

## FLOODS AND INSALUBRITY AS THE TRIGGER FOR CITY RESTRUCTURING IN SPAIN: THE CASE OF BURGOS

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### HIGHLIGHTS

- The morphological configuration of the urban space is the result of several different projects.
- These cartographical projects include the supply of water to cities, the channelling of rivers, and the establishment of drainage and sewer systems, among others.
- Hydrological cartography is the key to understanding the current configuration and structure of Spanish cities.
- The case of Burgos allows us to discern what the trigger for the internal and external restructuring of the present-day cities was.

### ABSTRACT

If we want to understand the morphological configuration of the urban space of some Spanish cities, it is necessary to research the different types of cartography that exist in the city. Among the many kinds of maps produced over time, we find a type of cartography that is a direct product of the interests on the structure of the city: the maps of civil engineers.

The topographic map of Burgos created by the civil engineers Mariano Martín Campos and Eduardo Lostau in 1894 and their sanitary project are framed within a type of cartography denominated hydrological cartography. These types of maps, which have scarcely been studied, were the result of the approach of bringing water to cities, channelling rivers, or installing sewerage systems.

This is the case of Burgos, where the urban planning was a product of the search for a solution to the floods and the insalubrity problems that had existed for decades, and of a desire, therefore, to restructure the city. In addition, as an added value, this map constitutes the first plan proposed at 1: 1,000 scale and with precise altimetry. The accuracy of this map led the civil engineers to propose it as the basis for a plan of alignments. In this way, this map is presented as the beginning of the internal (i.e., sewerage system and channelled rivers) and external (i.e., streets) restructuring of the city and an example for the rest of Spanish cities with the same problems: floods, restructuring of the streets and sanitation.

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## 1. INTRODUCTION

The current urban configuration in many countries is based on their many attempts to avoid water problems during the 19th century. At that time, the link between the growth of cities and the spread of disease led some countries to adopt a new perspective on health risks (Hamlin, 1992). For example, in the last third of the 19th century, England became the leader in terms of sanitation. Starting at that time, the mechanisms available to fight classic epidemics were reassessed, new preventive measures against transmissible diseases were adopted, a shift of focus from the environment to the people took place (Rodríguez Ocaña, 1994), and different by-laws concerning health were passed in many cities. Those by-laws affected areas as diverse as drains and sewers, street lighting, the regulation of accommodation, slaughterhouse activity, and markets.

However, these healthcare concerns spread slowly in most countries (Wohl, 1983), including Spain. By the end of the 19th century, Spain was clearly a backward nation in economic, political and social terms. This resulted in a proposal to adopt measures and develop infrastructure already in place in other European countries (Arnould, 1902; Sussman, 1997; Poligliano, 1984; Hildreth, 1987). The recommended modernisations included sanitation, as the state of health of the Spanish urban population left much to be desired (Real Consejo de Sanidad, 1901).

Conditions in Madrid, for example, were completely deficient, despite the extensive public works that had been carried out since 1856 on the city's sewers and drain network. There were over 3,000 cesspits in the city, while in outlying neighbourhoods and parts of the old city, the sewers had no traps to prevent the release of noxious fumes and more than 4,000 homes had no direct water supply (Hauser, 1902). Meanwhile, Barcelona City Council undertook a sanitation project between 1885 and 1893. As part of that project, tanks were built from which water was to be released in order to maintain the circulation in the sewer and drain system, due to insufficient connections to dwellings (Capel and Tatjer, 1991). In 1901, a conflict broke out in Seville between the League of Owners and the City Council which almost halted the construction of new drains in the old city (Pulido Fernández, 1992).

Specifically, of the seven Spanish cities with more than 100,000 inhabitants, only Zaragoza and Seville had extensive modern systems of drains, although the water supply was deficient. In Madrid,

Valencia and Malaga, the land set aside for water was unusable due to the poor state of repair of the drains; while in Barcelona and Murcia, the installations were also deficient. The high death rate due to infections was seen as evidence of the importance of the sanitation problem and of the relative backwardness of Spain in questions concerning urban reorganisation (Hauser, 1913; Pulido Fernández, 1902): urgent action was required.

