Transnational Quality Modelling of the Meuse District using the PᴇɢOᴘᴇʀᴀ Software suite

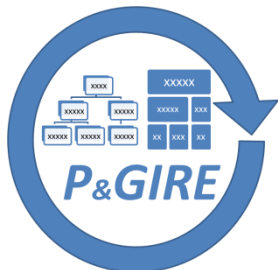*Liège, September 12th, 2023*

Pol Magermans, PeGIRE

Aline Grard, PeGIRE

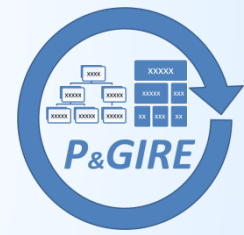*Prof. Jean-François Deliège, Dir. PeGIRE*

PₑGIRE
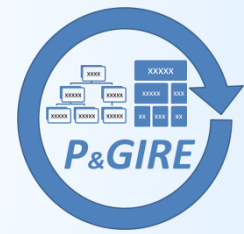
Planification et Gestion Intégrée des Ressources en Eau

Water Quality Modelling of the **Meuse** at the scale of its **International River Basin District**

❑ Methodology for Surface Water Quality Assessment
   PEGASE Model & PEGOPERA Software Suite

❑ Application to the IRBD Meuse

   Transnational management of surface water body quality

❑ Conclusions

PEGASE Model

Planning and Management of Water Treatment

Objectives

- o Better understand the mechanisms of the hydro-system
- o Quantify "pressure-impact" relationships and ease decision making
- o Structuring the knowledges (including "Input Data")

Usage

1) Simulation of surface water quality

- ✓ Relation Watershed / Rivers (→ extending "river" models)
- ✓ Taking into account Pollutants loads and Releases
  → data structuration
- ✓ Representation of the Aquatic Ecosystem and the Water Quality (O_2, C, N, P + various pollutants)
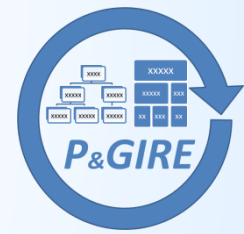 → **Deterministic model based on physics**

2) Operational Decision-Making Tool for

- ✓ Treatment and Depollution
- ✓ Management of aquatic environment quality / WFD / Management plans…
  → Continuous interaction with users
  → PEGOPERA Software Suite → Model + Graphical User Interface
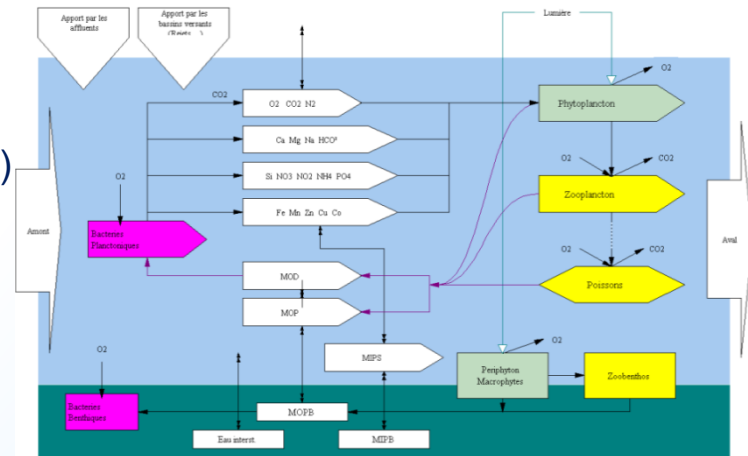
*Born in the 80's Constantly evolving since*

PEGOPERA Software Suite

The PEGOPERA Software Suite is composed of

o The PEGASE Model
  o Sediments / Micropollutants
  o Mixing Areas
  o Cyanobacteria
  o Accidental Pollution
  o …

