Predictive mapping of fluoride levels in groundwater in Central Benin (Western Africa) using a geostatistical approach

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1 : Hydrogeology & Environmental Geology, Urban & Environmental Engineering, University of Liège, Belgium
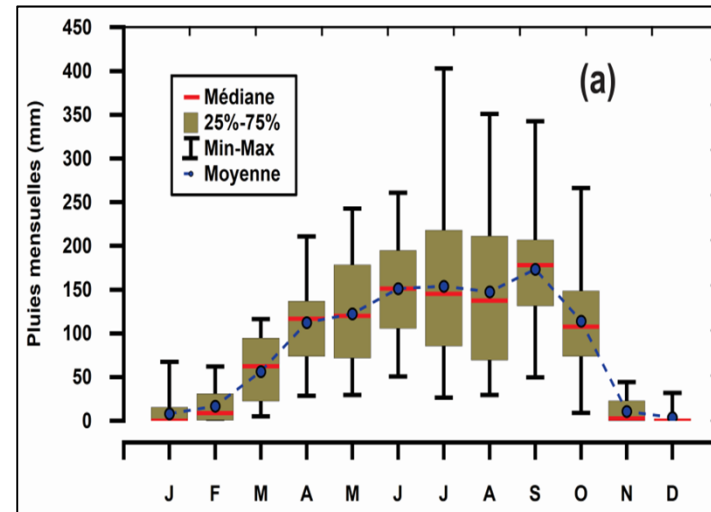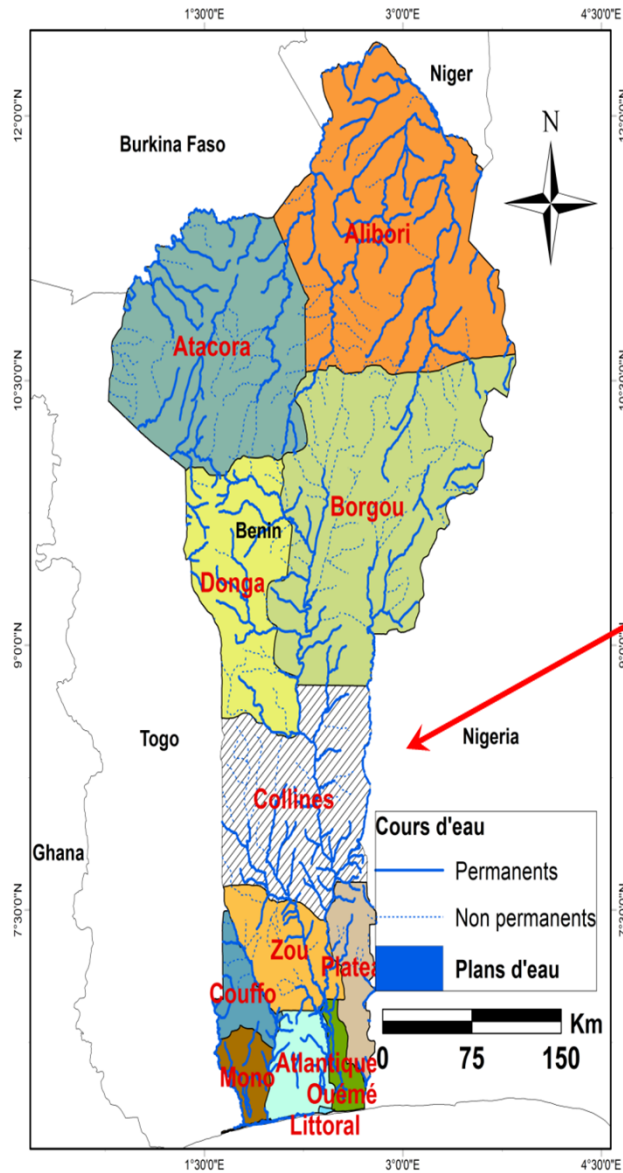
(p.orban@ulg.ac.be)

