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[371]

## Recognizing Temporalities in Urban Units from a Functional Approach: Three Case Studies

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**Abstract:** *The city is a complex object and its descriptions by urban actors have evolved over time. Therefore many ways to investigate it have emerged. In this paper, we propose to study cities through the combination of units of analysis, called “urban entity” and defined by a function, a form and a date on a continuous timeline. However, while the dating of items is often done in absolute time, the way it is determined is not always clearly formalized by archaeologists and historians. We present a formalization of the dates of urban entities, which take into account certainty and estimation. Each entity is defined by numeric dates so it is possible to explore the statistical distribution of urban entities through function and chronological periods, based here on 50 years (units). Then, the analysis and comparison of change and sustainability of three towns from the 1<sup>st</sup> to the 18<sup>th</sup> century may be systematized.*

**Key words:** *Urban archaeology, multivariate statistics, long-term dynamics, absolute chronology.*

### 1. Introduction.

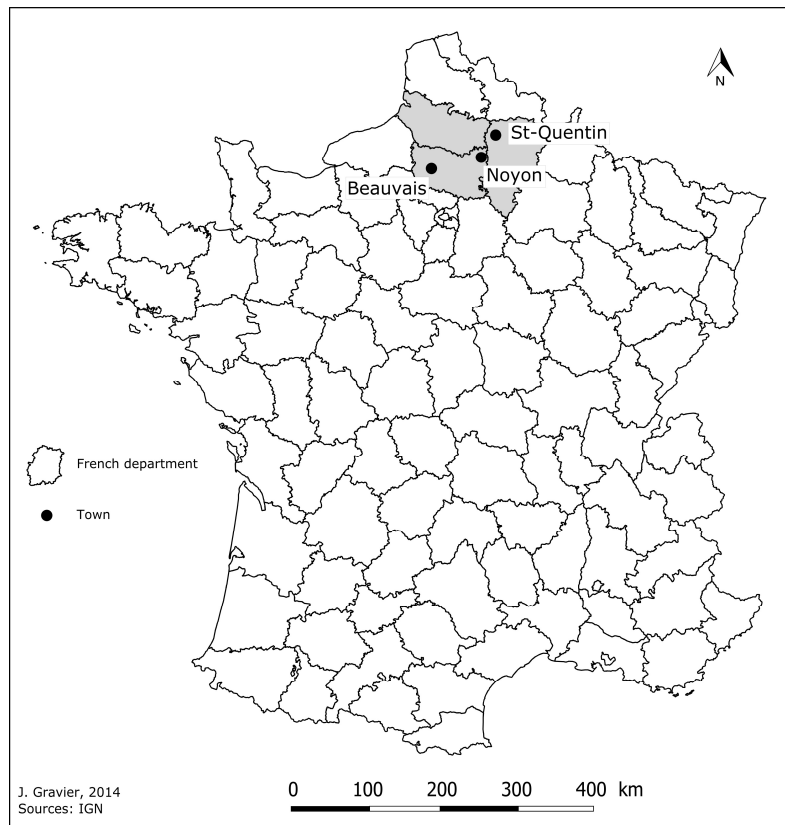
“Chronology is one of the first task of historian, which often serves as a framework for overall analysis”<sup>1</sup> (Offenstadt, 2006: 23). However, while the dating of items – in a broad sense – is often done in absolute time, the way it is determined is not always clearly formalized by archaeologists and historians. Consequently studies of change and sustainability of systems over the long term are frequently based on conventional time periods. One of the main questions of this paper is the analysis and synthesis of temporalities of urban spatial systems. It is established on the functions of space through a diachronic vision. The aim is to observe functional changes, paces and continuities, and it relies on three case studies. This subset of three towns: Beauvais, Noyon and Saint-Quentin located in Picardy (France), implies a comparative approach and allows the exploration of specificities and recurrences of urban trajectories (fig. 1).

Furthermore, the city is a complex object and its definitions by urban actors have evolved through periods of time. Therefore there are many ways to study it. For urban archaeology – which emerged during the 1960s in England – cities could be observed over long periods of time thanks to functions describing the physical urban space (Biddle, Hudson, Heighway, 1973). This approach is based on functional intra-urban units of analysis, such as abbeys, roads, handicraft activities, rivers etc. Then the combination of these entities allows to recompose and to analyze the occupation of a city and its changes.

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<sup>1</sup> French quotation : “La chronologie est un des premiers travaux de l’historien, qui sert souvent de cadre aux analyses d’ensemble.”

In France during the 1970s, this empirical process was applied by H. Galinié on the city of Tours (Galinié, Randoin, 1979). Since the 1980s, it has been afterwards systematized with monograph series titled *Documents of Archaeological Evaluation of French Towns*. Each monograph has been written by local archaeologists in collaboration with the National Center of Urban Archaeology, which has published the books.



**FIGURE 1:** LOCATION MAP OF THE THREE CASE STUDIES: BEAUVAIS, NOYON AND SAINT-QUENTIN.

[372] Our approach inherits from these researches, and like these, it is based on the assumption that cities could be studied through units of analysis. In this paper, these units are named “urban entities” and each one is defined by a function, a location (or a spatial form) and a date on a continuous timeline. Although our methodology is inspired by these works, we decided to add a dynamic aspect with the elaboration of an Archaeological Information System, as it has been done by others like the TOTOPI system (Galinié, Rodier, 2002). Thanks to computer science, the analysis of evolutions of urban spatial systems could be realized with a statistical approach and not only in an empirical way.

First we present the construction of urban entities. More specifically, it is an explanation of the processes of creating these entities from archaeological and historical documentation. Given that the study is diachronic, it involves difficulties in examining heterogeneous documentation. Next, we propose a way to systematize the examination of “source effects” over time. Lastly, we focus on a statistical approach toward the repartition of urban entities through function and time, using correspondence analysis and hierarchical cluster analysis. These analyses provide a strong basis to identify functional profiles of cities from the 1<sup>st</sup> century AD – origins of the three towns – to the 18<sup>th</sup> century.