o Graphical User Interface
  o Pre- and Post-Processing
  o Import / Export Services
  o Specific Editors
  o Linked to GIS
  o Validation Tools
  o Designed to be coupled with other models (hydraulic, lakes, soil…)
  o …
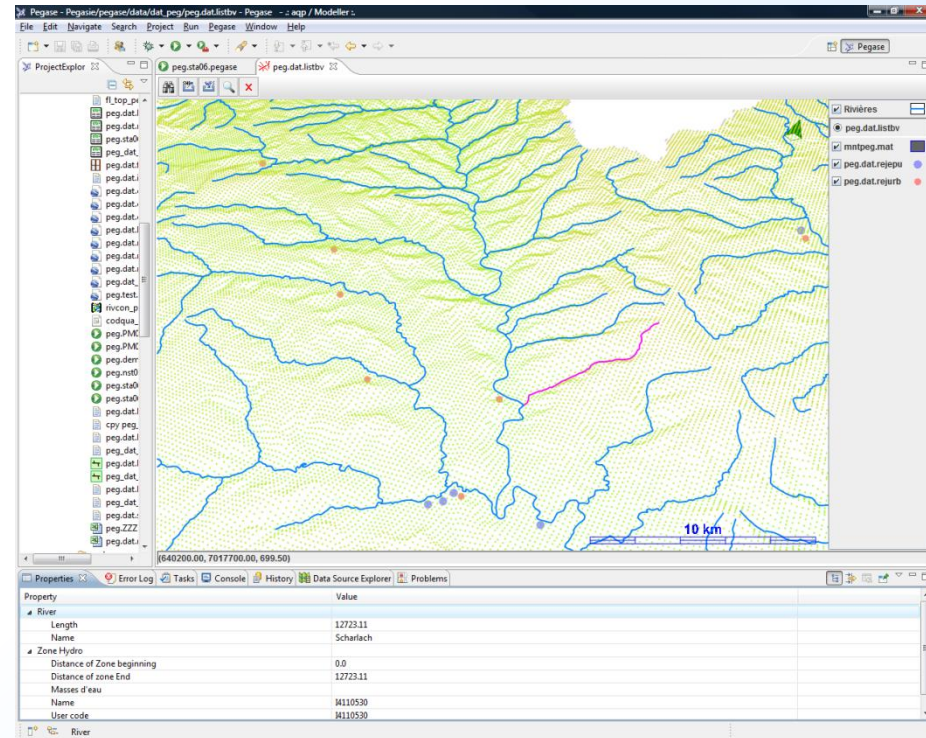
PEGASE Applications over Europe
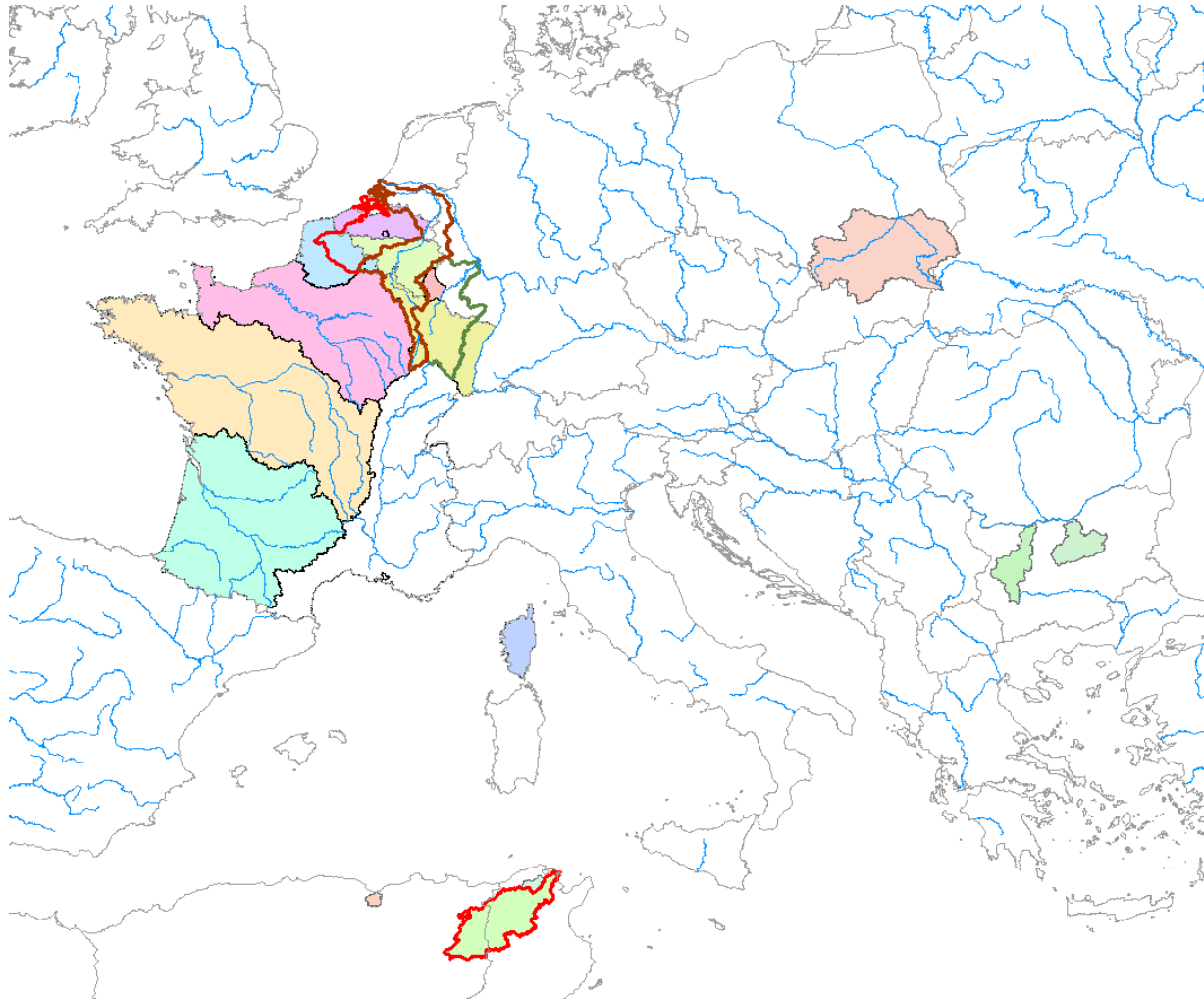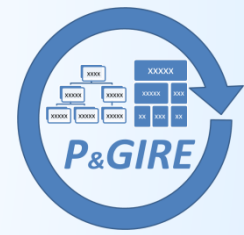
DGO3, Walloon Region, Be

Rhine-Meuse, France

VMM, Flemmish Region, Be

Adm. Gestion de l'Eau, Lux

Loire-Bretagne, France

Adour-Garonne, France

Artois-Picardy, France
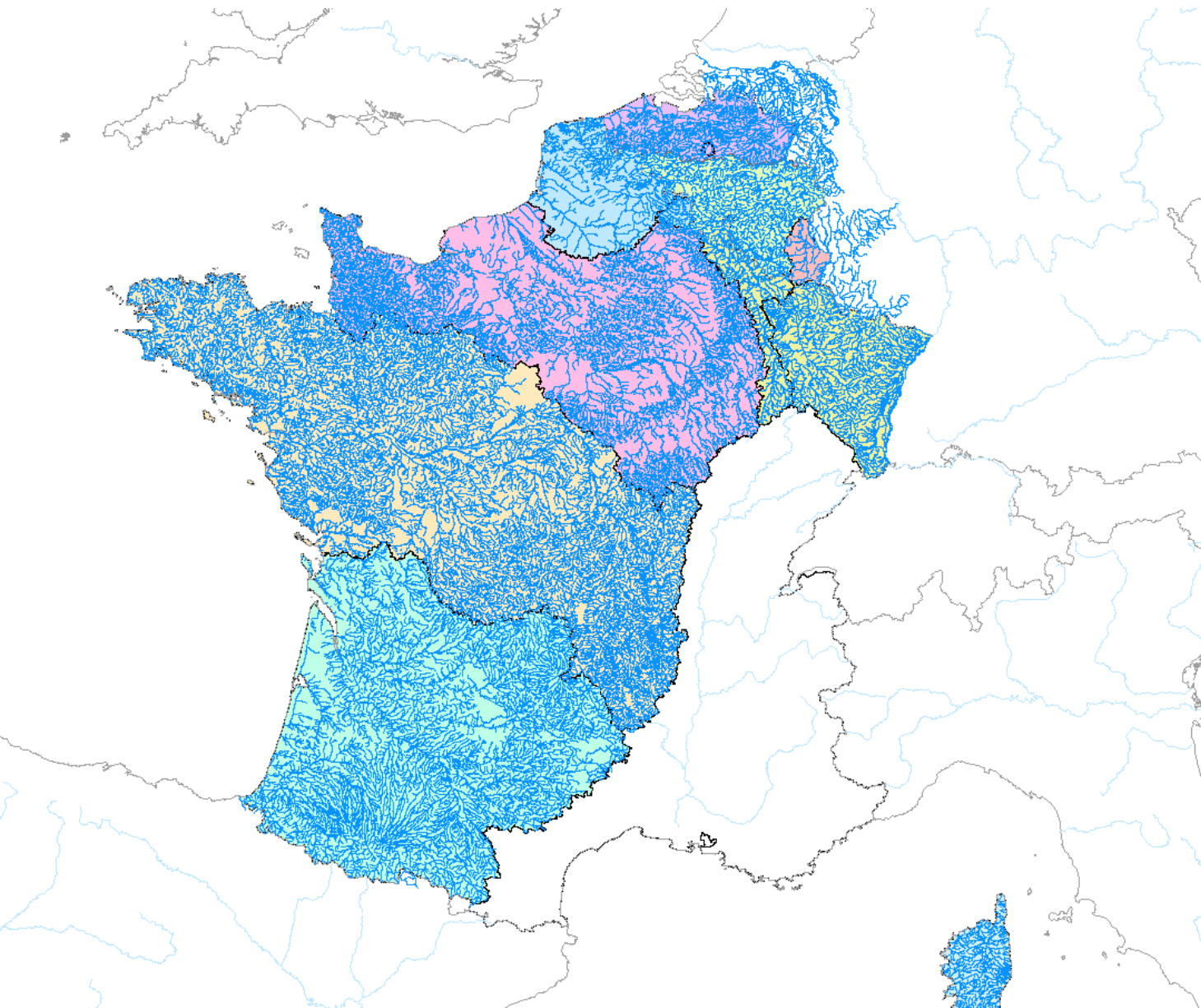
Seine-Normandy, France
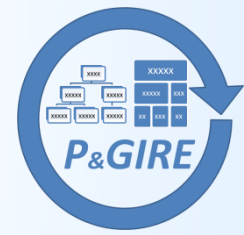
Medjerda, ANPE, Tunisia

