A Methodology to Minimize the Operating Cost of a Water Supply Network Using GNSS and Web Mapping

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OVERVIEW

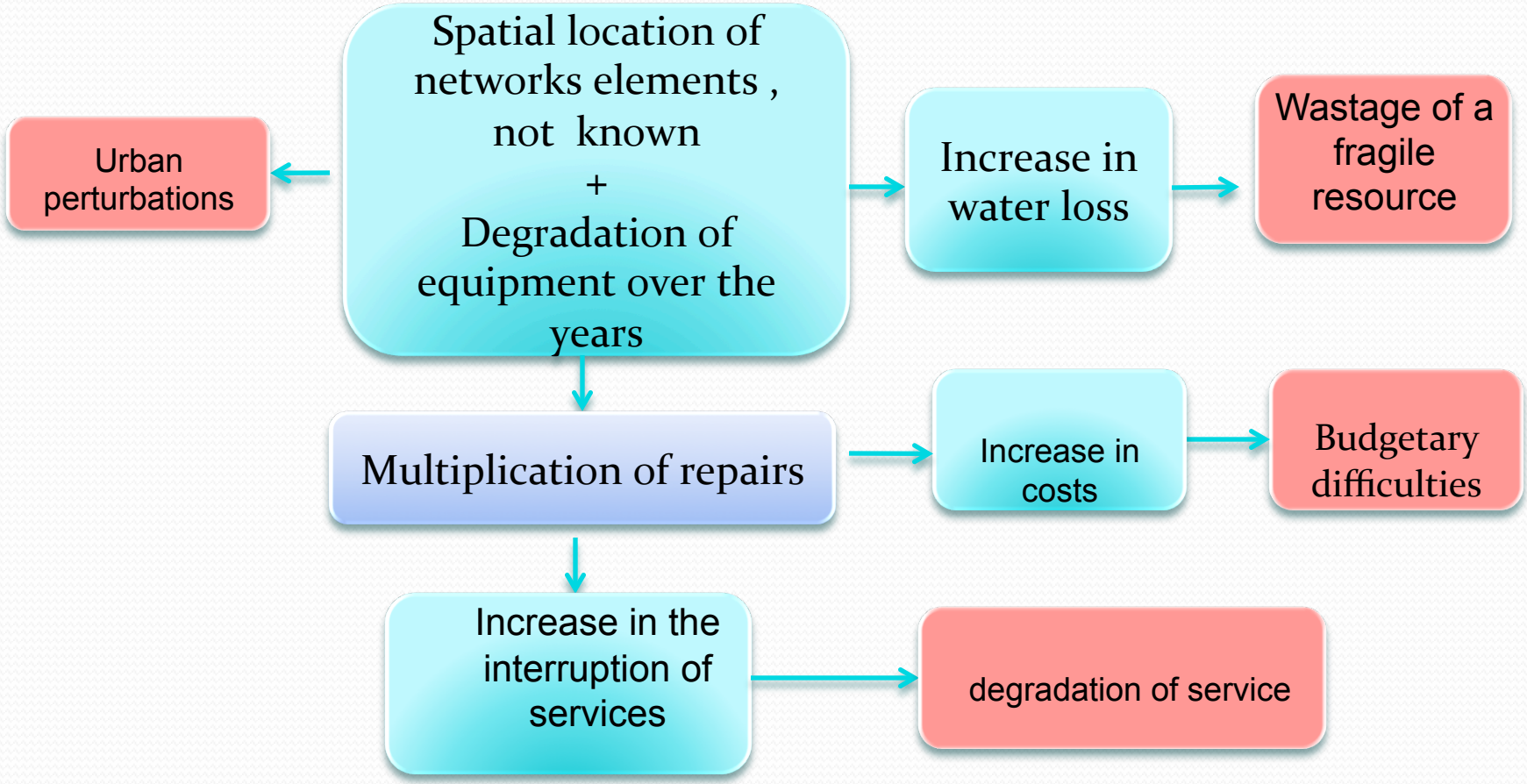
- Introduction
- Application of GNSS/nomad GIS to a Water Supply Network (WSN)
- Web mapping for the visualization and localization of equipment failures of a WSN
- A proactive maintenance strategy
- Conclusion

