John Lockerbie wrote in his paper on “Contribution of the Cassinis and Maraldis”¹ that

One of the key facts to bear in mind when looking at the work of the Cassini and Maraldi families in France – in fact, for all scientists working in France in the seventeenth and eighteenth centuries – is that their activities took place within a relatively small physical area, Paris, and within a privileged socio-cultural environment. Perhaps not so clearly understood is the extent to which this reflected the state of France at that time.

But Europe was, until relatively recently, an area in which there was considerable diversity in many of these aspects, as well as extraordinary inequalities in the distribution of its wealth. France, like many of its neighbours, was neither a coherent political nor cultural entity and the wars of the next few centuries would continue to define and redefine its borders in response to the aspirations of a number of individuals, particularly those boundaries to the east. While it is possible to follow the movement of these borders historically as discrete countries were created, fluctuated and established, development within the country we now know as France is not so easy to follow.

In fact, in the seventeenth and eighteenth centuries, not only would the majority of the population not have understood the concept of France, they did not even speak French. France was, in essence, Paris and its immediate surrounding area where the court was based, and it was mainly here that French was spoken and, to a lesser extent, written and read. The rest of France was populated, but by people with a wide variety of histories, speaking a miscellany of languages and dialects, living in relatively small cultural and economic units, and who mostly moved never more than half a day’s walk from their home, though there were some exceptions associated with seasonal movements for work and transhumance.

Because of this lack of movement and the loose pattern of settlement, there was little in the way of formal roads. The circulation system was fine-grained, poorly defined and changed with season. Those who moved through the countryside would see very few people on their journeys. Towns, such as they were, closed their gates at night and maintained border and customs posts outside them, as there were at the borders of most political entities, large and small. One of the consequences of this was that everybody feared strangers as they represented potential threats to their income, way of life or even life itself.

Beliefs were primitive and even those who were educated and came from outside the communities as teachers, doctors or ministers, had to accommodate and adapt to the local systems, learning to speak the local languages and unable to operate without local acceptance. Strangers were suspected of all kinds of things. One of Jacques Cassini’s young geometers was set upon in Les Estables, a commune in the Haute-

¹ Contribution of the Cassinis and Maraldis

© 1995 – 2019 The Napoleon Series
Loire region of France, and killed because the locals feared for the strange instruments of his trade he was carrying. All over France, the structures established by the geometers from which to triangulate their mapping, were destroyed both in order to furnish building material as well as in fear of their magical significance, the latter a characteristic commonly thought imbued in many natural features.

Against this background, it slowly became apparent that maps were indeed necessary both in order to improve knowledge of the State and, with it, a rational taxation base, as well as for military purposes.

Taxation was universally hated and, in most of the country, was resisted both by evasion as well as by the development of extensive smuggling systems, some of them extremely clever in concept and effective in execution. Barter formed the natural exchange mechanism for both goods and services, creating little money to pay to the demands of the Revenue authorities, their responses often being cruel, socially divisive and ineffective.

At the same time it was becoming increasingly obvious that there were improvements needed if armies were to operate more effectively. The lack of accurate information was a continuing constraint on their success. It was common for them to fail in their endeavours due to a lack of understanding of the terrain and the ways this affected the planning of their routes of march, tactics and opportunities. Accurate mapping was an obvious solution to many of their problems.

Although there was a small amount of two-dimensional mapping carried out, mostly as records by those who owned land, there was no national understanding of the way in which the communities linked due, in most part, to the difficulty described above in moving around the country. Strangely, many of the natural features of the country were not named, even by those who lived near them. In the middle of the eighteenth century there were over eight hundred different measures operating round France, there being centuries of resistance by nobility to royalty’s attempts to standardise them. (see following for details)

This, then, was the setting in which Cassini began the process of assembling teams of geometers, designing their instrumentation and rationalising recording, that was to lead to the first accurate map of France.

Whilst this describes the social context within France, it was almost certainly also the situation in the lands of the Holy Roman Empire, ruled from Vienna, as well as Spain, the highlands of Scotland and Ireland.