Test and Research Applications:
- Iskar, Bulgaria
- Yantra, Bulgaria
- Corsica, France
- Agrioune, Algeria
- Joumine, Tunisia
- Upper Wisla, Poland

Trans-National Applications:
- Scheldt
- Meuse
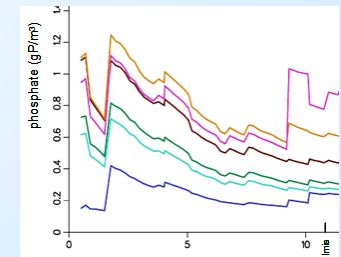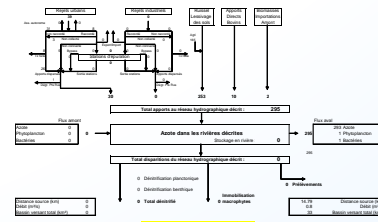- Mosel
- Medjerda

PEGASE Applications over Europe

12 countries

600 000 km²

30 000 Rivers
250 000 km

1 000 000 nodes

Pegase Methodology : Input & Output

Input data cylinders:
- River tree
- DTM Landcover data
- Hydro-Meteo data
- Activities impacts

PEGASE model

Output data cylinders:
- Hydrologic results
- Polluting loads balances
- Water Quality and fluxes
- WFD results
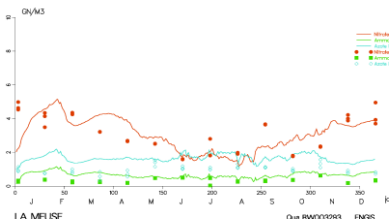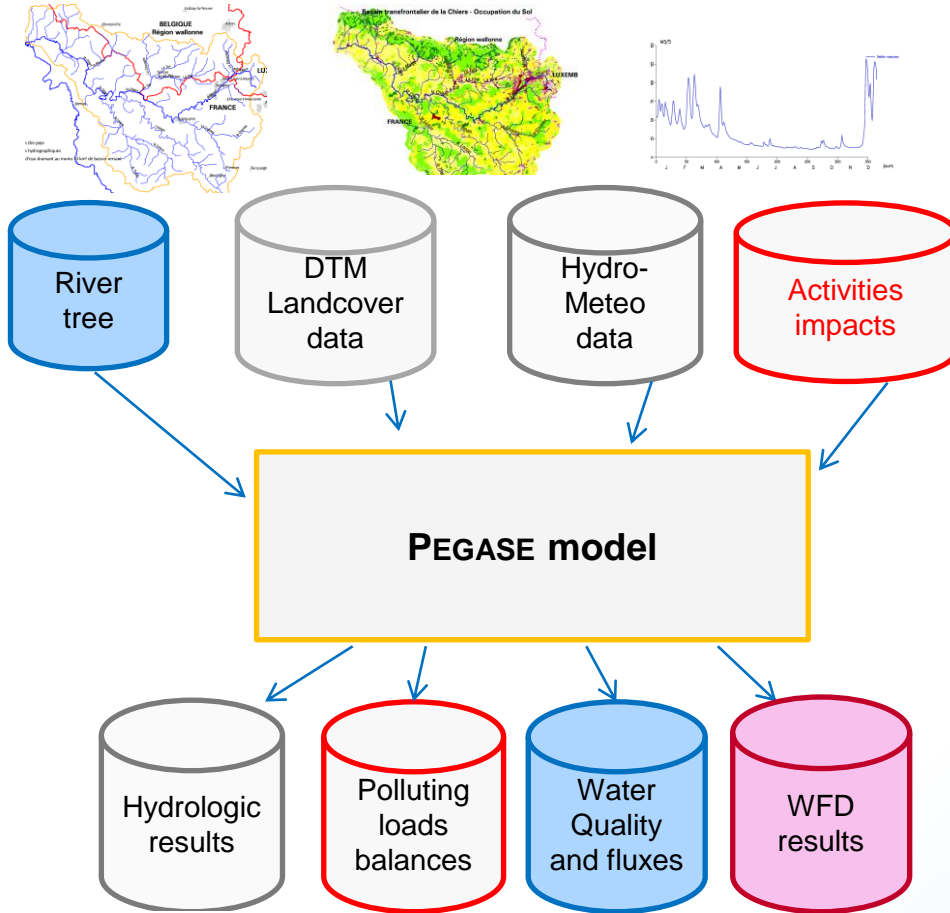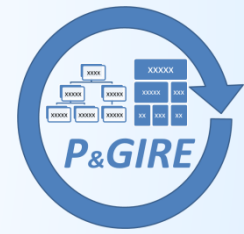
| Validating Simulation | Pollution fluxes balance | Water bodies results | Scenarios |