## 2. BURGOS AT THE END OF THE 19<sup>TH</sup> CENTURY

Burgos was among the cities that attempted to solve the sanitation problems. However, in this case, the origin of the sanitation and urban reorganisation was more closely related to the floods that the city had suffered during the last quarter of the 19th century than with the propagation of infectious diseases (Rodríguez Santillana, 2002 and Archivo Municipal de Burgos, 18 -924); it was the first among them in doing so, and it became the model for the rest of cities which faced the same issues.

In order to tackle these problems, restructuring schemes such as the canalisation of water in 1888 and the installation of street lighting had been undertaken. A civil honour was requested for this work (Archivo Municipal de Burgos, 2-505). However, the absence of a drainage system to evacuate waste did not allow the objectives of the sanitation and reorganisation of the city to be completely met. Those objectives were seen as particularly important since it had been suggested that Burgos would soon reach a population of 40,000. Therefore, if urban reorganisation and sanitation were not undertaken, the city would face problems associated with both floods and poor health conditions.

However, in order to carry out a detailed study for a drain and sewer network, a topographic map showing levelling precisely was needed. This was because it was necessary to study the inclinations on which the speed of the flow of water would depend; and on which, in turn, the transport of solid debris would depend. In addition, as drains already existed in part of the city, it was vital to draw up another map in order to facilitate to the greatest possible degree the use of the work previously carried out and thereby reduce the costs as far as possible. For this reason, on 28th July 1890, Aparicio Mendoza, a member of the Municipal

Corporation and of the executive committee of the Water Board, called for a general map of the town to be drawn up together with another map of the drains, as the starting point for the improvements that were to be made.

The person who was to be in charge of executing both projects was the municipal architect, Saturnino Fernández. However, his workload made it impossible to carry out the tasks. The alternative put forward was the civil engineer Ramón Aguinaga Arrachea (Coronas Vidas, 2008), who, in August 1890, proposed a work plan to be executed in two years.

Once the municipal architect received and read the dossier, he sent his opinion to the Works Commission. Among his observations, it stands out the fact that he approved of the idea that one map of the historical city should be drawn up to a scale of 1:500, but considered that another map, at 1:5,000 scale, should cover the whole of the territory included within the legal limits of the municipality of Burgos. In addition, he recommended adopting the provisions of the Waters Act of 1877, as it was a project that affected the state of health of the population of the city.

The Works Commission also thought it wise to seek the opinion of the civil engineers who resided in the city and ask for their collaboration in the project: Felipe Gutiérrez, Miguel Milano Guijarro, Mariano Martín Campos and Eduardo Lostau. The first two turned down the offer to participate, due to work commitments; but the last two agreed to take part, although with certain changes to the details of the plan.

## 2.1 *The proposal by Mariano Martín Campos and Eduardo Lostau y Páramo*

The details concerning the drawing up of the topographic map presented by the civil engineers Martín Campos and Lostau included a proposal, an economic report and a series of special guidelines. The most notable changes with respect to the details provided by Aguinaga were the 1:1,000 scale for the map of the whole area and the 1:200 scale for the detailed sections. This latter change was the result of studying the details of maps of cities of corresponding importance, such as Valladolid (Virgili Blanquet, 1979) and Zaragoza (Villanova, 2011), for which the scale used for the detailed sections was 1:250, therefore corresponding to a surface area one third smaller than that proposed in the case of Burgos.

For the drain and sewer project, they stated that it would consist of:

- A report of the sanitary conditions in Burgos; the situation of the drains; the improvements and benefits expected for public health; the system chosen and an argument defending it; the arrangement and shape of the pipes, galleries and main collector sewers; drains; police regulations; etc.
- Maps showing the situation of the drains at the time as well as the proposed network of drains and main collector sewers together with detailed information on these components and all the work necessary to draw up the maps.
- The budget for the work and the income that could be obtained from special rights and use of the waste waters.
- Conditions for the execution of the work.

