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The government of the waters and natural environment in the metropolitan area of the Lagoon of Venice from past to future

Piero Pedrocco^{a,*}

^aDPIA Dept. University of Udine, Udine 33100, Italy

Abstract

The Venice problems are not just about protection against flooding. And the Laguna problems are not only those of defense from the rivers that fill with sediment making it disappear. Of these two problems we talked a lot. Today we can say that, like yesterday, the city's problems and the problems of the Lagoon are intertwined. The city presents problems of depopulation, economic base and transport. In Laguna there are environmental problems, archaeological, eustatism and bradyseism. Laguna and city, also as metropolitan area, represent a unified whole, inseparable.

The paper describes the main problems of bradyseism, of eustatism, of high tides that flood the ancient centers (*acqua alta*) and speaks of the defense of the city from them. But there are also basic economics problems, for the life of the settlements and transport, required to give a reason for living the city, almost as much reason for living for the city is Laguna itself. It's also stressed the importance of integrating these issues with those of the tourist economy, the natural environment, the economy and the harbor, describing some solutions into a systemic vision, because Venice and the Lagoon are inseparable and can not work one without the other.

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* Corresponding author. Tel.: +39 339 2947858; fax: +39 0432 558052.
E-mail address: piero.pedrocco@uniud.it

1. Introduction

The subject of water governance in the *Serenissima* Republic is known and studied for centuries. Rivers of words have been written about Marco Corner or Cornaro (Pavanello, 1919), after troubled career Wise Water Authority (*Savio alle Acque*) and the first author of the river Brenta deviation out of the Laguna (not to be confused with the same name Doge and the Patriarch), and a lot of papers have been written around the debate between Alvise Cornaro and Cristoforo Sabbadino *ingegner proto* to the waters of the Venetian Republic (Cessi, 1930). The Venetian hydraulics study is, moreover, at the base of the great School of hydraulic of Padua, and it's the basis of the very *raison d'être* of Venice and its State, until 1797, the fall of the Republic due to Napoleon. From this School are born the works of Paleocapa and many other engineers of the nineteenth century and the twentieth century, under Napoleonic rule and especially under Austrian rule and the Kingdom of Italy.

Only recently, with drastic and questionable task, the Italian State abolished the “Magistrature on the Waters” (*Magistrato alle Acque*), through the Government Renzi, June 13, 2014, justifying this act with the climate of corruption generated following the tangents on the MOSE. The acronym stands for *MODulo Sperimentale Elettromeccanico* (Experimental Electromechanical Module). It is the hydraulic project, still in progress, aimed at the defense of Venice and its lagoon from high waters (tides). Large mobile gates, of concrete, quarries, filling with air should stand into the three inlets of Lido, Malamocco and Chioggia. They are hundreds, even more than 20 m high, and are pivoted horizontally on the seabed, in large containment caissons, equipped with the pumping and drainage systems. The work is now costing several billion euro (over 5) and is made of 85%. The functions of the Magistrate were transferred to a temporary Office of the Ministry of Infrastructure and Transport, in order to complete the work (Various authors, 2006).

But if the theme of sea water governance, especially from the fateful 1966 flood that invaded Venice and Chioggia with great clamor, over 1.90 m, has been much debated in the last 50 years, other issues can not be forgotten, such as for example the transport of turbid river, the formation of marine benches and difficulties of shipping.

2. Bradyseism, eustatism, high tides, and sediment

The phenomena of bradyseism and eustatism in the North Adriatic area are well known. Just think about how these phenomena have affected, along with deposits of sediments carried by the rivers, the ports of the dominant city of the region, namely Adria, Spina, Ravenna, Aquileia, Altino and Venice. These cities have had ups and downs affecting maritime fortunes, often forming into large emporiums for the link between the East and the West and between the North and the South. In addition to the barbarian invasions, anyway, they often found themselves faced with the occlusion of the mouths of the harbors and the subsidence of port facilities that had generated their importance.

We must not forget how this "erratic" port system in the North Adriatic, the closest Mediterranean maritime area to Central Europe unless the Alpine chain, has been conditioned in fact, even more than by the historical events, from the geological events and hydrographic bradyseism and eustatism, making harbours that were otherwise very efficient, ineffective for long decades.

