

Lorenzo Fabian, Ludovico Centis

The lake of Venice

A scenario for Venice and its lagoon



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The lake of Venice
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ISBN: 979-12-5953-022-6

Citation: Fabian L., Centis L. (2022), *The lake of Venice. A scenario for Venice and its lagoon*. Conegliano: Anteferma Edizioni.

Research group: L. Fabian (coordinator), C. Cangioti, L. Centis, L. Iuorio, G. Magnabosco, G. Mantelli, E. Longhin, I. Visentin.

Texts: L. Fabian, L. Centis.

Images and maps: L. Fabian with C. Cangioti, G. Mantelli, I. Visentin & the students of the Urban Design course and the City and Landscape Laboratory of the Bachelor of Architecture at the Università Iuav di Venezia (Academic years 2019-2020; 2020-2021; 2021-2022).

Design and layout: L. Fabian, C. Cangioti, G. Mantelli.

Photos: G. Sreliotto

Translation and revision of the English text: L. Centis & Just/Venice

Publisher: Anteferma Edizioni, Conegliano, Italy

The research group discussed and shared every part of the publication, however for the analytical detail of the attributions of texts, maps, images, and exploratory projects see the credits in the publication's appendix.

This book was published with the help of the Department of Architecture and Arts, Università Iuav di Venezia.

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A scenario for Venice and its lagoon

Foreword

Once again in its long history, the Venice lagoon needs profound rethinking in the light of the environmental crisis, demographic decline, and the tourist pressure it is under. This book on the future of the lagoon stems from the urgency that emerges from these aspects and as a synthesis of an exhibition, as well as of a series of ongoing research and educational experiences in which we are involved.²¹

Starting from the entry into operation of the MoSE and the scenarios related to the expected climate change, our contribution as architects and urban planners – entrusted with the task of bringing a gaze able to encompass such a broad and articulated framework – is to synthesize the possible vanishing points that the future of the lagoon delineates. The economic, environmental, and social challenges that characterize the metropolitan city built around the Venice lagoon are profound and to some extent unique but, as Secchi reminds us, they are part of a new global urban question with which all cities will be confronted (Secchi, 2011; 2013).

Introduction

The conclusions of the first scientific report on climate and environmental change in the Mediterranean region, presented at the Forum Régional de l'UpM on 10 October 2019 in Barcelona, tell us that the Mediterranean space is warming up 20% faster than the rest of the world. Such changes will have major impacts on temperature, precipitation, atmospheric circulation, extreme events, sea level rise, seawater temperature, salinity, and acidification (Cramer, Guiot, and Marini, 2020).

The Mediterranean is a 'geopolitical paradox' (Spadaro, 2020), an increasingly enlarged and fragmented shared space at the centre of one of the geographical areas of greatest transformation due to climate change, profound and tragic social and economic changes, and impetuous demographic transformations. We know the planet is transforming. The dynamics linked to the climate draw unexpected new geographies, and the scarcity of fossil fuels and natural resources reveals new lands to be abandoned and others to be plundered and exploited. The crisis conditions that characterize this great 'sea between the lands' today reflect this worrying climate picture. The Mediterranean has also become the epicentre of violence and urbicide (Albrecht *et al.*, 2017): it is perhaps necessary to have a broad reference horizon in order to solve specific and local problems linked to crisis situations.

The design studio 'The New Mediterranean System'^{1,2} of the master's degree in architecture of Università Iuav di Venezia had the objective of constructing a framework project for the Mediterranean space and defining an image, a far-reaching proposal towards a peaceful future for 500 million people able to meet the environmental, energy, and geopolitical challenges in progress. The unified Mediterranean project reconceptualizes the original idea of 'Le Système de la Méditerranée' introduced at the beginning of the 19th century by Michel Chevalier, where for the first time this 'sea between the lands' was understood as a *unicum* (Chevalier, 1832). From a geopolitical point of view, the Mediterranean continues to be the geographical field described by Fernand Braudel, a 'fissure in the earth's crust' which has become a crossroads of cultures and trade in goods, which united and unites around itself, often in a conflicting way, three types of civilization: that of the Christian West which had its centre in Rome and from which Europe was born; that of Islam, stretching from Moroc-

¹ Exhibition: Venice Canal, expo at the Musée des civilisations de l'Europe et de la Méditerranée (MuCEM), Marseilles (Fr). Research activities: *La Tourism and Cultural Heritage Lab* (2021-2022), funded by the Industrial Rehabilitation and Recursion Project, Venice Complex Industrial Crisis Area, VENETO SUD/INVALE/SMART TOURISM 2020 (2020-2021) funded by the European Social Fund Regional Operational Programme, Veneto Region, *Pole-sistemi della Laguna* (2019-2020), research carried out in the framework of the activities of the programme 'Venezia 2021 Scientific research programme for a regulated lagoon' funded by COBULA (Commissariat for the Coordination of Research on the Venice Lagoon System). Educational activities: *The New Mediterranean System* (Academic Years 2019-2020, 2020-2021) design studio of the master's degree in Architecture of Università Iuav di Venezia; *Mediterranean Metropolis of literal mediterraneità, enjeux climatiques et solutions de résilience* (Academic Years 2021-2022) educational project Erasmus Plus, Ecole Nationale Supérieure d'Architecture de Marseille (ENSA), Università Iuav di Venezia; *Facoltà d'architettura La Cambre-Horta ULB Bruxelles, Ecole Nationale d'Architecture de Tétouan Maroc; Scenari della laguna* (Academic Years 2018-2019, 2019-2020, 2020-2021) design studio of the bachelor's degree in architecture of Università Iuav di Venezia. For details see the *Research and teaching studies* in the Appendix at the end of the book.

•• The activities of the design studio 'The new Mediterranean System' of the master's degree in Architecture of Università Iuav di Venezia are part of the broader Erasmus-Mediterranean project *MediMed Océanopolis: digital Mediterranean, enjeux climatiques et solutions de résilience* an educational and research project to counter the environmental risks that loom over the Mediterranean space. During the three-year duration of the project the issue of the resilience of the Mediterranean coastal territories and metropolises to the challenges posed by climate change and rising seas is addressed, starting from three coastal cities - Venice in Italy, Marseille in France, and Tetouan in Morocco - through educational workshops involving instructors and students from the partner schools. See *Research and teaching results* in the Appendix at the end of the book.

co to the Indian Ocean; and finally the Greek-Byzantine one, a bridge between Asia Minor and the Balkans (Braudel, Coarelli, and Aymard, 1977). According to Henri Lefebvre, historically the cultural unity between the Mediterranean countries was organized around multiple forms of exchange based on 'tacit or explicit forms of alliances' (1992). In this context, starting from environmental issues, water can still assume the role of a central and unifying issue. In the south, from the African coasts to southern Italy, Turkey, Greece and Spain, water will increasingly become a problem of scarcity, declared in the themes of the territorial project to defend against desertification and drought, from heat islands and the danger of fires. To the north, in the territories bordering the northern coasts and in the hinterland of the floodplains of large rivers, the water problem is, and will increasingly be, a problem of defence against floods, overflows and sea level rise. These aspects touch the territories of the Camargue and the nearby production area of Martigues in Marseille, Kavaje in Albania, Elche in Spain, and Rosetta, the terminal point of the metropolis of Cairo on the Nile Delta. Territories that, like Venice, will see their existence increasingly threatened by the rise in sea level and for which it seems possible to explore the adaptive dimension of the amphibious project, through the construction of new lagoons, inhabited wetlands, and environmental reserves in the heart of a new metropolitan dimension.

In 1984, to highlight the different conditions of the urban project, Bernardo Secchi published in *Casabella* an essay entitled 'The conditions have changed' in which he pointed out 'the halting of migratory flows, of the growth of large cities, the slowdown of construction in urban areas and its displacement to other dispersed places, industrial delocalization, the progressive emergence of the urbanized countryside, widespread industrialization, the extension of the landscape of metropolitan suburbs' (Secchi, 1984) as signs of profound change. Today, in the light of the economic crisis at the beginning of the millennium, the environmental problems linked to climate change, the exhaustion of fossil fuels and the geopolitical tensions that follow, the global change we are experiencing has become increasingly evident. This appears even more true today, when as we write, the crisis deriving from the pandemic we are experiencing has been added to the environmental and economic emergencies. It is the opinion of many that the

world we will find at the end of this health emergency will never be the same again (Harvey, Camp, and Caruso, 2020). On the one hand, together with our lifestyle, the paradigms around which the social and anthropological structures of our societies and of our country, based primarily on human contact, on interpersonal and trust relationships, have now been put into question. On the other hand, the faith that had been placed on an economic model based on production chains on a global scale will change. Furthermore, what we are experiencing teaches us that the future is often unpredictable, that what we have achieved should not be taken for granted, that the world and its resources (material, economic, environmental, and social) on which we could count and that until yesterday we thought indisputable are actually very fragile, and we must take care of them, because everything can suddenly



The new Mediterranean System
Framing and study areas.

►) Scientific activity carried out in the frame of the *Venice 2021* research program, with the contribution of the Interregional Authority for Public Works for Veneto, Trentino-Alto Adige and Friuli Venezia Giulia, provided through the Concessionaire Consorzio Venezia Nuova and coordinated by CoRiLa (Consortium for the Coordination of Research on the Venice Lagoon System) with Iuav, Ca' Foscari, Padua universities and the national research bodies CNR (National Research Center) and OGS (National Institute of Oceanography and Experimental Geophysics). See *Research and teaching credits* in the Appendix at the end of the book.

change. This experience speaks to us of our greater or lesser capacity to adapt to risk and disasters, whether they concern health like today, or the environment –and access to resources– as they certainly will tomorrow. It is evident that all this will also have a cascade effect on the territory of the Venetian metropolis and on confidence in the large and small projects that are presently under construction. More generally, if we look away from Venice to the urbanized world, there will be an impact on the ways of rationalizing –and designing– the city, on public space intended as a space for democracy, on production chains and access to raw materials. Our research also fits into this framework dominated by uncertainty. We need to be prepared, with new planning models that know how to prepare for the unexpected (Arnoldi *et al.*, 2020).

The regulated lagoon

In 2018, the CoRiLa consortium launched a new research programme called *Venice 2021* which intends to investigate the evolution of the Venetian territory in light of the entry into operation of the MoSE, when the Venice lagoon system will become 'regulated'. The broader work programme contemplates the creation of 'new scenarios' for the future of Venice and its lagoon and involves a large number of researchers, hydraulic engineers, environmental scientists, technologists, restoration experts, chemists and biologists.^{* 1} In the aftermath of the tragic flood of 2019, the controversy over the long-term effectiveness of the MoSE and the various hypotheses of closure of the lagoon, our research is the illustration of a possible scenario for the future of the lagoon and the verification of its possible legitimacy.

The lake of Venice is neither necessarily the only possible scenario, nor the best one for Venice. It is not even an unprecedented scenario. However, we believe it to be a plausible one. A scenario developed starting from an in-depth historical knowledge and the awareness that, as D'Alpaos and Rinaldo underline, transformation represents the only alternative to the extinction of the lagoon: 'It should be noted, aside from the study on the evolution of the shape and function of the Venice lagoon, that the concept of equilibrium, in the static sense of maintenance and conservation that it suggests, has no place in natural evolutionary phenomena, especially in the Venetian context. As extinction is the only



alternative to evolution (of the residual lagoon forms and their environmental, physical, cultural services), the study of the many lagoons that have occurred in their evolutionary history aims to provide elements for informed historical analysis and to make transparent the causes and effects of measures aimed at the restoration, conservation, or use of the lagoon environment. The rigorous analysis aims to create sharing, conscious cooperation, moral commitment' (D'Alpaos and Rinaldo, 2015, p. 35).

According to Bernardo Secchi, in contexts dominated by uncertainty, 'The main [task of urban planning is] the idea of a continuous, patient construction of scenarios. [...] In a democratic and open society, everyone is free to make proposals and to justify them by resorting to the arguments they deem most appropriate. [...] But the task of every intellectual who claims legitimacy, including architects and urban planners, is to subject each of these ideas to a severe critical scrutiny, transforming them precisely [...] into scenarios' (Secchi, 2002). By mobilizing the tools of the territorial and landscape project –and based on the hypotheses of closure and compartmentalization of the lagoon advanced by some authoritative scholars– our research attempts to look at the past in a speculative way to critically rethink the present and imagine an alternative future. For this reason, the history of the lagoon plays an important role here. In fact, on the one hand, it allows us to understand that the environmental threats to which the lagoon is currently subjected are not entirely new. On the other, it assumes a crucial role as an empirical but indispensable framework for reasoning on the legacy of past projects and therefore on the legitimacy of the ideas and projects for tomorrow.

Chapter 1

On the lake of Venice

Venice, year 2100.

In 2100 the ancient Venice lagoon is divided into three parts. The central part, the lake of Venice, is a large hypersaline water space, protected by an embankment that preserves the immense monumental deposit of the historic centre of Venice and the other major islands (Murano, Burano, Torcello ...). The large city of Mestre, as well as Marghera, Favaro Veneto and the Lido, overlook the lake of Venice. This city has consolidated over time into a horizontal metropolis, an active urban space, crossed by mass tourism and trade routes, punctuated by the presence of metropolitan facilities such as the Venetian universities, the Mestre hospital, the Tessera airport, the new industrial and tourist ports located along the former *Petroli Canal*, between Fusina and the Malamocco lagoon mouth. The large embankment protecting the lake of Venice relies on the one hand on the MoSE system (using the movable bulkheads and adapting them to the new needs), on the other by exploiting the pre-existing morphological elements (dunes, salt marshes, consolidated islands). Furthermore, it will be necessary to strengthen the existing embankments and dams equipped with dewatering pumps with the aim of keeping the average level of the lake water below +90centimetres compared to the zero tide level of Punta della Salute (ZMPS).

The lake of Venice is a protected area, separated from the southern and northern lagoons by the Malamocco channel (formerly *Petroli Canal*) and the ancient riverbed of the Dese-Sile that runs along the islands of S.Erasmo, Torcello and Burano, on which new waterproof structures have been established. The lake is hermetically sealed on the Adriatic front thanks to the new embankment of walls integrated by breakwaters that preserve the Lido-San Nicolò strip from possible damage caused by storm surges. Access by water to the lake of Venice is allowed only to small-sized ships without carbon emissions through special navigation locks and outflow openings that allow water exchange with the surrounding water surfaces, avoiding stagnation, maintaining healthiness and the correct salinity levels of the water. Territorial trams run along the banks surrounding the lake, where the slow mobility networks that connect Marghera and the Marco Polo airport on the mainland to the coasts of Malamocco and Punta Sabbioni are also located. At the edges of the lake of Venice are located the northern and southern great lagoons.

The two lagoons, home to numerous animal and plant species that represent a great environmental heritage for the entire territory, are designed by landscapes of mudflats, sandbanks and tidal creek that recall the



original environment of the 'dead lagoon'. The ancient system of fishing valleys, interconnected with the centuries-old mechanisms of lagoon fluid dynamics, has been slowly converted into different and more contemporary forms of fish farming, which have become an important resource of the lagoon economy. Within

these landscapes the practices of fishing, cultivation and continuous maintenance of a fragile environment still take place thanks to the incessant work of fishermen and aquaculturists. These are the same populations of aquaculturists who in 2100 can count on a larger lagoon area of production, reconquered from the reclaimed agricultural territories following the closure of the water pumps which, until the beginning of the 21st century, kept the lands on the edge of the *conterminazione lagunare* –the administrative and juridical border of the lagoon– artificially dry. In memory of this ‘paleo-lagoon’, the stones that once defined the ancient boundary emerge from the water space. A large plant system acting as a forest buffer is found all around, punctuated by wetlands with macrophytic plants along the main hydrographic systems. This system guarantees the purification of the waters that come from the hydrographic system and that cross the polluted lands of the “diffuse city” located on the lagoon drainage basin. The territory of the new lagoons is crossed by the main road infrastructures that were built during the 19th and 20th centuries and which, given the original construction in relief with respect to the level of the countryside, survived the average sea rise. The sediments brought in thanks to the completion of the Padua-Venice waterway and an embank-

ment overlooking the southern lagoon along the *Petroli Canal* have allowed the terraforming of areas inside the lagoon, real inhabited islands. New navigable lagoon canals make it possible to reach these islands, secured by reinforcement embankments formed by the material resulting from the excavation of the canals.



A couple of years after the exceptional high water*¹, in the face of the incessant controversy about MoSE and more-or-less scientific ideas about the lagoon that emerge from popular debates, this text tries to deal with 'the hypothetical in a strong sense' (Badaloni, 1983, p. 40). Since the very beginnings of the Serenissima, the Venetian lagoon has been the subject of numerous ideas, plans and projects that have never been fully realized. The hypothesis that we put forward here is that these urban episodes (conceived and documented) may still be topical and capable of building new foundations for discussion about parallel lagoons. The possible story of a series of never-transformed lagoons thus becomes a tool to better understand the success and failure of the projects underway to protect the Venice lagoon.

From its origins, in fact, the centuries-old history of Venice is one of techniques, ideas, and projects to make a fragile, sometimes hostile and insalubrious territory habitable, combining the reasons for economic development with those of environmental protection. A story that in the *longue durée* is inscribed in the 'fabric' of the territory and in a specific geography that also shapes its destiny. This is true for Venice, for the Mediterranean Sea within which it has stubbornly carved out its vital space and its system of relationships, the nature of which '[...] cannot be fully understood except in the long perspective of its geological history' (Braudel, 1998, p. 15) and by the great plain to which it turns, which since prehistoric times has been 'the kingdom of rampant waters [to be] conquered against hostile swamps' (p. 15). The expression 'regulated lagoon' proposed by CoRiLa is actually an oxymoron that well expresses the ineluctable fate of the Venice lagoon, of its perpetual and centuries-old battle to oppose a specific hybrid and transitional geographical condition, whose natural future would be that of disappearing to become a part of the sea or an extension of the land. For almost fifteen hundred years, in order to oppose this natural future, man has changed the course of rivers, drained, and reclaimed entire parts of the territory, built embankments, artificial canals, bridges, dams, bridges, pumped water, consolidated mud. Within this long-term destiny, environmental, economic, political and health issues have always overlapped, and are part of the same attempt to make an uninhabitable place inhabitable

* 187 centimeters above the average sea level, recorded at the Punta della Salute survey station at 10:20 pm on Tuesday 12 November 2019.

*2. "Those who write about agriculture affirm for sure that from the corrupted nature and the stench of manure certain small animals are generated, which cannot be seen and that while breathing enter through the nose, causing an almost certain death suffered to animals and men" (unh.trans.).

through the construction of a 'regulated' space. Alvise Cornaro understood this well at the time of the Serenissima, when in support of his arguments for filling up a vast part of the lagoon, together with the need for new land for food resources, he recalled the risks derived from the growing marshes and the impairment of the quality of 'good air': 'Coloro che scrivono dell'agricoltura, affermano per cosa certa, che dall'humore corotto e la puzza deli letami generano certi animaletti di tanta picciolezza, che non si possono vedere, li quali nel respirare del fiato entrano per il naso, et sono causa de una morte quasi certa subita alli animali et agli huomini' (Cessi, 1941, p. 4).²² For Cornaro, of course, the health and environmental issues indissolubly intersect with those of economics and safety, in fact 'three were [...] the main conditions which could ensure the city long life: healthiness of the air, strength of the place, favourable living conditions for people; not easy to reconcile, because in one way or another subordinated to the maintenance of the lagoon balance, with which they could often enter into conflict [...]' (Cessi, 1941, p. VIII). The debate that arose over time demonstrates, on the one hand, how the problem with which Venice has been called upon to confront –the project of a regulated lagoon– is, and will always be, the same: combining the reasons for development with the environmental, health, social, and political issues. On the other hand, it is a story that shows us how the Venetian issues (of yesterday and today) are actually global issues which all human forms of settlement have had and will have to confront (Bevilacqua, 2009). With respect to these problems, the protagonists of our stories take a stand and propose a vision of the future through clear projects for possible lagoons. From the particular point of view in which we find ourselves today, it seems important to observe how the need and urgency of a project for Venice with which to embody a specific vision of the world, always reappears in the course of history. This happened with particular impact in the aftermath of health, environmental or economic disasters, which therefore assume the role of planning accelerators. It is a very clear matter to Eugenio Miozzi, who three years after the tragic flood of 1966, in the introduction to the volume *Il Salvamento* (The Saving), explains to us how Venice 'has now reached a crucial point in its life, to the point where its survival or its disappearance will be decided; in the present moment any mistake can be fatal' (1969, p.11). It is in these crucial

moments, after a disaster but before a possible catastrophe³³, that the future is written and that the past can still be of fundamental help 'so that the experiences of the past serve the present and so that yesterday's mistakes are a warning to the operators of tomorrow' (Miozzi 1969, p. 12). The history of Venice, its waters, and its disasters, is therefore the centuries-old history of man's battle to make a home in a fragile and uninhabitable world, made up of floods, swamps and malaria. A story that looking to the past can push us again to imagine the future, even today, in such a critical and delicate moment, because, as Bevilacqua reminds us, 'today there is a special, deeper reason for recalling this history [of Venice and its waters] to the attention of our contemporaries. [...] Our present situation, our precarious relationship to dwindling resources, our environment that is steadily deteriorating and threatening us, all make us turn to Venice's singular past to a history that in a certain sense faced our own problems, centuries in advance' (Bevilacqua, 2009, p. 2).

Studying Venice, the lagoon and its islands today inevitably means having to deal with a long history of hydrogeological modifications and the social, political, and economic changes that have resulted from it. The Venetian lagoon, in fact, is a territory in which the work of man has produced a historicized environment capable of containing and assembling cultural and natural information over time and space.

It is common knowledge that some emerged areas were inhabited in pre-Roman times, but it is from the 15th century onwards that the hydraulic engineers of the Serenissima began to impose on the territory a model of conceptualization of space collectively supported by the proverbial idea that 'a great lagoon provides a great port'.³⁴

In the 14th century, we begin to witness the material evidence of the great work of geographical modification that involved the entire drainage basin: the lagoon underwent a considerable process of burial caused by the large quantities of sediments introduced by rivers such as the Brenta, Bacchiglione, Dese, Muson, Zero, Sile, Piave (D'Alpaos, 2010a). The stretch of water, however, was an essential condition for the survival –not just commercial– of the population who lived there and had to be protected, safeguarded, defended. From the 15th century, the lagoon thus became an envi-

³³ On the concept of disaster and on the difference between disaster and catastrophe see Ferrin (2007).

³⁴ The aphorism is attributed to Marco Cornaro (1289–1368) (Cesari, 1960, pp. 49–50).

ronmental monument controlled by a continuous, experimental, and incremental anthropic enterprise. An interminable series of interventions and hydraulic conjectures follow one another and freeze this territory.