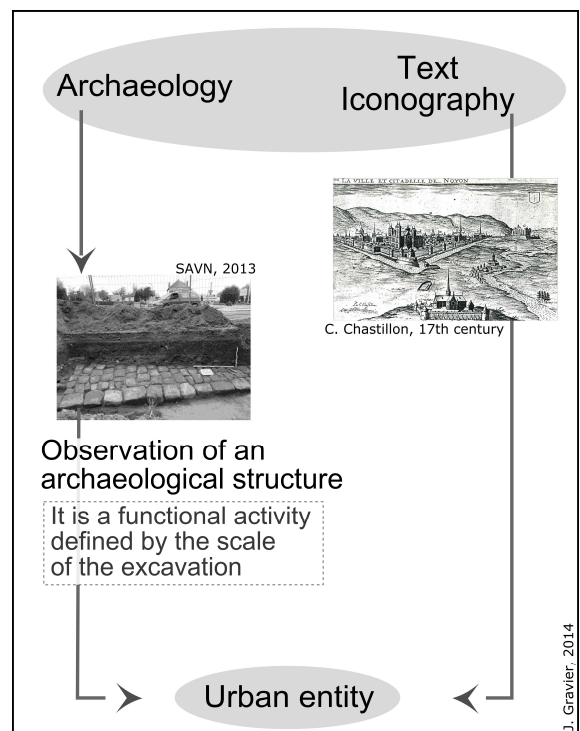
## 2. What exactly is an urban entity? Methodological aspects of data processing.

First, we propose to explain our interpretation of archaeological and historical documentation and what methodological choices were made for the processing of such data in the project. Each urban entity is based on archaeological remains, texts and iconography. However this documentation is in itself very heterogeneous, but also according to time periods and authors (Galinié, 2000). Therefore, the heterogeneity implies incomplete data and it is essential to take its uncertainty into account.

### 2.1. Archaeological remains, texts and iconography: from documentation to urban entity.

Archaeology, text and iconography are studied as complementary documentation to fill the data gaps existing between each one. Nevertheless, the data processing of archaeological remains is distinguished from text and iconography, because the first are more precise compared to the latter since they are based on a material point of view (fig. 2).

Sections	Functions
road	<b>F1.</b> Road and free space
free space	
bank and river planning	<b>F2.</b> Bank, river, relief planning and crossing system
relief planning	
crossing system	
water supply	<b>F3.</b> Water supply and evacuation system
collecting, evacuation system	
urban defensive system	<b>F4.</b> Defensive and military system
fortify structure	
garrison, barracks	
public space	<b>F5.</b> Civilian and religious public spaces
civil authorities, justice	
spectacle, sport	
public bath	
education, culture	<b>F6.</b> Host establishment (health, education)
health	
private housing	<b>F7.</b> Habitat
pagan worship	<b>F8.</b> Religious establishment
catholic place of worship	
conventual or monastic building	
ecclesiastical building	
worship other than catholic	
funerary	
trade, exchange	<b>F10.</b> Production, trade and craft
handicraft	
agriculture, breeding	
industry	
extraction	
natural formation	<b>F11.</b> Natural formation



**FIGURE 2:** SIMPLIFIED SCHEMATIC OF THE DATA PROCESSING FROM ARCHAEOLOGICAL REMAINS, TEXTS AND ICONOGRAPHY TO URBAN ENTITIES.

**TABLE 1:** THESAURUS OF THE FUNCTIONS USED TO DESCRIBE THE UNITS OF ANALYSIS.

Remains are first processed as an “observation of an archaeological structure” (OAS), which represents a [373] functional activity defined by the scale of the excavation. Each observation is described by a

function, called a section, inherited from the thesaurus of the National Center of Urban Archaeology (tab. 1). This stage suggests a first inference from an observable fact – the archaeological remains – to the analysis of an activity of a past society.

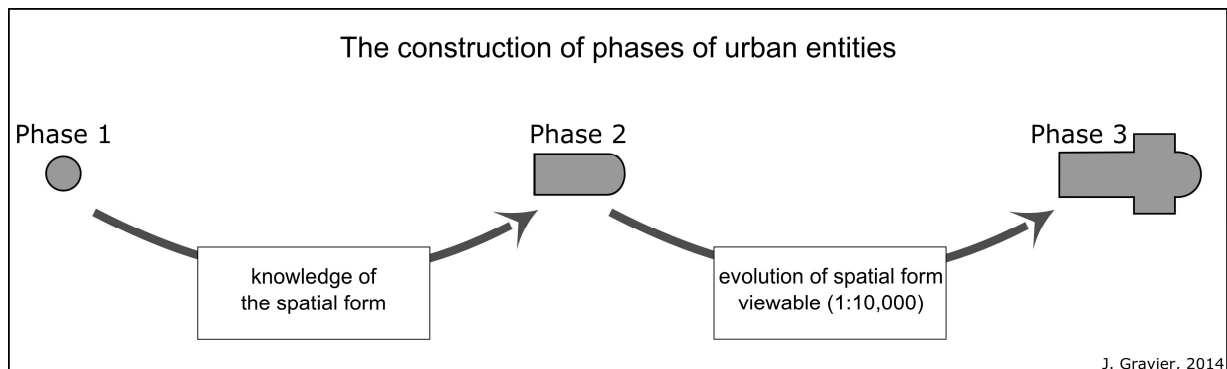
In a second phase, the OAS can be used to create urban entities by cross-checking the information. As an example, a rescue excavation was done in 1980 in the city center of Noyon by J.-P. Angot, wherein he found remains of pillars and a semi-circular structure (Ben Redjeb et al. 1992). Eight years later, another excavation was done by M. Talon, located further northeast. Some important pillars, about 0.70 meters high, and structures linked to an hypocaust were discovered. Finally, two OAS in data processing were recorded, described by a bath section. However on a city-wide scale, these observations were located near a main road, next to a Roman market and other public buildings. Therefore we can consider these OAS as the same part of a construction, which were probably some public thermal baths. Therefore they have been registered as a single urban entity, and thus, this step represents a second inference in the data processing.