The Definition of a League

According to the website Lieue a league is a unit of length formerly used in Europe. The land League has as origin the distance that can be travelled by a man on foot in an hour. In France under the Ancien Régime there were many definitions of the League / lieue as unit of measurement:

- l’ancienne lieue de Paris (before 1674) 10,000 paces = 3,248 km
- la (nouvelle) lieue de Paris (1674-1793) 2,000 toises = 3,898 km
- la lieue des Postes (1737-1793) 2,200 toises = 4,288 km
- la lieue tarifaire (1737-1793) 2,400 toises = 4,678 km

© 1995 – 2019 The Napoleon Series
According to the Grand vocabulaire français of 1768, other leagues have been in use in France before the French Revolution.

The common leagues of France are 2,282 toises & 25 degree, plus 15 toises; The leagues of Paris, Sologne, Touraine, of 2,000 toises, are 28 ¼ per degree; The leagues of Beauce and Gâtinais, contain 1,700 toises, & are 34 per degree; The leagues of Bretagne and Anjou include 2300 toises, & are 24 ¾ per degree; The leagues of Normandy and Champagne, are 25 per degree; The leagues of Picardy contain 2250 toises, & are 25 per degree, plus 810 toises; The leagues of Artois are 28 per degree; The leagues of Maine, Perche and Poitou, are 24 per degree; The leagues of Berry are 26 per degree less an eleventh; Bourbonnais leagues are 23 per degree; The leagues of the Lyonnais contain 2,450 toises, & are 23 per degree, plus 710 toises; The leagues of Burgundy are 21½ per degree; The leagues of Biscay & Provence contain 3,000 toises, & are 19 per degree.

In Anglo-Saxon countries, the English League is defined as being 3 Imperial miles, thus exactly 4.828 km. Before the revolution, this League was also used in the province of Bretagne.

According to the website French Cartography

In France, the first general maps of the territory using a measuring apparatus were made by the Cassini family during the 18th century on a scale of 1:86,400 (one centimeter on the chart corresponds to approximately 864 meters on the ground). These maps were, for their time, a technical innovation. They were the first maps based on geodetic triangulation, and took more than fifty years to complete; four generations of the Cassini family were involved in their production.²

The work of the Cassinis left its mark on the world; toponyms known as ‘Cassini signs’ still exist, revealing where triangulated measurements at that time were made. The "map of Cassini" or "map of the Academy" is the first general map of the kingdom of France, later known as the ‘Map of Cassini’. It was drawn up by the Cassini family—primarily César-François Cassini de Thury (Cassini III) and his son Jean-Domenique Cassini (Cassini IV)—during the 18th century. The adopted scale is one line to 100 toises, or 1:86,400 (the measuring apparatus contained 864 lines). The map does not pinpoint dwellings or the boundaries of marshes and forests; however, the level of precision of the road networks is such that satellite photographs correspond almost completely with drawn roads more than 200 years later.

² The members of the Cassini dynasty are described in French Mapmakers – the Cassinis and Maraldis

© 1995 – 2019 The Napoleon Series
Introduction

According to Kenneth Field

Mapping entire countries is not for the faint-hearted. The scientific survey based on the triangulation of France was begun by Cassini I after he moved there in 1669. By 1678 the Paris region had been mapped at a scale of 1:86,400. Various wars and other campaigns meant that surveying the remainder of France didn’t truly get going until 1733 when Cassini (strictly, Cassini III) recommenced the work. Before the surveys, it was necessary to carry out a triangulation of the territory.³

The plan for the triangulation survey is shown clearly in the *Nouvelle carte qui comprend les principaux triangles*... published in 1744 by his son, Cesar-Francois Cassini (Cassini III) and Giovanni Domenico Maraldi.⁴

However it required further surveys to fill in the map with topographic detail.⁵

Purpose :

- To measure distances by triangulation, ensuring the exact positioning of locations
- To measure the kingdom, determining the number of boroughs, cities and villages
- To depict unchanging landscape features

The new topographic map series, also at a scale of 1:86,400 began in 1748. It encompassed an 18-year plan with 10 maps to be published per year. The first two maps in the series took 8 years to be prepared yet they became the first properly surveyed, planimetrically accurate maps of a country.⁶ A copy can be seen at: *Nouvelle carte qui comprend les principaux triangles*... published in 1744

Survey Maps

The website French Cartography states

The surveys were carried out between 1756 and 1789 and the 181 sheets composing the map were published from 1756 to 1815. César-François Cassini died in 1784 with his work unfinished. His son, Jean-Domenique Cassini (1748–1845), later finished the work of his father.

