A statistical approach for estimating N emission to surface water bodies at national scale: methodology and first results

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Water Framework Directive (WFD) article 5 report for analysis of agricultural pressures and impacts aims to identify those catchments where prioritized nonpoint source control measures should be implemented in order to achieve good ecological status by 2015. Therefore, a semi-empirical conceptual N emission model is being developed for application at national scale in France, using only readily available data. This is a GIS model based on data for N surplus, together with data for watersheds and river systems characteristics.

Model structure

➢**Spatial and temporal resolution**
- WFD water bodies' watershed are the calculation units
- It predicts TN and $NO3^-$ load at annual scale

➢ **Calibration procedure:** over 200 catchments in France

➢**N transfer pathways**

Our approach take into account three different pathways for N emission to surface water, including:
- Point source emission from domestic and industrial origin
- Nonpoint source emission via surface runoff and quick interflow: the 'source data' considered is N surplus
- Nonpoint source emission via baseflow: the 'source data' considered is [$NO3^-$] in groundwater

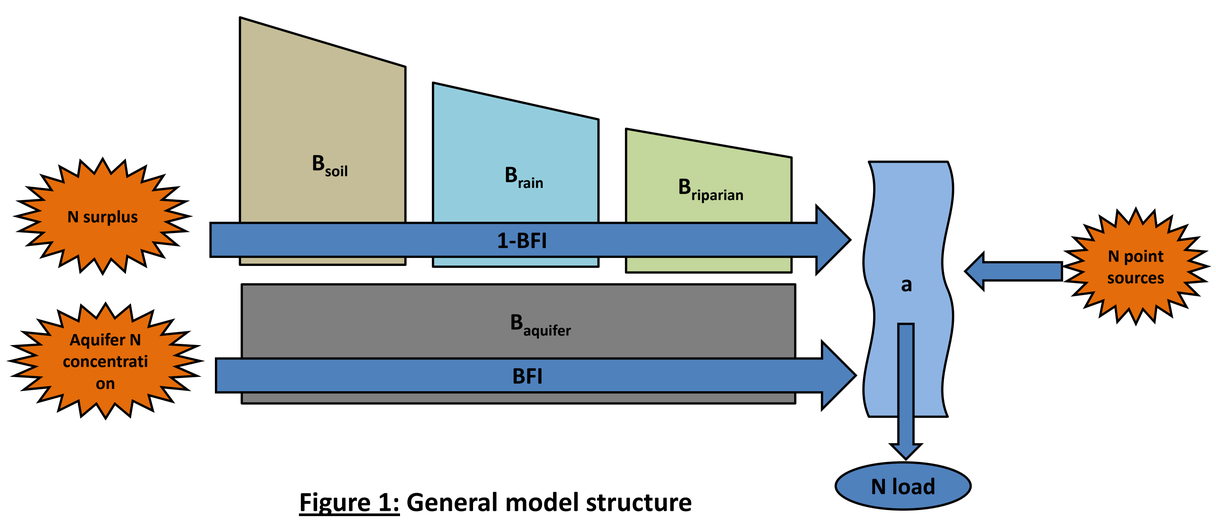
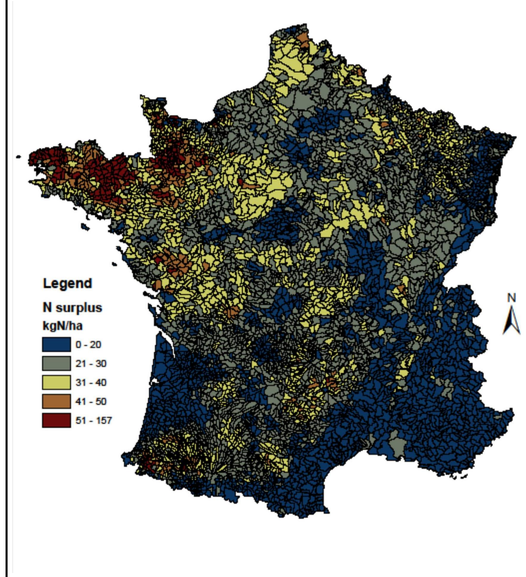


