Water quality and nutrient management

site specific management guided by sensors and machine learning algorithms

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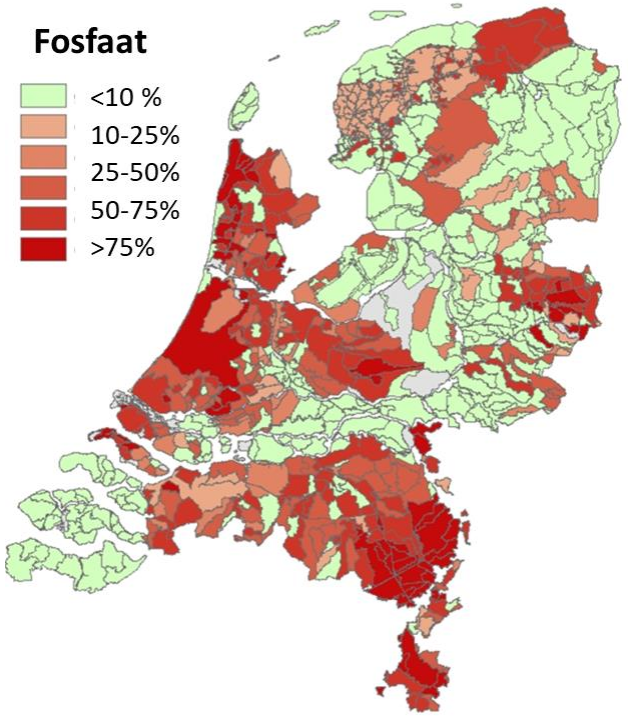
The agricultural challenge

- ✓ Water quality improvement
  - Nitrate & Water Framework Directive
  - 50% reduction needed agriculture
- ✓ Manure policy
  - application limits for N and P
  - guidelines for timing, storage, etc.
- ✓ Recent evaluation
  - current policy not sufficient
  - generic standards can not be lowered
  - increasing focus on 4xR strategy



Bron: Groenendijk et al., 2016

The agricultural challenge

- ✓ Huge compliance
  - well known stories about fraud
  - increasing administrative costs
  - inspection soil, manure production on farm level
- ✓ From compliance to environmental performance
  - in Common Agricultural Policy (CAP)
  - in 6th Nitrate Action Programme
  - in certification schemes from supply chains
  - high societal pressure on reducing environmental impact
  - comment of farmers in all kind of POP-projects: ‘how to quantify the impact of my management on water quality’

FarmHack december 2017

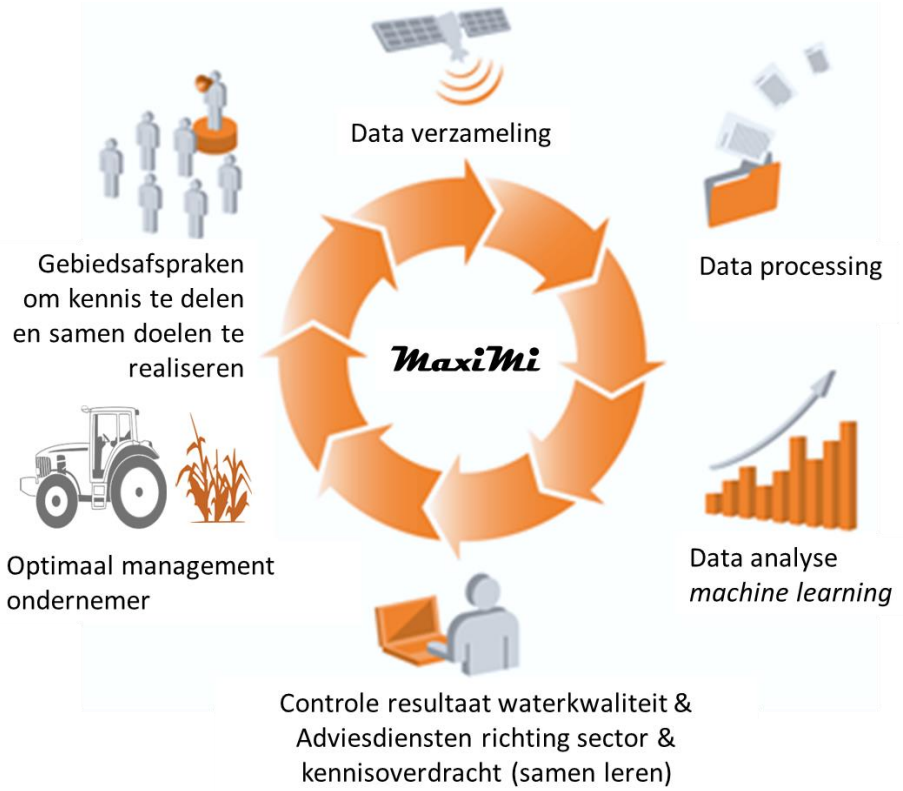
Find innovative solutions to reduce complexity of manure management (and compliance) in the Netherlands

