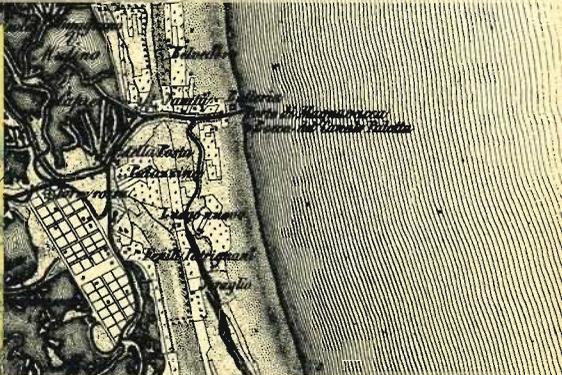


Land Reclamations: Geo-Historical Issues in a Global Perspective

Proceedings of the International Conference
held at the University of Bologna

Edited by Stefano Piastra



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**LAND RECLAMATIONS:
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IN A GLOBAL PERSPECTIVE**

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May 14th, 2010

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On the binding: cartographical representation of Comacchio wetlands (Po River Delta, Ferrara District, Northern Italy), dating to 1814, compared with a present-day satellite image of the same zone. Between 19th and 20th century, extensive hydraulic and mechanical land reclamations turned the vocation of this territory from a fishing-based economy into an agriculture-based one. *Sources*: PEZZOLI S., VENTURI S. (eds.), *Una carta del Ferrarese del 1814*, Cinisello Balsamo, Silvana Editoriale, 1987, and Google Earth, respectively.

On the binding background: Comacchio wetlands from a map dating to 1851. *Source*: REGIONE EMILIA-ROMAGNA, IBC EMILIA-ROMAGNA, *Uso del Suolo Storico. Carta Storica Regionale*, DVD, 2007.

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WATERS AND LAND RECLAMATIONS IN THE PO PLAIN (ITALY). AN OUTLINE (15TH-20TH CENTURIES)

FRANCO CAZZOLA

University of Bologna (Italy)

Dept. of History, Anthropology and Geography

Piazza S. Giovanni in Monte 2, 40124 Bologna (BO)

franco.cazzola@unibo.it

Abstract: *This essay could be considered an introduction to the historical theme of land reclamation in Italy, a country where the lack of lands has been a central issue through the centuries. In fact, the Italian territory is largely characterized by mountains with erosive and landslides trends, while the plains were affected by malaria disease until the 20th century. Starting from 1882, land reclamation programs were mainly funded by the public sector; moreover, even the concept of land reclamation was progressively reconsidered, with the rise of the so-called “Bonifica Integrale” (literally, “total land reclamation”). This paper has been developed regarding two main themes connected to water management in the Po Plain. The first one focuses its attention on the Western part of the Po Plain (Piedmont, Lombardy), where, starting from the 15th century, the efforts were dedicated to exploit waters potential for irrigation and breeding. The second theme concerns the lowlands of the Po Plain (Emilia-Romagna and Veneto Regions): here, programs and practises were linked to regulate the Po River course and its tributaries, and to drain deltaic wetlands, with the aim to create new lands for agriculture.*

Key-words: Land Reclamation; Irrigation; Rivers Management; Po Plain; History (15th-20th Centuries).

1. THE HISTORY OF LAND RECLAMATION IN ITALY. AN OVERVIEW

Due to its peculiar orographical and hydrographical features, most parts of Italy require land reclamation and water regulation interventions. Mountains and hills subject to strong erosion, cover two thirds of the whole territory, also owing to millenary agricultural and pastoral activities practiced on steep slopes. Moreover, in the peninsular area, a good number of short rivers flows rapidly and frequently, ruinously, into the sea, transporting solid sediments and, in most cases, stagnating near the coastline or in inland depressions.

Agriculture would have been easier to practice in the few coastal and inland plains located in Central-Southern Italy and in the islands, yet these swampy areas remained largely unexploited – or exclusively used for transhumance purposes – for centuries, also owing to the presence of a serious and pernicious form of malaria. The disease was transmitted to people by *Anopheles* mosquitoes, infected with the malaria parasites *Plasmodium malariae* and *Plasmodium falciparum*. A less serious form of malaria was also spread by parasite *Plasmodium vivax* in Northern Italy and especially in the Padano-Veneta Plain; here the disease, known as “*terzana benigna*” did not halt the expansion of human settlements in swampy areas. This provides an essential clue on how a massive reclamation project of flooded and swampy areas in Central-Southern Italy, as well in the main islands (Maremma in Tuscany and Lazio, Agro Romano, Pontine swamps, Tavoliere in Apulia, Campidano in Sardinia, and so on) for agricultural purposes could only be launched during the 20th century, following the medical discoveries on aetiology and prophylaxis of malaria (D’ANTONE 1988, pp. 123-140). Consequently, until the second half of the 18th century, investments in reclamation and water regulation projects essentially addressed two main areas, namely the Po Plain and Tuscany’s inland territories. During the 16th century, attempts were also made in order to reclaim land in the Reign of Naples (CIASCA 1928; BEVILACQUA, ROSSI-DORIA 1984, pp. 36-48) and in the deadly Pontine swamps, yet all efforts went unrewarded and malaria prevailed. Even a Pope, Sixtus V, got infected and, eventually, died of malaria, after personally attending the drainage works carried out in the Pontina plain. In a similar way, not even the intervention of Dutch and Flemish technicians, like Cornelio Witt of Alemar in 1637, Nicolò Vanderpellens in 1659 and Dutch Meyer in 1679, was able to produce enduring results. In 1777, one hundred years later, Pope Pius VII ordered to resume the drainage works with the excavation of a 20 km long ship canal connecting swampy areas from Terracina to the sea; 20 years of works only led to partial results, and it was only over a century later that the land reclamation project for agricultural purposes and the repopulation of the Agro Pontino could be completed (GIACOMELLI 1995; FOLCHI 2002).