After Aguinaga withdrew his proposal, only the one presented by these two civil engineers remained. The City Council accepted the conditions proposed for the drawing up of the map and study of a general drain and sewer network, together with the budget. The Council did, however, request that they present the details necessary to draft the project for the drain network; this was done on 12th June.

The municipal architect wrote a report in which he indicated that the maps to be drawn up at a scale of 1:200 should cover the neighbourhoods of Huelgas and Hospital del Rey as well as the intermediate land located between them and the city centre; the limit of the perimeter would be drawn at Puente de Malatos. With regard to the project for the restructuring of the drain network, he argued that this should include maps and budgets for all the work related to the water network and not just plans for the work involved in the new drains and restructuring of the existing network. He said that all the work should be carried out partially and that it was necessary to make use of all the watercourses that had been used up until that time.

In August 1891, the City Council granted the engineers permission to start work. It was agreed that the deadline to draw up the map would be eleven months thenceforth, and then eight months to draft the project for the drains, allowing a total of 20 months to complete both parts of the project. In June 1892, after justifying a delay with respect to what had been agreed upon due to the high workload, the impossibility of collecting data in the field during winter and the shortage of auxiliary personnel, the progress of the work was considered satisfactory. Only one sixth of the collection of data in the field was still to be completed, with

those data being used for both parts of the project, and less than half of the office work remained to be completed.

The scale used for the detailed maps was 1:200, which offered more detail than the maps of any other similar city in Spain; and the territory covered was so large that together the sheets of the detailed map took up a space of 13 m x 9 m. The precision that resulted from the use of such a scale meant that no detail of the general bulk of constructions and buildings was left out of the maps. However, after discussion with the Municipal Corporation, the Works Commission and the municipal architect were informed of changes in the execution of the general map. It was argued that, due to the degree of precision of the detailed maps, there was nothing to be lost by reducing the scale of the general map to 1:2,000, which would have two main advantages over the use of a scale of 1:1,000 agreed:

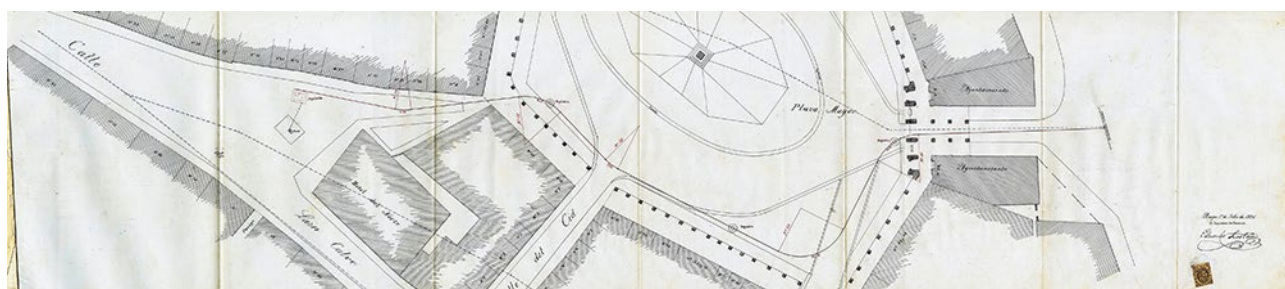
- in the first place, use of a 1:1,000 scale would make it impossible to represent the whole city on a single sheet. This would entail that there would be no overall general view and that there would be several discontinuities in the image;
- when time came to implement the work, it would be much more comfortable and manageable to use a map consisting of just one single sheet.