2 : Ministry for Mines, Energy and Water, Cotonou, Bénin

3 : Applied Hydrology Laboratory, University of Abomey-Calavi, Benin
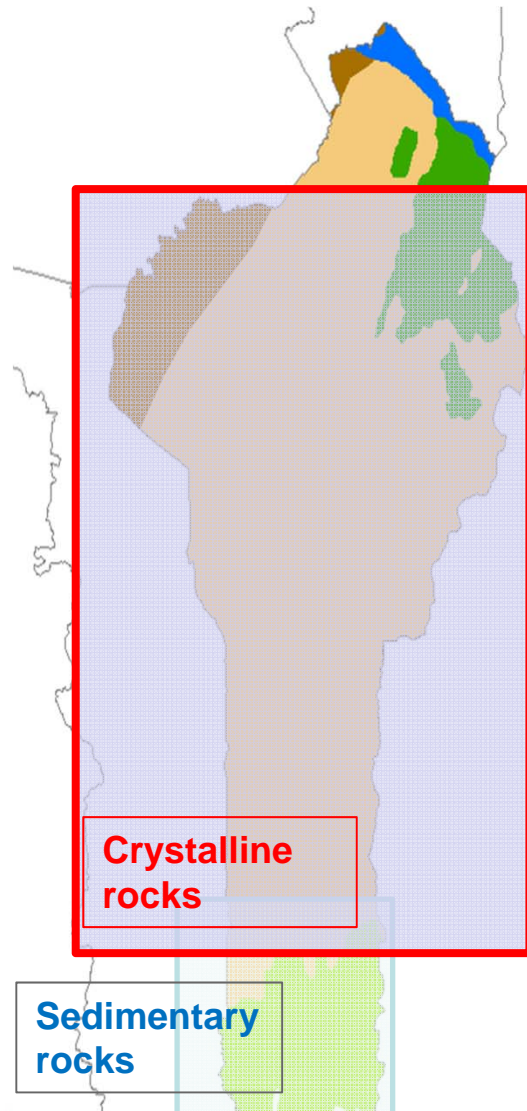
4 : Now at Department of Geology, University of Gent, Belgium,

45th IAH Congress : GROUNDWATER AND LIFE : Science and Technology into Action
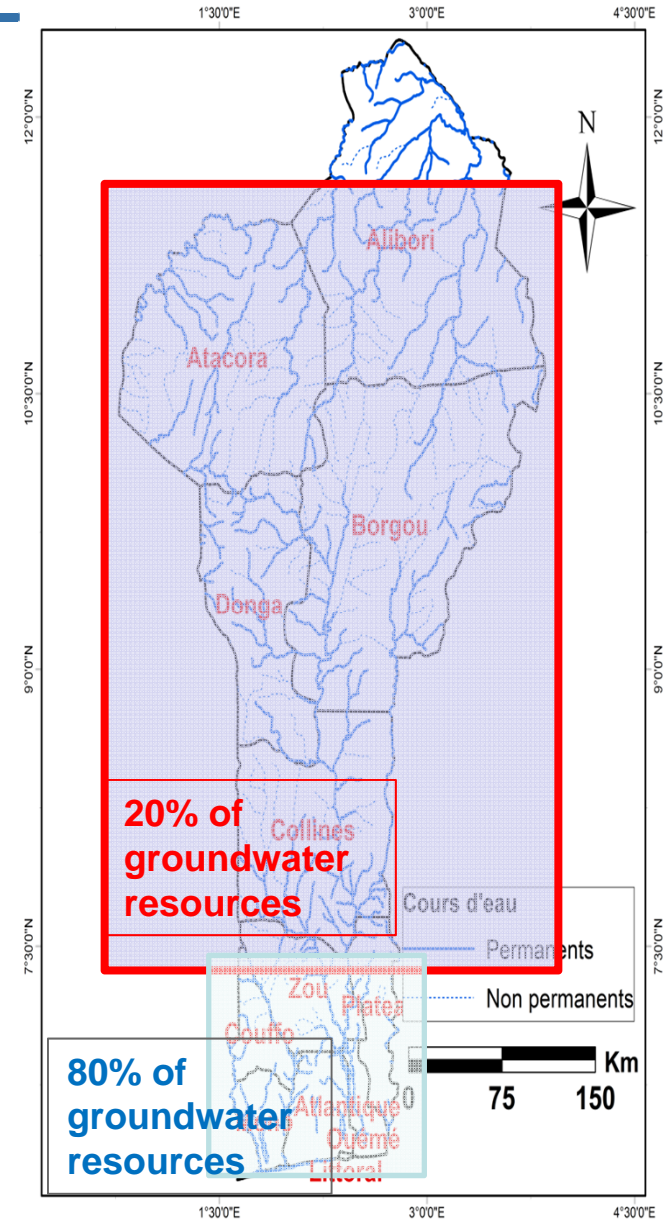Daejeon, Korea - September 9-14, 2018