The “battle against the waters”, engaged in Tuscany by the Medici family between the 16th and 17th century, and continued during the Lorenese reign of Pietro Leopoldo and Leopoldo II between the 18th and the first half of the 19th century, proved to be a no less difficult task (BARSANTI, ROMBAI 1986). The extensive inland depression called Chiane, stretching for over 100 km and collecting stagnating waters descending from the surrounding Apennine range, was progressively filled with solid river sediments, to the extent that, between 1700 and the first half of 1800, the direction of the river’s flow was reversed towards the Arno basin. However, on the other hand, malaria took its toll on workers who had repeatedly tried to drain the Grosseto plain and regulate the flow of the Ombrone River. Further small-scale projects were carried out in the attempt to reclaim swampy inland basins (such as Valdinievole, Bientina, Padule di Fucecchio, Massaciuccoli and others), yet works produced a conflict of interests with the local communities, whose economy essentially relied on fishing and harvesting of wetlands vegetation (TOGNARINI 1990; PROSPERI 1995; BEVILACQUA 1996, pp. 60-72).

In the Po Plain, successful land reclamation projects date back to the population growth recorded in the second half of the 15th century. Here, and especially in the lower Po Plain, huge efforts were made with the aim to obtain arable land and regulate the river flow, at least until the dewatering pumps powered by steam-engines were introduced in the second

half of the 19th century. A few figures should be sufficient to illustrate the extent of the land reclamation issue in Italy. According to a report drafted before the unification of the Italian reign was completed (thus excluding Veneto and Friuli Venezia Giulia) and submitted to the Ministry of Agriculture by Marquis Raffaele Pareto (PARETO 1865), swamps and marshes covered about 764,000 hectares, while 208,000 hectares had been already reclaimed. At a national scale (with the exception of the Veneto Region), nearly one million hectares thus consisted of either reclaimed or reclamable land, which made up for about 4% of the whole territory (with an extension of about 26 million hectares). In the provinces located in the Po Plain (once again Veneto excepted), wetlands covered about 235,000 hectares or 3.35% of the whole territory, mountains and hills included. However, according to a survey, an additional 260,000 hectares, including wetlands in Veneto and territories with poor drainage systems, had also to be added. The coastline, stretching from Rimini to the Molise region, featured similar figures, while in the coastal provinces belonging to the Reign of Naples, wetlands occupied nearly 5% of the whole territory (NOVELLO 2003, pp. 22-23).

It is important to underline how the concept of land reclamation and the role played by the project supporters evolved over time. The agricultural and private-oriented concept of early times was gradually turned, since 1882, into a new idea, increasingly involving the public sphere and also dealing with social, hygienic-sanitary and environmental aspects. The first act on land reclamation, which was essentially conceived according to the above mentioned patterns, was promoted by Minister Alfredo Baccarini in 1882. The law was then followed by further national acts aimed to ensure the governmental support to major land reclamation projects (NOVELLO 2003, p. 40).

After the First World War, the concept of “*Bonifica Integrale*” (literally, “total land reclamation”, which originated in 1919 with Francesco Saverio Nitti’s government, was eventually exemplified by several acts promulgated by the Fascist régime in 1923-1924. In 1928, land reclamation programs, financially supported by the Italian State, were transformed into a useful tool to support and valorise the land asset, which was seriously affected by the crisis that followed the revaluation of the Italian Lira (1927), and later, by the Great Depression that occurred in the ‘30s (SERPIERI 1947). During the fascist period, the government relied on theories elaborated by agroeconomist Arrigo Serpieri in order to strengthen its declared “ruralism”, by means of land reclamation and settlement projects. It is interesting to note how Serpieri, who was soon relieved of his duties by Fascist authorities, had placed emphasis on how the “*Bonifica Integrale*” could be seen as the ultimate solution to the historic land issue in Italy. At the same time, the process held the potential to force Southern Italy’s big landowners to invest in reclamation and improvement projects. According to the law (introduced in 1933), named after Serpieri, the State had to approve or elaborate the reclamation project guidelines, with indications on required public works and general regulations. The implementation of the works was commissioned by means of a concession contract to an owners consortium, while the owners were given the task to perform the transformation of the land (SERPIERI 1947, pp. 140-141; STAMPACCHIA 2000).

According to Arrigo Serpieri and his team of technicians, working at the Ministry for Agriculture, the land reclamation process held the potential not only to increase the surface of arable land for millions of poor peasants, but could also be used as a social-booster, suitable for managing works of soil stabilization in mountain areas, re-forestation of slopes, construction of roads, regulation of streams and access to waters resources, for the

production of hydropower and irrigation purposes, allocation and settlement of reclaimed lands. Such a concept was clearly exemplified by the large-scale works implemented in the Tavoliere (Apulia Region) in the '30s (D'ANTONE 1988, pp. 215-236; PIZZINI 1988). This strategy could be seen as a way to introduce an agrarian reform without drastically or violently questioning property rights. Indeed, the "*Consorzio di Bonifica*" (Consortium for land reclamation) was deemed as a sort of public body having the right (or duty) to acquire property and usufruct rights, with reference to field properties, whose owners were not inclined to transform them for agricultural purposes and they could be dispossessed when needed (STAMPACCHIA 2000).

Such principles, that were included in the legislation on "*Bonifica Integrale*", originated from the idea of a reclamation process seen as a general tool for land transformation:

In practical terms, – as Serpieri wrote – land reclamation in a given space and time, marks the transition from an initial land tenure régime with its related land regulation to another, ultimate land tenure regime, with its related land regulation system (SERPIERI 1947, p. 165).