INTRODUCTION

- Most of the WSNs of Cameroon were constructed in the 1980s
- A similar situation to the one described by GRAPHINFO (2006)
  - The knowledge (of maintenance technicians) about the location of WSNs becomes weak over the years
  - Paper plans deteriorate due to several manipulations
  - No coherence exists between as-built drawings with the real positions of network elements
- many failures occur on the networks over the years

INTRODUCTION

- Problems and consequences (inspired from the 2013 BOURGES, Conference « le colloque de BOURGES, 2013 »)



Application of GNSS/nomad GIS to a Water Supply Network (WSN)

- The knowledge about the localization of equipment is of paramount importance not only to technicians of maintenance , but also to public work's services (roads, gas, electricity, bridge, railways…)

- It is time to use modern technology: GNSS receivers for accurate and fast orientation

- Even better , a more specialized tool responding to the specific need on the field: for this study we proposed a GNSS receiver coupled with a nomad GIS software.

- Added Value of GNSS/Nomad GIS

  - Paper document are almost not necessary: everything is stored in the receiver
  - Good quality geo-location of the position, especially in slope areas and areas without reference
  - Direct recording of the data and reduction of mistakes
  - A more homogenous work process

- Application of GNSS/nomad GIS to the WSN of Ekounou Quarter

  - Methodological steps:
    - ✓ Collection of paper plans
    - ✓ Satellite image of the study area (resolution: 30 cm)
    - ✓ Field investigation: surveying missing elements (accuracy 1-2 m)

  - Exploitation of data collected: scanning the paper plan into .JPG file, importation and file digitization: lines (pipes), points (valves, suction device, venturi). System of projection =UTM zone 32 N

- Results : the MobileMapper 6 (a GNSS/nomad GIS receiver)

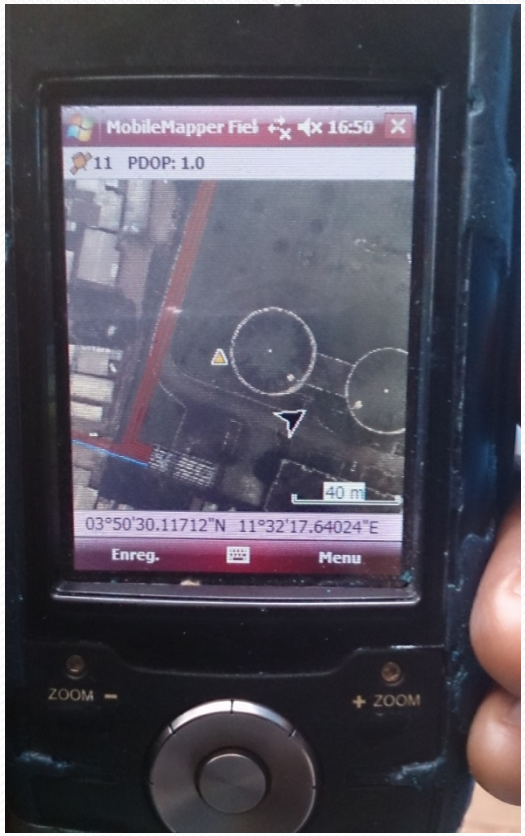


Fig.1: Visualization of underground pipes in the storage plant

The accuracy of the measurements was 1-2 m.

The technician of maintenance orients himself very fast, while distinguishing WSN elements amongst other objects on the field.