MaxiMi

Maximale milieuprestaties met minimale (overheids)inspanning

https://www.farmhack.nl/resultaten-mesthack/

MaxiMi, conceptual approach



- ✓ Data collection
- ✓ Adaptive models
- ✓ Compliance via environmental impact
- ✓ Agribusiness
- ✓ Collective approach

Ros et al. (2018)

Assumptions MaxiMi framework

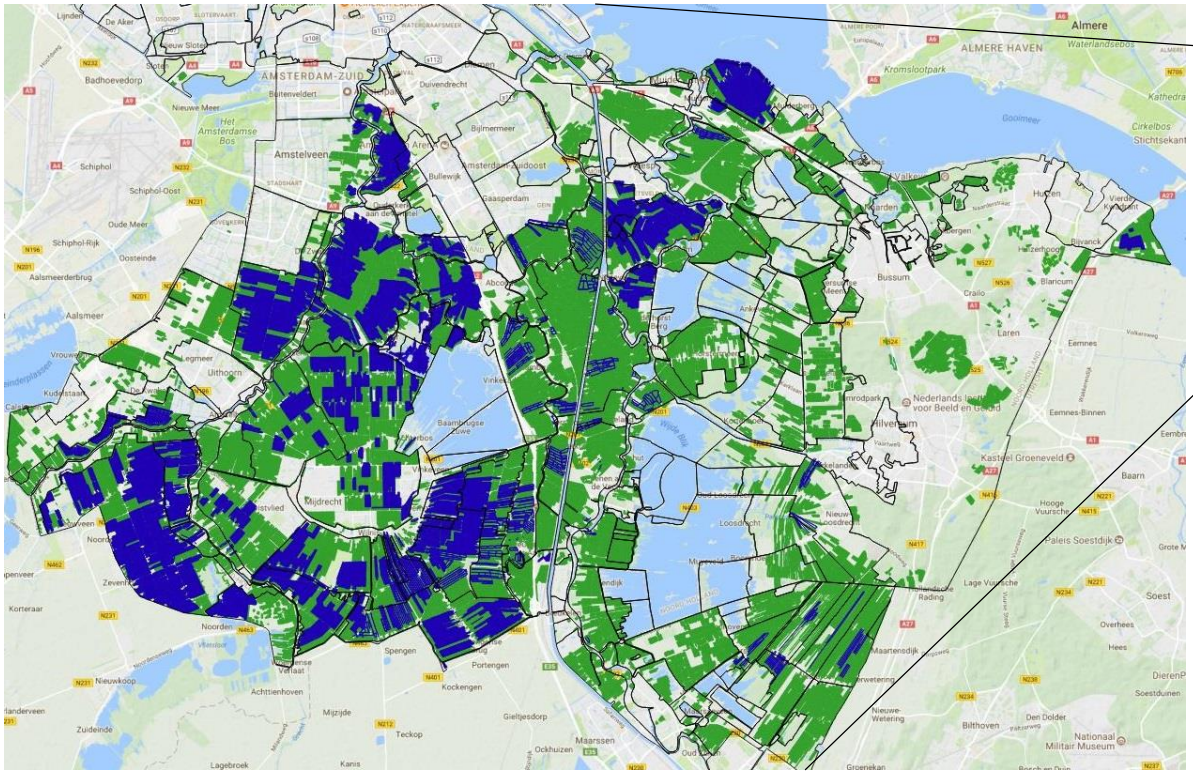
- ✓ Data sharing public and private parties
  - public monitoring datasets and sensors
  - satellites, drones, farm equipment, mobile sensors
  - soil properties (>30), weather and soil moisture on field level
  - crop production, nutrient management on farm level
  - properties of water system on catchment or polder level
- ✓ Coupling via machine learning
  - assess impact of individual parcels on water quality catchment/ polder
- ✓ Governance issues required for transition
  - private farm to collective responsibility
  - valorisation in supply chain