After the Second World War, the so-called "*opzione tecnica*" (literally, "technical option") (ISENBURG 1981, pp. 142-151) was once again suggested by followers of Serpieri. Meanwhile, the idea of a land reform meant the implementation of the art. 44 of the Italian Republic Constitution was emerging, with special reference to the limitations on private land ownership. In 1950, the enforcement of an extract from the agrarian law ("*Legge Stralcio*") allowed the government to dispossess 1 million hectares of private land. Moreover, the law implied the establishment of specifically conceived local institutions, which took over the previously existing consortiums with reference to the allocation and settlement of dispossessed lands.

The above mentioned institution became thus responsible for land reclamation projects. Later, in 1970, the task was eventually assigned to the newly established regional governments.

Due to its European dimension, the reclamation of the Po Plain described below is undoubtedly the most significant example of land reclamation in Italy.

2. THE LOWER PLAIN: RIVER FLOW REGULATION AND RECLAMATION OF MARSHES IN THE PRE-INDUSTRIAL ERA

The floodplain formed by the Po River and its tributaries is, alongside with the nearby Veneto and Romagna Plains, Italy's most extensive and potentially fertile plain (fig. 1). In addition, it is also the only area where, as described before, successful land reclamation and drainage projects for agricultural purposes could be undertaken, also owing to the absence of a serious form of malaria, which on the contrary affected most parts of the coastal areas and inland plains located in Central and Southern Italy. In the late Middle Age, local communities began to drain the margins of the extensive wetlands and marshes in the Po Plain by regulating the river flow and draining low lands. In this way, the fertile soil, eroded

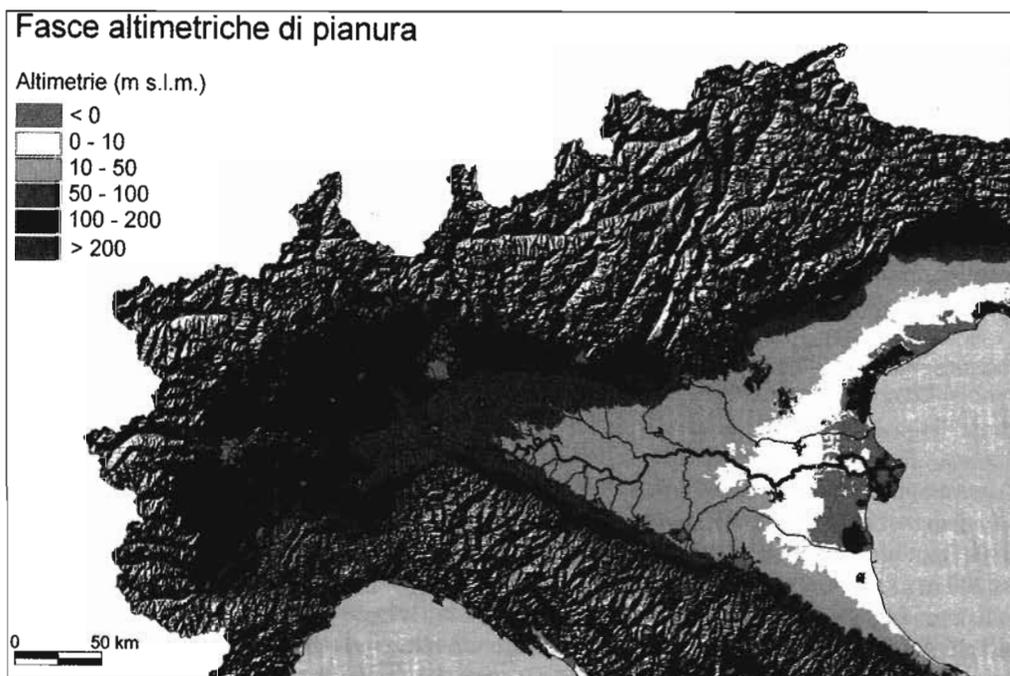


FIG. 1 – The Po Plain (Northern Italy): the hydrographic network is emphasized. *Source: VALLONI, CALDA 2003.*

from mountains and hills, which accumulated in the lower Po Plain, could be profitably recollected by farmers, although enormous investments and costs, in terms of money and human labour had to be calculated. As for the Central-Eastern portion of the Padano-Veneta and Romagnola Plain areas, massive operations were conducted in order to delimit river beds (Po included), with the construction of increasingly high dikes. It was only after the completion of a process, aimed to separate waters descending from the higher lands (in Italian, so-called “high waters”), from those stagnating in the lower lands (in Italian, so-called “low waters”), that effective works could be accomplished through the drainage and reclamation of flooded areas. The first lands to be reclaimed were of course those located near the river, which had been carved by flood waves. Here is where the oldest human settlements are usually found. The water excess was then removed from low lying areas with the implementation of a dense network of channels. In this way, rain water could be rapidly removed from cultivated fields.

In the medium and upper course of the Po River, from Piacenza to the Delta, embankment and flooding containment works have been performed ever since the Middle Ages to present (fig. 2). Once launched, the river flood control operations could not be abandoned; on the contrary, works also had to target the lower watercourse of tributaries and waters flowing from the Apenninic foothills and Alpine glacial moraines as “*fontanili*” (springs). Unfortunately, after the completion of water containment within artificial watercourses, the surrounding fields were exposed to an increasingly severe flood hazard. Indeed, during the Middle Ages, the floods of the Po River and its tributaries were still free to flow into