It's definitely the case of the ports of Altino and Aquileia, and the homonymous city that have disappeared with them, but most of Ravenna, who was on the sea with the civil harbor and the military harbor of Classe, at the time of the Roman invasion and the Imperial period of Augustus Caesar, and who now is 8 km from the sea. Its ancient urban structures that today are deep about 2 to 3 meters below ground level. The city was also once surrounded by vast lagoons, which have now been deleted from the accumulation of turbid of the Po, the Apennine rivers, and sea sand deposits carried by the current of the Adriatic. But in ancient times it had to be very different the situation in Ravenna, surrounded by the Seven Seas (Sette Mari) and the Adriatic Marshes (Andraghetti, 2010), compared to the situation of the Lagoon of Venice, which perhaps it was very small and narrow (Dorigo, 1983; Canal, 2013), probably having been formed with the marine ingression of the Middle Ages (about the IV, VIII and XI Century).

Currently it might also be in place a new slow marine ingression. The Lagoon seems to turn into an arm of sea (D'Alpaos, 2010). In this regard it deserves to make some notes.

The dig of the "Canale dei Petroli" (The Oils Channel), from the harbor mouth in Malamocco, may have affected more rapid input of water in the Lagoon, and so the deepening of all the channels of entrance, in Lido and Chioggia, due to the construction of breakwaters, designed and built by the Austrians to introduce modern ships first to the Giudecca and Marittima, in the ancient city, and then to Porto Marghera. Rather than referring to the principle of communicating vessels, which would deny a faster propagation due to the channels, it would be appropriate to target your searches to the combined effects of the Adriatic currents, with a penetration axis from north to south, central in the sea, and a counter-clockwise rotation towards the Italian coast and a clockwise rotation towards Istria and Dalmatia, which combined with the Coriolis principle and the Earth's rotation, makes the lower the Adriatic center than the Laguna. The lagoon watershed dividing the basins of Venice, Malamocco and Chioggia, however, would continue to exercise their functions, nicked, perhaps, only in the area partially embanked of the Canale dei Petroli (Industrial Canal so called of oils), to Porto Marghera.

That are disappearing the mudflats and shallows of the central lagoon, between Venice and Chioggia, with the basin deepening, it can not be attributed to the excavation of channels that only partly. The currents of these, accelerated by outer breakwaters, can affect the next *ghebbs* (minor natural channels that atrophy coming from the sea into the lagoon), moving and deleting tracks. The Lagoon seems to turn into a "sea arm" mainly because bradyseism and eustatism are no longer opposed by the nourishment of the sands carried by rivers (Brenta, Bacchiglione Piave, Sile), which have been diverted away from the Laguna centuries ago by the Serenissima Republic of Venice. Without these diversions the Lagoon, moreover, would have already disappeared, just like in Ravenna, although with longer times, because here does not act Po river, thanks to adriatic currents.

The phenomenon of the "flood tides" is secularly a dynamic phenomenon. Therefore, it does not save historic Venice if nothing is done dynamically on the system. And if nothing is done on the system will not save even the Laguna. For example: if you would raise the soil of the whole lagoon area, perhaps with pumping of deep water in the artesian aquifers in 1000-2000 m, it would have the effect of raising the city but also the seabed. Without a re-configuration of that we will find ourselves in the middle of fields. This hypothesis, proposed by the College of Engineers of Venice, not to be discarded, however, makes sense only if we were able to govern the morphology of the raised basin. In this sense we should therefore work combining multiple methods.

The systemic phenomena are also not static in time. They are dynamic, and these should be for growth and modification of the solutions adopted to save Venice, whether natural or artificial they are.

Even the envisaged mode of closing of the lagoon inlets do not appear definitive, but temporary, secularly, because the dynamics in progress. This means that can't cost too much, because other solutions might become necessary in the time, and that should not cost too much even the maintenance operations. This currently does not seem to come, having preferred the expensive MOSE system, for example, to so-called "ship doors", designed by Alberto Pellegrinotti and perfected and studied with modifications also by other engineers. These works would still be easily removable and able to navigate through to storage basins during the summer, to be entered back on site during the autumn and winter periods, during which add up almost all of the extraordinary high tide phenomena that flood the city.