Proof of principle

- ✓ Illustration for water board AGV
  - water fluxes on daily basis *(polder level)*
  - soil properties *(parcel)*
  - fertilisation *(farm and parcel)*
  - morphology *(parcels and ditch)*
  - water quality *(polder)*
  - ecology *(ditches)*
  - involvement nature governance *(farm, parcel)*
- ✓ Aims
  - create more insights in spatial differences
  - fact-finding together with farmers
  - input for polder specific measures

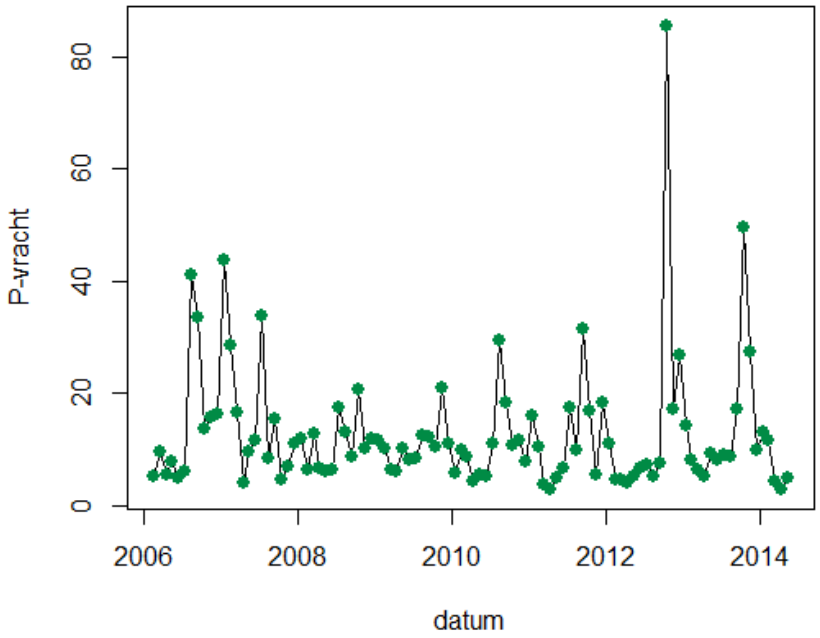
A proof of principle: illustration 1

Example: participation in Agriculture, Nature, Landscape Governance
(highly related to farming intensity)



