Development of Modeling System Based On the SWAT Model as a Tool for Water Management Institution

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Our dream

Modeling system, which would provide information needed for EU and national water reporting and provide capacity to analyze different pollution abatement strategies.

Short history

- Before 2004
  - National requirements
  - Preparation projects
  - Helsinki convention
- Since 2004 implementation of EU directives

Water modeling needs

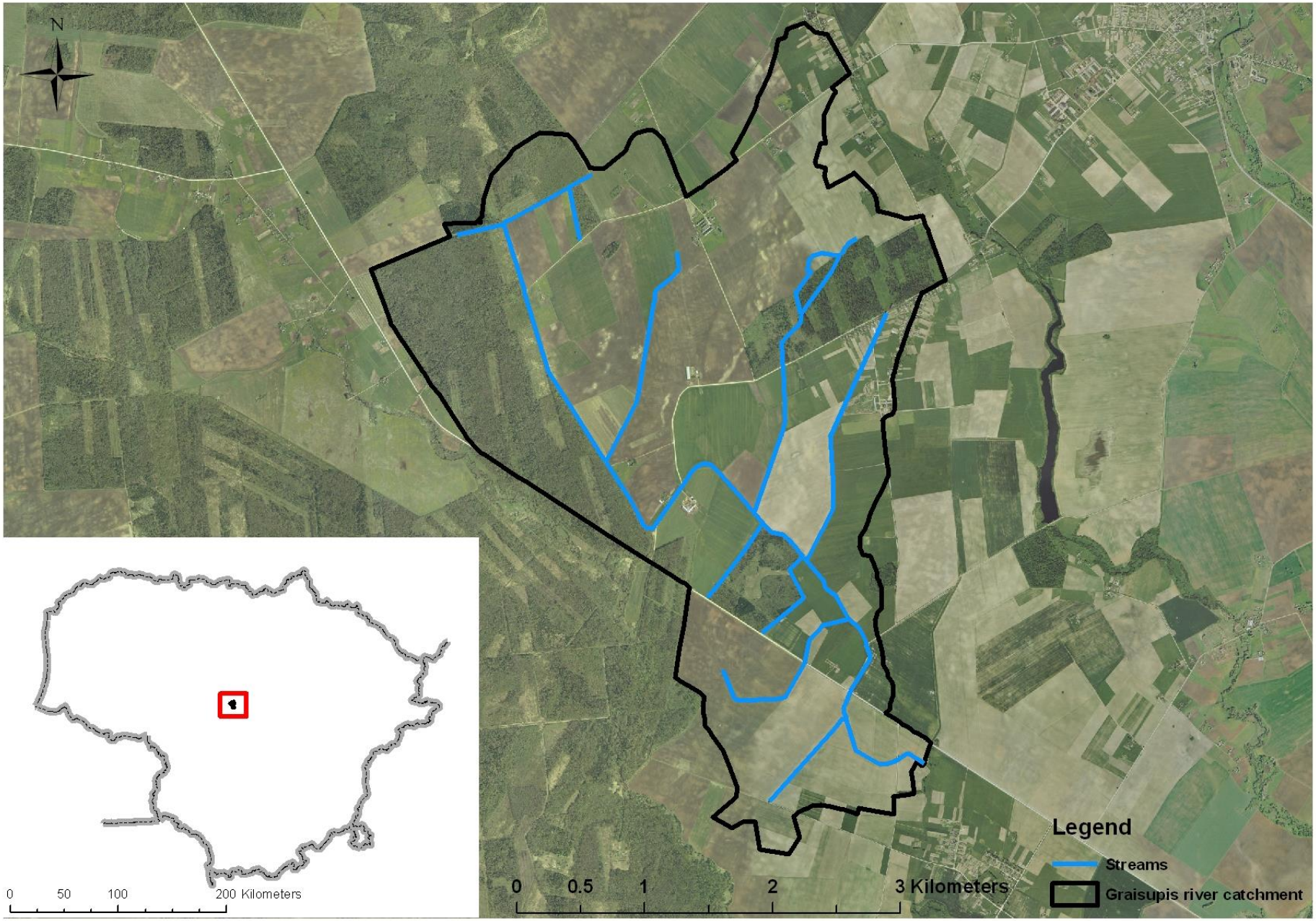
- Water Framework Directive (2000/60/EC)
- Nitrate Directive (91/676/EEC)
- Helsinki Convention (implementation of BSAP)
- Environmental Impact Assessment Directive (2011/92/EU)
- Rural Development Programme
- Climate Convention (greenhouse gas reporting)
- Flood Directive (2007/60/EC)
- Marine Strategy Directive (2008/56/EC)
- Others