The Venice lagoon is, by its nature, a mutable space, in transition between land and water and yet a constant maintenance work – from the great efforts of the Republic to the widespread micro-interventions of fishermen, millers and farmers– has supported the daily subsistence of an entire population for centuries. It can be said that the relationship between Venetians and the lagoon is traditionally risky and precarious. According to Bevilacqua (2009, pp. 20-21), in fact, ‘choices had been made in the past –diverting a river, opening of a channel, enclosing a fish pen– and the present could begin to evaluate the effects. The previous decades and centuries, therefore, gave not just the proof –a submerged island, a filled-in swamp– of what Venice could become in a more or less near future. They also testified to human error or successful choices, displaying before the eyes of contemporaries the consequence of actions undertaken by their predecessors. [...] This is another reason why the Venetians could only have a strictly secular relationship with their history and an absolutely open-minded, empirical view of the present and the future’.

If, therefore, the lagoon is a palimpsest (Corboz, 1983) of permanent nature in which, in the last six centuries, man has imposed his own energy through a tangible system of regulation works, then its future will not only have to deal with projects and ideas in progress but, measuring itself with space, it will necessarily have to deal with all the projects and ideas that have been deposited there.

Methodological notes

The incessant process of regulation of the Venice lagoon has built up a geographical imaginary that has survived to the present day but has not been homogeneous and smooth. Indeed, it can be said with certainty that various moments of crisis have followed one another. These moments impose themselves in the history of the lagoon as occasions in which institutions and technicians –the first with the power to determine choices even on a large scale according to different models of conceptualization of space, and the others capable of materially implementing the modifications proposed by governments– initiate a series of ‘debates on the fu-

ture'. In the past, those crises have produced an endless stream of projects, plans, inventions, weird ideas, illegitimate actions, and potential disasters. Some of these were in the process of being realized until shortly before they faltered and then finally collapsed and left room for alternatives.

In this regard, Bernardo Secchi wrote in 2004: 'whoever retraces the history of a city or a territory clearly grasps the periodical going out of its course from "legitimacy" and "necessity", from what could have been expected. The reasons can be the most diverse and it is often difficult to reconstruct them in convincing ways. This is precisely what opens the way to the attempt of hypothetical reconstructions of the course of history, reconstructions that help us to better understand current and future decision-making processes' (Secchi *et al.*, 2004, p. 21).

Urbanism, in recent decades, has trained us in 'what-if' as a critical tool of the project to represent potential, plausible and desirable futures. The construction of scenarios, visions and imaginaries has a fertile tradition: the 'what-if' responds to the need to visualize in the medium and long term, starting from contemporaneity, design choices that have vivid repercussions in space (Bozzuto, Costa and Fabian, 2008). The theorization and systematic development of scenarios is a relatively recent phenomenon. The military strategist and systems theorist Herman Kahn is commonly recognized as the father of scenario planning (Fahey and Randall, 1997) during his tenure in the 1950s at RAND Corporation. At the end of this period, he released *On Thermonuclear War* (Kahn, 1960), a treatise on the nature and theory of war in the nuclear age. Possibly the most celebrated and controversial nuclear strategist and among the founders of the Hudson Institute in 1961, Kahn believed in the necessity to address with his work not just specialists and military personnel. It is for this reason that he encouraged people to 'think the unthinkable' (Kahn, 1962), reflecting on possible consequences of a nuclear war that in those years seemed to be very close.

Kahn's insights into the benefits of using scenarios as strategic planning tools stretched further than military matters and scenario thinking began to emerge everywhere from politics and economics to public policy. A key experience in this sense is the one of Pierre Wack, head of scenario planning for Royal Dutch Shell in the Seventies of the 20th century, who contributed to

the creation of a more formalized approach to scenario thinking (Chermack, 2017).

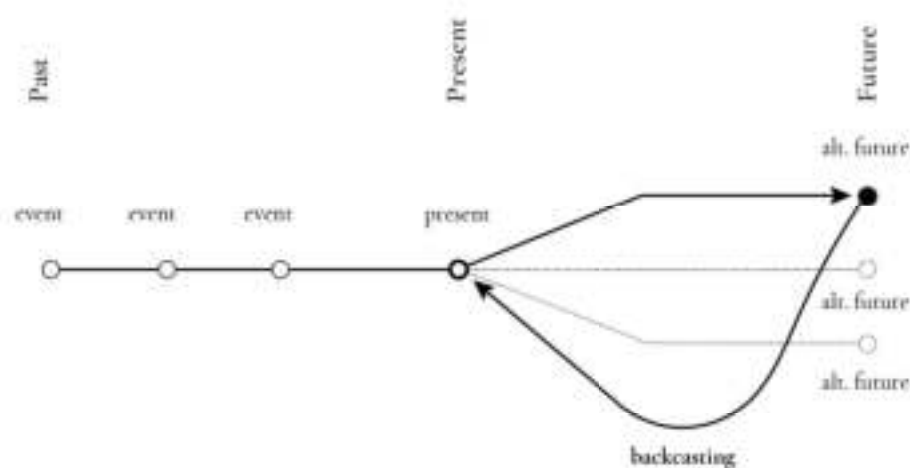
Stemming from the work of Kahn and Wack numerous approaches to scenario planning were developed, mainly in practice. This has led to a great diversity of methods and processes, and yet a clearly defined general approach that would result in a successful scenario planning still does not exist. Various typologies of scenarios have been suggested, without a consensus on them (Lena Börjeson *et al.*, 2006). This same variety seems to suggest that the ways of scenario constructing are very flexible and can be adapted to specific tasks and situations. Within this flexibility, it is important to set some boundaries and define how scenario planning differs from most other future-oriented approaches, such as forecasts, visions and simulations (Lindgren and Bandhold, 2009, p. 25). Scenarios usually provide a more qualitative description of how the present will evolve into the future, rather than requiring numerical accuracy. Scenarios differ from forecasts because they explore a range of possible outcomes resulting from uncertainty, while the purpose of forecasts is to identify the most likely paths and reduce uncertainty. Visions address a desired future, while scenarios –Kahn’s work on thermonuclear war is a perfect example– engage also with undesirable events. A vision builds a picture of a desired future together with strategies for achieving the goals. Lastly, there are also simulations, systematic quantitative models of the future without the assessment of probability, possibility, or desire.

The variety in defining methods and processes to build scenarios is reflected also in the definition of scenario itself. A scenario is ‘a set of hypothetical events set in the future constructed to clarify a possible chain of causal events as well as their decision points’ (Kahn, Wiener, and Hudson Institute, 1968, p. 6), ‘a means to represent a future reality with the aim of clarifying present action in the light of the possible and desirable future’ (Durance and Godet, 2010, p. 1488), ‘a hypothetical illustration of the future that describes a cross section in an established context, describes development paths and serves as a form of guidance’ (Pillkahn, 2008, p. 165). The scenario definition that best matches with this research and the imagination of a future lake of Venice is ‘a focused description of a fundamentally different future presented in coherent script-like or narrative fashion for better understanding

future uncertainties' (Schoemaker, 1993, p. 195). A definition that suggests how the development of a scenario is not only a planning tool but also an effective learning one, as it encourages an understanding of the development logic, clarifying driving forces, key factors, and actors. It is our belief that the adoption of the scenario tool for long-term planning and strategic foresight for Venice, its lagoon and metropolitan area, can facilitate a necessary adaptation to epochal challenges such as climate change and sea level rise, addressing key issues such as possibility, complexity, and uncertainty.

Counterfactual history

In addition to those placed in the context of the production of scenarios, there is a further question: 'what would have been the course of the urban history of a territory *if ...*' (Secchi *et al.*, 2004, p. 21). Thinking about the past –constructing a hypothetical alterna-

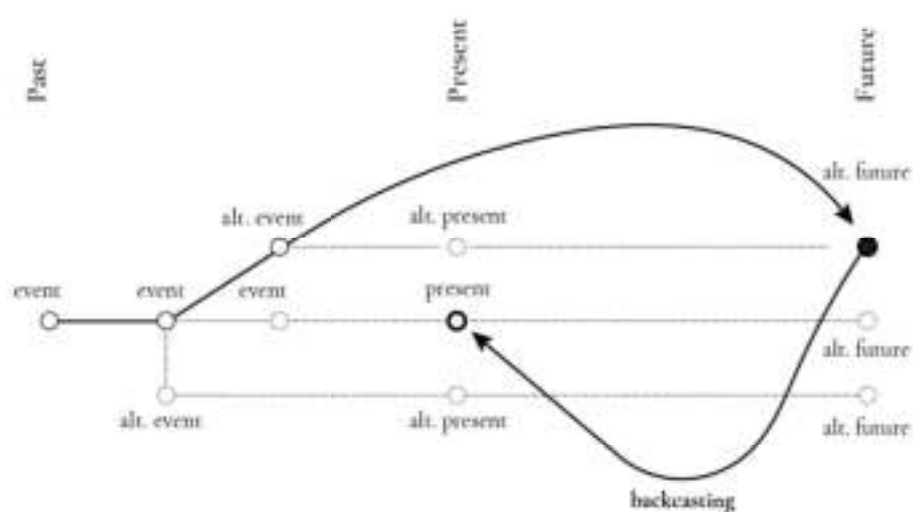


Backcasting Scenario

This diagram illustrates the relationship between past, present, and future through periodic events that define the urbanization of a territory. In this process, through a backcasting technique, the forecast desired in the scenario becomes normative, establishing a path that from the point of view of temporal logic proceeds from the future to the present.

five– and talking about the missing present [or future], according to Secchi, is a way to undermine the deterministic conviction of historical events: 'a rethought story [...] avoids both conservative nostalgia of a narration dominated by the process of worsening, and the naively progressive one of a narration dominated by the process of improvement and its heroes' (p.21). This question, 'not very frequented, usually evaded or producing hasty and superficial answers' (p.21) inevitably intertwines and clashes with the discipline of historiography.

Counterfactual history, in fact, has been the subject of controversy among numerous historians, and various objections have accumulated over the last century. One of the first systematic efforts in the field of counterfactual history is that carried out in the 1960s by the historian and economic scientist Robert Fogel (1964) who applied quantitative methods to imagine the state of the US economy if the railways did not exist. Fogel's effort remained almost



Retrospective Scenario

The diagram illustrates the methodology with which some past and never realized projects (alternative events) are actualized to be projected into the future.

solitary until the early Nineties of the 20th century, when the texts –which investigated three different counterfactual scenarios– by the sociologist Geoffrey Hawthorn (1991) were published as well as the collection of essays *Virtual History: Alternatives and Counterfactuals* (Ferguson, 2011). A collection that provoked bitter reactions, including that of Edward Palmer Thompson, for whom counterfactual history is ‘unhistorical shit’ (Ferguson, 2011, p. 5), a mere exercise of the mind tied to the narrative. Yet, as Niall Ferguson points out, ‘what we call the past was once the future; and the people of the past no more knew what their future would be than we can know our own. All they could do was consider the likely future, the plausible outcome. It is possible that some people in the past had no interest in the future whatever. It is also true that many people in the past have felt quite sure that they did know what the future would be; and that sometimes they have even got it right. But most people in the past have tended to consider more than one possible future. And although no more than one of these actually has come about, at the moment *before* it came about it was no more real (though it may now seem more probable) than the others. Now, if all history is the history of (re-recorded) thought, surely we must attach equal significance to *all* the outcomes thought about’ (p. 86).

Starting from the arguments accumulated by counterfactual history in recent decades, from the reflections on the role of scenarios in the future to design the present and from the enormous amount of projects that can be discovered by studying the Venice lagoon in history, in this book we will try to explore a possible future for the lagoon and to put it in tension with a series of projects that have never been realized. In a nutshell, some lagoons designed and documented but never completed, or only partially built, will offer the opportunity to evaluate the legitimacy of a future scenario with the profound awareness that many design ideas have already accumulated (in the archives) and settled (in places) and that the current challenges, from tourist pressure, to economic crises, to health emergencies, to environmental degradation and the risks associated with climate change, are by no means unprecedented challenges.



Elements / Key concepts

**What we talk about
when we talk about the
Venice lagoon?**

The Venice lagoon, by its very nature, is a mutable space in transition between land and water, characterized by natural morphological structures, *barene*, *velme*, *ghebi*, whose rhythms and form are marked by the tidal cycle. However, it is also a “regulated lagoon”, modelled by the incessant presence of man who has preserved over the centuries its equilibrium through drainage and reclamation, embankments and dams, canals, and humps.

1. laguna (noun) di Venezia (noun)



Surface and elements of the lagoon

Source of data: COIRIS, *Conoscere per il risarcimento delle maree* (increase of the Venetian lagoon), Venice, 2008.



Venice (noun) lagoon (noun)

The Venetian lagoon –an enclosed bay with a surface area of around 550 square kilometres– is the largest wetland in the Mediterranean basin. Formed about six to seven thousand years ago, it is the most important survivor of a former system of estuarine lagoons stretching over the entire North Adriatic Sea.

2. laguna (noun) viva (adj.) /
laguna (noun) morta (adj.)



Living and dead lagoon

In white the dead lagoon, the areas whose sediment residence times are between 12 and 100 days.

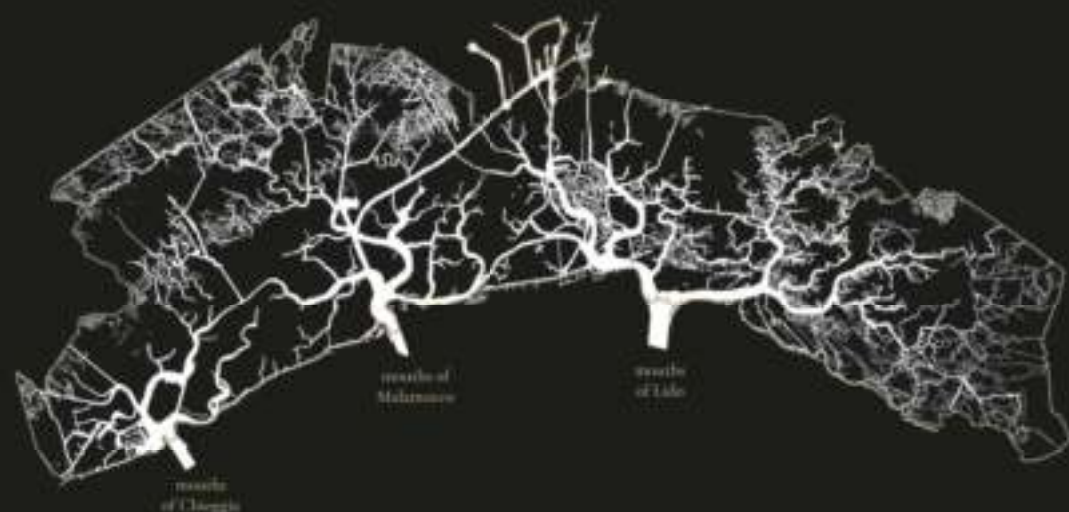
Source of data: ISMAR, Istituto delle Scienze Marine, 2014.



living (adj.) lagoon (noun) / dead (adj.) lagoon (noun)
Laguna viva is the living lagoon, the part which is closest to the mouths and most actively reciprocated by tidal currents. Here some areas are always submerged, while others are periodically submerged during high tides. *Laguna morta* is the dead lagoon, the part hydraulically and geographically decentralized with respect

to the mouths located towards its mainland edges. The dead lagoon is separated from the living one by the bands of larenz.

4. canale (noun)



Canals
66
140
(km)

Channels of the lagoon

In white the canals, in gold the *conterminazione lagunare* (juridical and administrative border of the lagoon).

Source of data: COBLOA, *Comitato per il coordinamento delle opere di mantenimento di interesse lagunare di Venezia*, 2010.



canal (noun)

Lagoon waterway of considerable width, wider than those of a *rio* or a *ghebo*. The channels of the lagoon can be natural or artificially excavated. Some of the main lagoon channels, like the Grand Canal, coincide with the paleo-beds of ancient rivers.

5. barena (noun)



Barena

0



54°

(lat)

Barena

In white the barene, in gold the *conterminazione lagunare*.

Fonte: dati CDRRA, Cassinica per il monitoraggio delle rische.
Inseriti al sistema lagunare di Venezia, 2000.

0 0,1 1 10 km



salt (adj.) marsh (noun)

Physical structure among the most characteristic of lagoon environments, it appears as a flat and low plateau, consisting of silty-clayey sediments, generally covered by halophilous vegetation. The sandbanks are located at intermediate altitudes between the islands and the mudflats. They normally have emerged, and

are submerged during the syzygy tides, that is, during the full moon and the new moon.

6. *velma* (noun)



Velma

In white the *velma*, in gold the *costermunazione lagunare*.

Source of data: CORISA, Commissione per il coordinamento delle ricerche scientifiche al sistema lagunare di Venezia, 2001.



marsh (noun) flat (adj.)

Portion of the lagoon bottom that remains submerged in normal tide conditions and emerges only with low syzygy tides. The *velma* is a habitat for European species that can withstand significant environmental variations -from salinity to oxygen dissolved in water and temperature- due to periodic and repeated surfacing.

7. ghebo (noun)

a) linear



b) linear dendritic



c) dendritic



d) meandering dendritic



e) reticulate



f) complex



g) superimposed



Abacus of ghebi

Different types of distribution of ghebi (from Allen, 2006)

tidal (adj.) creek (noun)

Small channel with a winding course that cuts through the *barene* and *telme*, connecting the innermost areas of the lagoon with the deeper canals.

8. valle (noun) da pesca (noun)



Fishing valleys

In white the fishing valleys, in gold the conterminazione lagunare.

Source of data: COBLOA, Comitato per il coordinamento delle attività portuali di interesse lagunare di Venezia, 2010.

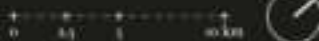
Fishing valley

98



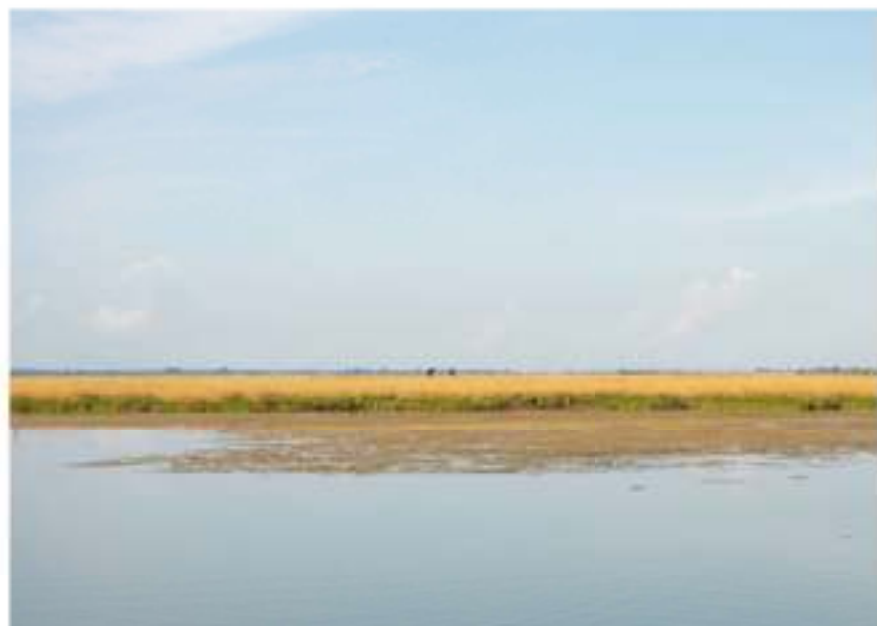
100

10000



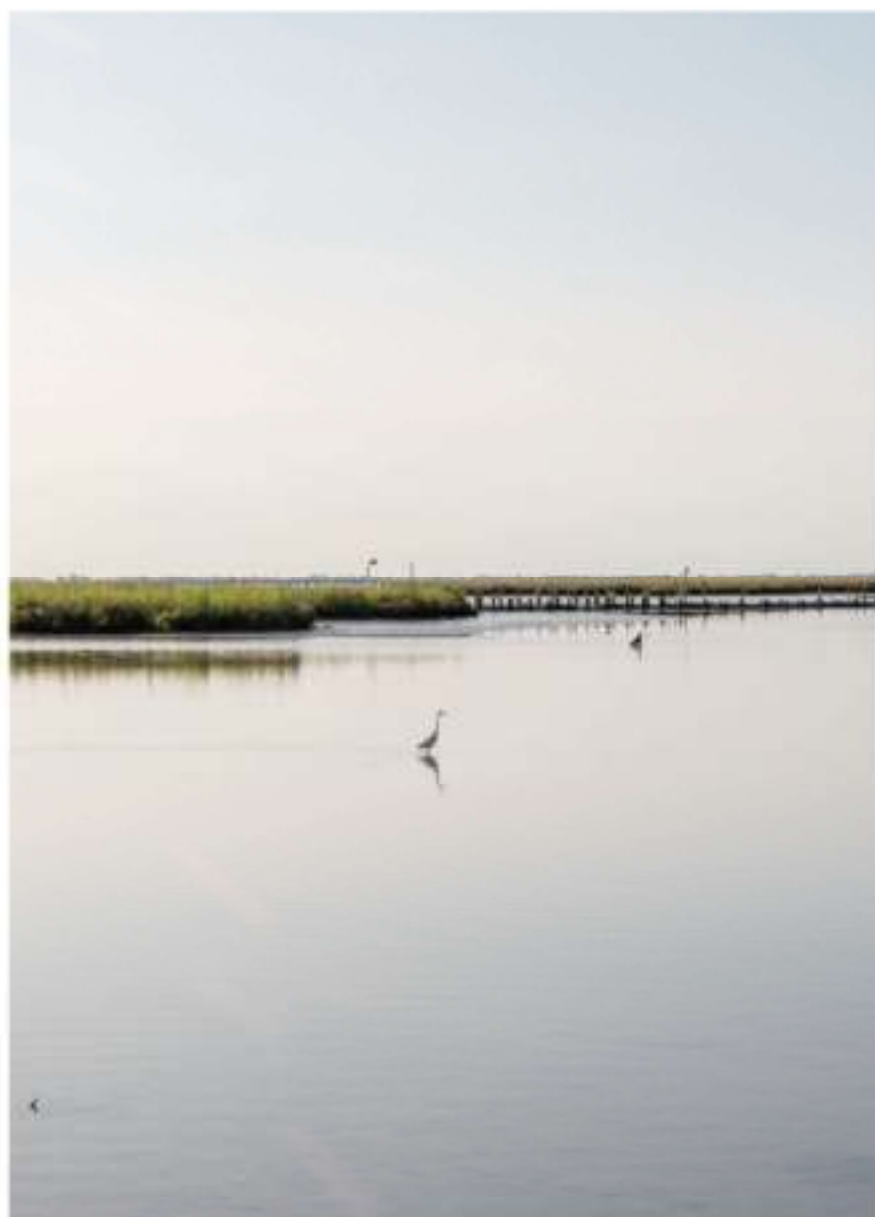
fishing (noun) valley (noun)

Lagoon area artificially separated from the open lagoon by a fixed fence made up of poles or alternatively by embankments. These are shallow pools of water used for breeding fish that are raised and then captured through devices that hinder their natural movement towards the open sea.













