function. The environmental balance of this area of coast and lagoon, but above all the hydraulic one, is guaranteed almost completely by the system of waterways of the Lagoon of Grado and Marano, and consists of both the internal canals and the rivers that flow here (Stella, Zelina, Muzzanella, Aussa, etc.). The most relevant datum of this system is its mutability due to floods and shoals. This phenomenon is one of the causes of the subsidence of the friulian deserts, because they are artificial soils that rest on sands and silt: they are the reclamation lands. The continuous movement of riverbeds and internal canal beds is the main driver of biodiversity for all species of the Lagoon of Grado and Marano, and for the ecotopes themselves. The lowest levels of naturalness have been recorded in the last 20 years, that is since the embankments have been "plastered". This has made the rivers hanging (they flow between the banks at a higher altitude than the countryside). Another cause has been the dredging of the internal canals of the lagoon, in particular since the dredging has become regular and cyclical: all this has limited the migrations of bacterial populations coming from the animals that live in the seabed (and that die there) and has eliminated the decomposition of plant matter that fell into water. All studies and environmental reports² on the Lagoon of Marano and Grado show that the continuous

² We report below two important geomorphological studies on the role of basins and salt marshes (barene) of the Grado and Marano Lagoon for naturalistic dynamics: Fontolon G. (2010) *Le trasformazioni ambientali della Laguna di Grado e Marano*, ArpaFVG rapporto tecnico UNITS, Trieste; Fontolon G. Covelli S. (2013), *Studio delle aree barenicole della Laguna di Grado e Marano*, ArpaFVG rapporto tecnico UNITS, Trieste.

hydromorphological transformation is the main source of naturalness of the entire lagoon habitat [14], but on the contrary it is also the main problem for the survival of the settlement systems developed on the perilagunar territories. The scenarios that we have elaborated are a proposal to rebalance the environment-human settlements, which starts from the role of water as an environmental frame and a continuity device for the reconstruction of the ecological lagoon network, but above all of the self-regulation processes, which they are based on controlled flooding and on the circulation of “descending and ascending” waters (tidal flows, and dynamics of sandbanks).

- *The water storage tanks: tanks, basins and floodable areas.* The first problem to solve during heavy rainfall is the surplus of the amount of water that the system cannot absorb: the "first rain" and the flood water. The topic solution is to provide natural systems and self-regulation for the management of the expansion of the *overflow volume*, which then reverberates over the whole environmental system (animal species, fauna, soil structure, crops), but even more and with seriousness on the settlement systems (rural villages, inhabited centers) and on all the network infrastructures, in particular on those for the collection and outflow of urban rainwater and on the relative purifiers (critical issues detected especially in the centers coastal beaches such as Grado, Lignano Sabbiadoro and Marano Lagunare). Thus was born the proposal to insert large swath areas in open countryside (with the function of water retention basin) and on “flywheel tanks” (storage tanks) that can be integrated with public spaces (water squares) in urban areas. This system, now widely indicated by the Regional Water Management Plan of the Friuli Venezia Giulia Region, would allow to collect the surplus of first rain or full water and then gradually release it (48-72 hours) into the aquifer, without causing a crisis the hydraulic system, using post-sub-infiltration basins, or simply unloading on open areas with a morphological conformation of the soil suitable to be flooded by water and then, after the event, to empty itself [15]. The proposal, which refers to important studies and experiments of northern Europe³, is therefore to include large flood basins and many small underground storage tanks in the area around the lagoon, which in emergency can contribute to satisfying the expansion of the overgrown volumes and which for the rest of the time are conformed as real environmental units, therefore integrated into the landscape system. These considerations show the importance of both landscape and environmental water for our study area, and above all as a continuous system and matrix of the ecological network for this fragile lagoon and coast system of the Lagoon of Grado and Marano: that's why the shapes of the water, and the forms generated by water are the paradigm of both the analytical and the design part. The scenarios therefore hypothesize a return to controlled "irregularity" in water management, or rather to forms of self-regulation which, however, start from the assumption of returning their spaces to the water of the Lagoon. This can only go through processes of restoration land reclamation (oasification), which lead to an arrangement of the flooded or semi-flooded landscape of the lowland forest, and to the settlement forms (*the square and the hexagon*) in balance with the forms of water.