Figure 1: General model structure

➢Meinardi et al. (1994) base flow index (BFI) is used to partition total runoff into a quick component 'surface runoff + interflow' and a slow component 'baseflow'

➢**Nitrogen nonpoint source data considered**
- [NO3-] in groundwater (ADES 2011)
- N surplus as calculated by NOPOLU method (SoeS 2007)



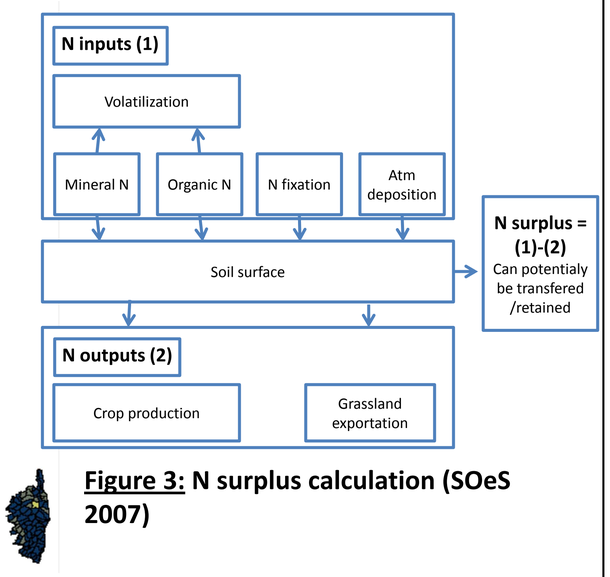


Figure 2: Spatialized N surplus map

Figure 3: N surplus calculation (SOeS 2007)

➢**N transfer coefficients**
- B_{soil}=f(saturated hydraulic conductivity), derived from Wösten et al. (2001) pedotransfer functions
- B_{rain}=f(effective rainfall), from Météo France SAFRAN database
- $B_{riparian}$=f(%riparian zones), from Mérot et al. (1995)
- $B_{aquifer}$: fixed
- a=f(residence time, depth in rivers and lakes), from Lamouroux et al. (2010)

Application at regional scale on 53 watersheds in Brittany

➢**Facts about Brittany:** The Brittany region (western France) is characterized by intensive agriculture, which has lead to high N surplus and high N loads (Figure 4). The 53 waterheds selected for this study are mostly located on igneous and metamorphic rocks: because these substratum are impervious, BFI is considered to be low and N load is derived from N surplus only. The region has a mild oceanic climate, rainfall ranges from 1500mm in the west to 700mm in the est.

➢**Available data:** The same databases are used as for national evaluation, exept for the regional soil database (Lemercier et al. 2010) and the hydromorphic soils database (Lemercier et al. 2011). Average distance to stream was added, as it was a significant and easily available variable.