3. Harbor, town and sea sandbanks

Save Venice without saving the port is impossible. It is not possible to keep a city out of work. Even the number of tourists, which amount to 30 million a year (including beaches), are not sufficient. They provide 20% -30% of the urban economic base.

The Port of Venice is made up of several parts, which have migrated within the city and the Lagoon over the past two centuries. Porto Marghera, for a total of 2,200 hectares, is the largest port area in Italy. Since 1996, the Marittima, in the old city, with the docks of San Basilio is home to the Passenger Port and the First Industrial Zone in Marghera is the new Commercial Port, while Arsenal has reduced the Military Port (Barizza S., Resini D., 2004).

Many changes, however, are in progress or are proposed.

The first change relates to a new port section in Fusina for ro-ro ships and the so-called Motorways of the Sea, immediately south of Porto Marghera, went into operation May 31, 2014. The urban transformation concern for now, in addition to 36 hectares on which stands the ferry terminal, the only network of mobility. It is expected that

the entire area will be in the future subject of urban transformation, triggered by the presence of the port, with both business units that service to people in transit, resulting in building localizations for other uses.

The second change concerns the port for cruises, located in the Old City, in the Marittima. Among the greatest hub ports for cruises in the Mediterranean sea. For reasons of protection of the ancient city, vessels of more than 90000 tons have been banned from the basin of San Marco. The path Marittima-San Marco-Lido cheered tourists, with views of the city. Now for the large ships this path is no longer possible. The proposals have been many.

The first proposal, of the Port Authority, without dislocating the Marittima requiring considerable amortization for work performed, consisted in entering from Malamocco along the Canale dei Petroli and the natural channel Contorta, to be expanded between Fusina and Marittima, to avoid front of Marghera and reduce conflict with the release of the ships from the commercial and industrial Port. This proposal has sparked controversy about the impact due to the expansion of an ancient canal in the center of the lagoon. To this was added another hypothesis, passing behind the island of Giudecca, allowing the view of Venice from ships and creating a large ring of canals around the Old Town. But even this proposal, little studied, collides with environmental criticism.

Between these two proposals now seems to prevail a third hypothesis, supported by the new Metropolitan and City Council, which regards the adjustment of the Channel Vittorio Emanuele III, also industrial and already in operation from Marittima to Marghera from the beginning of XXth century, with a longer ride, engaging the entire path of industrial channels of West Laguna and the entire front of Porto Marghera, and output of the large ships for cruises at the Port of Malamocco.

There are then two possibilities of displacement which, however, pose significant urban planning problems.

The idea of placing a hub for cruises in Porto Marghera, transforming Marittima to lower tourist stopovers, would require a different urbanization of industrial areas that are very full of impacts and currently poorly equipped to receive large passenger flows, as they are often still subject to industrial dangerous processes. Long times would need to adapt these areas, incompatible for the noise, for controls, for the danger for passengers, for the overlapping routes and schedules among different kind of ships.

The hypothesis of placing a hub for cruises in the harbor entrance of Lido, outside of the MOSE barrier also presents little equipped areas to receive large passenger flows, being necessary to handle more than 20,000 people per day, between workers port and tourists, and at different times throughout the day with boats to and from the Marittima and Historical Center. In this case the absence of a subway between Venice, the airport, the railway and the coast of Cavallino and Jesolo weighs on the feasibility of the project. Alpine rivers and the currents of the Adriatic, in addition, after the construction of outer breakwaters, have accumulated the Punta Sabbioni in just 150 years: a new area of 4 x 2 Km deposit sands, today mildly urbanized, which is here formed on the sea. The sands are about to cross the Punta Sabbioni lighthouse, recreating partially the sandy bench that prevented the navigability of the harbor in that direction (Various authors, 2006). And all that with the construction of MO.S.E. in the center. However, the latter solution appears perhaps the most eye-catching to a planning perspective, which will re-develop the city to the sea, with future quarters, which arose as a result of the new maritime station and a rebalancing of the urban masses between the mainland (Mestre and Marghera) and maritime lagoon area (Lido, Cavallino and Jesolo). There is no doubt that a break in transport as rich as that of tourist passengers would soon call service investments on the Cavallino peninsula, of great interest for mass bathing tourism.

