CARTOGRAPHY AND STATE: NATIONAL TOPOGRAPHIC MAPS AND TERRITORIAL STATISTICS IN THE NINETEENTH CENTURY

JULY 1995
CARTOGRAPHY AND STATE:
NATIONAL TOPOGRAPHIC MAPS
AND TERRITORIAL STATISTICS IN
THE NINETEENTH CENTURY

JULY 1990
Francesc Nadal and Luis Urteaga

Dirección para la correspondencia científica
Universitat de Barcelona
Facultat de Geografia e Historia
Catedra de Geografia Humana
08057 - BARCELONA (España)

Los trabajos incluidos en Geo Crítica
se publican sin ninguna clase de beneficio económico
para los autores o colaboradores de la serie.
Note on the article

This article forms part of a research project into the Institutionalisation of statistics and cartography developed by the authors at the Department of Human Geography at the University of Barcelona. It forms part of Project PB87-0462-C05-02, financed by the CICYT.
CARTOGRAPHY AND STATE: NATIONAL TOPOGRAPHIC MAPS AND TERRITORIAL STATISTICS IN THE NINETEENTH CENTURY

By Francesc Nadal and Luis Uteaga.

The nineteenth century was a crucial period for the development of modern cartography. At the end of the Napoleonic wars only France had a general map based on astronomical determinations and supported by a wide grid of triangulations. By the last decade of the eighteen hundreds all European states, with the exception of Greece and Turkey, were trying to complete highly precise topographic surveys based on normalised geodesic grids and had undertaken the publication of large scale topographic maps (from 1:10 000 to 1:100 000). Step by step, national topographic maps had progressed in clarity, precision and uniformity, while governments with hugely diverse political orientations were investing large sums of money in the organisation and maintenance of state cartography services.

Large scale topographic maps have an obvious military use as indispensable assistance in army operations, and in all countries military engineers, as well as officers of the General Staff, played a very relevant role in land surveys. A good part of recent research has been dedicated precisely to showing military prominence in the development of basic cartography. In a suggestive synthesis study Vladimiro Valerio\(^1\) highlighted the militarisation of cartographic activity at the beginning of the nineteenth century, underlining the move from court cartography to military cartography as a crucial milestone in nineteenth century cartographic history. The studies of Duranthon and Alinhac in French cartography\(^2\), of Alonso Baquer in Spanish cartography\(^3\) and of Lemoinpelsabeau on the Dépot de la Guerre and land survey in Belgium seem to show that, in effect, the institutionalisation of modern cartography was produced in military establishments for military needs. The argument is emphasised by two complementary aspects: 1) the administration of geodesic operations, generally in hands of the militia, logically gave the

\(^1\) Valerio, 1987
\(^2\) Duranthon, 1978; Alinhac, 1986.
\(^3\) Alonso Baquer, 1972.
military control over map production, and 2) military engineers were the only institution with sufficient experience and organisation to carry out the extensive and complex field work required in a general land survey. The conclusion, explicit or implicit, is that topographic cartography and military cartography were one and the same enterprise during the nineteenth century.

In spite of the importance of the work carried out and the solidity of the conclusions that may be put forward, we believe that further studies are necessary to throw light on the complex relations between map-making and the state, in particular on the role of civil and military institutions in the shaping of modern cartography. This paper proposes to show national topographic maps as part of a more general territorial information project, a project which includes topographic as well as cadastral surveys, along with the compilation and treatment of a large mass of statistical information. A project, in short, centred on the modernisation of the state and patronised by the liberal reformism of the nineteenth century.

In fact, topographic maps were considered indispensable not only for their strategic military use, but also for their fundamental importance in government programmes in the field of public works, the modernisation of transport networks or the development of agriculture, and in general for the organisation of public administration. In accordance with this, it seems more appropriate to understand the development of topographic cartography as the institutionalisation of a public service for which distinct institutions of the state were responsible, whether civil or military. In reality distinct models appear in the execution of topographic maps. In some countries, France and Belgium for instance, responsibility for topographic cartography fell exclusively to military institutions. In Great Britain, basic cartography began with a military design, but map production had clearly passed to the civilian administration by the second half of the nineteenth century. In Portugal and Spain nominal responsibility for topographic maps fell to civilian institutions, even when the participation of military organisations in geodesic operations was decisive. Here, as in other cases, military control over triangulations and partially over the topographic survey can be satisfactorily explained as one of the inconsistencies of civilian power during the nineteenth century, another result of the contradiction between the necessities of a modern state administration and the lack of economic, technical and institutional means to carry out the necessary work.

The paper is divided into two parts. The first offers a general panorama of the development of topographic cartography in Europe during the nineteenth century, emphasising the institutional and organisational aspects. The second part presents a more detailed analysis of the genesis of the National Topographic Map of Spain.

This paper is framed within a wider research project into the role of the modern state in the institutionalisation of statistics and cartography. This project is indebted to the research of Horacio Capel into cartography and the institutionalisation of geographical science in Spain, as well as his previous research into Hispanic military engineering. We are also indebted to Ignacio Muro who allowed us to consult his monumental doctoral thesis on the thought and geographical labour of military engineers in the nineteenth century, and the work of Mercé Tatjer on urban property and the official land register. Finally, we would like to mention the great intellectual stimulus received from research carried out by Antonio Lafuente and José Luis Peset on the history of geodesy and the process of the militarisation of science in Spain during the eighteenth century.

PART ONE

TOPOGRAPHIC MAPS IN NINETEENTH CENTURY EUROPE.

Usually underlined amongst the definitive traits of the cartography of the last century are those which testify to its technical and scientific advance. Also mentioned are the greater detail and expression in the maps published, growing precision achieved by the use of large scale, improvement in systems of representing relief and the generalisation of topographic survey based on internationally confirmed geographical grids. This is true, as is also the growing uniformity in map production brought about by the homogenisation of symbols and the internationalisation of the metric-decimal system. It is necessary, however, to add the main point. Nineteenth century cartography was not only expressive, precise and scientifically based; it was, above all, a «nameless» cartography; a state enterprise.

Topographic cartography as a task of the state.

In affirming that topographic cartography is above all a state enterprise, we wish to highlight two aspects of cartographic development that were decisive from the early nineteenth century onward. Firstly, that map production became progressively more an institutional responsibility whose execution depended on the combination of various technical and professional corporations: geodesists, topographers, draughtsmen and engravers amongst others, corporations that would be regulated in their formation, recruitment and exercise by detailed administrative regulations. Secondly, that cartographic activity was governed by factors apart from the simply scientific and technical. It essentially came to depend on political and administrative necessities and the budgetary possibilities of each country.

It can be claimed, of course, that cartography has always been a state «business». In effect, ever since the Renaissance European monarchies actively intervened in the production and distribution of maps. In some cases they commissioned, financed and stimulated the production of charts, especially those maps indicating the limits and dominions of the crown. In other cases, they censored or controlled the diffusion of certain cartographic works. However, it seems obvious that these activities of patronage and control acquired a new character in the last century, and for a powerful reason: the topographic cartography that developed according to the demands of territorial knowledge of the state in the nineteenth century appears governed by a new juridico-administrative framework. Here it is convenient to add that the scope of the cartographic operations carried out in the nineteenth century, and the budgetary and organisational effort that they required have no parallel in previous centuries.

At the end of the eighteenth century, as mentioned above, only France amongst the large European states could boast a general map based on a true geographic grid. This was the celebrated «Academy Chart», made to a scale of 1:86 400 and drawn up between 1750 and 1789 by the Cassini family. However, this map would soon be criticised for the lack of planimetric details and for its weakness in the representation of relief10. The systematic triangulation to form the topographic map of Great Britain dates from 1808, and it was not drawn up until the middle of the century. Cartographic development in other European countries lagged considerably behind those mentioned, although here and there isolated trigonometric observations could be found along with general large scale chart projects.


In fact, when Napoleon initiated his military campaigns throughout Europe, the best maps then available continued to have individual names: those of Delisle, Vaugondy and Cassini in France, Kinloch in Russia, Arrowsmith in Great Britain or Tomás López in Spain. Great geographers, or more frequently families or dynasties of geographers, held the secrets of chart production, their engraving and printing. The cartographic pieces published from the offices of family businesses such as those mentioned, limited circulation prints and at different scales had to be searched for and recomposed by Napoleon’s engineers with the same fanaticism displayed today by collectors of antique engravings.

This state of affairs would change within a few decades. From the beginning of the nineteenth century, and throughout Europe, the main cartographic projects were always a state enterprise. European states nourished, paid and directed the organisations commissioned for land surveys. Administrations sustained cartographic projects whose undertaking spread over several decades. Governments fixed the priorities and formed the teams necessary to carry out land surveys and obtain survey information and statistics at scales never before attempted. Finally, it was government institutions who were commissioned to engrave, print and distribute the maps.

The extent and ambition of cartographic works carried out during the nineteenth century is partially reflected in Table I, prepared from information collected between 1881 and 1885 by George M. Wheeler11. This chart gathers together the state of the surveys in fourteen European countries by 1885, indicating the scale of the surveys and the number of sheets published in each case. As can be seen, by 1885 the production and publication of large scale general topographic maps was very advanced in the majority of European states. Only Greece, Turkey and the small Balkan states failed to participate in this powerful territorial information effort.

In 1880, France had concluded the publication of the 273 sheets of its Carte de l’Etat Major at 1: 80 000 scale, and had planned the production of a more precise 1: 50 000 scale map. In Great Britain advances were even more considerable, as besides the 1: 63 530 scale survey map, whose publication was practically concluded, there were also more than 7 000 printed sheets of the «County Maps», drawn at 1: 10 560 scale, an incredibly detailed scale for the period.

11. George M. Wheeler, Captain in the Engineering Corps of the United States, acted as delegate of the U.S. Government in the Third International Geography Congress held in Venice in 1881. On his return to the United States the Ministry of War asked him to prepare a detailed report about cartographic surveys in Europe. This report, published in 1885 (Wheeler, 1885), constitutes one of the best sources on nineteenth century European cartography and has been extensively used in the preparation of this part of our paper.
In Belgium, where there had been important developments in cartography since the forties, complete 1:40 000 and 1:20 000 scale general topographic maps were available in 1865. Holland had printed its national 1:50 000 chart and begun the production of a 1:25 000 map. Both countries enjoyed well organized cartographic services and exploited the advantages of their limited surface area to finish the survey and publish the map in a short period of time. Switzerland is another example, where in 1865 a 1:100 000 scale map was finished and in 1870 the production of the so-called Siegfried map was embarked on, which would be published to 1:25 000 and 1:50 000 scales.

The larger European states had to adopt a less ambitious strategy in their cartographic coverage. They generally chose smaller scales that permitted greater speed and economy in the surveys. The first National Map of the Russian Empire, the 158 sheet Streibitzki Chart was produced between 1865 and 1871 to a scale of 1:420 000. By 1867, however, the execution of a more detailed map for the European part of the Russian territories had already begun, this time to a 1:126 000 scale. This new map would be made up of 372 sheets, more than half of which had been published by 1885. Norway and Sweden chose a scale of 1:100 000 for their national maps, their production being advanced by 1885. The Austrian Empire was also close to finishing the production of its ‘Spezialkarte’ in the same year, to a scale of 1:75 000 and featuring 576 sheets.

The processes of national unification in Germany and Italy had given a big push to the formation of regular large scale cartography for the new states. The unified cartography of the German Empire was planned at a scale of 1:100 000, making the most of the excellent base provided by surveys in Prussia, Saxony, Bavaria, Baden and Württemberg, made at a scale of 1:25 000. The Military Geographical Institute in Italy centralised geodesic and cartographic activity and quickly carried out the production of topographic maps at scales of 1:100 000, 1:50 000 and 1:25 000. Of the 277 sheets that made up the National Map of Italy at a scale of 1:100 000, 109 had been printed by 1885, and 50% of the 1:50 000 scale topographic map had been published by the same date.

In the same period in the Iberian Peninsula they were trying to make up for lost time in cartographic production. Portugal had just published the 37 sheets that made up its topographic map at a scale of 1:100 000 in 1894. In Spain, where a more ambitious 1:50 000 scale had been chosen, 93 sheets of the National Topographic Map had been published by the same year.