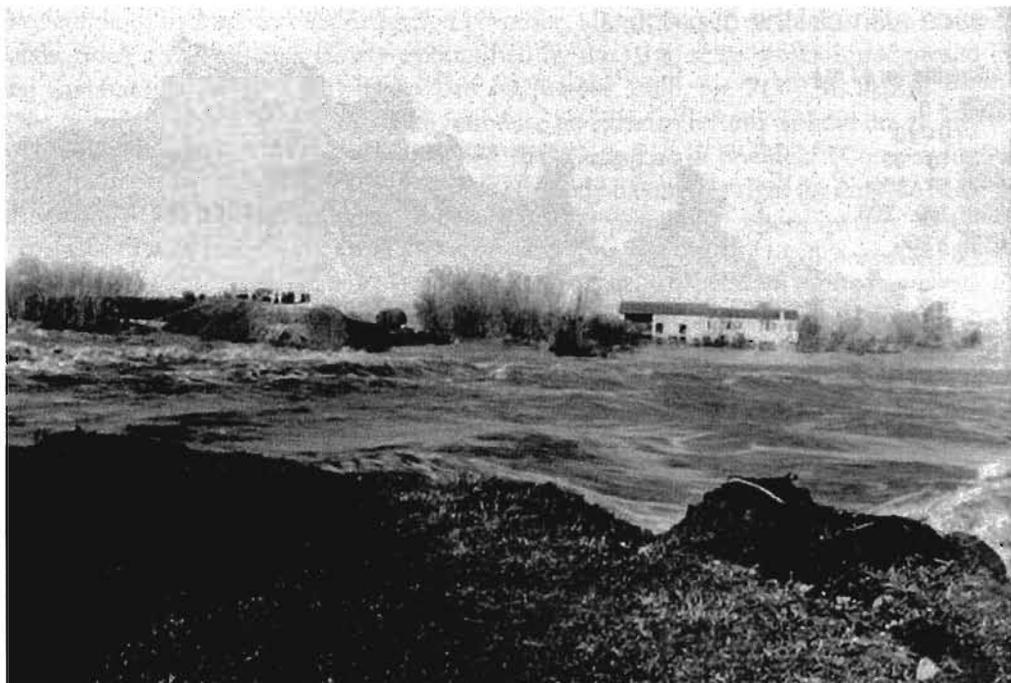


FIG. 2 – Lower Po River: 1951 banks collapse and flood. *Source:* LUGARESI 1994.

natural retention basins, such as wetlands and marshes stretching along the river and occupying depression areas delimited by mounds and natural banks, which had been formed by the river sedimentation process over time. Basically, the river embankment's function was the containment of flood waters within restricted areas, and this led, consequently, to an increase of the water speed, as well as of the flood and danger level. Each time the river reached the flood alert level, peasants were asked by the local village chief to patrol the river banks; in case of serious alert, the danger zone was kept under control 24 hours a day, while the flooding used to be contained with the help of sand bags.

Ever since the Middle Ages, specific institutions especially established to manage water-related issues, have been operating in nearly all cities having to deal with the Po River or with its main tributaries. An example is provided by the “*Giudice alle acque*” (literally, “Water Judge”), in charge of the implementation of the local strategy for water control and the realisation of required maintenance and repair works, whose figure was quite common in the major cities of the Emilia, Veneto and lower Lombardia Regions. The Republic of Venice, which had not only to face flood hazards, but also needed to maintain a delicate balance between the lagoon and the sea, established, in 1501, an office called “*Savi ed Esecutori alle acque*”; as a response to the worsening hydraulic general situation, an additional specific institution, named “*Provveditori all'Adige*”, was introduced in 1677, with the aim to monitor threats posed by the Adige River.

The Municipality of Ferrara, ruled by the Dukes of Este, encompassed most part of the Po Delta area and was consequently subject to a severe flooding hazard. The complexity of the situation required a peculiar organization and the establishment of a specific body,

“*Lavorieri del Po*” (literally, “the Po River works”), when identifying and implementing strategies suitable to mitigate the flooding risk. Similar institutions with inspection functions operated in Polesine (in the Rovigo area), a land stretching between the Po and Adige Rivers. In the lower lands of the Cremona Province, where the problems caused by the stagnation of rain and dripping waters was even more serious, and some areas were also situated below the Po’s flood line, a strict regulation was enforced in the attempt to curb floods. Cremona, Viadana and Casalmaggiore’s oldest statutes included rules for the maintenance of dikes and drains. In the province of Parma, a specific institution began its activity nearly in the same period, in order to ensure a proper water flooding strategy on the local scale. The “*Congregazione dei Cavamenti*” was established by Ottavio Farnese in 1559, with the aim to “regulate waters, dikes, roads and bridges in Parma and in its territory, for the benefit of residents as well of the public wealth, and in order to launch additional reclamation projects pursuing the increase of land surface and its profitability”, as the statute of the congregation, reformed in 1623 (CAZZOLA 2000, pp. 489-493), pointed out.

The above mentioned examples highlight the peculiar relationship established in the Po Plain with both land and water. After the steady demographic decline that had affected the countryside of Northern-Central Italy in the 14th and 15th centuries, the subsequent population growth induced farmers to regain control over abandoned plain areas. During a second stage, new land could be obtained by draining periodically or permanently flooded territories. However, whilst the re-colonisation of Central Italy’s hilly areas could be fulfilled from the second half of the 15th century onwards, thanks to individual initiatives and work carried out by small groups of settlers, in most cases including foreign immigrants, as it happened in the Marche Region hills and in some Maremma areas (ANSELMINI 1988; CAZZOLA 1991), in the Po Plain the access to new arable land was subject to a coordinated, collective and cooperative effort, supported by large manpower. Indeed, flood control measures, including the construction of impressive soil dikes and the complex canalization works, required huge investments, so that several teams of workers could be simultaneously engaged (CAZZOLA 1987a). In most cases, in connection with the work typology and its complexity, the projects were far from affordable in economic terms for single individuals or small owner groups. In addition, a number of technicians and engineers were needed for an extremely precise gradient measurement in areas where natural inclination was nearly absent (fig. 3). The two main obstacles to the realisation of drainage and irrigation works in the Po Plain thus implied both economic and “technical-demographic” limitations. This also explains how in the Po Plain public and collective endeavours prevailed over individual and private land transformation initiatives which had been launched during the 15th century. Especially after 1550, governments, princes and municipalities became increasingly interested in reclamation projects pursuing the enlargement of the wheat surface area. During the 16th century, the cultivation of this cereal became strategic with reference to the food-supply demanded by the increasingly overcrowded – both small and big – Italian cities.