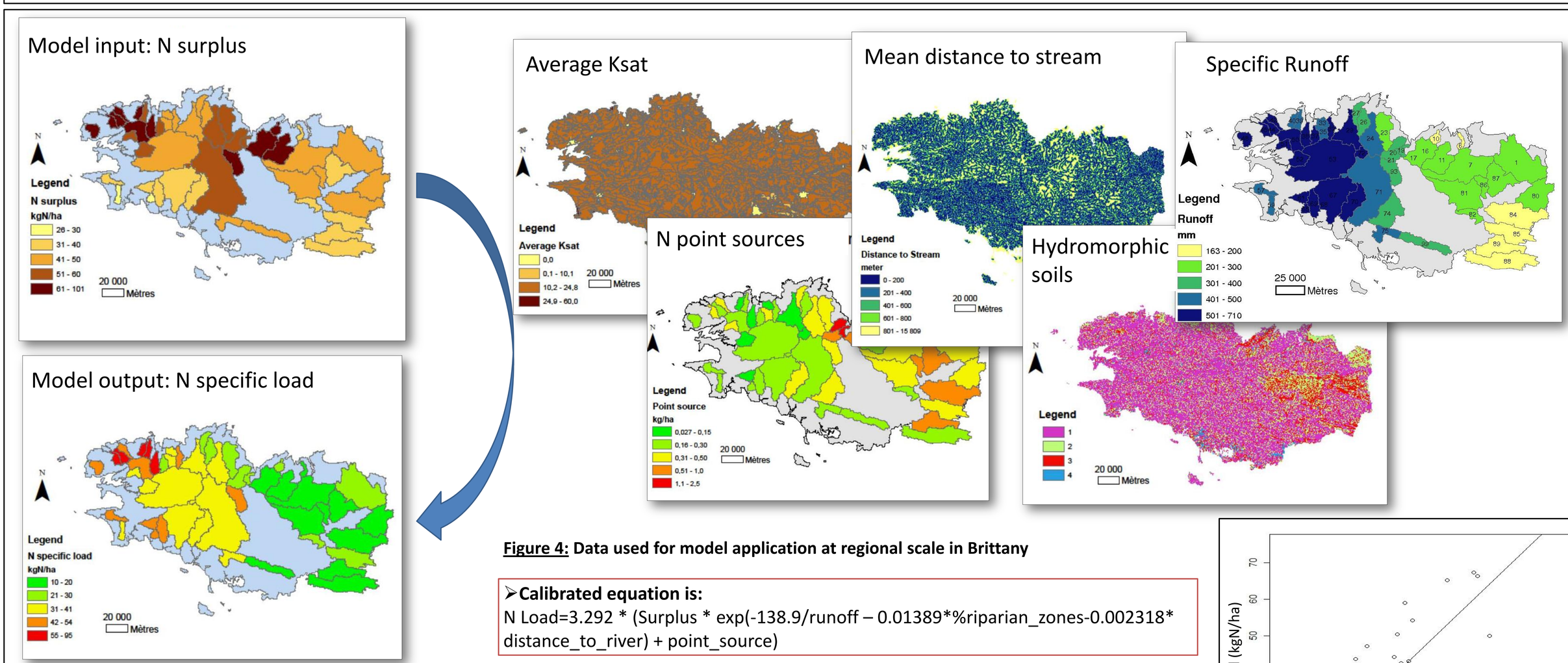


Figure 4: Data used for model application at regional scale in Brittany

➢**Calibrated equation is:**

N Load=3.292 * (Surplus * exp(-138.9/runoff – 0.01389*%riparian_zones-0.002318* distance_to_river) + point_source)

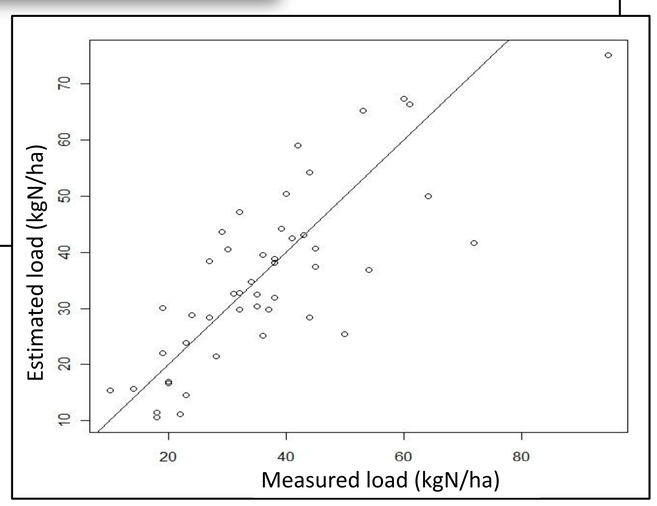


Figure 5: Modelled vs measured load (calibration dataset)

➢**Conclusion:** The particularity of our approach is to combine an exhaustive national evaluation with regional focuses, where local data enable us to improve the prediction. After Brittany, our model will be performed in the Loire and the Seine river basins.

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