Source tracing of fluvial suspended sediments by magnetic, geochemical and spectrocolorimetric particle characterization: example of the Canche Watershed (Nord-Pas-De-Calais, France)

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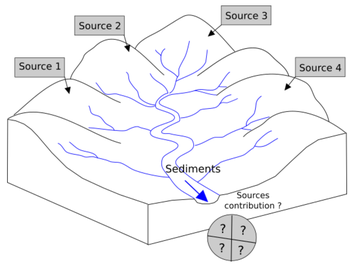
Introduction

In France, erosion by water run-off is estimated to 1.5 t ha^{-1} yr^{-1} and can exceed 10 t ha^{-1} yr^{-1} in large growing areas, such as the North of France (Nord-Pas-de-Calais) **[1]**. In this region, the Canche River sustains heavy loss of fertile soil. The land use is mainly dominated by arable lands (80%): e.g. in 2013, 104 kt of suspended sediment transited to the estuary. As demonstrated in the literature, agricultural soil erosion leads to the gradual disappearance and depletion of fertile soil, which constitute a non-renewable resource at human time scales **[2][3]**. Additionally, water erosion can significantly damage the aquatic habitat and can be responsible for the input of nutrients, bacteria, pesticides, heavy metals and radionuclides into surface waters **[4]**. Conscious of these effects, programs have emerged in the Nord-Pas-de-Calais to quantify, trace and reduce soil erosion.

1. Objectives

- Identify the sources of eroded material in the Canche watershed
- Evaluate the contribution of each source in the suspended particulate matter (SPM)
- Provide information for watershed managers and identify most erodible areas



Methodology ➔ **fingerprinting approach**

1. A tributary approach with the comparison of SPM properties from the Canche River and its tributaries
2. Then, approach strengthened by the study of the source material

2. Sampling

- 19 sediment trap samples of SPM were recovered in the Canche river and its tributaries
- Sampling perspectives : **snap shots** and **seasonal sampling**

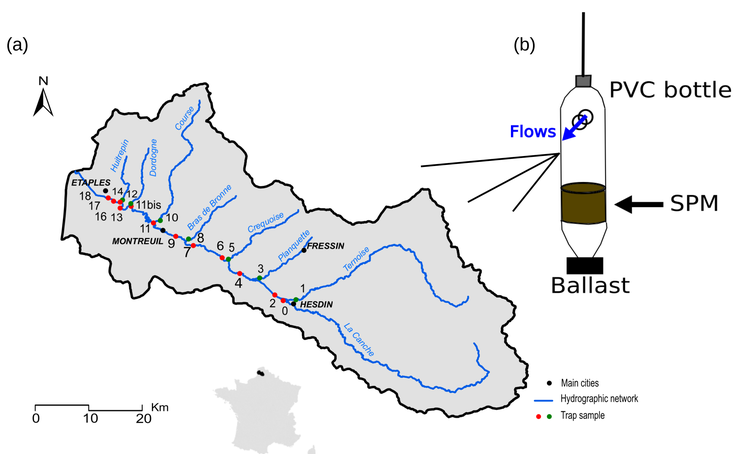
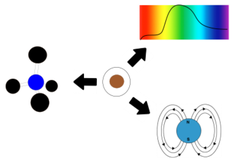


Fig.1 (a) Sample location within the Canche watershed (Nord-Pas-De-Calais, France) (b) Typical trap sample used for the collect of the SPM

3. Laboratory analyses

Elemental concentrations were determined by ICP-AES / ICP-MS



Spectrocolorimetric parameters were obtained using a spectrophotometer Minolta CM 2600 d

Magnetic hysteresis loops and backfield remanence were measured using an alternating gradient force magnetometer AGM2900

4. Preliminary results

- The S-ratio is the ratio between the remanent magnetization (Mrs) measured at both 0.3 and 1 T applied fields. In calculating the S-ratio on dry bulk sediment we can distinguish changes in magneto-mineralogy in the Canche River and its tributaries.
- The mainstream is mainly dominated by **magnetite assemblages** (typical of urban influence)
- The tributaries are characterized by high-coercivity assemblages typical for soil material **rich in hematite/goethite**

