Using Phenological Information Derived from MODIS-data to Aid Nutrient Leaching Modeling

First Experiences

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INTRODUCTION

- Nutrient leaching modeling is used to study and understand eutrophication of lakes and sea
  - too much nutrients result an excessive growth of algæ and other plants, with depletion of oxygen and consequent extinction of animal life
- Sources of nutrients
  - point: industry, urban areas, sewage treatment plants
  - diffuse: agriculture, natural land
- It is essential to know the relative significance of the different sources of pollution
  - to assess the effectiveness of current environmental policies
  - implement river basin management plans

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INTRODUCTION

- This presentation presents the first experiences in the combined use of remote sensing data with nutrient leaching modeling
  - tested in Loimijoki river basin during year 2006
- Phenological time-series
  - weekly maximum NDVI-mosaics from MODIS-images
  - transformed to estimates of the proportion of vegetation cover
- Nutrient leaching modeling uses information about the growing season
  - length of bare ground periods before and after growing season
  - date of the peak of growing season
- Part of GMES-project GSE Land

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NUTRIENT LEACHING MODELING

INCA-N model

- calculates NH_4-N and NO_3-N fluxes from terrestrial environment to river
- dynamic, process based
- semi-distributed
  - land use class in sub-catchment

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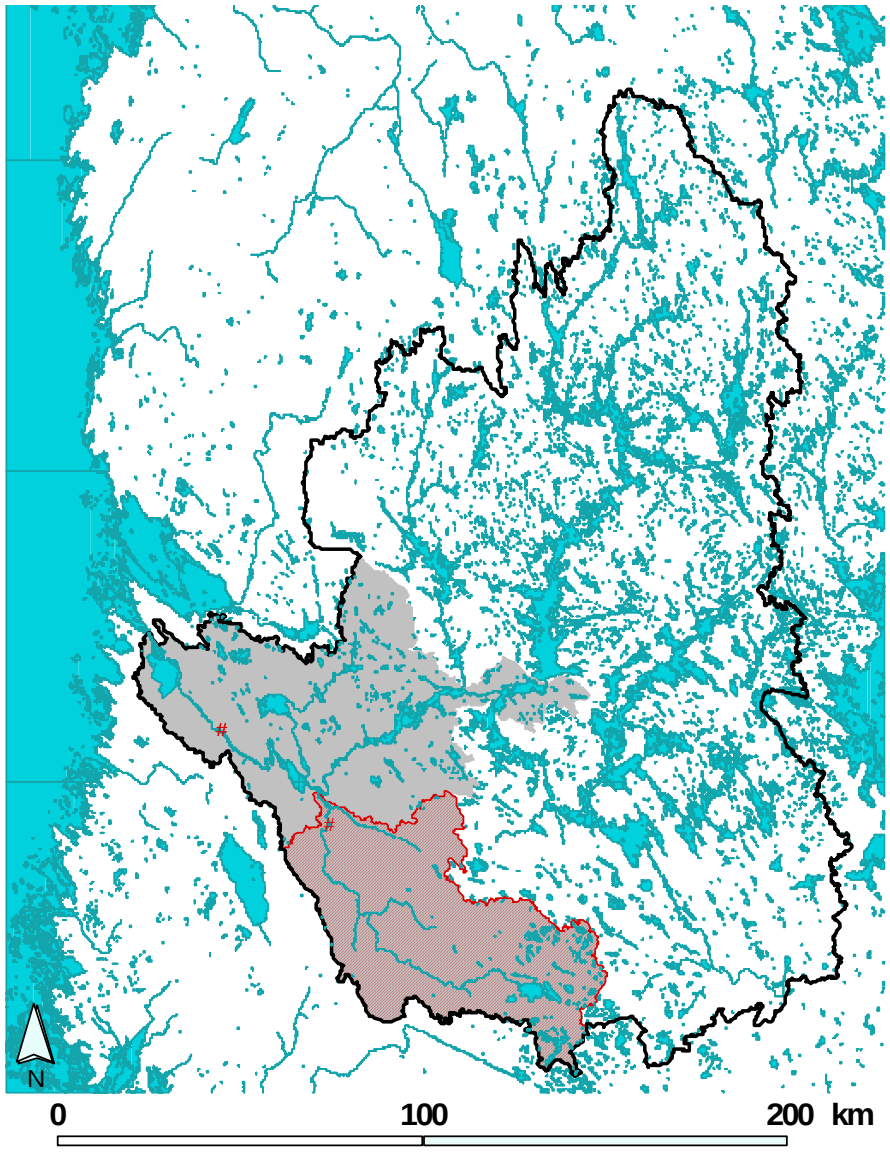
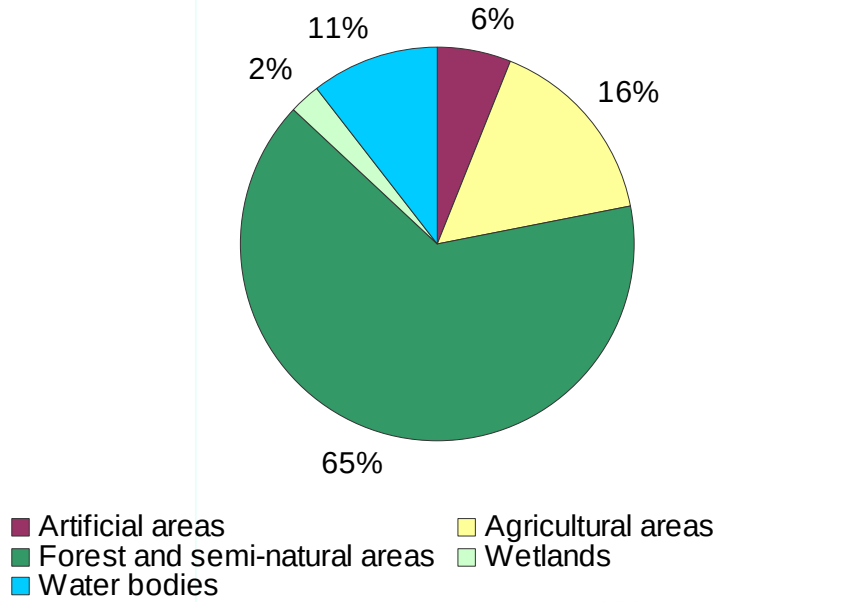
NUTRIENT LEACHING MODELING