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Study area and problematic

(a)

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Study area and problematic

Crystalline rocks

Sedimentary rocks

20% of groundwater resources

80% of groundwater resources

Cours d'eau

Permanents

Non permanents

3

Study area and problematic

High fluoride concentrations are found in groundwater

Health impacts are observed in the population
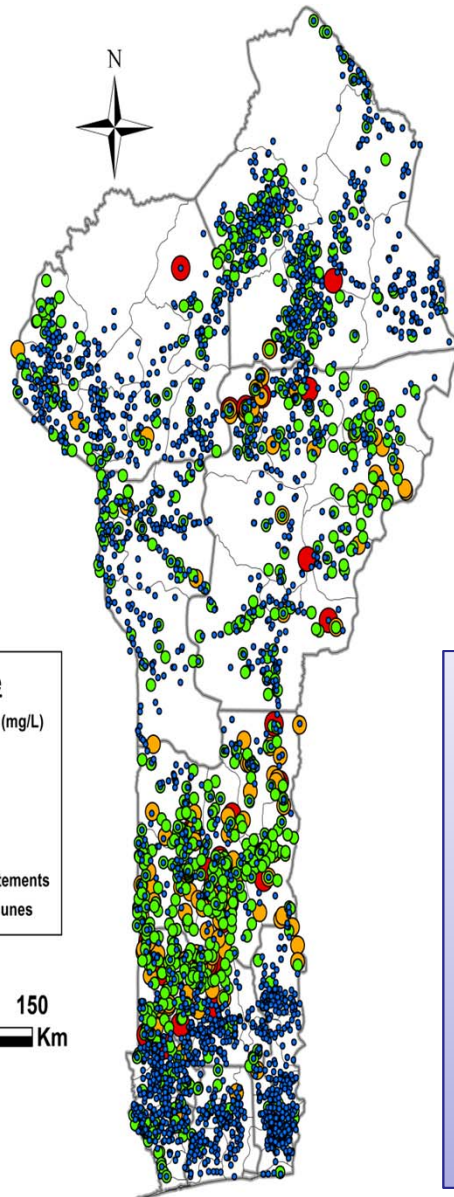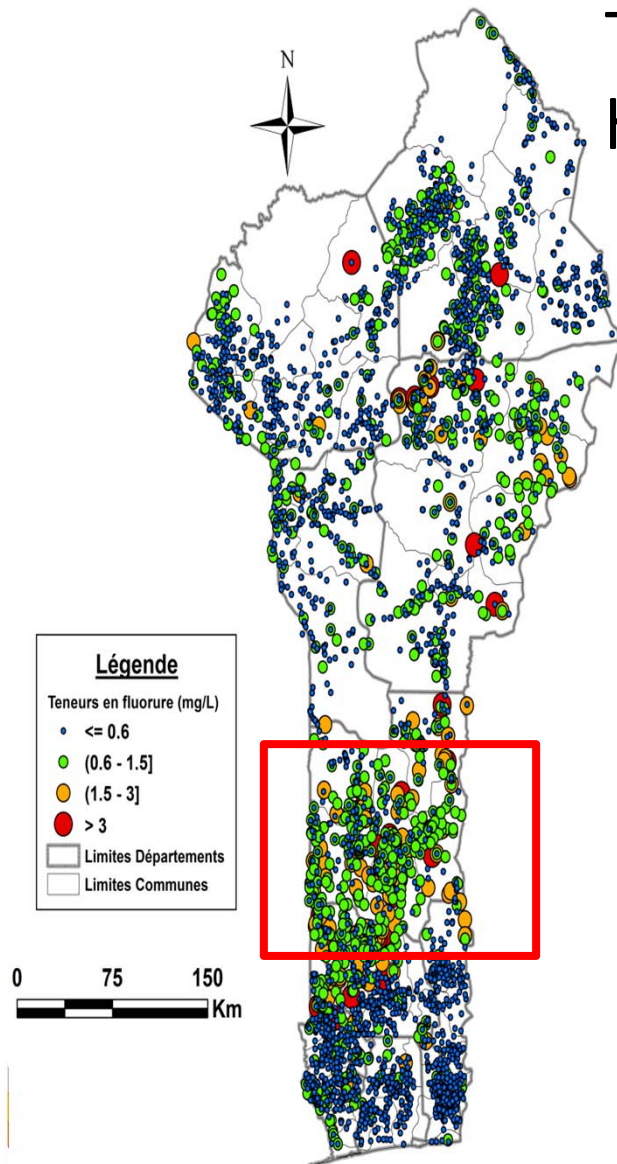
Health effects of fluoride (F-)
- F^- <0.6 mg/l in water → Dental decay
- F^- >1.5 mg/l in water → Dental fluorosis or squeletal fluorosis