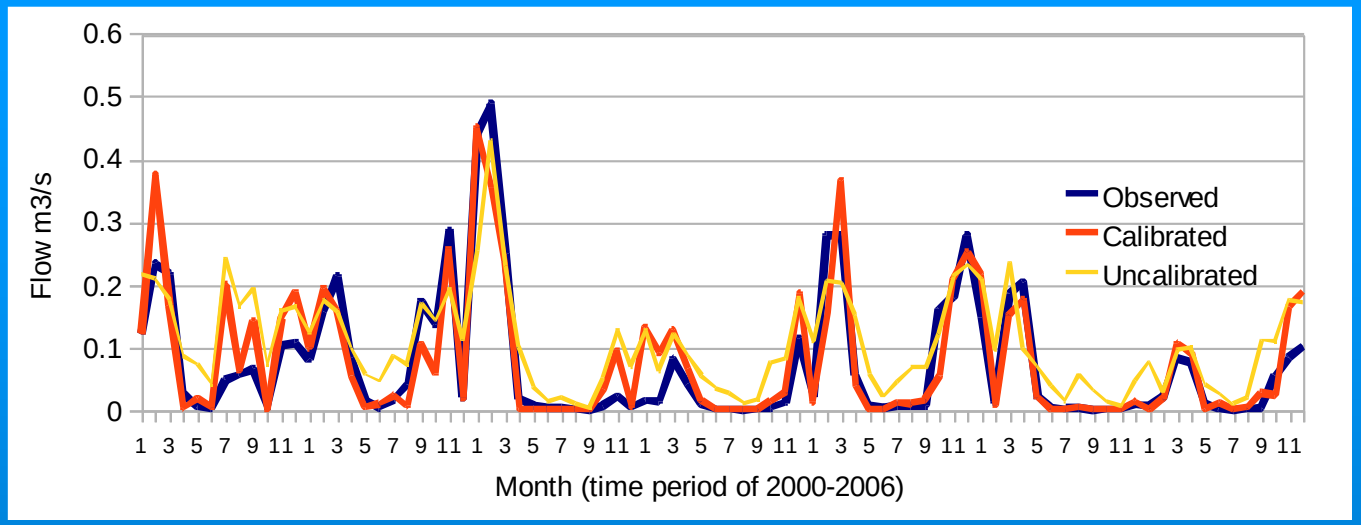
Past

- Before 2003 consideration of freely available models (SWAT, HSPF)
- In 2003 DHI company study
- MIKE BASIN model for 1st iteration of RBPMs
- Evaluation of results

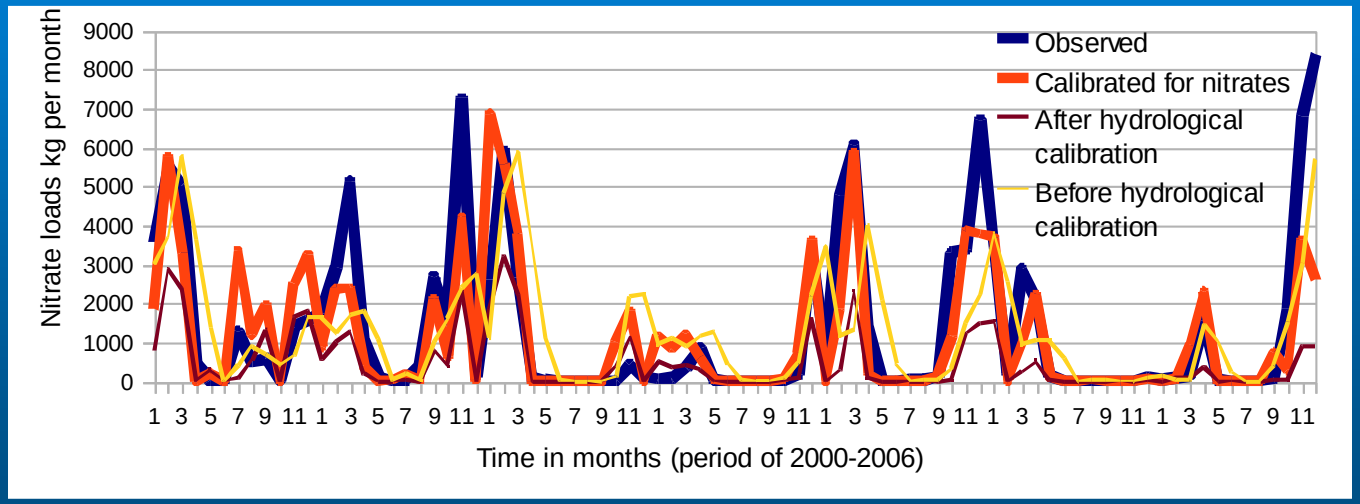
Rethinking

- Developing criteria
- Analysis of scientific literature
- Selected SWAT model
- Collection of data and testing on a pilot basin