The departments of Savoy, Haute-Savoie and part of the Maritime Alps were not part of the Kingdom of France at the time, and are not represented on the map; neither are the Île d’Yeu and Corsica. Most of the map sheets were published as a new edition in 1815.

---

³ MapCarte 318/365: Cassini Carte de France by César-François Cassini de Thury, 1788
⁴ Referred to as Maraldi II, he was born at Perinaldo, Liguria (at that time in the county of Nice), Maraldi came to Paris in 1727 and became a member of the French Academy of Sciences in 1731. There, while observing Comet De Chéseaux with Jacques Cassini (Cassini II) in 1746, he discovered two "nebulous stars", which later turned out to be globular clusters M15 and M2. Giovanni worked with his cousin, Cassini de Thury – Cassini III – between 1732 and 1740 on establishing the boundaries of France and producing the ‘Cassini map’ of 181 sheets. Maraldi retired to Perinaldo, Italy in 1772
⁵ French Cartography
⁶ MapCarte 318/365: Cassini Carte de France by César-François Cassini de Thury, 1788

© 1995 – 2019 The Napoleon Series
Kenneth Field points out that “The level of detail was astonishing for the time and out-shone previous cartographic efforts by other European map-making dynasties. These maps immediately elevated France to the pinnacle of European cartographic excellence.”

**Replacement by Napoleon I**

French Cartography shows that

In 1808, Napoleon I decided to establish a map intended to replace that of Cassini; however during the empire, geographical engineers who were attributed to it had to achieve more precise work and first create maps of battlefields.

The implementation of this new map can begin with the first work from a triangulation supported on the meridian; one from Delambre and Méchain. Work of this map was spread out between 1817 and 1866, by testing several different scales. It was a map for the use of the soldiers: Geological Survey map, on the scale 1:80,000. This Geological Survey map was raised and drawn by the Dépôt de Guerre, which then become the Geographical Service of the army*, and was replaced later by the Institut Géographique National (IGN).

Maps to the 1:80,000 generally appeared as a mosaic of squared paper stuck on a fabric, itself folded and protected by a hard-binding; it could thus support the constraints of campaigning by the military.

In January 1809 Napoleon established the Corps of Ingénieurs Géographes Militaires

In 1806 the following book was published in Paris by Chex Magimel, Libraire pour l’Art militaire, quai des Augustins, No 61

**Eléments de topographie militaire**, ou instruction détaillée sur la manière de lever à vue et de dessiner avec promptitude les cartes militaires. Par J.E.G. Hayne Ingénieur au service de la Prusse. Traduit de l’Allemande par un officier au corps impérial du Génie de France

J. C. G. Hayne was a Prussian engineer-lieutenant who lived in Berlin and Potsdam and served as an engineer in the Prussian army. He is also known with the wrong initials J. E. G. Hayne / Henye. He wrote some books on historic and military topics. He died in 1790 at Potsdam.

**Cassini Maps**

Jean-Baptiste Colbert, a protégé of Cardinal Mazarin, fed King Louis XIV’s animosity to the increasingly powerful and corrupt Nicolas Fouquet and was, in 1661, appointed Minister of Finance in his place by the King to begin the process of administrative reform, economic consolidation and reorganisation necessary for managing France.

Colbert, the son of a draper from Reims, was an unpopular figure but oversaw considerable change, beneficial to France. He occupied a series of important positions of State and, under his patronage, a number of key organisations were instituted and

7 Ibid

© 1995 – 2019 The Napoleon Series
initiatives begun. Among them Colbert founded the *Académie des sciences* in 1666 and, in 1667, l’Observatoire de Paris.