On the contrary, text and iconography are directly processed as urban entities because the observable fact of these documents is not the same as archaeology. Indeed, a mention in a text or a representation in an iconography present direct activities of past societies.

Each urban entity is defined by one of the functions proposed (tab. 1). This thesaurus is mostly inherited by the National Center of Urban Archaeology but reviewed for this project (Borderie et al. 2014). In the end, only eleven functions are taken into account since a city-wide scale study involves a generalization of the information. However some archaeological findings, despite being punctual knowledge, can be registered as urban entities if they are considered essential for the understanding of the town. What matters is the categorization and selection of the information that allows to grasp urban dynamics.

## *2.2. Spatial processing of urban entity.*

Besides a function, an urban entity is composed of a location or a spatial form. Sometimes an urban entity can be represented by a punctual location if it is not visible at the urban scale, considered for this purpose on a scale of 1:10,000; but it is also seen as a punctual location if the form of an urban entity is unknown. Moreover the form of an entity can evolve through time. Therefore in the data processing of the spatial form, we have decided that it is appropriate to translate these specificities as “phases” of urban entities (fig. 3).



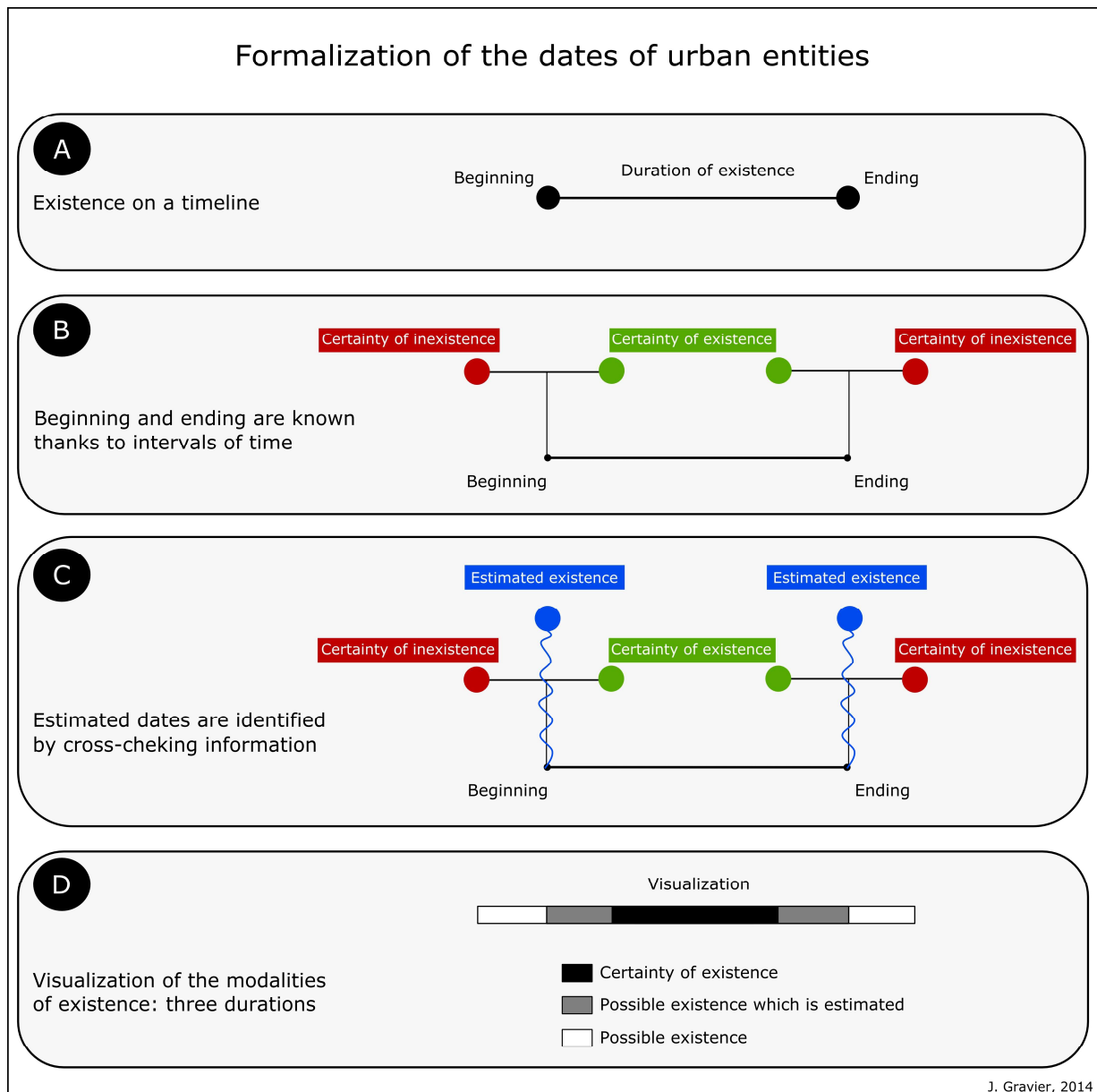
**FIGURE 3: THE CONSTRUCTION OF PHASES OF URBAN ENTITIES:**  
A TYPICAL EXAMPLE OF THE SPATIAL CHANGE OF A CHURCH THROUGH TIME.

This figure presents a theoretical example of a church to understand the formalization of these possible phases. This church is first mentioned in a text in 1240. At this date (phase 1, fig. 3), its existence and location are known, but not its form. However, by means of a rescue excavation the spatial form was recognized during the 14<sup>th</sup> century (phase 2, fig. 3). The knowledge of the form leads to a modification of phase of urban entity. A transept was added to the church during the 15<sup>th</sup> century (phase 3, fig. 3). In the process of managing change, this new phase of the urban entity represents an evolution of the spatial form visible on urban scale.

### 2.3. Processing of time of urban entity.

Each entity exists on a timeline. In fact, it has a beginning, a duration of existence, and an ending (A, fig. 4). However due to the lack of archaeological or textual data, the exact moment of the start date or of the end date are often not known. In most cases, they are discerned with intervals of time (B, fig. 4).