Pigs on the Wing

Some recent events that took place between November 2019 and December 2020 have brought the 'Venice question' back to the centre of world attention. On 12 November 2019 the high water hit Venice with exceptional and devastating force. With sirocco winds of up to 120 kilometres per hour and a tidal peak of 187 centimetres, the flood, second only to the '*aqua grande*' (great water) of 1966, struck violently across the coast and the lagoon, uprooting trees on the shores, lifting *vaporetti* and boats, killing two elderly islanders in Pellestrina, flooding houses, restaurants, churches, 96 percent of the surface of the historic centre, submerging the priceless heritage of the crypt and basilica of San Marco with incalculable damage. While citizens and shopkeepers try to repair the damage, in the following days three other exceptional tides hit the city (13 November 2019: +144 centimetres; 15 November 2019: +154 centimetres; 17 November 2019: +150 centimetres): such a persistence of the phenomenon had not been registered since 1872.

Eleven months later, on the morning of Saturday 3 October 2020, some 17 years after the start of the works, on the occasion of a strong disturbance on the lagoon with tide forecasts exceeding 130 centimetres, the MoSE (Electromechanical Experimental Module) successfully comes into operation, thanks to the coordinated action of 80 officials, technicians, and workers. The global media show unreal images of the huge yellow bulkheads that in sequence, like the famous flying pigs of *Animals*, rise slightly from the sea to protect the city. Despite the enormous operating costs calculated at 323,000.00 euros at each closure, this time and perhaps forever Venice seems to be safe. No high water phenomena occurred. Life, commerce, and tourism can return to swarm through the streets and squares of the island 'for overgrown children who are still capable of dreaming' celebrated by Braudel (1987, p. 243). Just five months after the high water of November 2019, a new emergency strikes the city: the lockdowns of March and September 2020 once again evoke the images of a ghostly Venice, the scenes of clear waters spread around the whole world, and the deserted streets and canals highlight other and perhaps deeper weaknesses. In the meantime, doubts are increasingly being raised about the long-term effectiveness of the MoSE, in relation to the huge manage-

ment and operating costs and the changed tidal conditions that will result from climate change. Once again Venice must question its fate as a transitional lagoon environment artificially frozen by human action. As in fact it was already clear in the 18th century and perhaps from the time of Sabbadino 'if the lagoon tended to silt up because of natural processes [...] now it was being threat-



ened by a much more serious and opposite phenomenon: the rise in the level of the sea; or perhaps more accurately, the slow but relentless sinking of the whole territory of Venice [...] it was precisely this condition that moved Filiasi to say, "if this goes on, in a few centuries it will surely be necessary to rebuild Venice on top of herself" (Bevilacqua, 2009, p. 15). To paraphrase Roger Waters, perhaps it is really true that Venice, like men, will change for the better only when pigs will fly.

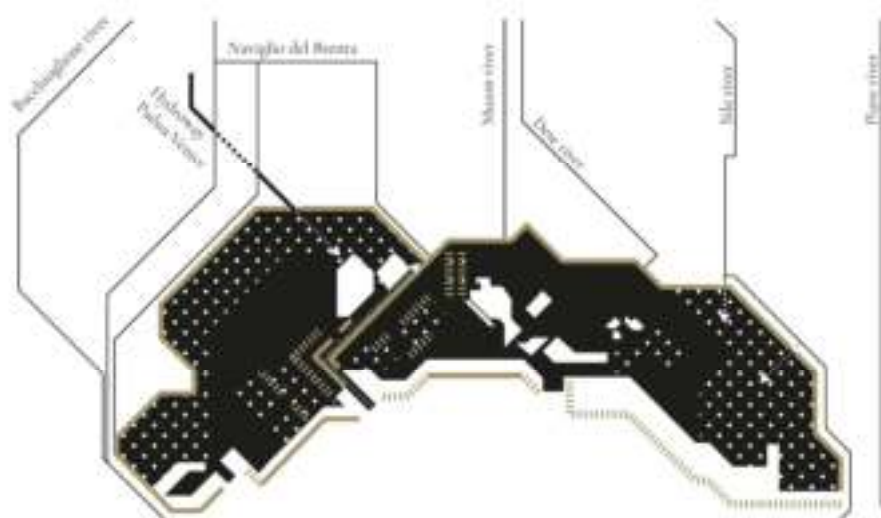
Two scenarios

The concurrence of the exceptional events mentioned above has prompted the community of scientists, operators, and citizens to look again at the challenges for the protection of Venice and its lagoon, and to map concrete scenarios for its evolution where, precisely following the November 2019 flood and at the entry into operation of the MoSE, various ideas about the lagoon are piling up in the local technical debate. Following the various special laws for Venice, the recent disastrous high tides and doubts about the effectiveness of the movable bulkheads in relation to the average sea levels expected with climate change, the issue of safeguarding has become increasingly pressing: also in the local debate there emerges, on the one hand, the collective need to protect the lagoon and its hydraulic functioning; on the other hand, that of preserving the immense historical and artistic heritage deposited in Venice and in the other historical islands.

Looking at current environmental pressures and medium and long-term climatic changes, there are two main scenarios that scholars of the equilibrium of the lagoon and the conservation of the immense historical-artistic deposit of the islands are addressing. The first looks at the lagoon as a territorial heritage stratified over the centuries and sees in Luigi D'Alpaos the main representative, aiming to preserve its equilibrium and ideally following in the steps of the design rationalities that were embodied by Cristoforo Sabbadino since the time of the Serenissima. A scenario that implicitly responds to the hypothesis 'if we want to preserve the equilibrium of the lagoon, then...' and, in this sense, seeks to '[...] restore centrality to safeguarding lagoon preservation issues as it happened at the time of the Republic when Cristoforo Sabbadino, the most famous of the ancient hydraulic engineers who worked in its service, managed to impose his ideas in this regard' (D'Alpaos, 2010b, p. 13). The hypothesis is developed in some reflections and graphic schemes by D'Alpaos in *Fatti e Misfatti di Idraulica Lagunare (Facts and Misdeeds of Lagoon Hydraulics)* which concern the re-introduction of sediments into the lagoon to counteract the erosion of the seabed caused in particular by the Canale dei Petroli (*Petroli Canal*) and the contextual reconstruction of significant areas of the *barene* (D'Alpaos, 2010a, pp. 275–318). The greatest amount of sediment would be carried through the Padua-Venice waterway in conjunction with the floods of the Brenta.

►5. Special Law for Venice n. 798 of 29 November 1964 'New Interventions for the Safeguard of Venice', Art. 3 (point a)

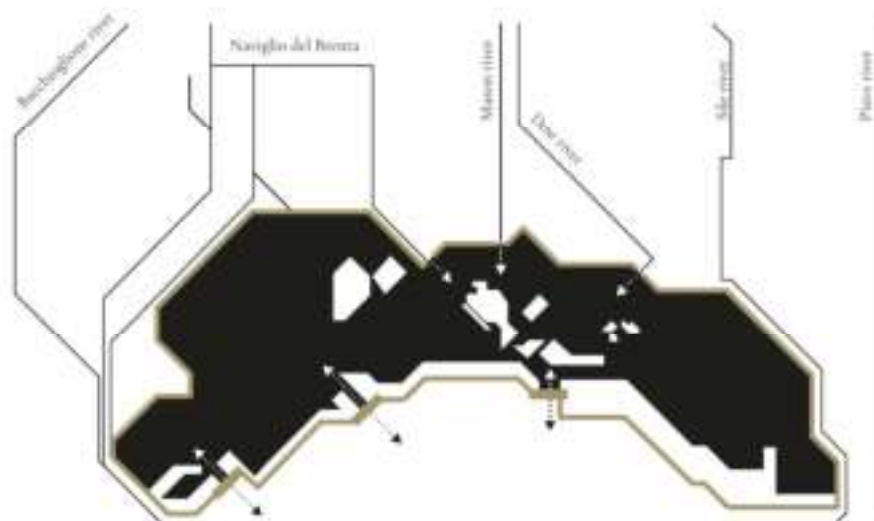
D'Alpaos envisages the construction of a discontinuous embankment along the *Petroli Canal* and along the *Vittorio Emanuele III* canal in the central lagoon, and lighter and reversible technologies to favour the terraforming of morphological structures useful for reducing the impacts of wave motion along the main waterways, at the same time maintaining the protection system of the shores. In this setting, Luigi D'Alpaos supports the extreme urgency and need to continue to perpetuate the care and maintenance of the lagoon: this is an immense territorial heritage in which natural and anthropic information is assembled. Although with different outcomes, the scenarios proposed by Luigi Bonometto also move on the line of environmental and morphological restoration for the rebalancing of the central lagoon. Bonometto suggests the re-burial of the *Petroli Canal* and the restoration of the hydraulic and navigation functions of the *Fisolò* canal, the terraforming of mudflats and sandbanks to protect the landfill coffer and submerged bumps to contain the turbid waters (2017). These are the scenarios that are inspired by the principles of 'experimentation, gradualness, and reversibility', established by the Special Law on Venice for interventions to protect the lagoon¹³.



Equilibrium conservation scenario

The diagram illustrates the future interventions proposed by Luigi D'Alpaos for the conservation of the hydrodynamic equilibrium of the lagoon: in dashed gold on a black background, the morphological structures between the central lagoon and the southern lagoon; the sea projections in gold on a white background; in black dotted lines the introduction of new sediments through the Padua-Venice waterway, which assumes the function of a spillway channel when the river Brenta floods.

The second scenario, advanced mainly by two CNR-ISMAR researchers, the German oceanographer Georg Umgiesser and the Venetian biologist Davide Tagliapietra, is apparently opposite to the previous one and responds to the hypothesis: *'if we want to safeguard Venice and its historical and artistic heritage, then...'*. It looks at the closure of the entire lagoon as the only possible long-term design choice, capable of guaranteeing the protection of Venice and the other historic islands from the rising phenomena that are derived from climate change, effectively proposing the ideas of separation from the sea that in the 16th century were supported by Alvise Cornaro (Umgiesser, 2016, 2020; De Marchi and Iuorio, 2021; Lionello *et al.*, 2021). According to the mathematical models considered by Umgiesser, by the end of the century global warming will lead to a rise of the Venetian sea level of at least 50 centimetres or more, with the consequence of an almost constant closure of the movable bulkheads of the MoSE to defend the lagoon. If for the protection of the lagoon we can easily act on the causes of endogenous phenomena –wave motion, loss of sandbanks, erosion and loss of sediments, water pollution– little or nothing can be done to counteract exogenous phenomena of planetary scope, such as those of the rising waters deriving from climate change that threaten the very existence of Venice and the historical islands. To safeguard Venice and the mainland, by 2100 the only solution would be the closure of the entire Northern Adriatic system through a sea wall and double dike, and the complete deviation of the rivers outside the lagoon. In the long run, climate change will sooner or later put us in front of an inevitable choice, in which the futures of Venice and the lagoon are destined to separate, where to save one it will be necessary to sacrifice the other. For the CNR researchers, closing the lagoon does not necessarily mean allowing it to die, but orienting it to a new ecological balance, looking at the narrow and fluvial lagoons and coastal lakes. The hypothesis recognizes the usefulness of the MoSE which, even if ineffective in the long term, allows to gain time for the progressive adaptation of the lagoon to become a lake according to a three-phase process: the first aimed at reducing aquatic pollution, the second aimed at providing the city with an efficient sewage system, the third aimed at the ousting of the industrial and tourist port. Naturally, the project of a coastal lake with few exchanges with the sea has cascading consequences that involve rigid systems



Lagoon closure scenario

The diagram illustrates a hypothetical complete closure of the lagoon starting from Grego. Umgiesser's observations on the safeguarding of Venice and the other historical islands from the sea rise expected by 2100, when the MoSE will no longer be sufficient, in gold the new embankments and the works at the lagoon mouth.

of control and purification of the water, and a transformation of the biological system that today characterizes the lagoon.

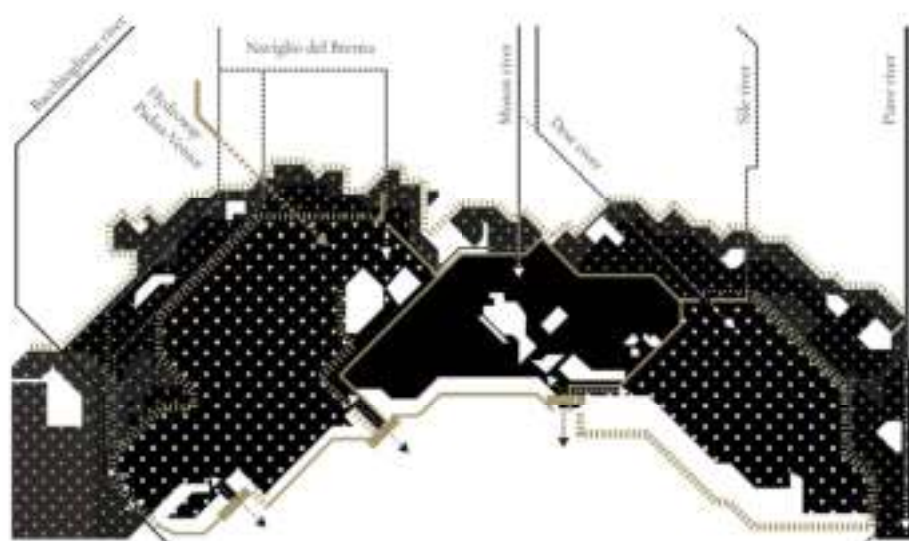
If D'Alpaos looks at the lagoon as a monument in itself, a territorial heritage that 'exists as a co-evolutionary historical construct, the result of reifying and structuring anthropic activities that have transformed nature into territory' (Magnaghi, 2010, p. 96), Umgiesser looks to the safeguarding of Venice as an unavoidable mission to deliver to the future that 'city both unreal and real' (Braudel, 2005, p.244), made of buildings, praised by history. If in the long history of Venice the theme of safeguarding the historic island was intrinsically connected to the safeguarding of its lagoon – a great lagoon provides a great port –, today the scenarios of Umgiesser and D'Alpaos push us to reflect on an unspeakable choice, where to save Venice it seems necessary to sacrifice its lagoon or vice versa. This choice essentially pushes us to reflect on the very idea of heritage and, more generally, on the territory as a renewable resource (Viganò, 2013).

Three lagoons

In reality these scenarios tend to assume the lagoon (and the strategies underlying its protection) as a homogeneous space. However, it seems to us that it is possible to put forward an intermediate hypothesis that responds to the hypothesis: *'if we separate the*

lagoon into several parts, then Together with the students of the bachelor's degree in architecture at the Università Iuav di Venezia⁴⁶ we tried to develop a scenario of separation of the central lagoon for the constitution of a closed lake –the lake of Venice– where the historical islands are located. All of this maintaining and strengthening the northern and southern great lagoons in their conditions of amphibious and osmotic spaces, radicalizing the biological, hydraulic, and practical differences that already characterize the water surface of the Venice lagoon. The scenario draws a lake with impermeable edges to safeguard Venice and the other historical islands –a water and metropolitan space for trade and mass tourism– and two lateral lagoons. The latter ones are intended as sanctuaries for biodiversity and to keep alive the osmotic relationship with the sea and drainage basin, intended for perpetuation of those practices and landscapes related to fish farming and 'slow' tourism that still survive in these areas today. A more extreme and perhaps more distant alternative in time envisages after 2100 the shutdown of the water pumps –made necessary by the exhaustion of fossil fuels– and the extension of the northern and southern great lagoons towards the neighbouring

►6 Scenario of the lagoon (Academic years 2008-2009, 2009-2010, 2010-2011), design studio of the bachelor's degree in architecture of Università Iuav di Venezia, Prof. L. Fabiani; teaching assistants C. Cangini, L. Iurria, G. Magnabosco, G. Mantelli, L. Vicentin.



Three lagoons scenario

The diagram illustrates a hypothetical separation of the central lagoon and expansion of the lateral lagoons by 2100; the new rigid embankments continue in a gold solid line, while the soft separation infrastructures (dunes and sandbanks) are dotted.

*7 'Speaking of living lagoons, we mean that part of the lagoon basin which is closest to the mouth and is most actively reciprocated by tidal currents. The dead lagoon, on the other hand, is formed by those parts of the lagoon basin that are located towards its mainland edges and are geographically and hydraulically demarcated with respect to the mouth, being separated from the living lagoon by the first imposing bands of bars' (D'Alpaos, 2006, p. 72)

reclaimed territories. In this hypothesis, the territories returned to water would not be subject to a retreat process, but would be converted into new inhabited amphibious territories. Experiments with aquaculture and fish farming could be run here, with the use of algae for energy production and halophytic plants for water purification, updating and radicalizing in these areas the ideas that had been put forward by the Front for the Defence of Venice and the Lagoon in the 1970s in response to the 1966 flood, which played a crucial role in the definition of the first special law for Venice of 1973. Architects and activists Piero Piseni and Paolo Rosa Salva published in 1972 in *Casabella* and in the local press the idea of an aquaculture project for the lagoon that puts all the rules of modern Venice into play. In this project, the endemic productive characteristics of the territory (such as fishing) extend over the territory to build an alternative development model (Piseni, 1971; Piseni and Rosa Salva, 1972). It seems appropriate to emphasize that the idea of subdivision of the lagoon, although radical, is by no means new. In fact, in the long history of Venice, from Cornaro to Sabbadino to Moscatelli to Miozzi, the hypotheses of division or closure of the lagoon have not been lacking. Nor has the lagoon ever been conceptualized as a homogeneous space: in relation to the exchanges with sea water, the ecological and hydrodynamic characteristics, a division of the water space into a 'living lagoon' and 'dead lagoon' has always been recognized.*7 Also for Bonometto, as for D'Alpaos, the theme of rebalancing does not allude to indifferenciation: in fact 'the concept of balance, like that of stability, in the environmental meaning on the contrary implies the tendency of systems to maintain their own complexity and functionality, in a dynamic and evolutionary context in which the dynamisms themselves, including human action, determine self-preservation capacities' (Bonometto, 2017, p. 61). These distinctions not only follow a hydraulic rationality but also geographical biological ones and use practices. 'In this sense we can recognize a subdivision of the lagoon into three vast expanses, not coinciding with the three lagoon basins but, approximately, with the areas indicated as the northern lagoon, central lagoon, and southern lagoon. In these, the combined effects of the actions that took place in past centuries and of the 20th century and current aggressions have led to different scenarios, which require different management strategies' (Bonometto, 2015, pp. 12–13).

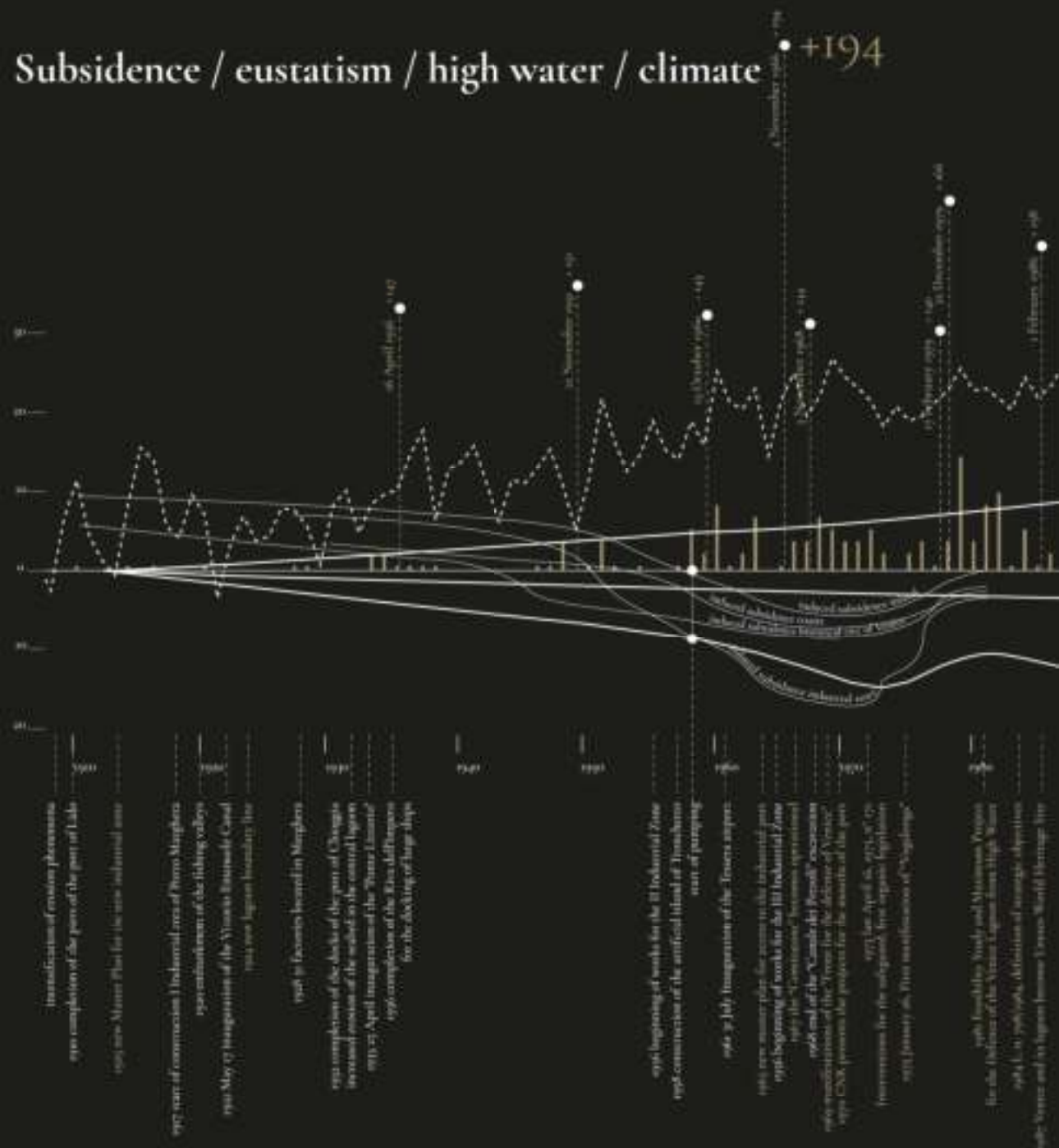
Pressure

What threatens the Venice lagoon?