The “public utility” of land reclamation programs implied a strong involvement of monarchs and public authorities, which used to supervise the projects by means of a concession. An example is provided by the powers granted by the Republic of Venice to the institution called “*Magistrato sopra Beni Inculti*”, established in 1545 (MOZZI 1926; BEVILACQUA 1995, pp. 81, 107; CIRIACONO 1996). However, an institutional supervision was actually needed to mitigate conflicts of interests between land owners and investors concerned with

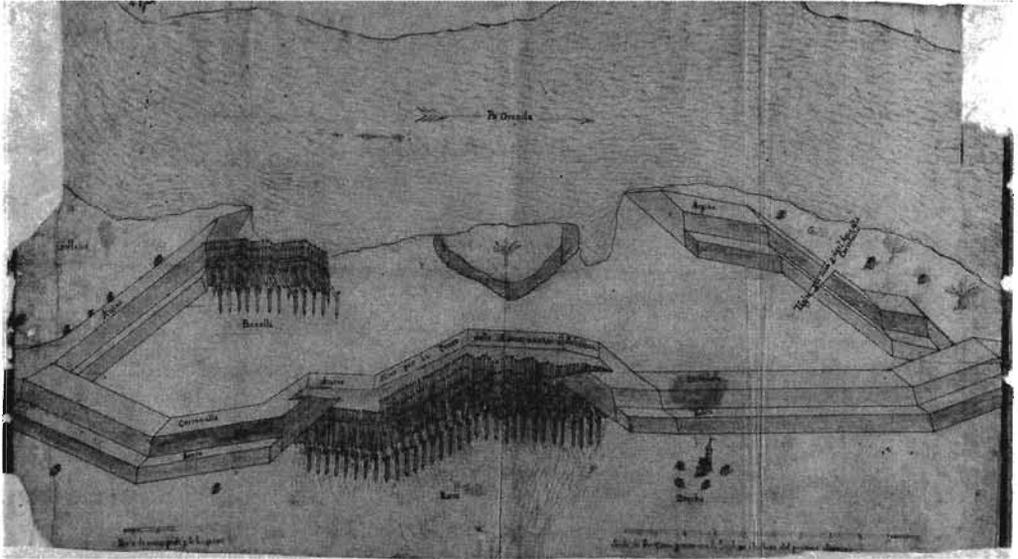


FIG. 3 – A drawing by Giovan Battista Aleotti (1546-1636), concerning the Po River: “*Disegno che mostra i modi per prendere una rotta del Po*”. Source: Ariosteia Municipal Library – Ferrara, Ms. Classe I, 763.

land reclamation, so that none of the owners of lands concerned with the project could avoid costs and contributions, arising in connection with the implementation of canalization and maintenance works. The “*Consorzio di Bonifica*”, in charge of representing private interests in front of the public authority, and holding a coercive power on owners concerned with a specific hydraulic district, was the tool, thanks to which the – more or less forced – agreement, that was intrinsically tied to the most challenging works, could be achieved.

During the Early Modern Age, owner consortiums and hydraulic-territorial districts especially conceived for the construction and maintenance of drainage and reclamation works were indicated with several different names. *Retratto* (reclaimed land) was commonly found in the Veneto area, while in Rovigo and in the Polesine area, the reclamation district was indicated with the term *Presa*, which exemplified the concept of a territory delimited by dikes. The terms *Serraglio* (Ferrara) and *Digagna* (Mantua) had similar meanings. On the other hand, *Consorti e Interessati*, referred to owners concerned with the control of local waters within a given reclamation district.

3. WATER-RESOURCES BENEFITS: THE IRRIGATION OF THE UPPER PLAIN IN LOMBARDY AND PIEDMONT

In the western Po Plain, similar and as important river regulation projects, were carried out from the 15th century onwards. Yet authorities had to face the opposite problems when compared to the eastern lower plain. Most part of the Alpine piedmont area, known as the springs zone, originated during the Quaternary Era and essentially featured glacial moraines

ad permeable gravel. During the summer period, the area turned into a dry heath or, at least, could not be properly used for agricultural purposes due to the water shortage. Here, a reclamation project meant basically the regulation of the spring waters, also re-directing the course of the abundant and perennial waters of both tributary rivers and extensive lakes, so that heaths and infertile gravelly soils, situated along the river (in Italian known as “*gerbidì*”), could be transformed in agricultural fields and pastures, suitable for cattle rearing. The implementation of a dense network of irrigation channels in the Lombardy and Piedmont upper plain and in the foothill area, included in the territory of the Republic of Venice (CRICACONO 1996; VERGANI 2001) thus became, from the Renaissance period onwards, the main land reclamation tool. With the introduction of the irrigation system, extensive, scarcely productive, areas were turned into mowable meadows, rice fields and cultivated lots. The Lombard regulations and consuetudinary laws provided a legal framework, which proved to be crucial for the expansion of the irrigation network. Indeed, owners of transformable land were allowed to have access to water resources through a network of channels, that could also flow through lands owned by other individuals, by simply paying a sum as a compensation and with no conflicts involved (CHITTOLINI 1979; ROVEDA 1984).