- On one hand, the dates indicate the *certainty of existence* of the urban entity (B, fig. 4). For example, the first mention of a hospital in a text provides this date for the beginning of the entity. At this exact moment the hospital does exist, but it has existed previously.
- On the other hand, they reveal the *certainty of inexistence* of the entity (B, fig. 4). For example, the ending of the existence of a street at Noyon is known by maps. On a first map, dated on 1889, the street is represented. At this point, it is sure that the entity continued to exist. However on another map dated on 1929 the street is not visible: it did not exist anymore at this time. Consequently, the ending of this urban entity is between 1889 and 1929. [374]
- To address one of the main purpose of archaeologists and historians, which is chronology of events, we propose the notion of *estimated dates* (C, fig. 4). In the example above, we know that the district where the street was had been destroyed by the French as they took control of the city during the First World War. So at this stage, the ending of the street can be estimated to be 1917. Therefore, the relations between urban entities and the general analysis of the documentation allow the estimation of dates inside intervals of certainty.



**FIGURE 4:** SCHEMA OF THE FORMALIZATION OF THE DATES OF URBAN ENTITIES.

Moreover, it is interesting to note that the dates of certainty of existence often are revealed by texts and iconography, while those of certainty of inexistence are mostly indicated by archaeological remains. In fact, mentions and representations provide the proof of the existence of an urban entity<sup>2</sup>. But frequently, the dates known from remains come from analysis of the archaeological material discovered in later layers. This is the case for layers coming from postholes, storage silos etc. Therefore archaeological dates often signal the moment when the activity is over and, thus, reveal the certainty of inexistence of an urban entity.

<sup>2</sup> Obviously, this statement should be qualified since a text or an iconography could include false reality. This is especially true in the case of ancient map, hagiography... and a first historical criticism of sources is necessary.

Finally, managing uncertainty occurs within the data processing thanks to six different dates and this formalization of dates of urban entities can be viewed with three modalities of duration (D, fig. 4).

### **3. Managing uncertainty and source effects over time: an automated tool for stratigraphic units applied to urban entities.**

The visualization proposed in this project (D, fig. 4) is inherited from the ongoing work of B. Desachy (Desachy, 2014). His research focuses on the creation of a beta version of “Le Stratifiant”, which is an automated data processing system for the management of stratigraphic units (Desachy, 2007). The automated tool provides answers to frequently asked questions about urban stratigraphy. It is based on layers recording, layers dates (when known) and the relations between stratigraphic units. It then allows us to:

- produce a graph, representing the relations of the units, in a similar fashion to the Harris matrix (Harris, 1979). In particular, it consists of assessing the uncertainty of the relations and offers various visualization possibilities (different phasing, choice of colors according to the type of layers etc.);
- produce an image of all the stratigraphic units on a timeline, which depends on the dates and relationships of layers. It is an automated process to see relative chronology, inspired by the common Gantt chart.

#### ***3.1. Stratigraphic units and urban entities: a possible analogy.***

In this project, we assume that the automated tool can be applied to urban entities. This assumption is based on the idea that dating and relations between urban entities may be formalized as stratigraphic units. Indeed three possible [375] relationships between entities do exist: an urban entity is prior, posterior or synchronous to another.

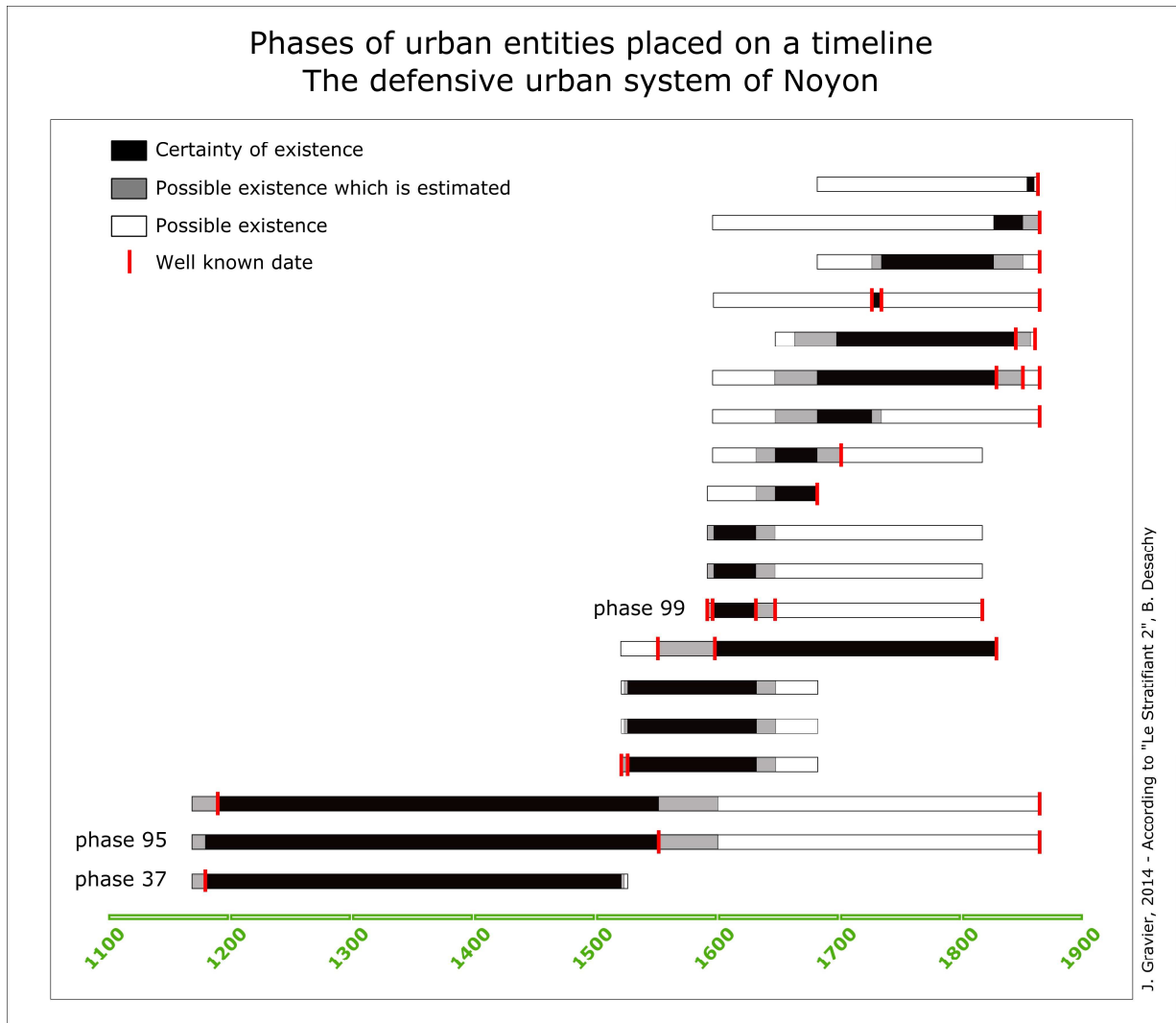
However contrary to stratigraphic units, the nature and relations of the urban entities are constructed. As an example, we know that city walls are built in the same time as ditches. In this case we induce that the two urban entities are synchronous. Therefore, layers and relationships between them are observable facts during an excavation, while urban entities are complex objects and their relationships are noted by inference during the analysis of a city.