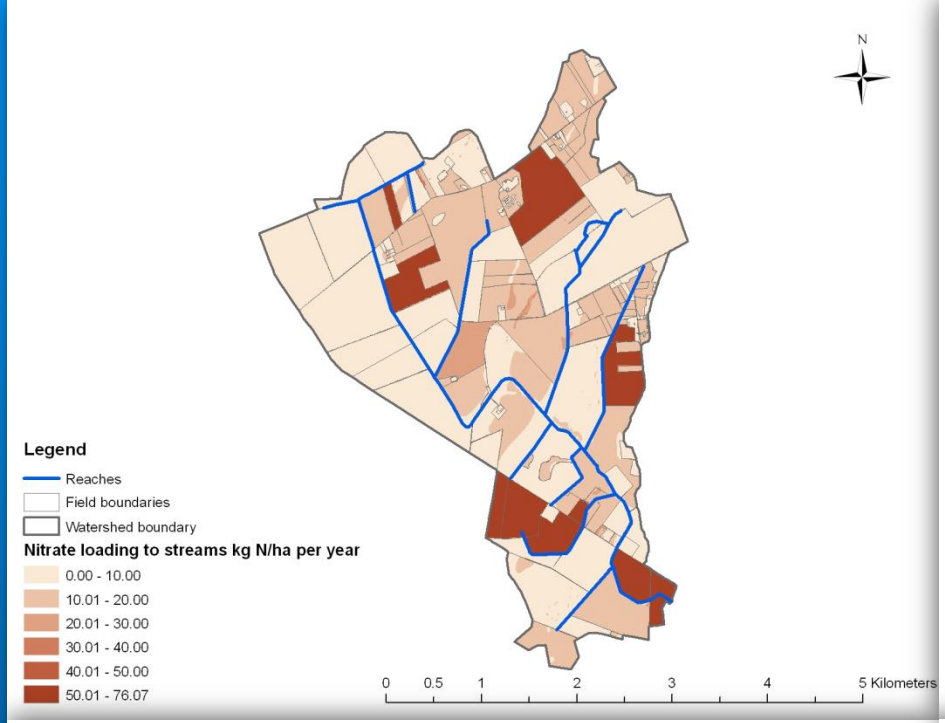

N
0 50 100 200 Kilometers
0 0.5 1 2 3 Kilometers
Legend
Streams
Graisupis river catchment