Finally, the third and last change under discussion, the most important, concerns the construction of a major container hub port for ships in Northern Adriatic. It was recently endorsed by the Council Inter Ministries for the Economy and Transport (CIPET-2016), but was temporarily stopped by Superior Council of Public Works (March 2016). An offshore platform, 8 miles off the Malamocco, with natural depth of 20 meters, would be an oil terminal and containers, able to accommodate ships of last generation. Besides Porto Marghera would be connected to the offshore Port also Chioggia, Porto Levante and on-shore port of Mantua Valdaro, by river. The transshipment would take place with “mama vessels” or vessels their own half sinking that would transfer the containers to the ground terminals. The proposed model seems interesting but still embryonic. Anyway, the use of smaller ships could allow you to resize the Canale dei Petroli, reducing the impacts in Laguna. This project would also help to improve the economic base of the area, recovering some of the lost inhabitants to the city through appropriate transport policies, re-grafted on sustainable industrial restructuring.

4. Metropolitan transport and lagoon

The city has been reduced in population during the second half of the twentieth century by nearly 400,000 to less than 300,000 residents. Counting the first mainland belts the overall population has increased to about 600,000. The metropolitan area with the provinces of Padua and Treviso, arranged in a triangle, are about 2.6 million residents in a Veneto region of 5.0 and a North East region of 10.0. The largest losses have occurred in the historical center of ancient Venice, from about 170,000 inhabitants of the early twentieth century to less than 60,000 today (without calculating city users non-residents).

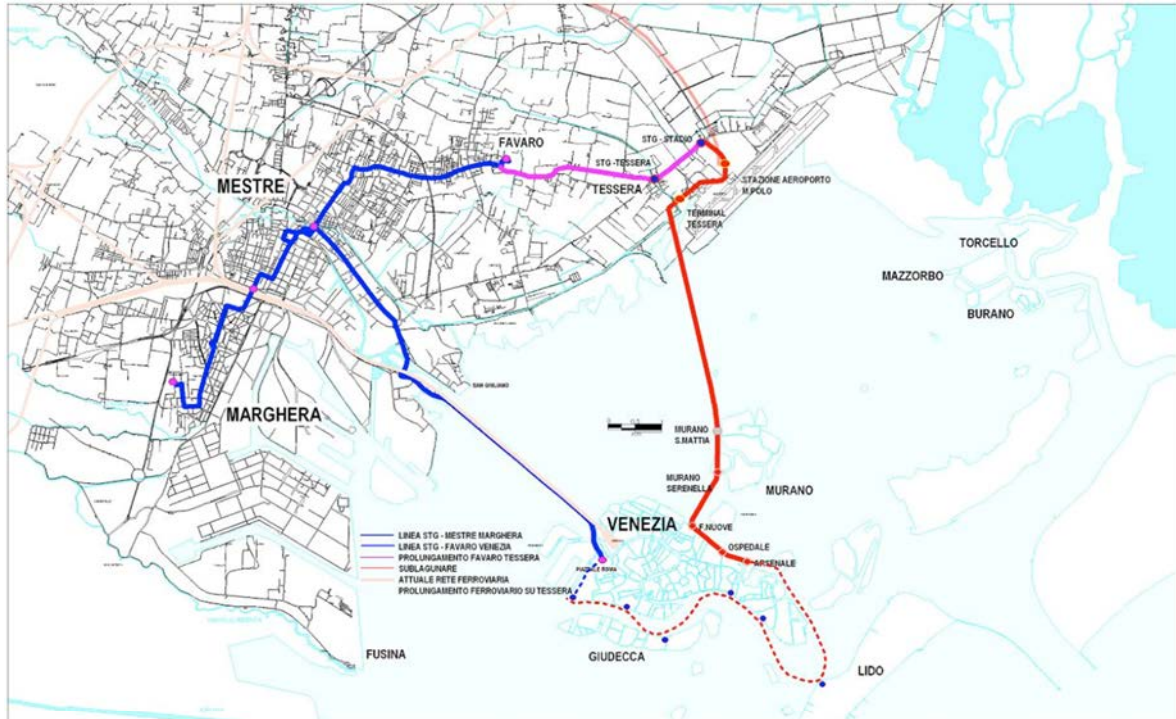


Fig. 1. Roberto Scibilia. Ring closure hypothesis of Sublagunare-tramway (figure by R. Scibilia; edited by P. Pedrocco, 2012).