Fig.2: Visualization of an underground valve within the market

- Discussion

  - Improvement of measurements

    - ✓ The post-processing option of the MobileMapper 6: connection to reference stations
    - ✓ Use of the SBAS
    - ✓ carrier-phase GNSS receivers

  - Traditional methods (topometry): where the sky is not open

Web mapping for the visualization and localization of equipment failures of a WSN

- **The starting point**: maintain and improve the performance of the WSN over the time

→ One must renew equipment that have deteriorated (especially pipes)

→ Renewing is very expensive, one must select the element to be replaced

→ The elements must be classified according to the renewal priorities, but

→ Modeling the prediction of deteriorating equipment becomes necessary

→ A database (location, material, diameter, age, type of soil, traffic…) is involved

- **Models for predicting equipment failures**
  - statistical proven models: proportional Hazards Model (PHM) and non-homogeneous poisson process (NHPP) to predict future breaks on the networks.
  - The models include: costs constraints, age, number of previous breaks, diameter, length, pressure, material, soil, aggressiveness of the water

- **Google Fusion Tables (GFT):** data management, visualization and publication of geographic data.

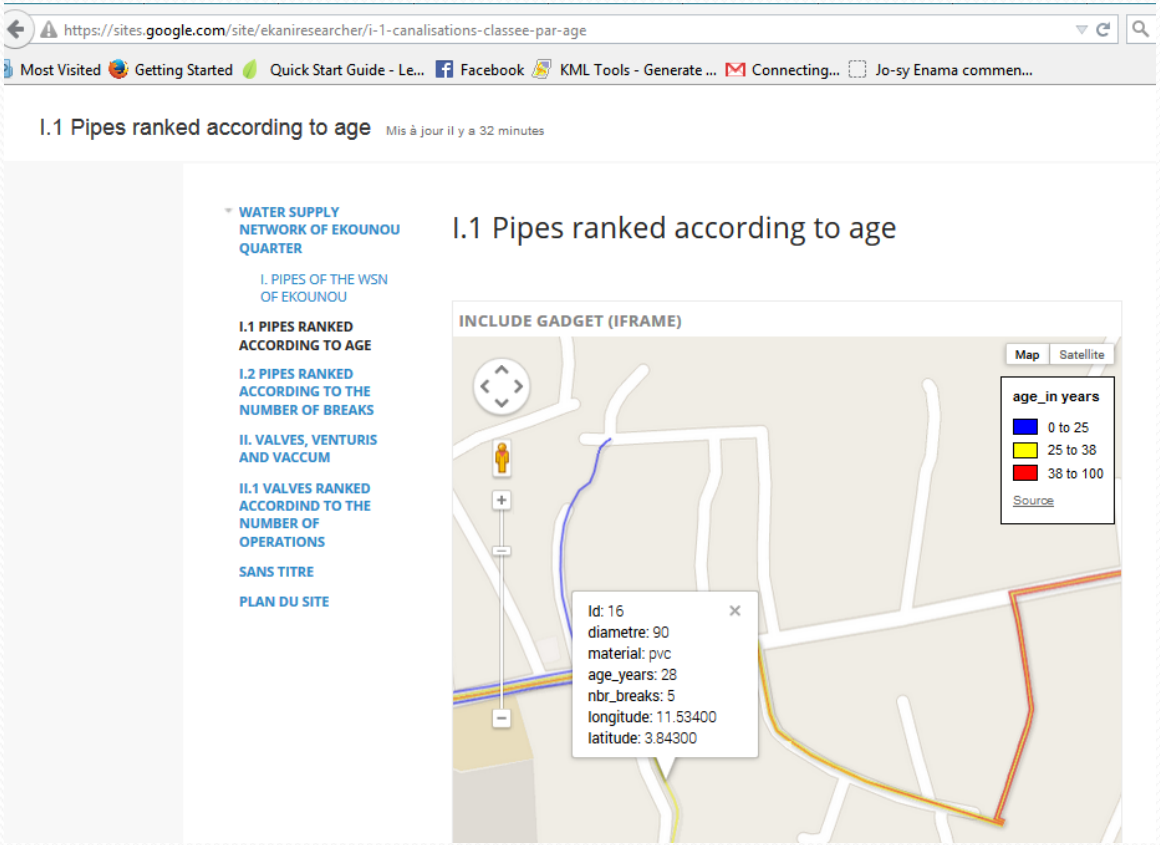
- Application to the WSN of Ekounou Quarter

  - Querying the data allowed to rank WSN pipes and valves according to certain criteria (age, previous breaks…) likely to predict a given number of failures.