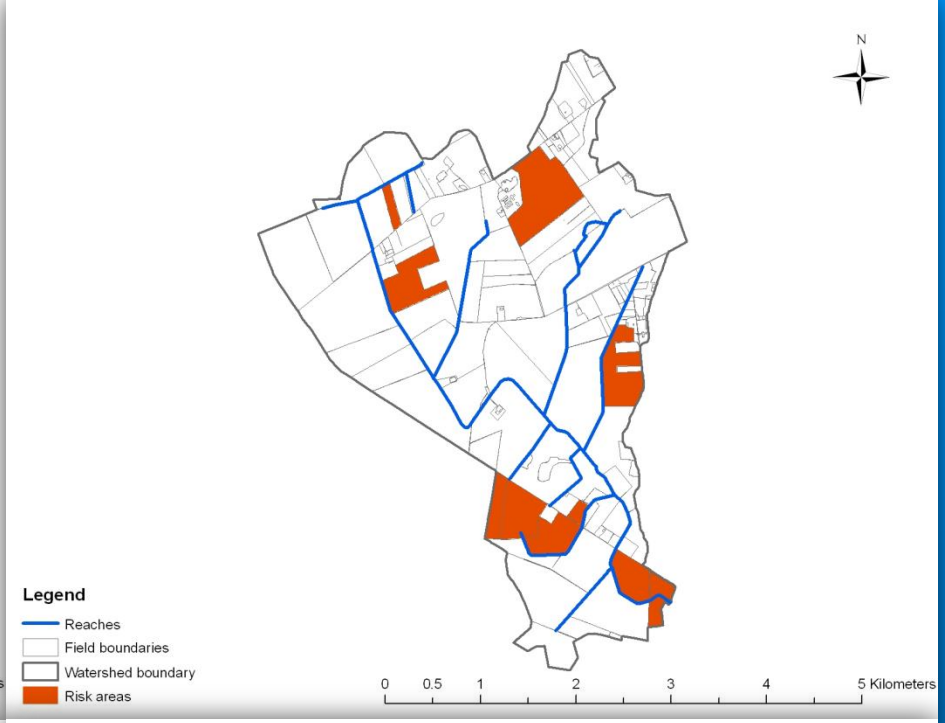


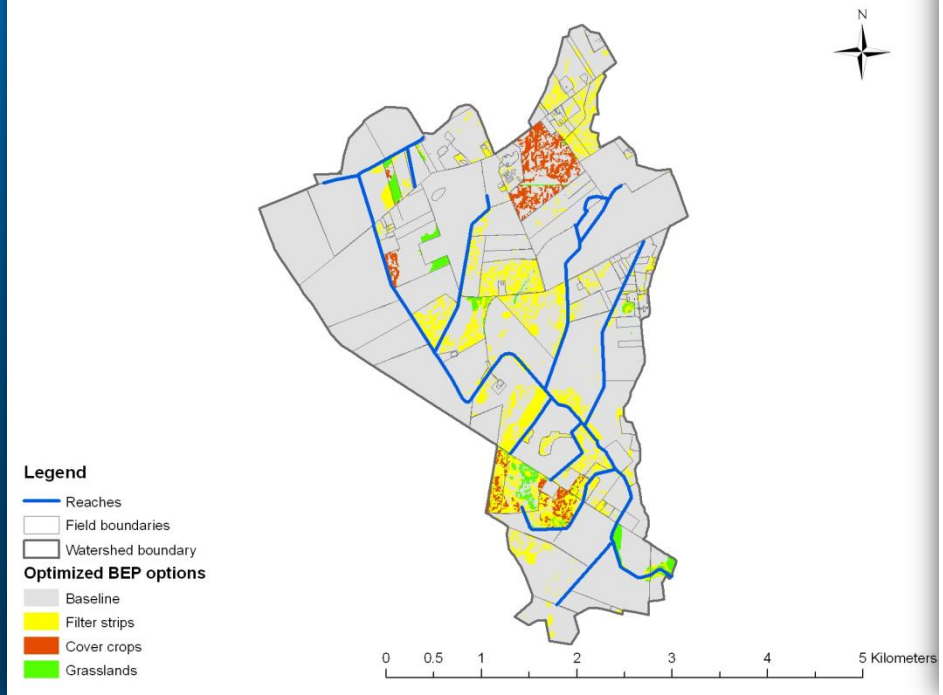
Flow Cal R^2 = 0.81, RSR = 0.45, NSE = 0.78, PBIAS =-9.21
Flow Val R^2 = 0.69, RSR = 0.42, NSE = 0.69, PBIAS =-3.15

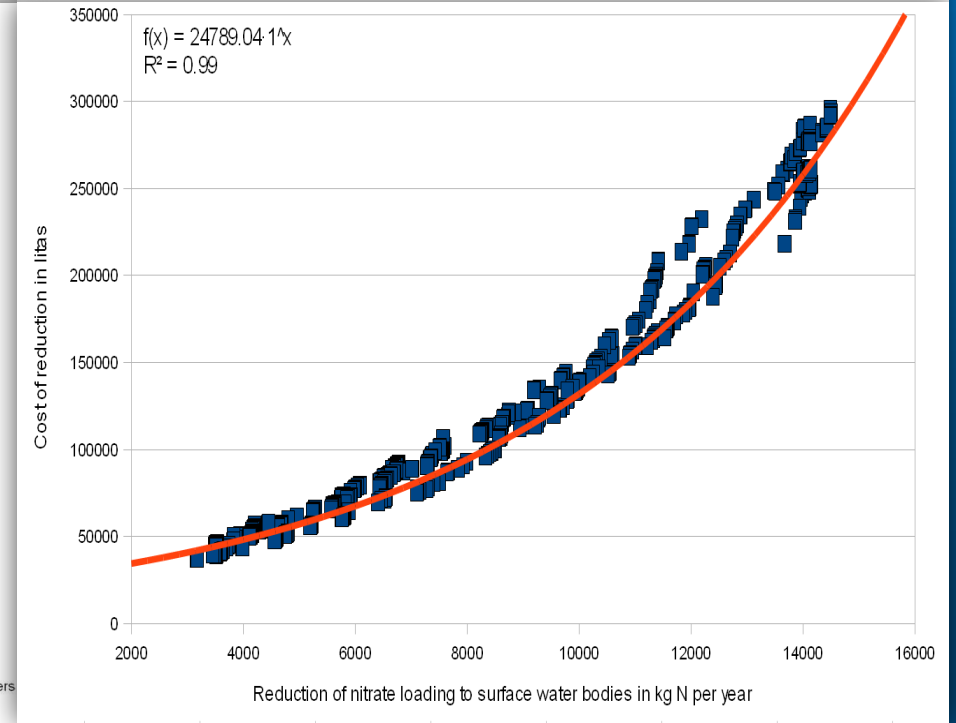


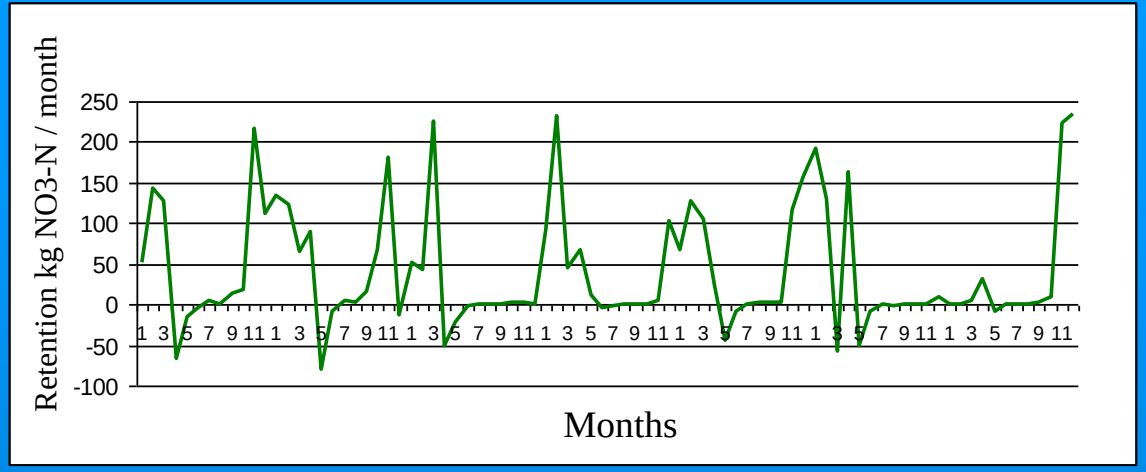
Nitrate loads Cal R^2 = 0.63, NSE = 0.62, PBIAS =13.73
Nitrate loads Val R^2 = 0.53, NSE = 0.53, PBIAS =-0.92