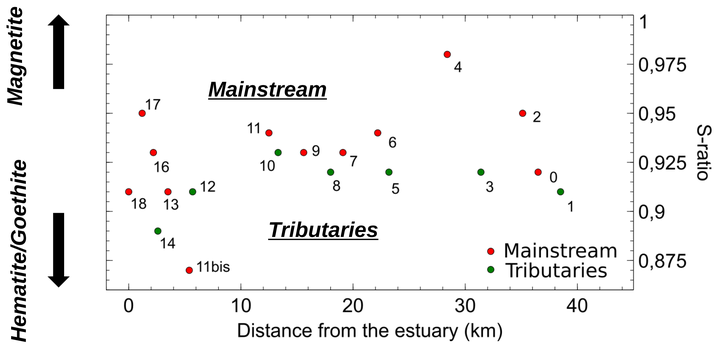


Fig.2 Variations of the S-ratio in the Canche River and its tributaries. S-ratio is calculated by dividing values of Mrs at 0.3T by those at 1T.

- Spectrocolorimetric analyses provide sediment mineralogical composition with precision, different studies have shown that some sedimentary components have distinct spectral signatures identified by the position of the first derivative peaks : 445 and 525 nm for goethite, 565 nm for hematite and from 605 to 695 nm for organic compounds **[5]**
- Here, the tributaries (sample n°1) show higher values of FDS than those of the maintsream (sample n°18): mainly for the hematite and the goethite peaks

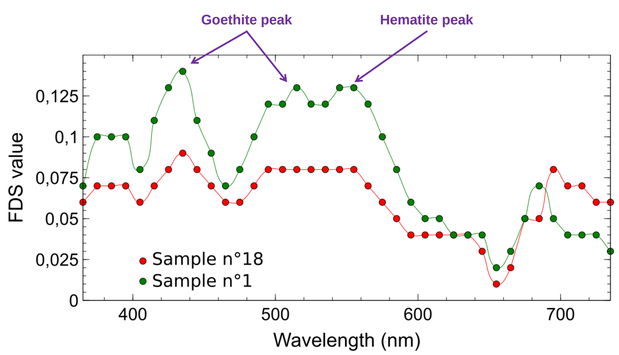


Fig.3 Variations of the FDS value in the Canche watershed: example for sample n°1 and n°18. Spectral reflectance were measured between 360 and 740 nm with a 10-nm resolution

- Finally, when confronting geo-chemical results and magnetic results we can distinguish the **upstream area** and the **downstream area**, that are characterized for example, by **different values of Si and S-ratio**

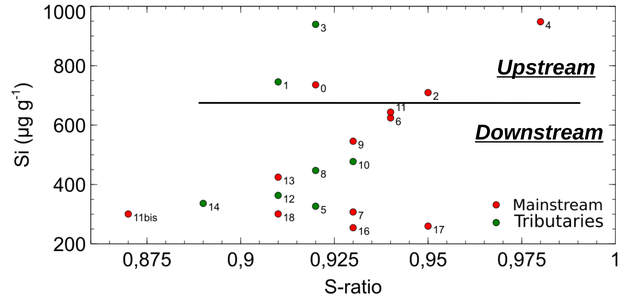


Fig.4 Variations of S-ratio and Silica concentrations in the Canche River and its tributaries.

Conclusions

- **Specific source areas are distinguishable** according to the combination of **S-ratio** values and **concentrations in Si** (upstream and downstream areas)
- The **Canche River** is mainly dominated by **magnetite assemblages** whereas the **tributaries** are mainly characterized by **hematite/goethite assemblages**
- The combination of different analyses may give valuable insight into the tracing of the suspended sediment sources

Perspectives

- Sampling campaign of source areas (soils)
- Geochemical, spectrocolorimetric and magnetic analyses on source material
- Evaluation of relative contribution of source material on SPM will be estimated using a multivariate mixing model (e.g. models available in Haddadchi et al., 2013 **[6]**)

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