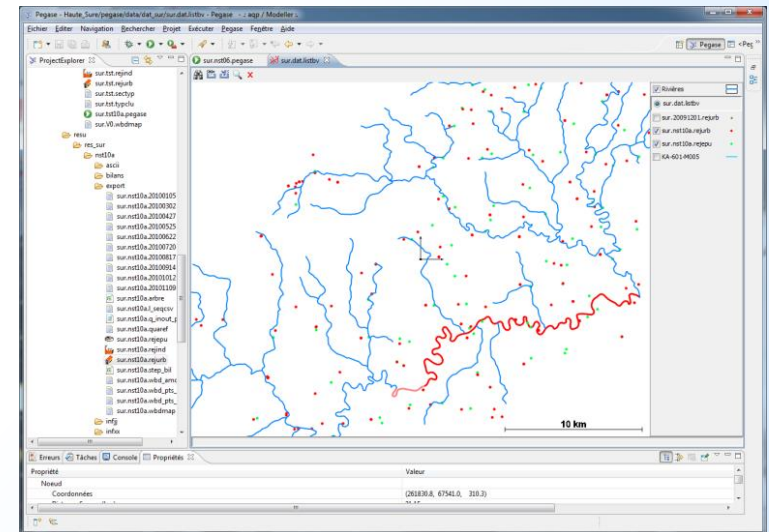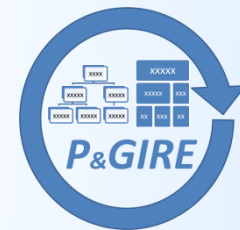# International coordination / WFD

Administrative rules for international coordination

❑ Agreement between partners for a coordinated transnational simulation (nature of scenario, Reference years…)

❑ Framework for transnational modelling (Meuse International Commission)

❑ Confidentiality of the data (industrial releases...) and results

❑ Who will run the model ?

Meuse International Modelling

A real challenge

- Administrative coordination (5 countries, 7 administrations)

- Integration of geographical databases with different scales and coordinates systems

- Coherent integration of releases databases

First step: 2005-2006
DB built and operational down to the Belgo-Dutch border (B-WR, F-RM, LUX, F-AP)

Second step: 2009-2010
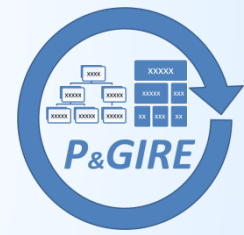DB built and operational on the whole IRBD (B-WR, F-RM, LUX, F-AP, B-FL, DE, NL)

Meuse International Modelling

The Netherlands (NL)
RijksWaterStaat
Coordinates: NL_RD

Belgium - Flanders (B-FL)
VlaamseMilieuMaatschappij
Coordinates: Belgian Lambert 72

Germany (DE)
Nordrhein-Westfalen Land
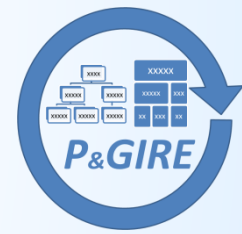Coordinates: Gauss Kruger DHDN

France (F-AP)
Agence de l'eau Artois-Picardie
Coordinates: Lambert 93

Belgium - Wallonia (B-WR)
Service Public de Wallonie
Coordinates: Belgian Lambert 72

Luxemburg (LUX)
Administration de l'Eau
Coordinates: Gauss Kruger Lux

France (F-RM)
Agence de l'eau Rhin-Meuse
Coordinates: Extended Lambert II
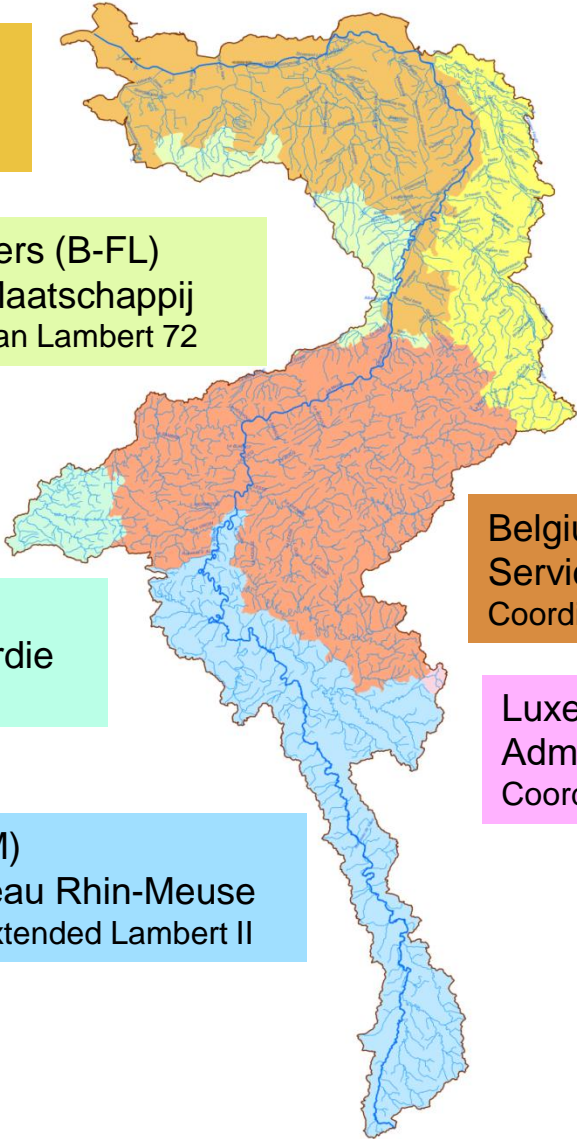
State of the art

Hydro-geographic databases

☐ Hydrographical Network

- Concatenation of sub-basins
- Continuity at borders
- Unique and coherent hydrographical codification

☐ Digital Terrain Model

- Aggregation of different models
- Cell grid different (25 → 100 m)
- "Zero level" different
- Overlapping at borders