The Abbé Picard, Prior of Rillé in Anjou was the successor to Gassendi in the Chair of Astronomy at the College de France. He recommended Giovanni Domenico Cassini to Colbert as the potential head of the Observatory and, in 1668, Colbert invited Cassini to Paris. Pope Clement IX, for whom Cassini was working at the time, agreed – perhaps hesitantly – to lend Cassini, who arrived in Paris on the 4th April 1669 to begin work.⁹

**The introduction of Cassini to France**

The maps of France at that time were uncoordinated and often inaccurate. At the first meeting of the Académie it was decided that the maps of France should be improved using the method of triangulation first introduced by Tycho Brahe and later developed in Holland and England. The Académie led the work which resulted in the publication, in 1678, of a map – in nine sheets of three by three array – of Paris and its surrounding area. This is a part of the central sheet.

The use of the principle of triangulation was an important innovation in that it brought greater accuracy in the surveying of land through the inherent characteristic of the triangle not to distort. But this accuracy was also dependent upon the quality of the surveying instruments measuring the distance and angles between measuring stations.

A copy of the 1744 Cassini map showing all the triangulations is available at the [David Rumsey Map Collection](https://www.davidrumsey.com/).

The illustration of triangulation on the next page is taken from a site dealing with the fascinating French initiative between 1792 and 1799 to set the length of the metre. The exercise was made by Jean Baptiste Joseph Delambre and Pierre Méchain along the line of the meridian running through the Observatory in Paris from Dunkirk on the Channel in the north to Barcelona on the Mediterranean in the south, but illustrates the same principle used in the earlier Cassini and Maraldi mapping. Earlier, measurements based on the triangulation of base points were made right across the Kingdom.

In 1793 the Revolution disbanded the Académie des Sciences but, before they did so, Jean-Charles de Borda had produced a tentative measurement of a metre based on the work of Cassini in 1740. Work continued on making a more precise measure for a metre, and this was completed in 1799 with the direction it should be used throughout France. However, not only was there reluctance in France to its adoption, England, Germany and the United States refused to accept it for a variety of reasons.¹⁰

Napoleon returned France to the old system of measurement in 1812* but, ironically, his successes in wars abroad had taken the metric system with him and, on his defeat, they were retained by the Low Countries.

---

⁹ [Contribution of the Cassinis and Maraldis](https://www.napoleons.org/)

¹⁰ [Contribution of the Cassinis and Maraldis](https://www.napoleons.org/)
Meridional Definition

In the 18th century, there were two approaches to the definition of the standard unit of length. One favoured Wilkins approach: to define the metre in terms of the length of a pendulum which produced a half-period of one second. The other approach was to define the metre as one ten-millionth (1/10 000 000) of the length of the Earth's meridian along a quadrant; that is, the distance from the Equator to the North Pole. This means that the quadrant (a section/distance ¼ of the Earth’s circumference) would have been defined as exactly 10 000
000 metres (10 000 km) at that time, with the total circumference of the Earth defined as 40 000 000 metres (40 000 km). In 1791, the French Academy of Sciences selected the meridional definition over the pendular definition because the force of gravity varies slightly over the surface of the Earth, which affects the period of a pendulum.

To establish a universally accepted foundation for the definition of the metre, more accurate measurements of this meridian were needed. The French Academy of Sciences commissioned an expedition led by Jean Baptiste Joseph Delambre and Pierre Méchain, lasting from 1792 to 1799, which attempted to accurately measure the distance between a belfry in Dunkerque and Montjuïc castle in Barcelona to estimate the length of the meridian arc through Dunkerque. This portion of the meridian, assumed to be the same length as the Paris meridian, was to serve as the basis for the length of the quarter meridian connecting the North Pole with the Equator.  

**Metric System**

In pre-revolutionary Europe, each state had its own system of units of measure. Some countries, such as Spain and Russia, saw the advantages of harmonising their units of measure with those of their trading partners. However, vested interests who profited from variations in units of measure opposed this. This was particularly prevalent in France where the huge inconsistency in the size of units of measure was one of the causes that, in 1789, led to the outbreak of the French Revolution.