A proof of principle: illustration 2

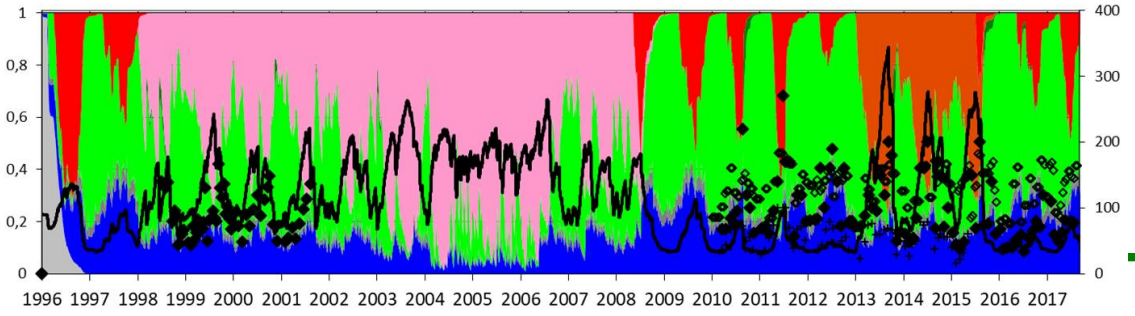
P loading measured pumping station X



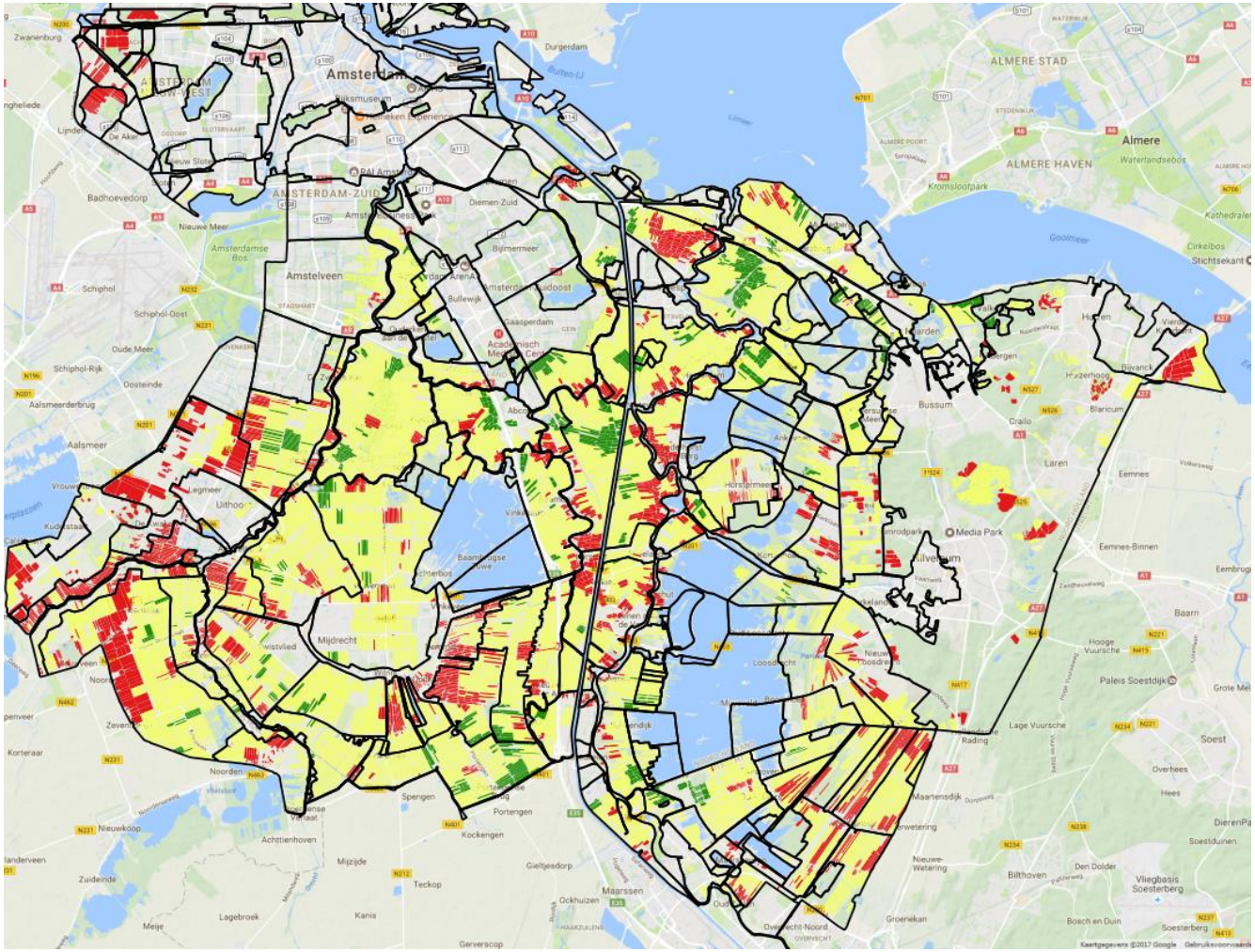
Monthly measurements

- > 100 sampling locations
- N and P concentrations
- biological and physical properties
- water balance per polder

Origin of water flux at pumping station X