- Large area Kokemäenjoki river basin
- Loimijoki basin (red area) modelled by INCA-N because large areas of agricultural land



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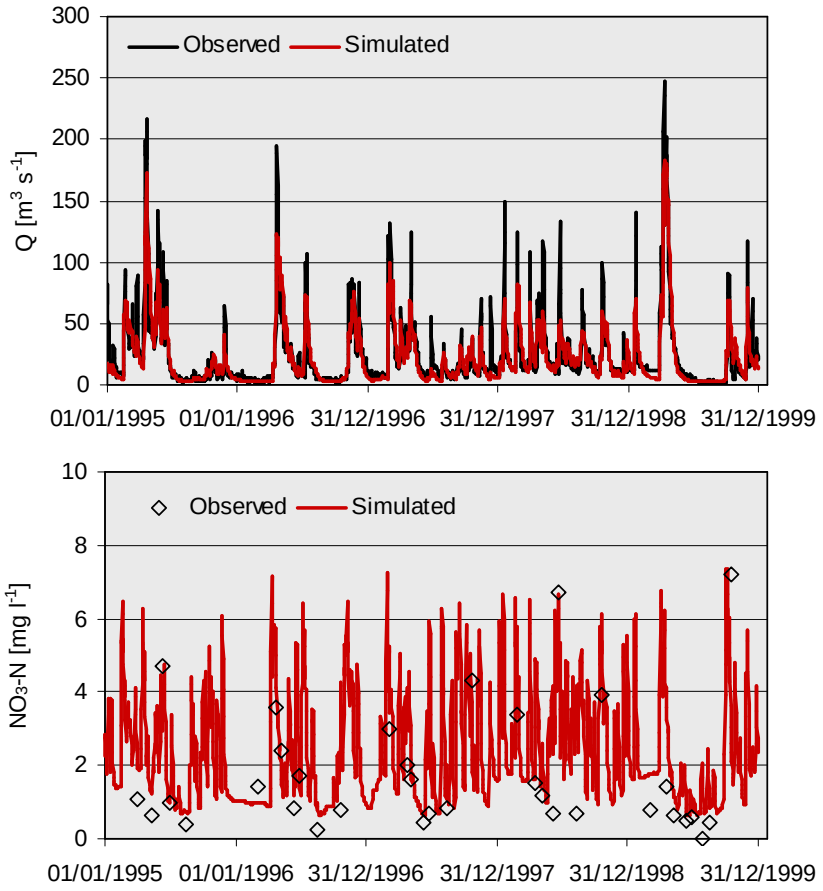
NUTRIENT LEACHING MODELING

