



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

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OVERVIEW

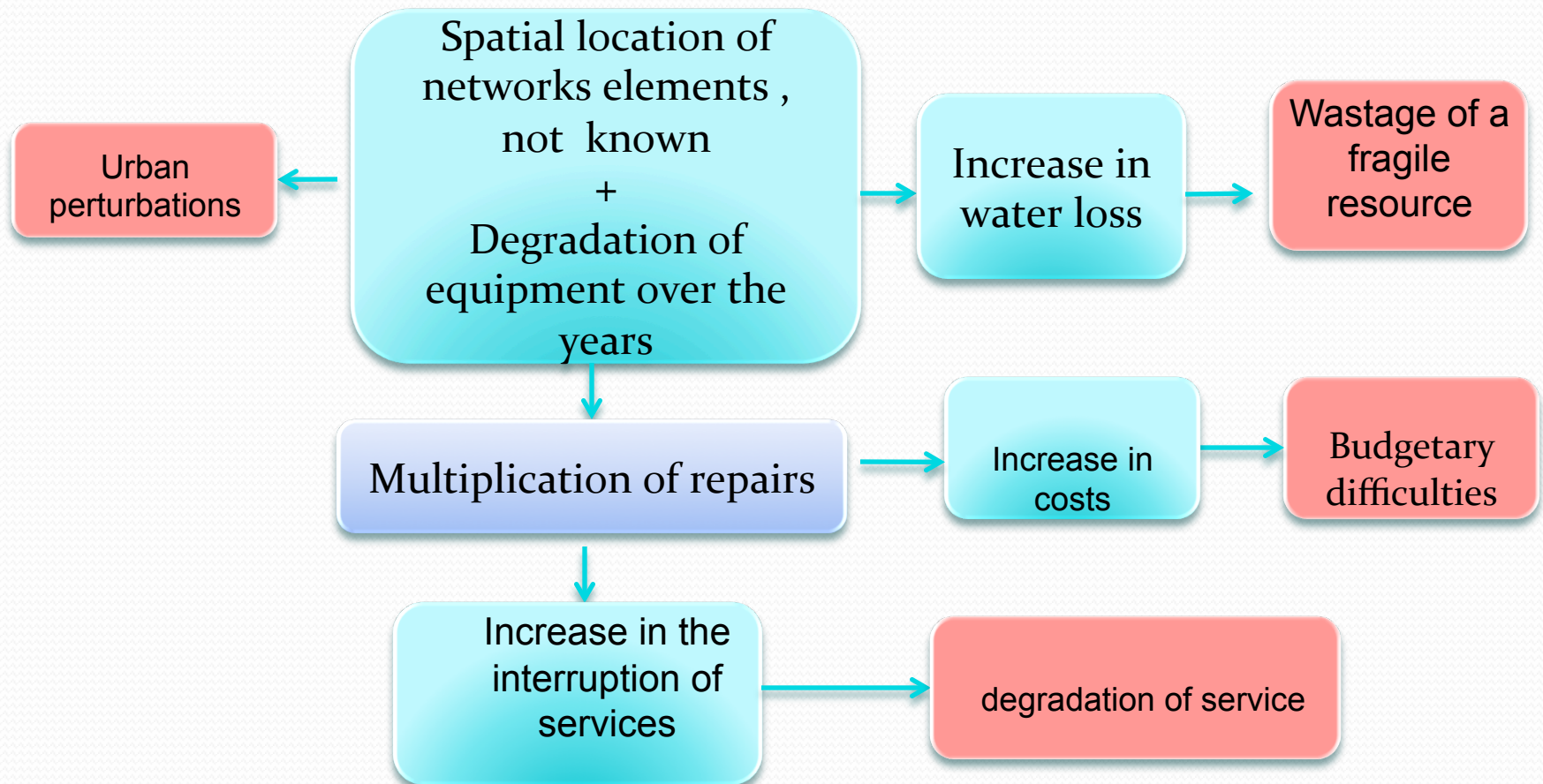
- ❑ Introduction
- ❑ Application of GNSS/nomad GIS to a Water Supply Network (WSN)
- ❑ Web mapping for the visualization and localization of equipment failures of a WSN
- ❑ A proactive maintenance strategy
- ❑ Conclusion

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)