France officially adopted the metric system on 10 December 1799. Although it was decreed that its use was to be mandatory in Paris that year and across the provinces the following year, the decree was not universally observed across France.

*In 1812 Napoleon introduced a system known as *mesures usuelles* which used the names of pre-metric units of measure, but defined them in terms of metric units – for example, the *livre métrique* (metric pound) was 500 g and the *toise métrique* (metric fathom) was 2 metres.*

**Mesures usuelles** were a system of measurement introduced by Napoleon I in 1812 to act as compromise between the metric system and traditional measurements. The system was restricted to use in the retail industry and continued in use until 1839.

**Rationale behind the New System**

The French First Republic's introduction of the metric system into France was poorly managed by modern standards. It was done district by district between 1795 and 1800, with Paris being the first district to change. Although thousands of pamphlets were distributed, the Agency of Weights and Measures which oversaw the introduction underestimated the work involved. Paris alone needed 500,000 metre sticks, yet one month after the metre became the sole legal unit of measure, the agency had only 25,000 in stock. This, combined with the excesses of the Revolution and the high level of illiteracy, made the metric system unpopular. Many people still thought in mostly non-decimal terms using the fractional subdivisions of the previous system: a *livre* (pound) was thought to be necessarily divided into sixteen *onces* (ounces) and a *toise* (fathom or double-yard) into 72 *pouces* (inches), as though these were absolute concepts.

Napoleon I, the French Emperor, disliked the inconvenience of surrendering the high factorability of traditional measures in the name of decimalisation, and recognized the

---

11
difficulty of getting it accepted by the populace. Under the décret impérial du 12 février 1812 (imperial decree of 12 February 1812), he introduced a new system of measurement, the mesures usuelles or "customary measures", for use in small retail businesses. However, all government, legal and similar works still had to use the metric system and the metric system continued to be taught at all levels of education.

The prototypes of the metric unit, the kilogram and the metre, enabled an immediate standardization of measurement over the whole country, replacing the varying legal measures in different parts of the country, and even more across the whole of Europe. The new livre (known as the livre métrique) was defined as five hundred grams, and the new toise (toise métrique) was defined as two metres. Products could be sold in shops under the old names and with the old relationships to one another, but with slightly different absolute sizes. This series of measurements was called mesures usuelles.13

**Notable French Cartographers**

**Pierre-Gilles Chanlaire**

Pierre-Gilles Chanlaire was a French geographer, born at Wassy in 1758 and died in 1817. (He is also described as Pierre Grégoire.)

Publisher, Distributor, Printer maker, Squire.

Lawyer at the Parliament of Paris in 1780. The Revolution prompted him to acquire geographical disciplines. Appointed at the beginning of the 19th century to the headquarters of the Waters and Forests Department. From 1803 to 1808 was the Director of National Atlas and the Topographical Bureau of the Cadastre (The Land Tax Register - an official register containing information on the value, extent, and ownership of land for the purposes of taxation).

In 1808 he began to publish the first series of the ‘Topographic and Statistical Description of France’. In 1811 he was co-publishing with Edme Mentelle. (E. Mentelle, ‘Membre de l'Institut National des Sciences et Prof'r aux Exoles Centrales du Dep't de la Seine’ and by P.G. Chanlaire, ‘l'un des Auteurs de l'Atlas National.’)

**Edme Mentelle**

Edme (aka Edmund) Mentelle (11 October 1730 - 28 April 1816) was a French geographer.

Student of Jean-Baptiste Louis Créviet at the Collège de Beauvais (at the time a constituent college of the University of Paris), he found employment with the Ferme générale (in ancien régime France, essentially an outsourced customs and excise operation which collected duties on behalf of the king). The poems and comedic plays he published early in his career were not successful.

He turned to the study of geography and taught geography at the École Royale Militaire during the 1760s. During the 1780s he taught geography to the royal household and in 1786 designed a globe, which is still on display in the Dauphin's

13 Mesures usuelles
14 Pierre-Gilles Chanlaire (1758-1817)
15 Edme Mentelle
apartments at the Palace of Versailles. Throughout his lifetime he wrote textbooks in geography and history.