---


---

**TABLE I**

STATE OF THE TOPOGRAPHIC SURVEYS IN EUROPE (1885)

<table>
<thead>
<tr>
<th>Country</th>
<th>Scale</th>
<th>Date Survey Begun</th>
<th>Planned Number of Sheets</th>
<th>Published</th>
<th>Representation of Relief</th>
<th>System of Reproduction</th>
<th>Organization in charge of Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>1:100 000</td>
<td>1859</td>
<td>674</td>
<td>417</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Landes Aufnahme (War)</td>
</tr>
<tr>
<td>Baden</td>
<td>1:100 000</td>
<td>1815</td>
<td>170</td>
<td>157</td>
<td>Contours</td>
<td>Topographisches Bureau (Trade)</td>
<td></td>
</tr>
<tr>
<td>Bavaria</td>
<td>1:100 000</td>
<td>1857</td>
<td>860</td>
<td>200</td>
<td>Contours</td>
<td>Photolithograph</td>
<td>Generalkarte Top. Bureau (War)</td>
</tr>
<tr>
<td>Prussia</td>
<td>1:100 000</td>
<td>1879</td>
<td>3658</td>
<td>131</td>
<td>Contours</td>
<td>Engraved in copper</td>
<td>Landes Aufnahme (War)</td>
</tr>
<tr>
<td>Saxony</td>
<td>1:100 000</td>
<td>1872</td>
<td>156</td>
<td>126</td>
<td>Contours</td>
<td>Chrono lithograph</td>
<td>Generalkarte Top. Bureau (War)</td>
</tr>
<tr>
<td>Württemberg</td>
<td>1:100 000</td>
<td>1829</td>
<td>152</td>
<td>152</td>
<td>Contours</td>
<td>Chrono lithograph</td>
<td>Statistisches Bureau (Treasury)</td>
</tr>
<tr>
<td>Austria</td>
<td>1:100 000</td>
<td>1853</td>
<td>720</td>
<td>576</td>
<td>Hochschule</td>
<td>Heligraphy</td>
<td>K.K. Milit. Geol. Institut</td>
</tr>
<tr>
<td>Belgium</td>
<td>1:100 000</td>
<td>1854</td>
<td>72</td>
<td>72</td>
<td>Contours</td>
<td>Engraved in stone</td>
<td>Instand Cartografische Mil.</td>
</tr>
<tr>
<td>Denmark</td>
<td>1:100 000</td>
<td>1839</td>
<td>131</td>
<td>61</td>
<td>Contours</td>
<td>Engraved in copper</td>
<td>GENERALISMAHREN Top. Bildung</td>
</tr>
<tr>
<td>Spain</td>
<td>1:100 000</td>
<td>1859</td>
<td>1,106</td>
<td>29</td>
<td>Contours</td>
<td>Engraved in stone</td>
<td>Instituto Geogr. Estadistico</td>
</tr>
<tr>
<td>France</td>
<td>1:100 000</td>
<td>1842</td>
<td>273</td>
<td>273</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Depute de la Guerre</td>
</tr>
<tr>
<td>Great Britain</td>
<td>1:100 000</td>
<td>1809</td>
<td>360</td>
<td>412</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Ordnance Survey (Public Works)</td>
</tr>
<tr>
<td>Holland</td>
<td>1:100 000</td>
<td>1839</td>
<td>82</td>
<td>82</td>
<td>Hochschule</td>
<td>Engraved in stone</td>
<td>Insfalt Topographie (War)</td>
</tr>
<tr>
<td>Italy</td>
<td>1:100 000</td>
<td>1827</td>
<td>277</td>
<td>109</td>
<td>Insfalt</td>
<td>Heligraphy</td>
<td>Instituto Geografico Militare</td>
</tr>
<tr>
<td>Norway</td>
<td>1:100 000</td>
<td>1828</td>
<td>54</td>
<td>43</td>
<td>Contours</td>
<td>Engraved in copper</td>
<td>Norveg. Geogr. Omskriving (War)</td>
</tr>
<tr>
<td>Portugal</td>
<td>1:100 000</td>
<td>1852</td>
<td>36</td>
<td>36</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Direcdo Tributario Geodesico</td>
</tr>
<tr>
<td>Russia</td>
<td>1:100 000</td>
<td>1857</td>
<td>506</td>
<td>506</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Mil. Geod. Staff</td>
</tr>
<tr>
<td>Sweden</td>
<td>1:100 000</td>
<td>1812</td>
<td>232</td>
<td>54</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>General Staff Top. Bureau</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1:100 000</td>
<td>1859</td>
<td>25</td>
<td>25</td>
<td>Hochschule</td>
<td>Engraved in copper</td>
<td>Bureau Top. Federal (War)</td>
</tr>
<tr>
<td></td>
<td>1:100 000</td>
<td>1868</td>
<td>110</td>
<td>110</td>
<td>Insfalt</td>
<td>Chrono lithograph</td>
<td>Bureau Top. Federal (War)</td>
</tr>
<tr>
<td></td>
<td>1:100 000</td>
<td>1859</td>
<td>400</td>
<td>355</td>
<td>Insfalt</td>
<td>Engraved in copper</td>
<td>Bureau Top. Federal (War)</td>
</tr>
</tbody>
</table>

Source: Based on G.M. Wrother, 1885
The production of this basic cartography, from which small scale maps and all thematic cartography would later be derived, required the investment of large sums of money and the mobilisation of numerous technical personnel. Although it is extremely difficult to obtain data about the real cost of the surveys carried out in the period, some comparative figures gathered by Wheeler in his 1885 report\(^\text{15}\) may serve as an illustration. The annual budget for the Ordnance Survey, the organisation responsible for map making in Britain, reached 1,433,000 dollars in 1881, easily the highest budget in Europe. This organisation, responsible for all geodesic, topographic and land register operations, then employed more than 3,200 full-time staff: 158 officials of the Engineering Corps, 229 soldiers, 1,665 civilian assistants and 934 labourers. The budget for the Geographical and Statistical Institute of Spain was 474,500 dollars in 1883, although this figure also includes money used to pay for statistical studies and other functions of the Geographical Institute. The Austro-Hungarian Empire spent 319,200 dollars during the same period on the cartographic functions of the Military Geographic Institute in Vienna. This centre was staffed by 296 officers from the General Staff, 190 technical officers and 300 soldiers and civilian employees. In France the annual cost of cartographic surveys was put in 1885 at 136,900 dollars. The total cost of the production of the Carte de l’État Major, excluding the salaries of military personnel, was estimated at 12 million francs\(^\text{16}\). The economic resources destined for the production of topographic maps in Italy, Holland and Belgium, although more modest, involved sums that only the national treasury could have provided. The budgetary effort that the production of large scale general cartography required was justified, from the point of view of the governments involved, by the distinct strategic and administrative functions that the topographic maps fulfilled.

A strategic tool: an instrument of government.

From the political and administrative point of view the national topographic map was considered during the nineteenth century as one of the most useful instruments of government. The topographic map constitutes a precise and systematic physical description of the land. Therefore, its survey became necessary as a preliminary step in the planning of communications links, the development of public works or plans for irrigation, and in general for any planned intervention in the territory. Furthermore, according to the scientific demands of the period, the inventory of the natural resources of the country had to be based on an appropriate cartography. For this reason, the production of thematic cartography, whether geological, agronomic or of forests, first required the availability of good topographic maps.

The topographic map contributed a uniform and general representation of the territory of the state, and in this sense it was an indispensable tool for carrying out any proposal of reform or territorial reorganisation, whether on a local scale, for example in studies of municipal boundaries, or on a national scale. Likewise, and in a purely administrative sense, the surveying of large scale topographic maps enjoyed a close relation with the different fiscal reform projects carried out in Europe during the previous century. The intention of imposing direct taxes on property and distributing territorial contributions equally, demanded the availability of an official cadastral survey drawn up with precision and to a large scale. Because of the precision required, the execution of the land register had to be based on a scientifically established triangulation grid. For this reason, various countries considered the topographic-cadastral survey as a task parallel or complementary to the production of the topographic map. Even in cases in which due to political or economic considerations an exclusively planimetric land register was planned, without any sort of altimetric information, the topographic map was usually considered as a map in advance of a complete survey, and therefore a useful administrative and fiscal instrument. It is not surprising then, that the national map, together with the official land register and statistics, should occupy a central place in the political rhetoric of the eighteenth centuries.

Furthermore, the large scale topographic map offered valuable uses in another area: military strategy. The military control of space imposed in each period its own demands of reconnaissance and territorial information. Until the eighteenth century the relative rationalisation of the art of war and the scarce mobility of forces allowed the representation of large spaces which were not direct theatre for military operations to be economised\(^\text{17}\). Military cartography was like this during a long period of time, aimed mainly toward a survey of plans of strongholds or production of maps of confines and borders; only of those spaces which had been assigned a greater strategic value.

Military engineering, which since the Renaissance had been made up of specialised knowledge regarding works of fortification and defence, extended the field of its applications during the eighteenth and nineteenth centuries. As shown by the research directed by Horacio Capel\(^\text{18}\), military engineers during the Enlightenment were one of the most efficient and

---

15. Wheeler, 1885.
solid technical bodies that the state could depend on where spatial organisation was concerned, in both civilian and military fields. In both France and Spain military academies and specialised centres were created in the eighteenth century for the training of engineers. The education given in those centres included fortification studies and the administration of civilian works, as well as the necessary knowledge to carry out cartographic surveys upon which large public works would be based. The model of Spanish military engineering, or the example of the French Geographical Engineering Corps, was adopted, with distinct national variations, by all European countries. In this way, when at the beginning of the nineteenth century the distinct governments instituted the production of large scale topographic maps, technical corporations experienced in geodesic and topographic operations were already in existence, featuring a high degree of organisation.

Parallel to this, the greater mobility of armies, already patent during the century of the Enlightenment, demanded new graphic documents. Here, the itinerant maps appeared, a classic product of military cartography designed to solve the strategic problems involved in the movement of troops. Soon, as seen in the Napoleonic wars, the administration of military operations would demand a precise and uniform overall cartography representing with the greatest possible detail variations in the land, topographic irregularities, communication routes and eventually the resources of the territory. The general topographic map would thus constitute the strategic tool demanded by the General Staff of all the European armies during the nineteenth century.

The multiplicity of functions, civilian and military, of the topographic map, and the key role of basic cartography regarding the general design of geographical information, opened diverse possibilities for the organisation of cartographic services, and in particular for the administration of land surveys. Was the production of plans of land parcels, necessary for the official land register, compatible with the execution of the topographic map? Should all large scale cartography be based on a single geographic grid? Could all the different cartographic surveys be coordinated under a single management? What would be, in this case, the division of responsibilities amongst the various organisations? And lastly, what relations should be established between topographic, cadastral and statistical information?

Questions such as those above were widely debated throughout most of Europe from the beginning of the nineteenth century. Reasons of administrative efficiency advised against a single administration for cartographic works and in favour of tying them closely to cadastral and statistical operations. Reasons of economy caused the cadastral survey to be coordinated with topographic measurements. However, it became obvious that whatever the organisational solution, it was going to affect already existing structures and touch on important aspects of the administrative design of the nineteenth century state. In concrete, what was being discussed was, amongst other things, the degree of centralisation and homogeneity of territorial information, the primacy of certain state bodies and organisations in the control of this information and the balance of power between the civilian and the military administration in cartographic affairs.

**Cartographic centralisation projects: The Cadastral survey and the Map of France.**

The case of France during the revolutionary period offers a particularly eloquent example of the situation in question. Amongst the first measures discussed by the revolutionary Assembly, in 1789, was the reorganisation of the administrative map of France, the modernisation of the system of weights and measures and the establishment of the land register. The three projects represented a complete break from the territorial model of the Ancien Regime, the carrying out of which involved important cartographic challenges.

The rationalisation of the administrative division of France was left to Cassini IV, who designed a new departmental map which was presented in April 1790. Barely a month later the Constitutional Assembly adopted a metric system to substitute the heterogeneous weights and measures used during the Ancien Regime. Shortly afterwards a commission was entrusted with carrying out the necessary geodesic work for the determination of the metre, particularly the measurement of a meridian arc between Dunkirk and Barcelona. The adoption of the metric system was followed by a new uniform and rationalising measure: the establishment of the land register. On September 3, 1791 a decree proclaimed the establishment of the general land register of France, whose technical production would be the responsibility of civil engineers. Gaspard-François de Prony (1755-1839), professor and later Director of L'Ecole de Ponts et Chaussées, was named as director of the Land Registry Office, and designed its general project.

The land register plan conceived by Prony sought to obtain complete statistical, topographical and fiscal information about French territory. In reality it combined the undertaking of a population census, a cadastral survey and the compilation of an extensive natural resource inventory. All this demanded, according to Prony, rigorous and centralised

---

19. In this aspect, and in general concerning cartographic policy of revolutionary France, see Konvitz, 1987.
operations administration. In a purely cadastral sphere, the project expressed the necessity of maximum uniformity and precision in measurements, and in such a way that the maps obtained in the distinct communes and departments would be compatible with each other and could be harmonized into a general representation of French territory. The cadastral maps, on a scale of 1:2,000 and 1:5,000, were based on the geographic grid of the Cassini Map, which required a new measurement for the secondary triangulation bases. The essential feature of the project was the technical and administrative centralisation of the land register and the conception of this as a scientific operation of territorial information that brought together geodesic and topographic-cadastral studies.

Prony believed the new metric system would be available before beginning the field work for the land register, which was scheduled to begin in 1795. Meanwhile, his activities continued in two complementary directions. In the first place he actively collaborated with Laplace, Lagrange and Jean-Baptiste Delambre in the metrological studies of the Weights and Measures Commission. Parallel to this he organised the National School of Practical Geodesy which was intended to train the personnel who would carry out the survey for the land register. In this centre, classes were given in geodesy, surveying, drawing and cadastral evaluation, and it was planned to train two hundred students each term.

However, Prony's ambitious project suffered successive setbacks and collapsed before the end of the decade. The measurement of the meridian arc between Dunkirk and Barcelona, on which Delambre and Pierre François Méchain worked, was delayed much more than had been planned. The geodesic operations were held up time and time again by the political instability of the period and numerous unforeseen hurdles, and the calculations were not completed until 1798. The following year the new decimalic metric system came into force, but by then it was too late. Inflation, budgetary difficulties and the scarce practical results achieved left the organisations of the land register in a difficult situation. The Geodesy School was closed following successive budget reductions and in 1801 the Land Register Office was finally dissolved.

The collapse of Prony's modernisation plan was preceded by the failure of another ambitious cartographic centralisation project and of the control of cartography by the civilian administration. On June 8, 1794, with Robespierre in power, the Committee of Public Health ordered the establishment of a National Map Archive under the control of the Commission for Public Works. The new organisation came to replace the important archives of the Military Topographic Bureau, the Fortification Corps, the Navy and other state organisations, bringing together in a single collection all types of geographical and cartographic works, both civilian and military.

The creation of the National Archive provoked the immediate hostility of the military corps affected by the loss of direct control over their map collections, and they implemented boycott measures. The fall of Robespierre a few months later and the consequent political commotion led to the unified map archive being dissolved, with the navy and the army getting their precious collections back.