The Venice lagoon is a fragile environment whose survival depends on a delicate hydrodynamic equilibrium between sea currents and river deposits, artificially maintained over the centuries.

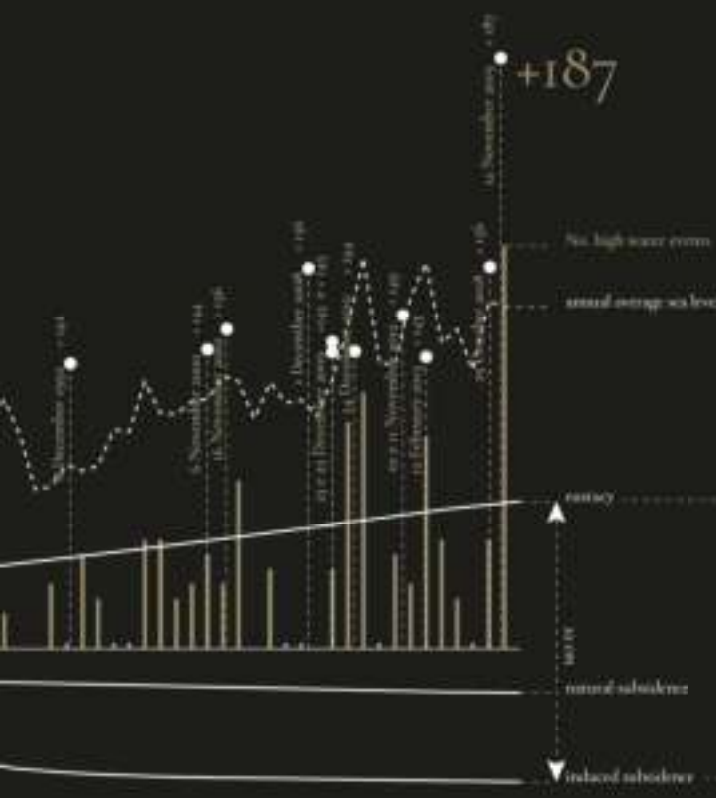
Threatening this equilibrium today and in the future are ever-increasing natural and anthropogenic pressures: natural and human-induced subsidence, sea level rise resulting from climate change, floods, erosion of sandbanks, lack of sediments, the deepening of the bathymetry and the flattening of the lagoon-bed.

Subsidence / eustatism / high water / climate +194



It is a while since the sea level rise and high water phenomena have represented the main threat to the survival of Venice and the other historical islands. Graph A illustrates the increase in high water levels during the 20th century due to the combined effect of the lowering of the ground level (subsidence), the rise in the mid-sea level (eustatism) and the intense me-

teorological and climatic phenomena caused by the mutations of climate. If eustatism is derived from climatic phenomena of planetary origin, subsidence is partly derived from natural processes of soil compaction, partly from local processes induced by anthropogenic activity on the subsoil. Starting from the Thirties of the 20th century, the extraction of



A. Subsidence, eustatism and high water
 On the left page, the diagram shows the correlation between subsidence, eustatism, morphological transformation of the lagoon, increase in the mean sea level and high water during the 20th century.
 Source of data: IAPPA, Istituto Superiore per lo Studio e la Ricerca Ambientale, 1973; CPSSM, Centro Provinciale e Regionale Studi del Comune di Venezia, 1996; IPCC, Intergovernmental Panel on Climate Change, 2014.



B. Stratigraphy of the Venetian subsoil
 The diagram above illustrates the stratigraphy of the Venetian subsoil. From a geological point of view, the subsoil of the lagoon is a multi-lake system characterized by an alternation of clay-silt impermeable layers and sandy layers. In the first 350 metres of depth, the latter house the Venetian aquifer that was affected by the artesian exploitation carried out for the construction of the first industrial nucleus of Porto Marghera starting in the Thirties of the 20th century. After the war, exploitation also affected the sixth aquifer, leading not only to a lowering of the piezometric level but also to the lowering of the soil with an average value of 8 millimetres per year.



groundwater for the construction of the industrial core of Porto Marghera became intensive. In a multi-layer system (section B) this process has led to a lowering of the ground level of the Venice lagoon by about 10 centimetres over the last century. As mentioned above, the repercussions on sea level resulting from climate change with average increases in the last century of

about 35 centimetres on the marine average are added to the subsidence. On the occasion of the floods and storm surges of 1966 and 2019, these combined phenomena resulted in high water levels of about two metres above the average sea level –considered as +/- 0– of Punta della Salute.

Sediments / currents / wave motion



Currents



Sediments

The Venice lagoon is the result of a complex hydrodynamic equilibrium existing between the tidal currents from the Adriatic and the deposit of sediments from the drainage basin. The difficult conservation of this equilibrium depends on the maintenance of the morphological structures of *barene*, *ghèbi* and emerged lands, and with them the biological health of the entire lagoon. Map A illustrates the system

of relationships existing between the currents coming from the Adriatic, the stay times and the transport of sediments of different nature and grain size coming from the drainage basin. If over the centuries the main challenge was to limit the risk of swamping, today the biological and hydrodynamic health of the lagoon appears threatened by the chronic lack of sediments and by the progressive erosion

A. Sediments and currents

Below, the map illustrates the nature and stay times of the sediments in relation to sea currents and the speed limits in the lagoon channels.

Source of data: IOMAR, Istituto delle Scienze Marine, 2001; DPSA - CRO-TE, Dipartimento di Scienze Ambientali - Università Ca' Foscari di Venezia, 2002; MAV, Ministero delle Acque di Venezia, 2002.



processes of the lagoon-bed and of the *baren* (see diagrams on the right). These latter aspects are largely determined by the hydrodynamic imbalances caused by climate change, by 20th century interventions on canals and lagoon mouths and by the wave motion produced by vessels with speeds and hulls that are not compatible with the fragile nature of the lagoon.

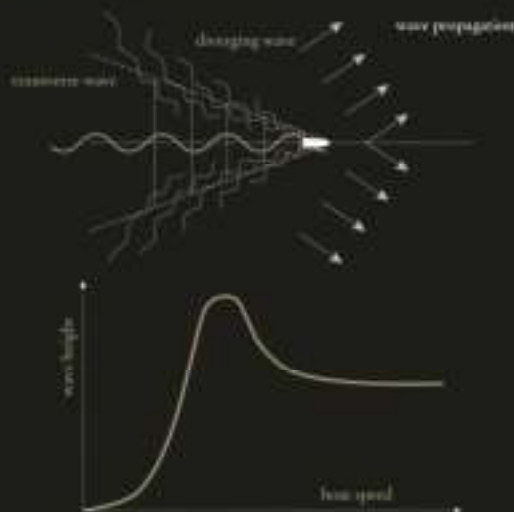
B. The erosion of the *baren* from 1930 to today

Source of data: CVN, Consorzio Venezia Nuova, 2002.



C. Waves and boats

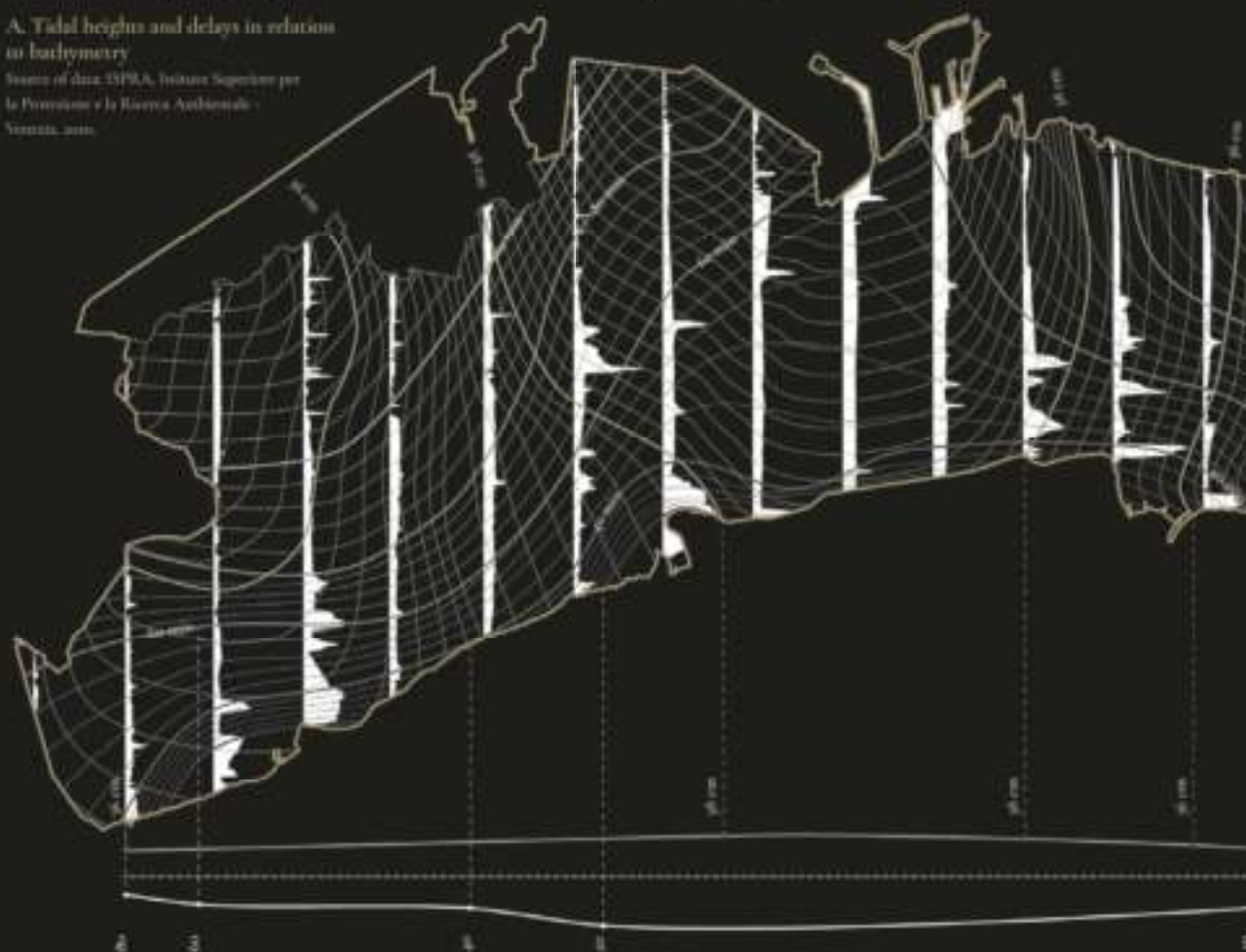
Below, the diagram illustrates the propagation mechanisms of wave motion derived from a vessel in relation to its direction and speed.



Tides / propagation times / bathymetry

A. Tidal heights and delays in relation to bathymetry

Source of data: ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale - Venezia, 2010.



B. Tide, pressure, and sea level during the November 2013 flood

Source of data: CPOM, Centro previsioni e Segnalazioni Mare, Comune di Venezia, anno: ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale, anno: CNR, ISMAR, Istituto di Scienze Marine del Consiglio Nazionale delle Ricerche, anno.



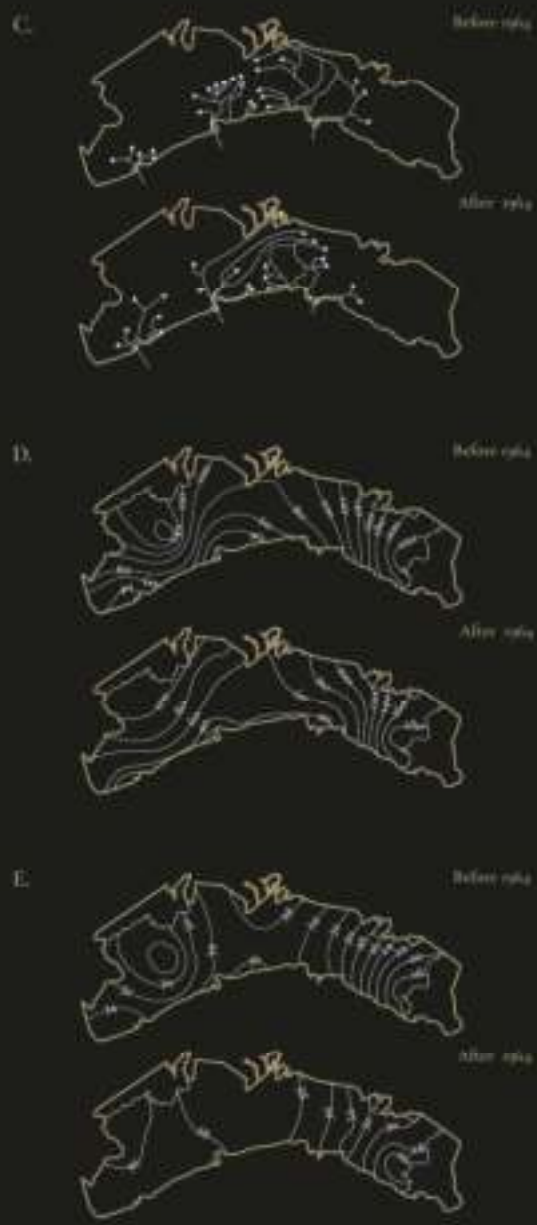
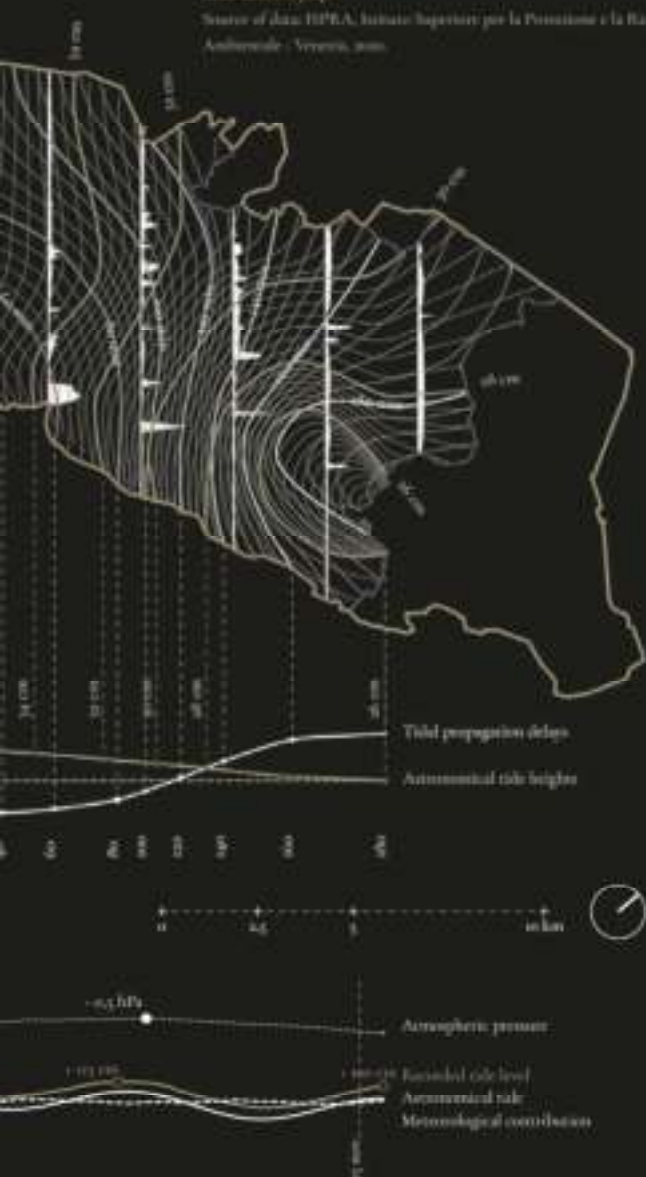
The processes of erosion of the seabed and high water are closely related to the timing and propagation of the tide. Map A illustrates how the propagation times of the tides (white curves) and tidal waves (gold curves) are significantly damped due to the friction developed by sand-banks and shallow waters (vertical sections).

The capacity of resistance to the tidal wave and to the impacts of high water have varied over time, with greater evidence after 1964, also following the changes in the hydrodynamic and bathymetric structure of the lagoon caused by the excavation of the *Petrolli Canal* (see maps C-E). If before 1964 the tidal delay between

The effects of 20th century transformations on sea currents and tidal propagation

Right, from top to bottom: C) Propagation of marine currents, before and after 1964; D) Delays in propagation of the tide in minutes, before and after 1964; E) Astronomical tide heights expressed in centimetres, before and after 1964.

Source of data: ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale - Venezia, 2008.



the lateral and the central lagoons was in the order of 160 minutes with tides that could vary up to 20 centimetres, at the beginning of the 21st century the tidal differences have almost disappeared and remain only partially at the far end of the North lagoon. Diagram B below the map shows how, during the November 2019 flood,

the normal tidal oscillations of an astronomical nature (solid white line) were exacerbated by specific meteorological conditions, *sirocco* winds and atmospheric pressure differences (dotted white line) which, on the night between 12 and 13 November, brought the sea level (gold line) to reach a height of 187 centimetres.

What-If

Lagoon Scenarios

The incessant process of regulation of the Venice lagoon has not built a homogeneous and smooth geographical image. Indeed, it can be said with certainty that various moments of crisis have followed one another. These moments impose themselves in the history of the lagoon as occasions in which institutions and technicians initiate a series of “debates on the future”. Starting from the long history of Venice and the challenges that await its lagoon in the future, in the following pages we will try to explore some alternative lagoon scenarios for 2100, when the movable bulkheads of the MoSe will no longer be sufficient.

01. Business-as-usual Scenario

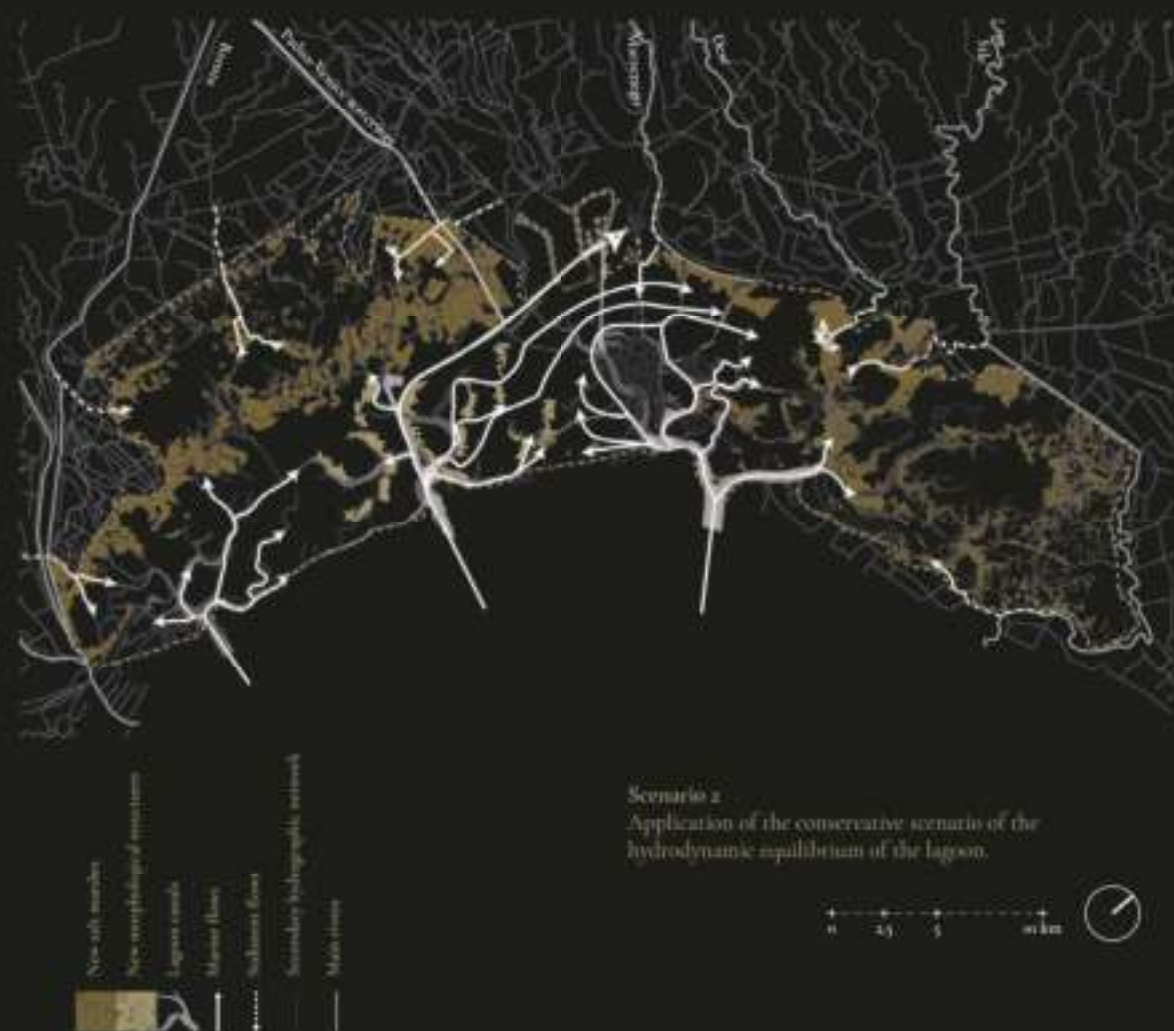


The Business-as-usual scenario answers the question: *“what would happen if there were no major changes in people’s attitudes and priorities, in technology, in the economy or in local public policies, such as to expect normal circumstances to continue unchanged?”*

For the lagoon and its drainage basin, this means assuming that entire territories will be rendered uninhabitable due to the combined effect of the average sea rise and the intrusion

of the saline wedge. Venice and the islands will be subject to repeated high water which will increase the need to close the MoSE. The effects induced by the tropicalization of the climate will increase, reducing the return times of floods.

02. Conservative lagoon Scenario



The scenario answers the question: *“what would happen if we wanted to preserve the fluid dynamic equilibrium of the lagoon by following the rationalities that had characterized the interventions of the great hydraulic engineers of the Serenissima?”* The scenario is inspired by the interventions proposed by Luigi D’Alpaos, concerning the re-introduction of sediments into the lagoon through the completion of the Padua-Venice waterway to counteract the erosion of the la-

goon-bed and the contextual reconstruction of significant areas of barene. The scenario includes the construction of a discontinuous embankment along the Perroli Canal and along the Vittorio Emanuele III canal in the central lagoon, and lighter and reversible technologies to favour the terraforming of morphological structures useful for reducing the impacts of wave motion along the main waterways.

