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Proposal of a Computerized Management Model for Real Estate Titles in a Non-Urbanized City Based on Geolocation and Web- Mapping

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Abstract: This study is part of an approach to improving land management in a city. Its main objective is to develop and implement an innovative digital application capable of facilitating the management, archiving and consultation of real estate titles. The problem of this research lies in the difficulties encountered by the Real Estate Titles Division in effectively managing land files due to the lack of a suitable digital tool. Land conflicts, due in particular to land fragmentation and fraud, are frequent and complicate the situation. In order to address this issue, we formulated the hypothesis that a technological solution integrating geolocation and web- mapping could optimize the process of allocating land titles. To validate this hypothesis, we conducted a field study combining documentary techniques, interviews and direct observations. This study allowed us to identify the specific needs of users and to design an application that meets the challenges of land management in a non-urbanized city. The methodology used is based on the UP approach for system design and on the structural-functional approach for the analysis of the existing system. These methods made it possible to identify the strengths and weaknesses of the current system and to define the functional specifications of the new system. The results of this study are very encouraging. The application developed has demonstrated its ability to efficiently manage land titles, improve productivity and reduce the risk of errors. It also offers greater transparency in the management of land files. In the end, this study allowed to develop an innovative and efficient digital solution for the management of real estate titles in a non-urbanized city. The results obtained open up interesting perspectives for the modernization of land management in a region.

Keywords*: *Land TITLES, Geolocation, Web- MAPPING, GIS (Geographic Information System), Geographic DATABASE, LAND REGISTRY.

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I. INTRODUCTION

In the Democratic Republic of Congo, and more particularly in the city of Bukavu in the province of South Kivu, the adoption of new information and communication technologies (NICT) in the various sectors of activity remains limited, if not non-existent. This gap is particularly glaring in the field of land management, even though geomatics, the science of geographic information, offers essential tools to remedy it.

Despite the vast Congolese territory and the diversity of its resources, which require precise and up-to-date geospatial data to support development policies, geomatics remains underused. However, effective land management is a crucial issue for any country, and the land register is a fundamental pillar. Current practices in terms of land occupation and use frequently give rise to conflicts between populations and between authorities and habitats.

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Furthermore, the excessive fragmentation of plots, observed in most municipalities, further complicates land management. This situation leads to difficulties in land use planning and encourages disputes between owners. A precise delimitation of plots, made possible by geomatics, would make it possible to avoid these conflicts and optimize land use.

After observation, we found that the land registry in a non-urbanized city encounters many of the difficulties in the management of real estate titles in this region, including:

- Land conflicts that arise from various sources, such as disputed property claims, poorly defined boundaries due to poor land fragmentation .
- Lack of automatic document backup system, which makes this division vulnerable in case of disasters like fire, flood, etc.
- Administrative complexity in initial title issuance, property transfers, updates and corrections. These manual processes can be prone to human error and delays as there is no centralised database for land titles, which also creates difficulties for stakeholders such as owners, planners and authorities seeking to access property information.
- Referring to the problems found, the following question needs to be asked: " Can the use of a geolocation and web- mapping based application improve the process of granting land titles by the Land Titles Division in a city?"

- *The Latter gives Rise to other sub-Questions which are as follows:*

- Is there a **computer system** for recording information relating to land title files?
- What should the Bukavu land registry do to significantly reduce the number of land conflicts arising from contested property claims, **poorly defined borders** while avoiding **land fraud** and **double titling** ?
- How should the land registry proceed to facilitate the safeguarding and centralization of information on land titles?
- The research hypothesis is a proposition formulated by the researcher and which aims to explain a phenomenon or to answer a research question (al. P. B.).
- Taking into account the concerns raised at the problem level, the hypotheses of this work can be formulated as follows:
- The transition to modern land management systems would be a solution to the problems linked to poor land fragmentation in the city of Bukavu.
- The design and implementation of a web application for land title management based on Web -Mapping would help the Land Titles Division to significantly reduce the number of land conflicts arising from contested property claims due to **land fraud** , **double titling;**
- Can the creation of a geographic database facilitate the saving and centralization of up-to-date information on land titles and owners while ensuring their security;
- In view of the above, the overall objective of this work is to propose a web application that will be based on geolocation and Web- Mapping , for the automation of the management of land titles in a city by the land registry.
- This work has the following specific objectives:

- To analyze the current problems of land title management in a non-urbanized city, the sources of these problems as well as the proposal of some solutions;
- Establishment of a geographic and cartographic database for the digitalized and centralized management of plots in this city;
- The design and creation of a computer system with a direct link to our geographic and cartographic database which will allow simple, transparent and centralized management of land titles with digital surveying.

II. METHODS AND TECHNIQUES

A. Presentation of Methods and Techniques

Mainly the UP or Unified method Process is a **software design/development process** . This computer method helped us in the design of the new computer system for managing land titles. It was accompanied by the structural-functional method. This method helped us to know the functioning and organization of the land registry of the city of Bukavu to have an idea on the non-computerized management of the granting of land titles and to understand the functioning of the organization chart within this establishment to allow us to make an analysis of the existing;

Both methods were supported by research techniques, the latter being a set of tools and procedures implemented to collect and analyze the data needed to conduct research. They emphasize the importance of choosing a technique that is appropriate to the research question and the objectives of the study. In this work, the following techniques were used:

The documentary technique, it led us to consult certain documents and/or works such as dissertations relating to the field of our study, to consult the documents used in the management of land titles. The interview technique, Thanks to this technique, we had interviews with the agents of the land registry of the city of Bukavu, We discussed how the process of granting land titles in the city of Bukavu is carried out as well as the means used to carry it out. The observation technique, this technique allowed us to go down to the field to observe what is done at the DTI in the context of issuing land titles in order to bring out constructive criticism. It was very useful to us in collecting data by observing what is happening on the ground.

B. Choice of Computer Modeling tool

There are several tools capable of modeling here we used the UML language using the Visual Paradigm UML software; we started by capturing the functional need.

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Table 1 Capturing user Needs

Actors	Roles
Archivists	- View plot information - Print reports; - Archive files;
Surveyors / Geometers	- Record, edit and view plot information; - Measure and draw plots; - Manage the summits; - Visualize the layers;

This was in relation to the architecture of a Web- Mapping application is based on that of the web. Here, in addition to the web and data servers, we have the map server. Depending on the client's request to the map server, the desired data is returned to the client in the form of a map. Below is the architecture of a Web- Mapping application.

C. Architecture of The Web-Mapping Application

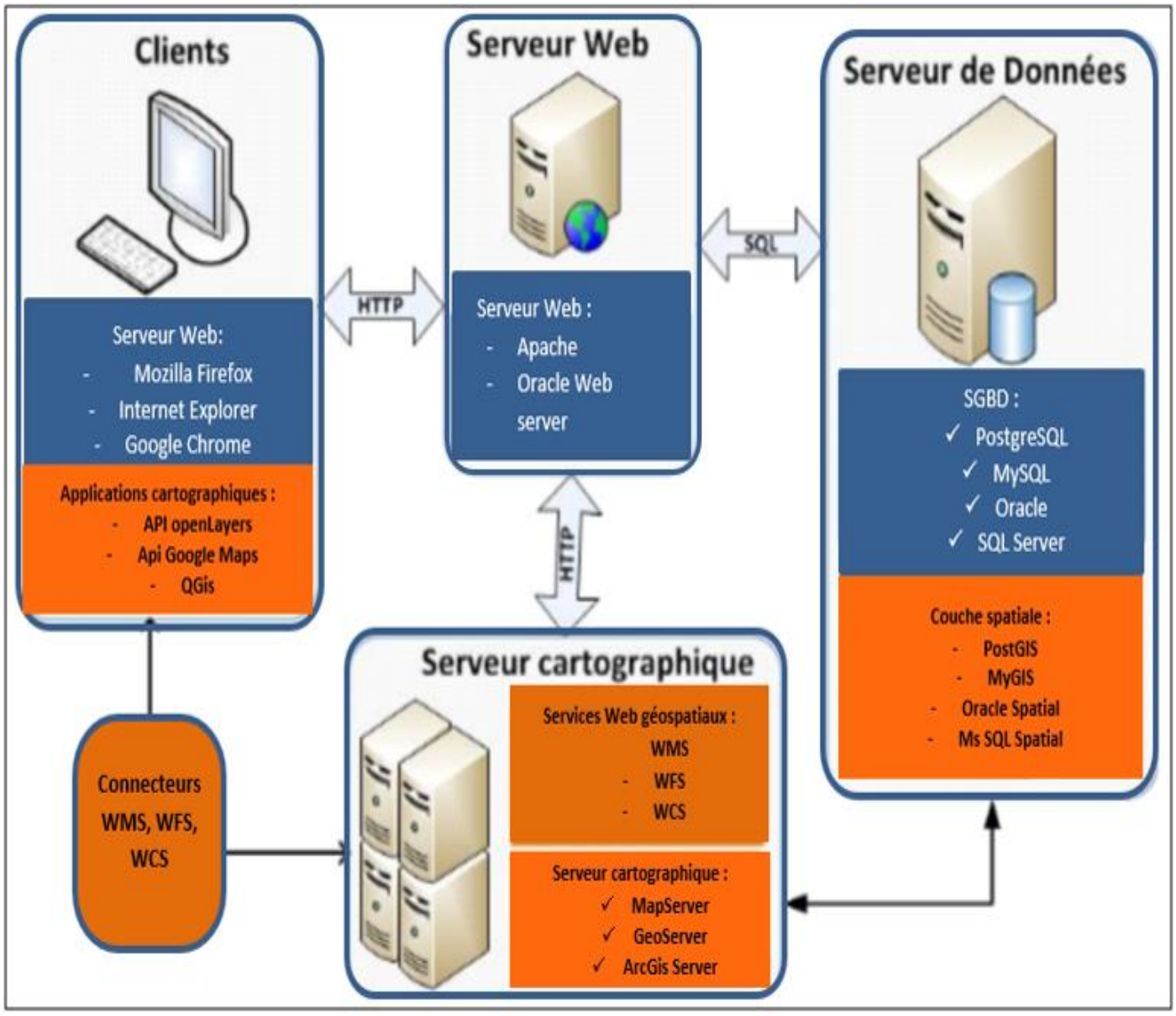

Fig 1 Architecture of the Web-Mapping Application

➢ *System Modeling By UML*

A use case diagram is a visual tool used in software engineering to represent interactions between users (called "actors") and a system. (https://fr.wikipedia.org/wiki/Diagramme_de_cas_d%27utilisation, s.d.)

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D. Use Case Diagram (Land Title Management)

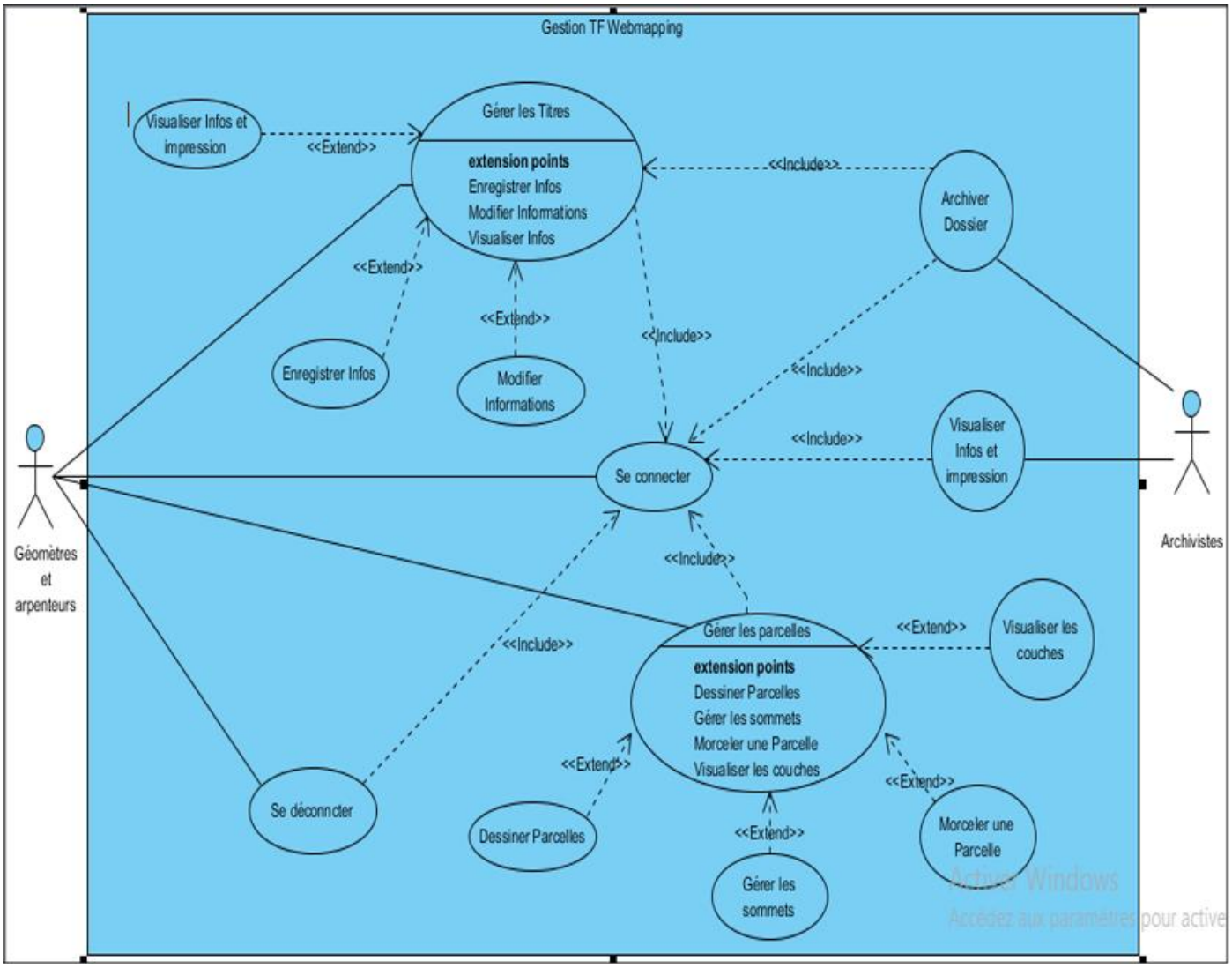

Fig 2 Use Case Diagram

E. Identification and Textual Expression of the use cases Presented in Figure 9

➢ *Log in to the System*

Table 2Detailed Connection Case

CU1	**Log in to the system**
Authors	Archivists, Surveyors, Geometers
Triggering event	Nothing
Interest	It allows you to authenticate to the system
Precondition	Server Startup
Post condition	Access the user interface
Nominal scenario	1. The user enters the website address 2. The system displays the login form 3. The user provides login information and requests a connection to the server 4. The server responds
Extension	No
Constraints (alternative scenario)	2a. the address is not filled in: go to point 1 3a. the form is not completed: go to point 2 4a. the server does not respond: go to point 2 4b. the server returns an error message: go to point 2