A proof of principle: illustration 3



P-status Soil
(mg P_2O_5/ 100 g)

< 27

27-50

>50

nmi

WAGENINGEN UNIVERSITY & RESEARCH

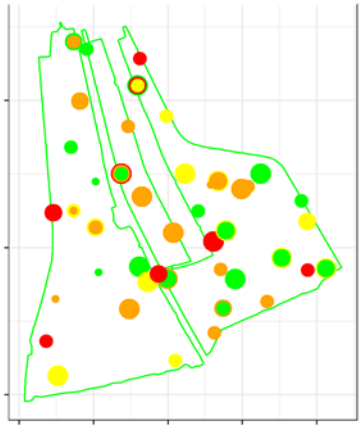
waterschap amstel gooi en vecht

A proof of principle: illustration 4

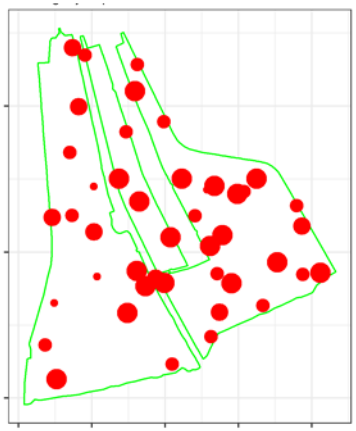
Abundance of vegetation type in aquatic ecosystems