#### ***3.2. An automated tool for visualization of source effects: the example of the defensive urban system of Noyon.***

What comes next is an example on the subject of the phases of urban entities related to the evolution of the defensive urban system of Noyon. This is done in order to show the usefulness of this tool for visualization of source effects over the long-term.

At the end of the 12<sup>th</sup> century, city walls were built in accordance with a Municipality and a bishop-count decision. During the middle of the 16<sup>th</sup> century, city walls were strengthened and fortified constructions raised to protect the town against new artillery techniques. Then at the end of the century, King Henri IV ordered the construction of a citadel, which was rapidly destroyed. At the end, city walls were dismantled during the 19<sup>th</sup> century. This brief summary of the evolution of the defensive urban system turns out to be registered with nineteen phases of urban entities in the database.





**FIGURE 5:** FLOW CHART OF THE PHASES OF URBAN ENTITIES PLACED ON A TIMELINE.  
THE DEFENSIVE SYSTEM OF NOYON.

- First, we process the relations of the phases of urban entities using the graph (Harris matrix). The resulting representation is an interesting way of checking data entry. In fact, although there are only nineteen phases in this example, we notice that some relations during the first data processing had been forgotten.
- Second, once the graph is established, we process data to produce a visualization of all the phases of urban entities through time (fig. 5). Each duration of phase of urban entity is placed on a timeline where markers represent a specific well known date for the phase. For example, city walls (phase 37) are specifically mentioned in a text in 1180. However, the beginning of the urban ditches isn't dated (phase 95). Since these two phases are synchronous, so the start date of ditches is the same as city walls.

We strongly believe that this tool assists in ensuring the view of source effects. As an example, the citadel (phase 99) is described by five well known dates and its relationships with other urban entities provide lots of deduced dates, up to eleven. In this case, the changes of the urban defensive system which were observed at the end of the 16th and the beginning of the 17th centuries are linked to the knowledge of the citadel dates.

In conclusion, this example reveals that a common dating system may be applied to different units of analysis and at separate scales. Moreover, this dating system is a useful tool for the visualization of source effects and it is an essential prerequisite to start an analysis of urban temporalities over the long-term.

#### **4. Functional approach of cities: Beauvais, Noyon and Saint-Quentin.**

Beauvais, Noyon and Saint-Quentin were important nodes for networks of cities in the north of France from Antiquity [376]