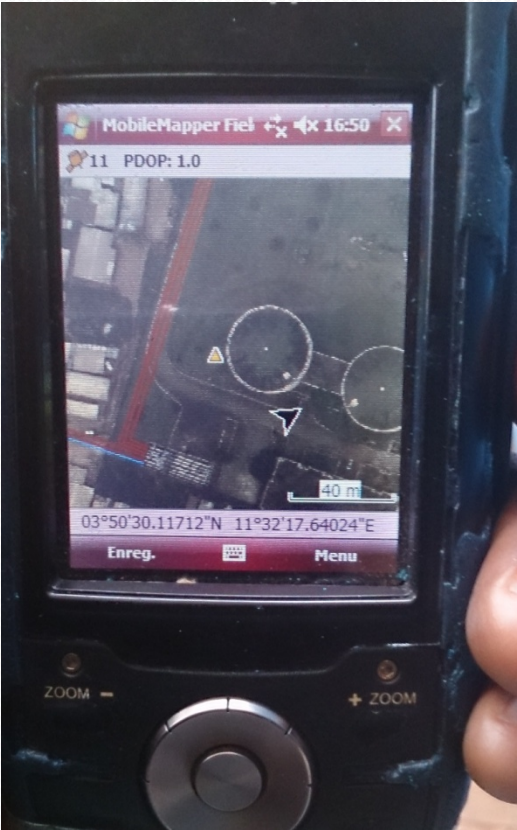


Fig.1: Visualization of underground pipes in the storage plant

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.

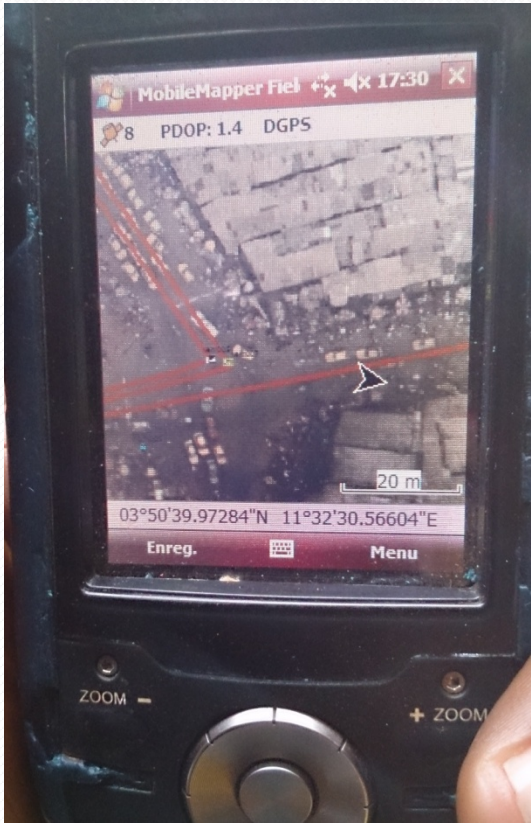


Fig.2: Visualization of an underground valve within the market

○ 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

https://sites.google.com/site/ekaniresearcher/i-1-canalisations-classee-par-age

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I.1 Pipes ranked according to age

Mis à jour il y a 32 minutes

- WATER SUPPLY NETWORK OF EKOUNOU QUARTER
 - I. PIPES OF THE WSN OF EKOUNOU
 - I.1 PIPES RANKED ACCORDING TO AGE**
 - I.2 PIPES RANKED ACCORDING TO THE NUMBER OF BREAKS
 - II. VALVES, VENTURIS AND VACCUM
 - II.1 VALVES RANKED ACCORDIND TO THE NUMBER OF OPERATIONS
 - SANS TITRE
 - PLAN DU SITE

INCLUDE GADGET (IFRAME)

Map Satellite

age_in years

- 0 to 25
- 25 to 38
- 38 to 100

Source

Id: 16
diameter: 90
material: pvc
age_years: 28
nbr_breaks: 5
longitude: 11.53400
latitude: 3.84300

○ The Thematic web maps of the WSN of Ekounou quarter

https://sites.google.com/site/ekaniresearcher/i-2-troncons-de-canalisations-classees-selon-le-nombre-de-casses-subits

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I.2 Pipes ranked according to the number of breaks

Mis à jour il y a 16 minutes

WATER SUPPLY NETWORK OF EKOUNOU QUARTER

- I. PIPES OF THE WSN OF EKOUNOU
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 - II. VALVES, VENTURIS AND VACCUM
 - II.1 VALVES RANKED ACCORDING TO THE NUMBER OF OPERATIONS
 - SANS TITRE
 - PLAN DU SITE

I.2 Pipes ranked according to the number of breaks

INCLUDE GADGET (IFRAME)

Map Satellite

nbr_breaks

- 0 to 5
- 5 to 20

Source

Id: 17
diametre: 90
material: pvc
age_years: 21
nbr_breaks: 10
longitude: 11.53300
latitude: 3.84302

