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Engraved Footprints from the Past

Retrieving cartographic geohistorical data from the Cassini *Carte de France*, 1750 - 1789

刻印された過去の足跡：
カッシーニの『フランス地図』から抽出された歴史地理学的地図データ（1750年1789年）

フランス全土及び特殊地図：No.52オーヴェルニュ地方クレルモン、シート110（1759-1777、2019）

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Antique maps are full of engraved geohistorical features. They provide representations of past states of the geographical space and are favored by historians and social scientists for their uniqueness and coherence. Working on a GIS dedicated to the history of the French territory, we extracted spatial information from the Cassini *Carte de France* (full name *Carte générale & particulière de la France*) as vector data. Based on the first geodetic survey of France [1, 4], this well-known and monumental map has been drawn on 182 paper sheets of size 610 x 955 mm at the scale of 1:86 400 or 1 line for 100 toises (*i.e.* 1 inch to 1.36 miles). It depicts the French territory with fine-grained information about populated and named places, settlements, landscape features, hydrographic, ecclesiastical and road networks [3, 5, 6, 7]. As a case study, the sheet numbered 52 provided more than 6 800 spatial footprints that we have stored as a geographical database. Following the distinction made by Cassini himself between « geometric » and « topographic » entities, our geographical database is composed of two families of data, namely Triangulated Geographical Entities (« geometric » entities in Cassini's own terms) whose geodetic properties are partly documented (Map. 3) and Relative Geographical Entities (« topographic » in Cassini's terms) which are dependent on and located relative to the former (Map. 1). Those entities are analytically distinct but come together from a single artifact: the primary source they have been engraved in during the mapmaking process. Because this process of embeddedness is not fully documented, retrieving both classes of entities called for a cautious cartographic visualisation with similar semiological rules and aesthetics as the original historical map. This « Cassini map style » preserves the cartographic properties of the geohistorical data extracted from this primary source: generalisation, scale, spatial granularity and the overall intentions of the mapmakers [2]. Often neglected, such properties are constitutive components and dimensions of the mapping style which forms the context of and gives crucial information on the accuracy and the relationships between geohistorical data enclosed in. Our GIS-based reconstructed map (Map. 2), which comes with its own legend and descriptive statistics (Tab. 2 and 3), provides a renewed cartographic visualisation of the entire sheet 52. It reveals unnoticed cartographic entities that were hardly legible in the original map (Fig. 4a-b).

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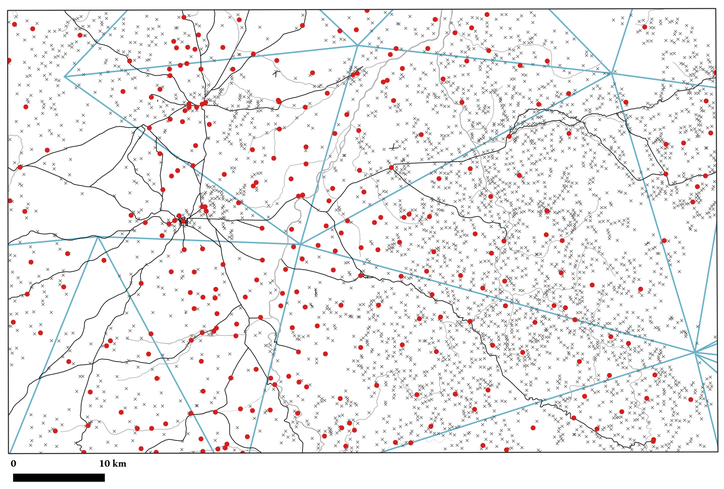
[1] C.-F. Cassini (1783). *Description géométrique de la France*. Imprimerie Desaint. [2] S. Christophe, B. Duménieu, A. Masse, C. Hoarau, J. Ory, M. Brédif, F. Lecordix, N. Mellado, J. Turbet, H. Loi, T. Hurtut, D. Vanderhaeghe, R. Vergne, and J. Thollot. Expressive map design: Ogc sld/se++ extension for expressive map styles. *Proceedings of the ICA*, 1:21, 2018. [3] F. de Dainville. La carte de Cassini et son intérêt géographique. *Bulletin de l'Association des géographes français*, 32(251), 138-147, 1955. [4] J. V. Konvitz. Redating and rethinking the cassini geodetic surveys of france, 1730–750. *Cartographica : The International Journal for Geographic Information and Geovisualization*, 19(1) :1–15, 1982. [5] C. Motte and M-C. Vouloir. Le site Cassini.ehess.fr: un instrument d'observation pour une analyse du peuplement. *Revue du Comité Français de Cartographie*, 191, 68–84, 2007. [6] J. Perret, M. Gribaudi, M. Barthelemy, N. Abadie, S. Baciocchi, C. Bertelli, O. Bonin, P. Bordin, B. Costes, P. Cristofoli, B. Duménieu, J. Gravier, J.-P. Hubert, P.-A. Le Ny, E. Mermet, C. Motte, M. Pardoen, A.-M. Raimond, S. Robert, and M.-C. Vouloir. The 18th century Cassini roads and cities dataset, `https://doi.org/10.7910/DVN/28674`, *Harvard Dataverse*, 2015. [7] J. Perret, M. Gribaudi, and M. Barthelemy. Roads and cities of 18th century france. *Scientific data*, 2 :150048, 2015. [8] B. Duménieu, S. Baciocchi, J. Perret, P. Cristofoli, J. Chadeyron, and I. Langlois. A GIS reconstruction of the Cassini "Carte de France" sheet No. 52, `https://doi.org/10.7910/DVN/XP8J6P`, *Harvard Dataverse*, 2019.