Amongst the maps entrusted to the Military Topographic Bureau was the Cassini map. This work was essential for any new triangulation project to be carried out, such as those patronised by Prony at the Land Register Office. In the middle of the Directory, on May 11, 1797, Prony had managed to have control of the Cassini Chart removed from the Military Topographic Bureau and placed in the hands of the Land Register Office. However, this situation lasted only a few months. Napoleon's success in the Italian Campaign revalued the role of the military engineers and the Military Topographic Bureau.

When Napoleon took power a lasting model of cartographic organisation was established. The geographic triangulations and topographic surveys were placed under the control of the Military Topographic Bureau. The land register came to depend on the Finance Ministry and its production was completely separated from the development of topographic cartography and geodesic operations.

The military engineers at the Military Topographic Bureau demonstrated their map making skills in the extensive territories conquered by Napoleon. Meanwhile, in 1802, the order was given to begin the cadastral studies again, but this time with a different orientation that sought to achieve short term results. Responsibility for the land register passed to the departments, and the method employed consisted of carrying out surveys of cultivated areas, doing away with the measurement of land parcels and the identification of properties. Once the overall surface of the cultivated area was determined, and its performance evaluated, the fiscal charge had to be apportioned in terms of the surface declared by the proprietor. The cadastral plans were made to 1:5,000 scale and in the next five years around 15,000 maps of areas under cultivation were made.

The cadastral procedure adopted featured serious difficulties, from both a cartographic and fiscal point of view. The plans of cultivated areas lacked topographic precision and did not allow, in any case, the identification of territorial ownership boundaries. In 1807 the land regis-

20. Among others the detention of Méchain in Spain.
ter plans were revised by order of Napoleon, returning to the project of the old Land Register Office in one respect: the land registered had to be by parcels. A commission presided over by Delambre codified the methods of execution of the cadastral survey and the field work began, at a steady pace, in 1808. In 1814 the cadastral evaluation of the 9,000 municipalities in France had been made, with the work carried out covering 12 million hectares and 37 million plots of land.

The fall of Napoleon and the dismembering of the Empire caused the overall design of cartographic policy to be revised, with different conceptions about the Map of France reappearing. In the same year as Napoleon’s abdication, 1814, the engineer Laplace proposed to the Finance Ministry that they should make a general topographic map combined with the land register. The idea was to exploit the numerous cadastral plans already available, made to a scale of 1:2,500 and 1:1,250, obtaining the drafts of the topographic map through successive reductions. Laplace’s proposal was passed by the government to a commission of civil engineers, headed by Prony. The commission raised several objections concerning the precision of the cadastral survey and its congruence with the geographic grid, but along general lines gave its support in principle to the derivation of a topographic map from the cadastral survey.

Parallel to this, the military engineers drew up their own plans. The loss of the Empire had left the Dépôt de la Guerre in a precarious position, condemned to inactivity and waiting to be dissolved since 1815. In that critical situation, winning the responsibility for the survey of the Map of France offered a clear path to survival for the Dépôt. Pierre Brossier, director of the Dépôt de la Guerre and Auguste Denain, officer of the General Staff, proposed a detailed project in 1816 for the production of a topographic map that could have civilian and military purposes. As a result of this initiative, a royal commission was set up the following year to study the project for a new topographic map of France suitable for all public services and combined with the production of the land register. The commission was headed by the astronomer Laplace and made up of representatives of the Interior, War, Navy and Finance ministries.

The interministerial commission reached a rapid consensus about the characteristics of the new topographic map. It would be made to a scale of 1:50,000, and carried out by means of collaboration between the Dépôt de la Guerre and the cadastral service. The Dépôt de la Guerre would take care of the primary and secondary geographic triangulations. The cadastral service would look after the tertiary triangulations, the planimetric studies and the reduction of the land parcel plans. In short, the geodesy would be the job of the military and the topography the job of the civilians. The engraving and publication of the map would be given to the Dépôt de la Guerre.

Work began in 1818 in accordance with this plan, but difficulties in coordination soon arose. General Brossier, director of the Dépôt de la Guerre, complained of imperfections in the cadastral plans and the lack of diligence of the Land Register Service in carrying out their work. Those at the Land Register blamed lack of resources. The interpretation of this conflict given by J. Konvitz, M. Bacchus and J.C. Dupuis is clear and coincides in arguing that the confrontation was manipulated by the army to extend their cartographic importance, and surely also by the Land Register to maintain their own autonomy.

The aforementioned interministerial commission met for the last time in 1826. By then the model of cartographic organisation in France was clearly defined. The Finance Ministry would carry out the land register survey with full authority and do without any sort of geodetic base. The Dépôt de la Guerre, for their part, would have exclusive rights over the topographic map of France.

This clear division of functions, settled in the 1820s after numerous comings and goings and hidden conflicts, continued throughout the entire nineteenth century and has in fact lasted until today. The cadastral survey culminated in the middle of the eighteen hundreds, responsibility for its execution having been transferred to the departments. Since then the Land Register has maintained the rights for the elaboration of the cadastral survey. The Dépôt de la Guerre carried out the survey for the topographic map, finishing the geographic triangulation in 1845 and publishing it in 1880. In 1887 the old military organisation came to be called the Geographical Service of the Army, keeping exclusive rights over topographic cartography. In 1940, to avoid the likely dissolution of the Military Geographical Service by German troops, its name was changed again, this time to the National Geographical Institute.

Parallel to the eighteenth century consolidation of the map-making services, the modernisation of the census and the institutionalisation of statistics took place in France. At the beginning of the nineteenth century statistical responsibilities were divided between the Bureau de Statistique, the Ministry of the Interior and distinct ministerial offices that compiled information of a sectorial nature. From 1832 the Statistics Office at the Ministry of Commerce acquired growing importance. Finally, in 1852, the Statistique Générale de France was organised as an authentic central

---

statistics service with extensive organisational autonomy and rights over all manner of demographic and economic information.  

To sum up, Restoration France, in spite of its habitually imagined tradition of administrative centralisation, ended up adopting a decentralised scheme for geographical information. The three pillars of the modern administration, according to nineteenth century rhetoric: the topographic map, the land register and statistics, appear fragmented in three different organisations and with diverse ministerial affiliation.

The maps of the General Staff.

The French state provided a model that can be characterised by the separation of the topographic responsibilities of the land register and statistics, and by military control over basic cartography. This model was widely repeated throughout Europe in the eighteen hundreds, in particular with reference to military primacy in the production of national topographic maps. The actual organisation of the cartographic services responsible in each country for the production of basic cartography shows the military prominence to which we refer. Eleven of the fourteen organisations mentioned in Table I were, in 1865, and had always been, under the administration of the Ministry of War. The exceptions were the cartographic services of Great Britain, Portugal and Spain, which were entrusted to ministries of a civilian nature. These cases will be examined later along with the relative peculiarity that they represent, with the case of Spain being dealt with in depth.

We saw in the previous section how the general topographic map of France ended up as the military map of France. More precisely it was converted into the Map of the General Staff.

During the 1820’s the geographical engineers of the Dépôt de la Guerre had taken charge of the geodesic and topographic operations of the Map of France, initially planned to a 1:50,000 scale. However, after the July 1830 revolution and the proclamation of Louis Philippe d’Orléans as King of France, the army was reorganised. The Geographical Engineering Corps was dissolved and the Dépôt de la Guerre fell under the direct independence of the General Staff. From then on the officers of this corps became responsible for the execution of the map. The surveys that they intended to carry out at a scale of 1:100,000 were finally made to a scale of 1:40,000. It was published at a scale of 1:80,000 so as to reduce the surface of the engraving and the costs of publication. La Carte de France de l’État Major, engraved in copper and with a representation of relief by normals, would for a long time be the base for all French cartography.

The stamp of the French model is evident in the countries that used to form part of the Empire. In Belgian territory the survey of the Napoleonic land register was carried out as soon as possible, and the engineers of the Dépôt de la Guerre carried out extensive activity. Following Belgium’s independence, the process continued its evolution on lines parallel to France. In 1831 the «Dépôt de la Guerre et de la Topographie» was created in Belgium in the image of its French counterpart, and the first important cartographic project carried out by this institution was a topographic map of Belgium at a scale of 1:80,000. The coincidence is easy to explain: General Evain, then Minister of War in Belgium, had been director of the Dépôt de la Guerre in Paris.

The initial idea for the Belgian map consisted in basing the geographic grid on French triangulation, and taking advantage of the planimetry of the land register to obtain, by means of reduction, the drafts of the topographic map. The cadastral reductions were carried out between 1833 and 1840, although the geographic triangulations suffered a notable setback. By mid-century the plans had been modified, and the chart would be produced to a scale of 1:40,000. The base measurement of the geographic grid was done in 1850; the triangulation and levelling works took from 1854 to 1873. Publication of the map was begun in 1861 by the Dépôt de la Guerre. The orography was represented by equidistant five metre contours, which was a considerable innovation amongst the topographic maps of the period. Lithography was used for the engraving and it was published in black.

The drafts of the «Carte Topographique de Belgique», 1:400,000, that had been carried out at a scale of 1:20,000 were published from 1865 onwards, using a new system of reproduction: chromolithography. Publication of the drafts led to the topographic map, in 427 sheets and published in colour. From 1876 the Dépôt de la Guerre de Belgique became the Institut Cartographique Militaire, later adopting the following names: Institut Géographique Militaire (1947) and Institut Géographique National (1976).

The astronomical observations to make the map of Holland had begun in 1802, being directed by General Krayenhoff, Inspector General of fortifications. Cartographic production was later divided into two different sections. The field work became the responsibility of the General Staff, while the indoor operations passed to the Topographic Institute of The Hague. The 62 sheets of the Topographic Map of Holland were engraved in

27. For the institutionalization of statistics in France see J. & M. Dupaquier, 1985.

28. For the production of the Topographic Map of Belgium see the documented work of Lemoine-Isabey, 1988.
stone, using the traditional system of hachures to represent relief. The production of a 1:25,000 scale topographic map began in Holland in 1809.

Administration of the cartographic services in Germany also fell into military hands, in spite of the relative decentralisation of the topographic works. Central responsibility for land survey in the German Empire fell to the Landes-Aufnahme, a military organisation based in Berlin and directed by a colonel of the General Staff. In 1885 this centre employed more than 500 staff, of which 93 were officers either of the Engineering Corps or the General Staff, and 408 were technical officers.

The Landes-Aufnahme also controlled cartographic activity in Prussia, where the surveys had been the responsibility of the War Ministry since 1814. In Saxony the topographic work was carried out by the General Staff and directed by a colonel from this corps. In Bavaria the surveys had been performed by this same military body since 1817. The trigonometric and topographic operations had been started in Baden in 1812 by the Military Engineering Corps. In 1885 the Topographisches Bureau depended on the Ministry of Commerce, but was in the charge of an officer of the Prussian General Staff. Only the Württemberg Office of Statistics and Topography, in which around 30 people worked, had civilian administration.

The first surveys carried out in Austria in the second half of the XVIII century were performed by army officers. In 1816 the Austrian War Office was transformed into the Military Geographic Institute of the General Staff, establishing headquarters in Milan. From 1839 the Military Geographic Institute, now moved definitively to Vienna, took charge of the production of the Spezialkarte of the Austro-Hungarian Empire on a scale of 1:75 000.

Following unification, the topographic studies carried out in Italy were directed by the Military Geographical Institute of Florence, a centre depending on the Army General Staff. The Military Geographical Institute was made up of officers from the General Staff, military engineers and artillery, infantry and cavalry officers, besides a number of civilian technicians and assistants.

The growing importance of the General Staff in cartographic activity was also registered in the Scandinavian countries. In Denmark, the Royal Scientific Society had undertaken important cartographic studies since 1843, sharing responsibility for the surveys with the General Staff, which had been created in 1808. However, from the middle of the century all cartographic activities of the Royal Scientific Society were transferred to the topographic division of the General Staff, which took exclusive charge of geodesy and topography.

Cartographic services in Sweden had been organized in 1811, forming part of the army's fortification corps, known as the Royal Engineers Corps. In 1831 an independent topographic body was organized only to be abolished in 1874, its functions passing to the General Staff.

Cartographic surveys in Norway were performed by the Geographical Institute of Christiania, which came from the fusion of the cartographic division of the Ministry of the Interior with the topographic section of the General Staff.

A General Staff had been set up Russia in 1783, and officers from this body produced various itinerary maps at the end of the eighteenth century. In 1787 the Imperial Map Deposit was founded, which would be transformed a few years later into the Military Topographic Deposit dependent on the War Ministry. The creation of the Topographic Engineers Corps stems from 1822. This corps, specialised in topographic surveys, was limited in 1832 to 70 officers and 456 topographers who had received a military education. Reorganization in 1866 set the staff at 8 general officers, 33 superior officers, 156 subalterns, 236 topographers with military rank and 170 civilian topographers. The Topographic Engineers Corps was responsible for the survey of Russian territory in Europe and Poland at a scale of 1:126 000 and the topographic maps of the Caucasus and Siberia at a scale of 1:210 000.

All these examples appear to support the thesis that topographic cartography was basically a military undertaking, apparently separate from other territorial information projects in the modern state. However, they still do not offer the entire picture of events. The scarcity of detailed research into the relations between the development of cartography and the land survey in Central Europe and in countries such as Italy lead to a certain caution in the conclusions. However, alternative examples can be given as evidence that topographic maps formed part of an overall policy of physical and economic description of territories and that policy was at the service of the public administration's rationalisation and modernisation projects. The cases of England and Portugal are appropriate here.

From the military to the civilian administration: Great Britain and Portugal.

As in the aforementioned cases, the development of topographic cartography in Great Britain is tied, in its origins, to a military institution.

29. Wheeler, 1885.
31. For the beginnings of Italian topographic cartography see Signori, 1867.
32. Wheeler, 1885.
However, important differences exist between British cartographic policy during the nineteenth century and that outlined thus far. These differences can be summed up in two key aspects: firstly, the efficient coordination of the topographic-cadastral operations into a single cartographic organisation, and secondly, an early attribution of cartographic responsibilities to the civilian administration.