Thus, the western Po Plain, with particular reference to the river’s left bank, underwent several land transformation programs aiming at the implementation of an irrigation network and at the rational use of the extremely abundant springs and “clear” superficial Alpine waters, flowing into the Po River during the summer period, alongside with the tributaries of the great lakes. An increase in the investments, made by private owners and big fictables, for the implementation of derivation channels targeting the “clear” waters streaming from the tributaries of the large Alpine lakes, was recorded between the 15th and 16th century, with the intervention of princes and communities willing to support the development of a channel network. The navigable basins, invented during the Renaissance period, led to an improved management of the plentiful water resources in the Piemontese and Lombardo-Veneta plains. In this way, a commercial and agricultural development occurred in areas where the availability of springs and perennial waters could support the extension of navigable channels (“*rogge*” or “*roste*” in the local idiom) needed to irrigate soils.

Some significant events are described below. During the 15th century the irrigation channels Bealera di Grugliasco, Bealera Sturetta, Canale Fiano and Bealera della Vaude were excavated in the Turin area. In the same period, the township of Vercelli completed the main structure of its irrigation system with a series of channels, namely Canale del Rotto, Camera, Livorno and Bianzè, the Roggia Marchionale in Gattinara, Roggia Molinara di Balocco; the Ivrea waterway also irrigated farmlands. In the territory surrounding the city of Novara, water was captured from the Rivers Ticino and Sesia for navigation and irrigation purposes: Roggia Rizzo-Biraga, Naviglio Sforzesco, Roggia Mora and Roggia Cleggio, to cite some, are the outcome of the major irrigation works implemented between 1424 and 1493. Other significant works addressed the Tanaro River and the Gesso stream (Naviglio and Bealera Grossa) in the Piedmont Region.

By the end of the 15th century, the main structure of the Milan waterways had been completed. Although ensuring an enduring commercial prosperity to the city and the surrounding territories, the process also gave rise to several conflicts, as the necessities of the navigation activities were incompatible with the increasing water demand for irrigation purposes. As Giorgio Bigatti points out, the Milan waterways were precociously mature

system with serious limits in terms of navigability and transport efficiency, perhaps due to the competition between irrigation practices and a declining commercial use (BIGATTI 1995, p. 104). In the Milan area, the construction of the large waterways (Martesana, Naviglio di Bereguardo and Navigliaccio di Pavia) was also significant; in the province of Bergamo, water was captured from the Rivers Adda and Serio (rogge Ritorto, Archetta, Martinengo); in the Municipality of Mantua, the Goito waterway and other channels were excavated to irrigate the upper territories (fig. 4). In areas located along the Po's left banks, local authorities finally realised how the introduction of an irrigation system was crucial for the development of agriculture and cattle rearing activities. Strongly encouraged by local communities and concerned land owners, Duke Borso d'Este gave the order, after 1450, to open a canal in the nearby Ciano, thanks to which the waters of the Enza River would irrigate the lower plains in Reggio Emilia (Canale Ducale or Correggio channel).

Summing up, tremendous endeavours were undertaken in the Po Plain, since the early Renaissance period, with reference to investments in hydraulic works and land reclamation projects. As land reclamation and irrigation works continued, a geographical diversification in productive activities also emerged: whilst the western areas essentially featured meadows and rice fields, in the eastern areas dry cereals, wine and fiber plants like flax and hemp prevailed. The following century, once disputes and difficulties, which had affected the first four decades, were settled, marked the beginning of a new Era of large marshes reclamation projects and land occupancy.



FIG. 4 – Deviation channel on the Mincio River near Mantua (Lombardy, Northern Italy). In the Municipality of Mantua, since the early Renaissance waters have been exploited for irrigation purposes. *Photo:* F. Cazzola.

4. THE RACE FOR LAND IN THE 16TH CENTURY

During the 15th and 17th century, reclamations and drainage projects were carried out on large portions of land in the lower Po Plain (with particular reference to the Republic of Venice, dukedoms and principalities in Emilia, Papal Legations in Bologna and in the Romagna area, as well as in the Dukedom of Mantua). Although uncalculated, the process may have targeted a land surface exceeding 100,000 hectares. As mentioned above, the most intensive stage of the process occurred between 1550 and 1620, when the population growth led to an increase in demand for food, both in cities and in the countryside. However, a good number of princes, merchants and bankers also played a major role, as land was seen as a safe investment and as a means to improve the social position and join aristocracy (VENTURA 1968; CAZZOLA 1987b).

Increased land resources were needed by all Renaissance courts in the Po Plain, also in the attempt to sustain the luxurious lifestyle of princes and their *entourage*. The princes themselves launched initiatives aimed to expand their land possessions, as a mean to increase both personal wealth and military power. Some of the most influential figures tried to gain economic advantages or consolidate their power over their territories with the implementation of hydraulic strategies, land reclamation works and public works. In other words, the princes themselves used to support water control works; apart from increasing the land value, this behaviour also encouraged other land owners to undertake similar initiatives, either as single individuals or as members associated in local *consortes*, sharing the same land reclamation program.

In the second half of the 16th century, the Peace of Cateau-Cambresis inaugurated a period of relative political and economic stability in the Italian peninsula. In this period, princes, local communities, private investors and speculators promoted several land reclamation projects, carried out on a small and a large scale. The main target was the realisation of new and large scale projects, so that thousands of hectares of new land could be added to the cultivated surface. The main reclamation and water control projects of course addressed the Po's lower course and the Veneto area. Yet a serious obstacle posed a major threat to the project accomplishment. Although specific theoretical and practical tools had been made available by Renaissance technicians and engineers, rivalries among small and large local States might have delayed, or even halted, the most ambitious and significant programs. To avoid that, numerous agreements (*Concordie*) and contracts were signed during the 16th century by princedoms, feudal lordships and local communities in order to put under control a natural element that does not tolerate boundaries: water. However, while men required months or even years to find the resources needed for reclamation works, the river only took a few hours to destroy what had been achieved with exhausting negotiations.