Bedekking

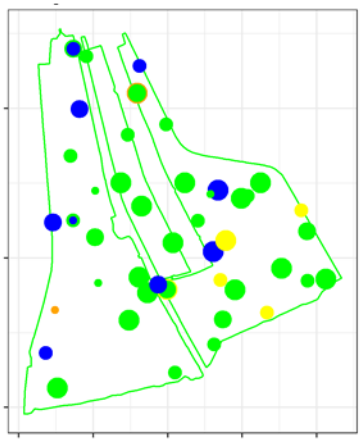
Emerse planten



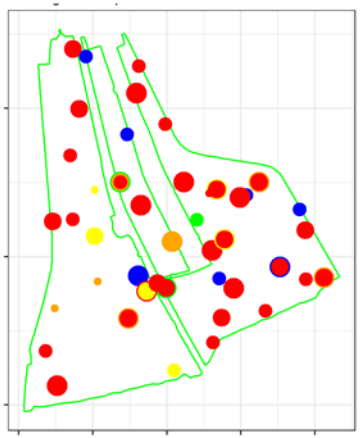
Drijfbladplanten



Flab & kroos

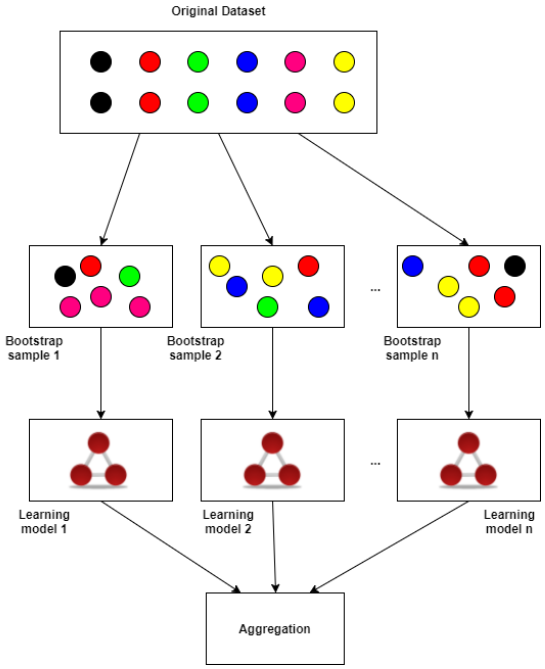


Submerse plant



Data coupling via machine learning

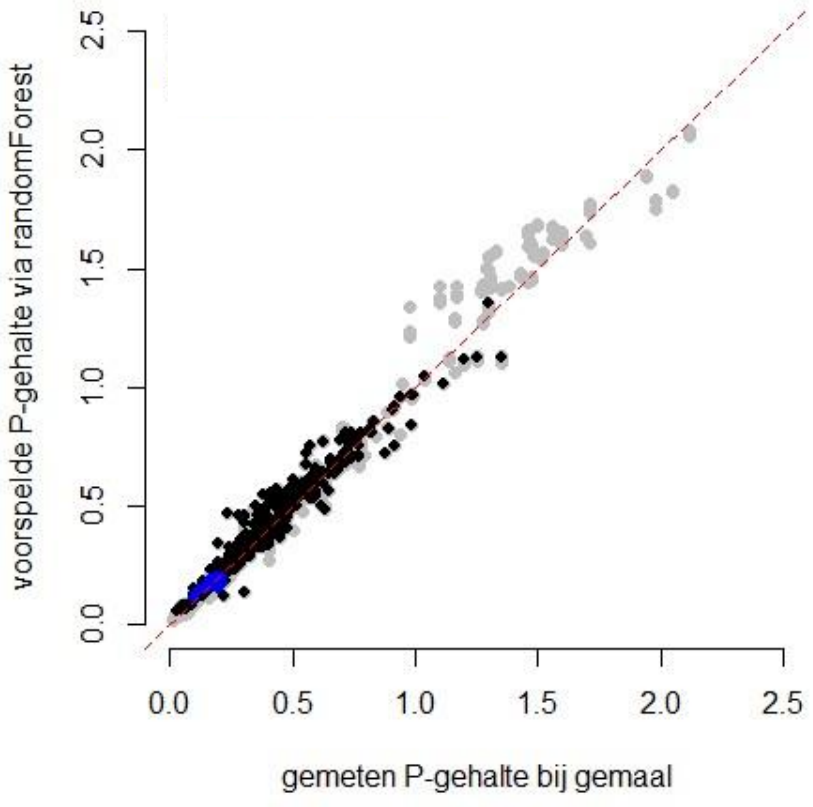
- ✓ Estimate P-load per parcel and polder
- ✓ Three possibilities (in NL)
  - mechanistic modelling: ANIMO-SWAP
  - meta-models: INITIATOR, Nutricalc
  - statistic approach
- ✓ One example for AGV
  - performance of random forest models