The responsibility for cartographic surveys in Great Britain fell to the Ordnance Survey, an organization of military character set up by George III in 1791 and dependent on Board of Ordnance, an English civil institution with medieval roots. The military engineers of the Ordnance Survey established the geographic grid and drew up a complex cartographic design that included the combined survey of three large scale maps: the Topographic Map of Great Britain at a scale of 1:83,630 (one inch per mile), the County Maps at scale 1:10,560 (six inches to the mile) and the cadastral maps, also known as Parish Maps at scale of 1:2,500. We are given an idea of the scope of this cartographic operation by the fact that the cadastral map was made up of 63,000 sheets.

In 1800 the body known as the Royal Military Surveyors and Draftsmen was created and financed by the Ordnance Survey. This military organism, created to carry out cartographical work, was disbanded in 1817. The same thing almost happened to the Ordnance Survey during the Napoleonic wars because it was closed due to the conflict of cartographic powers within the Army. Once the war was finished the Ordnance Survey grew constantly because of its positive answers to the cartographic needs of the dynamic British society. Thus, between 1826 and 1845 the Geologic Service was integrated into the Ordnance Survey, and during those years the Irish Topographic Map of six inches to mile was surveyed. At the same time the geodesic survey of Scotland was finished.

Later, in 1849, the Superintendent of the Ordnance Survey, Lewis A. Hall, drew attention to the need for a larger scale map for cadastral survey and transport planning. His opinions opened what is known as the «dispute of scales», that to a great extent symbolized the struggle for the topographical cadastral. Thus, in 1857 the House of Commons forbade surveys for maps of 25 inches per mile. Meanwhile, a campaign of the new Superintendent, Henry James, succeeded, and in 1863 the Treasury approved the survey of the South of England at a scale of 1:2,500. The end of the «dispute of scales» arrived with the endorsement of the Land Registry Act in 1862, and with the creation of the Land Registry the same year.

The Board of Ordnance was abolished in 1855 after the Crimean War and the reorganization of the Army. Its duties were transferred to the War Office. The aim was to join together under the same authority all the cartographic offices of the Army: the Dépôt of Military knowledge, the Topographical Office and the Ordnance Survey. As a result, the Topographical and Statistical Department of the War Office was created, and was commanded by the Superintendent of the Ordnance Survey. Nevertheless, the militarization of the Ordnance Survey was not an easy task, because of its close relations with the civil society and because of its substantial budget. In fact, in 1870 a reorganization of the British Army left the Ordnance Survey in the hands of the Public Works Office.

After 1875, due to the Land Transfer Act, the cadastral survey accelerated. Thus, in 1876 the House of Commons named a special Committee to report on the measures that should be taken «to simplify the title to land, and to facilitate the transfer thereof».

As a result of the new cadastral needs more staff were taken on. In 1885 the Ordnance Survey employed 28 Officers, 2 Warrant Officers, 364 NCOs and Sappers of the Royal Engineers and 2,846 Civilians. The predominance of civil servants, and the subordination of the Ordnance Survey to the Civil Administration, did not stop military employees from being the leaders in cartographic work.

In 1890 the Ordnance Survey was transferred to the Board of Agriculture, which naturally was interested in directing cadastral survey. Criticism of cartographic work set up a new committee, named the Dorton Committee. Its aim was to elaborate a report on the future orientation of the work. The report had great repercussion in the development of British cartography in matters such as engraving, map printing and place-names. The Land Transfer Act of 1897 made Land Registry compulsory. After that year new cartographic operations were carried out, beginning in the London area.

The new cadastral revisions caused serious disagreements between the Ordnance Survey and the Land Registry. In search of an agreement the two institutions and the Treasury decided in 1898 to set up the Survey and Mapping Department inside the Land Registry, Colonel Washington, member of the Ordnance Survey, was named chief of the new department. The removal of the cadastral duties met resistance from the Ordnance Survey. As a result of that opposition the cadastral revision of the Land Registry was incorporated into the maps 1:1,036 published by the Ordnance Survey, known as «Land Registry Series».

Britain’s extraordinary cartographic activity corresponds to a country that was taking the leading role in a rapid process of industrialisation and economic growth. In Portugal the achievements were, logically, more modest, but its cartographic policy also arouses a certain interest. As we can see, the definitive impulse for the Topographic Map of Portugal clearly coincides with a period of economic and political reform, and is a process parallel to the institutionalisation of civil engineering.

The first geodesic operations in Portugal were carried out at the end of the eighteenth century, and were contemporary with the first projects for the production of a land register. Motivation behind the geodesic works came from the artillery officer Sousa Coutinho, who became War Minister in 1788. Sousa Coutinho ordered the formation of a Reconnaissance Commission, directed by the naval officer Francisco de António de Cirera, who in 1793 carried out the measurement of the geographic base of Batel-Montijo, the first base of the proposed geometric Chart of Portugal. A few years later, on June 9, 1801, a royal decree was given for the establishment of the land register. The geographic operations already in progress were to serve as the basis for a geometric land register of property. This decree ordered the appointment of a cosmographer to each region of the kingdom, who would carry out the measurement, description and demarcation of all properties. The war with Spain, in 1801, and later the French occupation of Portugal ruined these plans. In 1803 the geographic operations were suspended and the land register was not even begun.

During the first half of the nineteenth century successive political crises and the scarcity of resources impeded the carrying out of the previous century’s projects. The scarce activity developed was promoted by the Military Archive, which had been set up in 1802 to collect and look after all kind of maps, and by the Royal Engineers Corps, whose organisational rules stem from 1812.

Cartographic plans were directed from the War Ministry, and usually channelled through two commissions; the Geodesic Commission and the Statistical and Land Survey Commission. The Statistical Commission was situated on the premises of the Military Archive and was in charge of statistical studies, the administrative division and the topographic surveys. Between 1820 and 1846 the naval officer Miguel Franzini performed the functions of director of this commission, and later became a member of the Engineering Corps. Franzini was a man with reformist ideas and a liberal background. In the 1840’s he would become Treasury Minister. The Geodesic Commission, for its part, was given responsility for the general triangulation of the country. The geodesic works were directed during many years by Brigadier Pedro Folque, and later by his son Filipe Folque, another soldier and illustrious liberal politician, and who was finally responsible for the surveying of the topographic map. Both commissions lacked adequate resources and suffered numerous ups and downs due to political changes.

In spite of the continuous interruptions in the cartographic works, it is necessary to underline that the basic ideas of enlightened cartographic policy remained, in particular the continued and express link between the geodesic, topographic and cadastral plans. «It is indispensable», wrote Filipe Folque in 1842, «that the Land Register, Topography and Statistics are the three great instruments of the science of government, from these knowledge of facts is derived, which is responsible for true knowledge, and it is therefore the strict obligation of every government that calls itself enlightened, of a government characteristic of the great century in which we live, to establish these methods of government incessantly». One year later, the royal decree that ordered the temporarily suspended triangulation works to begin again, was worded in the following terms: «Her Majesty the Queen, in view of the fact that on the General Triangulation works of the Kingdom depend the Geographic Chart of the Country, indispensable base for the Land Register and Statistics, elements necessary for good administration and public service, and considering the urgent necessity that the same works should be continued with greatest haste in order to achieve a result serving such important ends, has determined that Field Marshal Pedro Folque, Commander General of the Engineers Corps and Doctor Filipe Folque, Major in the same corps, Professor of Astronomy and Geodesy from the Polytechnic School should be newly commissioned with the general triangulation of the Kingdom and other operations necessary for the undertaking of the above mentioned Chart.»

The creation of a new Land Register Commission in 1846, under the control of Antonio José d’Avila, pointed in the same direction. He visited Italy to gain experience in cadastral organisation, and 1847 presented a report in which he defined the land register as an indispensable base for the economic reorganisation of Portugal and the development of agriculture. According to the author of the report, the Portuguese land register should fulfill two basic requirements: 1) it should be a general register, containing a description of property, an inventory of the value of products and land titles; and 2) the cadastral plans should be based on it.

---

40. Barata Pinto, 1985.
41. For the scientific and political trajectory of M.M. Franzini, see Maria de F. Nunes, 1988.
42. For Filipe Folque see Maria C. Pereira da Costa, 1986 & 1987.
43. Núñez de las Cuevas, 1982, p. 76.
the general triangulation of the country, so that the topographic map and
the land register should be simultaneous enterprises.

For political reasons the establishment of the land register in Por-
tugal did not become a reality until the twentieth century. However, the triang-}
gulation grid and the topographic map progressed without setbacks. Pedro
Peckouh died in 1848 and his son Filipe was appointed director of the geo-
desic and topographic works. He drew up the definitive project for the pro-
duction of the Topographic Map of Portugal at a scale of 1:100,000, and the
opportunity to carry it out presented itself in 1852, the year in which the Civil
War ended.

A period of relative political stability and economic expansion be-
gan in the middle of the eighteen hundreds, bringing with it important pol-
itical reforms. One of the first was the creation of the Ministry of Public
Works, Commerce and Industry, made responsible to stimulate the eco-

donomic modernisation of the country. Between 1852 and 1880, 6,000
km of roads and more than 1,200 km of railways were built in Portugal.
Improvement in transport and the modernisation of productive structures
demanded a parallel growth in cartographic projects. Within the new
ministry, with the reformist Fontes Pereira de Melo at its head, a General
Office of Geodesic, Topographic and Cadastral Works was organised
in 1852, with the intention of setting up a coordinated administration of all
cartographic works. Filipe Folque was made head of the General Office,
and decided to begin production of the topographic map immediately.
Operations for the survey of the 1:100,000 chart began in 1853, choos-
ing Bonne’s system of projection and Pulsant’s ellipsoid of reference.
Given the lack of experienced engravers in Portugal, the Polish lithog-
grapher J. Lewicki was contracted in France and made responsible for the
drawing and lithography of the maps. The first 1:100,000 sheet, drawn and
engraved by Lewicki, was published in 1856.

In those years a model of cartographic policy came about which, with
few variations, would last for several decades. Control of operations,
budget and responsibility for these fields, corresponded to a civilian or-
organisation (the General Office of Geodesic Works) and a civilian ministry
(Public Works). The practical execution of the surveys was carried out by
military and naval engineers under the orders of Colonel Filipe Folque.
At the same time, in the sphere of military cartography, the Military Archive
continued in existence, having been reorganised in 1851, as did the cart-
ographic section of the General Staff.

The Royal Engineers Corps’ responsibilities were not limited to
geographic triangulation and the execution of the topographic survey. In


fact, given that no corps of civilian engineers existed in Portugal, the offi-
cers of the Engineers Corps were also made responsible for the administra-
tion of all type of public works, such as the planning of railways
and roads, works at ports and the installation of telegraph lines. This
situation was hardly congruent with the course of capitalist development
that Portugal was following. One reform of the army in 1864 reduced
military prerogatives, removing those army officers of all services apart
from those from the War Ministry. The institutionalisation of civilian engi-

48. See H.G. Mendes, 1981, p. 53. For contemporaneously published infor-
mation about the institute in Spain, see M.M. de Arróio, 1871.
plained if it is borne in mind that the majority of them had been collabor-
ing with Filippe Folque for years in the survey of the topographic map. It 
was also symptomatic of a more general process, however: the demili-
21纳税isation of engineering was done very slowly and the implantation of 
civil engineering was very weak. Between 1864 and 1868, 91 individu-
als entered the Civilian Engineering Corps. Of these, only 20 had been 
trained as civilian engineers, the rest were army or navy officers.

In spite of this weak implantation of civilian engineering, the pro-
gressive loss of prerogatives in military engineering generated notable 
resistance from the armed forces. In 1868 a conservative cabinet led by 
the Marques de Sa da Bandeira, and in which the Bishop of Viseu also 
set, decided to dissolve the Civilian Engineering Corps, its functions and 
their performance passing to military engineers. At the same time they 
permitted General Staff and artillery officers not needed by the armed 
services to be admitted into public works projects. The civilian engineers 
of the corps organized in 1864 were admitted to the Military Engineering 
Corps, with honorary rank. The new corps was fixed at 100 officers, two 
thirds of whom were earmarked for service at the Ministry of Public 
Works.

The liquidation of civilian engineering meant that the General Of-
office of Geographic Works had to be completely reorganised. A decree 
on December 23, 1868 abolished the Geographical Institute, uniting its 
functions and those of the Military Archive in a new creation: the Military 
Topographic Bureau. Later, the bureau took charge of all the geodesic 
and topographic works, along with publication of the Map of Portugal at 
a scale of 1:100,000.

However, this military counter-reform did not last long. Hardly a 
few years later the recently created Military Topographic Bureau was 
dissolved, returning to the old organisation and passing full responsi-

bility for national cartography once again to the Ministry of Public Works. 
The foreword of the decree of December 18, 1869, that abolished the 
Bureau and handed its responsibilities over to a General Office of Geo-
desic, Topographic, Hydrographic and Geological Works of the King-
dom, began significantly stating that «in all the civilized nations of Europe

the chorographic and hydrographic charts, those of topographic land 
parcels and the geodesic works that serve as their base, are considered 
indispensable to the good exercise of public administration.» It concluded 
saying that such works should be carried out under the control of a civil-
ian administration.

Tensions between civilian and military engineering were not 
solved, and in the following decades reforms and counter-reforms of 
engineering continued to be put into practice; however, the organization 
of the geodesic and topographic works remained basically unaltered, and 
the formation of the Topographic Map of Portugal remained within the 
sphere of responsibility of the Ministry of Public Works. The geographic 
triangulation was finished in 1887, and in 1882 the field work for the sur-
vey of the 1:100,000 map was finished. Its publication, in 37 sheets, was 
completed in 1894.