A supporter of the French Revolution, he taught at the Écoles Centrales and at the École Normale Supérieure. He was elected to the Institut de France in 1795. Mentelle is described by Tooley as “geographer and historian ‘aux Galeries du Louvre No.19’”.

He worked on the Cassini Carte de France, and collaborated with P.G. Chanlaire on a number of atlases. Their work *Carte d'Espagne et de Portugal en neuf feuilles*, in the original French edition, or the English version of this map engraved by Samuel John Neele, published in 1808, was in use by British officers.

Edme's brother, Francois Simon Mentelle, was also a famous cartographer.

**Jean-Baptiste Bourguignon D'anville**

Born 11 July 1697 in Paris (France) where he died on January 28, 1782, was a geographer and cartographer. (The Spanish cartographer, Don Tomás Mauricio Lopez de Vargas Machuca had studied geography and cartography in Paris with D'anville from 1752 to 1760.) Appointed geographer of the King in 1718, he produced 211 maps that were considered the best of his time. Their precision revolutionised cartography.

Apart from the maps of which he was the author, D'anville accumulated an abundant collection of mapping documents, more serious than manuscripts, which, according to Bon-Joseph Dacier, were the most complete and the most valuable that perhaps ever existed.

As early as 1772 he had considered ceding this collection to the King, but the matter was not settled until 1779. At the death of D'anville in 1782, the collection passed from the Louvre, where he lived, to Versailles, where Jean-Denis Barbie du Bocage maintained the inventory, since the collection belonged to the King and this was completed in 1828. Louis-Charles-Joseph of Manna, Curator-Director of the Library of the King, who had inherited all his papers, produced a record of the works of the geographer in 1802. The works of D'anville should contain 6 volumes accompanied by maps drawn by the geographer but publishing was interrupted by the death of de Manne in 1832 and only 2 volumes were published in 1834 by his widow and his son.

**Map of European Russia (or Large Map of the Russian Empire) in scale 1:500000, 1812**

In preparation for war, Napoleon ordered the creation of several topographical maps of Russia.

The most accurate of these was the Map of European Russia (or Large Map of the Russian Empire) in scale 1:500000 (original title *Carte de la Russie Européenne en LXXVII feuilles exécutée au Dépôt général de la Guerre*). Map consists of 104 sheets, 77 maps (size 50x79 cm) show European part of Russia. Maps named by columns and rows: column named by Latin letters (A-G), rows by digits (1-11).

---

16 Jean-Baptiste Bourguignon d’Anville
17 Bon-Joseph Dacier, born in Valognes 1 April 1742 and died in Paris on 4 February 1833. He was an historian, philologist, translator of ancient Greek and a French curator. He was president of the Conservatoire from 1806 to 1829.
How did the French create such an accurate map? Researchers believe that French topographers used a Russian map named Detailed map of the Russian Empire and neighboring foreign holdings (or 100 sheet map, original name "Подробная карта Российской империи и близлежащих заграничных владений", published by order of the Russian Government in the years 1797-1805.

There are several hypotheses as to how the Russian map found its way into the French Dépôt général de la Guerre. According to one of them, copper prints of the Russian map were secretly purchased by the French ambassador, J.A.Lauriston, from one of the employees of the State Archive in St. Petersburg. The General Depot of the French army replaced all Russian-language place names to French.

Whilst there is the above speculation about how a copy of the map was acquired by the French Depot de la Guerre, there was also another possible, and perhaps more probable, source:

‘THE RUSSIAN DOMINIONS IN EUROPE drawn from the latest Maps, printed, by the Academy of Sciences, St. Petersburg; revised and corrected, with POST ROADS & NEW GOVERNMENTS, from the Russian Atlas of 1806; by Jasper Nantiat’. Large (wall) map of Russia, printed on two double sheets, not joined. Published by William Faden, London 1808. 106 x 91 cm when joined.

Placed on the Napoleon Series: January 2019