○ The Thematic web maps of the WSN of Ekounou quarter

https://sites.google.com/site/ekaniresearcher/ii-1-vannes-classees-selon-le-nombre-d-operations-effectuees

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II.1 valves ranked according to the number of operations

INCLUDE GADGET (IFRAME)

Map Satellite Prison centrale

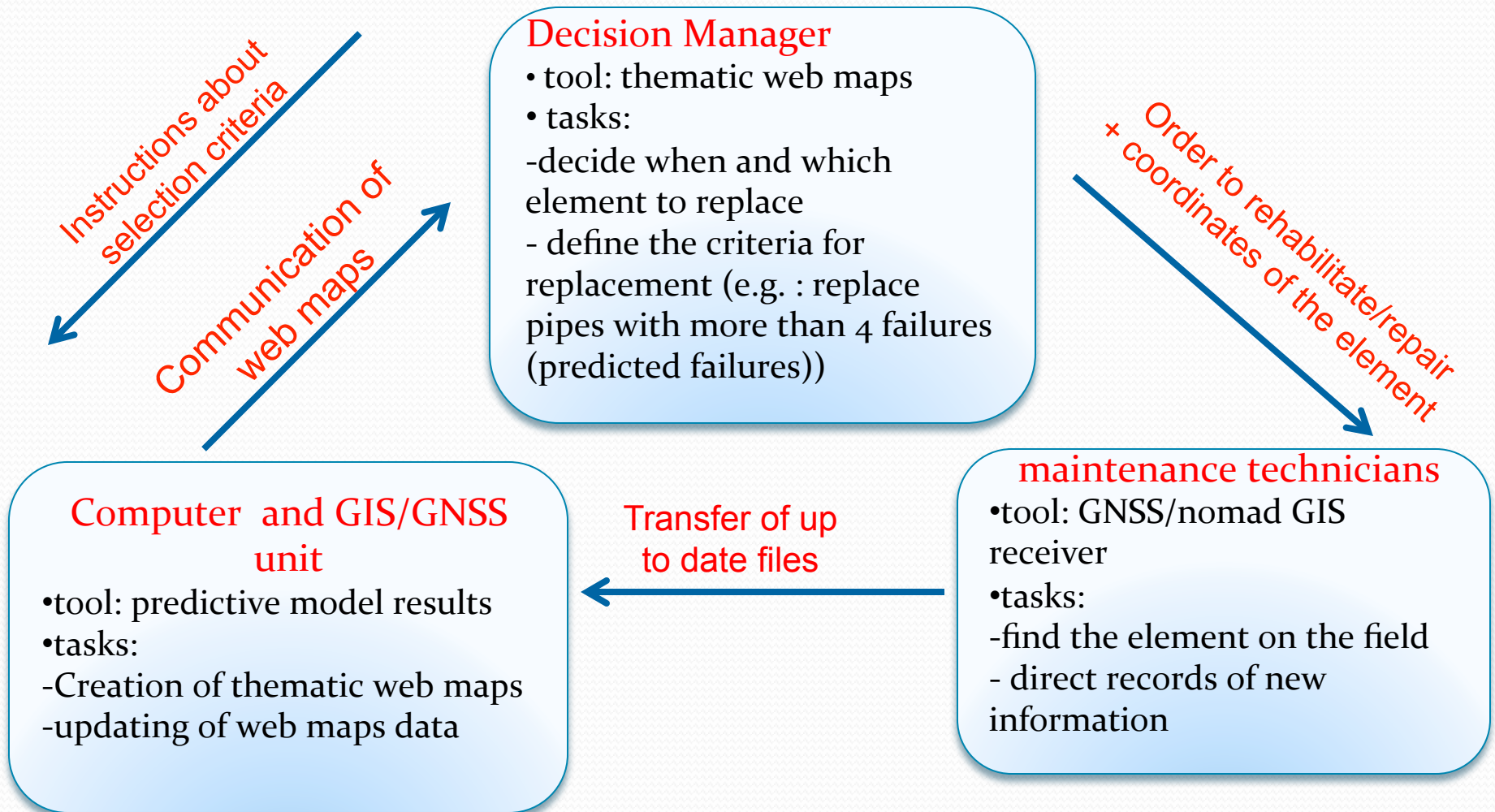
nb_operat

- 0 to 28
- 28 to 40
- 40 to 100

Source

id: v008
longitude: 11.53132964550
latitude: 3.84258951818
name: valve
lieu_dit: CFTA
age_annee: 7
number of operations: 32
geometry: 11.53133,3.84259

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