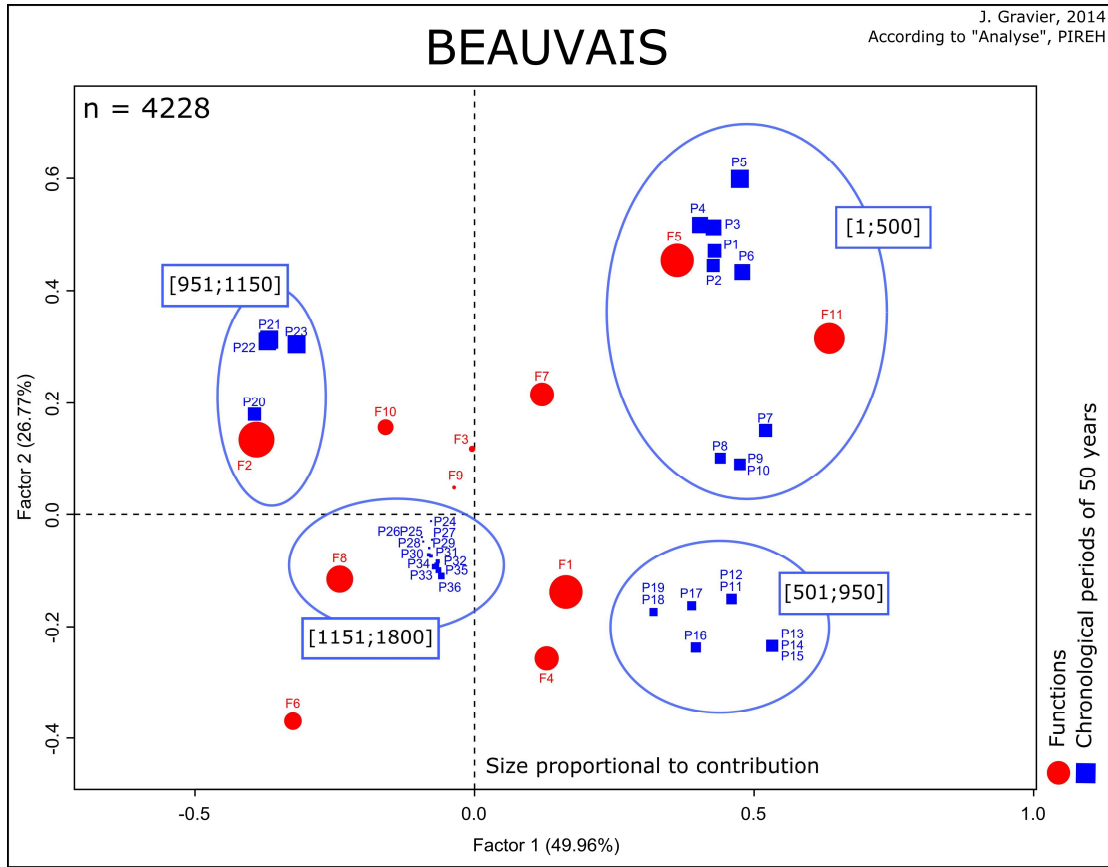


FIGURE 6: BEAUVAIS: FACTORIAL CORRESPONDENCE ANALYSIS

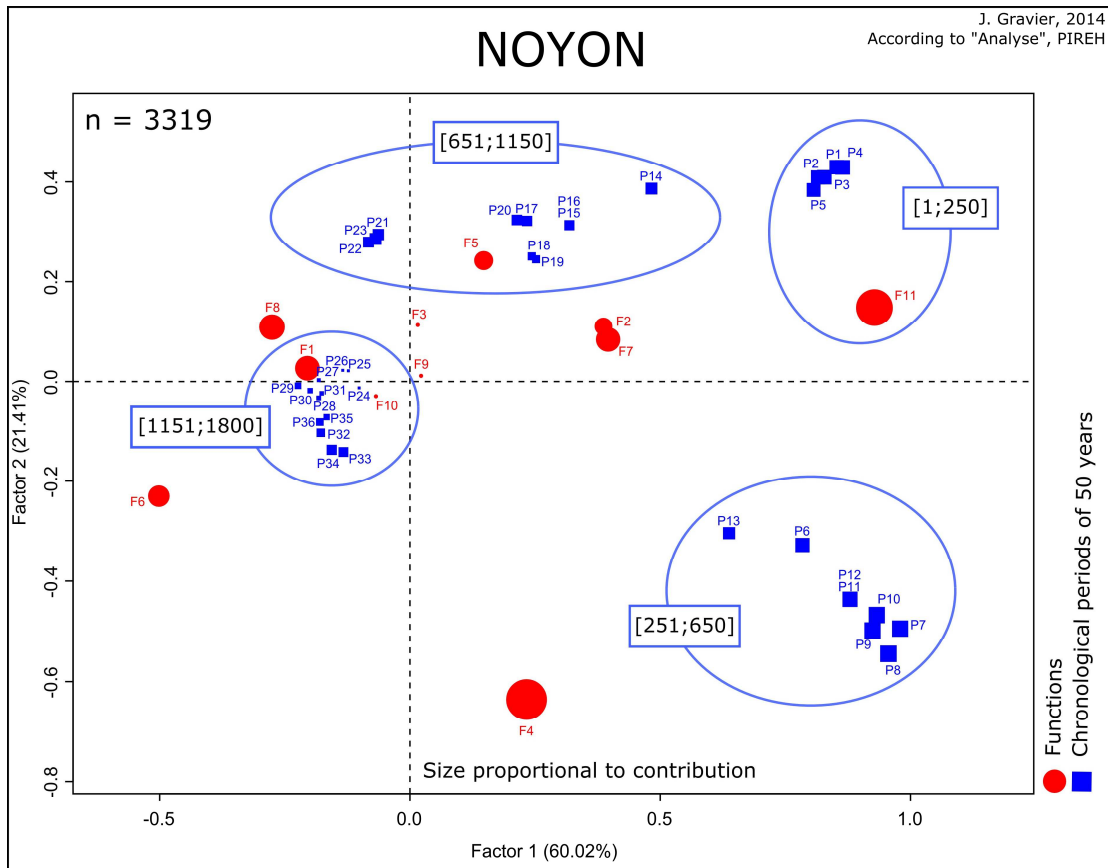


FIGURE 7: NOYON: FACTORIAL CORRESPONDENCE ANALYSIS

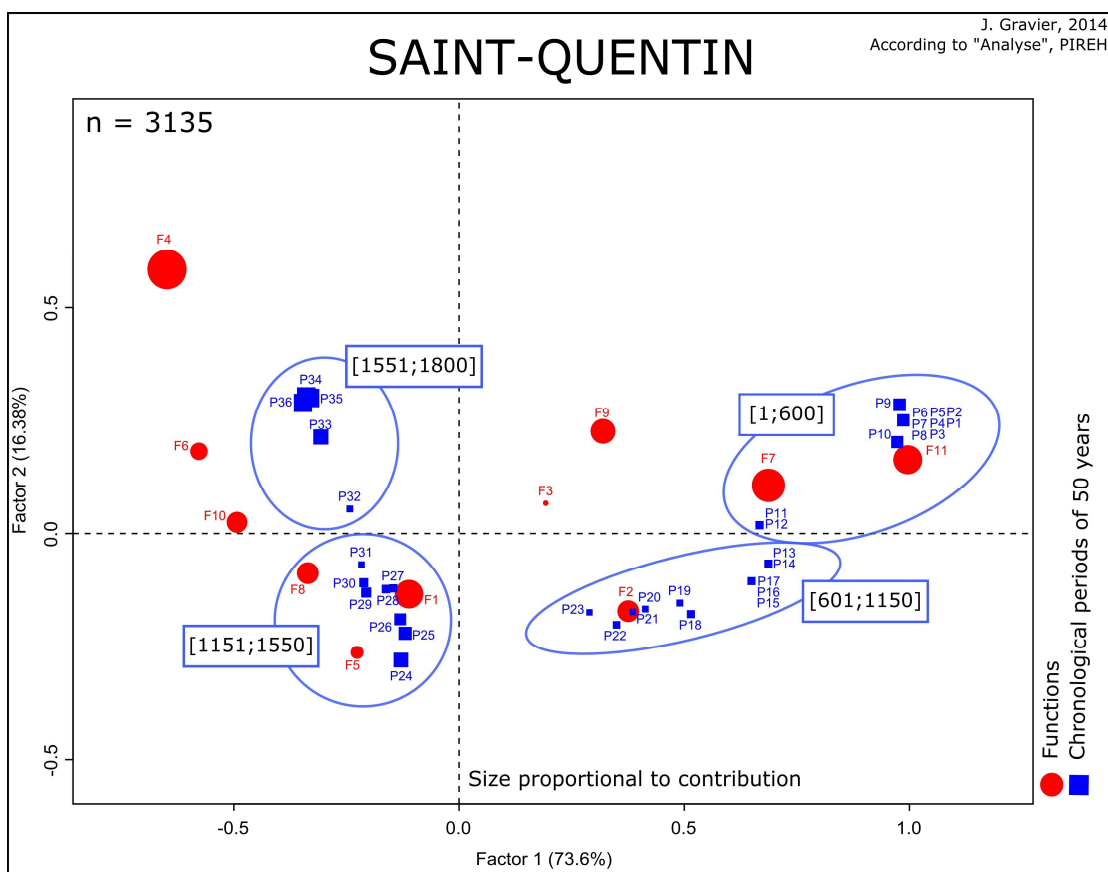


FIGURE 8: SAINT-QUENTIN: FACTORIAL CORRESPONDENCE ANALYSIS

[377] to the end of the modern age. Indeed, it appears that they were part of two systems of cities<sup>3</sup>. The first one was composed by Beauvais and the cities of the ancient *civitas*, then, of the diocese. Those towns had special political and religious relations with Beauvais, at least during Antiquity and the Middle Ages. The second network was partly composed by Noyon and St-Quentin. In this case, St-Quentin was the capital of the roman *civitas*, and then Noyon was the seat of the diocese from the 7<sup>th</sup> century (Collart, 1984). The two cities were then in direct conflict with each other during the medieval and modern periods, and neither of those towns succeeded to be an economic and a political pole of relative stability.

#### *4.1. The use of statistics in understanding change and sustainability of urban systems.*

In this section, urban temporalities are examined through multivariate statistics, which provide a systematic way to compare the trajectories of towns. Given that each urban entity is defined by numeric dates, it is possible to study the statistical distribution of urban entities through function (variables) and through chronological period (units), based on 50 years. Factorial correspondence analysis (FCA) for each town has been established<sup>4</sup> and is viewed in this paper based on the first two factors.

Four major periods seem to emerge from the analysis of the Beauvais data set (fig. 6). The first periods are mostly associated with the functions of civilian and religious public spaces, and natural formations (see the functions on tab. 1). The periods between 501 and 950 AD are linked with roads and the defensive and military system. It is probably a visualization of the importance of the city walls during Late Antiquity and the early Middle Ages, in comparison