☐ Land Use

- Aggregation / use of European Data (Corine Land Cover)
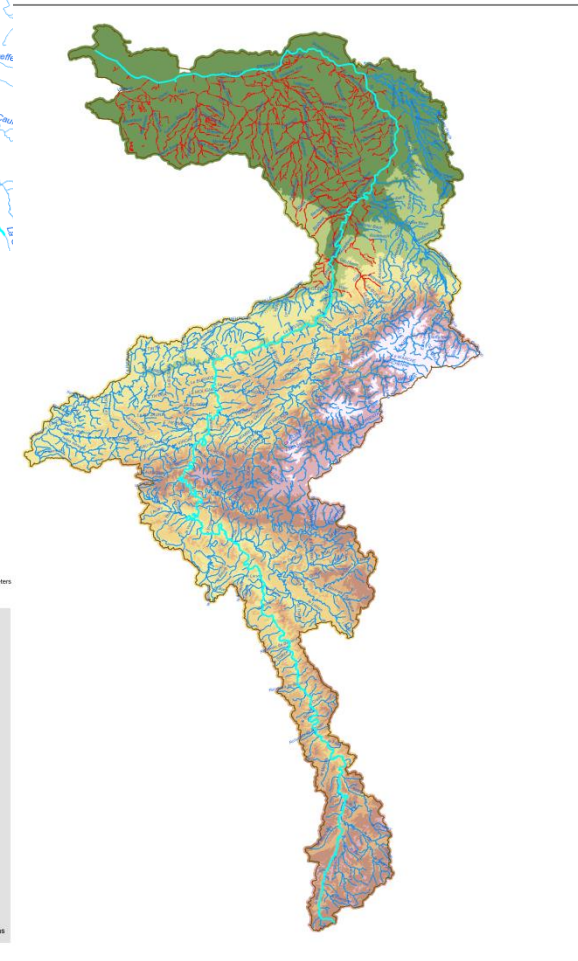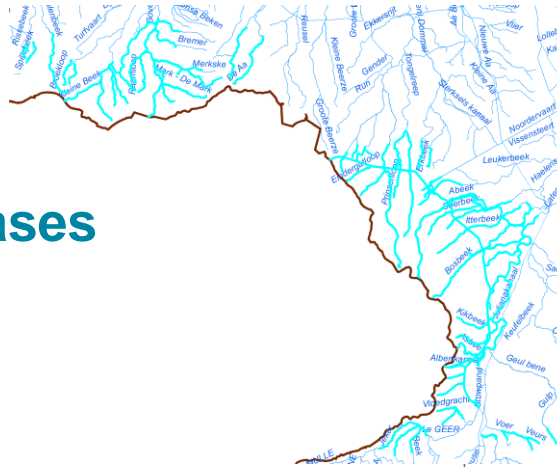
The hydro-geographic databases (river network, DTM, land use...) have been built and connected for the whole IRBD Meuse

State of the art

Pressure databases and simulation

IRBD Meuse is
35 140 km²
1 319 rivers
13 560 km of rivers
modelled by PEGOPERA

Harmonization of the databases
- the reference year
- the pressure data
  - ✓ unique codification
  - ✓ discretisation
- coordinates transformation
- …

Run test of the reference situation available on the whole Meuse District

First validation

NL : 2008-2010
241 rivers – 2720 km

B-FL : 2009-now
65 rivers – 550 km

B-WR : 1988-now
638 rivers – 5430 km

F-AP : 2010-now
68 rivers – 540 km

LUX : 1996-now
3 rivers – 18 km

F-RM : 1992-now
197 rivers – 2630 km

Results

P90
NKj

jjvmm05p90 Events
Kjeldahl stikstof (V_AZKJ)
— < 1.5
— 1.6 - 6.0
— 6.1 - 12.0
— 12.1 - 18.0
— > 18.0

P90
COD

jjvmm05p90 Events
CZV (V_DCO)
— < 20.0
— 20.1 - 30.0
— 30.1 - 40.0
— 40.1 - 80.0
— > 80.0

Results

P10
Diss. O_2

jjvmm05max Events
Opgeloste zuurstof (V_OX_DISS)
— < 3.0
— 3.1 - 4.0
— 4.1 - 6.0
— 6.1 - 8.0
— > 8.0