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- *Registration Info*

Table 3Detailed Case Record Plot Information

CU2	**Save plot information**
Author	Surveyors, Geometers
Triggering event	Click on the add button
Interest	It allows you to record information about the plot
Precondition	Log in to the system (CU1)
Post condition	Retrieving connection information
Nominal scenario	1. User requests registration page information 2. The system displays the registration form 3. User completes and submits the registration form 4. The server responds
Extension	
Constraints (alternative scenario)	3a. the form is not completed: go to point 2 4a. the server does not respond: go to point 2 4b. the server returns an error message: go to point 2

- *Modification of plot information*

Table 4 Modification of Plot Information

CU3	**Editing plot information**
Author	Surveyors, Geometers
Triggering event	Click on the edit button
Interest	It allows you to update the information of a plot
Precondition	Log in to the system (CU1)
Post condition	Record plot information
Nominal scenario	1. The user requests the information modification page. 2. The system displays the info edit form. 3. User edits information and submits registration form; 4. The server responds
Extension	No
Constraints (alternative scenario)	2a. the server returns an error message: go to point 1

- *Archiving File*

Table 5 Archiving File

CU4	**File archiving**
Author	Archivist
Triggering event	Click on the archive button
Interest	It allows you to archive a closed file
Precondition	• Log in to the system (CU1) • Record plot information
Post condition	
Nominal scenario	1. The subscriber requests the document page; 2. The server responds; 3. Click to archive the document;
Extension	No
Constraints (alternative scenario)	2a. the server returns an error message: go to point 1

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➢ *Draw plot*

Table 6 Draw plot

CU5	**0Draw plot**
Author	Surveyors, Geometers
Triggering event	Click on the button click on validate
Interest	It allows you to draw a plot
Precondition	Log in to the system (CU1)
Post condition	Draw plot
Nominal scenario	✓ Activating the layer to make the drawing ✓ Draw the plot
Extension	No
Constraints (alternative scenario)	2a. the server returns an error message: go to point 1

➢ *View information*

Table 7 View Information

CU6	**View your title information**
Author	Surveyors, Geometers, Archivists
Triggering event	Click on the view button
Interest	It allows you to view information about the plot or title
Precondition	Log in to the system (CU1)
Post condition	View plot information
Nominal scenario	• Opening the information visualization page; • Selecting the plot to display; • Click on the view button
Extension	No
Constraints (alternative scenario)	2a. the server returns an error message: go to point 1

➢ *Printing Documents*

Table 8 Printing Documents

CU7	**Print documents**
Author	Archivist
Triggering event	Click on the print button
Interest	It allows you to print documents from a specific folder.
Precondition	Log in to the system (CU1) and check the section number
Post condition	Print documents
Nominal scenario	1. Selecting the section number and document to print 2. Request to print the document;
Extension	No
Constraints (alternative scenario)	2a. the server returns an error message: go to point 1

F. Sequence Diagram

We complete the description of the use cases identified by the sequence diagrams. The sequence diagrams allow to represent the collaboration between the actors, the system and the objects from the temporal point of view. In its elaboration, we highlight the chronology of the sending of messages.

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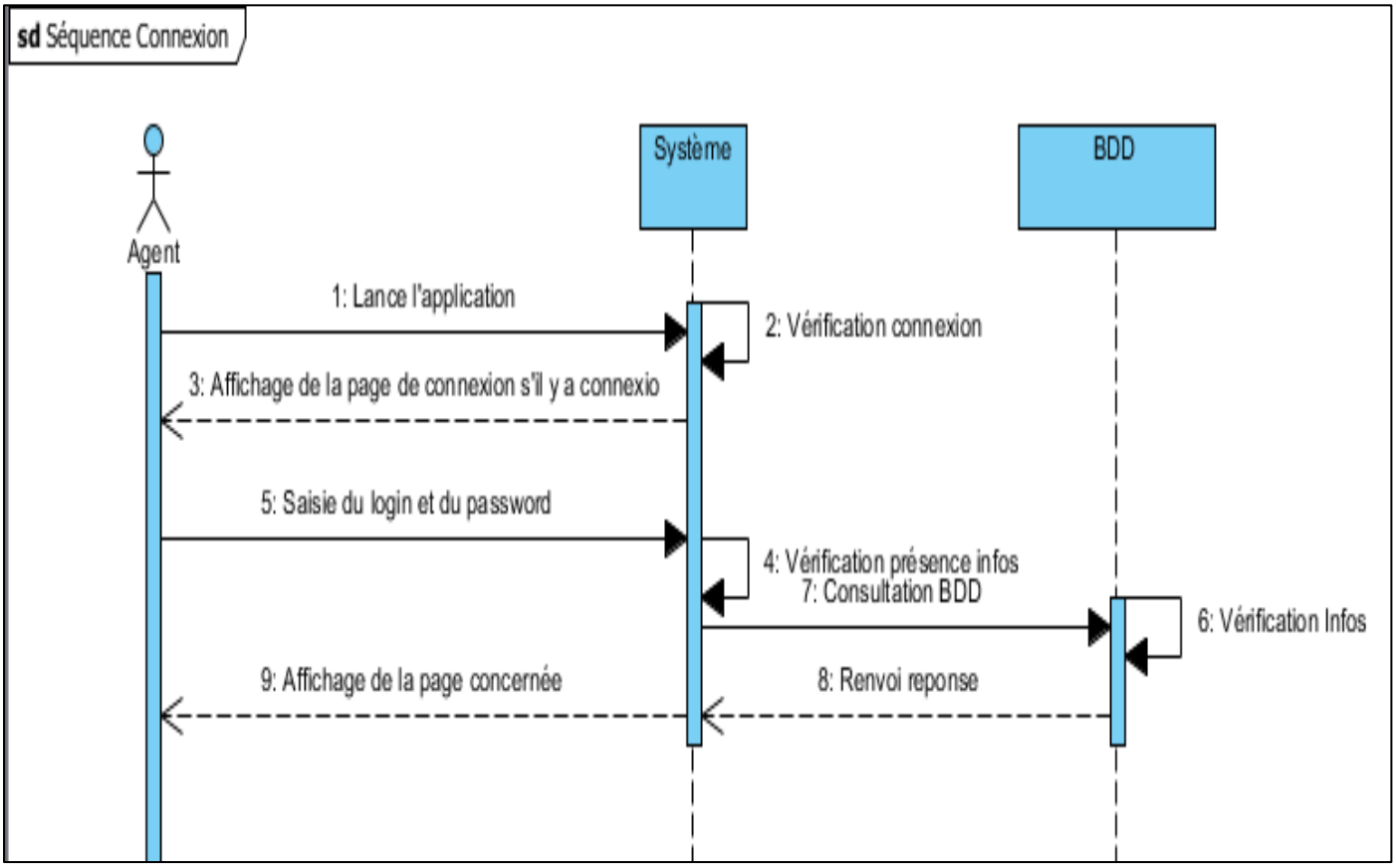