In addition to this modification, it was considered that, due to the vast volume of data collected up until 1892 with great detail and precision, it was possible to appreciate the big picture containing the conditions of each of the different elements that constituted the city of Burgos. This was of great significance when it came to establishing a plan for restructuring and implementing improvements. It was suggested that modest, practical and feasible solutions should be sought to perfect what already existed constantly and progressively, from the double perspective of ornamentation and hygiene. Grandiose projects of broad boulevards and long avenues could not be considered due to the

limits of the Council's funds; and furthermore, if Madrid had not taken on such ambitious projects, Burgos certainly did not need to.

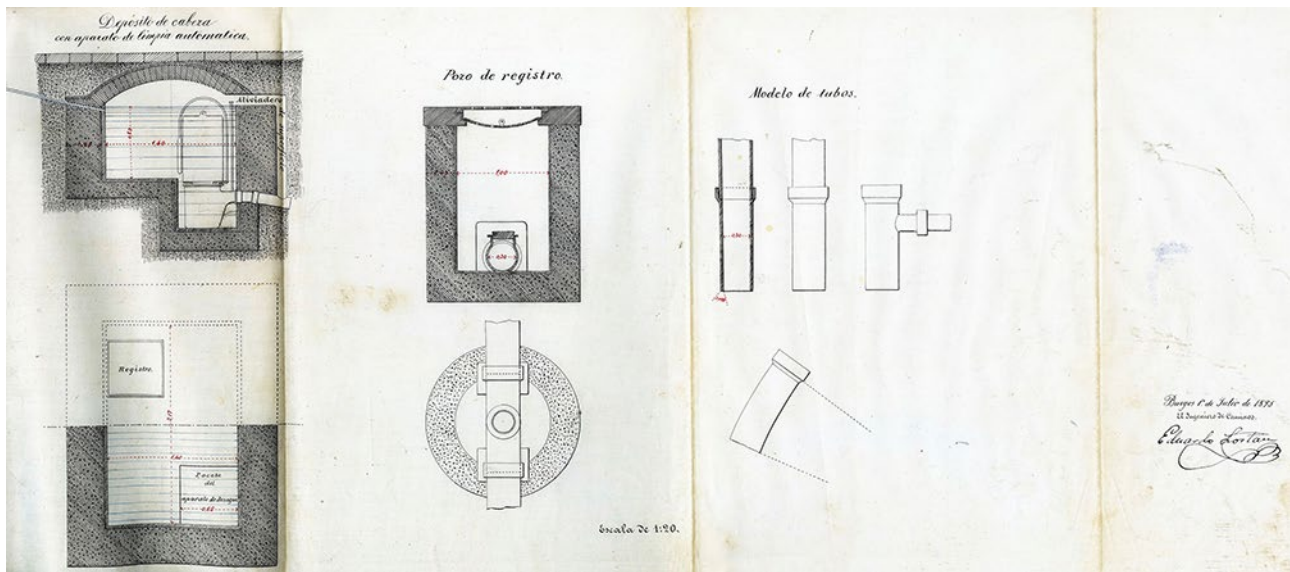
The architect considered that the arguments put forward were reasonable and the change of scale of the general map could be accepted. However, he once again pointed out that, according to a report of 16th July 1891, the detailed maps should cover the neighbourhoods of Huelgas and Hospital del Rey, along with the intermediate land between them and the city. Concerning the second point, he considered that, as the municipal corporation had to execute a project of restructuring and trace out the definitive plan of the city's streets that complied with the Enlargement and Interior Reform Act of 1892, the work carried out by the two engineers would be extremely useful because it would mean saving up money by not having to prepare another project. In August of that year, the City Council agreed to change the scale of the general map and approved the proposal to present a plan of reforms and improvements, which contained choices that were feasible considering that the city would have to execute the general project of restructuring and tracing out the definitive plan of the city's streets once the work had been presented. Because of this, Burgos was not only the first city to start a project to prevent floods and insalubrity, but it also was the first to unite two different projects in one map. Moreover, the value of these increased due to the occupation of their map makers: civil engineers, something very uncommon at the time.

