



period of time, e.g. to spatialise the tax households in 1300 from thematic data. Therefore, these thematicians can process queries on their data and manipulate it in the aim of testing spatial hypotheses. Such a process was almost impossible before.

From a diachronic point of view, the goal is to study the urban morphology on a long term period in order to show that social practices have an effect on the urban morphology in addition to the classical explanations of planning: the way people lived in spaces, their needs and what they did, can partly explain the maintainance of some shapes of roads and parcels. How were urban shapes created? How did they evolve? What were the social customs at different times? The aim is to observe the transmission of the roads and parcels shapes through the permanent recomposition of the social uses of urban space. This idea of multiple urban temporalities and the interest to confront the short temporalities of social conventions with the longer temporalities of spatial shapes, have been studied, especially in the works of (Roncayolo 1996, 2002), (Lepetit and Pumain 1993), (Galina 2000) or (Chouquer 2003).

To study the link between spatial structures and social uses of the urban space, it is necessary to have on the one hand, layers of historical information which spatialise the social activity of actors living and involved in this urban space at different times, and on the other hand, vector layers of old parcels and not only the road network.

Based on a robust and referenced geographical database, the creation of this GIS has also the aim of creating new university research dynamics by proposing topics which can be achievable during the time of a master or a doctoral degree – time devoted to historical studies and not only to cartography –.

## RESULTS

### *Georeferenced and vectorised plans of Vasserot's atlas*

During the project, the 910 urban block plans of Vasserot's atlas have been georeferenced and vectorised (see figure 2). The georeferenced and accurate raster and vector data provided by the APUR (the Paris Urban Planning Agency) to the ALPAGE project, have been used as current referenced data framework.

The georeferencing and the vectorisation process of the 910 Vasserot plans – each plan is the drawing of a Parisian urban block – have been realised in accordance with the needs and the expertise of the historians, the geomatics technical possibilities, and the needs and the contributions of the automatic vectorisation process carried out by the computer scientists. As a result of this active collaboration between historians, geomaticians and computer scientists, this co-production of spatial reference data has allowed the project to take into account the natural and social dimensions of the Parisian urban space.



Figure 2. Georeferenced Vasserot's atlas.

### *Evaluation of the georeferencing process*

To accurately measure the geographic and geometric qualities of the old parcels reconstructed map, some evaluation criteria are defined. Due to the georeferencing process, a coefficient of distortion is firstly

computed for each urban block. Then an evaluation of the shifts between georeferenced Vasserot's plans and the current APUR map is undertaken.

These criteria allow a critical point of view on Vasserot's plans as a historical information source. Like any source, this one is not perfect. Indeed, certain plans have some important shifts. Based on the coefficient of distortion, 6.5% of these plans are potentially problematic.

Moreover, the comparison of the 5000 parcels which are both present in the Vasserot plans and in the current APUR data, show that the differences in position (X, Y) are only 1.5m on average, and the orientation differences are 2.2° on average. Therefore, the overall result is very satisfactory and the accuracy is more than sufficient to enable the realisation of a historical study, in comparison with medieval and modern written sources.

### ***Production of historical data***

During the ALPAGE project, 35 different historical vector data have been produced. These data can be classified into 4 main themes:

- Data in relation with the parcels: urban blocks and parcels between 1810 and 1836, urban blocks in 1300 and in 1380,
- Historical topography: walls between the 10th and the 12th century, Philippe Auguste's walls, Charles V's walls, walls of the "Fossés Jaunes", aristocratic mansions and town houses in 1300 and 1400,
- Historical dominions: neighbourhoods and arrondissements (i.e. urban districts) between 1790 and 1860, medieval regions, tax collection in 1300, parish taxes in 1300, manors in the 18th century (a manor is a tax which is applied both on land and on men), sewers in the 18th century,
- Road systems: roads in 1300 and in 1380, Bièvre (the Parisian part of the Bièvre river) between 1810 and 1836, the linear structure of the parcels between 1810 and 1836 which fits with the Roman urban orientation, floods in 1740 and in 1910.