The subject of transport is definitely critical to obtain a rebalancing, bringing back people in Laguna, in a city that we have not yet been able to integrate and that presents itself, despite the efforts of a century, still as a set of distinct settlements.

The latest project is the underground "sublagunare" Tesserà - Arsenale (Fig. 1, red) launched by the Municipality of Venice and continued at the level of preliminary design by the promoter identified through the procedure of so-called project financing. In 2002 the procedure was initiated, with a proposal declared of public interest by the city in 2003. With the passing of new local Councils, these acts have not been followed by any executive work plan and no contract, all remaining suspended. It was planned a route from Favarò Veneto, along the Via Triestina, with stops in Tesserà, New Stadium (speculated) and arriving at Marco Polo Airport after 4.218 km, then began the underground tunnel of 8.166 km., which included stops at Airport Marco Polo, Terminal Tesserà - parking lots, Sacca San Mattia, Murano, Fondamenta Nove, Hospital and Arsenale. The means chosen was a tram of the same type as the one currently in service between Venice Piazzale Roma, Mestre and Favarò Veneto and between Mestre and Marghera, to ensure the continuity of the network in the mainland and Laguna (Pedrocco, 2012).

Actually this work would be appropriate with double driving rod, no hazardous and problematic interchanges and continuing at least until the Lido, where the tram could replace some bus lines running to the surface again. The

system continued to Chioggia on the one hand, along the Lido towards South, and to Jesolo on the other hand, toward North would ensure a new centrality to the historic city compared to the whole lagoon area and the beaches of Sottomarina, Lido, Cavallino and Jesolo (Pedrocco, 2013, *Scritti* ...). This would serve millions of users in the summer period and would ensure reduction of the wave motion. Such a case could also hold a new port section for large cruise ships to be made on the Lido inlet port and allow to have more residents in the smaller islands of the lagoon, easily accessible by short lines of waterbus from metro stations.

5. To achieve these purposes, archeology and natural environment

Last but not least the issue of recreational/tourism by connecting it to the big topic of the lagoon dynamic conservation of the environment. The artificial-natural basin of the Lagoon, created by the combination of the efforts of man and nature, as well as hosting a city of art of the most important in the world and be surrounded by great beaches for mass seaside tourism, also hosts a natural landscape of high value and practically forgotten archaeological resources.

In a world where the concept of "city", which has become improper, applies both to the so-called historical centers that to conurbations more and more extensive, much of the Venetian Lagoon is the outskirts of the metropolitan area, where unusual events and resonant events coexist with overt environmental degradation and cultural decadence, making it a place of margin. Today the shoreline of Lagoon borders with unfinished waterfront facing brackish non-places. Lacking a unified design (Pedrocco, 2013, *Venezia* ...). Venice is less and less connected with the villages and towns neighboring from the waters, that become a limit to mobility, but they were the element that secured the movements during the past centuries. Never the Lagoon of the Serenissima became a rear area, where only admit the uncomfortable and dirty things, as in a cellar, neither city nor country with respect to Venice, but not even the suburbs, because the Lagoon was Venice and Venice was the Lagoon. It extended well within the Venetian territory, up the rivers and waterways, in a sprouting metropolitan area, as well extended into the Adriatic Sea, not surprisingly Gulf of Venice.