In 1893, the drain and sewer map for the neighbourhoods in the southern area was presented, including a main collector sewer in the Gimeno ravine. These neighbourhoods were affected by serious health problems as they had no drain system. All of this was accompanied by reports, files, maps, budgets and detailed notes. In June 1894, a proposal was presented for a general sanitation system; in July, they also presented the topographic map of the city.



**Figure 1:** Part of the drain and sewer Project. Source: Archivo Municipal de Burgos, signature 18 -1583





**Figure 2:** Project of automatic mechanisms. Source: Archivo Municipal de Burgos, signature 18-1583

## 2.2 Project for the sanitation of the city of Burgos

In their proposal for the sanitary system, the engineers pointed out that the drains and sewers lacked water and so they adopted a system that had been used in other major European cities (Halliday, 2013; Geneviève, 2007; Rodger, 1996). The system was based on installing water tanks with a capacity of two to three cubic metres each. These would be filled by the runoff from public water fountains. Once a tank was full, and through the action of an automatic mechanism, it would empty out its water all at once, and the water discharged from the tank would then flush through the drain. Due to the small amounts of water that the tanks could hold, this action would be repeated three or four times every 24 hours. Due to the shape and arrangement of the existing drains, the engineers considered using circular section pipes made of liquid- and gas-resistant materials that passed through them. It was suggested that the automatic mechanisms and the pipes be acquired abroad, as they were not made to the necessary degree of precision by the Spanish industry. All these reasons led to the preference for the work on the most important parts of the drain system to be contracted out. It was also taken into account that, although it would be slower, the work should be carried out in accordance with the requirements of a general plan. It was calculated that the cost of this system of drains would not exceed that of similar drain networks and it was considered to be of benefit to the city. Indeed, although it would

be necessary to construct water tanks, automatic mechanisms, ventilation and inspection shafts, street drains, and so on, the pipes would still be more economical.

The architect and the Works Commission considered that it was a priority to provide the city with a network of drains and sewers, particularly in certain areas which completely lacked this infrastructure. It was therefore agreed that they would construct a pilot scheme to test the proposed system. This would act as a prototype allowing any defects in the proposal to be rectified, and exact data concerning the cost of execution of the full project to be generated and collected. This would form the basis for the construction of the rest of the network. At the same time, the engineers were requested to select the place in the city where the pilot project should be constructed, taking into account the opinions of the architect regarding the limits on the extension of the drain network. Finally, a branch of the drains running along Laín Calvo Street down to the main collector sewer was selected (Rodríguez Santillana, 2002). After receiving a favourable report from the architect, it was agreed to tender out the work via auction.

It was necessary to wait until 1896 for a new budgetary period to begin and the public funding to become available. After governmental approval, on 4th February that year, a notification on the allocation of the work by public auction was published in the Official Provincial Bulletin, no. 20, with the winner being Emilio García. However, the work was delayed due to the difficulty in obtaining the materials that had to come from abroad, and so

the contractor had to request an extension. Work did not actually start until the end of September. In December 1897 the president of the Works Commission signed the definitive receipt for the handing over of the drains. Once the working of the drain system had been observed, at the beginning of 1898, the Commission sent up a positive report to the City Hall. However, the unfavourable economic situation made it impossible to install the system throughout the whole city. In 1899, part of the proposed design for the main drain and sewer system in the south of the city was handed over; and on 30th April the architect signed the definitive project.

### 3. THE 1894 TOPOGRAPHIC MAP OF BURGOS

The research project succeeded in demonstrating The result of the work carried out between 1891 and 1894 to draw up the topographic map of Burgos and the project for the general drain and sewer network was a 1:2,000 scale map, consisting of

a total drawn surface area of almost three square metres, and several more detailed sheets at a scale of 1:200.