Guideline for F- value in drinking water *(WHO)*:
0.6 - 1.5 mg/l

Objectives of the study

To provide decision support tools to help water managers :

o Focus on the central zone ('Région des Collines')

o Geogenic origin of fluoride has been proved

(Tossou et al 2017, Environmental Earth Sciences)

o Creation of a map of estimated fluoride concentration

o Creation of a map of probability of exceeding the WHO 1.5 mg/l limit

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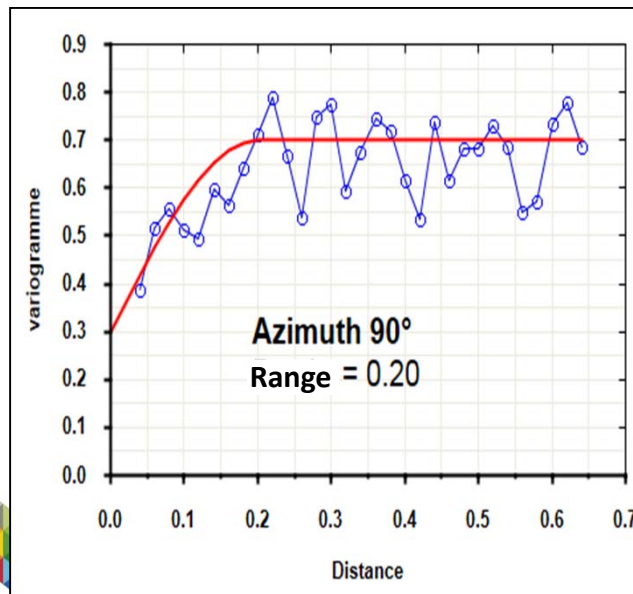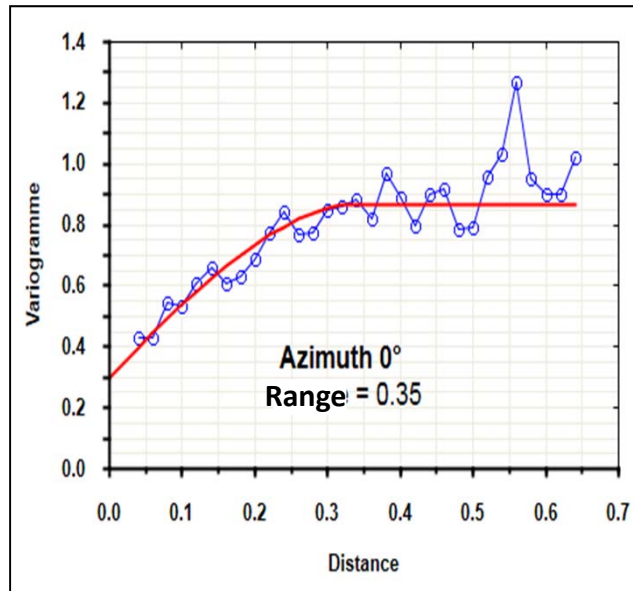
5