with other functions. The next periods are characterized by the function 2. The latter have a significant contribution on the factor 1 (38.8%). According to the knowledge of the city, this association can be understood as the statistical visualization of the relief and river management, which has been achieved for sheet production. Indeed, Beauvais was one of the main cities for such production during the Middle Ages and it has belonged to the Hanseatic League – a commercial confederation of cities probably created at the end of the 12<sup>th</sup> and known from the 13<sup>th</sup> century (Laurent, 1935, Carolus-Barré, 1965). The last periods are associated with the religious and host establishments. Those chronological periods have a low statistical weight on both factors. Furthermore they are especially linked with each other since these units are very similar.

Four major epochs can be distinguished from the analysis of Noyon, as in the case of the city of Beauvais (fig. 7). However, the changes do not emerge at the same time. The periods between 1 and 250 AD are associated with the natural formations and the habitat, while subsequent periods are strongly linked with the defensive and military system. This function does not have an important statistical weight on factor 1 but really does contribute to factor 2 (78.4%). Then a set of periods is portrayed by the function 5. Nevertheless, two subgroups can be observed: the periods between 651 and 1000 are more associated with functions 2 and 7 on factor 1, whereas the periods between 1001 and 1151 are further determined by function 8. The last periods make up a coherent group linked with the roads and the religious and host establishments.

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<sup>3</sup> This current study is part of a PhD, focusing on system of cities over long periods of time.

<sup>4</sup> The statistical distribution depends on the estimated dates of urban entities. Beauvais is known from the 1<sup>st</sup> to the 18<sup>th</sup> century thanks to 294 urban entities, Noyon due to 253 and St-Quentin according to 281 entities.