The transference of the cartographic work from the military ad-
administration to the civilian administration was a parallel and almost si-
multaneous process in Great Britain, Britain and Spain. Only a few 
months separated the reorganisation of the Dirección General dos Tra-
balhos Geodesicos in the Ministry of Public Works in Portugal, the trans-
fer of the Ordnance Survey to the equivalent ministry in Great Britain 
and the creation in Spain of the Geographical Institute within the Ministry 
of Development, which provided the definitive impulse for the production 
of the National Topographic Map of Spain.

Besides similar administrative dependence, an identical intention 
was also registered in the three cases: the centralisation and coordination 
of the different surveys, regardless of their scale and use. This identity 
is even more pronounced in the Iberian countries, seeing as cartography, 
statistics and the land register were put together in a single institution. As 
we shall see below, the survey of the topographic map and the organisa-
tion of the cartographic services, was not devoid of tension in Spain.

PART TWO

TELETRITRITORIAL STATISTICS AND THE PRODUCTION 
OF THE MAP OF SPAIN

At the beginning of the eighteenth century the enlightened refor-
mers, who had set in motion ambitious projects for the territorial orga-

sation of the kingdom, such as the establishment of the land register, making the interior customs map uniform or the rationalisation of the administrative divisions of some of its territories, noted the lack of a general map of the peninsula and adjacent islands with concern. To provide a solution to this lack, the Marqués de la Ensenada commissioned the Jesuits Carlos Martínez and Claudio de la Vega to produce a general map of Spain in 1739. These map makers delivered 36 sheets in 1743 that covered a good part of Spanish territory. A few years later, in 1751, the young Spanish scientist and geodesist Jorge Juan, who had closely followed developments in French cartography, proposed a plan to the Marqués de la Ensenada to survey and direct the general map or plan of Spain.

Jorge Juan’s plan did not prosper, but Spanish cartography received an important boost from his geographic concerns and in the second half of the eighteenth century Tomás López and Juan de la Cruz Cano were sent to Paris to receive training in order to produce the map of Spain. The cartographic efforts of both men represented a very important contribution to Spanish cartography, but for different reasons, and the topographic map was still not carried out. At the end of the eighteenth century the project to survey the map of Spain received a new impulse thanks to the winds of reform caused by both enlightened governments and the great development that Spanish hydrographic cartography had experienced since 1780 in the peninsular and American coasts. As a result of this intense hydrographic labour carried out on the scientific expeditions of Malaspina and other Spanish seamen, the Hydrographic Bureau was created in 1797, which would constitute the cartographic centre from which sailors such as José Espinosa y Tello and Felipe Bauzá carried out their plans for the survey of the map of Spain.

It was in 1792, three years after the completion of the map of the Spanish coast, when the sailor José Espinosa y Tello (1767-1816) presented a project in which he proposed that a systematic survey of Spain should be carried out using the human and technical resources produced on the Malaspina expedition. In 1794 Dionisio Alcalá Galiano, also a sailor, wrote to Espinosa y Tello with the aim of carrying out the topographic map of Spain together. The following year Alcalá Galiano was commissioned by Godoy to produce a plan for the production of the map of Spain, although this project did not prosper either. Two years later, in 1796, it seemed that a decisive step had been taken toward the production of the national map when Godoy decided to set up the Cosmographic Engineers Corps, which was given responsibility for the production of the Geometric Chart of the Kingdom, but this geographical body was dissolved in 1804 as a consequence of diverse pressures.

The War of Independence upset the smooth development of all the enlightened reformist projects, but particularly cartographic work. In 1807 the sailor Felipe Bauzá (1764-1834), gave an acceptance speech to the Historical Academy titled El Mapa de España, in which he outlined his labours dedicated to its production. This outstanding constitutionalist sailor was commissioned in 1813 by the Liberals of Cadiz to draw up a new territorial division of Spain, which did not get off the ground. During these difficult years of construction of the Spanish liberal state the reform of territorial division and cartographic development were two sides of the same coin. Both administrative and fiscal reform of territorial divisions constituted a desire held by all liberal reformers, who saw it as an indispensable instrument for good government of the country.

It now became difficult to perform a good territorial division with the deficient cartographic and statistical information available. In 1821, with the liberals once again in power, Felipe Bauzá was appointed director of the Territorial Division Commission and of the Treasury. From this commission and together with José Agustín Larramendi he produced a report proposing the creation of five commissions responsible for carrying out the Geographic Chart of Spain. The main commission would be in Madrid, two commissions would be responsible for the triangulation of the midday zone and western peninsula and the remaining two commissions would carry out reconnaissance work. According to this project outlined by Bauzá, the survey of the Geographic Chart of Spain would cost the state a total of 579,010 copper reals in payment for materials and staff, along with 60,000 more to pay the wage of the project director.

Problems of the institutionalisation of statistics (1853-1861).

If up to 1840 the idea of the National Map was tied to the enlightened reform schemes for territorial division, both symbolized in the Bauzá’s projects, after 1840 they would be increasingly related to the fiscal and administrative necessity of carrying out a cadastral survey. In spite of being different cartographic documents, and that in almost all European countries their survey was done separately and without connections, the carrying out of a cadastral survey which would constitute the fundamental instrument of territorial statistics became one of the most longed-for aspirations of Spanish liberal reformers such as M. Cortina,
Fermin Caballero, F. Coello or L. Figuerola, who believed that topographic, cadastral and statistical maps should form part of a single territorial information enterprise at the service of the public administration. As with France and other European countries, the development of territorial statistics had also been a growing obsession in Spain throughout the eighteenth century. The fiscal needs that came from the implantation of absolutism in Spain led treasury officials and geographers such as Josep Aparici to collaborate in Intendent Patiño’s Land Register of Catalonia in 1715 and to reflect his fiscal knowledge of Catalan territory in his map titled Nueva descripción geográfica del Principado de Cataluña, published in 1720. Following on from this, the La Ensenada’s Land Register for Castile begun in 1749 represented an ambitious effort on the part of the eighteenth century state to avail itself of a good statistical survey of territorial wealth. The same is true of the Planimetría General de Madrid, the most important urban land register of the eighteenth century carried out between 1749 and 1770 for fiscal purposes. It was in the last quarter of the eighteenth century when the efforts of enlightened rulers to provide public administration with good territorial statistics became increasingly stronger. The Censo de la Población de Floridablanca in 1787, the Censo de Frutos y Manufacturas in 1799 or the creation in 1802 of the Statistics Office belonging to the Treasury are a consequence of this enlightened impulse, given that for the enlightened rulers it was not possible to rationalise the administration of the territory without the corresponding statistical knowledge. For their part, the liberal rulers took this up concern for territorial statistics as shown by the formation in 1833 of the Statistical Commission and the work of liberal reformers such as Pascual Madoz or Laureano Figuerola.

Now, in spite of the aforementioned efforts, the lack of statistical information about the territorial wealth of Spain during the nineteenth century was, in the opinion of the historian M. Artoila, one of the most pressing problems faced by the Treasury during this period. With the purpose of remediating this situation, the Minister of the Interior, the progressive Manuel Cortina, signed a royal decree creating a professional commission to carry out a new map of Spain to substitute the maps made by Tomás López, which were now out of date. One month later, on December 20, 1840, the government ordered the purchase of instruments necessary for the rectification of the provincial maps. A few months after the proclamation of this decree, on February 7, 1841, the same Manuel Cortina approved a further royal decree asking the town councils to complete certain statements, designed by Fermin Caballero and known as the matricula catastral or Cadastral Register in which an exact account had to be given of the territorial wealth of their residents. Although the provincial councils sent in the completed information to the government regarding the territorial wealth of its municipalities, this was carried out in a generalized form in order to hide the real available wealth, as recorded by P. Madoz in his Diccionario geográfico-estadístico.

The following year the Treasury Minister Ramon Mª de Calatrava, also with progressive leanings, approved through another royal decree on June 26, 1842 a project for the formation of a general statistics or registers of public wealth, in both capital and income. Specific commissions were set up and experts consulted so that the cadastral registers should reflect territorial, livestock, urban, commercial and industrial wealth. In spite of the effort made, the 1842 cadastral register revealed, according to M. Artoila, «the impossibility of obtaining precise statistics without the aid of numerous independent and paid agents commissioned to carry out or check the declarations».

For his part, in 1843 Fermin Caballero, who was Minister of the Interior in the last of the progressive governments before the moderates took over, issued an order dated September 23 of the same year about the organisation of personnel in the operations and work of the Directive Commission of the Map of Spain, which was completed by a further order on October 30 appointing the members who would compose the board of directors. Scarce references are available about the commission’s activities, but they were certainly paralysed by General Narváez’s arrival in power in May, 1844, which opened a decade of uninterrupted moderate domination.

With reference to the work on the production of territorial statistics, it is necessary to point out that on May 23, 1845 Mon’s Taxation Reform was passed, consecrating the tax assessments as the eighteenth century system of territorial contribution. One year later, in July, 1846, the same Alejandro Mon decided to create a Central Statistical Directive of Wealth, whose objective was the constitution of a property register and the elaboration of a land register, but budgetary shortages meant that the production of a land register did not get beyond the drawing board. If the work for the production of the land register did not prosper, the projects for the survey of the national map fared little better, being characterized during this decade of moderation by the slowing down or stagnation of topographic and cadastral studies. In spite of this atony, on July 12, 1849 one of the moderate governments led by Narváez created the Geological...
Map Commission of Spain, containing a division dedicated specifically to the development of the geographical map.

It was not until the beginning of 1853 under another moderate government when the work to carry out the topographic map effectively got under way. On January 11, 1853 the Ministry of Development set up the Board of Directors of the Geographic Chart of Spain, headed by the General of State Major M. de Monteverd y Betancourt. Nine months later on October 14 the board passed to the control of the Ministry of War, with the Brigadier of Engineers Fernando García de San Pedro taking charge. A few days later, on October 27, he presented a Plan of Operations, which was approved by the Board and which consisted of a survey of the entire country. For this it was necessary to draw up various primary geographic chains, which, following the directions north/south and east/west divided the peninsular territory into quadrilaterals of approximately two degrees in width each, taking as base lines the meridian and parallel of Madrid. Besides these chains, another was to follow the coast line with the objective of determining the perimeter of the peninsula.

At last, on March 23, 1854 six of the eight officers that composed the specialized staff left to begin the field work, while the other two left for abroad to purchase instruments and study the most recent topographic proceedings used by other European countries in the production of their respective geographic maps. One of these officials was the young Captain of Engineers Carlos Ibañez de Ibañez de Iberio (1825-1851), who before leaving for Paris designed an instrument to measure geodesic bases known as the Spanish rule, to be constructed in Paris by the Frenchman Jean Brunner and with which the central base of the Spanish geodesic triangulation was measured in Madrid (Toledo).

Following the triumph of the progressives and the death of Fernando García de San Pedro in July, 1854, various changes were produced in the control of the geographical works. Thus, with the advent of the Progressive Biennium, the Board of Directors of the Geographical Chart came to depend once again on the Ministry of Development. Meanwhile control of work on the map of Spain was put in the hands of the Brigadier of Engineers Joaquín de Loretocha, Marqués de Híjosa de Alava, with which control of the cartographic work was handed to the military engineering corps. The new director made a few alterations to the initial plan, but without changing the substance of the original project.

Few references are available regarding the cartographic work carried out by this commission during the Progressive Biennium. Now, if it is borne in mind that the first nominal census of the population of Spain was made in 1857 and that, although attributed to the Statistical Commission of the Kingdom created in 1856, a result of the active statistical work performed during the Biennium, it is reasonable to suppose that a notable advance in cartographic works must also have been experienced. In October, 1856, with the return to power of Navarrete, new changes were produced in the organisation of the cartographic works for the map. Thus, on November 3, 1856, Navarrete created by royal decree the General Statistical Commission of the Kingdom, which was dependent on his presidency and with which he tried to unify in a single organisation all the statistical, cartographic and cadastral work that had previously been dispersed amongst various ministries.

In fact, this was not the first time that the Spanish administration in the eighteenth century had coordinated and put together the statistical and cartographic work. Here it is necessary to mention the valuable geographical work carried out in Cuba between 1827 and 1857 by the island’s Statistical and Territorial Division Commissions. The decisive participation in this work of men such as the military engineer J.G.J. Valcourt, who not only directed the survey of the Carta Geográfico-topográfica de la Isla de Cuba between 1821 and 1835, but also the elaboration of the Statistical Chart of the Island of Cuba, corresponding to the year 1827 (1829), reveals, on one hand, the geographical ability of the Military Engineering Corps, and on the other hand the close ties of statistics and cartography in the reform of the territorial administration and which stem from enlightened reform. Besides, the fact that both commissions, of statistics and of territorial division, were created in 1844 and 1845 by the then Captain General of Cuba, General O’Donnel, puts the relevance of the Cuban experience into perspective in the development of eighteenth century Spanish cartography and statistics.