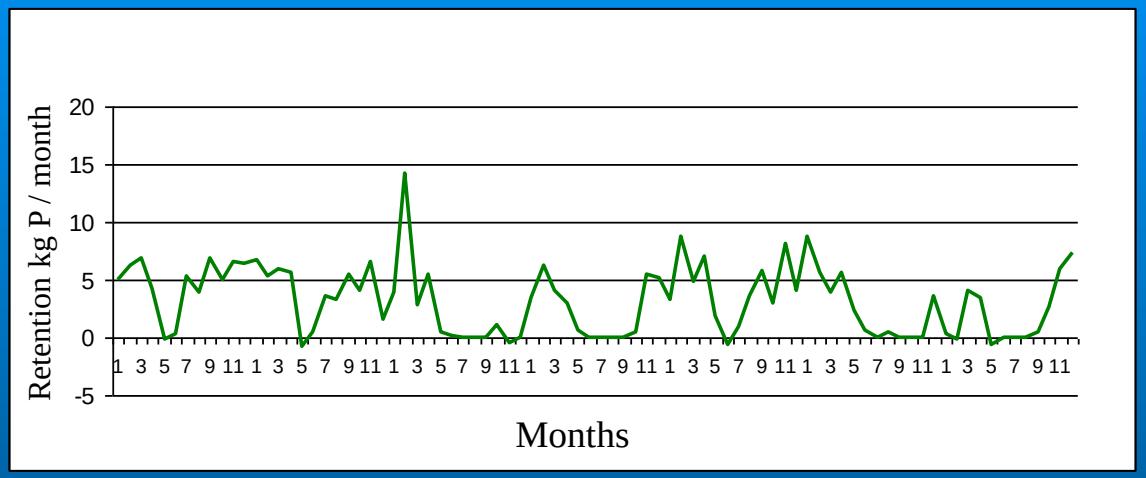

N
Legend
Reaches
Field boundaries
Watershed boundary
Nitrate loading to streams kg N/ha per year
0.00 - 10.00
10.01 - 20.00
20.01 - 30.00
30.01 - 40.00
40.01 - 50.00
50.01 - 76.07
0 0.5 1 2 3 4 5 Kilometers


N
Legend
Reaches
Field boundaries
Watershed boundary
Risk areas
0 0.5 1 2 3 4 5 Kilometers


N
Legend
Reaches
Field boundaries
Watershed boundary
Optimized BEP options
Baseline
Filter strips
Cover crops
Grasslands
0 0.5 1 2 3 4 5 Kilometers


f(x) = 24789.04·1^x
R² = 0.99
Cost of reduction in litas
350000
300000
250000
200000
150000
100000
50000
0
2000
4000
6000
8000
10000
12000
14000
16000
Reduction of nitrate loading to surface water bodies in kg N per year





Subbasin for wetland	Area draining to wetland km^2	Sediment reduction (t/a)	Nitrate reduction (kg/a)	Phosphorus reduction (kg/a)
1	3.47	-19.05	-64.61	-46.97
2	0.98	-31.55	-27.94	-5.92
3	3.51	-58.93	-936.21	-30.55
4	5.78	-51.57	-751.17	-52.69
5	10.02	-106.74	-1014.67	-58.75
6	1.41	-16.77	-367.55	-10.83
7	11.64	-122.31	-1022.46	-54.59
8	0.98	-11.22	-28.25	-3.38
9	14.15	-159.47	-903.21	-41.65

Project in 2011

"Development of methodics and modeling system of nitrogen and phosphorus load calculation for surface waters of Lithuania"

SIA „Procesuanalīzes un izpētescentrs" &
UAB „Estonian, Latvian & Lithuanian Environment" and