03. Enclosed lagoon Scenario



The scenario for 2100 answers the question "what would happen if we want to safeguard Venice and the historic islands from the rising sea?" The scenario, which is inspired by the hypotheses put forward by Georg Umgiesser, looks to the closure and separation of the lagoon as a long-term solution, when the rise in sea level will lead to an almost constant closure of the movable bulkheads of the MoSE to defend the

lagoon. The transformation of the lagoon into a lake will have cascading consequences that involve rigid water control and purification systems, a transformation of the biological system that today characterizes the lagoon, interventions aimed at reducing aquatic pollution, providing the city with an efficient sewage system, as well as the ousting of the industrial and tourist port.

04. Three lagoons Scenario



The scenario dates forward to 2100 and answers the question: *“what would happen if we separated the lagoon into three interconnected parts with different water levels, hydrodynamic, biological and use characteristics?”* The scenario explores the possibility of separating the central lagoon by means of embankments, sheet piles, navigation basins, dewatering pumps, and technological

infrastructures such as to ensure a water level and use practices compatible with Venice and the other historical islands. The lateral lagoons, and with them the fishing valleys and the *haren* areas, expand into the territories maintained today through mechanical drainage: after the water pumps are turned off these are converted into new amphibious territories.

Business-as-usual Scenario



Sea Level Rise

Approximate risk with sea level rise (10)

P1 - moderate (10-20 years, 1-2 m)

P2 - moderate (10-20 years, 2-3 m)

P3 - high (10-20 years, 3-4 m)



Business-as-usual Scenario

Application of the business-as-usual scenario.

Source of data: P.M. Piano di Assetto Idrogeologico della Regione Veneto, 2011; IITM Digital Terrain Model della Regione Veneto, 2010.

Three lagoons Scenario



new agricultural lands

South Lagoon Park

Adriatic

Località Dorsena Marina del Sale

Campagna One

Campagna Venezia

- old marshes
- New morphological structures
- Environmental corridors
- New aqueducts
- main rivers
- Balsadivatore
- Navigation routes

Cala spina



Three lagoons Scenario
 Application of the lagoon division scenario.

Three lagoons Scenario





Lake of Venice
(Central Lagoon)

Adriatic Sea

Chapter 2

On the lake defences

Venice, year 2100.

The tram that runs on the large embankment along the edge of the lagoon canal and connects the new districts of Marghera with the beaches of the Lido, offers a unique vantage point across the stretches of water that embrace Venice. From one side, towards the east, the view runs over the lake to frame the monuments with the historic islands and, closer and all around, the swarming of boats that have always ploughed the waters around Venice. On the other side, looking west, the gaze is still projected towards a liquid world but slower and denser, lingering on the amphibious landscapes of the large park of the southern lagoon. Dominating this point of view are the stretches of water with the light infrastructures for fish farming that form the backdrop to the daily work of fishermen and the vegetated wetlands that give home to cormorants, ducks, gulls, herons, as well as teals, mallards and a whole human and animal world united by the search for fish and shellfish. The robust strip of land –the Malamocco-Marghera embankment– built to protect Venice divides these two aquatic worlds. The trams are mainly used by the citizens of Mestre and Marghera who make the beaches of the Lido their daily destination for free time and seaside relaxation, but

also by the many tourists who can find cheaper and more comfortable accommodation in Mestre than the limited places now available to stay in the historical islands. The few minutes that today separate the Lido from Mestre have brought the industrious world of the mainland much closer to the beach, its practices, and frivolous rituals.

Construction of the Malamocco-Marghera embankment was slow and did not happen easily. The embankment was consolidated following an incremental process, such as the progressive stratification that leads to the solidification of sedimentary rocks. It took years to convince the islanders to metabolize the trauma of the partition of the lagoon and the construction of the lake, and above all to accept the inevitability of the separation and transformation of the central lagoon.

Already in the early years of the new century, engineer Luigi D'Alpaos, the greatest expert in lagoon hydraulics of the time, although starting from assumptions devoted to safeguarding the lagoon –and therefore to the salvation of the integrity of the stretches of water around Venice which by then enjoyed very bad health– spoke of the necessary construction of 'morphological structures' to be placed along the edges



Lake of Venice
(Central Lagoon)

abandoned structure

abandoned structure

Alberoni warehouses

Alberoni road

Lido di Peldestina

Alberoni Beach

pasture

woods

new Marston

road

Alberoni train stop

grass and lake lagoon

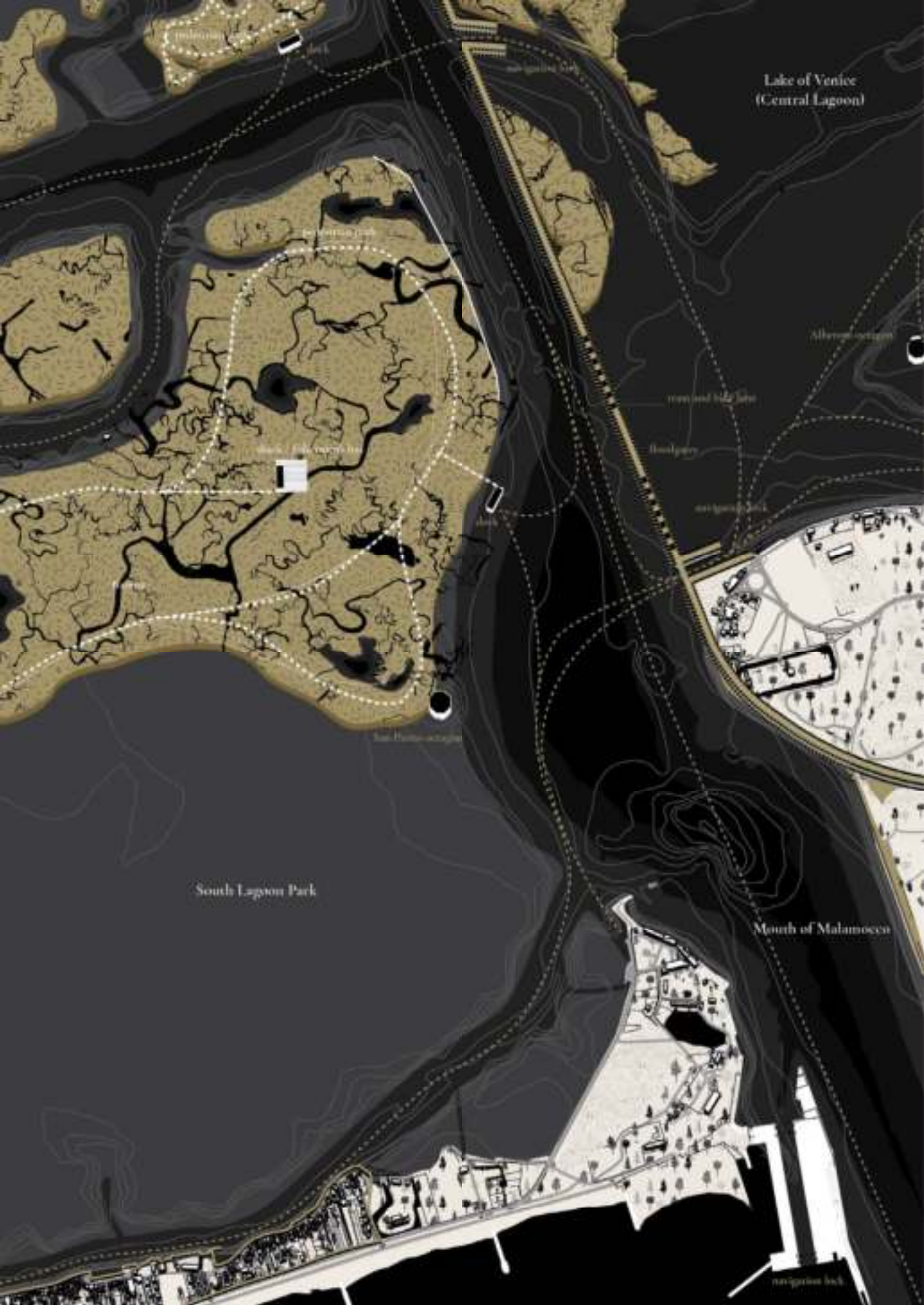
new Marston

Adriatic Sea

of what was once the *Petroli Canal*. On closer inspection, the artificial *barene* imagined by engineer D'Alpaos have little to do with the current embankment that dominates the liquid plain from its height of 2.5 metres, although looking at them today we can perhaps say that they already represented the first involuntary traces of foundation. The artificial *barene* around the canal were slowly built starting from the Twenties of the 21st century.

The construction site began the day after the entry into operation of the first version of the MoSE and the scandals that led to its construction, to counter the wave motion produced by large ships, when tankers filled with oil and cruise ships loaded with cheering tourists were still passing from the mouth of Malamocco towards Marghera. For years, these tiny sediments around 45 centimetres high, covered with a dense layer of glasswort and halophytic plants, had represented a fundamental safeguard for maintaining the fluid-dynamic equilibrium of the lagoon. They limited the phenomena of resuspension of sediments by wave motion, first responsible for the erosion of the lagoon slums which had already led to a strong flattening of the bathymetry and simplification of the landscapes of the central lagoon.

The idea of placing at the edge of the canal some morphological structures that never existed before in that part of the lagoon had initially aroused perplexity on the part of supporters of a poorly understood protection of the lagoon environment, but the elderly engineer did not care too much and loved to repeat often: 'it would be desirable that these people, hastily judging the intervention beyond its potential effectiveness to be impossible, knew how to stifle their feelings, giving space to reasoning and a well-conducted and controlled experimentation, able to shed light on the complex interactions of lagoon morphodynamics produced by the insertion of these structures'. Beyond the inertia of the decision-making mechanisms, the construction of the sandbanks at the edge of the canal was nevertheless necessary to counter the amplitude of the waves deriving from the increasingly frequent *bora* storms that regularly cross the lagoon on one side, and the growing lagoon traffic that crossed the channel on the other. D'Alpaos, who, as already mentioned, dedicated a large part of his life as a scholar and professional to the integrity of the lagoon and its equilibrium, could never have imagined that these first terraforming processes would become a pretext for upsetting the initial project, plotting the concep-



Lake of Venice
(Central Lagoon)

Alberoni Island

San Marco Island

San Marco Island

San Marco Island

San Marco Island

South Lagoon Park

Mouth of Malamocco

Navigation Dock

tual foundations of a process which, by legitimizing the idea of a radical transformation of the central lagoon, would sooner or later also authorize the possibility of its division. In fact, it is precisely on these first salt marshes, initially created through the simple arrangement of cordons of polyester huts filled with stones, that over the years, together with the higher sea levels, the increasingly solid elements have settled, thus giving rise to the current massive embankment that separates the central lagoon.

The consolidation of the salt marshes and their transformation into the current embankment followed the acceleration of the rhythms dictated by the return times of the high waters which with climate change became more and more frequent, imposing after more than fifty years the almost daily closure of the mobile dams located at the Lido and Malamocco mouths. Naturally, the daily closure of the MoSE, even if widely expected at the beginning of the century, had now become unsustainable as well as a continuous source of quarrels and accusations between the various decision-making bodies. The tensions due to the continuous closures were determined not only by the huge management costs exacerbated by the energy crisis, but also by the damage to the lagoon and to the nu-

merous activities linked to the tourist and industrial port, which was partly still located on the mainland. To further exacerbate the situation were the divergent interests represented by the defenders, on the one hand of the safeguarding of Venice, on the other of the fluid-dynamic equilibrium of the lagoon, not to mention the functioning of the port located between the mainland and the mouth of Malamocco.

The first to introduce the idea of the permanent closure of the lagoon to protect Venice was Georg Umgiesser, a German oceanographer of the CNR of Venice. He did so more or less in the same years in which D'Alpaos formulated the operational hypotheses useful for preserving the fluid-dynamic equilibrium of the lagoon. According to Umgiesser, who had made mathematical models of the lagoon to simulate its breathing, closing the lagoon was not optional. 'The problem is not if it will happen, but when it will happen ...,' he would often repeat to the local press, which relaunched the news with sensational headlines. It was a few decades later, towards the second half of the 21st century, when it became clear that the MoSE, despite its name, would no longer be enough to save everything (Venice, together with its port and the lagoon), when the only solution which at that point seemed fea-

sible gained ground. The construction site was thus launched for the largest work built after the MoSE to save Venice, an embankment of 14,350 metres located to enclose the central lagoon which, having reached the tip of the Alberoni on the Lido, was linked to the ancient system of *Murazzi* in Istrian stone, accordingly extended and raised for the entire length of the island. The infrastructure was connected to a system of 46 kilometres of reinforced banks and beaches to defend against storm surges towards the sea, and 45 kilometres of waterproofed shores and banks towards the polluted sites of the hinterland to build a single large infrastructure of embankments, dunes and sheet piles that isolate the central lagoon. The construction of the tram line above the embankment appeared then to be the most obvious thing to do, as a natural consequence of an unexpected opportunity or compensation for the bereavement suffered.

Together with the construction of the embankment, the former *Petroli Canal* has gradually been transformed and today has become the fundamental connection between the two port facilities, now located between the inlet of Malamocco and the ancient port of Marghera. Along the canal run hundreds of medium and large-sized ferries used for the transport of

goods and people, powered by the nearby Hydrogen Park in Marghera. The connection between the canal and the lake of Venice is governed by complex systems of navigation basins, pumps, and transfer ports that selectively cut into the embankment. These hydraulic devices and great works of architecture inspired by Leonardo da Vinci are entrusted with the task of maintaining the heights of the lake at the warning levels of the first half of the 20th century, when the high waters marked the rhythms of the Serenissima and were still a manageable threat.

Alongside the embankment towards the lake, and on the other side of the channel towards the lagoon, remain the now consolidated traces of the ancient *barene* built by D'Alpaos, that define a modern archaeology of mudflats on which the new southern lagoon, at least in part, was founded.



San Lazzaro park and boat storage

Malamocco-Murano Canal

train and bike line

Lake of Venice
(Central Lagoon)

navigation lock

park and boat storage

lock

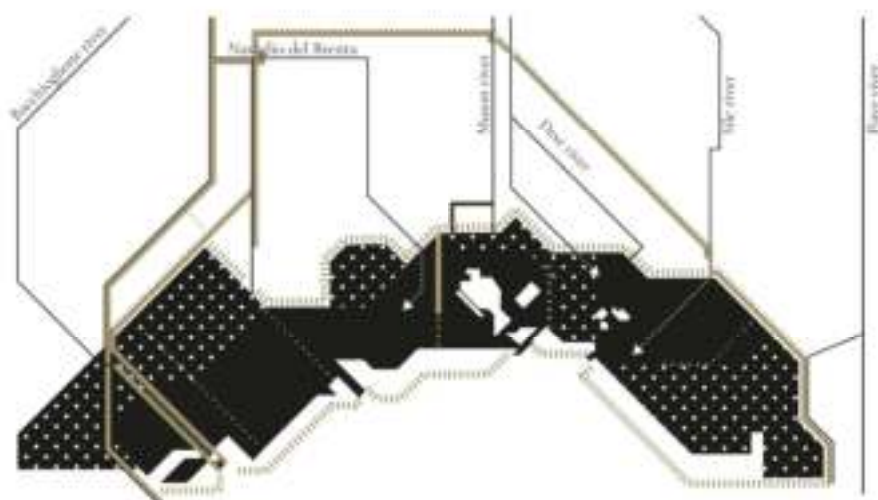
South Lagoon Park

Divided lagoons

Watersheds, embankments, and locks

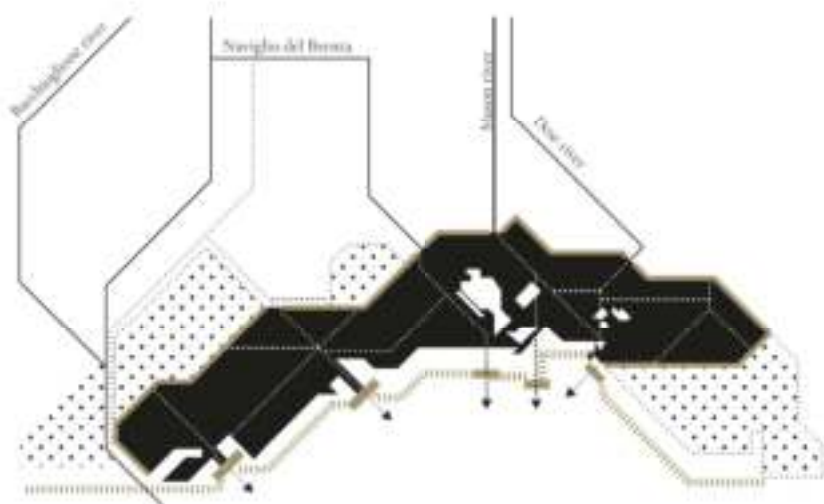
The myth of the origin of Venice, carefully constructed and updated by the Serenissima Republic of Venice over the centuries until its definition in the 13th century (Bettini 2006, p. 125), went and often still goes hand in hand with another myth. Or rather, with another dogma: the unity of the lagoon. On the contrary, historical maps show how the lagoon space has always been understood in a non-homogeneous way, and how in fact there was never a single lagoon. We are also aware of centuries-old customs linked to the presence in the Venice lagoon of watersheds that transformed it in everyday life into independent lagoons that can be traced back to the inlets. Watersheds that both fishermen and ship captains were well aware of, and whose existence had been taken into account by hydraulic experts in order to develop projects for the lagoon.

Starting from the 16th century, a new awareness and sensitivity regarding the consistency of the urban fabric and its relationship with the surrounding environment developed in Venice, as well as in other Italian cities including Milan, Florence, Verona, Ferrara, and Rome (Calabi 2006, p. 2). It is precisely in this perspective that



Subbiado's lagoon

Approx. year 1595. The diagram illustrates the project for the diversion of rivers and protection of the lagoon developed by Cristoforo Subbiado: the diversion of rivers outside the lagoon in gold; inside the lagoon the new embankments in gold; towards the sea, along the shores, the coastal protections. Note on the left the embankments protecting the outlet to the sea of the new course of the Brenta, that separate the ancient Brentidolo lagoon (now filled in) from the southern lagoon; between the central lagoon and the southern lagoon the preparation for the *maraviglio* to protect Venice.



Cornaro's lagoon

Approx. year 1550. The diagram illustrates the hypotheses for the closure of the lagoon developed by Alvise Cornaro towards the mainland, in gold a continuous embankment separating the land and the water; towards the sea, in gold, the coastal protections along the shores; inside the lagoon, in dashed white, the navigable canals. Note the contraction of the lagoon caused by the reclamation and conversion of dead lagoon areas into arable land; the closure of the lagoon mouths.

the proposals made by the *proto* of the *Magistrato alle Acque* (Magistrate to the Waters), Cristoforo Sabbadino, should be read: in two maps from 1547 (Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, Disegni, Laguna 9) (Image 1, p.96) and 1556 (Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, Disegni, Laguna 13) (Image 2, p.96) he elaborates one of the first attempts to avoid that the sediments carried by the rivers were pushed by the *sirocco* towards Venice through a 'light' instrument. This tool – alternatively referred to as a *traversagno* or *parador* – consisted of a barrier of wooden poles coinciding with the watershed south-west of Venice. Only later, in 1558, did Sabbadino himself elaborate a more radical project (Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, disegni, Diversi n.106) (Image 3, p.97) of deviation of the major rivers that flow into the lagoon, first of all the Brenta which is directed towards the sea by two robust embankments through the mouth of the port of Chioggia, effectively separating the southernmost part from the rest of the lagoon.

In the same years Alvise Cornaro, contrary to Sabbadino who wanted to allow free expansion of the lagoon waters towards the mainland, proposed clearly separating the lagoon from the mainland through the construction of an embankment (Archivio di

Stato di Venezia, Savi ed Esecutori alle Acque, Atti, filza 231, reg.3, 0006, 003r) (Image 4, p.98). This structure was also extended into the lagoon to ensure that the sediments of the Brenta –in the meantime forced into a new bed that diverted it from the lagoon– were led towards the sea and as far as possible away from Venice. The alternative visions developed by Sabbadino and Cornaro would have a strong echo also in the following centuries. It is no coincidence that around 1660 an expert in hydraulics (probably Federico Gualdi or Fantin Contarini) reworked Alvise Cornaro's proposal to create an embankment that embraced the entire lagoon, locating it halfway between the mainland and the urbanized islands, including Venice (Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, filza 123, 0790, 362-r) (Image 5, p.98). In this way the structure separated the living lagoon and the dead lagoon, while channels that led in a straight line to the lagoon mouths were dug.

A few years later, in 1673, engineer Alfonso Moscatelli –originally from Brescia– presented a plan for dividing the lagoon into four phases to ensure its survival, radically changing its morphology (Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, b.131, dis.2) (Image 6, p.99)¹¹.

Viewed from a contemporary angle, Moscatelli's proposal may appear naive, difficult to implement –in particular with the technical means of the late 17th century– and of dubious effectiveness. However, it reiterates once again how in past centuries the hydraulic engineers –even the most 'unlikely' ones like Sabbadino himself– did not consider the unity of the lagoon as a dogma and were willing to make radical choices in order to guarantee its existence.

Bridges, roads, and docks

Radical choices, such as those proposed by the engineer Eugenio Miozzi in the second half of the last century. In the Sixties of the 20th century, at the end of a long career and a few years after the dramatic flood of 1966, the engineer proposed a futuristic solution to the 'sinking' of Venice caused by the combined action of sea level rise and land subsidence: to lift the entire city by injecting large quantities of water into the subsoil to reconstitute the artesian aquifers, emptied in particular by the feverish industrial activity of Porto Marghera. Through the construction of a compression chamber –delimited in the lower and upper part by layers of

¹¹ The four phases of Moscatelli's proposal respectively involved:

Phase 1:

- Closure of the Chioggia mouth with construction of navigation locks for maritime navigation;
- closure of the San Erasmo mouth;
- creation of a watershed between the mouths of Chioggia and Malamocco following the closure of the mouth of Chioggia;
- creation of a watershed between the Port of Venice and the Treporti mouth following the closure of the San Erasmo mouth.

Phase 2:

- Construction of an embankment that closed the Chioggia lagoon behind the Mont'Albino canal to maintain a sustained level of water in Chioggia;
- construction of locks to allow navigation from the Chioggia lagoon to the Lombardy canal (which connected the lagoon to the river Po). The locks could be opened for maintenance purposes, thus letting the water flow from the lagoon to the canal, favouring the excavation of the latter;
- creation of gates to be opened as needed to replace the water in the Chioggia lagoon and reinforce the zone (ebb tides) in the lagoon area adjacent to the Malamocco mouth.