Inorganic N dynamics in Loimijoki

90% of tot-N
is in form of nitrate

Less than 10
water quality samples
in year



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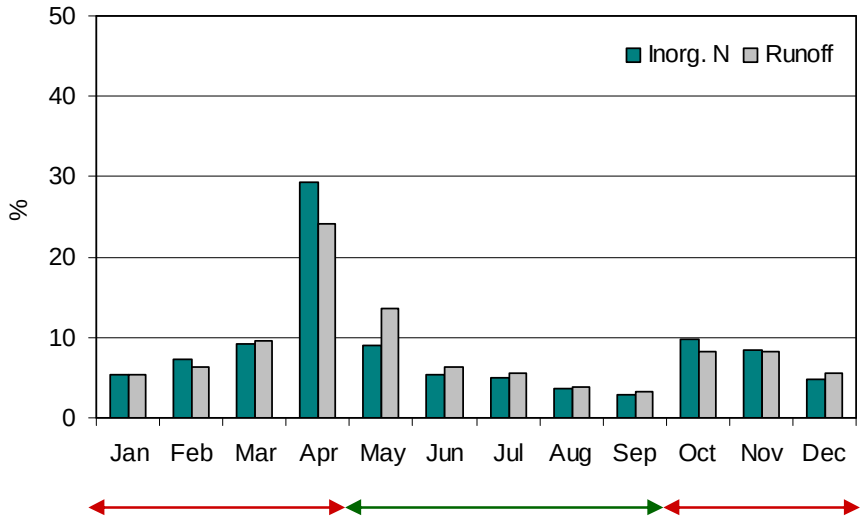
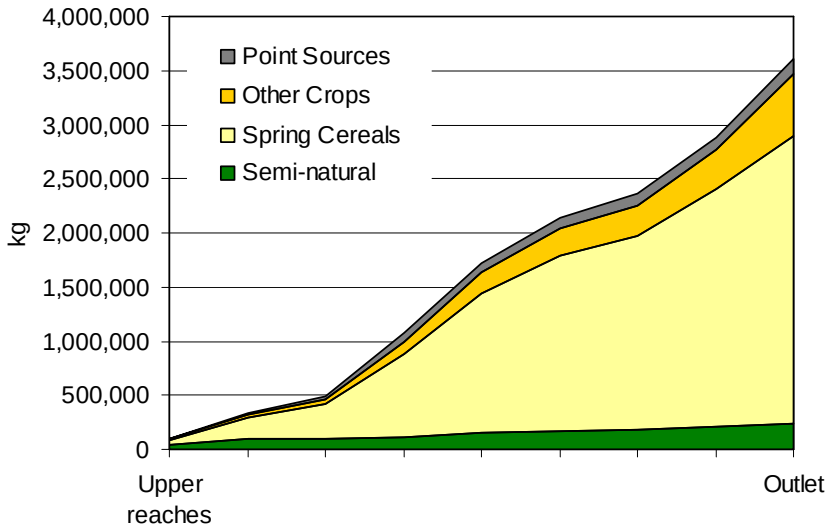
NUTRIENT LEACHING MODELING

Simulated timing and origin of inorganic N loading from Loimijoki





§ 75% outside growing season

§ Agriculture main source

- 74% Spring Cereals
- 16% Other Crops

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NUTRIENT LEACHING MODELING

Length of growing season in Jokioinen Observatory

Year	Starting date	Ending date
1990	15.4.	19.10.
1997	6.5.	2.10.