³ Topos magazine was one of the first landscape architecture magazines to dedicate monographic issues to these water retention systems and hydraulic devices for collecting and infiltrating the aquifer integrated into the overall design of public spaces, parks or entire and vast countryside areas. Topos in the early 2000s published the following 2 issues to these topics: *Water. Design and Management*, Topos n.59/2007, and *Water. Resource and Threat*, Topos n.68/2009.

Discussion. Restoration land reclamation and oasification

Criticality and potential of the results

The "study process" through the mapping of the geomorphological structure of the territory, the hydrographic and infrastructural networks on the PAIR scenarios has highlighted some critical issues and potential. Among these, we highlight the management of water, which on the one hand is necessary for the survival of settlement systems and crops and on the other is a process that progressively reduces the overall level of biodiversity of the lagoon ecosystem. The changeability of the geomorphological structure is the origin of the natural processes that constantly regenerate by exchanging between lagoon and perilagunar habitats (land reclamation), but it is also the origin of the fragility of the settlement system, in contrast to the rigidity of the system fragility, while for settlements it is a safety factor. If we look at the system as a whole, the loss of biodiversity, however, is not positive for anyone, as it leads to greater expenses for ecosystem services, which then transfer to social cost. The scenarios that we proposed arise from an existing antithetical condition, and aim to build a new balance, which arises from the recovery of an original, pre-reclaimed territorial structure, therefore already inherent in the landscape matrices and in the environmental units of the Lagoon of Grado and Marano.

The restoration land reclamation (oasification) is a first solution capable of reconfiguring the environmental and landscape continuity of the peri-lagoon territories, the basic condition for the formation of environmental frames. Bringing water back to the reclaimed lands may seem a little pragmatic, but in reality the analysis of various case studies such as the case of Val Padusa, Cassa del Quadrone and wetlands in the lower Bolognese [16], but also the case experimental, already implemented in this area, in Fossalon, near the Grado Lagoon and the Cona Island, at the mouth of the Isonzo river [17], show how reversibility has worked, especially in terms of time, because it has been shown that marine habitats reform faster and easier than others. The consequent problem is constituted by the consolidation of the same, which should in this case, given the heavy anthropic action of man carried out so far, be accompanied by various types of actions (environmental restoration, renaturalization, monitoring of the seabed and cover-up phenomena, analysis of the processes of modification of the chemical compositions of the soil, reintroductions of birdlife, etc.), especially for the areas cultivated since the 1926 reclamation to date, and then the land reclamation of the 1920s as well as responding to a need for land to be cultivated, they were the solution to various diseases, including malaria, the most important. Today, however, technology and medicine, together with a series of hydraulic devices (water oxygenation) could reduce, if not completely eliminate the latter problem. The return to the pre-remediation condition (oasification) and the archipelago structure are the most relevant results of this research: both for the analysis documents and for the techniques with which we have reconstructed the knowledge framework. Another important fact that we have discovered are the dynamics that led to the current structure (criticality / potential). Understanding the dynamics allowed us to elaborate the overall visions and the detailed project proposals. Restoration land reclamation (oasification) and archipelago are two ideas-tools [18]. The instrument idea is a conceptual device and a programmatic approach⁴, which has allowed us to design a masterplan for the entire territory of the Lower Friuli and Isontina Plain (coast and lagoon territory), which integrates the environmental frame and

⁴ I The concept of "idea-tool" was developed by Franco Purini in 1997 and published in: Purini F. (2000), *Comporre l'architettura*, Laterza, Roma-Bari, pag.29.

settlement models to provide a solution to the problem of ecological fragmentation, and more generally, to the problem of Friulian deserts, without however completely erasing them: in summary we propose to “planning and design with nature” [19].