The map is remarkable because it is part of a set of cartographic products that haven't been studied very often: those produced by civil engineers with the aim of resolving various urban issues experienced at the end of the 19th century, such as problems related to water supply, drains, sewers, etc. In addition, it stands out in the history of Spanish sanitation because no general map for this purpose had been drawn up at this or any more detailed scale before then. At the same time, the way in which the altimetry is represented should be highlighted: this was done using equidistant two-metre contour curves, and not sketched as it had been previously.

The chart takes up a single sheet of 145 x 206 cm, with the title "Map of Burgos" appearing in the bottom left corner in black and grey capital letters. Next, from top to bottom, we can see the date on which it was submitted, the signature of the cartographers, the altitudes they took as references, and the geographical portion and the scale; while the proper names of the city landscape appear in the right-hand margin.



**Figure 3:** Map of the city drawn up by the civil engineers Mariano Martín Campos and Eduardo Lostau in 1894. Source: Archivo Municipal de Burgos, signature PL-372





**Figure 4:** Sheet at a scale of 1:200. Source: Archivo Municipal de Burgos, signature PL-372

The map was drawn in Chinese ink, using sienna for the contour curves, red for the grid lines, blue to highlight the hydrography, green to indicate parks or wooded areas, different shades of grey to mark public buildings, and hatching to represent arable land and black for the place names.

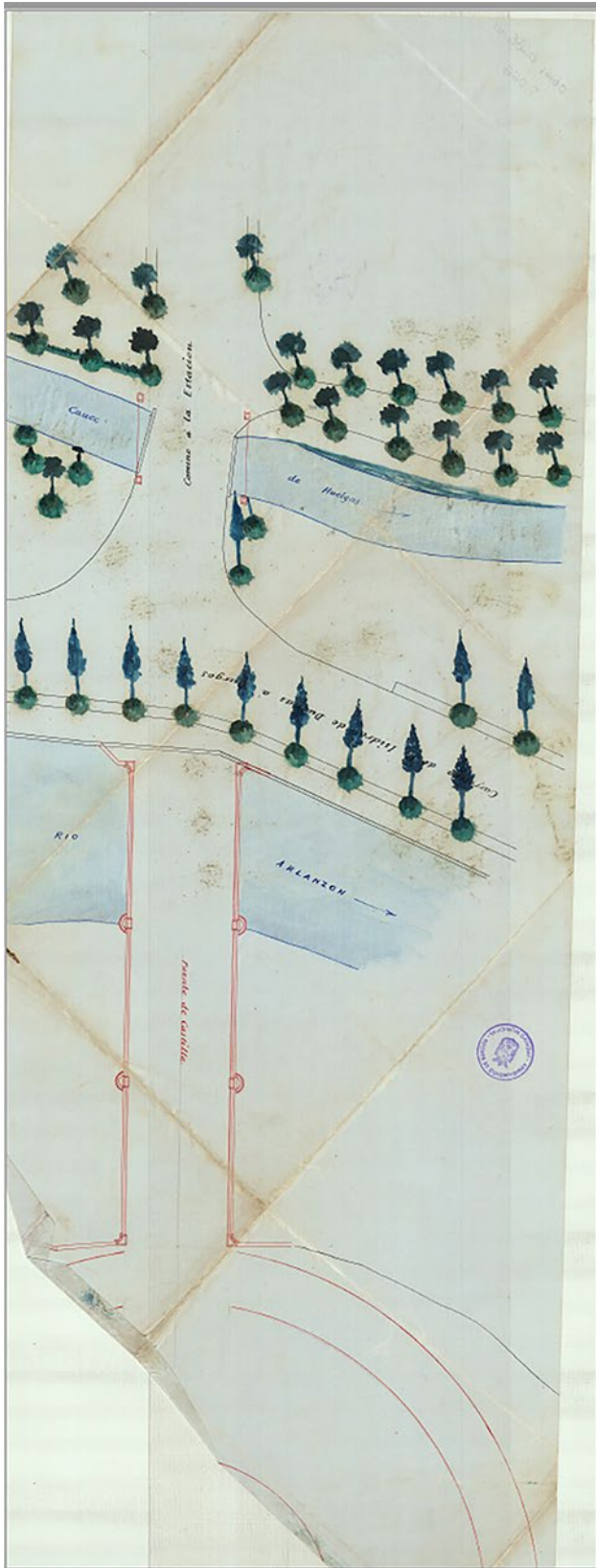
The map drawn up by the two civil engineers reflects very precisely the built-up areas of Burgos. It incorporates the names of the public streets and offers a complete image of the city in which we can appreciate in considerable detail the demarcation between the public and the private. All the city blocks are represented and the built-up areas within each one are clearly shown. The separation between each plot is indicated, with the private buildings being coloured in light grey, while buildings of a public nature (including religious and military buildings) are highlighted through the use of dark grey and their internal distribution is also shown.