The extraordinary impulse given to land reclamation projects during the 16th century, which apparently finished in the first decades of the 17th century, had transformed the Po lower Plain into a huge construction site, where teams of hundreds or even thousands men used to cooperate. In this period, land reclamation projects were so numerous that an exhaustive report can be hardly provided. The most significant initiatives range from the several *Retratti* carried out in the Republic of Venice, to the Great Reclamation project launched by Duke Alfonso II of Este, which targeted a Polesine portion belonging to the

Municipality of Ferrara; other projects worth mentioning include the reclamation works carried out with the support of the Bentivoglio family in Gualtieri (Reggio Emilia, lower Po Plain) and in the Ferrarese Transpadana (Zelo and Stienta), and the Gregoriana land reclamation, coping with the marshes formed by the Lamone River in the Ravenna area; diversions and sluice-gates were realized in the territory belonging to Fossalta Mantovana and the Burana collection drain, addressing waters flowing through Modena, Mirandola and Mantua. Attempts were also made to drive the Reno River into the Po River. At the end of a century spent fighting against water, the Venetians finally managed to complete, between 1599 and 1604, the long term project to divert, with a large cut (so-called “*Taglio di Porto Viro*”), the main course of the Po, at its mouth, thanks to an unprecedented monumental work (TUMIATTI 2005).

5. THE STRUGGLE AGAINST THE RIVERS IN THE 17TH AND 18TH CENTURIES

The “*Taglio di Porto Viro*” was inaugurated in 1604 and it was destined to produce a massive impact on the Delta of the largest Italian river. Meanwhile, Pope Clement VIII, who had regained control over the Dukedom of Ferrara in 1598, authorized the realization of an impressive project, in the attempt to restore the Po navigability through the excavation of its riverbed. The project expenditure was enormous, and its accomplishment would have prevented the Reno River and other local rivers from merging with the Po (1604). In the first decades of the 17th century, crowds of engineers and mathematicians worked at the “*Bonificazione Clementina*”, also called “*Bonificazione Generale*” (“General Land Reclamation”), in Papal Legations of Bologna, Ferrara and Romagna. According to the most reliable experts, the project was clearly unfeasible, as the Po River waters could no longer flow towards Ferrara and Ravenna. Actually, this part of the river was only affected by floodplains, which seriously threatened lands that had long been used for agricultural purposes.

The results of several surveys and inspections carried out by Cardinals, with the support of mathematicians and technicians, showed (1620-1622) how the Po Grande waters could no longer flow in the old riverbed (Po in Ferrara), as this was situated over 28 “local feet” (about 6-7 meters – before the Unification of Italy, each State had its own unit of measurement) above the level of the main river branch. The Panaro River, which flowed into the Po River in the nearby town of Bondeno, was heading upstream, occupying the Po’s previous riverbed in Ferrara. The attempt (1617) to deviate and re-direct the river course towards lower areas, with a channel called “*Cavo Serra*”, after the name of the Cardinal of Ferrara who supported the project, was completely useless. The navigability of the river in the Ferrara area was permanently lost, and the river could be only turned into a channel collecting waters from the upper territories located in the territory of Cento. The small channel in Cento (Canalino di Cento) also supported the residual navigability of the Po di Volano and Po di Primaro, Po River Southern branches.

In Romagna, whilst experts and ambassadors debated on how to overcome difficulties related to water control, with the help of useless inspections (“*Visite d’Acque*”) carried out during the 17th and the first half of the 18th century, the river continued to fill depressions

with sediments, expanding to the South and enlarging the surface of lands prone to flooding and water stagnation. After 1604, hundreds of hectares of land were lost in the Bolognese countryside as the Reno River and its streams (or *riazzi*) moved southeast and waters were set free to flood Valle Sanmartina, which had been previously reclaimed by the Estensi family at the end of the 15th century. As a result, the landscape, the toponymy and the structure of human settlements were completely devastated for a century and a half (GIACOMELLI 1983; GAMBI 1994).

It was only around 1750, at first with Pope Benedict – who held significant land interests in the area – and later with the favourable resolution of the “*Sacra Congregazione delle Acque*” (literally, “Holy Congregation for Waters”) on the vote of the hydrostatic technician Antonio Lecchi (June 2nd, 1767), that works were undertaken in order to deviate the Reno River into the Po di Primaro, in the nearby Traghetti (Argenta). Downstream from Traghetti, the former Po di Primaro gathered waters from Reno and, later, other rivers (Idice, Quaderna, Senio, Santerno, etc.). From Traghetti to Ferrara, the Po di Primaro’s old bed was named “Po Morto di Primaro” (literally, “Dead Po di Primaro”), which underlined the irreversible condition of the river waters in this southern area. Finally, the situation had become favourable for resuming the land reclamation and settlement process, even in the extensive wetlands stretching from the Panaro River to Ravenna.

In this period, the Republic of Venice completed a series of hydraulic works that exemplifies the strategy pursued after the 1604 cutting of the Po River. All branches in the Delta were closed to the north, and the course of any other river (Brenta, Piave, Sile, Bacchiglione, Dese, Marzenego, etc.), flowing into the Lagoon or threatening the area with large quantities of sediments, was deviated (ZENDRINI 1811). At the end of the 18th century, when the fortune of the *Serenissima* began to decline, the so-called “*Conterminazione*” of the Lagoon area was brought to completion. By placing an impressive number of stones along the boundary, salt waters were separated from the mainland, with the delimitation of the Lagoon area subject to the State authority (BEVILACQUA 1995, pp. 103-108).