Fig 3 Connection Sequence

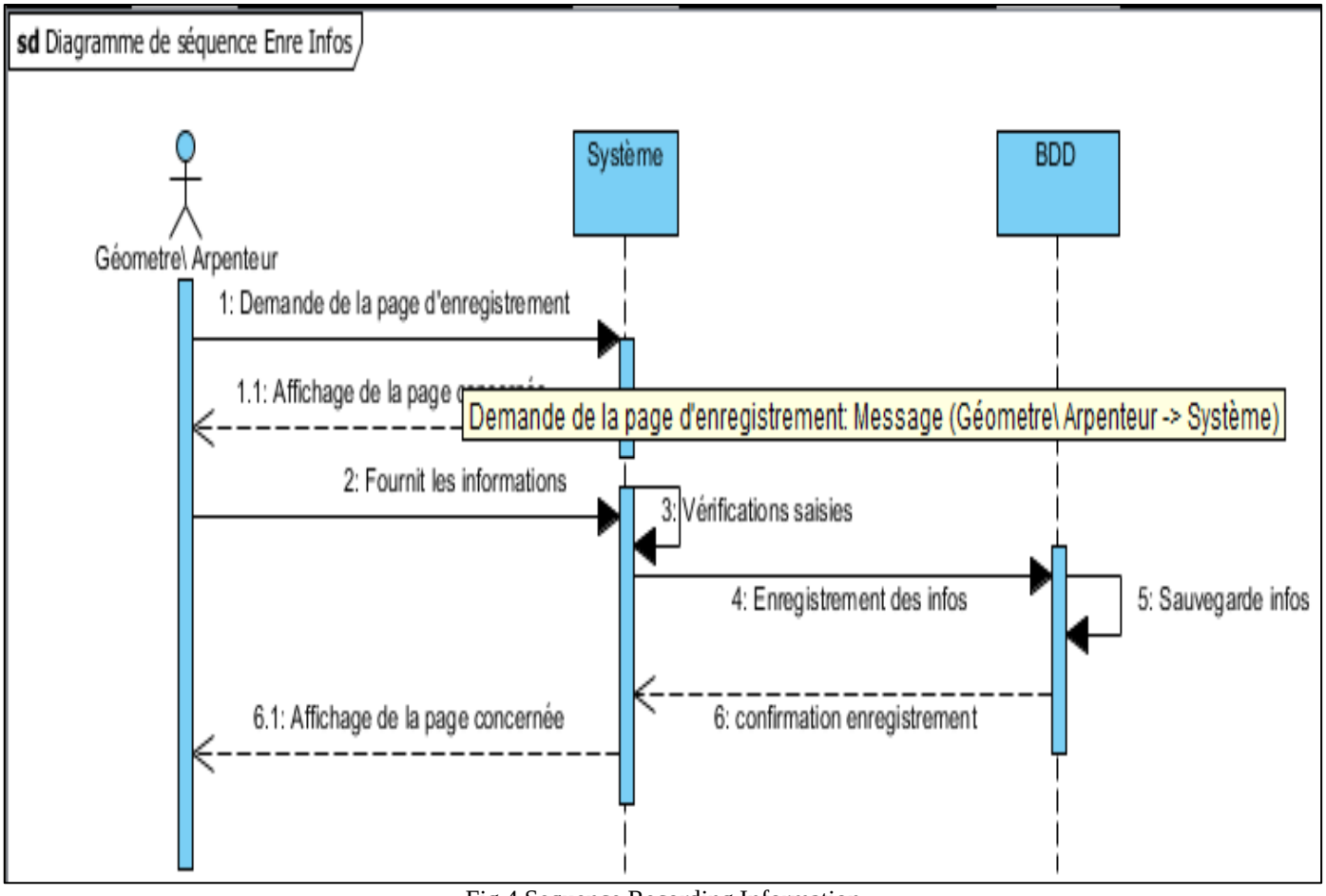

Fig 4 Sequence Recording Information

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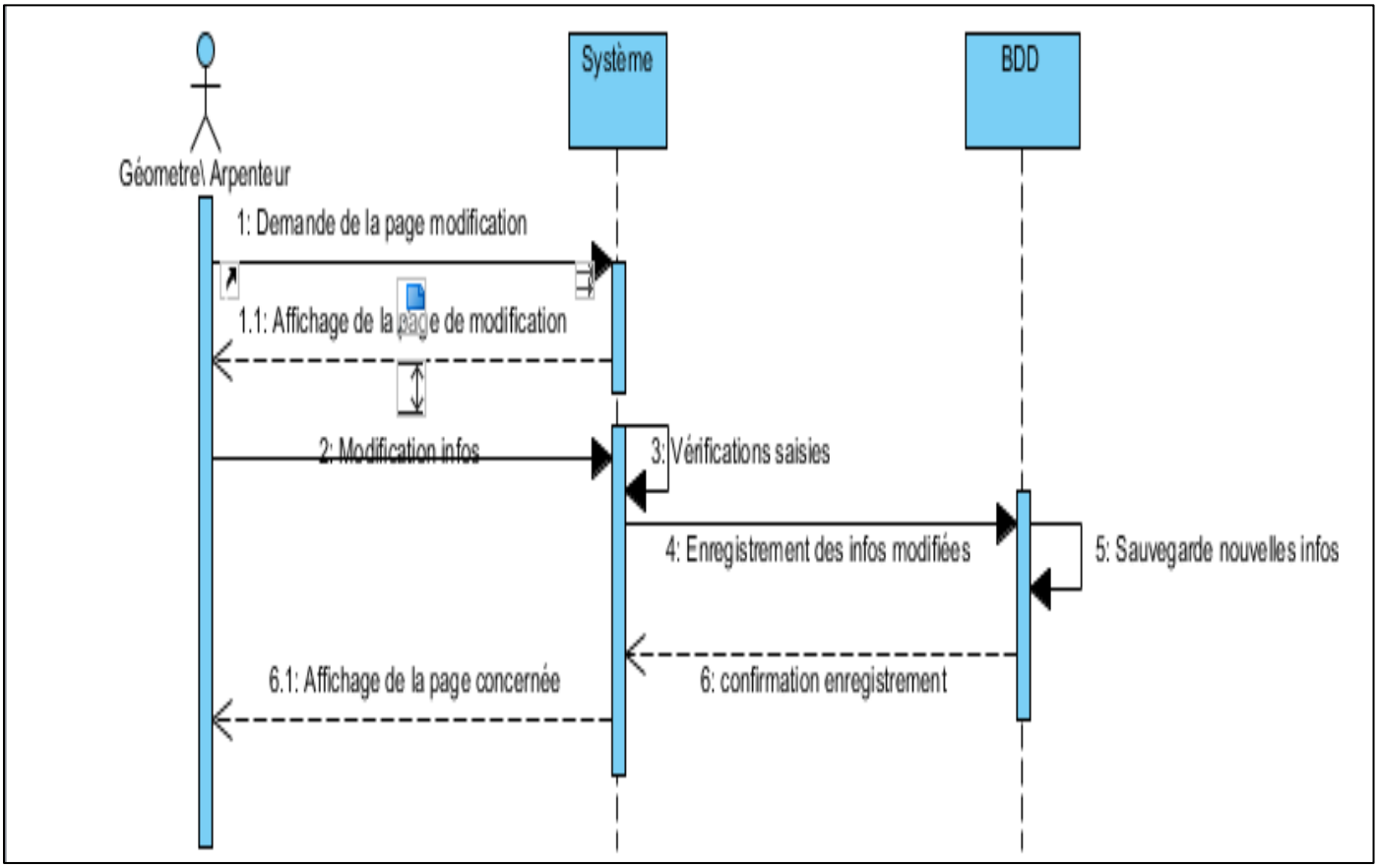

Fig 5 Sequence Modification Information

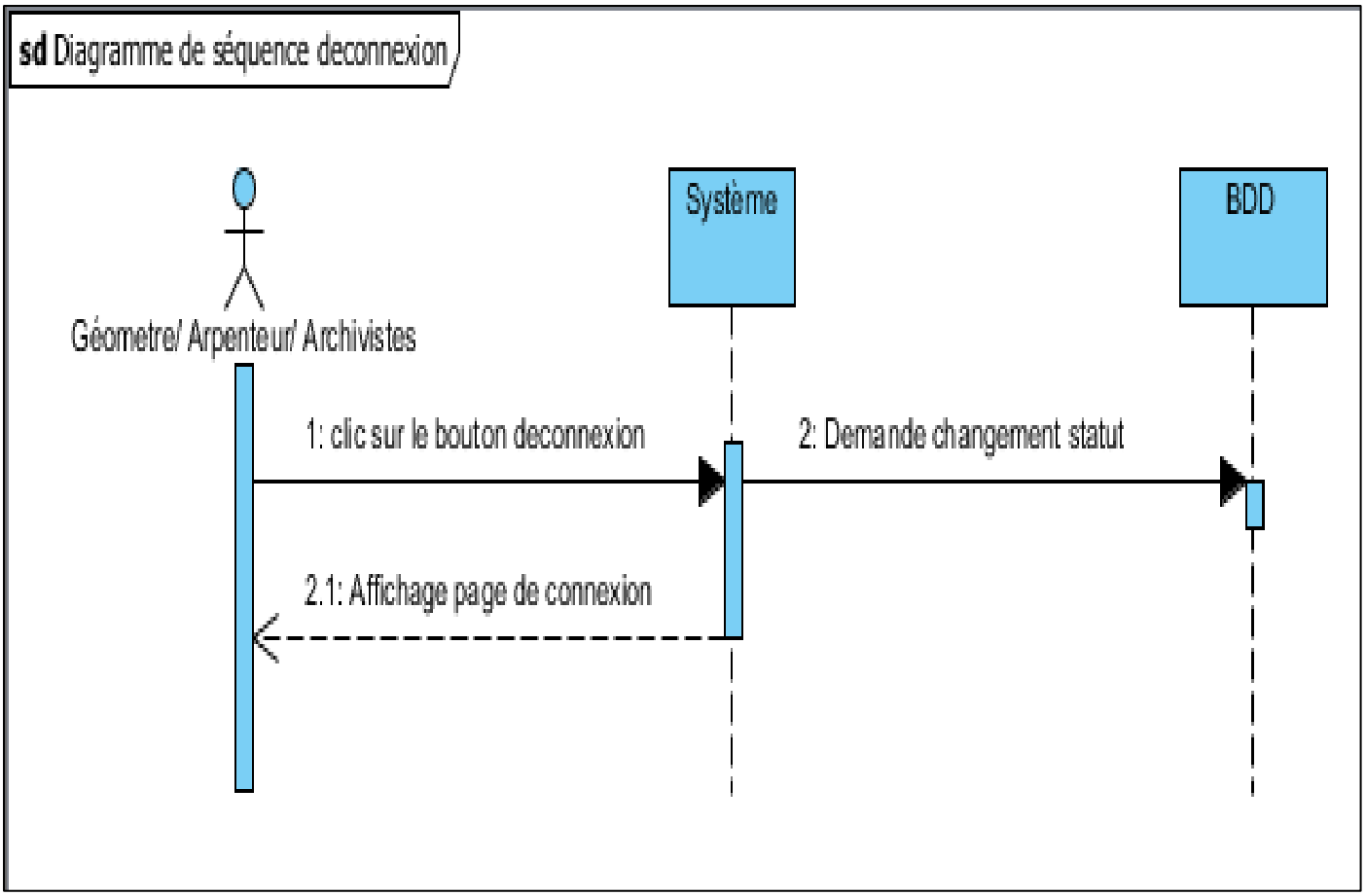

Fig 6 Disconnection Sequence

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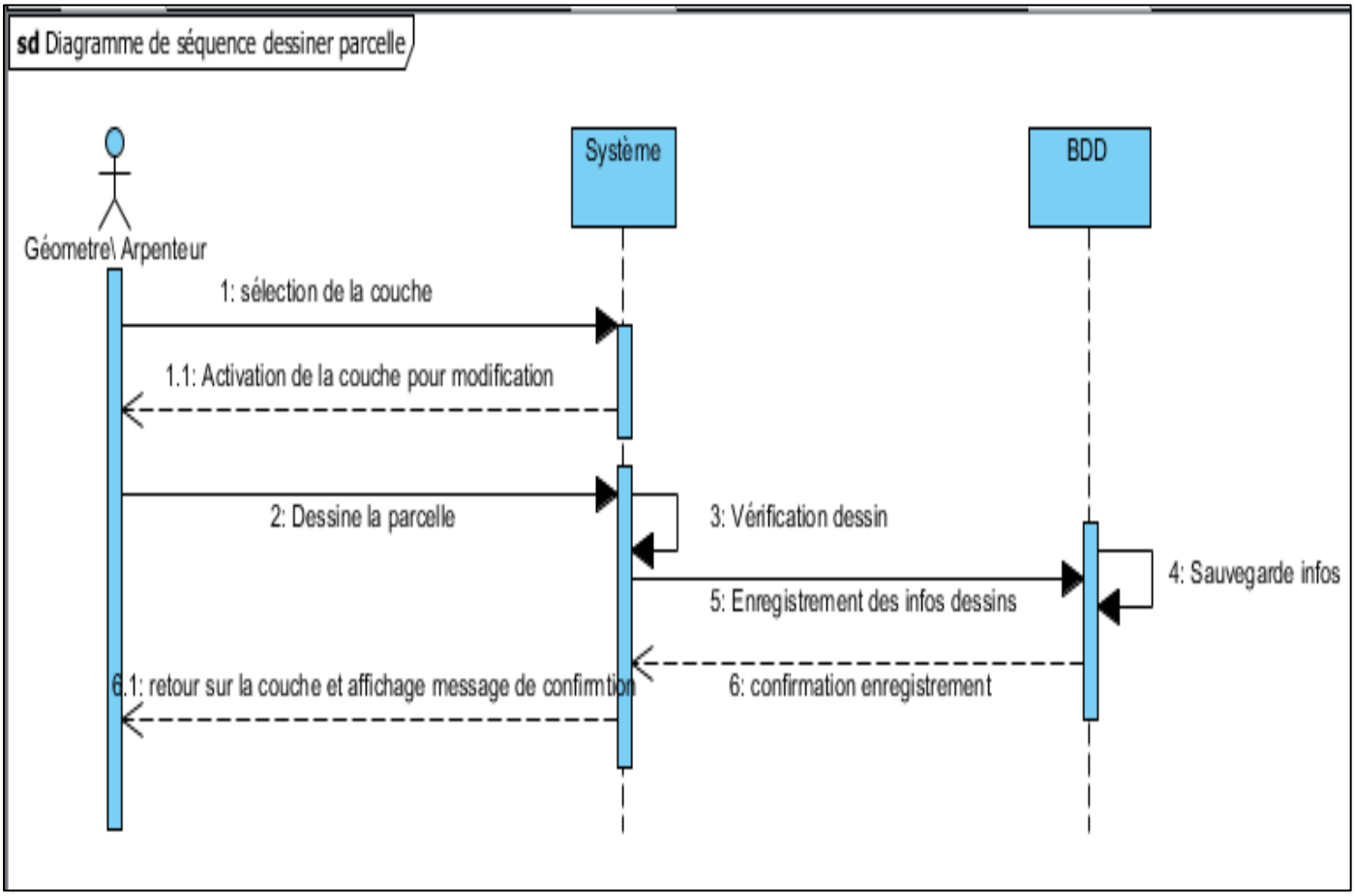

Fig 7 Plot Drawing Sequence

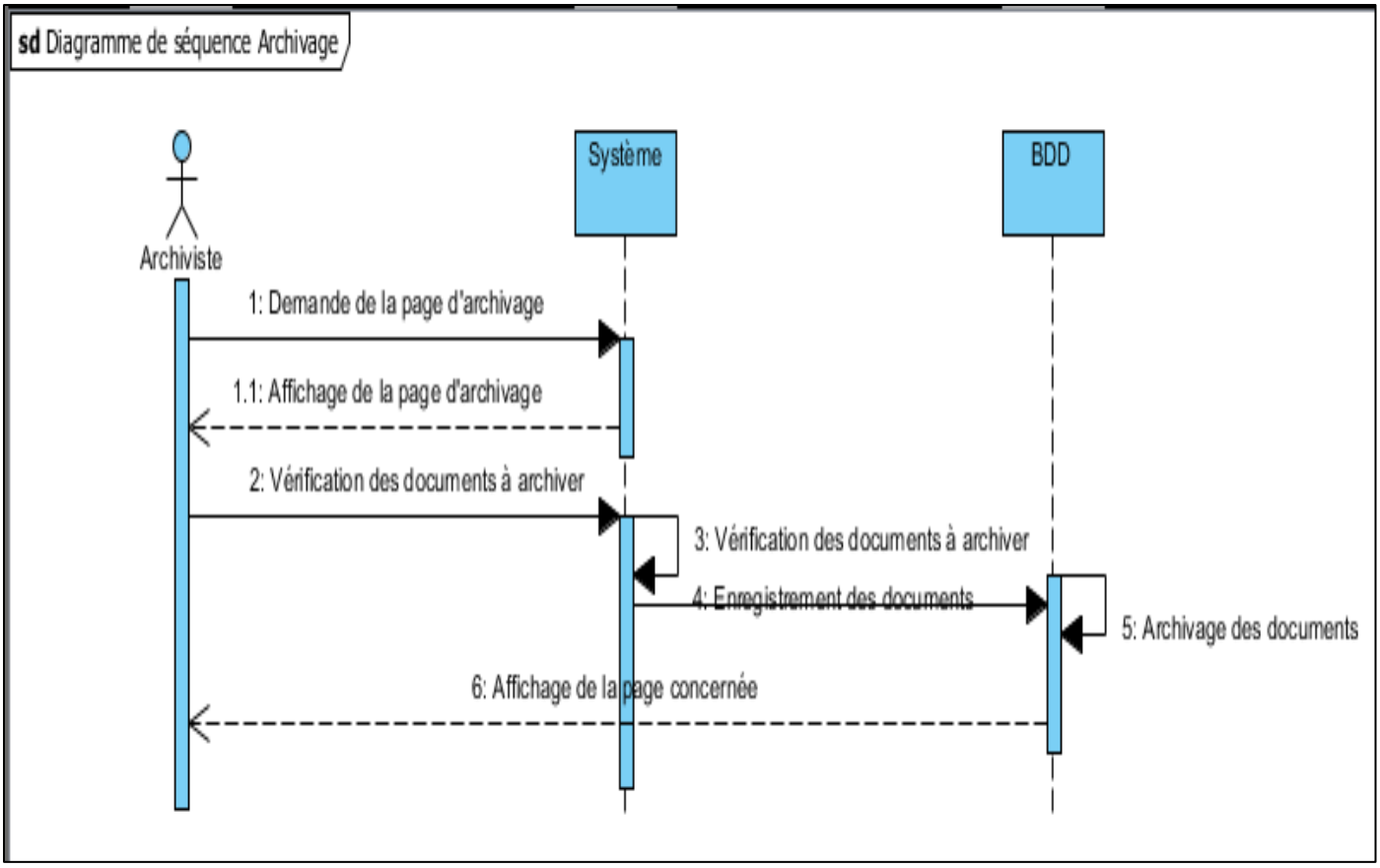

Fig 8 File Archiving Sequence

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1. Activity Diagram

The activity diagram is attached to a class category and describes the progress of the activities of a category. The progress is called " control flow ". It indicates the part taken by each object in the execution of a job. It will be enriched by the sequencing conditions. It may include synchronizations to represent parallel progress. The concept of activity corridor will describe the responsibilities by distributing the activities between the different operational actors. (https://www.ibm.com/docs/fr/dmrt/9.5?topic=diagrams-activity, s.d.).