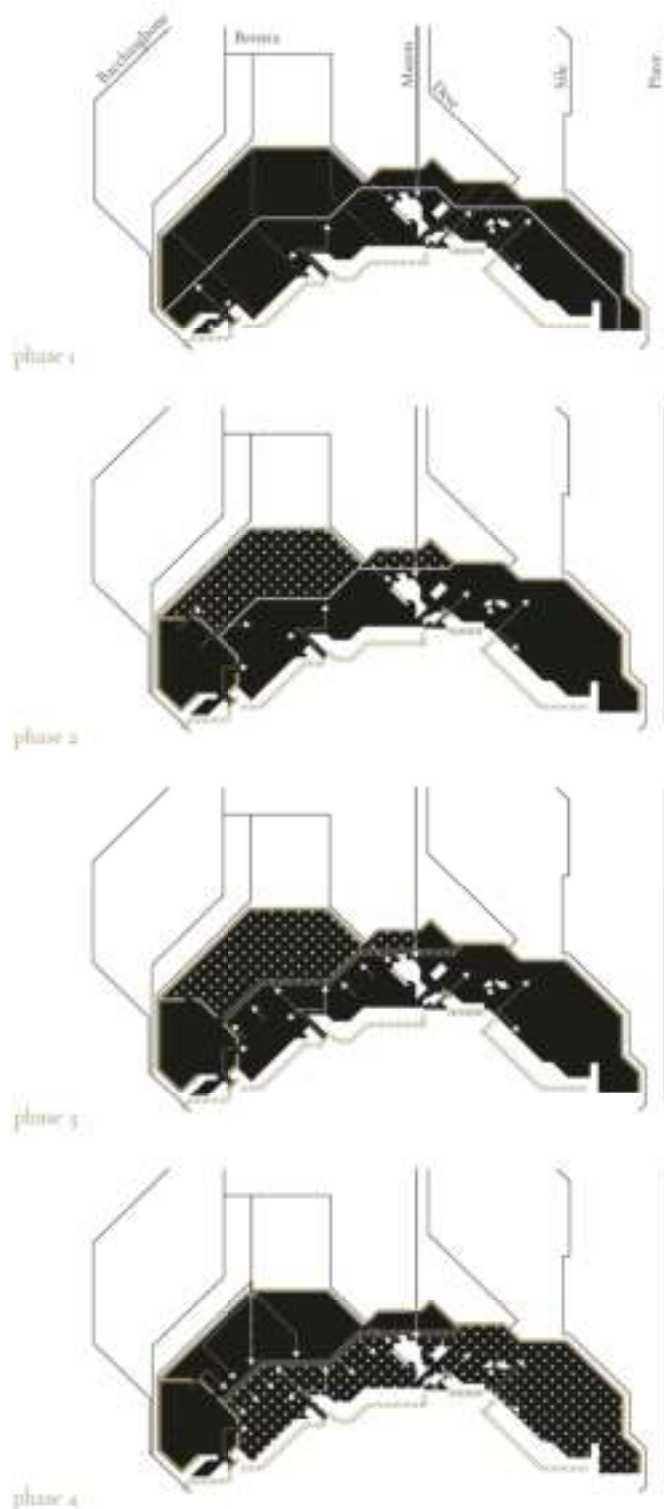
Phase 3:

- Construction of an embankment punctuated by openings that longitudinally separated the dead from the living lagoon;
- creation of a canal parallel to the embankment on the side of the dead lagoon;
- maintenance of canals and cuts in the dead lagoon so

that the water could drain as needed when the locks that closed the embankment separating the two lagoons were opened.

Phase 4

- Simultaneous opening of one or more locks that closed the embankment that separated the two lagoons to encase the living lagoon;
- construction of a lock in the embankment that divided the *Taglio Nervissimo del Berona* from the dead lagoon, and opening of the same lock during the flood waves of the *Brenna* in order to encase the dead lagoon and reinforce the *ossare* in the living lagoon.



Moscatelli's lagoon

Yusa (1973). The diagrams illustrate the four phases of subdivision of the lagoon elaborated by Albino Moscatelli. Note the reconceptualization of the dead lagoon as a hydraulic service system in function of the living lagoon.

caranto, a thick layer of natural clay, and on the sides by artificial diaphragms—the goal was to raise the ground, which over the centuries had lowered also due to the phenomenon of eustatism, and bring the average piezometric altitude back to +4.00 m, the altitude measured in 1858 (Miozzi 1974, pp. 1–47).

Faced with the enormous technological challenge that the solution of raising the ground would have represented, Miozzi imagined two alternative and more pragmatic versions for the protection of Venice at the end of the fourth volume, *Il Salvamento*, of his work *Venezia nei secoli* (*Venice over the centuries*) (1969, pp. 475–494). The first alternative consisted in the creation of a basin of 27,000 hectares including Venice and the entire northern lagoon. The second, more limited, was the creation of a basin of 9,000 hectares including Venice and the other historic island centres (Murano, Burano, Mazzorbo, and Torcello). The regulated closure of the basin provided for the mechanical removal of the ‘old water’. It would have taken place through a system of vehicular embankments—which at the same time would have also radically redesigned the mobility of the lagoon—and the construction of gates and navigation locks at the Lido mouth, to some extent anticipating the MoSE project. In the first case (basin of 27,000 hectares), the barrier would have been double, built between Sant’Erasmus and Cavallino and between Sant’Erasmus and the Lido; in the second case (basin of 9,000 hectares), it would have been completed only between Sant’Erasmus and the Lido, thus leaving the northern lagoon with an open basin of about 18,000 hectares²².

In more recent times, some of the protagonists of the debate around the advisability of creating the MoSE have raised once again the fundamental issue of lagoon unity, hypothesizing alternative solutions to the MoSE that in some ways recalled a centuries-old Venetian design tradition. In this sense, it is worth mentioning the proposal made by Professor Antonio Foscarini²³ to divide the lagoon into three parts through the use of *palancole*, thus allowing to maintain different levels of water according to the preservation needs of the historic centres and operational conditions of Porto Marghera. This proposal pertains to the logic of graduality and reversibility that has guided the interventions in the lagoon area over the centuries, and has many elements in common with the barrier imagined centuries earlier by Sabbadino.

Today, in the light of the repetition of extreme high-water events,

22 As a demonstration of the profound historical knowledge of Venice and its lagoon, Miozzi recalls in his proposal (1969, pp. 482–483) precisely the *navosaggio* located west of Venice, which specifically for the 27,000-hectare basin envisaged:

– isolating the Lido basin from that of Malamocco with an earth bank crossing the entire lagoon, from the Terra Perse in the Lido to Fusina, ‘renovating’ the *navosaggio* embankment built in the 16th century;

– closing existing communications with the open sea or with canals in twin communicating with the sea: in order not to jeopardize river navigation, these outlets would have been equipped with locks, in which one of the two doors would always be closed, thus ensuring isolation;

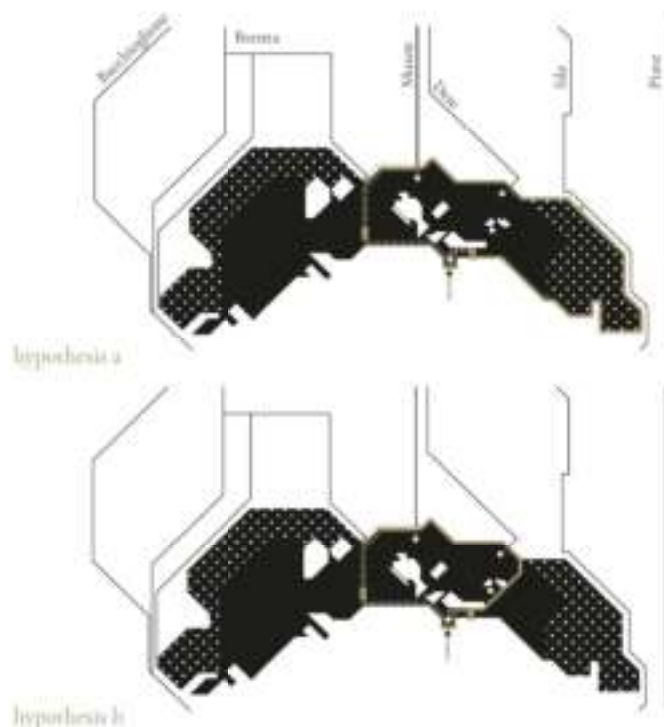
– closing the Canale di S. Erasmo with an embankment partly in earth and partly in masonry;

– closing the Lido mouth between S. Nicolo and S. Erasmo with an earth embankment in the shallower area and with a masonry dam in the navigation channel;

– the construction of two lifting stations for the ‘old waters’, one of them in Malamocco, and one in Cava di Galigo near Jesolo;

– the construction of a dam with coastal preconsolidation on the lagoon edge with the mainland between Malamocco and the area currently occupied by Marco Polo airport.

23 During a lecture held by Professor Foscarini on 25 October 2019 at Palazzo Rudovik in Venice as part of the ‘Forum of knowledge, forms of rationality’ module (Lectures Ludewig-Centel) of the European Master in Urbanism.



Miotzi's lagoon

Year 1969. The diagrams illustrate the two hypotheses for dividing the lagoons developed by engineer Eugenio Miotzi after the 1966 Venice flood: the separation embankments in gold; hypothesis a) basin of 27,000 hectares; hypothesis b) basin of 9,000 hectares.

the environmental effects of the hydrodynamic and morphological relations between water and land re-emerge in a form particularly accentuated by the phenomena of subsidence and eustatism. As hypothesized by Umgiesser, the gates of the three mobile dams –under construction in the respective mouths of the Lido, Malamocco, and Chioggia– with an average sea level increase of 50 centimetres by the end of the century, will come into operation on average at least once per day.

In the perspective of a gradual but total closure of the lagoon, the studies and hypotheses developed over the centuries that we have retraced constitute a fundamental source of reflection for the advancement of the idea of a possible division of the lagoon into areas characterized by different landscapes, uses, hydraulic and ecological characteristics. Not only that: they oblige us to understand that the need to safeguard Venice necessarily implies –then as today– a project of radical transformation of the environment in which it is located.



01



02



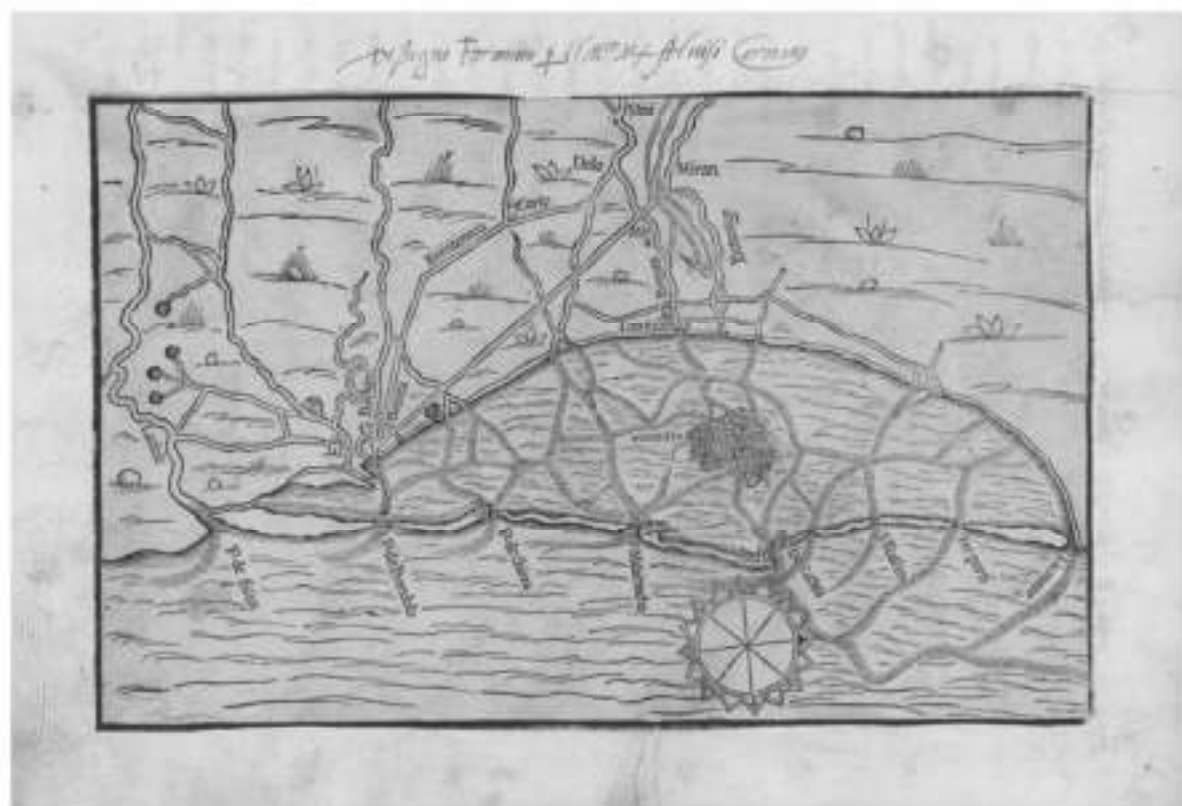
115

Image 01. Map of the central lagoon basin produced by Cristoforo Sabbadino (1547) Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, disegni, Laguna n.9. In red at the top the quarries that intercept the terminal stretch of the Brenta diverting its waters towards Malamocco. In the centre, the straight line of the *traversaglio* (perhaps only planned) which coincides with the watershed and consists of a double order of poles and planks to prevent the sediments of the Brenta from being carried towards Venice by the *strocco*.

Image 02. Map of the entire lagoon produced by Cristoforo Sabbadino (1550), copy by Angelo Minocelli from 1695 Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, disegni, Laguna n.13

Map showing rivers and canals in dark blue and the *banco* in light brown. The watersheds are indicated in text form on the map; the *traversaglio* between Venice and the mouth of Malamocco is also traced.

Image 03. Map of the lagoon produced by Cristoforo Sabbadino (1550) with the Brenta diversion project Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, disegni, Diversi n.106. Deviation project of the Brenta-Maion towards the mouth of Chioggia. Real embankments that separate the southern lagoon from the rest of the lagoon are imagined.



94

Image 04. Map by Alvise Cornaro dating back to the mid-16th century, depicting an embankment that clearly separates the lagoon from the mainland

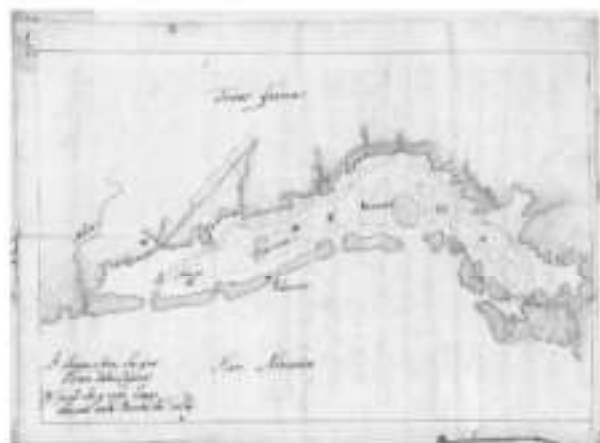
Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, Atti, filza 231, reg. 3, 0006, 0012.

A new embankment is built that clearly separates the lagoon from the mainland and which also extends into the lagoon to ensure that the sediments of the Brenta are diverted towards the sea away from Venice. It is relevant to note the presence of more lagoon mouths than those existing today.

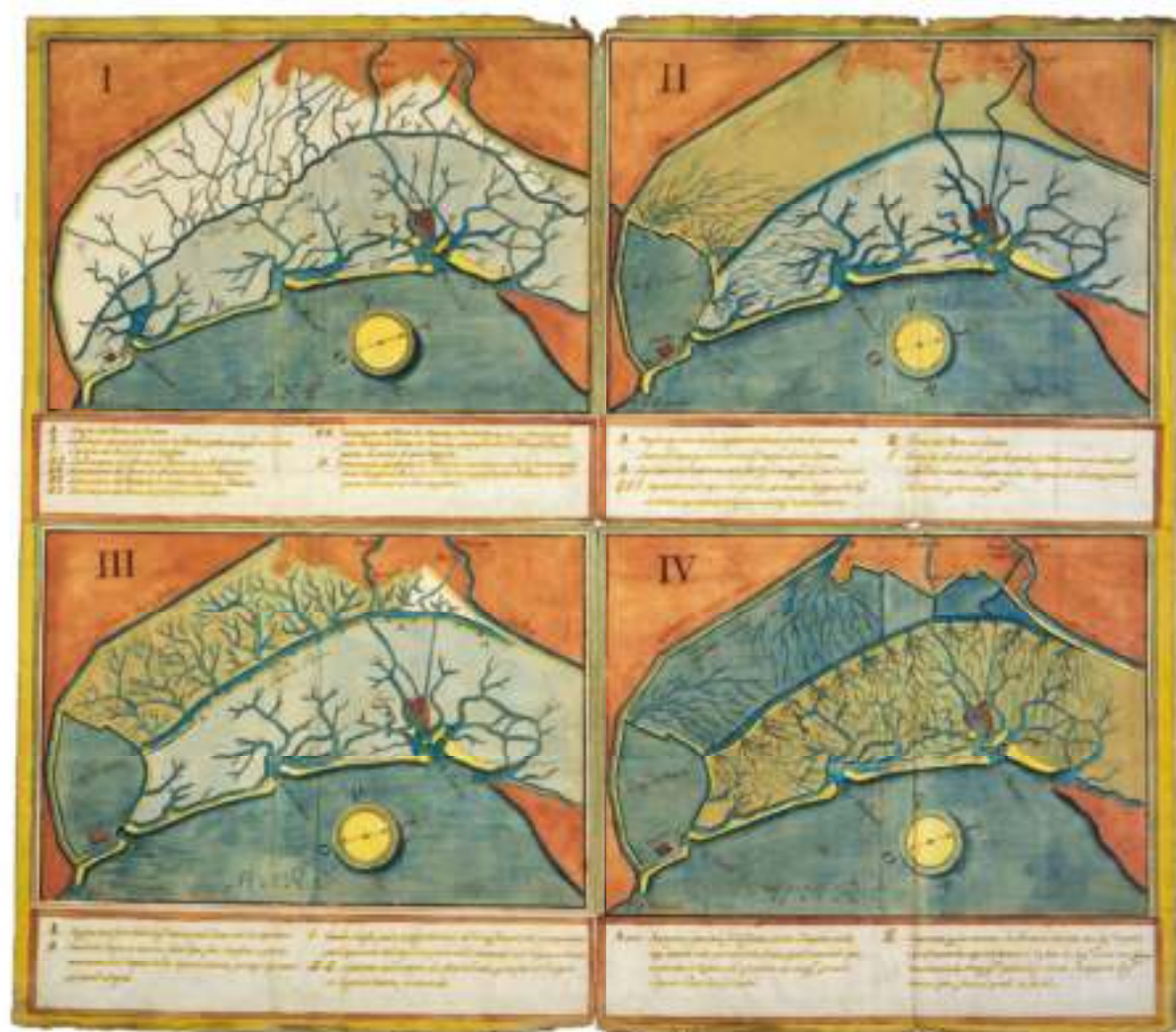
Image 05. Anonymous map (Federico Gualdi? Famin Comarini?) dating back to around 1660, depicting an embankment that embraces the entire lagoon

Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, filza 123, 0790, 760 r.

A new embankment that separates the living and dead lagoon as well as canals that connect to the lagoon mouths is built.



95



06

Image 06. Phased project by the Brescian engineer Alfonso Muscatelli to divide the living lagoon from the dead lagoon (1673)
 Archivio di Stato di Venezia, Savi di Lavori alle Acque, b.131, Dis.2.
 Muscatelli updates and develops the suggestions of Albise Cornaro. Specifically, he plans to close the ports of Chioggia and San'Elmo, an embankment to enclose the lagoon of Chioggia, the excavation of a large perimetral collector channel along the demarcation between the living and dead lagoon, and the introduction of the Brenta Novissima into the dead lagoon.

Designing edges

The lagoon is made up of amphibious territories on which the effects of climate change and sea rise will become more evident. For this reason, in the future, as has already been the case in the past, it will be subject to the definition of new limits and the modelling of its edges, followed by important and radical transformations. A privileged point of view on these aspects can be more clearly grasped at the edges of the lagoon, where the effects of transformation on the territory induced by the interventions initiated with the government of the Serenissima are still clearly visible. The construction of the *argine di intestadura* (an embankment acting as a dam), begun by the Venetians starting from the 14th century with the aim of diverting the rivers that were responsible for the lagoon's silting phenomena, continued through trial and error until the mid-16th century (D'Alpaos 2010, pp. 32–37).

The embankment and the canals associated with it were a complex infrastructure, operating at the same time on a hydraulic, ecological, and territorial governance level, that was to 'act as a clear element of separation between fresh and salt water' (D'Alpaos 2010, p. 32) setting the limits, including political ones, between the interior and exterior of an environment which by nature would otherwise be in continuous and perennial transition. At the northern limit of the central lagoon, in the stretch between the park of San Giuliano and the airport of Tessera, the effects of the transformations induced by the construction of the embankment and the Osellino canal in 1507 can still be read: a straight line of about 15 kilometres on which the waters of the Marzenego, Dese, Zero and Sile rivers flow. Here, beyond the net limit defined by the edge, a system of *barene* that were previously cultivated fields is located on the side towards the lagoon. On the other side, towards the hinterland, there is countryside where once stood marshes and lowland forests. The *barene* along the Osellino canal are 'well known because they can be easily reached from the ground [...], they owe their high stability to the continental soils on which they rest, so that to this day can be recognized the signs of the agrarian structure prior to their separation from the mainland in some straight *ghebi*, which once were ditches' (Bonometto 2014, p. 22). On the other side of the canal are the territories today characterized by widespread urbanization, and the countryside resulting from the 20th-century reclamation, readable by the reg-



ular rhythm of the fields, ditches, and locks for water regulation. Five Venetian feet high (- 1.75 m) above sea level and up to 20 (- 7 m) wide at the base (D'Alpaos 2010, p. 33), the embankment remains a complex and multidimensional infrastructure on which hydraulic, ecosystemic and legal rationalities overlap. Along the embankment is it still possible to find the *Pietra d'Istria* markers that defined (and still define) the limits of the *conterminazione lagunare* and the jurisdiction of the *Magistrato alle Acque*.

Here the border takes on the character of a peremptory straight line that artificially separates two worlds that would otherwise be blurred and, with them, the main design rationalities that from the times of Cornaro and Sabbadino to Umgiesser and D'Alpaos define these spaces. The edge separates, on the one hand, a lagoon whose survival is linked to the maintenance of those environmental systems of *barene* and halophytic plants on which the health of its own waters depends; on the other, a territory of countryside, towns, metropolitan infrastructures and widespread urbanity, whose survival depends on the sophisticated and fragile mechanical drainage system and dewatering pumps inherited from the past.

