Suspended solid concentration in the Seine Estuary based on the SYNAPSES turbidity monitoring network: quantification and variability

Flavie DRUINE[1], Robert LAFITE[1], Julien DELOFFRE[1], Romaric VERNEY[2] and Jean-Philippe LEMOINE[3]

[1] UMR CNRS 6143 Morphodynamique Continentale et Côtière, Bâtiment IRESE A, Université de Rouen, 76821 Mont-Saint-Aignan, France
[2] IFREMER, Laboratoire DYNECO/PHYSED, PB70, 29280 Plouzané, France
[3] GIP Seine-Aval, Pôle des Savoirs, 115 Boulevard de l'Europe, 76100 Rouen, France / Web site : http://seine-aval.crihan.fr

flavie.druine@etu.univ-rouen.fr

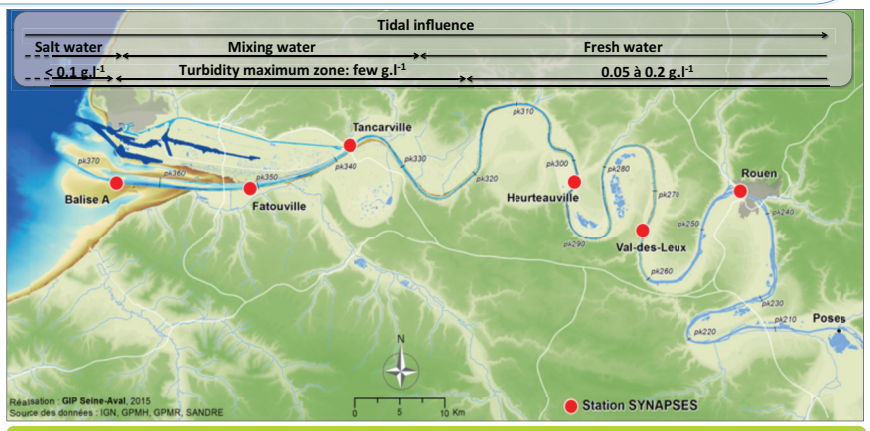
Context and problematic

The Seine Estuary system:

- A strategic position **at the ocean/continental interface**
- A **"critical" area** which concentrates several conflicting ecological/economical issues
- Driven by **complex hydro-sedimentary processes** controlled by hydrodynamic forcing (macrotidal estuary) and anthropogenic pressure
- **Understanding the estuary morphological evolution require knowledge on fine sediment fluxes**

Scientific issues :

- Evaluation of fine sediment fluxes in estuaries based on long term automated measurements
- Require to quantify **suspended particle matter (SPM) concentrations (NTU vs g.l^{-1} relationships)**
  BUT SPM features (size, shape and density), controlled by flocculation processes, are strongly variable and may modify these relationships
- **Require to investigate SPM behavior and variability**
  - › For different key compartments within the estuary : Fresh water zone, mixing water zone and turbidity maximum zone
  - › For different time scale: Semi-diurnal cycle / Neap and Spring cycle / Seasonal scale

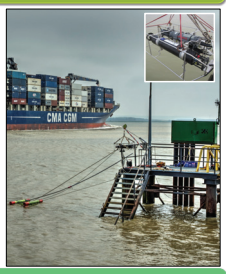


SYNAPSES monitoring network

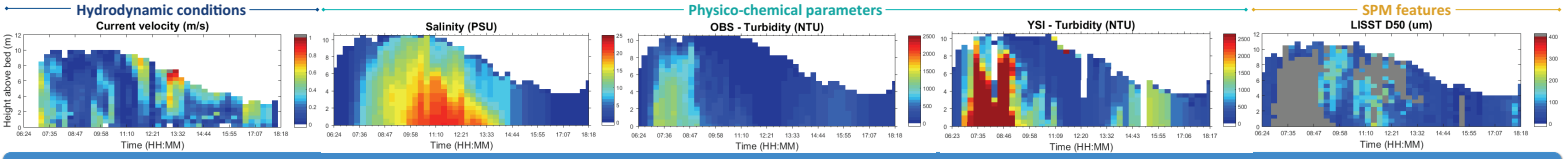
- Supported by Rouen Port Authorities and GIP Seine-Aval coordination
- **6 key stations** from the fluvial compartment to the estuary mouth
  - › **Including the turbidity maximum zone** *(cf. map)*
- All sites equipped with YSI 6600V2 multi-parameter probes
- Physico-chemical parameters (measurement interval: 5 min):
  - › Conductivity / Salinity / Temperature
  - › Dissolved oxygen / Fluorescence / Turbidity
- Depth of measurement:
  - › **1m in sub-surface**
  - › **1m above to the bed for three downstream stations**
- Data available from the web @ *synapses.seine-aval.fr*

Field campaigns and methodology

- 5 stations located at SYNAPSES stations
- **Continuous measurements** from piers:
- During spring tides (between 6.35 et 7,05m) for a 12h tidal cycle
- **Profiles** every 15' from the surface to the bottom
- Instruments deployed for each profiles (*cf. picture*):
  - › **A CTD Seabird 19plusV2** probe associated with an OBS3+ (2Hz)
  - › An **YSI 6600V2 multi-parameter** probe (1Hz)
  - › A **LISST 100X-C** (Laser In-Situ Scattering and Transmissometry) (1Hz)
- **Coupled with water samples (every hour)** in sub-surface (1m) and close to bottom (1m)
- Assess **current velocity from an ADCP** (RDI Workhorse Sentinel 600kHz)