The production of other data has also begun but is not yet completed, e.g. the churches in the Middle Ages. Subsequently, to improve the understanding of Vasserot's data, other plans dated from 1300 to 1380 have also been georeferenced to allow for the comparison and confrontation with medieval texts. Thus, the geocoding on the Vasserot's road system of the taxpayers of the Parisian royal tax in 1300 has been possible. The geocoding of the 10.000 taxpayers has been possible thanks to the development of an ad hoc software module on top of MapInfo. This module allows us to realise an analysis of the socio-topography based on different economic information such as the name of the taxpayers, the amount of taxes, their business, etc., for each taxpayer located in a section of the road system in 1300. Nevertheless, the procedure was very slow to establish because we have had to previously set up a correct spatial reference system, particularly the road system in 1300.

All these data are referenced based on a ISO-19139 metadata (which is the standard used in the INSPIRE directive) system called ALPAGE-References, available online: <http://lamop-intranet.univ-paris1.fr/alpage-references/>. This metadata system enables the traceability or genealogy of data (date of creation, author, written source in link with the created object, etc.).

Finally, due to the quality and the collaborative process of the production of data created in the ALPAGE project, the question of data sustainability and diffusion has been raised early. These issues have been solved administratively and technically. Administratively, agreements have been signed with institutions providing data: the APUR, the French National Archives and the Ville de Paris. Then a consortium agreement has also been signed between the different partners of the project. Technically, some data are directly available for downloads in the ALPAGE website (<http://lamop.univ-paris1.fr/alpage/index.php/cartographie>) and all data are available online through the webmapping platform (more details are given below in the webmapping platform section).

### ***Historical data analysis***

The type of results is twofold, both intrinsic to each data and linked to the possible combinations of these data.

A first level of results concerns the specific knowledge of each data: the walls are now mapped as accurately as possible, thanks to archaeological remains (Philippe Auguste's and Charles V's walls), to their traces in the former parcel system (the 3 medieval walls) or to specific surveys made on the ground (the walls of the "Fossés jaunes") (see figure 3); all the aristocratic mansions in the late Middle Age are for the first time geolocalised and this mapping allows us to frame new working hypotheses about the nobiliary presence in town; the mapping of the different manors in the 18th century allows to measure precisely the distribution of seigneurial power.

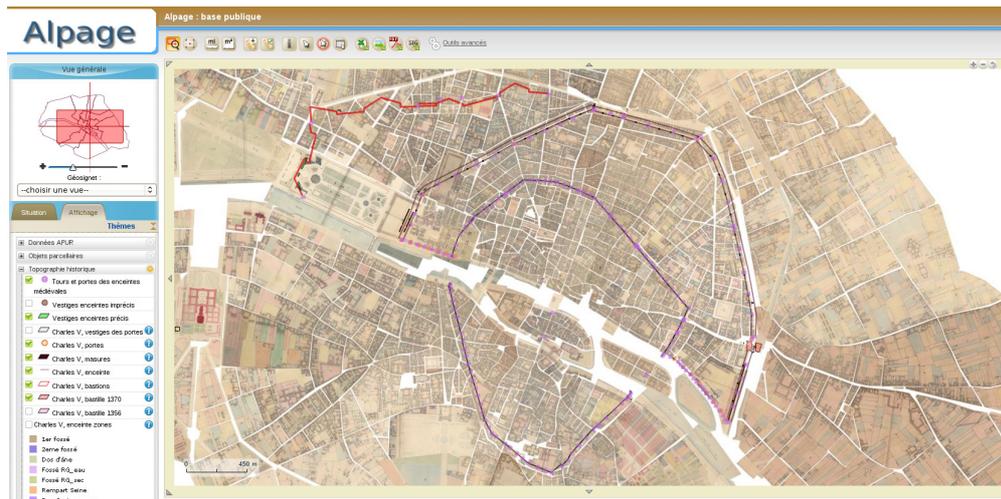


Figure 3. Map of the walls through the ALPAGE webmapping platform.

A second level of results concerns the possibility to realise some spatial analysis thanks to GIS, which enables to produce new knowledge, in particular concerning the manors. Indeed, the spatial combination of the road network and the manors in 1300 enables us to discover the hierarchy of the seigneurs (or lords) who had the role of road surveyors, by identifying the seigneurs who had a land right on both sides of a road. It also allows us to identify the royal part of the tax which can be defined as the percentage of the area of the roads which have on their sides two different seigneurs, in the whole area of the road system. This part, unknown until then, is up to 64% in 1300, which reveals the overwhelming royal power at that time.

