**Context**

**Previous studies**
- Hypoxia in the estuary [1, 2]
- Middle Loire = most eutrophic sector
  - During the 1980s, Chl. a ≈ 250 µg L\(^{-1}\)
  - Hyper-eutrophication in the Gironde (G) and Villerest (V) reservoirs [Fig. 1].
- Phytaltonk development since 1990 [9, 10]
- With climate change, lower flow rates, increased water temperature [11]

**Questions**
- Eutrophication evolution in the Loire River and its tributaries since the extreme conditions (1980s) and the EU Directives enforcements (1990s)?

**Basin features**
- At Basin outlet:
  - 110 000 km\(^2\)
  - 1000 km long (Fig. 1)
  - 8 million inhab. concentrated along the Loire River (45% of the Loire basin)
  - Average annual discharge: 860 m\(^3\) s\(^{-1}\)
  - Water flow: 100 m\(^2\) s\(^{-1}\), water depth ≈ 1m
  - 10 days to travel Middle and Lower reaches

**Phytoplankton and nutrients trends**

**Figure 1**: Loire Basin presentation and stations locations. Stations 1 to 21: freshwater, Loire River; Stations e1 to e8: estuarine zone, Loire River. Reserves Villerêve (V), Grangent (G) and Naussac (N).

**Figure 2**: Population density and arable land percentage profiles along the Loire River.

**Figure 3**: Input and output phosphorous load evolution at Tours city waste water treatment plant (100 000 inhabitants equivalent).

**Results and Discussion**
- Summer phytoplankton biomass was divided 4-fold in Middle and Lower Loire and in major tributaries since 1990 (Fig. 4)
- PO\(_4\)\(^3-\) decreased 3-fold since 1990 (Fig. 5 & 6)
- Late summer blooms no longer occur
- Inverted PO\(_4\)\(^3-\) seasonality between Upper and Lower Loire reaches
- 10% increase of  NO\(_3\) since 1980
- Clear NO\(_3\) seasonality unchanged over time

**Conclusions and perspectives**
- Eutrophication mitigation started in the early 1990s as a response to the reduction of phosphorus inputs => when hydrologic conditions remain favorable for phytoplankton growth, P is the limiting factor
- Eutrophication trajectories in the main tributaries were similar to the evolution observed in the Middle and Lower Loire.
- Other recent changes should be considered: e.g. what is the impact of Corbicula clams sp. invasion which started during the 1990s [13] on the observed phytoplankton decrease (Fig. 8)?

**References**