Criticality and potential of the method

This is a "qualitative" research, it is certainly partial and not exhaustive, and has several problems, which emerged during the mapping. The limit of this method is often linked to the precision of the georeferencing of historical cartography, and the relative level of approximation of the position of the individual territorial systems. We have completed the reconstruction of the territorial knowledge framework also with a screening of historical-literary treatments taken from excerpts from literature, historical and archaeological research and local history texts (especially on land reclamation, economics and agricultural society) and ethnographic research. There are many local authorities that govern this territory, and this implies a strong disaggregation of data, which in some cases are also conflicting and inconsistent between them. In these cases we have reworked the data by interpolation. This research is therefore a qualitative investigation with a transdisciplinary character to solve territorial problems. A substantial part of the study derives from the objective data of the soil: in the geometry of the countryside, in the morphology of rural settlements (farmhouses), in the plant wrecks along ditches and drainage channels and in the conformation of the banks along the lagoon eaves. The method of combining these indicators and the syncretic reading of these traces and landscape constitutes an important method for the reconstruction of the landscape matrices and the basic environmental units of the perilaguna territory of the land reclamation: the Friulian deserts.



Figure 7 - Friulian deserts: portion of land reclamation, area of the case study: Land reclamation of Fossalon between the island of Cona and Grado.

Conclusion. *City beyond the city, or city that floats on the city*

The specificity of the Low Friulian Plain consists in the totality of the territorial form generated by the water and of the settlement structure (Tentori 1983), which without considering the historical and morphological analyzes on the landscape, can still be read today as an archipelago, a territorial figure, an instrument of reading and project. This territorial figure as a planning tool was thus described by Rem Koolhaas and Oswald Mathias Ungers in 1977 in *The city in the city. Berlin: a green archipelago*:

[*"For ten years, the notion of urban archipelago or city-archipelago has been increasingly recurrent in the debate on urbanism, since they well describe both the way in which develop urban territories and because they explicitly explain how they should be designed. In our metropolitan condition, where the explosion of urban or suburban phenomena has individually blurred the distinction between city and countryside, this "terraqueuse" figure, borrowed from physical geography, suddenly seems to impose itself in the field of human geography as a capable meta form to translate and structure the shapeless, éclatée, diffuse, dispersed or multipolar city. Plural and identity at the same time, shaped by all the imaginary of navigation, it conveys the promise of a new convention or a new dialectic on the city and the territory, nature and culture, which overcome the classic opposition between cities and countryside. We can say that the archipelago is today one of the great possible figures of the hyper-city or the post-urban metropolis, able to overcome the obsolete dialectic between city and countryside "*by S. Marot, in F.Hertweck, S. Marot, *La Ville Dans La Ville: Berlin: Un Archipel Vert*, Lars Muller Publishers, Baden, 2013]

Our case study obviously has a different scale, urban layout and settlement origin, but, to paraphrase Koolhaas and Ungers, we could talk about *city beyond the city*, or *city that floats on the city*. The use of this figure together with the strategy of restoration land reclamation have allowed us to draw up territorial scenarios and to elaborate an overall masterplan for the Friulian deserts, which starts from the concept of renaturalization, from the need to increase biodiversity by reducing fragmentation. In summary we propose to reconstruct the environmental continuity (through the restoration land reclamation) at different scales, then to configure through the watershape (considered both as form and as matter: solid water) an ecological perilagunar network for the Friulian deserts, which, however, is also new at the same time settlement form: a new landscape. This approach and the first results allow us to continue the development of research in architectural themes, therefore studying new settlement typologies consistent with the coastal archipelago of the Low Friulian Plain and its genesis. We have already started to identify these new water living forms in “lagoon shelters”, “agro desert camps” and “stilt countryhouses”.



Figure 8 - Experimental settlement typologies for Friulian deserts, from left: “lagoon shelters”, “agro desert camps” and “stilt countryhouses”.

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