Material and methods

o 483 points with fluoride concentrations in groundwater
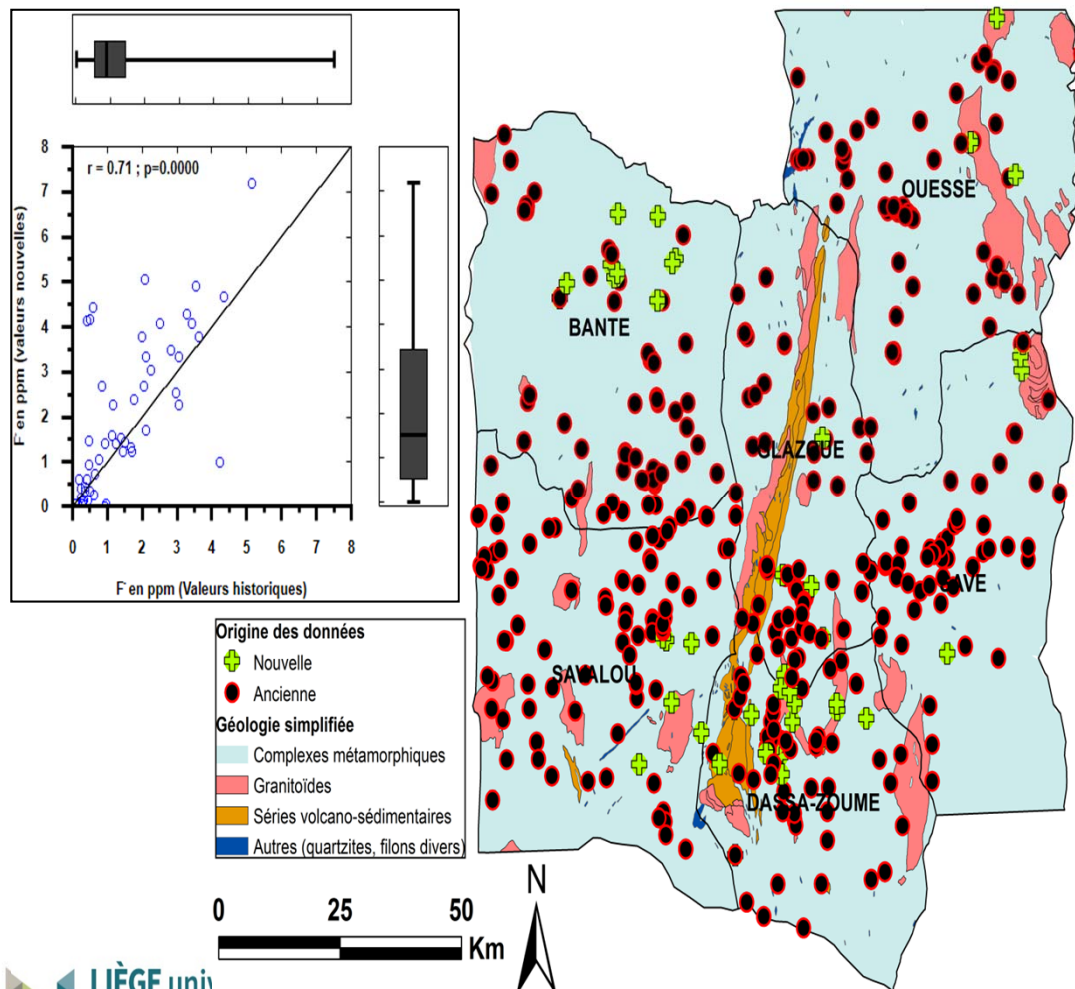
Kriging   interpolation method

o Ordinary kriging ➔ **estimation map**

o Indicator Kriging (threshold value of 1.5 mg/L) ➔ **probabilty map**

Analysis of the spatial structure of the data

Azimuth 0°
Range = 0.35

Azimuth 90°
Range = 0.20

Modelling of variograms following different directions : 0° ; 22,5° ; 45° ; 67.5° et 90°