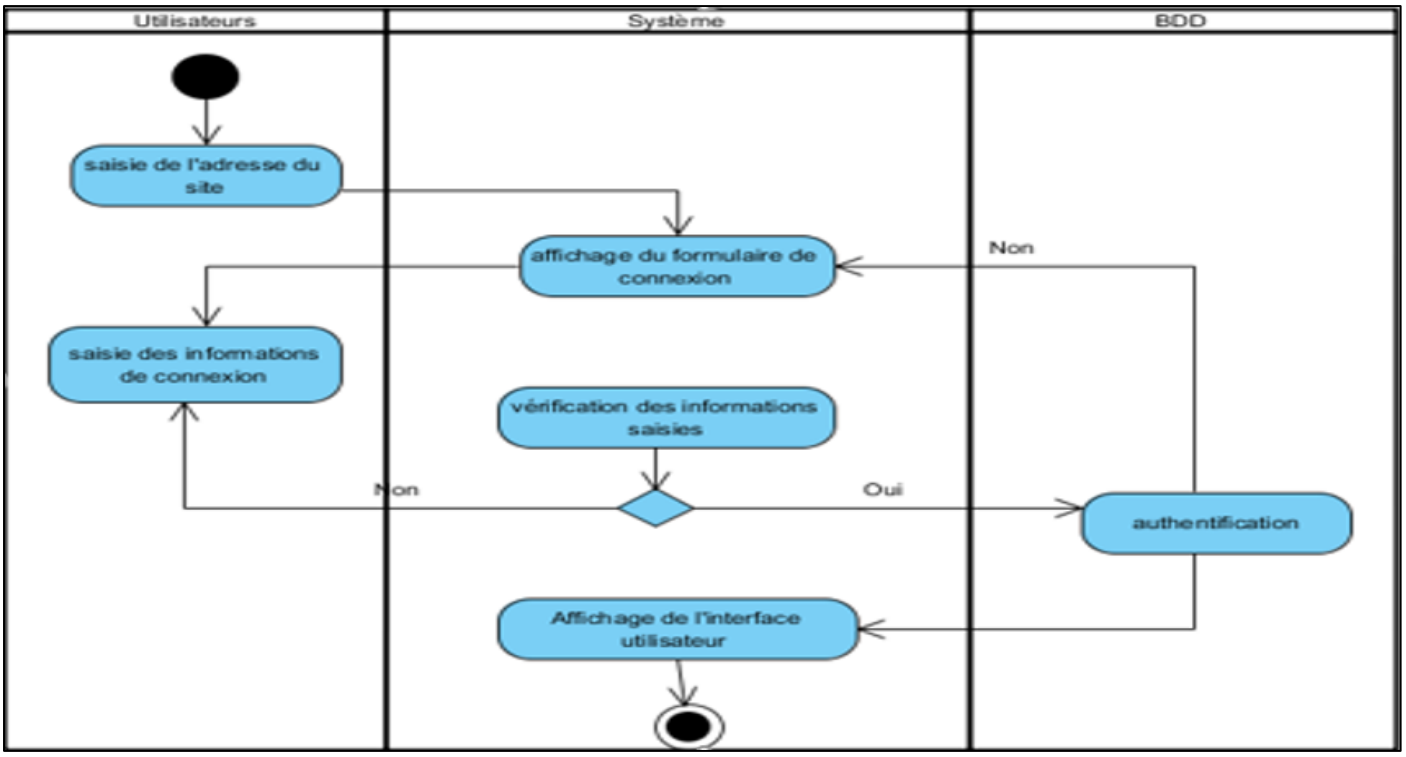

Fig 9 Activity Login

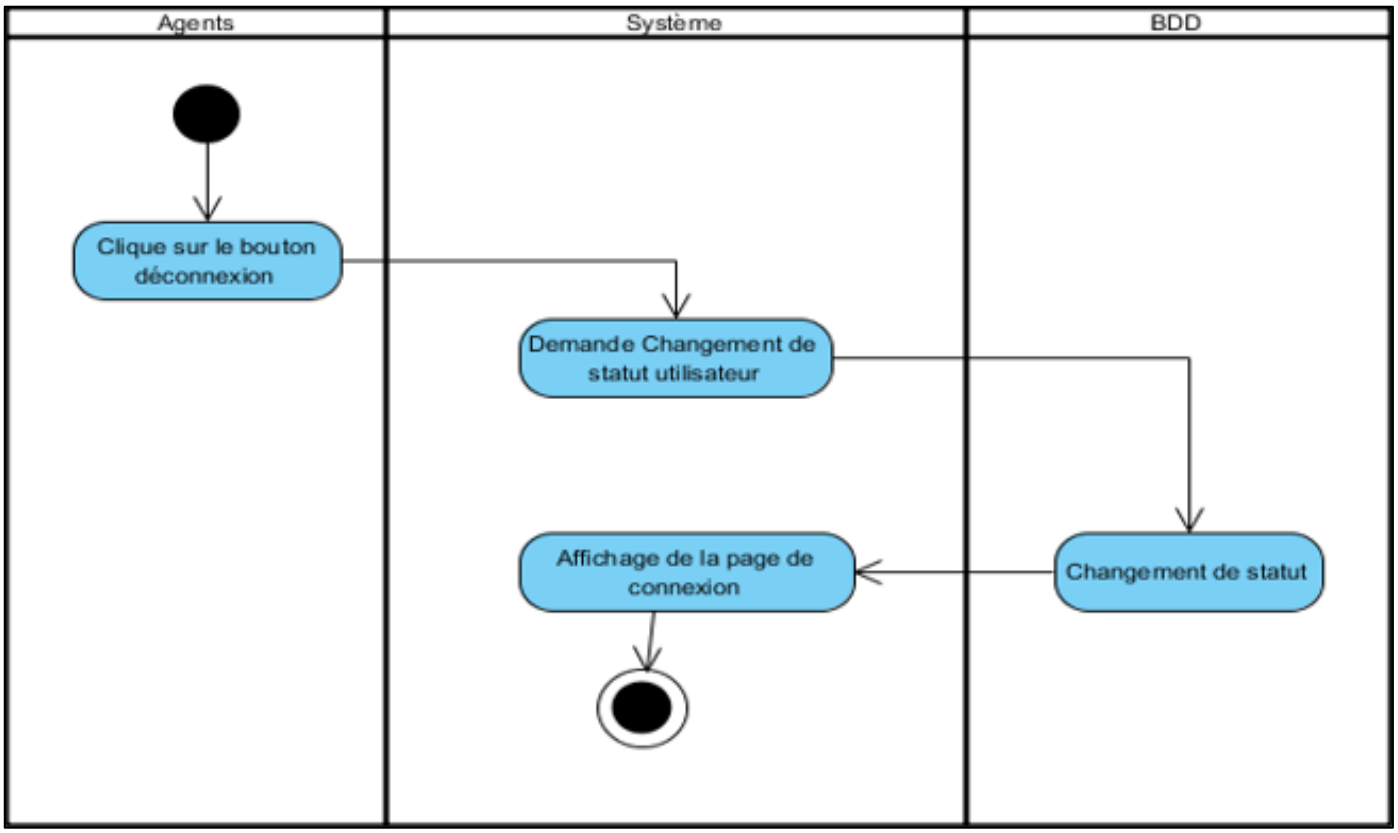

Fig 10 Activity Logout Diagram

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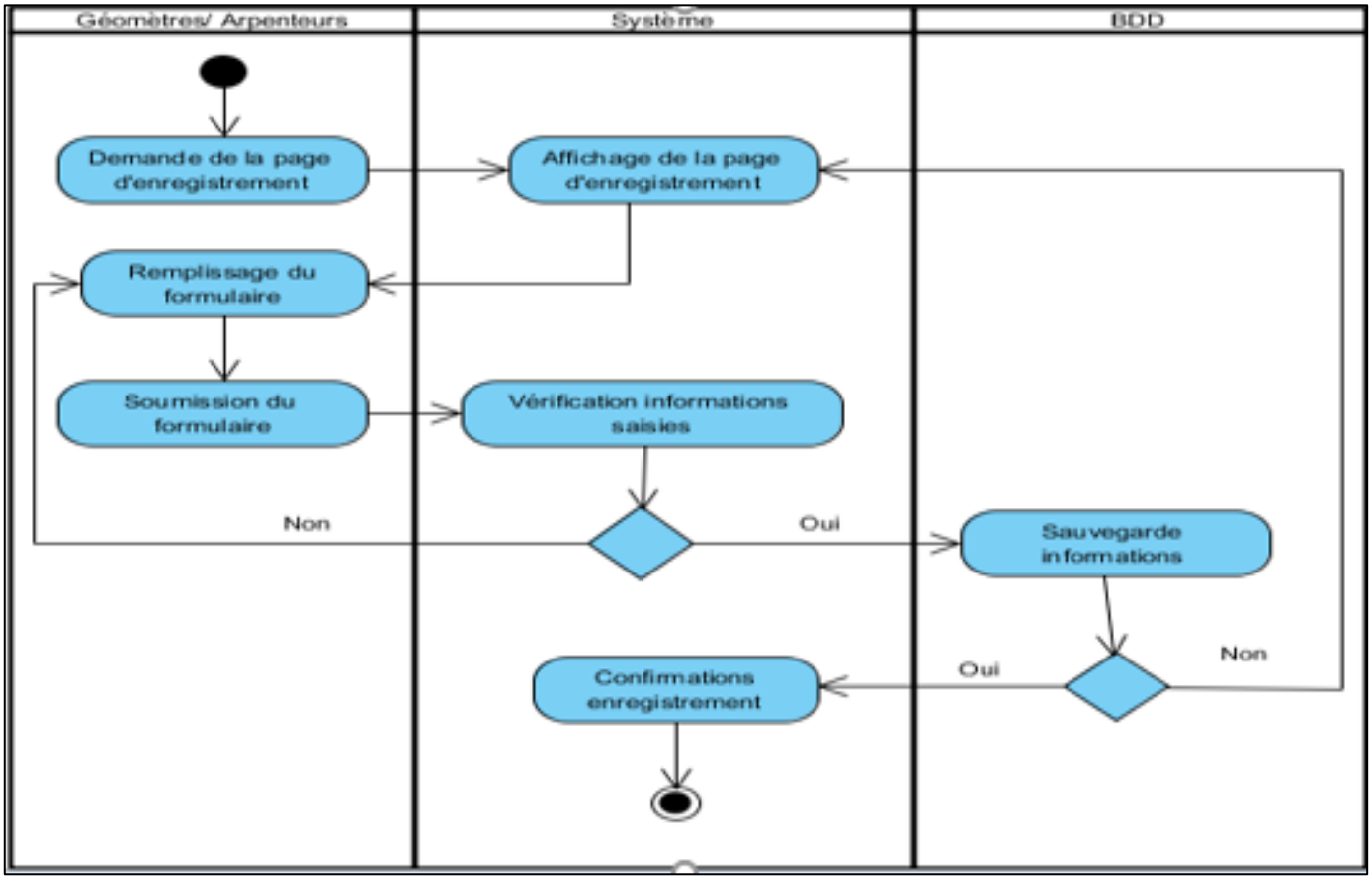