  - The results : Thematic web maps were published on this website:

https://sites.google.com/site/ekaniresearcher/home

The Thematic web maps of the WSN of Ekounou quarter



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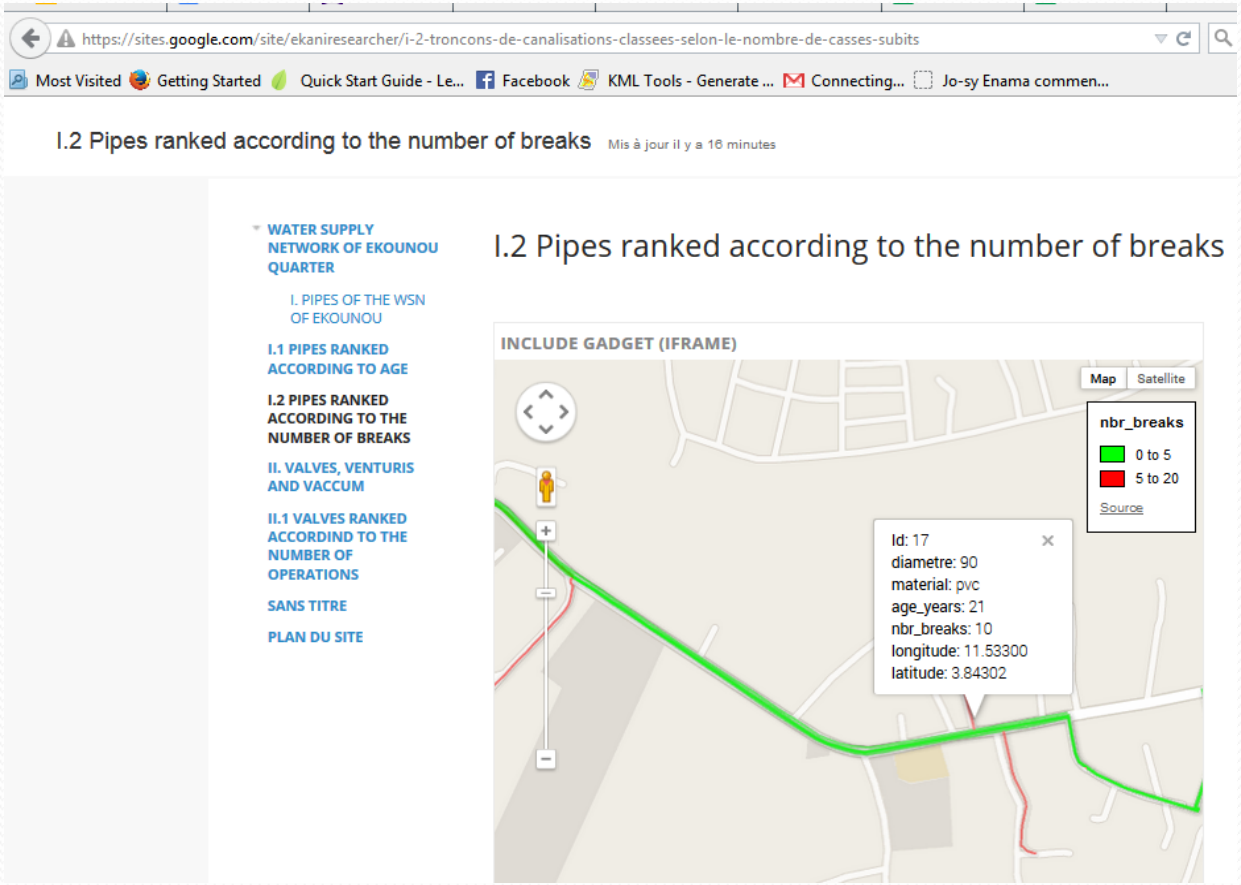

