

## Long-term accumulation of metals and persistent pollutants (PAHs, PCBs, organochlorine pesticides) from Eure river watershed (France) in sediments: possible consequences of a dam removal

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 $3.1. \sum_{16} PAHs$ 

*3.2.* ∑<sub>7</sub>PCBs

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- Context of the European Water Framework Directive (2000/60/CE)
  - Allow free Suspended Particulates Matter transfers in rivers
  - French authorities decided to remove dam of Martot
    - Consequences for sediments blocked upstream the dam ?



### > Observatory of the Seine Sediments in the Eure River (Eure county: 27) and the Seine River (Seine-Maritime county: 76)

- Aim: Study dam removal impacts (dam located on the Eure River (Normandy, France))
  - Qualities and quantities of sedimentary transfers

> Accumulation of polluted sediments in Eure Watershed since the last century

- Fate of organic (PAHs, PCBs, organochlorine Pesticides) and metallic pollutants after dam removal
- Assessing the bio-accessibility

#### THE EURE WATERSHED

CORE SAMPLING

#### CORE DATING



## **Eure River:**

- 228.7 km long
- One of the main tributaries of the Seine River downstream
- Two main tributaries:
  - Iton (131.8 km long)
  - Avre (80.4 km long)

## **Eure Watershed:**

- 6,017 km²
  - Land use: Agricultural land: 71.2 % Forest: 22.3 % Artificial lands: 6 % Water and humid surfaces: 0.5 %

**CORE DATING** 

#### • THE EURE WATERSHED

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Eure River downstream (~ 10 km long)

The Eure River and the Seine River are « side by side » until the confluence

**CORE SAMPLING** 



#### • THE EURE WATERSHED



- CORE SAMPLING
  CORE DATING
- Eure River downstream (~ 10 km long)
- The Eure River and the Seine River are « side by side » until the confluence
- Dam of Martot: 300 m upstream the Eure River/Seine River confluence



#### • THE EURE WATERSHED





Dam of Martot

### CORE SAMPLING CORE DATING

- Eure River downstream (~ 10 km long)
- The Eure River and the Seine River are « side by side » until the confluence
- Dam of Martot: 300 m upstream the Eure River/Seine River confluence
- Two ponds: Martot pond & Les Damps pond



### • Martot pond:

- Formerly connected to the Seine River
- Since 1942: connected to the Eure River
- Filled by Seine then Eure sediments inputs

- THE EURE WATERSHED
- MARTOT POND

- Core sampling in 2015:
- MAR15-01; MAR15-02; MAR15-03; MAR15-04
- Core sampling in 2016:
- EUR16-01; EURE16-02; EUR16-03
- **MAR16-02**; MAR16-03
- Core sampling in 2017:
- EUR17-01; EUR17-02; EUR17-03; EUR17-04
- MAR17-01; MAR17-02

#### CORE SAMPLING

CORE DATING



**CORE SAMPLING** 

CONCLUSIONS AND PROSPECTS

- THE EURE WATERSHED
- DAM17-01 DAM17-02

- CORE DATING
  - LES DAMPS POND
- (10 km upstream Martot pond)
- Core sampling in 2017:
- DAM17-01; **DAM17-02**



THE EURE WATERSHED

## CORE SAMPLING CORE DATING

- **Dating of DAM17-02 core** (sampling in Les Damps pond):
- Dating of MAR15-01 by absolute dating using <sup>7</sup>Be, <sup>137</sup>Cs, <sup>210</sup>Pb (in 2015)
- Dating of DAM17-02 by correlation with MAR15-01: correlation with XRF Core Scanner data
  - Correlation with Pb/Ti = f(z) and Mn/Ti = f(z)
  - ➢ Find several references points

THE EURE WATERSHED

#### CORE SAMPLING

#### CORE DATING

2020 y = -0.8088x + 20172010 R<sup>2</sup> = 0,9995 y = -0,9203x + 20172000 R<sup>2</sup> = 0.9996 y = -1,032x + 2017 $R^2 = 0.9997$ 1990 Kears 1980 1970 1960 "Middle Age" 1950 Age + Age -1940 10 30 40 50 60 20 70 0

Depth - cm

- **Dating of DAM17-02 core** (sampling in Les Damps pond):
- Dating of MAR15-01 by absolute dating using <sup>7</sup>Be, <sup>137</sup>Cs, <sup>210</sup>Pb (in 2015)
- Dating of DAM17-02 by correlation with MAR15-01: correlation with XRF Core Scanner data
  - $\succ$  Correlation with Pb/Ti = f(z) and Mn/Ti = f(z)
  - $\succ$  Find several references points
- Plotting DAM17-02 Age Model
  - > Obtaining a sedimentation rate for Les Damps pond
- □ Sedimentation rate : 0.92 cm an<sup>-1</sup>
- ➤ Comparable to the sedimentation rate of Martot pond: 1.08 cm an<sup>-1</sup>