Fig 11 Save Plot Information

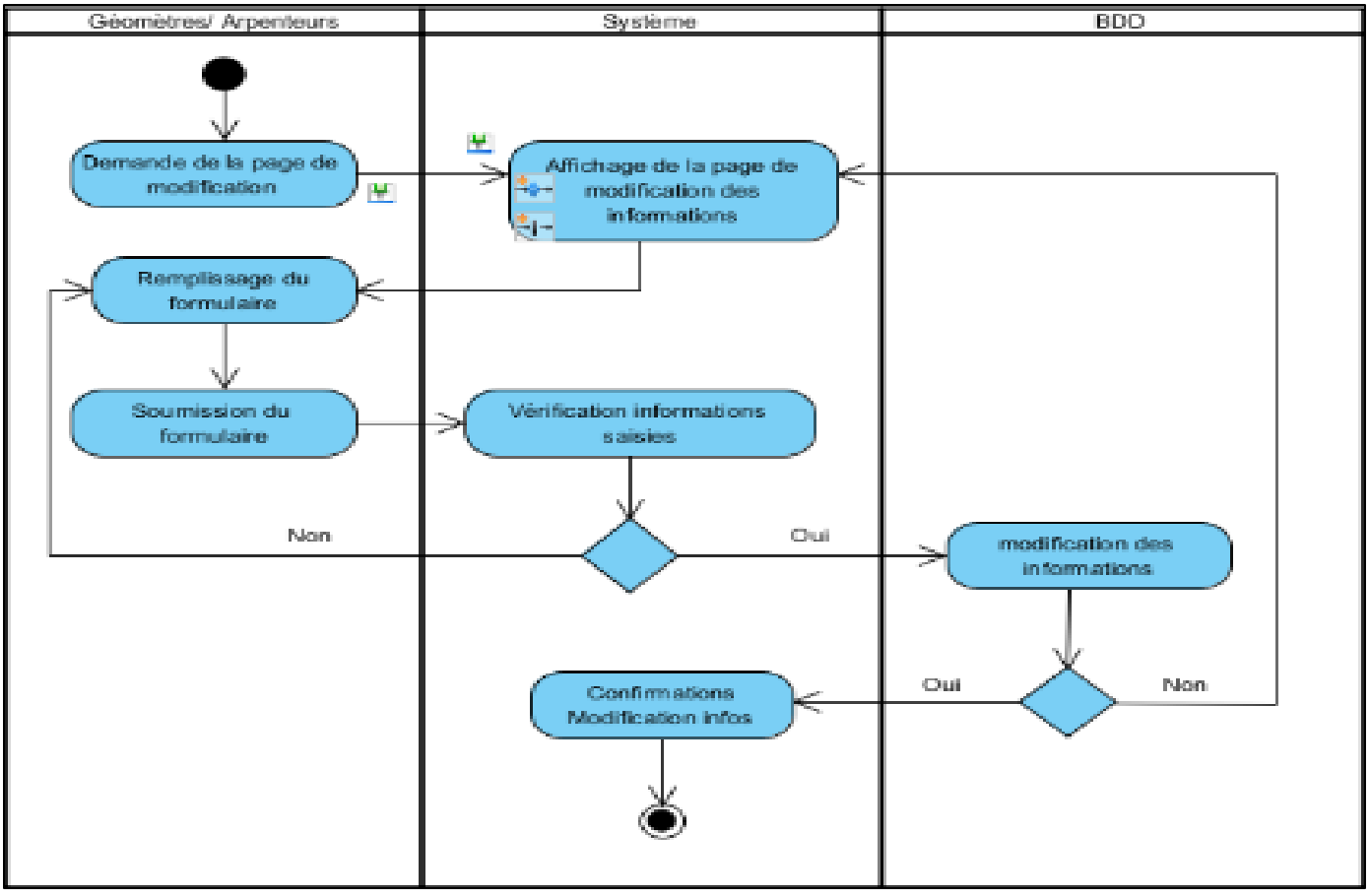

Fig 12 Edit Plot Information

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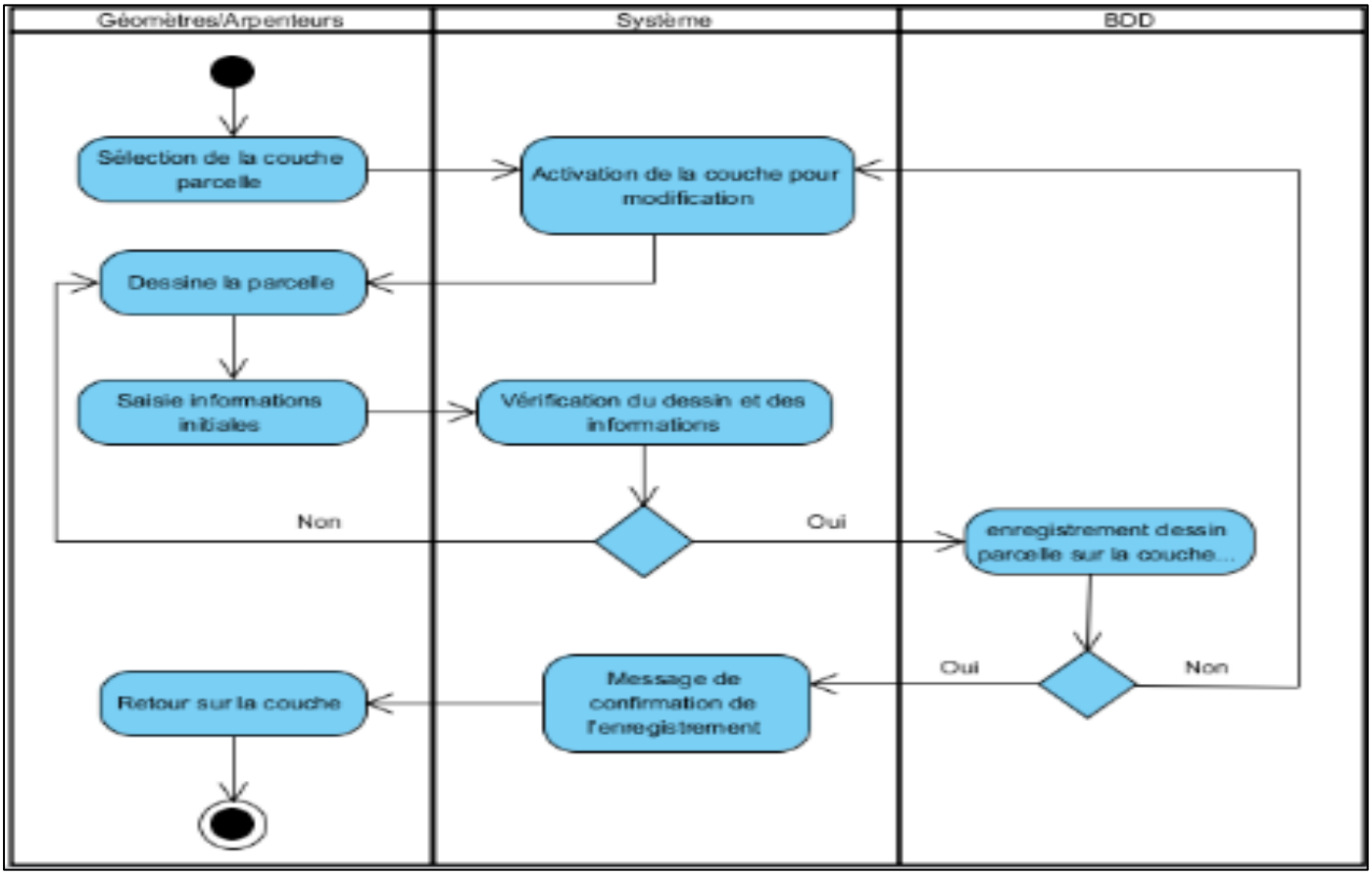

Fig 13 Draw Plot

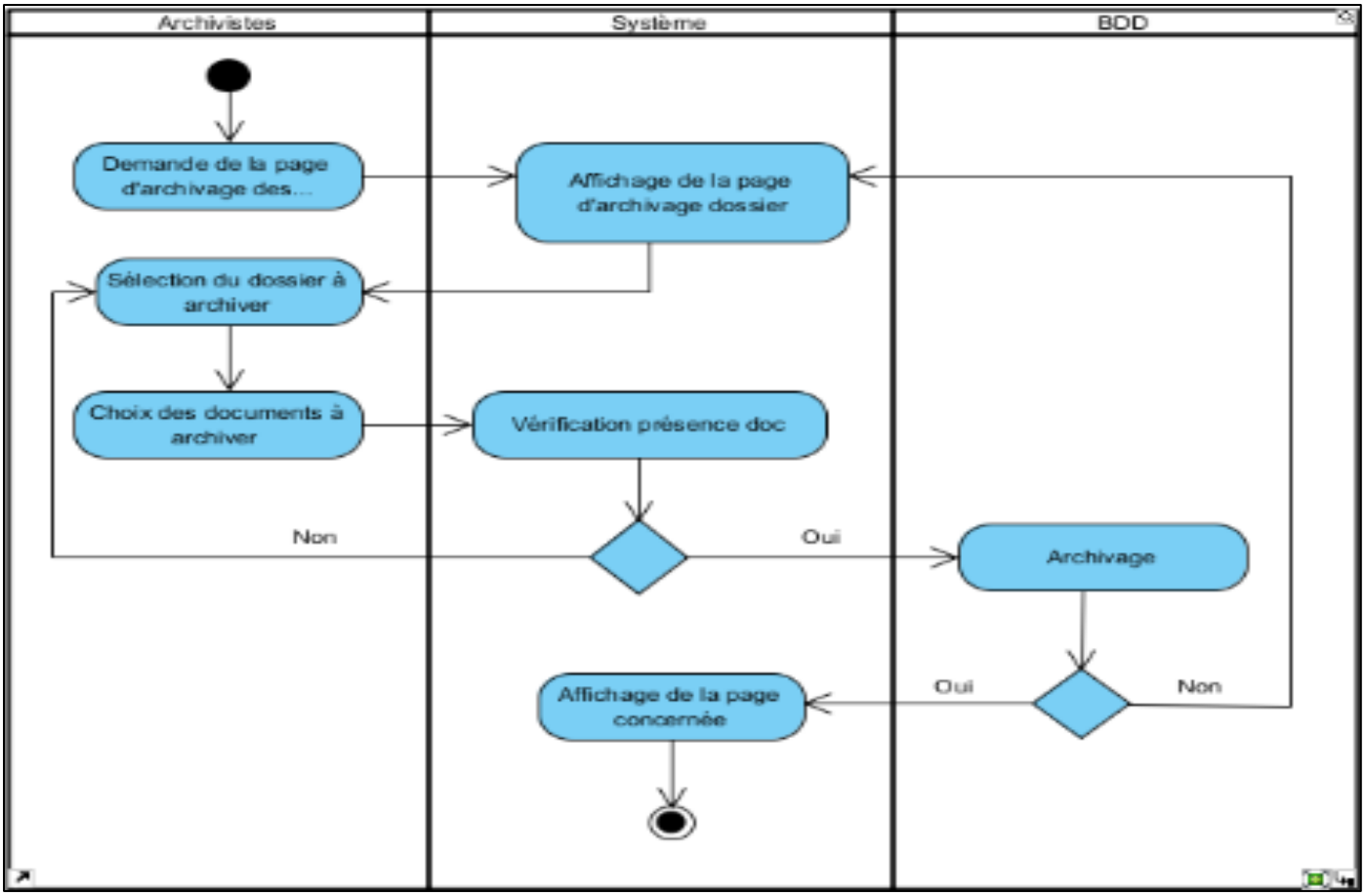

Fig 14 Archive Folder

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G. Class Diagram

The class diagram describes the internal structure of the system. It thus provides an abstract representation of the objects of the system that will interact together to realize the use cases. The class diagram is considered the most important in object-oriented modeling. (https://www.lucidchart.com/pages/fr/diagramme-de-classes-uml, s.d.) A class represents a set of objects having the same characteristics (attributes, methods, relationships). Below is the class diagram;

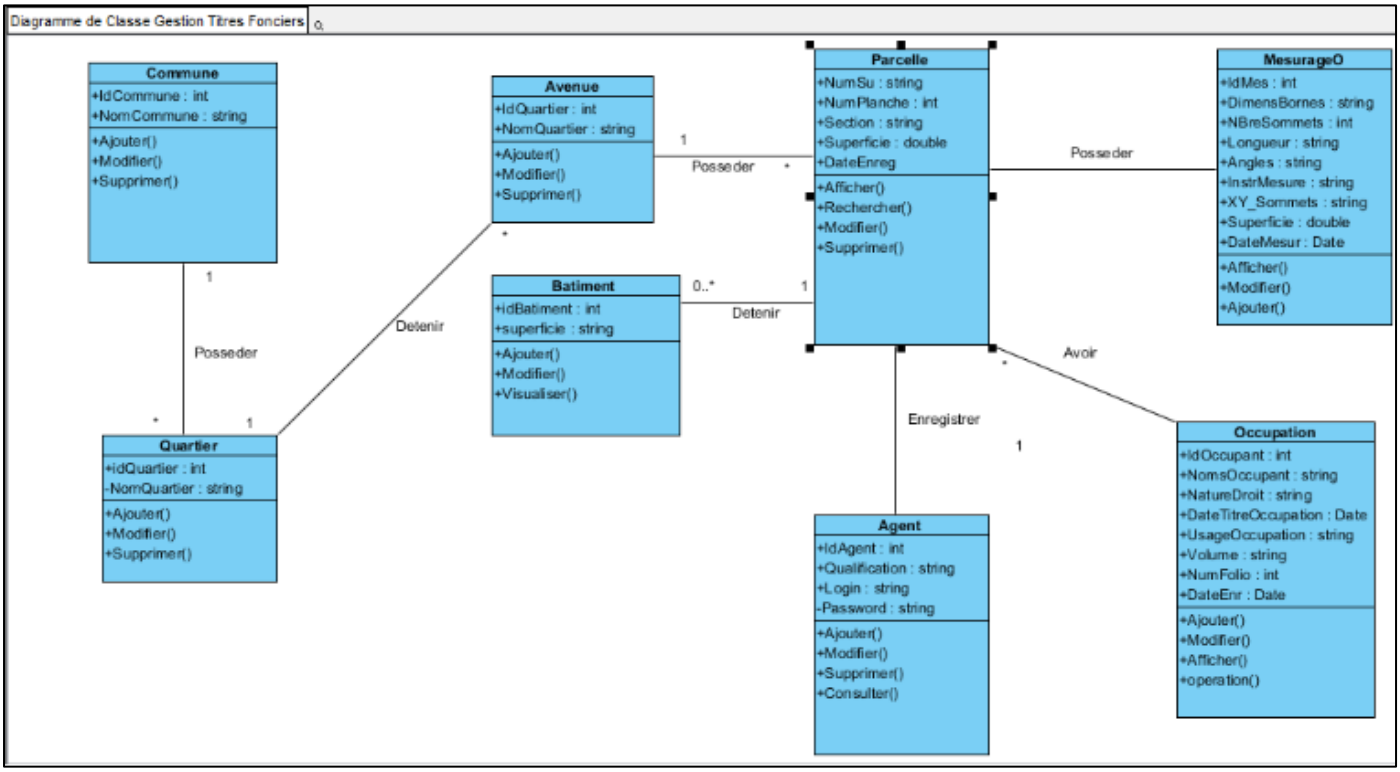

Fig 15 Class Diagram

H. Deployment diagram

A UML deployment diagram is a graphical representation of the physical architecture of a system. It shows how the various software and hardware components are distributed and connected to each other. In other words, it is a plan that illustrates where the software and hardware are located in a computer system, and how they communicate with each other.