In addition, this map constitutes an advancement with respect to the cartography that had been carried out up until that time. This was represented through the use of equidistant two-meter contour

curves, as the aim was to offer an image that reflected as exactly as possible the relief of the city, so that the map could be used in the installation of a system of drains and sewers in the city, and to precisely retrace the streets.

The proposal to align and straighten streets included numerous indications such as: the construction of new access routes into the city; providing access to the railway station; extending areas in the south of the city, where religious buildings predominated; straightening the streets in the historical centre of the city; restructuring the watercourses, etc. The municipal architect, Saturnino Fernández, objected to all of these proposals, indicating the density of the population in the historical city centre, the economic costs that would be incurred through expropriation of dwellings, and the impossibility of rehousing the displaced people in areas mostly dominated by the bourgeois middle class as the main obstacles to these plans. Therefore, the City Council opted to continue with the system of partial alignment and straightening of streets.

In this way, even in the nineteenth century, the project of Burgos made it become the first city to



propose a modern plan of sanitation for the whole city in Spain and also the first in including an alignment plan. This project entailed the modernisation of the city, and the changes made as a result of it were taken into account in later projects during the twentieth century. Moreover, the cities which presented these kinds of problems found in this project a feasible solution to their situations

#### 4. CONCLUSIONS

In order to understand the morphological configuration of the urban space of a city, it is necessary to study the different types of cartography that are the direct product of various interests. These include such projects as the supplying of water to cities, the channelling of rivers, implanting drain and sewer systems, straightening and aligning streets, and allowing for population growth.

For this reason, I consider that in the case of Burgos (Spain), the topographic map of the city drawn up by the civil engineers Mariano Martín Campos and Eduardo Lostau in 1894 and which falls within what we could call hydrological cartography, is key to deepening our understanding of the current configuration and structure of Spanish cities. This is the case because it represented the answer to various problems that had emerged at the same time: floods, restructuring of the streets and sanitation.

This study elucidates how some Spanish cities were able to place themselves at the same level as cities in other European countries in terms of sanitation systems. In Burgos, we can consider this map, which grew out of the sanitary needs of the city, to represent the start of the internal and external restructuring of the present-day city

**Figure 5:** Sheet at a scale of 1:200.  
Source: Archivo Municipal de Burgos, signature PL-372



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## REFERENCES

Archivo Municipal de Burgos, signature 18 -924

Archivo Municipal de Burgos, signature 2-505

Archivo Municipal de Burgos, signature PL- 18 -1583

Archivo Municipal de Burgos, signature PL-372

Arnould, J. (1902), *Nouveaux éléments d'hygiène*. París: Libr. J.B. Baillière et Fils, pp. 1.003. Retrieved from: [https://archive.org/stream/BIUSante\\_90141x1903x49/BIUSante\\_90141x1903x49\\_djvu.txt](https://archive.org/stream/BIUSante_90141x1903x49/BIUSante_90141x1903x49_djvu.txt)

Capel, H, & Tatjer, M. (1991). Reforma social, serveis assistencials i higienisme a la Barcelona de final del segle XIX (1876-1900). In A. Roca Rosell (ed.), *Cent anys de Salut Pública a Barcelona* (pp. 31-73). Barcelona, ES: Ajuntament de Barcelona.