Map 1. Analytical map of the geographical features surveyed for the making of the sheet number 52 of the *Carte de France*, whether triangulated (316 red dots) or relative (6 565 grey crosses). The first-level triangulation used by surveyors is figured in blue.



1. A digital map à la Cassini: reconstruction of the *Carte générale & particulière de la France*, 52th sheet (1759-1777, 2016-2019)

Vector geographic data extracted from the georeferenced sheet number 52 of the *Carte de France* is rendered under QGIS as a digital map mimicking the original style of the Cassini map (Map 2). The original historical map has been georeferenced and its content manually extracted by the team GeoHistoricalData (EHESS / IGN / UCA) in 2016-2018: Nathalie Abadie, Stéphane Baciocchi, Pierre Boivin, Julien Chadeyron, Pascal Cristofoli, Jean-Michel Delaveau, Bertrand Duménieu, Stéphane Gomis, Maurizio Gribaudi, Isabelle Langlois, Claude Motte, Julien Perret & Marie-Christine Vouloir. Printed at the scale of 1: 69 000 in Saint-Mandé, France, in January 2019 by Thierry Chaffaud and Régis Fiol at the IGN France Printed Products Manufacturing Department. With the support of the *Centre de Recherches Historiques* (EHESS/CNRS), the *Centre d'Histoire « Espaces & Cultures »* (UCA), the *Laboratoire des Sciences et Technologies de l'Information Géographique* - LaSTIG (IGN), the *Laboratoire de Démographie et d'Histoire Sociale (EHESS - Centre de Recherches Historiques)* and the SoDUCo project (ANR grant Project-ANR-18-CE38-0013). The dataset is freely available online [8].

Map 2. The digital Cassini map, reduced to the scale of 1: 100 000.

2. A dense, extensive and geometrically accurate description of an 18th century landscape: descriptive statistics of the sheet numbered 52 of the *Carte de France*

This large-scale map was built upon a trigonometric canvas rigorously calculated by Cassini's engineers, making it easier to georeference (see table 1). Although less important to Cassini, land use and networks are visually salient in the map. These geographical objects were not triangulated but rather sketched out on sight by the surveyors. Their planimetric accuracy is therefore low and their contours imprecise (table 2). Due to the visual clutter produced by the abundance of place names as labels, it is easy to miss the richness and density of places portrayed recorded in the map. It offers a detailed view of the 18th century French settlement and proto-industrial landscape with a high consistency across sheets. Table 3 shows the quantity and diversity of places in the sheet numbered 52. Symbols refer to the legend of map 2.

Table 1. Rectangular extent of the map in two coordinate systems: the Cassini map projection and WGS84

	Projected coordinates (toises)		Geographic coordinates (degrees)	
	Distance to the central meridian	... to its perpendicular	Latitude	Longitude
upper left corner	20 000	162 500	45°59'9.98"N	2°52'23.60"E
upper right	60 000	162 500	45°58'39.6"N	3°50'48.22"E
bottom left	20 000	187 500	45°32'52.36"N	2°50'9.38"E
bottom right	60 000	187 500	45°32'21.11"N	3°20'03.97"E

Table 2. Descriptive statistics on sketched geographical entities. Town centers are triangulated entities, but their boundaries were sketched

	Landscape features								Towns	Hydrography					Roads	Total
								Farmland								
Features count	257	32	111	-	150	6	-	-	37	9	240	-	-	-	-	-
Area sum (km²)	279	75	87	1 368	142	0,6	0,8	1 871	4	1,2	4	19	-	-	-	3 852 km²
Network lenght (km)	-	-	-	-	-	-	-	-	-	-	-	-	341	2 841	624	3 806 km

Table 3. Census of triangulated and relative geographical entities

															Total
Place symbols count	15	22	234	11	93	28	196	2 277	39	1 135	501	1	5	6	4 563
of which unnamed	-	-	*1*	*2*	*25*	*15*	*46*	*28*	*1*	*52*	*427*	-	*4*	*1*	*601*