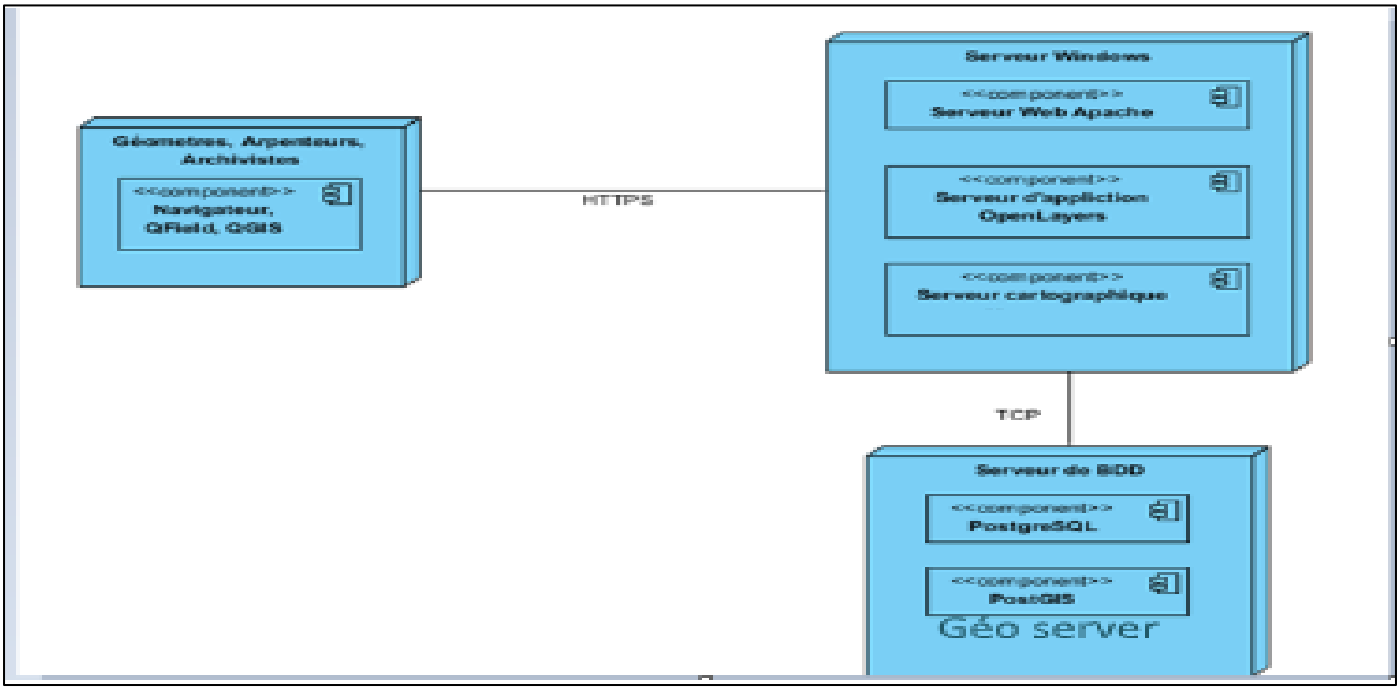

Fig 16 Deployment Diagram

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III. RESULTS

After research work we noticed that the combination of three essential flavors computer tools including QGIS for desktop, Q Field for Smartphone and a web application on a server with the database using Post Gis. QGIS which is a cartographic software that will allow us to create our geographic project, it is connected to our geospatial database Post Gis , it will be much more used by surveyors and surveyors in the context of this project; it is also the tool for synchronizing project data from the QF Iield mobile application .

A. QGIS Interface with Map Project

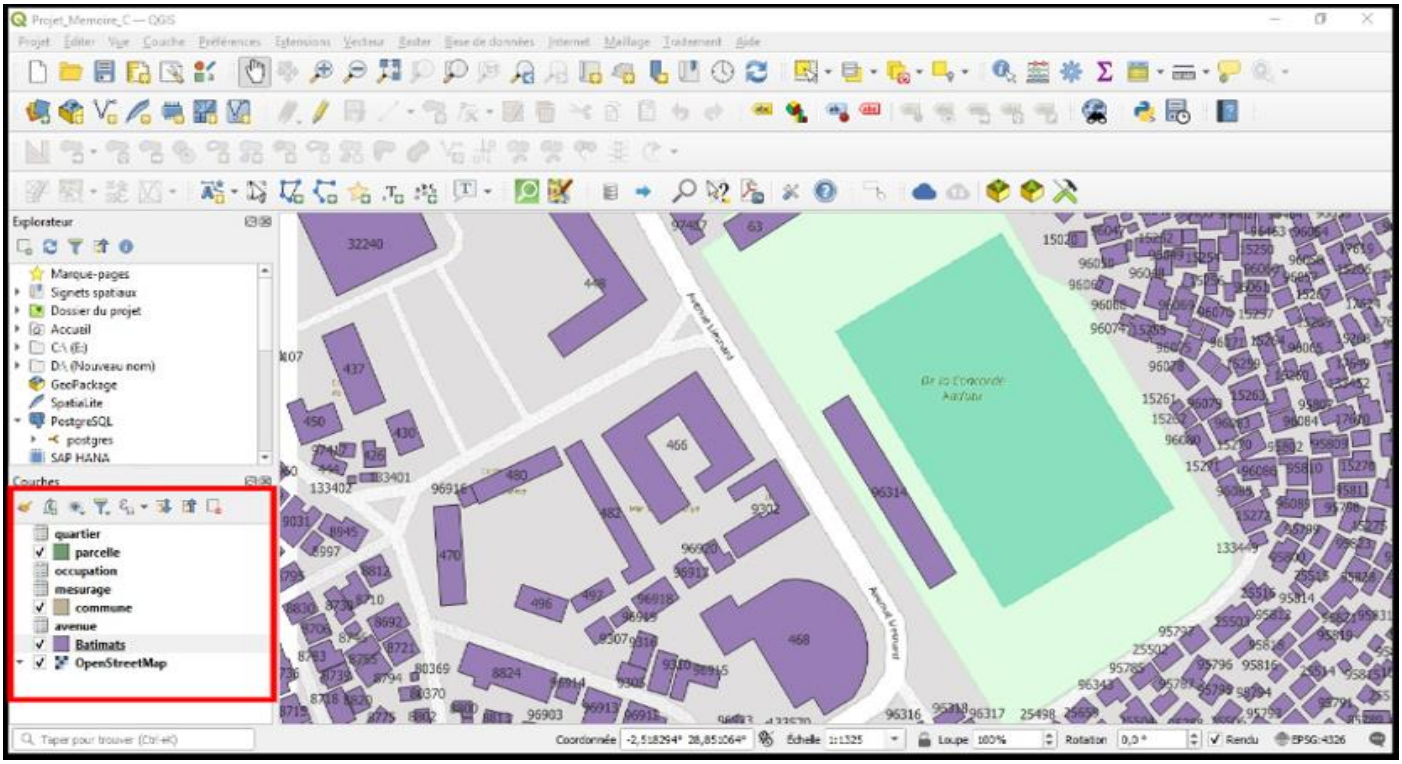

Fig 17 QGIS Interface

B. GCADASTRE" Web Application

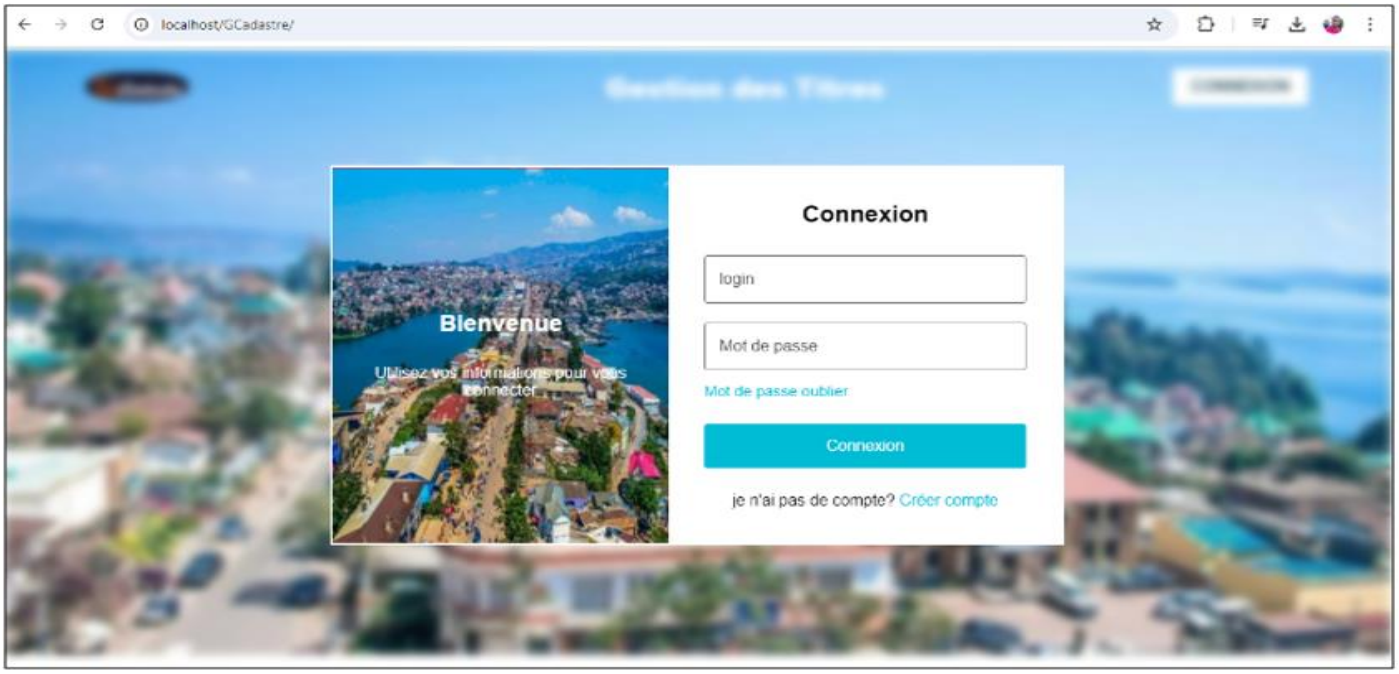

Fig 18 GCADASTRE" Web Application

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After logging in, we find ourselves on the interface for registering a new file. This interface registers a new parcel file, it allows you to list information related to the description of the parcel such as the section number**,** the district**,** the municipality**,** the avenue, the date the file was created, etc.

C. Interface for Saving A New Folder

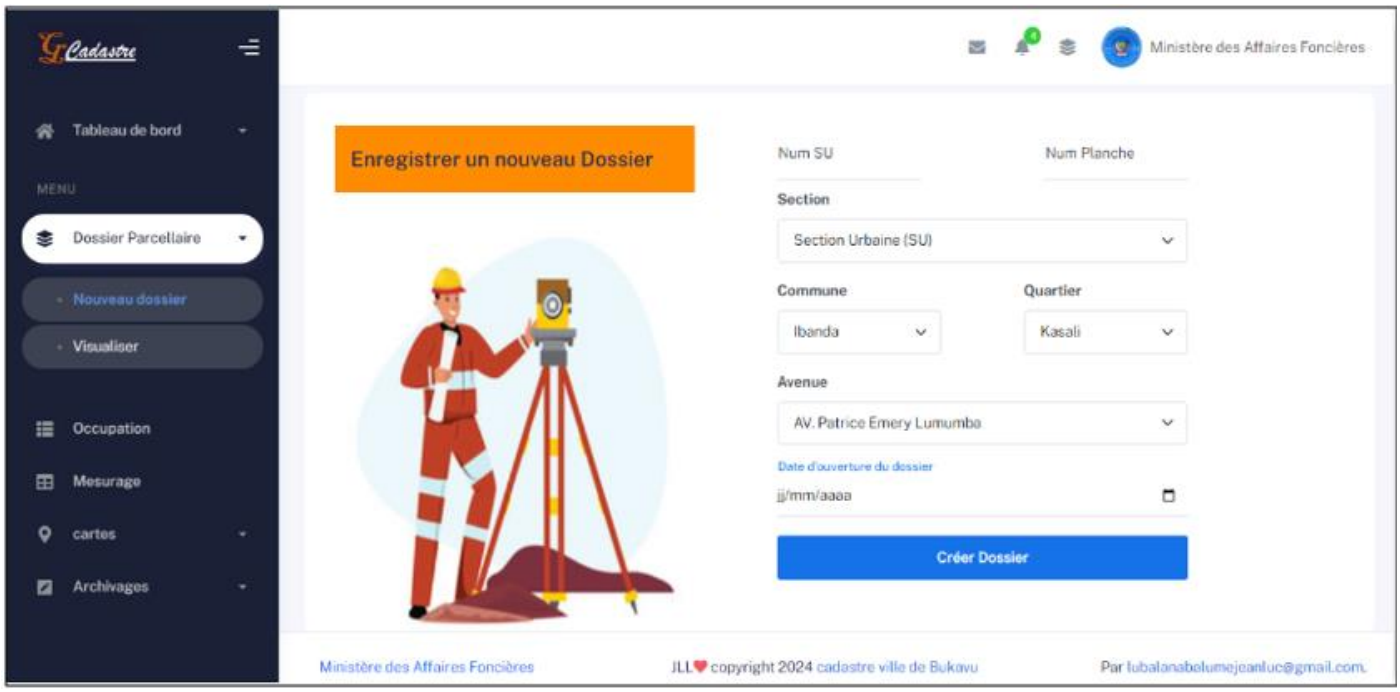

Fig 19 Interface for Saving a New Folder

Next will be the interface for viewing files and their progress. This interface allows you to track individual files, and you can view the progress of the file;