From the creation in 1856 of the Statistical Commission, the desire to make a land register available became a growing concern for Spanish politicians in general and liberals in particular. For this reason, the aforementioned royal decree of November 3, 1856 «fixed its intention in the measurement of the territory as the fundamental base to come to know the way territorial property is, its importance, its accumulation...»66. To carry out the cadastral studies a section of the Statistical Commission was set up by Royal Order on February 4, 1857, and made responsible for the survey of cadastral plans. This section, which depended directly on the Ministry of War, was composed of 18 army officers and 36 soldiers, distributed in 9 brigades. The first plan of cadastral operations passed by the Statistical Commission determined that surveys of cadastral plans

---

63. Comisión General de Estadística del Reino, 1860, pp. VII-VIII.
64. Alonso Baquer, 1972, p. 136.
66. Comisión General de Estadística del Reino, 1860, p. XVII.
the first, carried out using the cultivated area system, a brigade composed of two officers surveyed on average a surface of 4,490 hectares, in the second undertaken according to land plot criteria, the surface surveyed by a similar brigade was 2,263 hectares. The development of the Territorial Measurement Law allowed the creation on November 13, 1859 of the Practical School of Assistants dedicated to training the Assistants Corps or topographers responsible for the triangulation, levelling and checking work of the Cadastal Labourers Corps, trained to carry out the detailed land plot work; and the sights carriers or labourers for auxiliary field work. All these bodies constituted the staff of the topographic brigades, which from the mid-1860's onward would actively work in the province of Madrid. However, the lack of qualified personnel and the enormity of the land parcel work to be done made the Statistical Commission sensitive to the numerous private initiatives that had proposed their participation in carrying out the land plot register. The large number of projects presented demonstrates not only the interest awakened in Spanish society, but also the economic scope of the enterprise. One surveyor proposed to perform the cadastral survey for the entire Catalan territories for a price of 6 reals per hectare, while a private firm promised to undertake the cadastral survey for the whole of Spain, in exchange for payment which would be a percentage of the territorial taxation. After the different time limits, November 1, 1861 was decided upon as the closing date for the delivery of the different cadastral trials carried out in the province of Madrid by the fourteen authorized concessions. In José Gómez Pérez's opinion the result obtained from this cadastral work could not have satisfied the administration, as few cadastral surveys were subsequently given to private contractors. During the period between 1853 and 1859, the Managing Commission of the Map of Spain received a net income of 3,027,002 reals. Of this 1,640,000 reals were spent on the purchase of topographic instruments, scientific work and campaign material; 351,051 reals were spent on personnel; and the rest, 1,036,751 reals, was returned when the commission ceased to function at the end of 1859. In September, 1860, and as a consequence of the 1859 Territorial Measurement Law, the resources available for both geodesic and cadastral work were substantially increased to 3,988,000 reals. Of this quantity, 1,720,000 reals were

68. Comisión General de Estadística del Reino, 1860, pp. XVII-XIX.
72. Comisión General de Estadística del Reino, 1860, p. VIII.
invested in the geodesic operations, while the remaining 2,268,000 reals were for the cadastral work.  

In April 1861 O'Donnell created the General Statistical Board, which was also dependent on the President of the Government, and which substituted the old General Statistical Commission. This Board, the embryonic Geographical and Statistical Institute, was organized in two large sections, geographical and statistical, which grouped together five different offices, one of which was the Office of Geodesic Operations, with Ibañez de Ibero as its secretary, and another, the Topographic-Cadastral Operations Division, was entrusted to Coello and was responsible not only for the cadastral work, but also for the tertiary triangulation.

In mid-1861 Coello drew up a set of standing orders for the topographic-cadastral operations, which following various deliberations in the Statistical Board constituted the General Regulations for the Topographic-Cadastral Operations, being approved four years later, on August 5, 1865, by royal decree. This became a basic piece of legislation upon which to survey the land register by parcels, with 218 precise articles about the altimetry of plans or conservation of cadastral documentation. In the theoretical foreword to these regulations, Coello justified the need for the topographic map and land register enterprise, which in the majority of European countries had been contemplated separately, to be the result of a common project in Spain. In this way, according to Coello «the efforts made by all the countries since the beginning of this century to obtain a topographic map of summary exactitude and precision, have been promoted (...) to ensure the permanent defence of the country. For this reason the execution has usually been left to the Ministry of War, just as the Treasury has been commissioned with the production of the land register(...). These two centres have carried out, almost always with absolute independence, both works without mutual assistance and even making a show of ignoring each other, repeating identical operations at great expense, and which have inevitably been done, largely over again, by other ministries (...)».  

The Spanish state, on the other hand, thought Coello, had the opportunity to save effort and resources if the topographic map and the land register were carried out together. In Coello's opinion these projects must not be confined to their military or fiscal limits, but have an additional use for both the good progress of public administration and the development of public works. For this reason, its undertaking would contribute to their not being «few the economies that result in the studies of all types of public works, for which the survey of large areas of land is constantly repeated, and that once the topographic-cadastral plans are concluded, and kept up to date, they may be used over them, being drawn up with greater security and speed».  

A first step toward the coordination of the geodesic and topographic work was the creation on August 11, 1864 of two geodesic-cadastral districts, with one of them headed by Ibañez de Ibero. Later, in 1865, the liberal O'Donnell, who had arrived in power for the third and last time, proceeded to reorganize the General Statistical Board, reducing the directorships of the centre to two: Geographical Operations and General Statistics. The standing orders for the Office of Geographical Operations, approved on August 14 in the same year, foreshadowed the future organisational structure of the Geographical Institute. Thus, the following organisations and sections were grouped beneath this office: the geodesic-cadastral districts, the Special School of Geographical Operations, the facultative archive and the consulting library; the calculations department; the cartographic section; the planimetry section; the lithography section; the photography section; the instruments section; the storage of material; the workshop for the construction and repair of instruments and the register of proceedings.  

For the first time both the geodesic and the topographic-cadastral work came to depend on a single management under the control of Coello. In 1866 the topographic-cadastral operations continued at a steady pace and had covered almost all the municipalities of the province of Madrid, reaching as far as the provinces of Guadalajara, Cuenca and Toledo. The comparison of the results obtained in 1866 with those expressed in the tax assessment: the only fiscal document then available displayed a degree of concealment of territorial wealth higher than 47%.

But in July, 1866 the return to power for the last time of General Narváez produced a sharp turn from the cartographic policy designed by the liberals. Through a royal decree of July 31 in the same year Narváez proceeded to break up the Office of Geographical Operations. At the same time Narváez abolished all payment to facultative officials involved in both cartographic projects, reducing to three the number of topographic-cadastral brigades. Besides, the budgets set aside for the geodesic and topographic work, which had already suffered a significant reduction in 1865 under O’Donnell’s presidency to 2,054,189, received an even more drastic reduction.

74. Royal decree of August 5, 1865 on the General Regulations of the Topographic-Cadastral operations, Gaceta de Madrid, Madrid, August 11, 1865, nº 223, p. 2.  
75. Ibidem, p. 5.  
76. Dirección General de Operaciones Geográficas, 1865, p. 5.  
A few weeks later, Narváez put the production of the map of Spain in the hands of the Military Topographic Bureau. With this responsibility for the map fell exclusively to the General Staff and the Ministry of War, excluding the civil administration and military engineers such as Coello and Báez de Ibero.

One of the first consequences of the militarisation of the cartographic tasks imposed by Narváez was the dissolution of the Special School for Geographical Work created by Coello for the training of the Topographers Corps. For M. Alonso Baquer the reason that would explain Narváez’s decision to put the General Staff in charge of production of the map of Spain lay in the great cartographic success enjoyed by this military body in production of the Military Itinerary Map 1: 500 000 (80).

Now, apart from the cartographic capacity of the officers of the General Staff, who as has already been mentioned, were those responsible for carrying out cartographic surveys in most of Europe, there existed other factors that determined Narváez’s decision.

In the first place, it is necessary to reiterate the decided opposition of the bourgeoisie to the elaboration of any type of strict statistic regarding territorial wealth. In the words of the historian Miguel Artola «the carrying out of the Land Register was fought during the entire century with insupportable doctrinal arguments and ruined by not renewing budgetary allocations and the transfer of officials destined to this work.»

For their part, M. Tatjer and M. Lépez Guallar have pointed out that «the big contributors were also interested in the execution of the land register not becoming a reality, as the system of tax assessment basically carried out by the town councils favoured their interests, especially in the cases of certain buyers of state property that were not well measured.»

Besides, to understand Narváez’s decision to undo Coello’s cartographic project one must also bear in mind the close relations between the moderates and the land owning oligarchy, as well as the public knowledge, thanks to the cartographic-cadastral work directed by Coello, of the scandalous percentage of concealment of territorial wealth.

In second place, the decision adopted by Narváez to assign the Map of Spain enterprise to the General Staff demonstrates the strong latent tensions between the different professional bodies of the armed forces for control of the project. These tensions almost certainly originated from the formation of the Managing Commission of the Map of Spain in 1853, as although in principle the presidency of the organisation was in the hands of the General Staff, it would soon be military engineers

82. Lépez & Tatjer, 1985, p. 461.

### TABLE II

<table>
<thead>
<tr>
<th>Year</th>
<th>Geodesic Work</th>
<th>Topographic Work</th>
<th>Engraving &amp; Lithography</th>
<th>Administration of I.G.E.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870-71</td>
<td>871 73.4</td>
<td>0 0.0</td>
<td>170 14.3</td>
<td>145 12.2</td>
<td>1.186 100</td>
</tr>
<tr>
<td>1871-72</td>
<td>871 73.4</td>
<td>0 0.0</td>
<td>170 14.3</td>
<td>145 12.2</td>
<td>1.186 100</td>
</tr>
<tr>
<td>1872-73</td>
<td>3.100 69.5</td>
<td>1.269 28.4</td>
<td>38 0.9</td>
<td>55 1.2</td>
<td>4.462 100</td>
</tr>
<tr>
<td>1873-74</td>
<td>3.100 69.5</td>
<td>1.269 28.4</td>
<td>38 0.9</td>
<td>55 1.2</td>
<td>4.462 100</td>
</tr>
<tr>
<td>1874-75</td>
<td>293 17.7</td>
<td>1.285 77.5</td>
<td>38 2.3</td>
<td>43 2.5</td>
<td>1.660 100</td>
</tr>
<tr>
<td>1875-76</td>
<td>293 17.7</td>
<td>1.285 77.5</td>
<td>38 2.3</td>
<td>43 2.5</td>
<td>1.660 100</td>
</tr>
<tr>
<td>1876-77</td>
<td>293 17.7</td>
<td>1.285 77.5</td>
<td>38 2.3</td>
<td>43 2.5</td>
<td>1.660 100</td>
</tr>
<tr>
<td>1877-78</td>
<td>291 17.7</td>
<td>1.273 77.5</td>
<td>38 2.3</td>
<td>43 2.5</td>
<td>1.660 100</td>
</tr>
<tr>
<td>1878-79</td>
<td>284 17.5</td>
<td>1.270 76.1</td>
<td>32 2.0</td>
<td>39 2.4</td>
<td>1.625 100</td>
</tr>
<tr>
<td>1879-80</td>
<td>284 17.5</td>
<td>1.270 76.1</td>
<td>32 2.0</td>
<td>39 2.4</td>
<td>1.625 100</td>
</tr>
<tr>
<td>1880-81</td>
<td>284 16.4</td>
<td>1.329 76.6</td>
<td>56 3.2</td>
<td>66 3.6</td>
<td>1.735 100</td>
</tr>
<tr>
<td>1881-82</td>
<td>284 16.3</td>
<td>1.340 76.7</td>
<td>56 3.2</td>
<td>66 3.6</td>
<td>1.745 100</td>
</tr>
<tr>
<td>1882-83</td>
<td>284 16.2</td>
<td>1.351 76.8</td>
<td>56 3.2</td>
<td>66 3.6</td>
<td>1.755 100</td>
</tr>
<tr>
<td>1883-84</td>
<td>286 16.2</td>
<td>1.351 76.8</td>
<td>56 3.2</td>
<td>66 3.6</td>
<td>1.755 100</td>
</tr>
<tr>
<td>1884-85</td>
<td>286 16.2</td>
<td>1.351 76.8</td>
<td>56 3.2</td>
<td>66 3.6</td>
<td>1.755 100</td>
</tr>
<tr>
<td>1885-86</td>
<td>274 15.7</td>
<td>1.352 77.3</td>
<td>54 3.1</td>
<td>68 3.9</td>
<td>1.748 100</td>
</tr>
<tr>
<td>1886-87</td>
<td>274 15.7</td>
<td>1.352 77.3</td>
<td>54 3.1</td>
<td>68 3.9</td>
<td>1.748 100</td>
</tr>
<tr>
<td>1887-88</td>
<td>282 15.7</td>
<td>1.376 76.7</td>
<td>71 3.9</td>
<td>66 3.7</td>
<td>1.795 100</td>
</tr>
<tr>
<td>1888-89</td>
<td>244 23.7</td>
<td>0.569 55.3</td>
<td>132 12.6</td>
<td>64 8.2</td>
<td>1.029 100</td>
</tr>
<tr>
<td>1889-90</td>
<td>244 23.7</td>
<td>0.569 55.3</td>
<td>132 12.6</td>
<td>64 8.2</td>
<td>1.029 100</td>
</tr>
<tr>
<td>1890-91</td>
<td>225 15.6</td>
<td>1.090 76.8</td>
<td>33 2.3</td>
<td>90 6.3</td>
<td>1.438 100</td>
</tr>
<tr>
<td>1891-92</td>
<td>225 15.6</td>
<td>1.090 76.8</td>
<td>33 2.3</td>
<td>90 6.3</td>
<td>1.438 100</td>
</tr>
<tr>
<td>1892-93</td>
<td>224 15.5</td>
<td>1.111 76.7</td>
<td>39 2.7</td>
<td>75 5.1</td>
<td>1.449 100</td>
</tr>
<tr>
<td>1893-94</td>
<td>212 15.1</td>
<td>1.082 77.2</td>
<td>33 2.4</td>
<td>75 5.3</td>
<td>1.402 100</td>
</tr>
<tr>
<td>1894-95</td>
<td>212 15.1</td>
<td>1.082 77.2</td>
<td>33 2.4</td>
<td>72 5.3</td>
<td>1.399 100</td>
</tr>
<tr>
<td>1895-96</td>
<td>212 15.1</td>
<td>1.082 77.2</td>
<td>33 2.4</td>
<td>72 5.3</td>
<td>1.399 100</td>
</tr>
<tr>
<td>1896-97</td>
<td>215 15.8</td>
<td>1.082 79.5</td>
<td>33 2.4</td>
<td>32 2.3</td>
<td>1.302 100</td>
</tr>
<tr>
<td>1897-98</td>
<td>215 15.8</td>
<td>1.082 79.5</td>
<td>33 2.4</td>
<td>32 2.3</td>
<td>1.302 100</td>
</tr>
<tr>
<td>1898-99</td>
<td>214 15.8</td>
<td>1.073 79.4</td>
<td>50 3.7</td>
<td>15 1.1</td>
<td>1.352 100</td>
</tr>
</tbody>
</table>

Total: 14,376 28.8 31,923 64.0 1,671 3.4 1,898 3.8 49,868 100

Source: Torres Muñoz, 1902
who took over effective control of the geodesic work, whether in the drawing up of the primary geographic grid or making important contributions to the survey of the grid.