100 Venetian markers

In recent years there has been discussion of a possible division of the Venetian metropolitan area not only in physical terms, through projects involving the construction of barriers made of sheet piles or embankments, but also in administrative terms. Various *referendum*, the most recent in 2019, have proposed the division into two different municipalities, those of Venice and Mestre. Despite having all had negative results, these referendums expose unsolved problems and tensions by now consolidated between the lagoon and mainland spheres of the metropolitan city. The definition of a possible new administrative border has pushed both citizens' committees in favour of separation, and research groups in the university field (DeVine *et al.* 2016) to reflect on a boundary that can realistically be shared and effective for this purpose. In most cases this boundary takes up large sections of the perimeter of the *conterminazione lagunare*, the area historically under the control of the *Magistrato alle Acque*.

As we have seen, since the days of Sabbadino and Cornaro, defining both a physical and political/administrative boundary of the Venice lagoon poses tremendous issues in terms of space and time. In spatial terms, we face the problem of the management and the construction of the border –as a territorial and legal entity– for a mutable physical body with an extension of 550 square kilometres fed by a hydrographic basin more or less four times larger. In temporal terms, we face the phase displacement between geological time and human providential time, between the natural and man-driven evolution of the morphology of the lagoon and the myth of the origin of the Venetian Republic.

The case of the Venice lagoon is one of the most fascinating case studies in territorial terms. If, according to Robert Sack, we consider territoriality as the means by which space and society are interrelated, as the basic geographic expression of influence and power, as 'the attempt by an individual or group to affect, influence, or control people, phenomena and relationships, by delimiting and asserting control over a geographic area' (Sack 1986, p. 19), few other cases might be more relevant –and thoroughly historically documented– than that of the Venice lagoon.

Territoriality is the first form of spatial expression of political

►4. L'assunto che il territorio costituisce elemento essenziale per l'esistenza dello Stato – congiuntamente al popolo e all'ordinamento – viene inteso di regola come riferimento a quella quantità ben definita di spazio nel cui ambito si esercita il potere di sovranità. Venezia, Città-Stato insulare, offre invece il singolare esempio di Stato che lotta soprattutto per la difesa della "qualità" del suo territorio lagunare. La tutela della laguna contro gli eventi suscettibili di mutarne lo status intesi come "qualitas soli" costituisce sul piano giuridico la ratio di tutta la legislazione sulle acque, mentre su quello politico diviene la ragion di Stato che determina le scelte che portano alla realizzazione di grandiose opere di ingegneria idraulica (ambrazini).

power, and this also translates into legislation. Silvano Avanzi, superintendent of the *Guardia di Finanza* in Venice and among the three experts who guided the most recent process of redefinition of the area of *conterminazione lagunare* in 1991, expressed very clearly the relevance of the Venice lagoon case study in territorial terms: 'The assumption that the territory constitutes an essential element for the existence of the state –together with the people and the legal system– is normally understood as a reference to that well-defined amount of space in which sovereignty is exercised. [...] Venice, an island city-state, offers the singular example of a state that fights above all for the defence of the "quality" of its lagoon territory. The protection of the lagoon against events likely to change its status understood as "quality of the soil" constitutes the rationale for all legislation on water, while on a political level it becomes the *raison d'état* that determines the choices that lead to the creation of grandiose hydraulic engineering works' (Avanzi 1989, p. 55).⁹⁴

And if the quality of the lagoon territory is rather unique, it is also rather unique the way in which different notions of time overlap above and below the surface of this expanse of water and islands. As Tafuri reminded us, after having carefully shaped and redefined through the Late Medieval period its own origin, 'Venice tried to *endure within her origin*: Venice will become the symbol of such a resistance, when continuity in her begins to be betrayed by repetition and impotent fetishism' (Tafuri 1995, p. X).

Venice, according to Carlo Ossola (2003), has always anticipated its beginnings and on the other hand has precipitated its end, dissolving by its own initiative a pluri-centennial Republic in 1797. Only a few years earlier, between 1791 and 1792, the Venetian Republic had placed 100 markers –for the sake of precision, 98 markers and one wall with an inscription that counted as two markers (Caniato 1991, p. 52)– to define once and for all the borders of the Venice lagoon. Yet, as we know, the boundaries of Venice and the boundaries of its lagoon are by their very nature unstable and subject to continuous negotiations. The whole operation revealed a paradox: how to define for eternity the boundary of 350 square kilometres of marshes and navigable waters that made the existence of the Republic possible? The positioning of these humble markers –made either in *Pietra d'Istria* or bricks and mortar, and ranging from 1 to 1.5 metres in height– proved obviously inade-

quate to fulfil such an ambitious goal and represented the swan song of the Republic that dissolved itself a few years later before Napoleon conquered it.

An ecological fable

*Essende il principal objecto del studio nostro la conservatione de queste nostre lagune*⁶⁷
(Savi ad Esccutori alle Acque, 1734)

*Venerunt sub / divina dispositione Providentia / in aquis fundata / aquarum ambitu circumscripta / aqua
pro muro stantur. / Quisquis igitur / quopiammodo detrimens / publicis aquis inferre ausus fuerit / et hinc
patriam indicet / nec minime placitur poena / quam qui sacrosae muris patriae violasse. / Hinc effecti sui
ritum perpetuamque cur.*⁶⁸

(Latin inscription for the headquarters of the Magistrato alle Acque in the Doge's Palace, 16th century, Museo Correr).

The conservation of the lagoon has always been a dogma and represented one of the major economic and technological efforts for the Venetian Republic. It is not by chance then that in the collective imaginary guaranteeing eternal life to the lagoon equalled guaranteeing eternal life to the Republic. The fact that the lagoon should have been preserved for eternity did not obviously mean that the Venetians –and above all experts in hydraulics such as Cristoforo Sabbadino, head of the *Magistrato alle Acque* around the mid-16th century– were not aware that the lagoon was a living and mutable body. A mutable body divided in *laguna viva* –living lagoon, where some areas are always submerged and others are periodically submerged during high tides– and *laguna morta* –dead lagoon,⁶⁷ where the areas have emerged or are invaded only exceptionally by the waters (Morandini 1960, p. 71). A mutable body related both to daily cycles, as the one of the rising and decreasing tide illustrated by Sabbadino himself, and long-term modifications, as reported by ancient historians such as Strabo and by the capillary activity of survey and preservation led by the Venetian Republic since the Late Medieval period.

The borders of the Venice lagoon played a crucial role in the military and political tradition –historic or mythical– of the Republic, to the point of being considered as the true walls of the Republic (Ortalli 2003, p. 104). The history related to the maintenance of these ‘walls’ has been described as an ‘ecological fable’ (Bevilacqua 2009, p. 13), with a wise governance capable of preserving a delicate and vulnerable habitat with the consent and contribution of the universality of citizens.

►7 Being the main objective of our state the conservation of our lagoon (*infra*, trans.).

►6 The islands of the Venetians at the behest of divine Providence, founded on the waters and surrounded by the waters, are protected by waters instead of walls. Anyone therefore daring to cause harm in any way to public waters is condemned as an enemy of the homeland and is punished no less seriously than the one who violated the holy walls of the homeland. The right of this edict is immutable and perpetual (*infra*, trans.).

►7 Sabbadino underlined that while Alvise Corazzis considered the lagoon only the *laguna viva*, he considered fundamental the preservation of both the *laguna viva* and *morta* for the survival of the lagoon. *Ten è vero che essa laguna è divisa, parte lago discoperto e parte canali e canali salati, e dove può entrar il sabbio, non essendo occupato dal dolce, ma tutto in un corpo della laguna, e volendola conservar, il tutto bisogna conservar, e par essendo sforzati in qualche parte perderne per salvar il resto, perderne mancho che si possa, com'ei dice nel suo fondamento 22 delle acque salze, là dove dice che la conservatione della laguna consiste in conservarla in lagrezza, granlezza et empietza. Hor volendo lui quella parte, ch'egli intende laguna, conservar, consiglia che? si faci l'arzeri e canali soprascritti. Dice io ch'egli propone non solamente cosa difficilissima e quasi impossibile a farsi, ma cosa d'ammirabilissima quando la si facesse? See Cessi (1987, p. 121).*

The prevailing attitude when dealing with the Venice lagoon has been one of extreme caution: if measures to control the evolving morphology of the lagoon have been taken since the origins of human settlements in this region, it was only between the 15th and 16th centuries that an original hydraulic doctrine was developed and institutionalized (Cessi 1960, p. 23). This was made possible by two fundamental facts: the sovereignty of the Republic over the Venetian hinterland, that meant control over the entire hydrographic basin of the Venice lagoon, and the division of the original lagoon, that in ancient times extended from Ravenna to Trieste. A further push came from the recognition, after the defeat of Agnadello in 1509 and the ensuing siege, of the fundamental role that the lagoon played in military terms.

The planned or realized interventions on the Venice lagoon therefore varied between a set of extremes, ranging from daily maintenance and fixing recurrent damage to radical modification of the morphology of the bodies of water to prevent long term problems; between a conservative approach that put military and salubrious aspects first and the pressure exercised by a diverse set of pri-



Drawing of a marcher in bricks and mortar, 1791.
Archivio di Stato di Venezia, Savi ed Esecutori alle Acque, Busta 121

vate economic interests; between the determination to safeguard the lagoon guaranteeing public control and the free expansion of waters and the inexorable manmade transformation and possible overexploitation of resources.

At the beginning of the 18th century –after many radical interventions on rivers carried out during the 17th century, many of which had already been proposed by Sabbadino around 1550– the future of the Venice lagoon was to some extent considered to be secured from what in earlier centuries had been seen as the main menace, the landfilling caused by river sediments. The government of the Republic aimed thereafter at securing this *status quo* through a form of enforcement that took the name of *conterminazione lagunare*.

The *conterminazione lagunare*

While the unstable balance between water and earth has been allegorically represented on multiple occasions –as in the frontispiece of Bernardo Trevisan's *Trattato* of 1718 that carries the motto *Opponesi elemento ad elemento*,¹⁸ where the two elements are depicted as two fighting women– the tangle of private but also public general interests that shaped this environment meant that for centuries the question of clearly delimiting the Venice lagoon did not arise. It was not discussed even during the intense debate on the destiny of the lagoon between Cristoforo Sabbadino and Alvise Cornaro in the mid-16th century. This inertia was broken only at the beginning of the 17th century, and it took more or less two hundred years to establish a final definition with the positioning of the 100 markers of the *conterminazione lagunare*, a kind of 'lagoon protection belt interposed between salt and fresh water' (Cessi 1960, p. 58). The safeguard of the lagoon required on one hand a juridical action, including the revising of specific legislation, and on the other technical interventions that radically modified the morphology of the borders of the lagoon. Since the 17th century the *Magistrato alle Acque* had continually issued proclamations related to the harm that incautious and fraudulent activities were causing and could cause to the Venice lagoon, stipulating very harsh punishments for those caught in violation. These proclamations were obviously not sufficient: the defence of this environment required a coordinated normative action to be enforced 'nel giro d'una fissa linea di conterminazione...per indi-

¹⁸ 'Elements opposing each other' (unh.citn).

►► "Within a fixed boundary line... to indicate it truly acted within the assigned boundaries" (auth. trans.)

carla veramente sacra dentro gli assegnati termini,"⁷⁹ as Rompiasio (1733, p. 126) stated. The *conterminazione lagunare* was completed in four phases, starting from the south-western area of the lagoon, proceeding towards the north-east and then concluding with the coastal tract (Tiepolo 1992, p. 91):

- 1605-1615, between Chioggia and Lizza Fusina, in relation to the deviation of the Brenta river with the realization of the *Brenta Novissima* riverbed;

- 1616-1636, between Lizza Fusina and Marghera, continuing then along the Osellino canal until the Dese river;

- 1670-1683, between the Dese river and Torre del Caligo, following the deviation of the Sile river with the realization of the *Taglio del Sile* riverbed and the deviation of the Piave river;

- 1783-1792, from Torre del Caligo to Chioggia along the coast of Cavallino, Sant'Erasmo, the Lido and Pellestrina.

One hundred years passed between the completion of the third phase and the beginning of the fourth and final phase. A fundamental push came from the report produced in 1762 by Angelo Emo on the deterioration of the lagoon. The report followed his appointment to produce a map where every alteration to the lagoon border morphology, whether produced by nature or by private interests, was to be highlighted (E. Bevilacqua 1992, p. 56). After noticing severe alterations throughout the border of the lagoon, Emo strongly suggested that measures be taken to complete the *conterminazione lagunare* and the positioning of new markers as substitutes for those placed in the 17th century, which had in the meantime largely disappeared.

Even if since the fall of the Republic of Venice the pre-eminence of the symbiotic relation between Venice and its lagoon in relation to the mainland has disappeared, the *conterminazione lagunare* is still relevant as an expression of political and technical awareness, as a morphological and juridical element that reminds us of the necessity of defining a space devoted to the daily as well as long-term safeguarding of the unique environment of the Venice lagoon.

Elements / Key concepts

**Immaterial division
devices**

The Venice lagoon is a space with mutable borders also from an administrative point of view. It is a 'regulated lagoon' not only with respect to its morphology but also through a series of legislative instruments that overlap and sometimes 'collide', creating a complex system of cross-linked constraints and safeguards that respond to heterogeneous rationalities.

Immaterial division devices



Administrative perimeters of the lagoon
Conterminazione of the lagoon, watersheds, municipal
boundaries, reclamation consortia

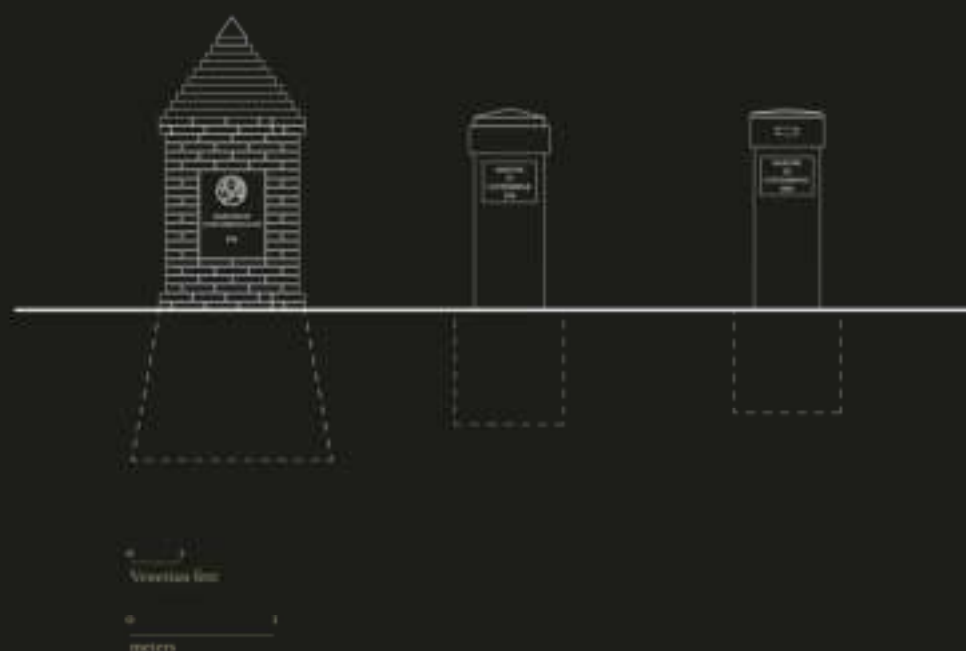
Numerous intangible perimeters have been recognized, conceived, defined, and retraced over the centuries. The first, linked to the morphology of the Venice lagoon itself and to the presence of the lagoon mouths and related areas of influence, are the watershed lines. While not representing a fixed obstacle, these implied a relevant limit to navigation across the lagoon

in the event of low tide. The *conterminazione lagunare* was officially established at the end of the 18th century; however, it had already been conceived at the beginning of the 17th century and was implemented over a long period, in the face of considerable discussions. To these borders were then added further ones, such as the administrative borders of the municipali-



ties –which have undergone various modifications over the years, such as the redefinition of the borders of the Municipality of Venice at the beginning of the 20th century– and of the reclamation consortia that manage the complex mainland hydraulic machine.

cippo (noun)



marker (noun)

Border marker –originally in brick and *co-ciopesto*, then in *Pietra d'Istria*– placed by the Republic of Venice starting from 1791 to delimit the lagoon boundary. Originally there were about a hundred stones, to which another twenty in concrete were added in the Twenties of the 20th century following a modification of the boundary line.

conterminazione (noun) lagunare (adj.)



A delimitation of the lagoon territory within which the provisions and regulations for the environmental protection of the lagoon are valid. It was delimited with markers indicating the border, and its construction was completed in 1792. In 1990 the borders were updated to also include the stretches of water of the three lagoon mouths and the island of Sant'Erasmus.

Land is land, water is water

*Il futuro del Comune non è Venezia, è Mestre dove c'è la gente che vive**
Luigi Brignone, Sindaco di Venezia

*00 'The future of the Municipality is not Venice, it is Mestre where there are people who live in'. Auch trans. Quoted from *La Marea di Venezia* 2003.

The reasons behind the land and water disputes during the 16th-century between Alvise Cornaro and Cristoforo Sabbadino –the greatest experts in lagoon hydraulics at the time of the Republic of Venice– are to be found on a tiny triangle between the island of Chioggia, the port of Brondolo and the agricultural lands reclaimed from the lagoon. On a portion of reclaimed land facing the lagoon overlooking Chioggia are clustered the opposing lines of reasoning that still characterize an important part of the implicit and unspoken rationalities of the ‘Venice problem’. Ideas about the lagoon realized only in part, which in a few kilometres precipitate and crystallize in space and in a territorial capital built on expertise, forms of government, but also of devices such as artificial canals, embankments, reclaimed agricultural fields as well as bridles, dams, pumps, dewatering pumps, and fishing valleys. Chioggia is the island where Cristoforo Sabbadino spent his childhood and where he declared that he had learned about the lagoon phenomena (Cessi 1941). On the mainland, in the nearby Fogolana, a hamlet of Codevigo, were located the headquarters of Cornaro in the lands inherited from his uncle. Here he was able to experiment and become one of the leading reclamation experts, recovering the techniques that were introduced in the Paduan countryside by Benedictine monks, burying and cultivating portions of the lagoon, erecting embankments to achieve a clear separation between water and land, and building part of their economic fortune based on cultivation. This is the place that more than any other gave form and voice to the thinking of the ‘agrarian party’ and that found in Cornaro ‘its main and pleased exponent, who exalted [...] the role of “holy agriculture” and considered decisive for the destiny of Venice, together with a more marked projection of its influence towards the mainland, which was already well consolidated, the conquest of new lands to be reclaimed and cultivated, in order to make the Serenissima autonomous with respect to its primary food needs’ (D’Alpaos 2010, p. 42). It was here, around the Fogolana embankments built illegally by Cornaro, that the most exciting debate on the future of the

lagoon during the Republic of Venice era would begin, and where the private interests of a land entrepreneur and those of the 'market party', represented by Sabbadino on behalf of the *Magistrato alle Acque*, became intertwined. Within this debate between the two *Savi* (saviours), a geographical shift between water and land crystallized, to create a conceptual gap that introduced the specific and well-characterized visions of the lagoon that are still with us today.

The extreme weather events and the devastation that in recent decades have affected the metropolitan city of Venice on several occasions have, on the one hand, highlighted the close and indissoluble relationship that exists between the lagoon and the city that has grown on its drainage basin, while on the other, they have revealed the main rationalities that have shaped this territory since the times of Cornaro and Sabbadino. Within this speculative exercise it is not difficult to recognize who the representatives of one point of view or another are today: on one side there is the 'agrarian party', with an often unscrupulous –even if enlightened– vision of entrepreneurship which aspires to become an active part of political action, while on the other side the 'market party' places Venice and its waters at the centre, often promoting an implicit project whereby safeguarding the balance of the lagoon must be put above any other interest. In fact, it should not be forgotten that at the time of the Republic of Venice the action of safeguarding the lagoon was often carried out to the detriment of the liminal territories: 'Focusing on the Brenta for now, it must immediately be pointed out that if its exclusion from the lagoon saved the stretches of water around Venice from silting, a heavy price was paid immediately by the mainland' (D'Alpaos 2010, p. 43).

On the embankments built to protect the lagoon and, at the same time, separate land, water, and sea, Cornaro wrote many texts between 1540 and 1560. As mentioned, Cornaro became a precursor of the reclamation of these territories in the Codevigo areas located to the south-east of the lagoon, between Venice and Padua, made uninhabitable and marshy due to the construction of the 'Brenta Nova' excavated during the 15th century. It was to protect these reclaimed lands that Cornaro erected the Fogolana embankment on the lagoon, which was later demolished by order of the *Magistrato alle Acque* and that generated a judicial and intellectual confrontation with Sabbadino. It is from the stubborn defence of

this first embankment that Cornaro began to gradually formulate the idea of a lagoon entirely closed and separated from the surrounding territory. A healthier, richer, safer, and more beautiful lagoon.

If for Cornaro the separation and protection devices are initially tools intended to defend and protect his lands from *mal-aere* (bad air) and to define a clear limit of ownership of his possessions, they quickly become the hallmark of an overall idea of the lagoon understood as a defined space, in which the land is land, the 'lake' is a 'lake' –lake here stood for lagoon– and the sea is sea. Thus, the embankments towards the land become walls with bastions, doors, and wooded embankments. Along the shores they become barriers against storm surges and dams towards the sea, to 'lock' the ports of Treporti, Sant'Erasmus and Malamocco that expose the lagoon to incursions of the sea and enemy armies. The actions of excavation, reclamation, separation, and protection become design devices capable of satisfying the request for a healthy¹¹¹, safe¹¹² and beautiful¹¹³ place. A project made possible by the construction of ever larger embankments, walls, and dams. Technological devices that are simultaneously protection and territorial specialization; they define a hinterland which is the productive belly of the region and a lagoon which, isolating itself from floods and storm surges, preserves Venice and crystallizes it over time. Large-scale works on a territorial scale, made possible by the action of the State because, as Cornaro constantly reminds us, 'non si concede a una privata persona per bonificare li suoi luoghi aprire et serrare l'acque, tagliar arzeri, far scoladori nuovi, cambiar alvei a fiumi, levar via molini, rimover livelli [...]'¹¹⁴ (Cornaro 1540, p. 8).