- o Important nugget effect: Rapid decrease of spatial correlation

- o Higher correlation for the 0° direction

- o North-South anisotropy coherent with the main geological structures

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Map of estimated fluoride concentrations
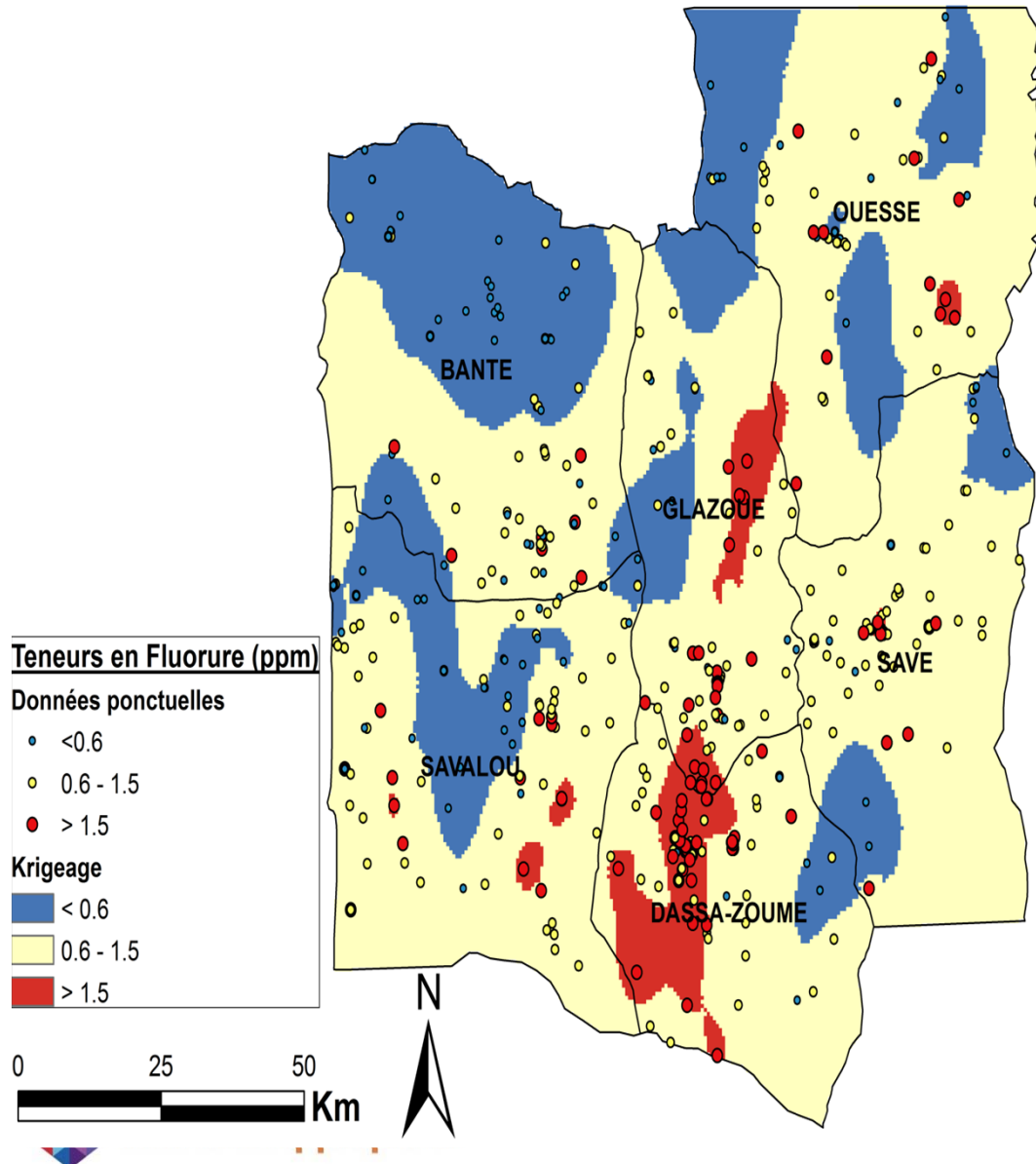
Patches with high fluoride content mostly in the immediate vicinity of the granitic outcrops in the Dassa-Zoumé area.