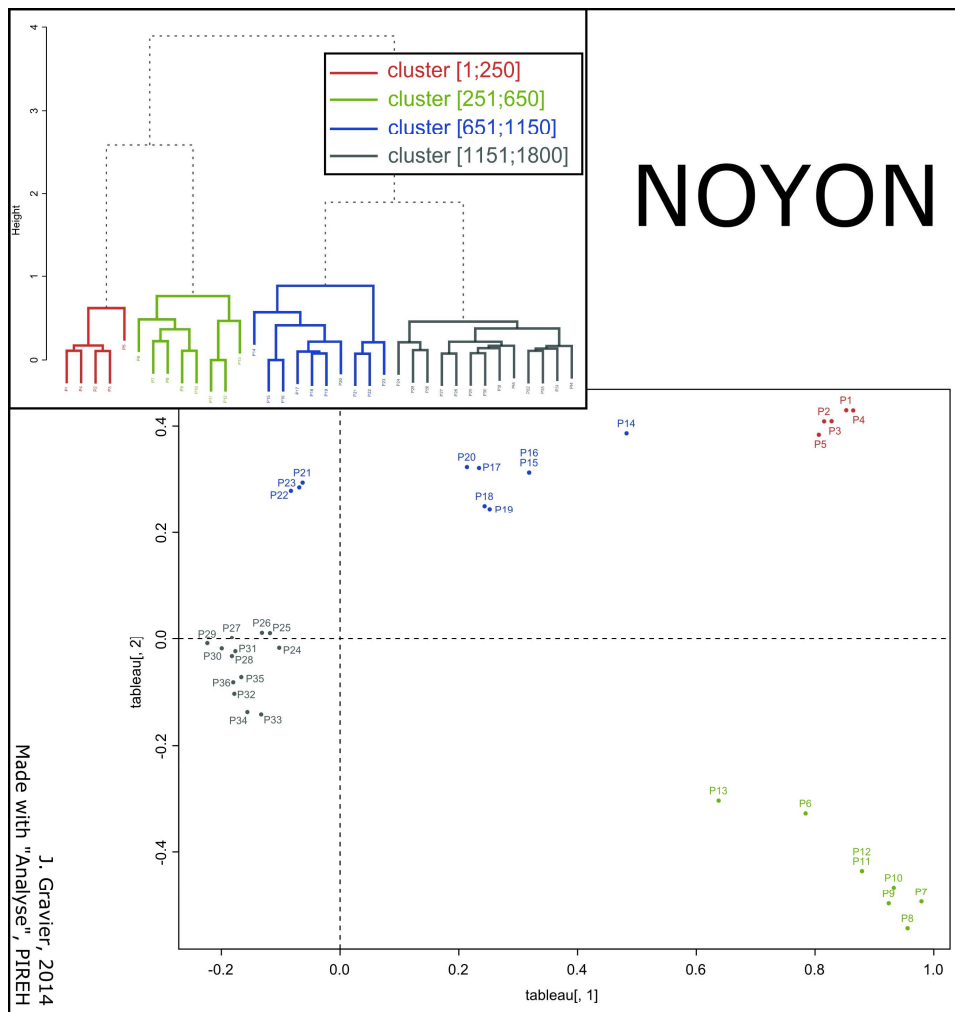


FIGURE 9: NOYON: HIERARCHICAL CLUSTER ANALYSIS ON CORRESPONDENCE ANALYSIS COORDINATES.

[378] As well as the previous towns that I just discussed in this paper, the trajectory of St-Quentin is characterized by four major ages (fig. 8). The periods between 1 and 600 AD are linked with the habitat, the natural formations and the funerary function. Unlike the cities of Beauvais and Noyon, the latter contributes to the factors. This is probably a resurgence of source effects because the knowledge of cities during the early Middle Ages in Northern Europe is incomplete due to the complexity of the stratigraphy, pictured by the “dark earth”<sup>5</sup>. Therefore, those centuries are often known only by the funerary function, as for the city of St-Quentin. Whereas for Beauvais and Noyon some others functions can be discerned, recognizing by the analysis of dark earth (Borderie, 2011). The next periods are associated with the same functions, but also with the second function on factor 2. Moreover, the period from [1151; 1550] differs from the others periods by the importance of the roads, the civilian and religious public spaces, and religious establishments. Finally the periods between 1551 and 1800 are highly associated with the

<sup>5</sup> Dark earth in archaeology represents layers that frequently separate Roman from Medieval stratigraphy (Macphail, Galinié, Verhaeghe, 2003). Those appeared to be very uniform and have been for a long time considered as gardens or abandoned zones, related to the Barbarian Invasions and a gradual collapse of cities. But current researches consider that the layers actually reflect a variety of the uses of the urban spaces.

defensive system of the city. The latter does contribute on both factors: approximately 15% on factor 1 and 54% on factor 2. These last associations reveal the building of many fortified structures in the mid-16<sup>th</sup> century.

In order to complement and to specify the FCA, a hierarchical cluster analysis of the coordinates has been performed. Indeed, it seems necessary to explore chronological periods clusters with this technique, since it involves the data processing of all factors. For example, the process has been applied to the city of Noyon (fig. 9). The associations of chronological periods which have emerged are the same as for the correspondence analysis, probably because the cumulative contribution of the first two factors is 81.4%. However, this process strengthens the assumptions adopted in the previous statistical approach, and thus, provides a basis to the establishment of a comparative approach of the towns.

#### ***4.2. A comparative approach of three towns: specificities and recurrences of urban trajectories.***

The multivariate statistical analyses imply a generalization of information, and consequently, facilitate a comparative approach, specifying the recurrences and the particularities of urban trajectories. As we have been able to note, each town is characterized by functional changes during the middle of the 12<sup>th</sup> century (fig. 6, 7 & 8). After that date, the periods are strongly associated, excepted for the periods between 1551 and 1800 in the city of St-Quentin. However, the statistical pattern of Beauvais and Noyon during the chronological interval [1151; 1800] is really similar: the periods have low statistical weight and they are linked with the host and religious establishments. This functional profile probably demonstrates that the urban landscape did not vary much from the 12<sup>th</sup> to the 18<sup>th</sup> century. Even though the periods between 1151 and 1550 of St-Quentin are analogous to the other two cities, an important change is visible during the mid-16<sup>th</sup> century. The most recent periods are associated with the defensive and military system because the town had become highly fortified. Indeed, St-Quentin was a border city and a strategic node at that time.

Furthermore, for the three cities, the oldest periods are characterized by different time of changes. This situation probably depends on source effects since the documentation is truly incomplete during that epoch. However, it could also be a picture of the different trajectories of the cities over time, well known in the scientific literature. Beauvais is the capital of an ancient *civitas* and the seat of a diocese (1<sup>st</sup>-18<sup>th</sup> century), while St-Quentin is only known as the capital of a *civitas* (1<sup>st</sup>-5<sup>th</sup> century), and Noyon as the capital city of a diocese (7<sup>th</sup>-18<sup>th</sup> century). Therefore, the particularities of each town could affect the intra-urban functional profiles; but the only way to disentangle these two assumptions is to conduct additional analyses on others cities.

The research should also be supplemented by a detailed analysis of networks of cities over long periods of time, where Beauvais, Noyon and Saint-Quentin have existed. This could lead to a second point of view of the towns on a different scale and would allow an interesting prospect of the results.

Moreover, we would like to conduct a study of the three towns from Antiquity to nowadays, which is already the case for the city of Noyon, since this would enable an overview of the changes of urban systems.

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