P90
PO_4

jjvmm05moy Events
Fosfaten (V_PO4)
— < 0.15
— 0.16 - 0.30
— 0.31 - 0.60
— 0.61 - 1.20
— > 1.20
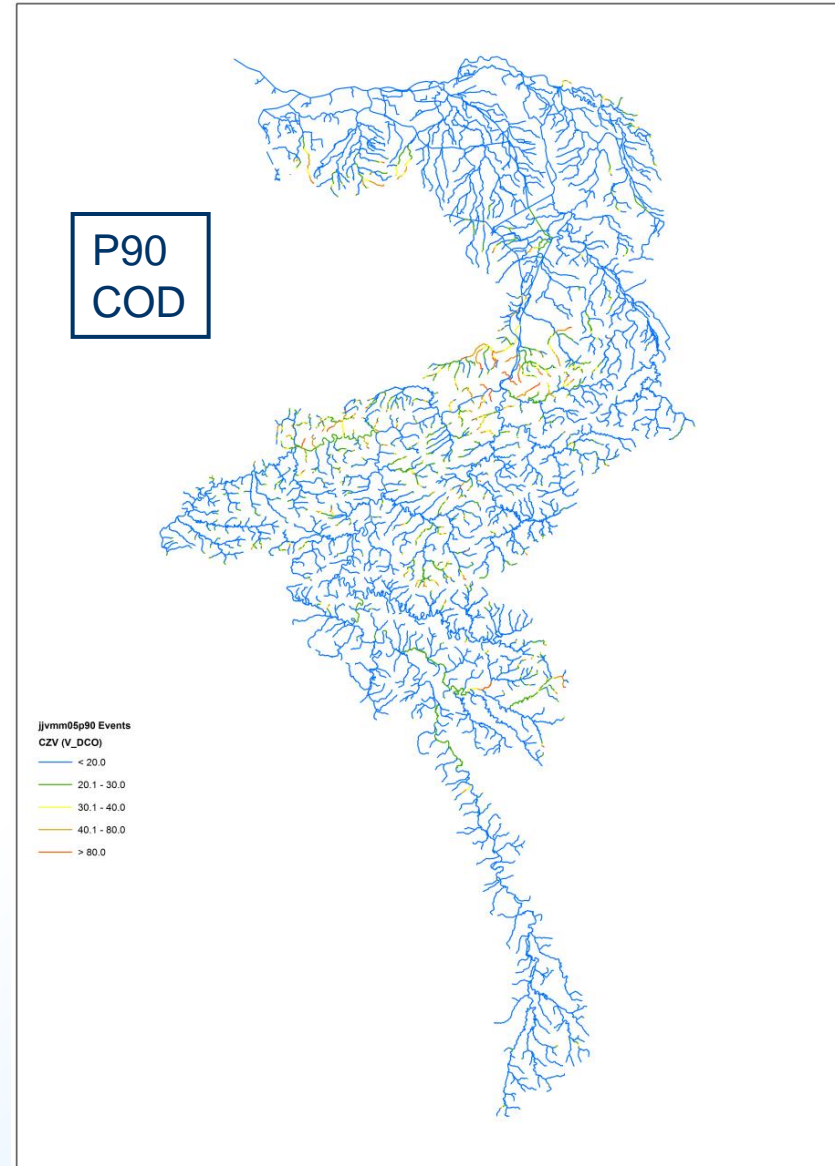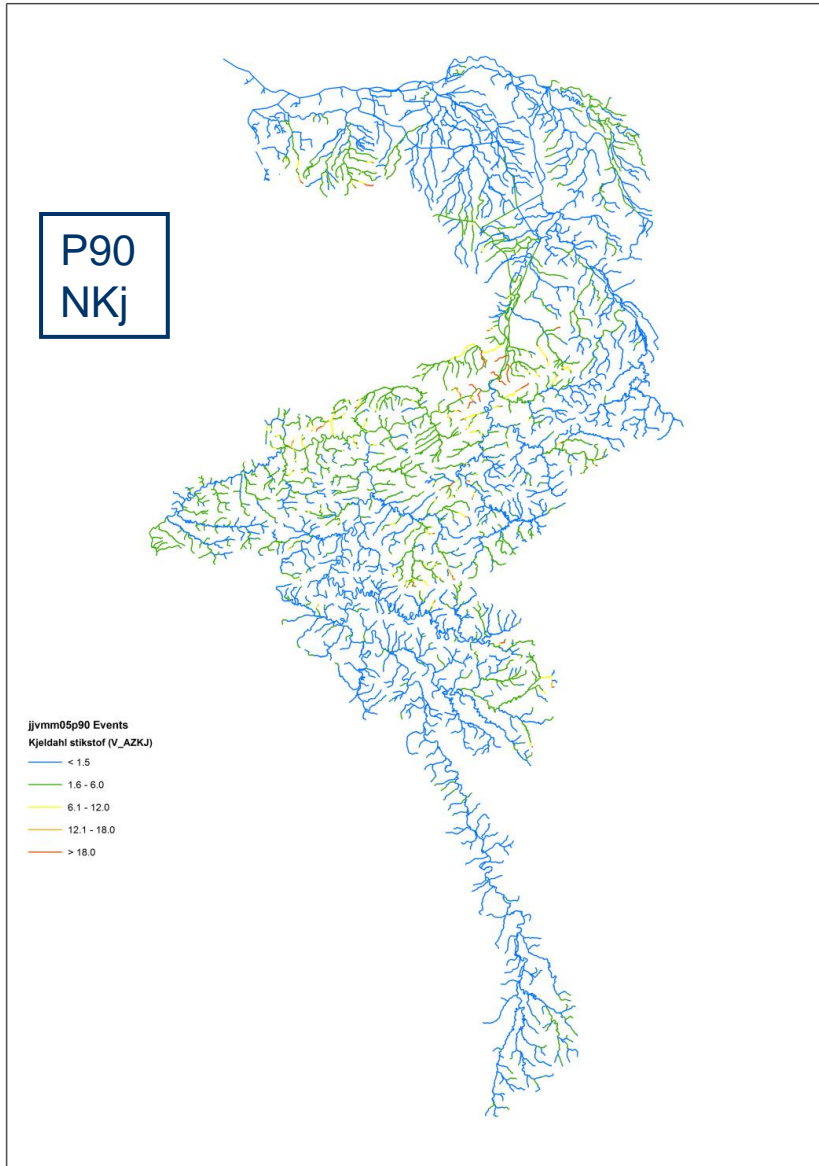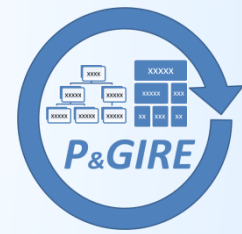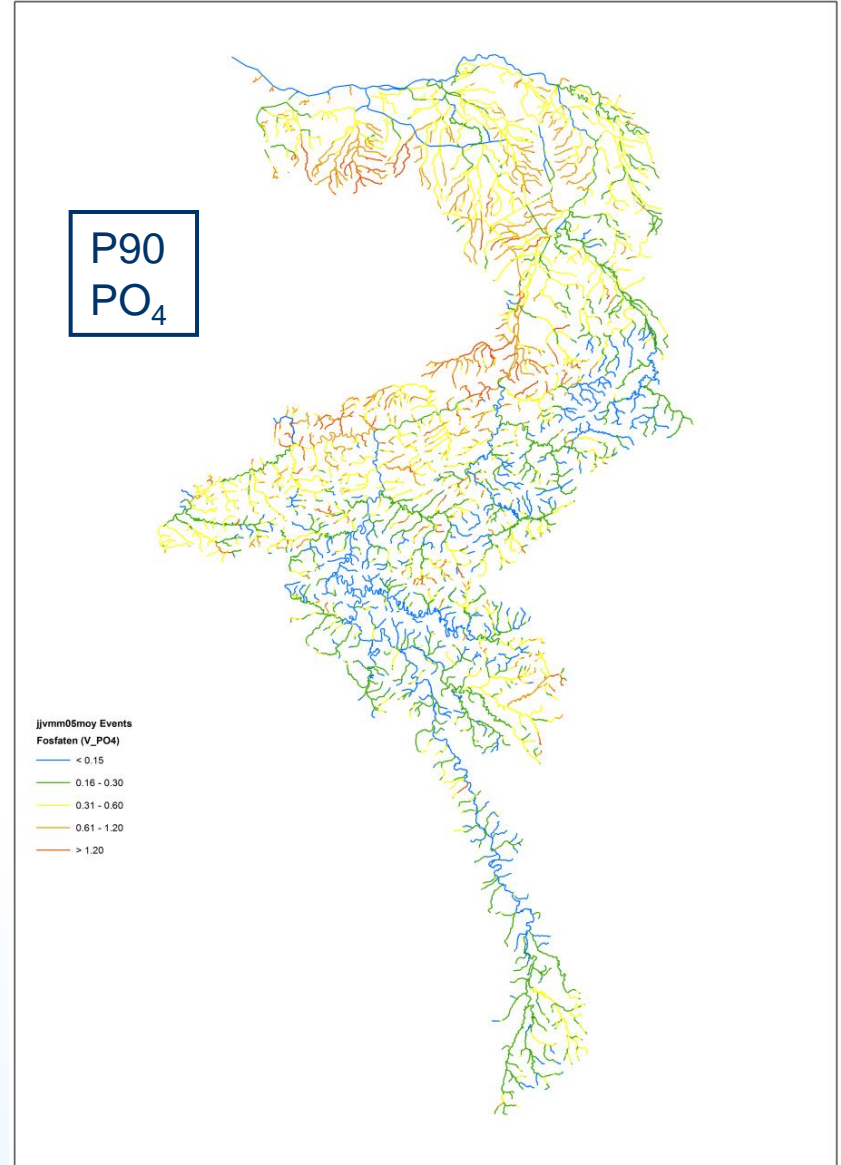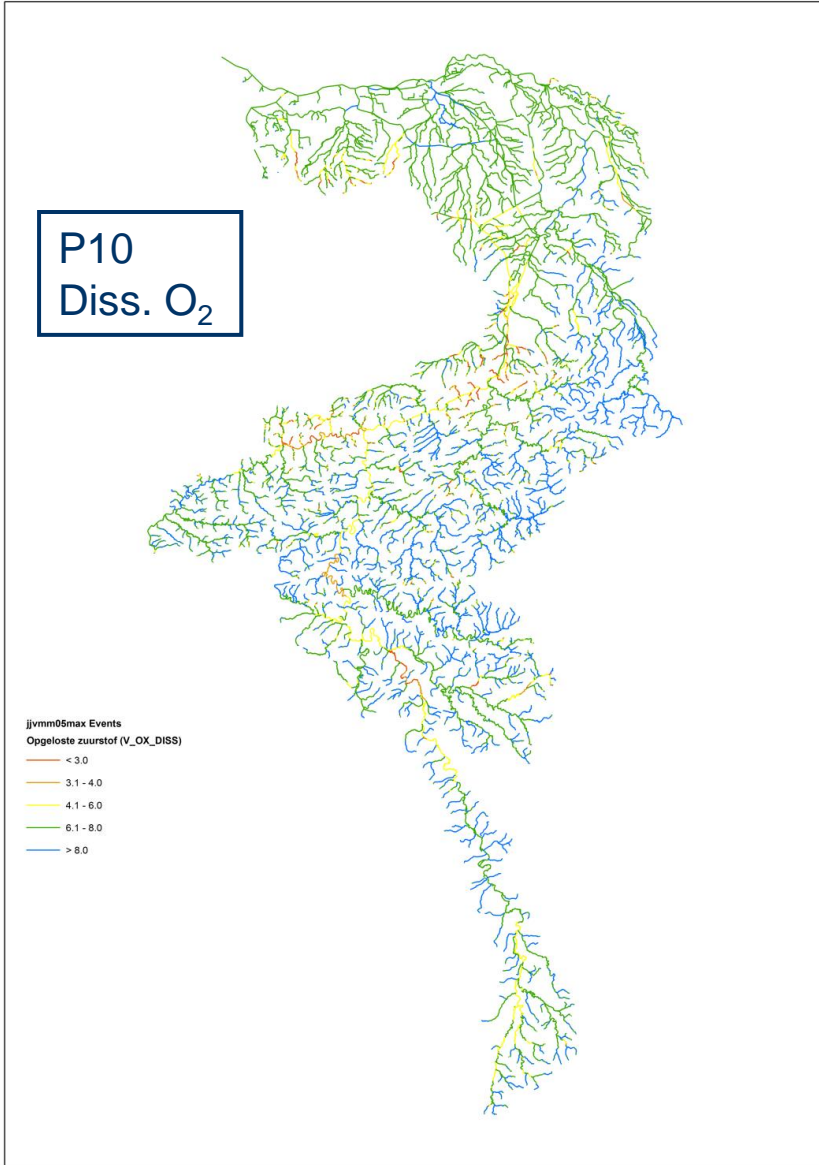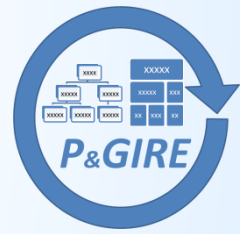
Results: 2005 → 2015 Base Meas. Scenario