Water and land today

Long after the 16th-century controversy between Sabbadino and Cornaro, it is still possible to glimpse the strong relationships but also the (historicized) conflicts that emerge between Venice, in the lagoon, and the metropolitan city that has been created around it, on the mainland. In other words, the two great sets of antithetical arguments are revealed: on the one hand, a territory that in its long history has been extensively altered in order to protect the lagoon and on the contrary, the city of Venice which, in recent decades, has been rethought (first politically then spatially) also as a function of its metropolitan area. Indeed, from the

111 [...] il parere mio saria, che fosse fatta una divisione di questi paludi, o con arzeri, o con altro, et li paludi più bassi [...]. Vorei che fossero curati et dategli fondo fino a confine degli arzeri, acciò s'agrandisse la laguna et si levasse la causa del mal aere, che è il nascer della canella.' (Cornaro 1540, p. 6). 'It is my opinion that a division of these swamps should be made, with embankments or something else, and the lowest swamps [...]. I would like them to be excavated and levelled up to the border with the embankments, so that the lagoon could become larger and the cause of the sickness –which is the growth of cane thickets– eliminated' (Lauth/trans.).

112 'È dunque necessario chiudere prima il porto deli Treporti, e poi quello di San Erasmo, e poi quello di Malamocco, che essi sono quelli, che han tolto la laguna a questa, e sono porti aperti senza difesa alcuna, onde si può entrar nella laguna, che è aperta, e massime per quello di Malamocco, che non è pur aperto e patente, ma profondo e estremo ad ogni grande armata nemica' (Cornaro 1540, p. 72). 'It is therefore necessary to close first the port of Treporti, and then that of San Erasmus, and then that of Malamocco, which are those which have taken the lagoon away from it, and are open ports without any defence, so that one can enter the lagoon, which is open, and especially for that of Malamocco, which is not only open and apparent, but deep and convenient for every great enemy army.' (Lauth/trans.).

113 'È richiesto che questa città sia recinta di mari, nel territorio si sia uno bosco e dentro di essa città la sia solennata di theatro, di fontana del bil, come si può, e di tutto

vago nuncicello, le quali, perché sono cose belle, che si possono fare, sono certo che si faranno, e la voga loro, come si fussono fare. Oh che bella città vego, che sarà questa veramente illustre! (Cornaro 1966, 69). 'And I remember that this city should be enclosed by walls, on the embankment there would a fountain and within it there will be a city I adorned with a theatre, a fountain with life river water, so it will be possible, and with a vague mound, which, because they are beautiful things, which can be done, I am sure they will be done, and I foresee now as they were done. Oh, what a beautiful city I foresee, which will be truly illustrious!' (auth.transl.)

►14 'It is not granted to a private person to reclaim his possessions, open and close the waters, cut embankments, make new drains, change riverbeds, remove mills, remove levels' (auth.transl.)

post-war period to today, the opposing parties (of *mercatura* and 'agrarians') seem to acknowledge each other, even in the local debate. On the one side, the ardent defenders of the conservation of the equilibrium of the lagoon, of its landscape and artistic forms, of the cultural and microeconomic practices that have consolidated here (Montanelli 1969; Mencini 2011; Mencini *et al.* 2013) and on the other those who interpret Venice and the lagoon –also in anticipation of potential economic development processes– within a complex territorial framework (Rollet-Andriane and Conil-Lacoste 1969; Zucconi 2002; Fondazione di Venezia 2019). Starting from the multifaceted reclamation project, Cornaro's



Detail of an ancient map of the lagoon drawn by Zuane Trevisan in 1542 depicting the Fegolana embankment built by Alvise Cornaro and his associates.

Archivio di Stato di Venezia, *Scritture ed Esercitori alle Acque, Disegni, Laguna*, n.6

intellectual legacy informs us about the possibility of looking at the decentralized lands of Venice –the reclaimed and urbanized countryside, the mainland shore, the industrial areas, the islands, the seashores, and the coastal strip– as active places in a necessary transition process. Cornaro pictured a scenario that still appears profoundly timely, separating the lagoon and repositioning it in a wider field of relations within a territory that is made healthy and

productive by the work of man. Looking at the cultivated countryside, Cornaro sheds light on a development model based on autonomy, access to local resources and circularity. Through the obstinate defence and construction of a landscape made of water, of a dense network of navigable rivers and ports, of previously marshy soils transformed into productive agricultural spaces and woods, Cornaro reconceptualized the idea of heritage and brought it back to the territory. In this sense, the lagoon and its drainage basin are not just a background for Venice but, together with the landscapes and practices that cross it, they constitute her fundamental significant frame. In light of environmental emergencies, cyclical economic crises, depopulation, and land consumption phenomena, looking at the areas covered by the Cornaro reclamation plans means examining the problems –but also considering possible solutions– which, inevitably, also affect the lagoon as an environment and Venice as a city.

Conversely, also following the various special laws for Venice and the recent disastrous high tides, the issue of safeguarding the lagoon has become increasingly pressing; even in popular debates the collective need to protect the hydraulic, biochemical, and sociocultural space of Venice emerges. In this setting Luigi D'Alpaos argues, as mentioned, the need to continue with the maintenance work of the lagoon that was carried out by the *provi* (magistrates) to the waters of the Serenissima: this, in fact, has always been an important cultural heritage, between nature and anthropization (D'Alpaos 2010; 2019). Today, the cultural heritage of Sabbadino brings the gaze back to the lagoon intended precisely as heritage: a territory that must be protected and maintained, firstly through the ousting of all that is considered incongruous, irreconcilable (large ships, the industrial port, mass tourism); secondly, through a large project composed as a sum of small works aimed at maintaining the balance between salt and fresh waters that the transformations of the 20th century and the new environmental emergencies risk to irreparably compromise.

Thus, on the edges of the lagoon, the logics of water and land congregate in a contemporary kaleidoscope through incongruous demands, apparently irreconcilable political claims, movements from below, and great modernizing works supported by the Italian state in Rome. The opposing rationalities settle on the ground, populating the territory with a schedule of building works, in-

infrastructures, technological devices whose framework of shared meaning is hard to grasp. In a certain sense, looking at the logic of the land, these are often resistant and hierarchical devices, large works aimed at defining a territorial and functional specialization: sheet piling, embankments, dams, bridges, mobile bulkheads, information and high speed infrastructures; by contrast, looking at the water, they seem to be weaker devices, often inspired by the paradigm of resilience and transition: micro-artifacts made of halophytic plants, aquatic grasslands, clod transplants, bundles of twigs, new amphibious morphological structures, reeds and wetlands.

Today, in the light of the repetition of extreme high-water events and the consequent environmental effects, the hydrodynamic and morphological relationships between water and land re-emerge in a particularly accentuated form by the phenomena of subsidence and eustatism. As hypothesized by Umgiesser (2016; 2020), the gates of the three mobile dams –in anticipation of an average sea level rise of 50 centimetres by the end of the century– will have to come into operation on average at least once a day. As already mentioned, this perspective will lead us to have to choose between safeguarding Venice –through a progressive but total closure of the lagoon– and safeguarding the lagoon for the maintenance of which, as mentioned, the exchanges between sea and salt water are vital. The closure of the lagoon would be incompatible with both navigability and the industrial port on the one hand, with the ecological needs of the natural environment on the other. In facing this choice, Umgiesser mixes the logic of water and land and accepts the idea that the body of water could one day be separated from the sea and the land, returning implicitly –and paradoxically– to the ideas that belonged to the party of agrarians. Therefore, in the perspective of a gradual but total closure of the lagoon, the studies advanced by Cornaro still constitute an important source of reflection: they push us to think about the surface of water around Venice as an artificial space that is the result of the work of man. A space which is neither fixed nor immobile, which can be modelled and transformed.

Elements / Key concepts

Physical division devices

Even if the division of the lagoon may seem immoral, it should be remembered that it has always been a territory-palimpsest designed by physical devices whose purpose is to define, separate and regulate what by nature would be unstable and in transition. The definition occurs through corrugations of the ground, such as embankments, sometimes through small deformations of the soil surface of an incremental type, such as the protection systems of the salt marshes, sometimes through peremptory and resistant limits, as with the sheet piles of the marginal systems of the lagoon or the protection systems towards the sea. Secular corrugations of the ground that have made an uninhabitable territory habitable and whose future is still –as always– threatened by the same water that Venice has been attempting to contain or eliminate for centuries.

Physical division devices



Lagoon protection and division devices

- A. *bricole* (dolphins),
- B. *burghe* (otterse bukes), *fascinate* (fascines),
- C. embankments of fishing valleys,
- D. sea defences,
- E. *spande* (banks),
- F. embankments of the drainage basin.

The material divisions that structure the space of the lagoon follow rationalities of control, defence and separation of a space which by nature would otherwise be indefinite and in perennial transformation. In the water space of the lagoon, the *bricole* separate the flows of the boats, define the edges of the canals and

therefore accessibility, making manifest the bathymetry that would otherwise be invisible. *Burghe*, *palafitticole* and *fascinate* protect the *buene*, setting the limits of a microtopography of a few tens of centimetres which by nature would be mutant, osmotic, and alveolar. The banks define the islands and the lands that



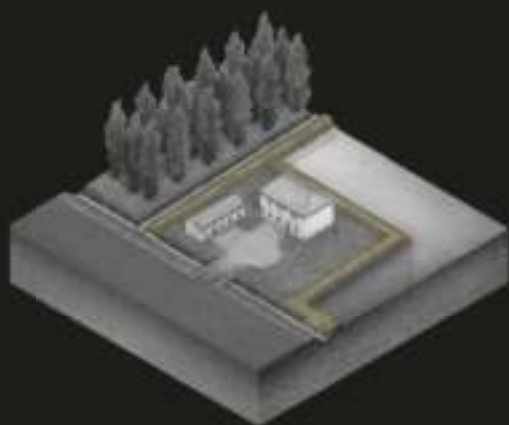
have emerged, consolidating and outlining their edges. The levees and sewers of the fish farms compartmentalize the streams, trap, and care for the fish. Towards the lagoon eaves, embankments, sheet piles, pumps and water pumps divert rivers, define the edges and limits of the lagoon, turning into land what would

otherwise be a swamp. Towards the sea *murazi*, dunes, groynes and mobile dams protect the shores and the lagoon, separate the salt from the brackish water, and protect the space of the lagoon from storm surges.

argine (*noun*)

embankment (*noun*)

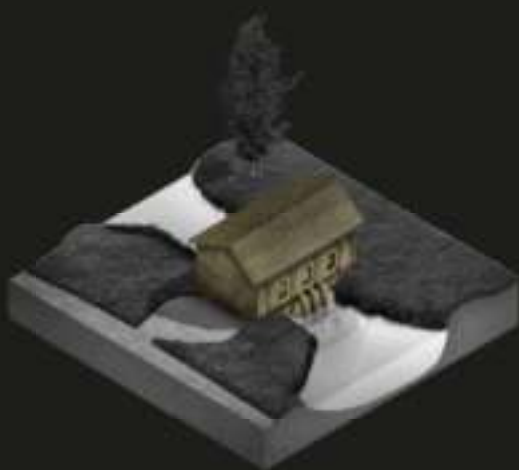
Structure built to shelter from the water that can also serve as a defensive purpose in military terms. The first large embankment built by the Republic of Venice was the Saint Mark's Embankment in 1543, following the flood of the Piave river in 1533 which caused the burying of large areas in the northern lagoon near Torcello, Burano and Mazzorbo.



idrovara (*noun*)

water (*noun*) pump (*noun*)

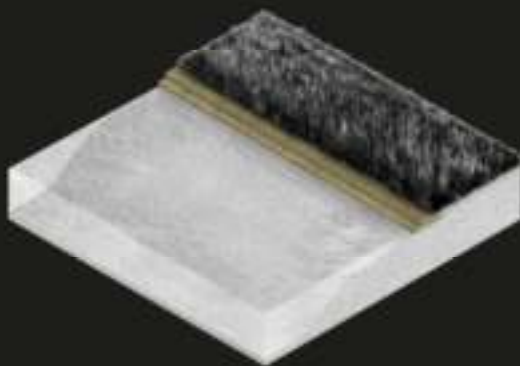
Pump (or pump system) for the disposal of masses of water used in reclamation works. They are housed in a network of buildings that, together with the farmhouses (now largely abandoned), dot and characterize the agricultural areas of the Venetian mainland.



burga (noun)

coarse (adj.) basket (noun)

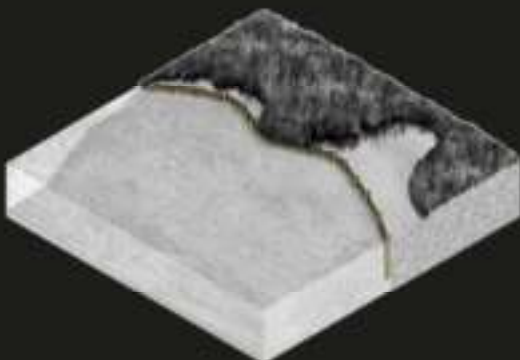
Coarse basket of willow branches, cylindrical or conical in shape, which, filled with stones, works in river defences against the erosion of the *barre*.



fascinata (noun)

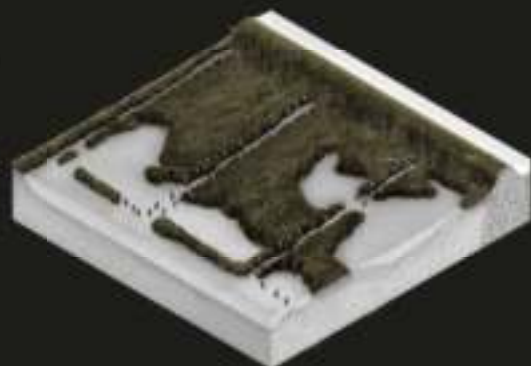
fascine (noun)

biodegradable naturalistic engineering intervention with low environmental impact to protect the margins of the *barre* from waves and currents. It consists in the hand-making of wicker bundles that are placed and fixed, together with the trawling of sediment deposits, transplanting of vegetated clods and installation of wavebreaks, windbreaks and groynes.



gronda (*noun*) lagunare (*adj.*)

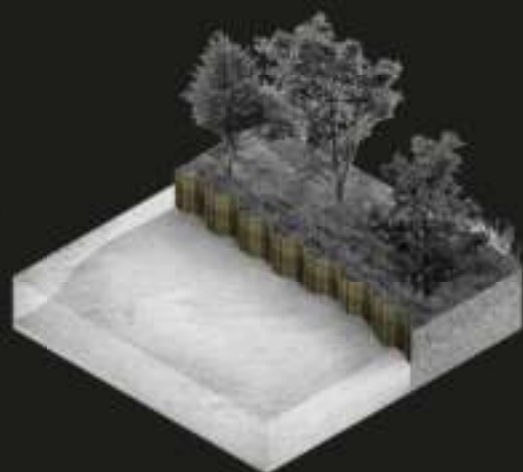
Portion of the drainage basin in which rainwater flows towards the lagoon itself.



palancola (*noun*)

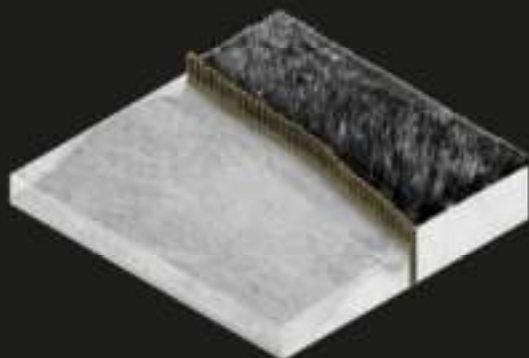
sheet (*noun*) pile (*noun*)

Component with a structural function –commonly steel in hot or cold rolled form– which once driven into the ground below the excavation plane and connected appropriately with other modules forms a continuous vertical element called “sheet piling”. This acts as terrain support and/or hydraulic barrier and can be designed as temporary or permanent.



palafitticole (noun)

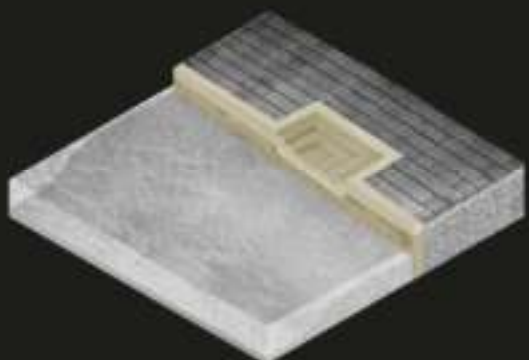
Biodegradable naturalistic engineering intervention with low environmental impact to protect the edges of *barene* from waves and currents. It consists of a barrier of logs implanted in the lagoon-bed with the function of supporting the ground.



sponda (noun)

bank (noun)

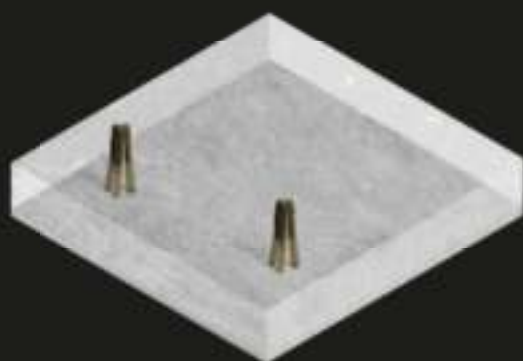
The Venetian banks usually have *Pietra d'Isiria* edges, may or may not have a parapet and are dotted with landing stages with steps that descend into the water for mooring boats and loading and unloading goods. They are also commonly called *fondamenta*, a term deriving from the consistent continuous piling and the overlying foundation masonry works necessary to build them.



bricola (*noun*)

dolphin (*noun*)

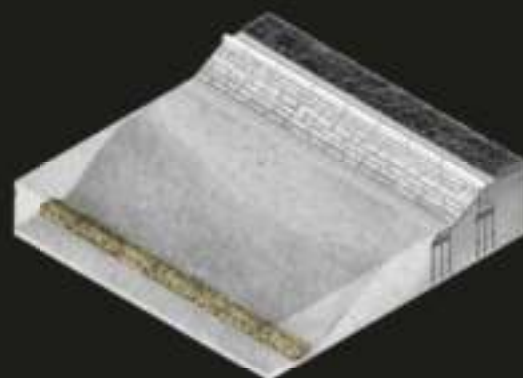
Venetian term that indicates the poles planted on the bottom of the lagoon and used to delimit the navigable canals and occasionally for the mooring of large boats. Today the originally wooden bricole are often replaced by models made of artificial materials that require less maintenance.



diga (*noun*) soffolta (*adj.*)

underwater (*adj.*) dike (*noun*)

Modular structure in reinforced concrete, placed and juxtaposed on the seabed along a continuous line parallel to the coast and at a distance of at least one hundred metres from it. The dam is placed in order to dissipate the energy of wave motion, favour the sliding of the sand towards the shore and counteract its return in order to limit the erosion of the coasts.



lunata (*noun*)

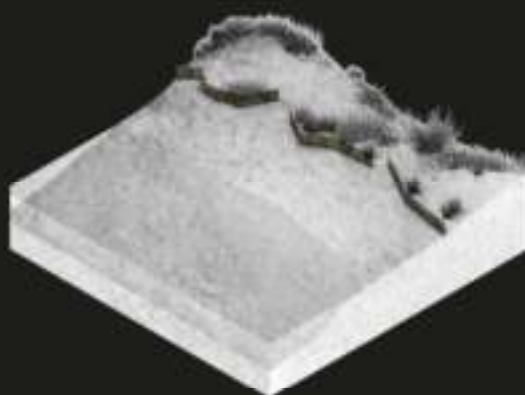
Curvilinear artificial reef that dampens the strength of the tidal currents entering the lagoon.



duna (*noun*)

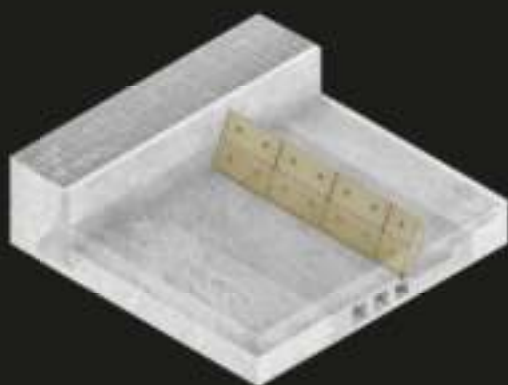
dune (*noun*)

Heap or cord of sand, generally fine-grained and uniform, mostly horseshoe-shaped, with asymmetrical slopes that are formed on the coasts by the action of the wind blowing constantly in the same direction. In addition to the wind, the prevailing sea current, which circulates counterclockwise, also affects the deposit of sand and the consequent formation of dunes in the upper Adriatic.



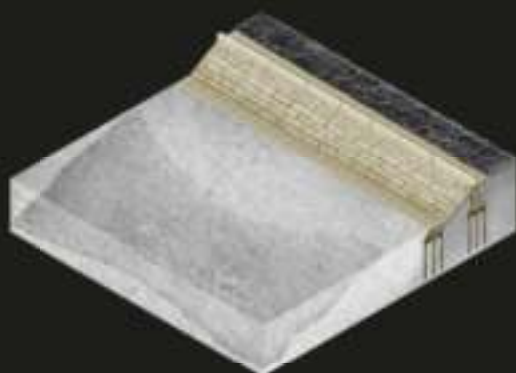
MoSE (acronym)

The Modulo Sperimentale Elettromeccanico (Electromechanical Experimental Module) is a project developed since the late Seventies of the 20th century (following the 1966 flood) to protect the Venice lagoon from high tides. The main feature of the project are the rows of mobile gates –installed at the lagoon mouths of Chioggia, Malamocco and the Lido– capable of temporarily isolating the lagoon from the sea. The works only started in 2003 and should be completed by 2022.



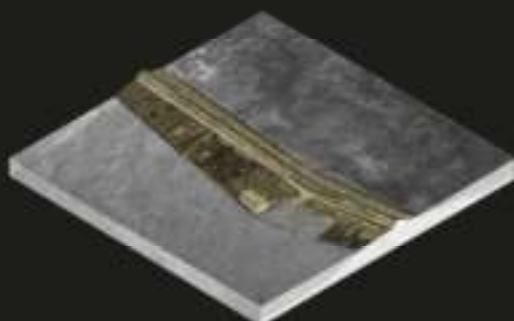
murazzi (noun)

The set of dams parallel to the coast close to the shores to protect them from erosion caused by the sea. They were designed as defence works from the sea in *Pierra d'Istria* and *pozzolana* by the mathematician Bernardino Zendrini starting from 1739 on behalf of the Republic of Venice along the coasts of Malamocco, Pellestrina and Sottomarina.



lido (*noun*)

Narrow sandy strip of land parallel to the coast that divides the lagoon from the sea, also known as "coastal strip".



pennello (*noun*)

groyne (*noun*)

Structure for the defence of the shores or marine beaches that stretches towards the water, perpendicularly or inclined, against or according to the current, built in stone masonry or obtained with simple piles of boulders resting against a reinforced concrete wall, or with gabions.