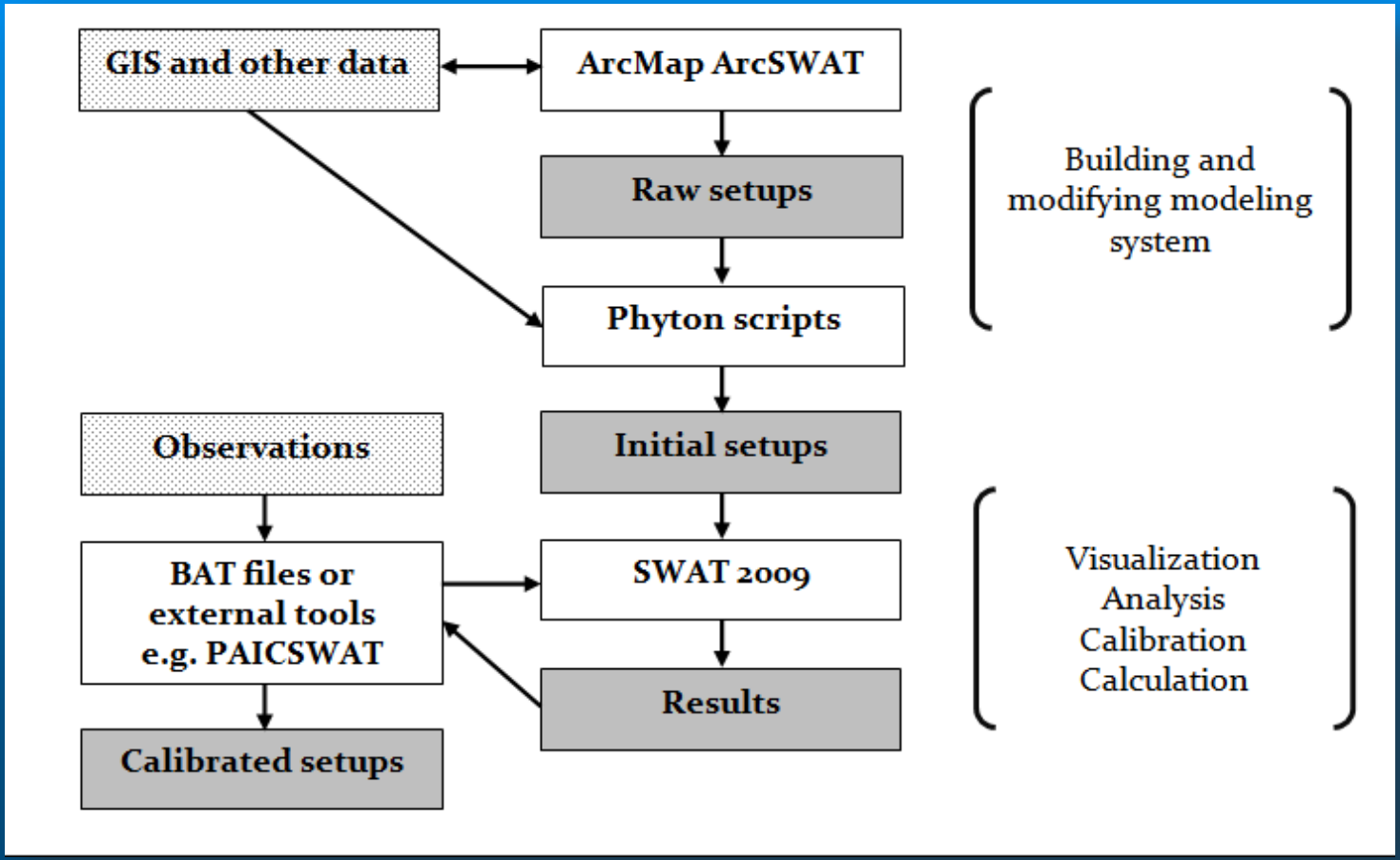
16 months

Finished in 2012

Main results:

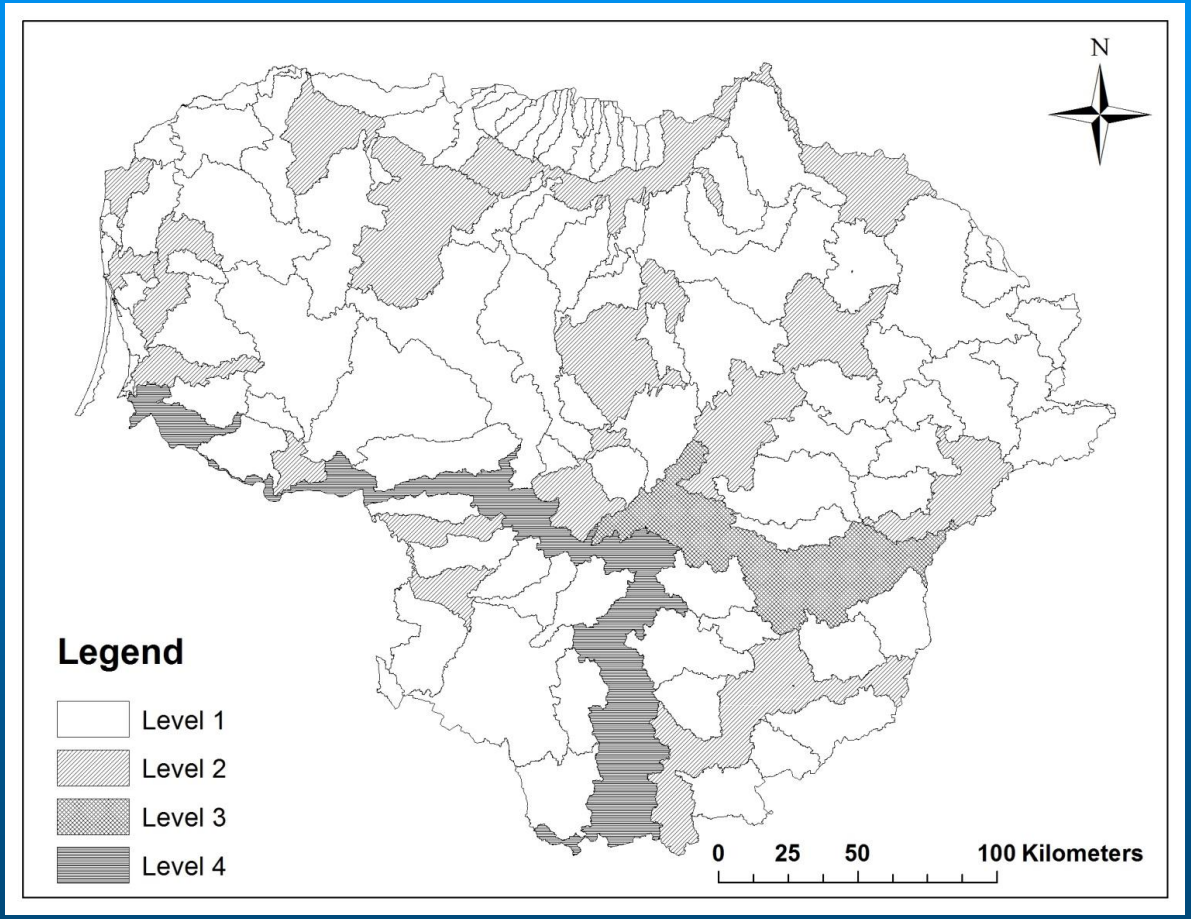
- Input data collected and prepared
- Model setups for all Lithuania
- Phyton scripts to manage input databases and updating setups
- Setup integration tools (batch and exe files)
- Output analysis software - PAIC-SWAT (integrated with monitoring data)

Workflow


GIS and other data
ArcMap ArcSWAT
Raw setups
Phyton scripts
Initial setups
Observations
BAT files or external tools e.g. PAICSWAT
SWAT 2009
Results
Calibrated setups
Building and modifying modeling system
Visualization
Analysis
Calibration
Calculation

Division and integration

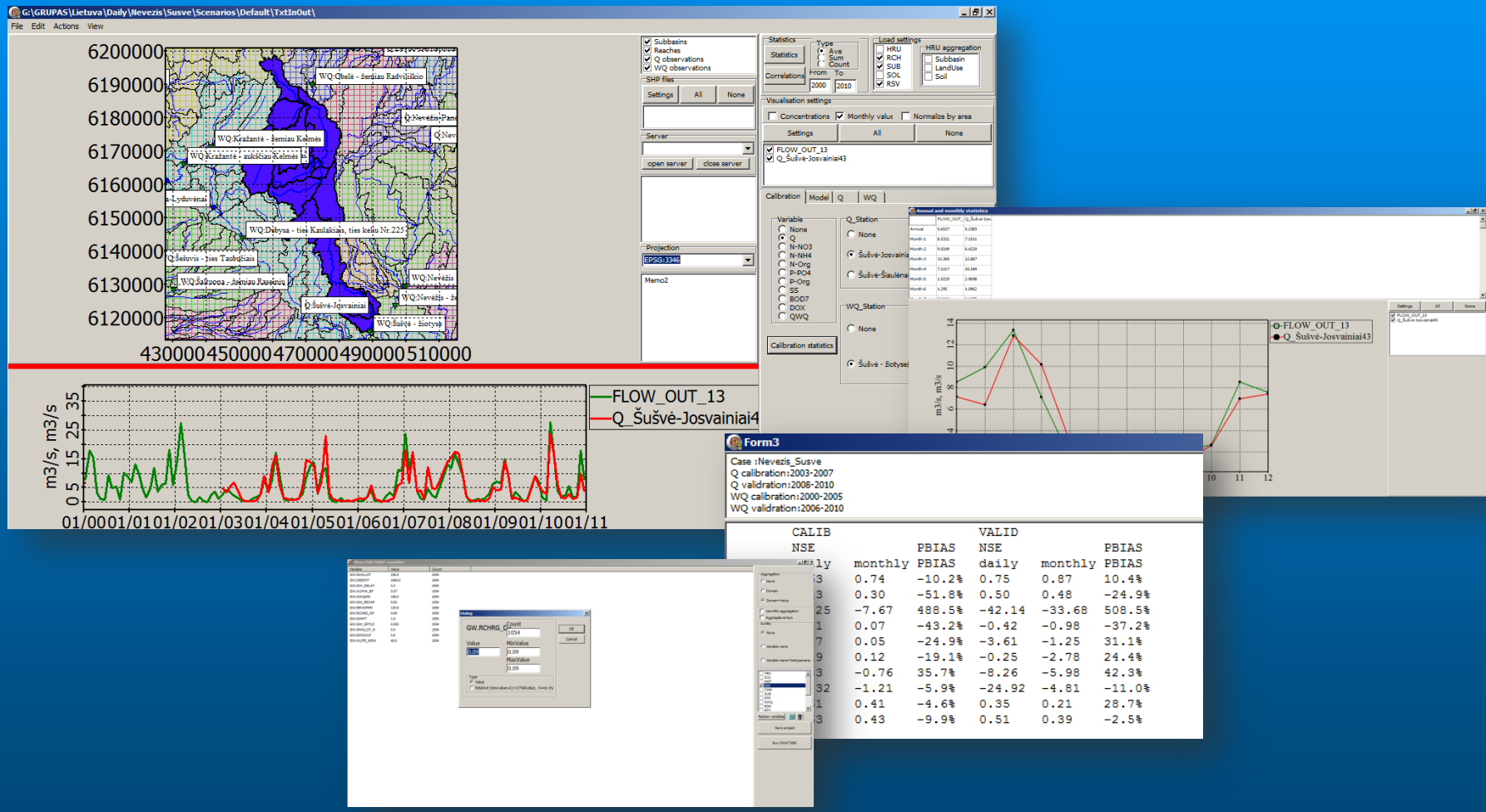
- 4 levels
- 129 setups
- >1000 subbasins
- 19 major rivers for calibration