Phosphorus fluxes (T P/day) computed in the Meuse river

Legend:
- frontiere fr_be_05
- frontiere_fr_be_15
- frontiere be_nl_05
- frontiere_be_nl_15
- embouchure_05
- embouchure_15
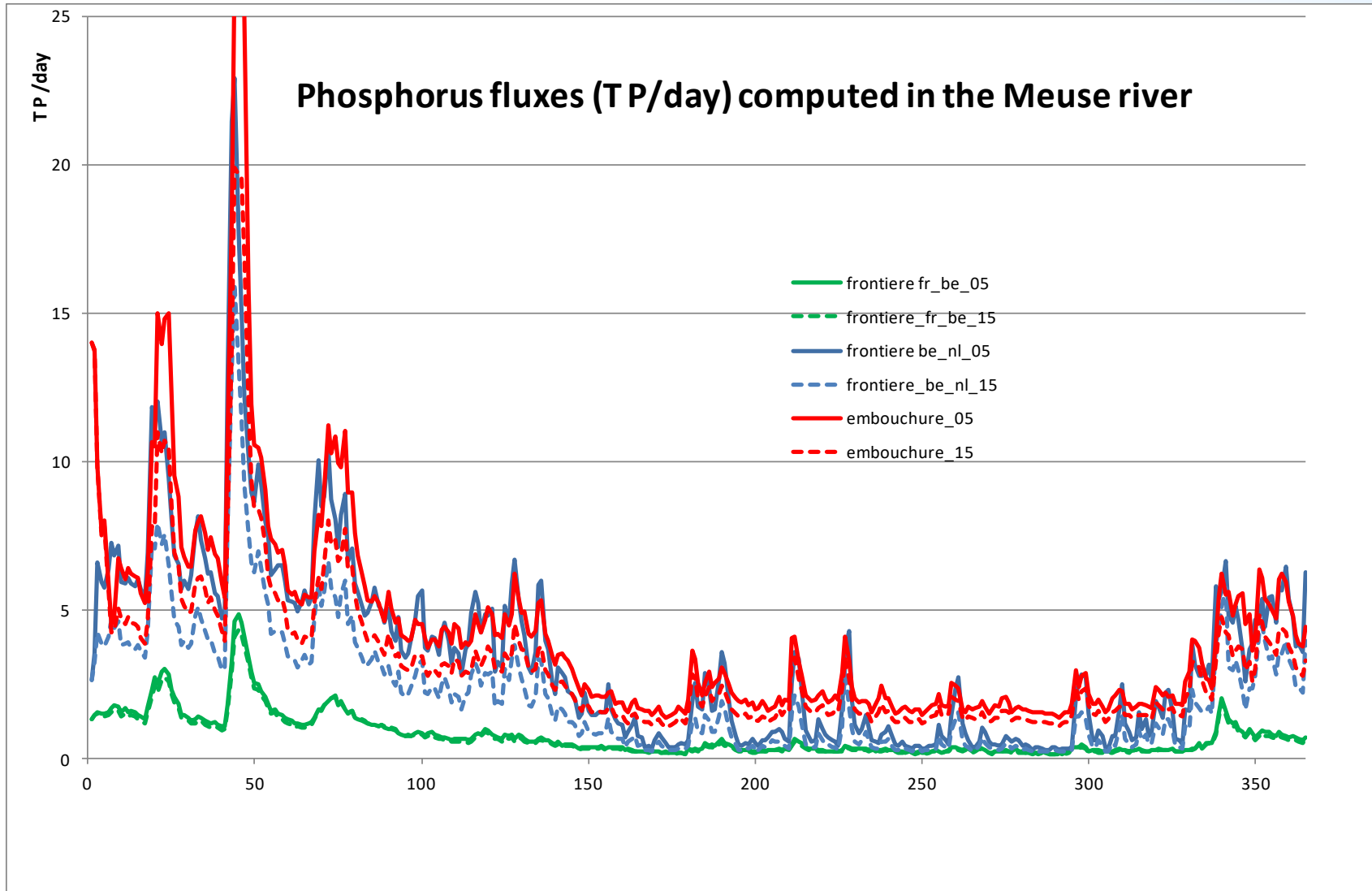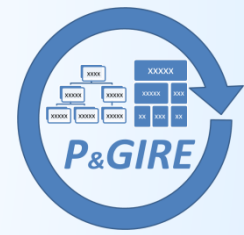
State of the Art