Probability map

o Southern area more exposed

o Similarity between areas with high probability and direction of geological structures => strong link between fluoride concentrations in groundwater and geology
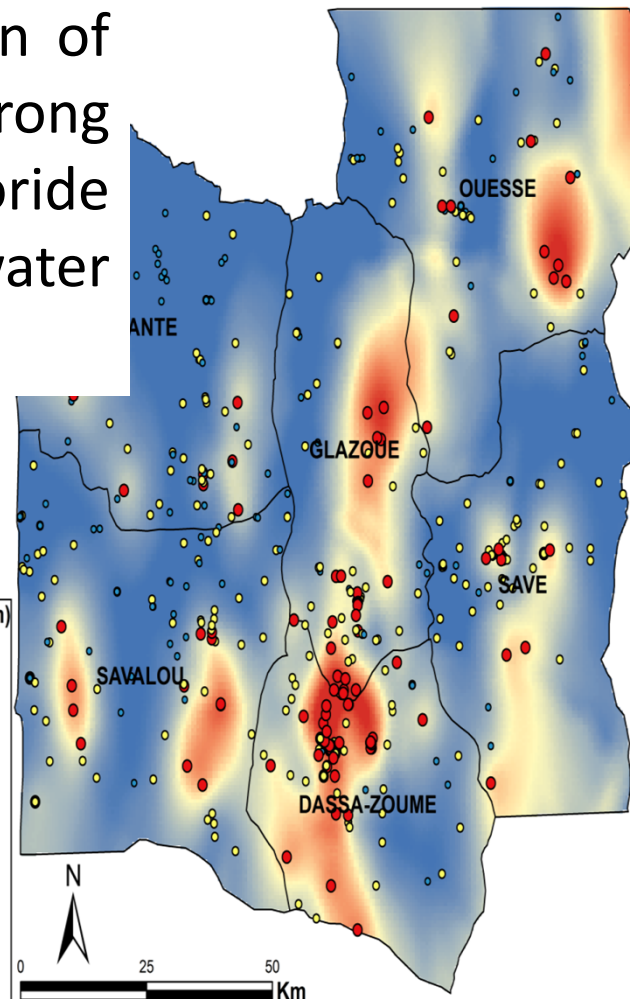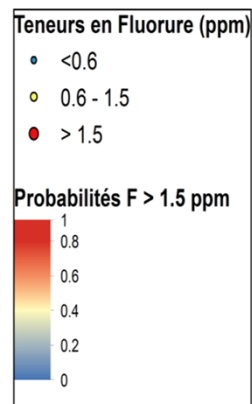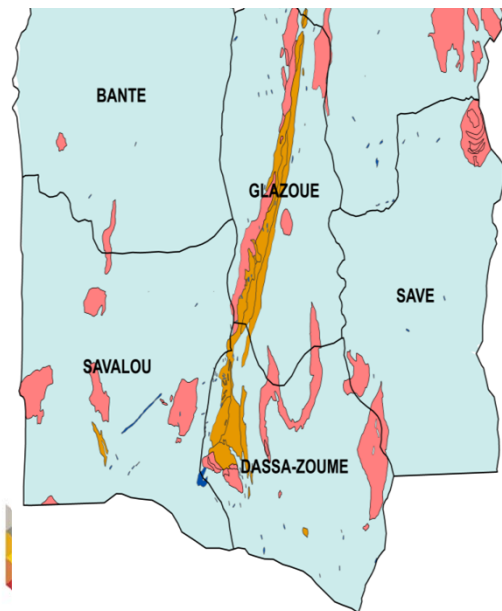
Conclusions:

This work has allowed:

o To create of a map of estimated fluoride concentration

o To creation of a map of probability of exceeding the WHO 1.5 mg/l limit

o To improve knowledge on the distribution of fluoride content in the department

o To provide guidance for more appropriate choices of drilling locations

Acknowledgment :

Any questions?

Groundwater Quality 2019
The next IAHS conference on Groundwater Quality (**GQ 2019**) will be held in Liège (Belgium) on 9-12 September 2019 !
With the support of IAH, NICOLE, UK CL:AIRE and EU H2020 ITN iNSPIRATION

More information : **aimontefiore.org/GQ2019**
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