D. Interface for Viewing Files and Their Evolution

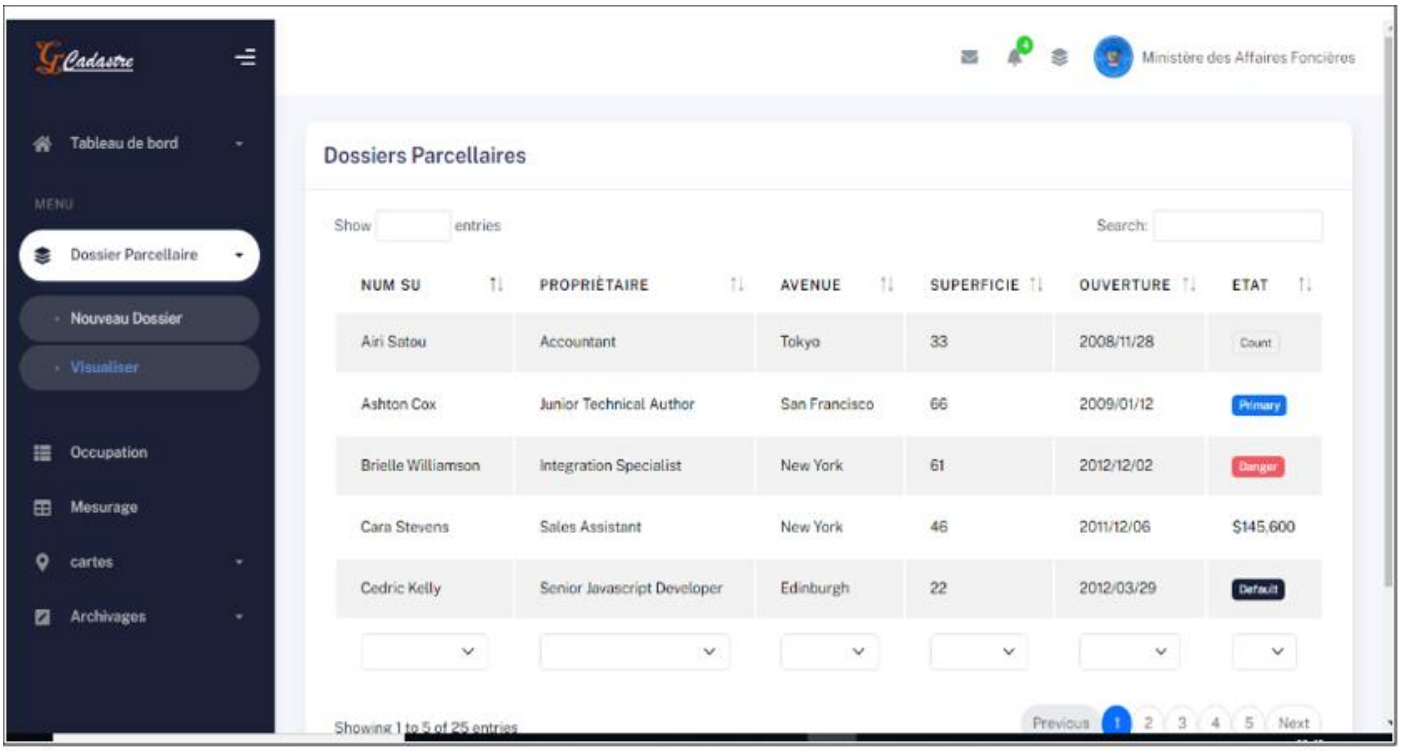

Fig 20 Interface for Viewing Files and Their Evolution

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Then the plot occupation recording interface. This interface allows you to record information related to the plot occupation, the occupant and information related to the occupation contract;

E. Interface for Recording Plot Occupations

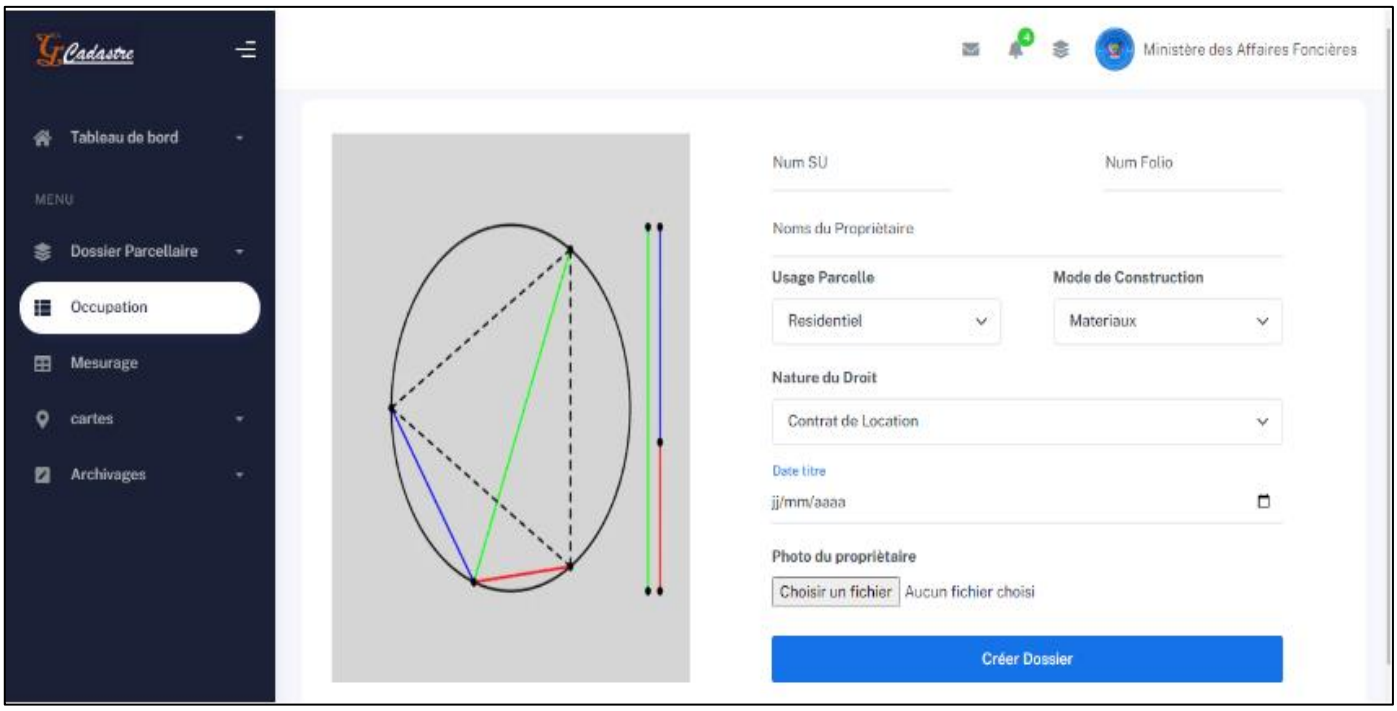

Fig 21 Interface for Recording Plot Occupations

The main one is the digital or computerized surveying whose interface records measurements of the plot. Any surveyor or surveyor has the obligation to complete this page after the measurement and boundary operations; here he must record the area, the instruments he used, the dimensions…

F. Interface For Recording Plot Occupations

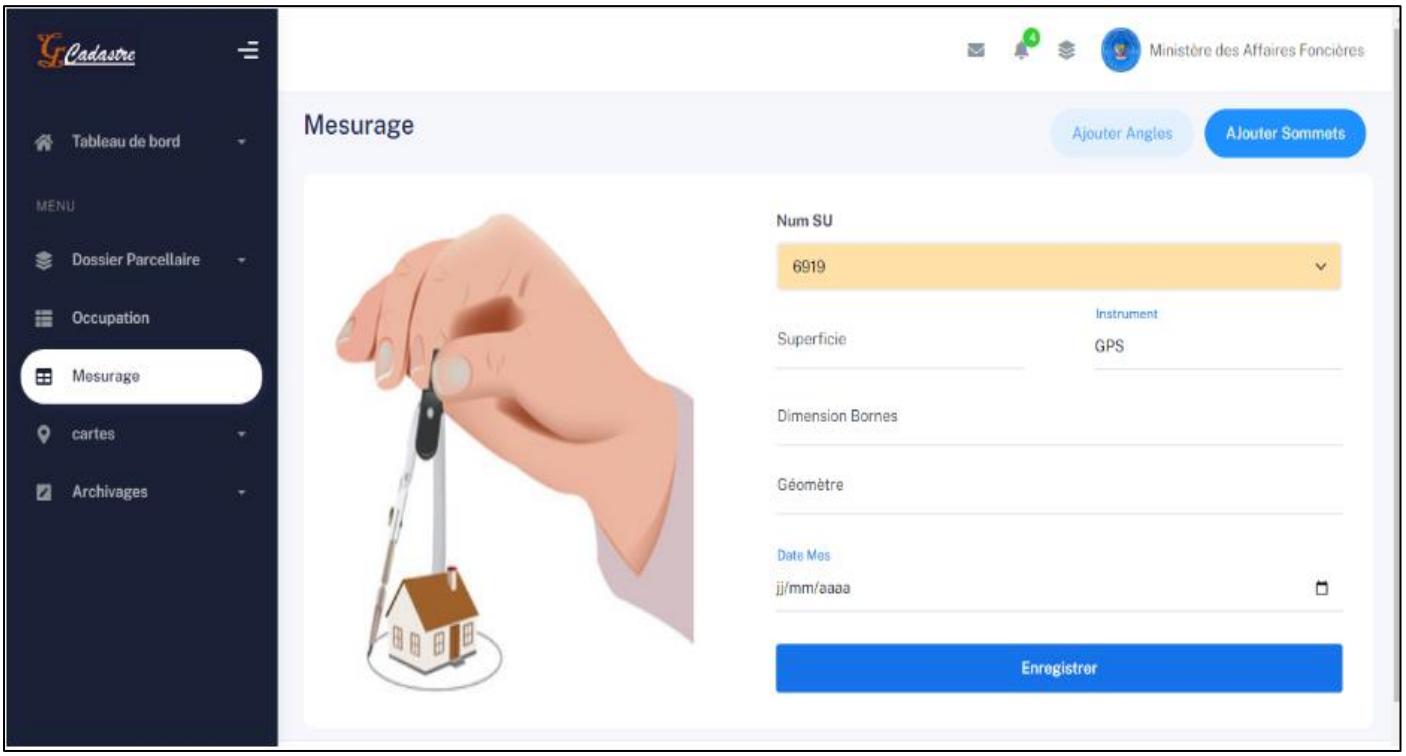

Fig 22 Interface recording plot measurements

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G. To Size the Terminals via the map, the Open layers Interface Integrated into our Application Isused.