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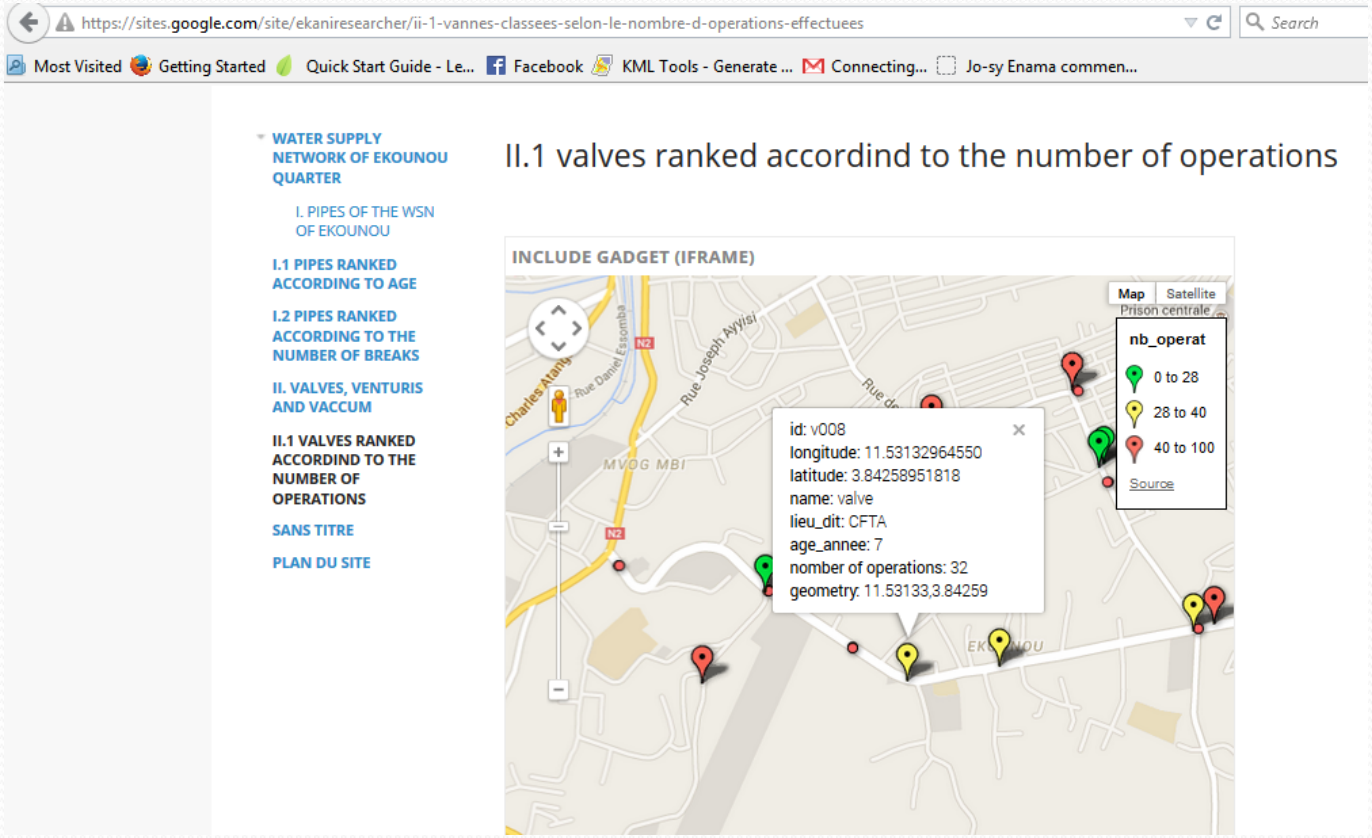
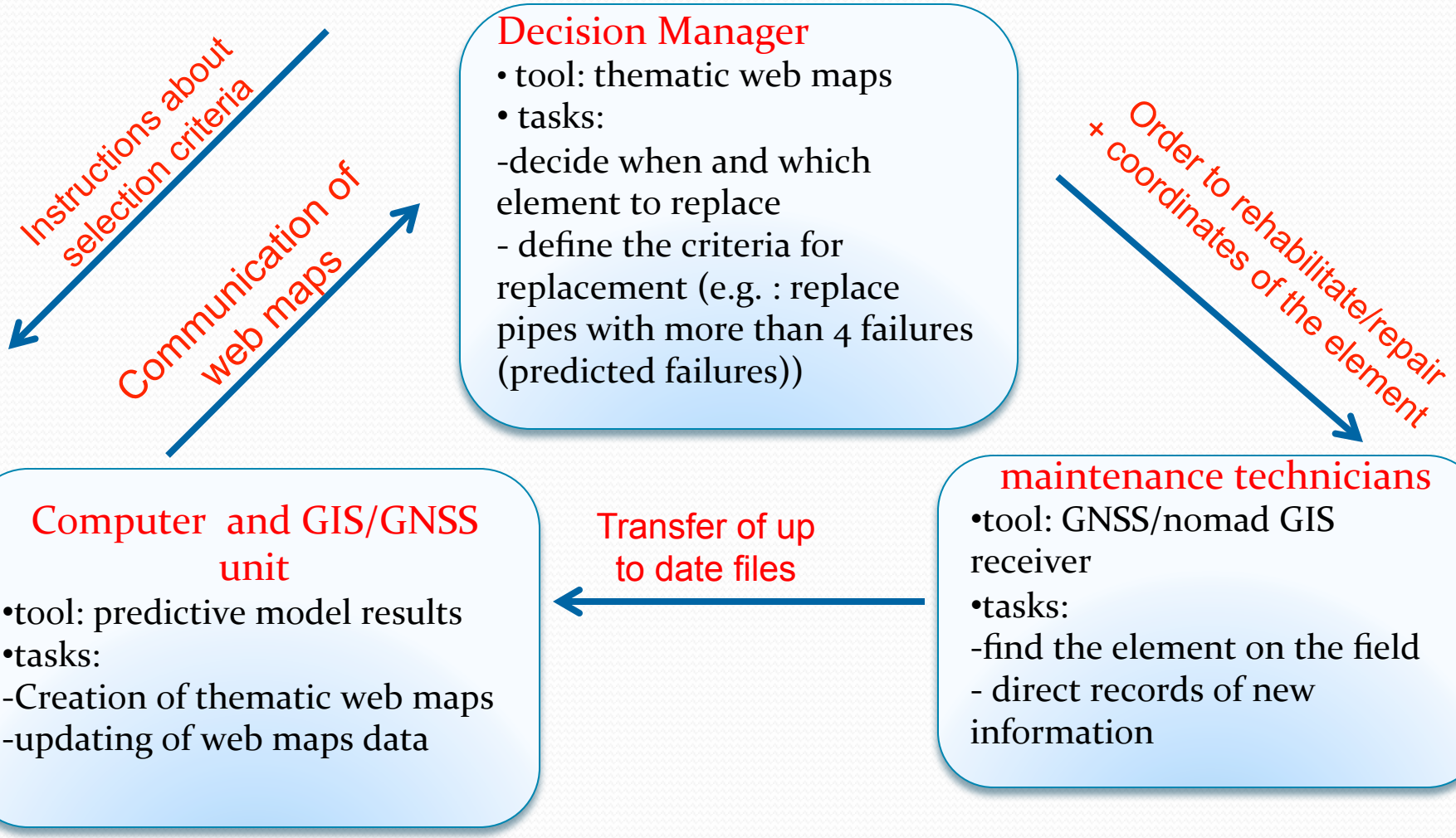


A proactive maintenance strategy



Conclusion

- Tools for:
  - fast and accurate localization of WSN elements
  - visualization and localization of equipment failures

  → gain of time, ergonomic method of working

- These tools combined with predictive models offer the opportunity to manage the network in a cost efficient way

- From a reactive maintenance to a proactive maintenance strategy: Perspective towards a new philosophy for managing WSNs of Yaoundé, and even Cameroon…

to be continued…

Thanks for listening