3. Primary sources, original mapmaking process & renewed Cassini map style

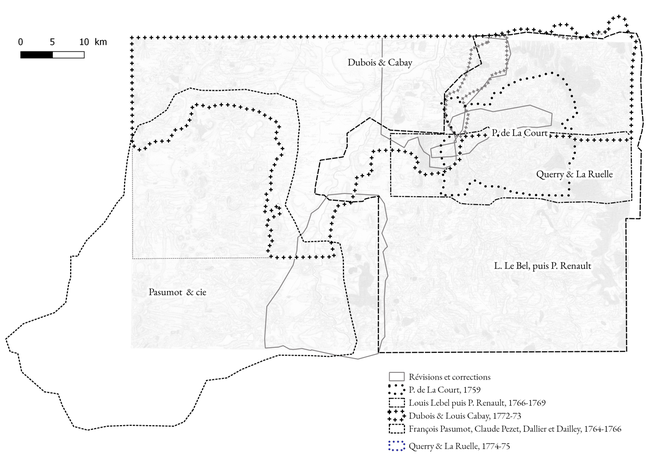
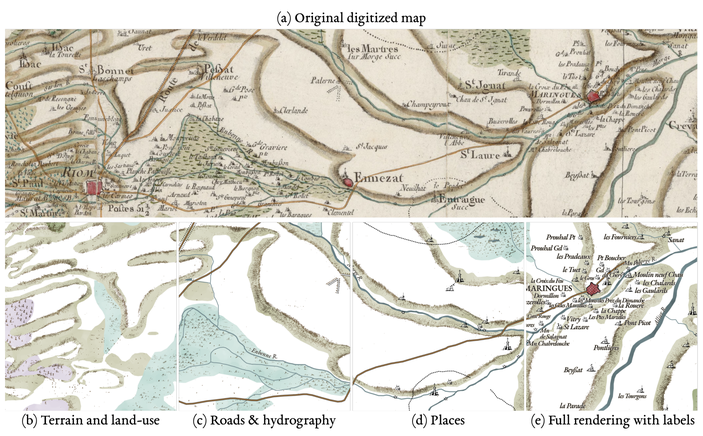
From antique to renewed GIS-based historical map

Historiography of cartography has long been based on critical edition of old maps published as non-georeferenced *facsimile*. We propose to renew this approach by producing digital maps from vector geographic databases that combine the aesthetics and semiology of old mapping styles with the modelling capabilities of modern GIS.

Original 610 x 955 mm colour map (« grand aigle » format) on a scale of 1: 86 400 or 1 line for 100 toises. Drawn up from 1759 to 1777 under the direction of César François Cassini de Thury, Charles Étienne Louis Camus (then Rodolphe Perronet) and Étienne Mignot de Montigny. Triangulated from 1759 to 1775 by P. de La Court (ne partial, 1759), François Pasumot, Claude Pezet, Dallier and Dailley (no-so, c. 1764-1766), Louis Le Bel (se, 1766-1768; ne and so, 1769), Dubois & Louis Cabay (no-ne, 1772-1773), Querry & François La Ruelle (ne, 1774-1775). Field checked, 1767-1774 by P. Renault (se, 1767-1768), Querry & F. La Ruelle (no-ne-so, 1774). Map engraved in Paris in 1774-1777 by Louis Capitaine son (for the plan, 1774-1776) and Nicolas Bourgoin (for the letter, 1775-1777). Printed intaglio on the press of Paris Observatory in 1777 on behalf of the *Compagnie associée pour la Carte générale de la France*. Presented to the King and the Royal Court, Versailles, April 16, 1777 (« silk printing »).

Main primary sources to establish the critical edition of the original map: BnF (Paris, France) - Map division, GE C-22286 (Rés), *Nouvelle carte qui comprend les principaux triangles qui servent de fondement à la description géométrique de la France, levée par ordre du Roy, par mess. Maraldi et Cassini de Thury, 1744*; IGN France map library (Saint-Mandé, France) - Drafts of the Cassini map (sheet 52); Registre < A > *Registre des Ingénieurs et Vérificateurs, paraphé par nous, Directeurs de la carte de France*, le 15 juillet 1778, de Montigny, f. 94, 96 et 126; Registre < E > - *Copie du Journal de la Carte Générale de la France tenu par Mr. [Jean-Charles] de Borda [, trésorier de la Société], commencé le 26 juin 1756 et fini le 1er juillet 1784.*

Map 3. Successive drafts of field surveys, map corrections and reviews (1759-1775)



Map 4. Vector geographic data extracted from the digitized and georeferenced original map (a) is arranged into GIS layers and composed to build the renewed version of the Cassini's *Carte de France*. Subfigures (b), (c) and (d) show an overview of the 15-layers composition that results in the final rendering à la Cassini (e).