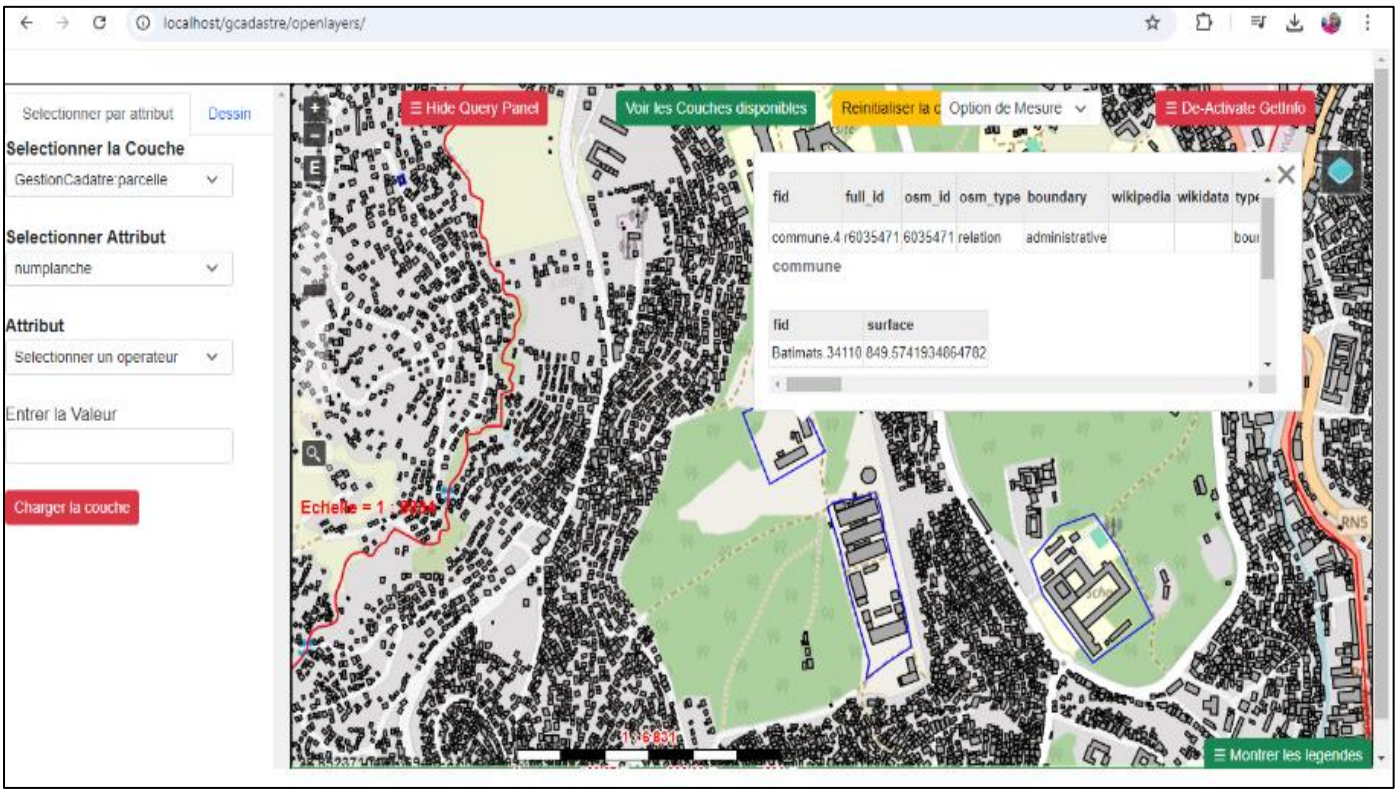

Fig 23 Interface to Size the Terminals via the Map

H. We can now Archive the file or print it. This Page allows you to Archive the Necessary Documents Related to the file;

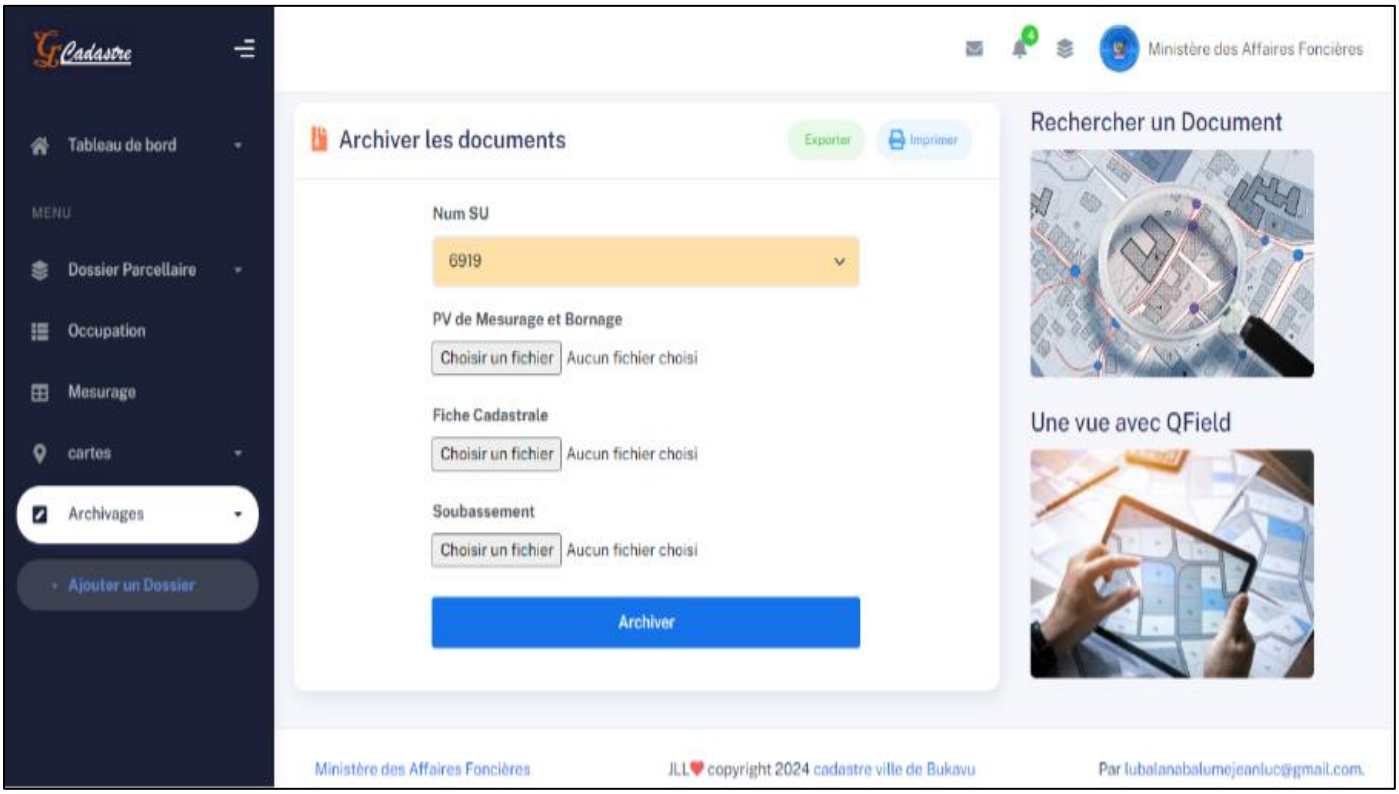

Fig 24 Interface Archiving the Documents Accompanying the Land File

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I. We can now print a land title cadastral record

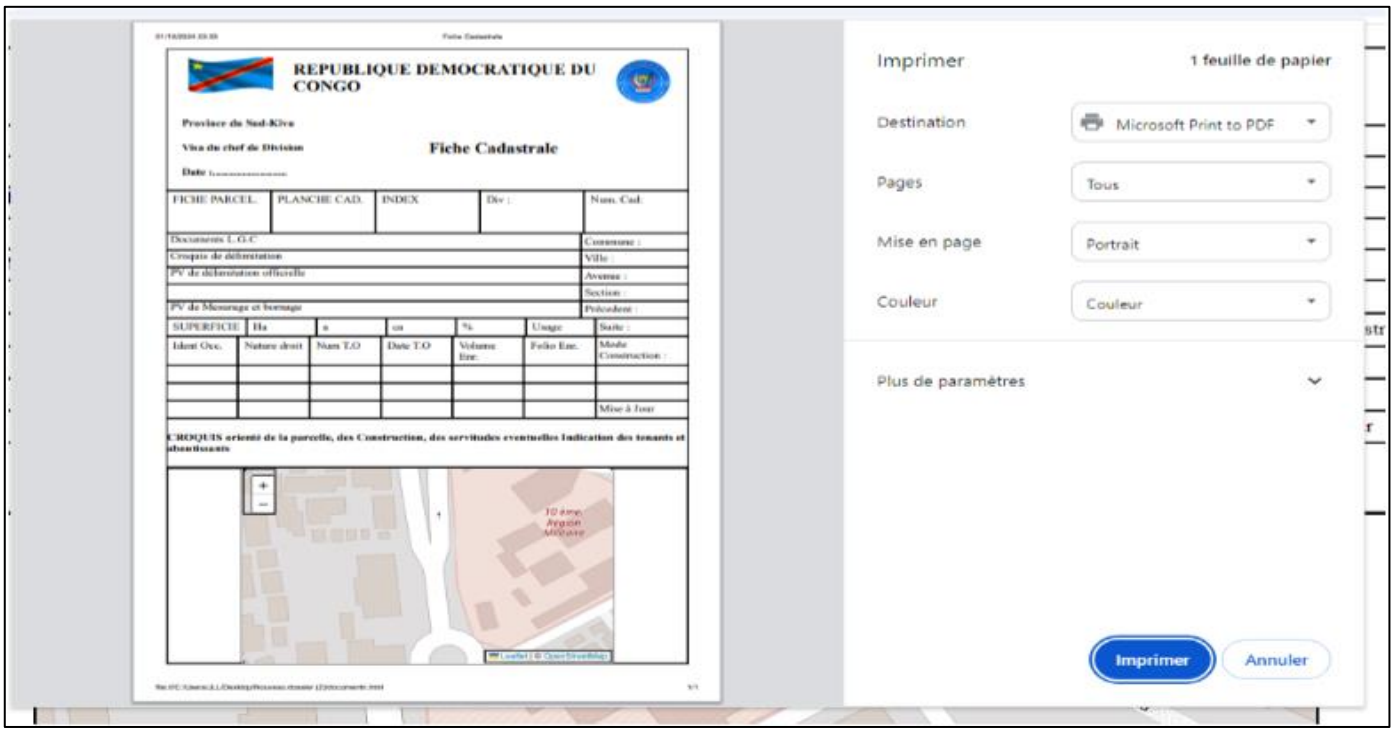

Fig 25 Interface to Print Document Land File

J. The Smartphone or Mobile Technology Part With qf ield

Where the field agent will have to choose the connection mode to the project or to the cadastral application, this is done either from a Qf ield Cloud online project or via a local file;

Fig 26 Field Home Interface

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Fig 27 Project Viewer Interface in Qfield Figure

Fig 28 Layer Viewer Interface

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Fig 1Plot Drawing Interface

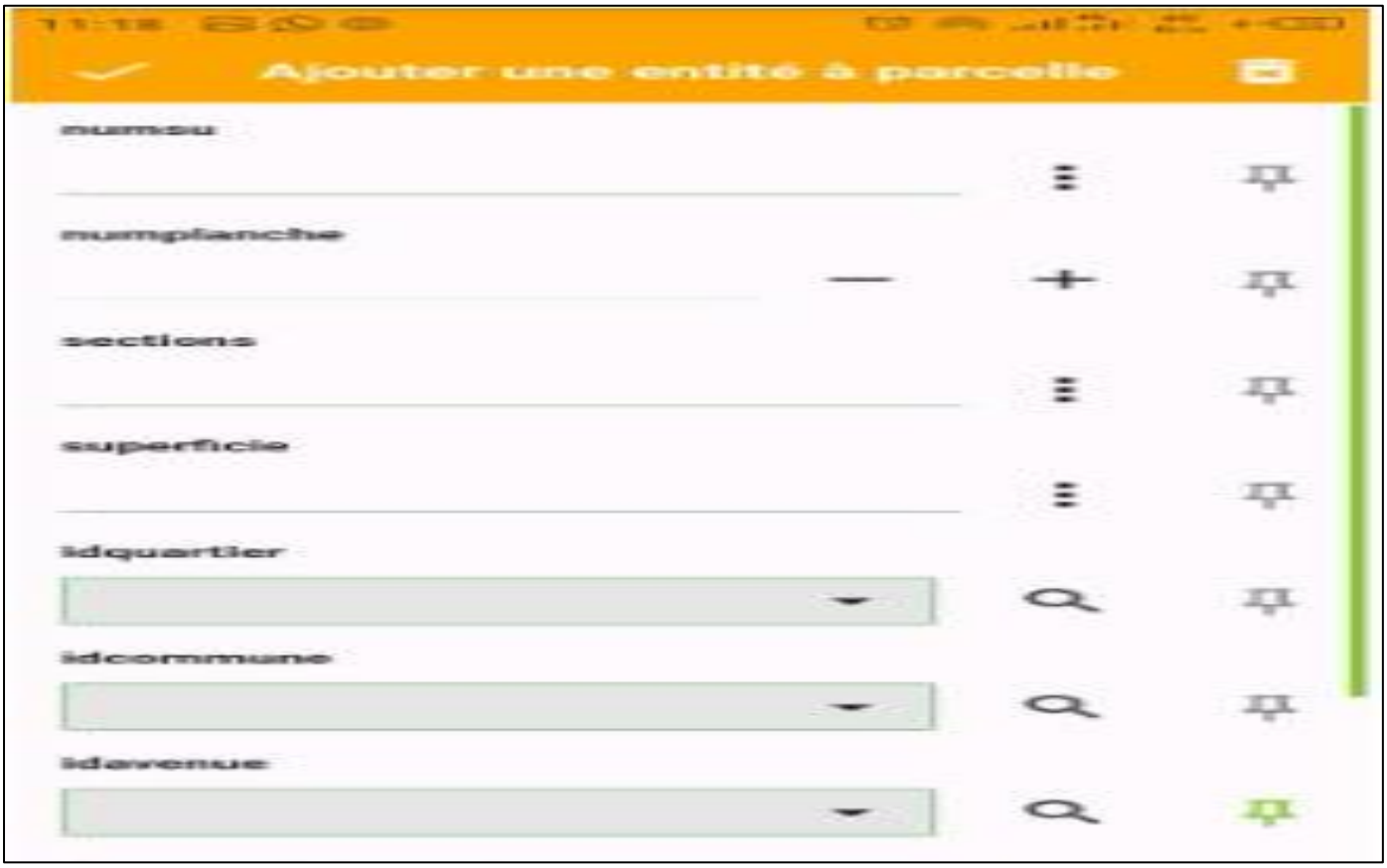

Fig 30 Plot Form

In terms of on-board technology, the surveyor can carry out measurements and boundary marking from his phone.

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IV. CONCLUSION

➢ *Mapping Technologies.*

Our main objective was to provide the Real Estate Titles Division with an innovative digital tool, facilitating the management, archiving and consultation of land files. can a technological solution integrating geolocation and web- mapping optimize the process of allocating land titles?

In order to validate our hypotheses, we conducted a field study combining documentary techniques, interviews and direct observations. This approach allowed us to better understand the reality on the ground and to identify the specific issues of land management.

In particular, we used the UP (Unified Process) and structural-functional. The UP method helped us design the new IT system, while the structural-functional approach allowed us to analyze the organization and operation of the existing land registry. Thanks to these methods, we were able to identify the strengths and weaknesses of the current system, including [list the main problems identified, for example: lack of centralization of data, slowness of procedures, risks of manual errors, etc.].

This in-depth analysis allowed us to better understand user needs and define the functional specifications of the new system.The results obtained fully confirm our initial hypotheses. Our system has demonstrated its ability to efficiently manage land titles, covering key operations such as file creation, measurements and boundary marking, monitoring and archiving of documents. Although slight disruptions may occur in the event of a poor internet connection, the system has proven to be robust and efficient overall. Aware of the challenges associated with the appropriation of new technologies, we are proud of the result obtained.

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