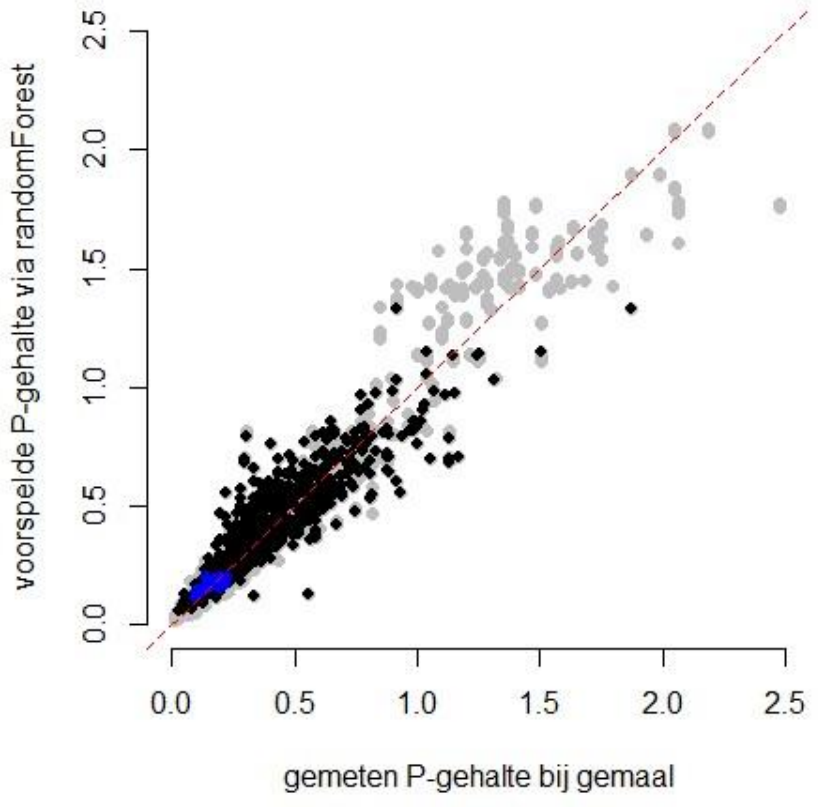
Estimation of annual P-loading

P-gehalte (mg/ liter) over 2000-2016

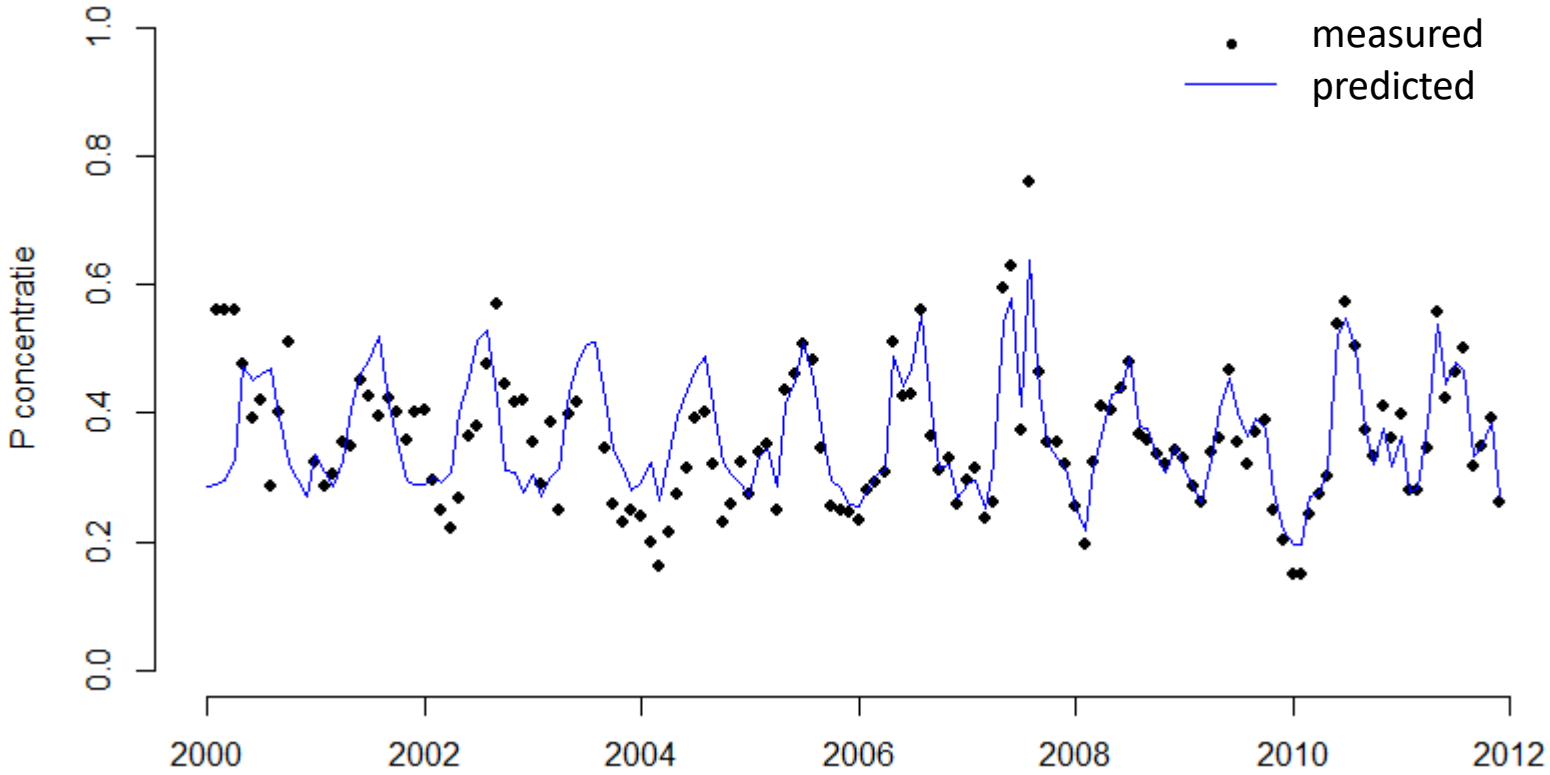
annual mean



monthly mean

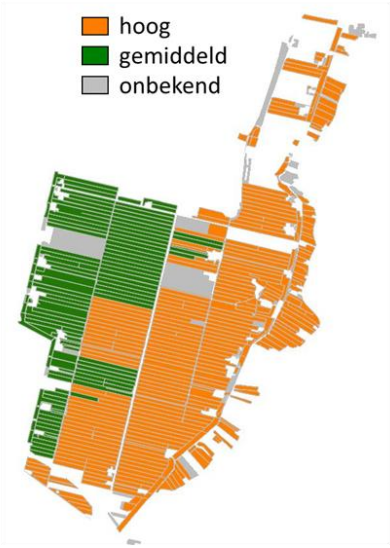


Estimation of daily P-load

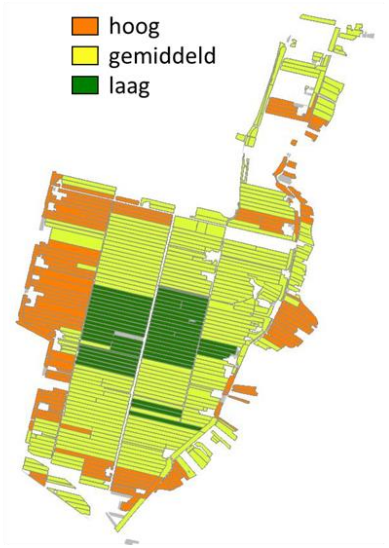


Our final recommendation

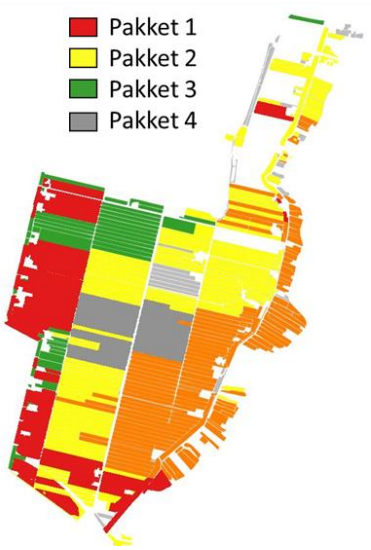
Where are measures effective?



What is risk on high P-loadings surface water?



What measures are suitable improving wq?



Verhoeven & Ros (2018)

Take home message

- ✓ Improvement ecological water quality requires site specific measures, and insights in system soil – agriculture – water
- ✓ Challenge: aims and effects are scale dependent
- ✓ Combining (sensor) data and adaptive models increases insights and makes site specific solutions possible