Prospective scenario (2015 basic measures)
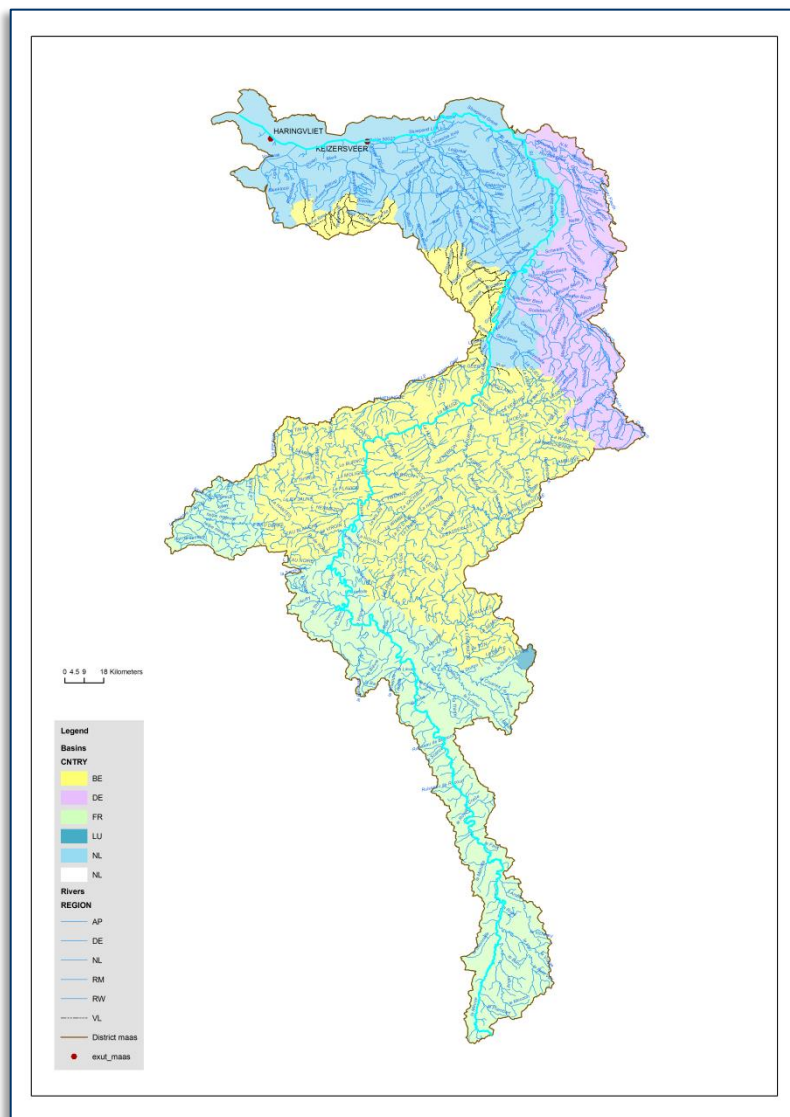
Simulation of the prospective scenario on the whole Meuse District for the **1st cycle of the management plans** of the WFD

Towards the **2nd & 3rd cycle of WFD** (Next cycles of River Basin Management Plans)

To do
- ➤ more detailed pressure data (some regions)
- ➤ locally improved databases
- ➤ Update of hydrometeo and pressures

Conclusion

- ❑ Regional validated applications: B-WR, F-RM, F-AP, LUX, ...

- ❑ Merging of regional applications and benefit from local validation to build the integrated IRBD Meuse application

- ❑ Scenario of Basic Measures at the District level (1st cycle of WFD)

- ❑ Ready to run other prospective scenarios

- ❑ The PEGOPERA modelling tool is operational

  - ➢ on all the Meuse sub-basins (Regional & National)

  - ➢ on the whole integrated International River Basin District Meuse and its tributaries

  - ➢ by stakeholders, on their own Meuse sub-basins

Visit
www.pegase.ulg.ac.be
- Info
- Download CE version

Conclusion
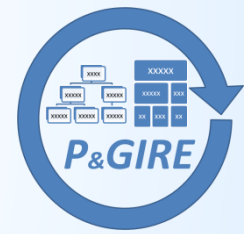
❑ Example of Advantage of maintaining an up-to-date database :

    ❑ In 2020, a sugar industry on a tributary of the Scheldt in France released a large quantity of COD (564 tons over 30h) after a breach in a dam.

    ❑ Large amount of fish died in France and Wallonia.

    ❑ VMM reacted immediately by:

        ❑ Setting up ventilators to re-oxigenate the Scheldt

        ❑ Performing measurements of quality parameters

        ❑ Performing Simulation with PEGASE to assess the extent of the pollution

Concentrations en oxygène dissous calculées et mesurées à Spiere, km 31
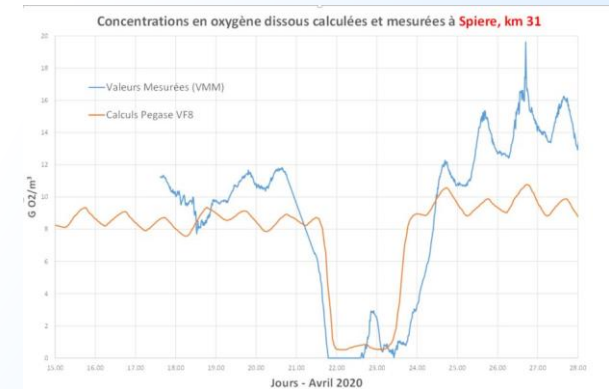
Afterwards, a study has been comitted by AEAP, SPW and VMM to simulate the accident and understand better the conditions and impact of the accident, using the trans-national Scheldt PEGASE database

PEGASE is currently a few developments away from being able to calculate such an accident in real-time.