Bearing in mind the fundamental contribution made until now by military engineers (García de San Pedro, Coello or Ibañez de Ibero) to cartographic work, the decision of Narváez to exclude them from the survey of the map of Spain has to be explained by both the professional antagonism that existed between both armed forces bodies, and the mistrust that Narváez felt toward the military engineers, who were more committed to liberal reform. In this respect it must also be borne in mind not only that Narváez enjoyed a close relation with the General Staff, but also the overall relation of this body with modernism.

In third place, the measures adopted by Narváez supposed a new fluctuation in the struggle going on between the Ministry of Public Works and the Ministry of War for control of the cartographic enterprise. In fact, behind this constant battle over the civilian or military nature of the map scheme were hidden two models set out since the middle of the previous century to survey the map of Spain. On one side was the liberal reformist and progressive project designed by geographers such as Coello, in which the topographic map and cadastral survey would make up a common civilian enterprise, defended by military personnel. On the other side was the moderate project defended by military staff such as Narváez, in which the map of Spain and the land register would constitute two separate enterprises, with the General Staff in charge of the topographic map.

In general, a close relation was established between the Military Engineering Corps and the civilian cartographic policy of the liberal and progressive reformers. Meanwhile, close ties can also be discerned between the General Staff and military cartographic policy defended by moderate politicians. The constant swing during the 1850’s and 1860’s between institutions and professional bodies commissioned to survey the map of Spain reveals the strong economic and corporate interests behind the scheme. Besides, both the fact that the Statistical Commission and its successor, the Statistical Board, should depend directly on the presidency of the government, as well as that cartographic legislation should be an authentic form of the nineteenth century political activity reveals that the Map of Spain project was a fundamental objective for the Spanish governments of the previous century, who in assuming and leaving the presidency did not forget to take with them various files full of decrees of a cartographic nature.

The creation of the Geographic Institute.

The decree dissolving the Office of Geographical Operations managed to disorganise and paralyse the work set in motion by Coello.

However, the advent of the progressive September revolution of 1868 opened a new chapter of cartographic and cadastral activity.

From 1868 the undertaking of the land register became one of the progressive claims debated in the Cortes, or parliament. One result of this new reformist period was the presentation of various projects to carry out the cadastral survey. Thus, in 1869 Count Nils de Barck presented a memorandum to the Constitutional Parliament in which he proposed to carry out the cadastral survey by a process known as the perimeter system, which had proved to be impossible with Geographic triangulation. Its procedure was the object of harsh criticism from topographers, and its practical application did not prosper. In his explanatory report Count Nils de Barck strongly criticized the project designed by Coello to perform the cadastral survey by parcelling, as in his opinion Coello had wanted to make a cadastral monument, yet an unfinished one; because not only has he wanted to tie the cadastral operations to the great geographical triangulation operations of the peninsula, but has also wanted to complicate with topographic details the measurement of the country’s surface while at the same time its projection and relief.

Another more interesting project was that presented to the government in 1869 by Colonel of the General Staff Joaquín Pérez de Rozas, who was one of the fourteen private contractors commissioned to do the cadastral survey for the province of Madrid. This officer, who had presented a proposal for a land register by cultivated areas, believed that the problems of measurement constituted an authentic obstacle for the carrying out of a land register, and to overcome such an inconvenience he tried to find a system of measurement that was both brief and economical. With the objective of verifying the topographic advantages of his system, on August 31, 1869 the government appointed a commission composed of armed forces officers and civilian engineers with the objective of producing a report. One year later, on July 7, 1870 the General Statistical Directive rejected Pérez de Rozas’ system for a land register survey.

In July 1869 the progressive government of General Francisco Serrano created the General Statistical Office, which came to substitute the defunct Statistical Board. The progressives doubled the budget for the Office and handed over the geodesic operations to it, which since 1866 had been under the control of the Military Topographic Bureau.

From this moment onward the Statistical Office would take charge of the work involved in the Map of Spain project, with Ibañez de Ibero in charge.
of the Topographic-Cadastral Operations Section. In a memorandum sent by the Office to General Prim's government, it stated that «it is of absolute necessity that the geodesic and the topographic-plot work should be united and performed in unison (...). In trying to produce the geographic chart of a country and determine the fundamental and fixed data of the land register, those operations must be tied together, not only through technical demands, but also for reasons of economy and essential rules of organisation».

The organisation of the statistical and cartographic work underwent an important renovation when the Geographical Institute was founded by decree on September 12, 1870, as a civilian organisation dependent on the Ministry of Public Works. Its creation was patronized, according to Eduardo Saavedra, by the liberal economist and Treasury Minister Laureano Figuerola, who, aware of the failed efforts made to discover the territorial wealth of Spain, decided that the only way to get an approximate knowledge of this was through correct measurement of the national territory. However, the mathematician and then Minister of Public Works (Fomento) José Echegaray and President of General Prim's government also definitively contributed to its foundation. In the opinion of M. Alonso Baquer, Prim was interested in separating the General Staff from control of the map of Spain, not only because this body had been associated with Navarrete, but also through opposition to the French General Staff formula that he had known in Mexico. Whatever the reasons that motivated General Prim to take his decision, it represented the negation of the decision taken four years earlier by General Navarrete and reflected the lack of trust that liberals and progressives felt toward the General Staff.

In putting forward this decree José Echegaray indicated the necessity of separating the statistical and geographic work into two different organisations. In this fashion, the initial creation of the Geographical Institute responded to the necessity of providing the topographical and land register work with an organisational unity and autonomy and to avoid external interference in its development. The new Geographical Institute, with Ibañez de Ibero at its head, came to depend on the remodelled General Statistical Office, beneath whose control the statistical and census work was also placed. In principle the jobs with which the Geographical Institute were commissionned, expressed in article 5 of the decree, were «the determination of the shape and dimensions of the land; geographic triangulations of various degrees; precise levellings; topographic triangulation; topography of the map and the land register and determination and conservation of the international types of weights and measures».

Moreover, the aforementioned decree also took up Coello's idea about the necessary coordination between the carrying out of the map and the cadastral survey. In the same decree Echegaray set up the Topographers Corps, then composed of 10 chiefs, 89 officers and 179 topographers of various levels. In another decree signed a few days later on September 27, Echegaray approved the standing orders of the Geographic Institute, which determined the sections into which the institution would be divided, along with the functions and responsibilities of the different technical bodies that composed it. For its operation the Institute would be organized into the following five sections: geodesic work; topographic work; publication of the map; metrological work and accounts.

Each of these sections was managed and controlled by the different technical bodies that made up the Institute. Thus the specific regulation that the primary geographic grid was the exclusive responsibility of artillery officers, military engineers and the General Staff. In order to avoid tension between these armed forces corps, it was established that the number of officers «considered necessary will always be divided in equal parts amongst the three bodies, with any vacancies that occur to be filled with individuals from the same corps in which the vacancy was produced, in order that at any time all three shall have equal representation in such an important and honourable scientific service».

For their part, the Topographers Corps would take part in the secondary geographic triangulations, under the inspection of armed forces officers, in topographic triangulation, in the survey of plans for the production of the land register and in cadastral conservation. Meanwhile, the civilian engineers would be responsible for the sections for publication of the map and metrological work, also performing the scientific commissions that the Institute Director considered convenient.

The general plan for topographic triangulation and survey of plans of the Geographical Institute was submitted on September 12, 1870 and approved on September 30. The topographic work that had to be carried out in accordance with this plan consisted of the topographic triangulation of each municipal limit, the survey of boundary plans for the mun...
nicipalities, the production of plans for population groups of more than 10 houses, the levelling operations necessary to represent relief by contours, the production of 1:25 000 scale drafts with all topographic details, and the determination of all areas under cultivation larger than 10 hectares.

A few months after the approval of this plan on March 31, 1871, Ibarz de Ibero published «State of the Work of the Geographical Institute», in which he succinctly detailed the advances produced in the geographic grid and in topography, what remained to be done and the immediate projects that the Institute had to embark upon. According to this report in 1870, when the Geographical Institute was organized, more than half of the verticles of the fundamental chains projected had already been stationed. However, much work still remained. The geographical coordinates had not been established for any of the verticles of the chains, with the exception of the positions corresponding to the astronomical observatories of Madrid and San Fernando. The azimuth directions had not been observed either, nor had the geodesic levelling work begun. Finally, the method to compensate for errors had not been decided upon. In this account Ibarz de Ibero also pointed out that the topographic brigades were actively at work in the provinces of Córdoba and Seville. Meanwhile the publication section of the map was carefully studying the question of the type of projection to use in publishing the map, as well as the different systems of representation and reproduction in series.

One of the tasks handed to the Geographical Institute was that of the metropolitical service, which while intimately related with the development of modern cartography, its importance in the evolution of contemporary science and economics transcends the strictly cartographic limits and reveals the civilian and modernizing character of the territorial administration that the labour of the Geographical Institute encouraged. As with the idea to carry out cadastral survey, the formation of the metric-decimal system was, as we have seen, one of the most important scientific achievements bequeathed by the French Revolution.

The creation of a uniform and universal weights and measures system was a necessity felt by scientists and map makers who had to cope with endless heterogeneous local and regional measures, which complicated both their work and scientific communication. However, the development of the metric-decimal system did not stem from uniquely scientific reasons, in spite of their obvious importance, but also responded to economic and administrative demands in harmony with both the development of capitalism and the modern unitary and uniform state itself. Likewise, one of the most common complaints expressed by the French bourgeoisie in the «Cahiers de Doléances» of 1789 was «the most sincere request to have a single king, a single law, a single weight and a single measure», asking «that there should only exist a single weight and a single measure in the entire territory of the kingdom (as) this would make trade and contact amongst all the kingdom’s subjects easier». If the economic advantages of the metric system appear clear in favouring commercial exchange by creating a unitary economic language, a similar thing happened in relation to the territorial administration.

Here from the point of view of fiscal rationalisation, if one wanted to proceed, as the reformers did, to a simplification of taxation and its more equitable distribution in the different territories of the kingdom it was necessary to substitute the great diversity of local and regional weights and measures for a system of weights and measures that would appraise all citizens by the same standard.

How was it possible to carry out a cadastral survey, a basic piece in this new policy of fiscal fairness, if there was not a single system of measurement for the whole kingdom? Therefore, the development of a unitary system of measurement constituted the cornerstone on which the policy of fiscal and territorial uniformity suggested by physiocrat economists and taken up by eighteenth century liberal reformers was based. From this perspective, the reform of the metric-decimal system and the cadastral survey constituted two complementary projects destined to modernise and make uniform the territorial administration of the state.

Now, if the development of the metropolitical labour received a great impulse with the creation of the Geographical Institute, the same cannot be said of the cadastral work. Although the arrival of the progressives in power theoretically made the activation of cadastral work possible, as reflected in the «Instructions» decreed by the government on February 17, 1869, the same decree that founded the Geographical Institute on September 12, 1870, temporarily suspended work on the land register in article 11. The recently created Topographers Corps, commissioned to carry out the land register, analysed the decree with moderate optimism in its mouthpiece «Revista del Catastro». Here, the topographer M.M. Arriola wrote in October 1870: «let us begin, because this is what common sense advises, to lay the foundations of the building, and let us build upon these a solid and well arranged frame, and with these elements, it will be easy for us to later cover the work with the Land Register of the nation serving as its crowning, which will provide so many results for the state and the individuals that form it».

93. Instituto Geográfico, 1871, pp. 4-5.
94. Instituto Geográfico, 1871, pp. 1-17.
96. Arriola, 1870, p. 122.
Months later, on March 15, 1871, the outstanding topographer Francisco Valdudzi published in the «Revista Topográfica y Catastral», successor to «Revista del Catastro», an article titled «The Need for a Land Register», in which, in spite of the lack of a plan for cadastral operations, showed optimism toward the topographic labour being performed by the Geographical Institute. This topographer affirmed that the «topographic work today being undertaken in various provinces for the production of the map, is the true advance of a complete survey, whose importance we shall never tire of extolling».

Two months later, on May 15, 1871, another article appeared in the same journal, signed by the topographer M. del Busto and titled «On the Decree of September 12, 1870». It saw the work of the land register becoming a more distant reality, and which would take second place to the carrying out of the topographic map. In this sense he assured that «it is understood that at the moment it is not possible to reach the ideal of our aspirations, which are those of everyone interested in the nation’s prosperity, of the execution of the cadastral survey, a great step toward that end has been taken with the execution of the Map [...]».

Therefore, faced with the political and economic difficulties that hindered the carrying out of the cadastral survey, the option chosen by Ibañez de Ibero was to give priority to the work of the National Topographic Map, relegating the carrying out of the land register to the near future. This option, surely the only one possible for the directors of the Geographical Institute in the face of the strong reticence of the bourgeoisie to survey the land register by parcels, not only sank Coello’s reformist project of carrying out the two projects simultaneously, but also revealed the same incapacity of different progressive governments of the sixties to undertake the production of the cadastral survey for once and for all. To all this it must be added that in the cadastral work begun by the Geographical Institute in 1871, «the cadastral unit would not now be the parcel, but the cultivated area larger than 10 hectares... Neither would this work gather data about the quantity of production, and even less would evaluations be made».