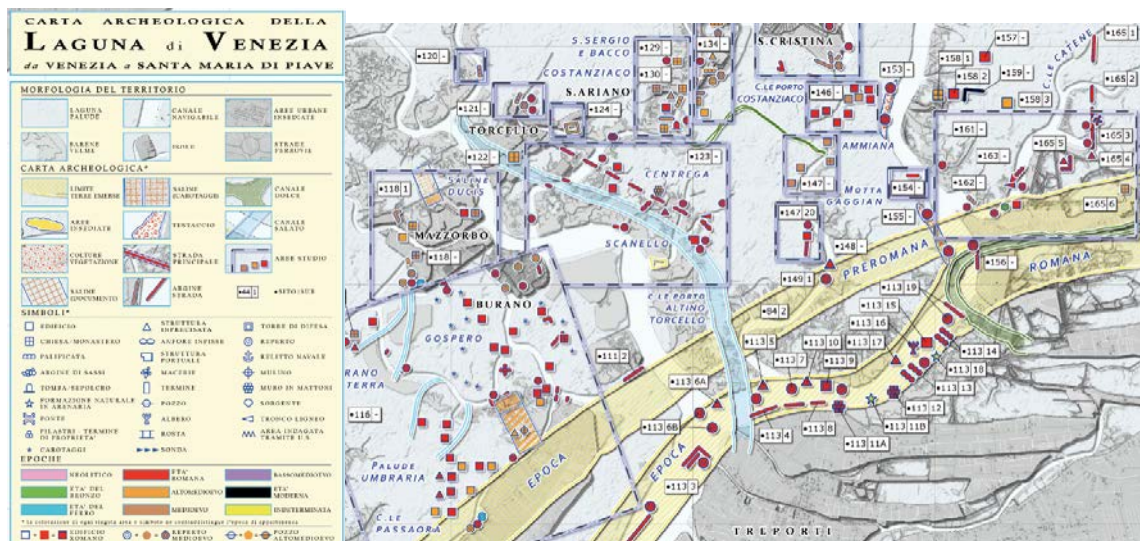


Fig. 2. Particular taken from the archaeological map of the Lagoon towards the missing islands of Ammiana and Costanziano. Provided by the same Ernesto Canal (figure by A. Novello; edited by E. Canal, 2013).

At this degradation we need to respond with environmental regeneration projects, that are the metropolitan-generation projects, able to qualify the Lagoon Park with targeted interventions, but also suitably connected to each other, integrated with the settlements and any where this is possible, even profitable investment business. This

opportunity would give tourism a strong element in addition, because the changes occurred in the seaside tourism demand new opportunities for diversification than the beaches, in the hinterland. The ecological tourism, as well as offering new capabilities, would guarantee funds for the maintenance of the morphology of the Lagoon, and would allow, at least in part, to relieve the overcrowding of the area of San Marco and the city of art, now at the limits of practicality for excess of demand. At this environmental tourism, which in the lagoon would be able to satisfy the demand for green metropolitan spaces, it could give strength also an archaeological tourism of great level. The Ernesto Canal investigations have yielded ninety thousand artifacts and 175 sites including the ancient Romans and medieval sites, located mainly in the North Lagoon, opposite the ancient Roman city of Altino and near the medieval site of Torcello (Canal, 2013) (Fig. 2). Connect a dozen of the most important archaeological sites of the Lagoon with the city of Altino could ensure a corporate economic return, currently overlooked.

6. Conclusion

To achieve these purposes, in the future recovery phase of the Kondratiev cycle, serve political farsightedness, sensitive entrepreneurs, free to act, obviously within the limits imposed by the superintendent, and public-private integrated projects of large and long perspective. This is certainly true for large transport projects and urbanization necessary to reactivate Venice. But it's true for the lagoon area too. Here the operations to be performed may be summarized as follows:

- design and implementation of the Park of the Lagoon, existing factual only as a project on the paper and as definition in the local planning of wide area, with the aim above all to constrain, according to a model frankly exceeded;
- construction of a large Museum of the Lagoon, on the model of education and promotion of American museums;
- formation of tourist operators naturalistic-environmental and archaeological, with entrepreneurial propensity;
- creation of special natural and archaeological guided tours, both linked to the archaeological museum in Piazza San Marco, surely to be enhanced over the current condition, both to the new Museum of the Lagoon, which could present an important section dedicated to fishing in Chioggia, blatantly missing, and also linked to the museum recently restored in Altino and to the archaeological Museum of Torcello;
- restoration of the most important sites discovered by Ernesto Canal and route creation for their visit, making it possible to rediscover the origins of Venice and the Venetian lagoons to the resident population of the metropolitan area and to the tourists that crowd it.

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