Coronas Vida, L. J. (2008). El abastecimiento de agua potable a las capitales de Castilla y León: entre la concesión y la municipalización (1886-1959). In *IX Congreso Asociación Española de Historia Económica*. doi 10.14295/rbhc.v9i18.448

Geneviève, M.G. (2007). Pour une histoire environnementale de l'urbain. *Histoire urbaine*, 18, 5-21. doi: 10.3917/rhu.018.0005

Halliday, S. (2013). *The Great Stink of London: Sir Joseph Bazalgette and the Cleansing of the Victorian Metropolis*. Stroud, UK: The History Press.

Hamlin, C. (1991). The Sanitarian Becomes an Authority. 1859. In *International Conference on the History of Public Health and Prevention*. Stockholm.

Hamlin, C. (1992). Predisposing causes and public health in early nineteenth century medical thought. *Soc. Hist. Med.*, 5, 43-70. doi: 10.1093/shm/5.1.43

Hauser, P. (1979). *Madrid bajo el punto de vista médico-social*. Madrid, ES: Ed. del Moral y C. Editora nacional.

Hauser, P. (1913). *Geografía médica de la Península Ibérica* (pp. 235-236). Madrid, ES: Eduardo Arias.

Hildreth, M.L. (1987). *Doctors, Bureaucrats and Public Health in France, 1888-1902*. New York-London: Garland publishing Inc.

Pogliano, C. (1984). L'utopia igienista (1870-1920). In F. Della Peruta, (ed.), *Storia d'Italia. Annali 7. Malattia e Medicina* (pp. 589-631). Torino, IT: G. Einaudi editori.

Pulido Fernandez, A. (1902). *Sanidad pública en España y ministerio social de las clases médicas*. Madrid, ES: Est. Tip. Enrique Teodoro.

Real Consejo de Sanidad. (1901). *Cuestiones fundamentales de Higiene Pública en España*. Madrid, ES: E. Teodoro.

Rodger, R. (1996). *A Consolidated Bibliography of Urban History*. Aldershot, UK: Scholar Press.

Rodríguez Ocaña, E. (1994). La salud pública en España en el contexto europeo, 1890-1925. *Revista de Sanidad e Higiene Pública*, 68(0), 11-27.

Rodríguez Santillana, J.C. (2002). *Saneamiento y espacio urbano (Burgos 1870-1920)*. Burgos, ES: Dosoles.

- Sgobbo, A. (2017). Eco-social innovation for efficient urban metabolisms. *TECHNE Journal of Technology for Architecture and Environment*, 14, 337-344. doi: 10.13128/Techne-20812
- Smith, F. B. (1979). *The people's health 1830-1910*. Canberra, AU: Australian National University Press.
- Sussman, G.D. (1977). Enlightened Health Reform, Profesional Medicine and Traditional Society: The Cantonal Physicians of the Bas-Rhin, 1810-1870, *Bull. Hist. Med*, 51, 565-584. doi: 10.1017/CBO9781139381185.011
- Virgili Blanquet, Maria Antònia (1979). *Desarrollo urbanístico y arquitectónico de Valladolid: 1851-1936*. Valladolid, ES: Ayuntamiento de Valladolid. doi: 10.7419/162.11.2014
- Villanova, J. L. (2011). Dionisimo Casañal y Zapatero: Del catastro a la topografía (1864-1878). In C. Montaner; F. Nadal and L. Urteaga (eds.), *Cartografía i agrimensura a Catalunya i Balears al segle XIX. 2011* (pp. 209-223). Barcelona, ES: Institut Cartogràfic de Catalunya. doi: 10.14198/INGEO2011.56.11
- Wohl, Anthony S. (1983). *Endangered Lives: Public health in Victorian Britain*. London, UK: Dent. doi: 10.1017/S0963926800007148