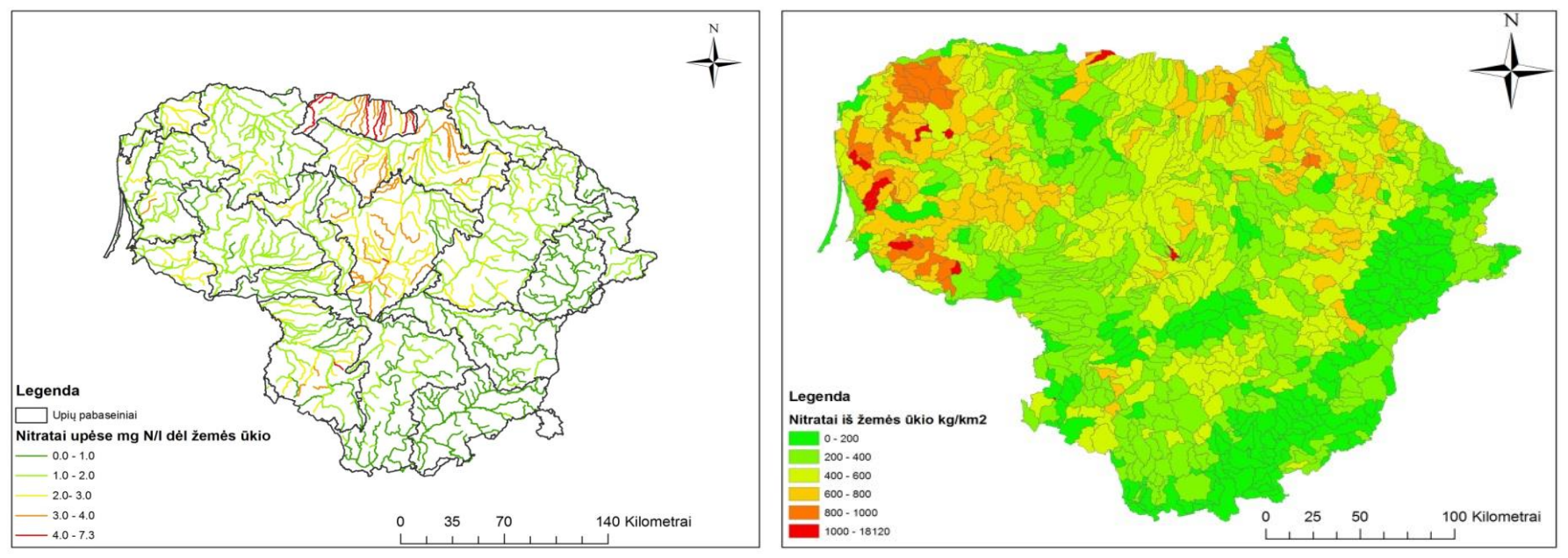
Overall model performance

- Median Flow Daily NSE 0.5, Monthly NSE 0.6
- Median Flow PBIAS 9%
- Median Nitrate loads Daily NSE 0.27, Monthly NSE 0.17
- Median Nitrate loads with >5 years monitoring Daily NSE 0.37, Monthly 0.26
- Median Nitrate loads PBIAS 41%
- Median Phosphorus loads PBIAS 39%

Output analysis



Output analysis



Next

- Updating of input data, adding new
- Detailed calibration
- Attention to processes, activation of important
- Develop methodic and tools multi-objective spatial optimization, CSA and other
- Structural agriculture change scenarios
- More info into RBMPs

Major challenges

- Data (soil, fertilization, etc)
- Lack of experience and similar examples
- Lack of understanding on higher level
- Lack of possibilities to attract and keep specialists

Conclusion

No conclusion ☺…