A second interesting spatial combination is the one between the layouts of the walls and the old parcels system that reveal that the defensive system goes beyond the localisation of the defensive structures. This phenomenon informs the rhythms of the urban growth, e.g. the late opening (in 1288) of the Chaume's postern in Philippe Auguste's walls has still an influence in the early 19th century, influence identified by the smaller density of the front parcels in Chaume's street. The influx of the 13th century have been focused on the Temple and on the Vieille du Temple streets which had from the beginning a passage through the walls. Therefore showing that the 13th century has been found to be a time which has durably structured the urban fabric.

Another interesting spatial combination is the one between the taxpayers in 1300 and the parcels system in the early 19th which fully confirms the interest of studying the link between spatial structures and uses in the Parisian urban space. For example, the number of taxpayers on both sides of Male Parole's street is very unbalanced, with 9 taxpayers on the northern side of the street and 21 on the southern side. In this socially well inhabited street in the early 14th century, this asymmetry could reflect an imbalance of urban density which can be partially found in the parcels system of the early 19th century, with 6 parcels on the northern side facing 11 parcels on the southern side. This suggests that social practices in the late 13th century have had influence on the urban fabric beyond the 13th century: this morphological differentiation of the Parisian parcels system is both old, as attested from 1300, and above all constantly reactivated by other social practices for more than 5 centuries.

### **First morphological analysis**

This project has also allowed historians and archeo-geographers to study the geometrical characteristics of parcels through different criteria including density, shape diversity, and the geometric orientations of the road network and of the parcels. These identified morphological characteristics are then explained by social practices that redefine these shapes over a long term period (e.g. planning, reuse of old parcels shapes in earlier social contexts).

Then the spatial dimension of these historical vectorised objects has been analysed, e.g. influence of walls and road network on the parcels, inheritance of past flows on the feudal domains and the sewers. It is therefore now possible to measure the resilience of a former meander on the material and conceptual space layout. Therefore, the urban parcels became a current object of history.

To be able to realise these two first morphological analysis, an open source module, called MorphAL (for Morphologic AnaLysis), has been developed as a plugin of the open source GIS software OpenJUMP (<http://www.openjump.org>). MorphAL has been released under a GPLv2 licence (it can be downloaded at <http://lamop.univ-paris1.fr/alpage/index.php/cartographie/>). In particular, MorphAL allows us to know if a



This data can also be used in the fields of town-planning and land settlement. The old urban system as described in Vasserot's plans could be taken into account by urban planners when they undertake a project in the Parisian space.

Another aspect, beyond historical research, is that the webmapping platform can be used as a cultural and social vector. Indeed, anyone can now access to this information and even produce their own maps in respect to the ALPAGE cartographic and legal conventions.

Finally, the results and the experience of people involved in this project are that we aim to extend this collective work by developing the work begun on the parcel and medieval topography, but also by addressing new issues in fields such as hydrography and relief.

More information about the ALPAGE project is available online, including the webmapping platform: [http://lamop.univ-paris1.fr/alpage\\_english](http://lamop.univ-paris1.fr/alpage_english) (English version) and <http://lamop.univ-paris1.fr/alpage> (French version).

#### **REFERENCES**

Boudon F, Chastel A, Couzy H, Hamon F (1977) *Système de l'architecture urbaine – Le quartier des Halles à Paris* –, 2 vol., CNRS (eds), Paris.

Chouquer G (2003) *Crise et recomposition des objets : les enjeux de l'archéogéographie. Introduction*", *Études rurales*, 167-168, p. 13-31.

Darin M (1998) *The study of urban form in France*, *Urban Morphology*, 2, n° 2, pp.63-76.

Galinie H (2000) *Ville, espace urbain et archéologie*, *Maison des Sciences de la Ville*, Tours.

Lepetit B, Pumain D (1993) *Temporalités urbaines*, *Anthropos Economica* (eds), Paris, 330p.

Pornon H (2007) *Bilan et perspectives de 20 années de géomatique*, *Géomatique expert*, 57, pp.36-60.

Roncayolo M (1996) *Les grammaires d'une ville, Essai sur la genèse des structures urbaines à Marseille*, EHESS (eds), Paris.

Roncayolo M (2002) *Lectures de villes. Formes et temps*, *Parenthèses* (eds), Marseille.