CONCLUSIONS AND PROSPECTS

•  $\sum_{16}$  PAHs

•  $\sum_{7} PCBs$ 

• TRACE-METAL ELEMENTS: example of Pb

MARTOT POND: MAR16-02

• LES DAMPS POND: DAM17-02



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LES DAMPS POND: DAM17-02

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- TRACE-METAL ELEMENTS: example of Pb
  - LES DAMPS POND: DAM17-02



SCIENTIFIC CONTEXT | METER

LES DAMPS POND: DAM17-02

•  $\sum_{16}$ PAHs

•  $\sum_{7} PCBs$ 

• TRACE-METAL ELEMENTS: example of Pb

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• MARTOT POND: MAR16-02





SCIENTIFIC CONTEXT | ME

 $\sum_{16}$ PAHs

•  $\sum_{7} PCBs$ 

• TRACE-METAL ELEMENTS: example of Pb

• MARTOT POND: MAR16-02



• LES DAMPS POND: DAM17-02



CONCLUSIONS AND PROSPECTS

 $\sum_{16}$ PAHs 

 $\sum_{7} PCBs$ 

TRACE-METAL ELEMENTS: example of Pb 

MARTOT POND: MAR16-02

#### LES DAMPS POND: DAM17-02 ٠



CONCLUSIONS AND PROSPECTS

•  $\sum_{16}$ PAHs



• TRACE-METAL ELEMENTS: example of Pb



- $\sum_{16}$  PAHs •
- $\sum_{7} PCBs$

TRACE-METAL ELEMENTS: example of Pb

• MARTOT POND: MAR15-01





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SCIENTIFIC CONTEXT | METERIALS

- $\sum_{16}$ PAHs  $\sum_{16}$
- $\sum_{7} PCBs$

TRACE-METAL ELEMENTS: example of Pb

• MARTOT POND: MAR15-01



## • LES DAMPS POND: DAM17-02



SCIENTIFIC CONTEXT | METERIALS AND METHODS

- $\sum_{16}$ PAHs •
- $\sum_{7} PCBs$

TRACE-METAL ELEMENTS: example of Pb

• MARTOT POND: MAR15-01



## • LES DAMPS POND: DAM17-02



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 $\sum_{16}$ PAHs 

 $\sum_{7} PCBs$ 





- MAR15-01: First increase:
  - Changes in sediments inputs
  - Opening of a cathode-ray tubes factory in the Eure watershed in 1956: not visible
  - 2<sup>nd</sup> increase on MAR15-01 튐 <sub>60</sub> and 1st increase on DAM17-02: 1974
  - > Opening of a 2<sup>nd</sup> factory in 1974 100



LES DAMPS POND: DAM17-02

•  $\sum_{16}$  PAHs

•  $\sum_{7} PCBs$ 



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- According to the age model:
  - MAR15-01: First increase: 1942
    - Changes in sediments inputs

- Opening of a cathode-ray tubes factory in the Eure watershed in 1956: not visible

- 2<sup>nd</sup> increase on MAR15-01 and 1<sup>st</sup> increase on DAM17-02: 1974
- Opening of a 2<sup>nd</sup> factory in 1974

1990: peak of activities



 $\sum_{16}$ PAHs

- MARTOT POND: MAR15-01



 $\sum_{7}$ PCBs

- **TRACE-METAL ELEMENTS: exemple of Pb**
- According to the age model:
  - MAR15-01: First increase: 1942
  - **Changes in sediments inputs**  $\geq$
  - Opening of a cathode-ray tubes factory in the Eure watershed in 1956: not visible
  - increase on MAR15-01 and 1st  $2^{nd}$ increase on DAM17-02: 1974
  - ➤ Opening of a 2<sup>nd</sup> factory in 1974
  - > 1990: peak of activities
  - Decrease to the top of the core:
  - > Emerging of flat-screen television
  - > Purchasing of the factory
  - $\square$  Pb/Ti at the top > Pb/Ti at the bottom of MAR15-01:

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 $\triangleright$  Other sources ?

#### LES DAMPS POND: DAM17-02 •





- Eure River Watershed:
- Historical pollution linked to anthropogenic impacts
- Accumulation of pollutants throughout the last century
- Potential re-suspension and re-mobilisation after dam removal



- Eure River Watershed:
- Historical pollution linked to anthropogenic impacts
- Accumulation of pollutants throughout the last century
- Potential re-suspension and re-mobilisation after dam removal
- Impact of the dam removal ?
  - Hydro-sedimentary transfers
  - Pollutants transfers











## **THANK YOU FOR YOUR ATTENTION**



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