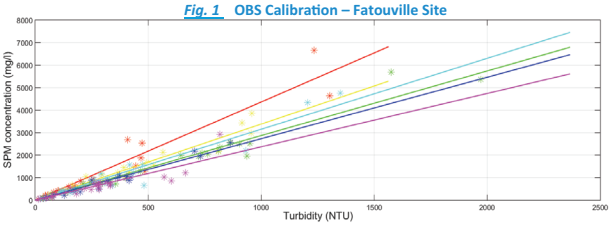


Main parameters measured



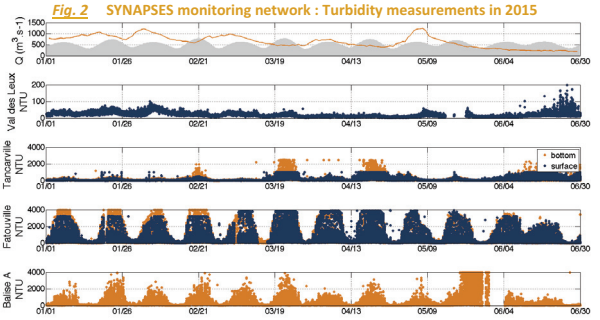
SPM concentration (mg.l^{-1}) and turbidity (NTU) relationship variability

Fig. 1 OBS Calibration – Fatouville Site



18-Feb-2015	Tidal range:6.5	[MES]=4.36xNTU	Discharge (m3/s)=628
19-Mar-2015	Tidal range:6.6	[MES]=3.38xNTU	Discharge (m3/s)=509
22-Apr-2015	Tidal range:7.05	[MES]=2.87xNTU	Discharge (m3/s)=416
18-May-2015	Tidal range:6.95	[MES]=3.15xNTU	Discharge (m3/s)=573
17-Jun-2015	Tidal range:6.45	[MES]=2.73xNTU	Discharge (m3/s)=218
03-Jul-2015	Tidal range:6.35	[MES]=2.37xNTU	Discharge (m3/s)=188

Fig. 2 SYNAPSES monitoring network : Turbidity measurements in 2015



Field measurement analysis/processing:

- **Work in progress**
- Example on one site: **Fatouville**

Hydrodynamic conditions *(Fig. 2)*:

- Quasi-identical spring tides (Tidal Range: 6.35 to 7.05m)
- Different discharge (188 to 628 m^3/s)
- **Located in the turbidity maximum zone**

Turbidity/concentration relationships *(Fig. 1)*:

- **Variable** according to the field results
- Calibration slope: **factor of 2** between February and July
- **Temporal variability:**
  - › **Seasonal cycle**
  - › **Tidal variability**

Driving parameters on variability:

- SPM features (*Fig. 5*)
  - › **Size** / Shape / **Density**
- Feature depend on
  - › Seine river **discharge** at Poses dam *(Fig. 3)*
  - › **Tidal range** *(Fig. 4)*

Hypothesis on seasonal variability:

- **Turbidity maximum zone movement**
- **Planktonic bloom development**
- **Change in the SPM nature**

Fig. 3 Correlation calibration coef./ Discharge

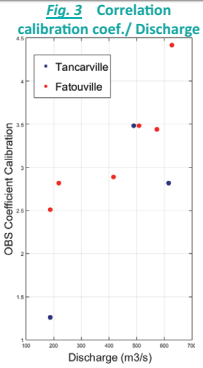


Fig. 4 Relation between floc density and median floc size

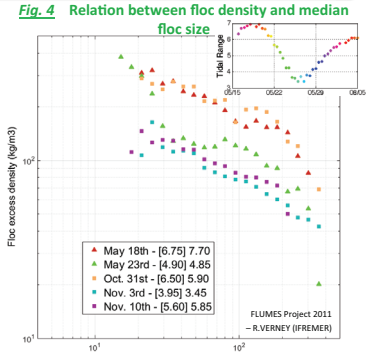
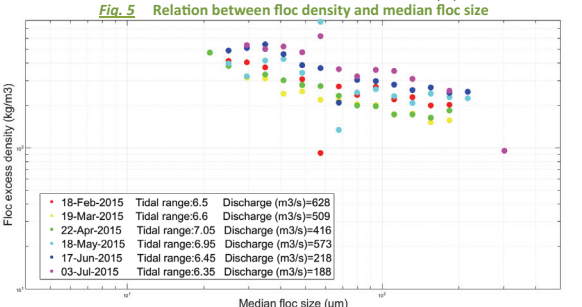


Fig. 5 Relation between floc density and median floc size



18-Feb-2015	Tidal range:6.5	Discharge (m3/s)=628	
19-Mar-2015	Tidal range:6.6	Discharge (m3/s)=509	
22-Apr-2015	Tidal range:7.05	Discharge (m3/s)=416	
18-May-2015	Tidal range:6.95	Discharge (m3/s)=573	
17-Jun-2015	Tidal range:6.45	Discharge (m3/s)=218	
03-Jul-2015	Tidal range:6.35	Discharge (m3/s)=188	

Perspectives

Next months:

- Conduct 21 days **Spring-Neap cycle campaign** to access the short term SPM variability
- **Complete the monthly field campaigns** to access the seasonal variability
- **Define a calibration method** adapted for long term monitoring network and estimate uncertainties
- **Analyze data** from all sites to evaluate the along estuary spatial variability

Next year : Cross section field measurements

- Examine the **spatial representativeness** of the bank measurements
- Sediment fluxes quantification
  - › **Calculation methodology / Uncertainly estimation**

GRR Grands Réseaux de Recherche Haute-Normandie · SCALE · DYNALIT · Région Haute Normandie · Normandie Université · Université de Rouen · Ifremer · GIP Seine-Aval Groupement d'Intérêt Public · Port de Rouen la maritime vallée · Préfecture de la Région de Haute-Normandie · Liberté • Égalité • Fraternité République Française · Financé avec l'aide du FEDER Fonds Européen de Développement Régional