6. THE STEAM-POWERED LAND RECLAMATION

As previously noted, wetlands still covered hundred of thousands of hectares in the lower Po Plain when Italy was politically unified (1861). One of the most serious constraints to the land reclamation process was ascribed to the difficulties found in the implementation of a natural reclamation method, simply relying on the excavation of drainage canals, as the natural inclination was nearly absent in the area. Moreover, suspended rivers were extremely common in the plain. The natural grooves formed by rivers along the Po also obstructed the flow towards the sea, causing a water stagnation in interfluvial depressions. The slow, yet safe method called “*colmata*” (used in Tuscany), supporting the progressive rise of low-lying territories by relying on the flooding of streams, descending from the Romagna Apennine, could only be used in the lower plains stretching across Ravenna and – although only partially – in the Bologna area.

The extensive wetlands stretching along the Po River, on the contrary, could only be drained by using the steam engine, the crucial invention introduced during the Industrial

Revolution. In these basins, where the bottom lies just a few centimetres above or even below the sea level, the use, on a large scale, of a pump driven by a steam engine enabled workers to deviate waters into a watercourse – usually a “hanging” river – flowing into the sea.

Dewatering pumps – steam engines that were originally installed on wheels and later on more efficient centrifugal pumps – allowed the lifting of large quantities of water up to over three metres, which was unthinkable in past times. The introduction of the mechanical lifting inaugurated a new land reclamation Era in the lower Po Plain, but it also led to the emergence of huge business and financial speculative interests.

The first successful initiatives of mechanical drainage, undertaken around 1850 by a few land owners in the lower Polesine, with the reclamation of some wetlands included in the Dossi Vallieri consortium, were followed by a land reclamation frenzy.

The most significant cases include the drainage of extensive portions of land in the eastern province of Ferrara, to the extent that such lands were defined as “the Italian Netherlands”. The land reclamation operations conducted with mechanical methods were launched in 1872 with the drainage of the Polesine area in the surroundings of Ferrara, where the “*Grande Bonificazione*” (literally, the “Great Reclamation”), undertaken by the Estensi, had taken place in the 16th century. The new project was supported by a public limited company initially established with British and Italian funds and later joined by a few banks and Italian financiers. Before the commencement of works, the company had acquired inexpensively 22,000 hectares of swamplands that would later constitute the land estate of a big agricultural company (*Società per la Bonifica dei Terreni Ferraresi*, SBTf; literally “Company for Land Reclamation in the Ferrara Area”). In 1883, the reclamation project was declared accomplished, in spite of legal controversies among the concerned land owners. A co-active consortium for the maintenance of 54,000 hectares of reclaimed areas, also including zones served with drainage systems, was then established (CAZZOLA 1987c).

Between 1873 and 1895, further impressive reclamation projects were undertaken with the support of private financiers and speculators in the Ferrara eastern plain and more precisely in the large area of Polesine San Giorgio, where the Valle Gallare and Valle Volta wetlands were drained (12,500 hectares). Moreover, the Polesine San Giorgio area underwent nine additional partial reclamations (32,000 hectares), carried out with dewatering pumps and a mechanical drainage system. The project was undertaken by a specific owners consortium, which had been dealing with drainage issues since 1605. In a few years, 342 km of drainage channels were newly excavated or at least improved, with a soil displacement amounting to 3.35 million m³ (ISENBURG 1971).

At the beginning of the 20th century, 10 reclamation districts supervised forested areas and farmlands in the province of Ferrara, with 109,000 hectares served with a drainage system. Moreover, part of the 84,555 hectares, belonging to the interprovincial consortium for the Burana land reclamation project, had also to be added. After the opening, in 1899, of the Botte Napoleonica, a channel passing under the Panaro River, the dirty waters produced in a large area delimited by Rivers Secchia, Panaro and Po across the provinces of Modena, Mantua and Ferrara, were driven directly to the sea through the Po di Volano old riverbed (SPAGGIARI 1992; BIANCARDI, CAZZOLA 2000). Along the Po left bank in the Province of Rovigo, several consortiums supported the renewal of the water management system with the excavation of a large collector drain and the construction of a good number of mechanical lifting equipments (fig. 5) (CONSORZIO DI BONIFICA PADANA POLESANA 2002).



FIG. 5 – “Ca’ Vendramin” dewatering pump (Rovigo Province, Northern Italy), dating to the beginning of the 20th century. *Source:* Ca’ Vendramin Land Reclamation Museum website.

However, at the beginning of the 20th century, most part of the works undertaken in the east part of the Po plain, as well as new projects, were under the jurisdiction and economic support of the Italian State, as the promulgation of acts like the Baccarini law (1882) and the above mentioned Serpieri law (1933) highlights. Over time, and even in recent years, the history of these land reclamation projects has been the subject of several studies and researches, to which we may refer (figs. 6-7) (SALTINI 2005; CAVAZZOLI 2008; CHIARENTIN 2008; MENZANI 2008).

The glorious period of the land reclamation and settlement programs came to an end at the beginning of the ‘70s, after that the enforcement of laws issued in 1950 implemented the “*stralcio*” (extract from the law) of the agrarian reform and established an agrarian reform institution, alongside with a “*Cassa per gli interventi straordinari nel Mezzogiorno*” (the institution concerned with specific issues in Southern Italy), the task of which was the implementation of an irrigation system in Southern Italy as well as in the islands, also exploiting, in agricultural terms, the few malarial and inhabited plains situated in the area.

Yet the story of land reclamation in Italy is not over.

On the opposite, it can be said that its first, and only, agricultural role has evolved over time into a new concept, addressing the general and integrated management of water resources.



FIG. 6 – “Umana” dewatering pump (Argenta Municipality, Ferrara Province, Italy), dating to the ‘30s of the 20th century. *Photo: S. Piastra.*



FIG. 7 – “Fosse” dewatering pump, linked to the “Valle del Mezzano” land reclamation (‘50s-‘60s of the 20th century). Comacchio Municipality (Ferrara Province, Italy). *Photo: S. Piastra.*

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