In this way the cadastral survey was put into storage in the hope of better days and was not started on again until 1906, the year in which a royal decree was passed authorising the first phase of the budget for the carrying out of an advance general survey and in a second stage the topographic cadastral survey.

On June 19, 1873 the Republican government headed by Pi i Margall reorganized the Geographical Institute, which from then on would be known as the Geographical and Statistical Institute and would continue to depend on the Ministry of Public Works. With this new organization the statistical work came to depend on a single management and institution, along with the cartography. From that moment on Ibañez de Ibero took charge not only of the cartographic and meteorological work, but also of the statistical work. In this way statistics, that had experienced during the nineteenth century a development parallel to that of cartography and which for liberal reformists like Fernán Caballero, Coello or Pascual Madoz together formed part of a common and inseparable project of knowledge of the land and territorial wealth, became one of the principal activities of the Geographical and Statistical Institute. The republican reform nominally created the Statistical Corps, although it did not effectively become organized until the beginning of the Restoration.

The work of Ibañez de Ibero.

The brusque end to the first republican experience and the consequent restoration of the monarchical order affected above all the economy of the Geographical and Statistical Institute as can be seen in Table I. In spite of political ups and downs, Ibañez de Ibero, who in 1875 had achieved the publication of the first sheet of the National Topographic Map corresponding to Madrid and the first volume of «Memorias del Instituto Geográfico», continued to direct the Institute until 1889, managing in his almost twenty years of mandate to give the decisive impulse to the production of the map of Spain. For its part, the Geographical and Statistical Institute, which continued beneath the Ministry of Public Works, was the object in 1877 of new regulations that substituted and completed those elaborated during the republic period.

On April 27, 1877, the Minister of Public Works, the conservative Francisco de B. Queipo de Llano, Count of Torano, approved the new Regulations of the Geographical and Statistical Institute, which would remain in force until 1899. These regulations, made up of 16 different chapters and 118 articles, specified that the objective of the Geographical and Statistical Institute was: the determination of the shape of the land; primary, secondary and tertiary triangulations; precise levelling; topographic triangulations and topographic plans for the production of the Map of Spain; the land register and its preservation; publication of the Map of Spain and other cartographic works; the determination and preservation of new types of metre and kilogram; the production of a census of population and houses; and movement of the population. The re-

97. Valdudzi, 1871, p. 33.
98. Busto, 1871, p. 67.
sponsibilities and functions established by the republican regulations were also maintained.

To carry out the tasks with which it was commissioned the Geographical Institute was divided into ten different departments, five more than in the regulations of its foundation, which demonstrates both a maturing in the process of institutionalisation of geographical work and its growing organisational complexity. For the first time the primary geographic observations were not the exclusive responsibility of armed forces officers, but could also be carried out by civil or mining engineers or forestry experts. In compensation, armed forces officers could perform the tasks relative to the publication of the topographic map and metrological work. The new regulations therefore broke the functional division of labour between the different civilian and military bodies established in the 1870 regulations. Of course, the proportion of officers from the three corps was respected.

Besides, the aforementioned regulations gave life to the Statistical Corps, put in charge of the production of the census of persons and things, population movement and different types of statistics. This corps was made up of heads, statistical officers and assistants, and entrance to the corps was by open examination. Finally, the regulations outlined the responsibilities of the Geodesic Auxiliaries, earmarked to help in the geodesic work, whether as draughtsmen, clerks and calculators, whether as constructors of geodesic signals, in the handling of heliotropes and other services of the field brigades.

If from the organisational and consolidational point of view of Ibañez de Ibero’s geographical project the restoration of the monarchy was positive, from an economic perspective it supposed, as has already been pointed out, a drastic reduction in the budgets assigned to the Geographical Institute. In Table II, relating to the annual budgets destined for the Geographical Institute between 1870 and 1888, it can be seen that the largest budgets, of almost 4.5 million pesetas were assigned during the six democratic years, and especially during the republican period. With the restoration this figure fell to almost a third. Between 1874 and 1889 the budgets assigned were established at around 1.7 million pesetas annually, but in 1889 with the departure of Ibañez de Ibero the budgets started to diminish again until reaching the critical point of a million pesetas. From 1891 onward the budgetary quantities recuperated somewhat, settling at around 1.4 million pesetas, but the economic health of the Geographical Institute and the cartographic project had been wrecked. On the other hand, if a structural reading of the expenditure of the Geographical Institute during this period were carried out, one would see how, almost constantly, the items destined for topographic work took the lion’s share of 64% of the available resources, while the geodesic work represented 28.3%, engraving and lithography 3.4% and management and administration 3.8%.

In spite of the rapid dwindling of economic resources that the new political order meant for the Geographical Institute, the energetic management imposed by Ibañez de Ibero on the geographical work during his period in office soon bore important fruit. Between 1875 and 1889 eight volumes of the «Memorias del Instituto Geográfico» were brought out, which represented a fundamental contribution to Spanish geodesy, topography and metrology in the nineteenth century and in which the advances made in these fields is clearly shown. Moreover, El Censo de la Población en España en 1877 was published in the same year as the formation of the Statistical Corps, which brought up to date the last census taken in 1860, and in 1887 yet another was produced. One year later, in 1888, Ibañez de Ibero published the Noticia geográfica y estadística de España, which with its almost 1,300 pages was the most important representation of nineteenth century knowledge about Spanish territory. Besides, during these years of Ibañez de Ibero’s management of the Geographical Institute, he achieved not only his own international prominence, but also that of the Geographical Institute, becoming President of the International Geodetic Association and the International Weights and Measures Committee.

During the years of his mandate the geodesic and topographic operations experienced considerable advances. Here, the work in relation to precision levelling was started and pursued at a steady pace. Similarly, the work continued to determine latitudes and azimuths, stations being set up in Montalbán, Quintanilla and Javalón (1893), in Faro, Desierto and Matadore (1884), in the Mola de Formentera (1886) and Reducto (1886). Likewise, for the development of the primary geographic grid the bases at Cartagena and Madridejo (1884) were established. Also determined were the differences in geographical longitudes between Madrid and Badajoz, Lérida and Madrid and Lérida and Badajoz (1886). Furthermore, the calculations were made to determine the compensation of the angular errors of the primary geographic grid (1886 and 1888).

The National Topographic Map

The enormous effort made during the years of his presidency did not distract Ibañez de Ibero from his main concern, which was to carry out...

102. Gaceta de Madrid, 1877, n° 119, p. 298.
and publish the National Topographic Map. Between 1875, the year of the appearance of the first sheet corresponding to Madrid, and 1889, 69 sheets were published, the most fruitful period being 1885-1889 with 45 sheets printed, a quantity that it would take thirty years to improve on.

In the general plan for the topographic triangulation and the survey of plans approved on September 30, 1870 it was determined that the publication of the sheets of the Topographic Map should be to a scale of 1: 50,000. The Geographic Institute commissioned the civil engineers Miguel Muruve and Alberto Bosch, of the publication department, with the calculation of the value in metres of the meridian and parallel arc corresponding to each of the sheets making up the map. In principle it was not possible to establish the exact number of sheets that would be needed for the map, as at that time the exact longitudes and latitudes of various points of the outline of Spain were unknown. For this reason the initial project considered that the Topographic Map should be made up of approximately 1,076 sheets, 18 sheets less than the number actually used.

For the representation of relief the contour system was adopted in place of that of hachures adopted for the majority of the European topographic maps. According to Claire Lemoine-Isabeau the first time that the contour system was used in a general fashion was for the 1: 40,000 scale Topographic Map of Belgium, made between 1843 and 1860. In Spain none of the great cartographic works previous to the National Topographic Map had used contours. Domingo Fontán had turned to the technique of hachures in his Geometrical Chart of Galicia (1845), while Francisco Coello, for his part, used configuration curves or sketched curves to give an idea of relief in his provincial maps at a scale of 1: 500,000.

Furthermore, the National Topographic Map constituted the index representing municipal boundaries, a fact demonstrating the desire of the Geographical Institute to be a basic tool of public administration. It was a particularly useful index for this purpose, as even in 1870 Spain lacked an authentic map on a municipal base. An indirect consequence of the municipal demarcations drawn up in the topographical map was, according to Juan Pro Ruiz that «on scientifically measuring municipal boundaries, the overall volume of the lands conceded from the treasury came to light; villages measured at times twice or thrice the sum of the properties declared. The system of fraud tolerated in tax assessment was uncovered.»

From the point of view of cartographic production it must be borne in mind that, in spite of the steady rhythm of work imposed by Ibarz de Ibero, the speed of the topographic work was a function, in a large part, of the scale of the survey. In this way, the decision that the drafts should be made to a scale of 1: 25,000, an habitual practice in the period, conditioned the pace of the topographic operations. Operating at this scale it was taken for granted that an experienced topographer could not cover much more than a square kilometer per day, and less on uneven ground. This simple fact gives an idea of the organisational immensity of the topographic work when it was planned to carry out a survey of half a million square kilometres.

During the decade following the departure of Ibarz de Ibero from the Geographical Institute there was not only a substantial reduction in the budget, but the pace of publication of the Topographic Map also fell. Besides, between 1890 and 1902 the Geographical Institute was headed by four different directors with the consequent organisational imbalance that such changes usually involve. All these events reveal a certain crisis in the cartographic project promoted by Ibarz de Ibero, which was on the point of sinking. An echo of this crisis can be found in the opinion put forward by Vicente López Puigcerver, officer of the General Staff and future director of the Geographical Institute, according to whom: «it cost General Ibarz great disappointment and not a little effort to be able to avoid more than once that they - the cartographic works - be suspended, and his immediate successor, Sr. Armillaga, great pains and work to impede that this scientific Centre be dissolved, as to many and very influential people (…) it seemed almost an extravagance to concede great quantities to a work of such long duration and whose results were not immediate (…) but while it was possible to avoid that catastrophe, he had to resign himself to seeing the budget diminish each year and consequently the work become more and more delayed.»

However, in spite of the strong interests encountered that prolonged the cartographic labour of the Geographical Institute and the economic and organisational difficulties that they had to face, the institutional and scientific contribution made by Ibarz de Ibero was sufficiently solid for the National Topographic Map scheme to press forward. An example of the vitality of the Geographical Institute and its cartographic project was the royal decree of February 15, 1900 which set up the Geographical Engineering Corps and which in 1908 was made up of 108 members, whose principal task was to produce the National Topographic Map.

CONCLUSIONS

Throughout the nineteenth century the majority of European states embarked on the survey of precise topographic maps of their ter-

106. Instituto Geográfico y Estadístico, 1875, Tomo I, p. 951.
110. Cuerpo de Ingenieros Geográficos, 1908, p. 68.
Geographical Institute) would together carry out the topographic map and the cadastral survey. On the other hand, there was the moderate position defended by General Narváez to impose the French model, according to which the cadastral survey and the topographic map would be carried out separately, with the latter being the exclusive responsibility of the General Staff.

For this reason, when in 1870 the progressive politicians decided to create the Geographical Institute as the civilian organisation commissioned with the carrying out of the topographic map and land register, they put such an outstanding military engineer as Ibáñez de Ibero at the head of the enterprise. In this way, the topographic map scheme took on in Spain, with respect to the French model, the double originality in being an eminently civilian project with the prominent positions occupied by military engineers until 1890. And in spite of the different vicissitudes that the cartographic project had to face, both in the creation of the Geographical Institute and the extraordinary labour performed by its director Ibáñez de Ibero, they decisively contributed to the institutionalisation of the tasks related to the National Topographic Map.

Finally, we would like to underline that this process of institutionalisation of the topographical map constitutes a crucial episode in the evolution of geography and cartography in contemporary Spain, due to the fact that its survey and publication allow us to observe the close relations existing between political and economic interests in the development of contemporary map-making. Besides, its carrying out constitutes an indispensable document for understanding the complex relations between the development of large scale cartography and the construction of the modern state.
BIBLIOGRAFÍA


CAPELL, Horacio; SANCHEZ, Joan Eugeni y MONCADA, Omar: De Patala a Minerva. La formación científica y la estructura institucional de los ingenieros militares en el siglo XVIII, Barcelona, Serbal/C.S.I.C., 1988, 390 pp.


IBÁÑEZ DE IBERO, Carlos: «SAAVEDRA, Fray Luis; MONET, Fernando & QUIROGA, Cesáreo: Base central de la triangulación geodésica de España, por ... Publicación de Real Orden, Madrid, Imp. y Est. de M. Hivadeneyra, 1865, VI


LEMOINE-ISAIEAU, Claire: La carte de Belgique et l'Institut Cartographique Militaire (Dépôt de la Guerre), 1900-1914, Bruselas, Musee Royal de l'Armée, 1988, 332 pp.


INDEX

CARTOGRAPHY AND STATE: NATIONAL TOPOGRAPHIC MAPS AND TERRITORIAL STATISTICS IN THE NINETEENTH CENTURY 9

PART ONE. TOPOGRAPHIC MAPS IN NINETEENTH CENTURY EUROPE 11

Topographic cartography as a task of the state 12
A strategic tool: an instrument of government 16
Cartography centralisation projects: the Cadastral survey and the Map of France 19
The maps of the General Staff 24
From the military to the civilian administration:
Great Britain and Portugal 27

PART TWO. TERRITORIAL STATISTICS AND THE PRODUCTION OF THE MAP OF SPAIN 35

Problems of the institutionalisation of statistics (1853-1861) 37
Coello and the General Statistical Board’s project 42
The creation of the Geographic Institute 48
The work of Ibáñez de Ibero 55
The National Topographic Map 57

CONCLUSIONS 59

BIBLIOGRAPHY 62