- Data of Finnish Meteorological Institute
- Average day temperature >5 ^{0}C

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PROCESSING OF RS DATA

- MODIS images received from Finnish Meteorological Institute, Sodankylä Receiving Station
  - one or two images acquired daily from early April to mid-October 2006
- SYKE's operational processing system:
  - Radiometric correction to TOA reflectance using the calibration coefficients and solar zenith angles
  - Atmospheric correction using SMAC4 model
  - Geometric correction was done using latitude and longitude files
  - Clouds were detected using their temperatures and masked out
- Creation of phenological time-series:
  - Normalized Difference Vegetation Index-images from MODIS
  - weekly mosaics by selecting the maximum NDVI within that week

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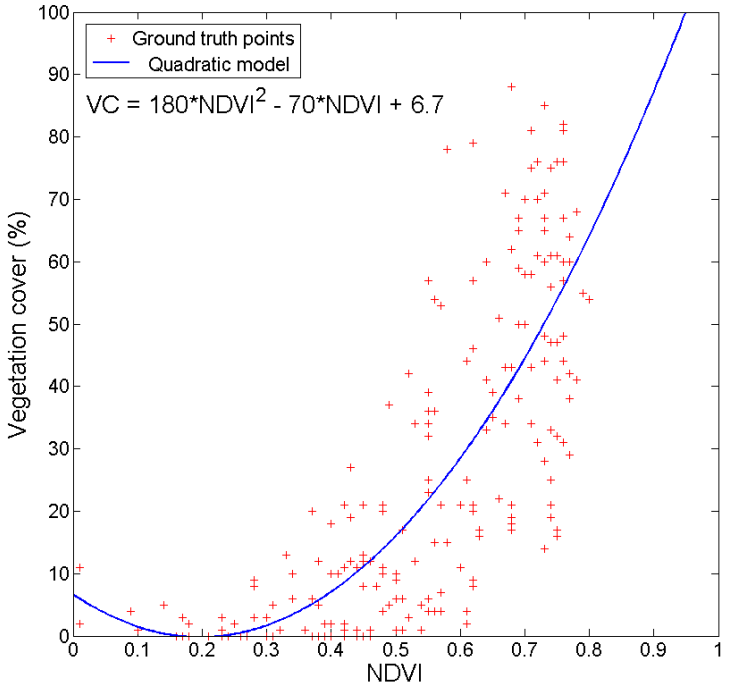
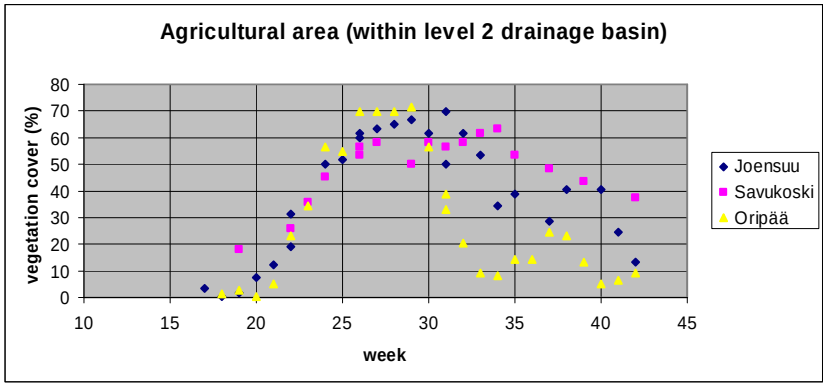
PROCESSING OF RS DATA

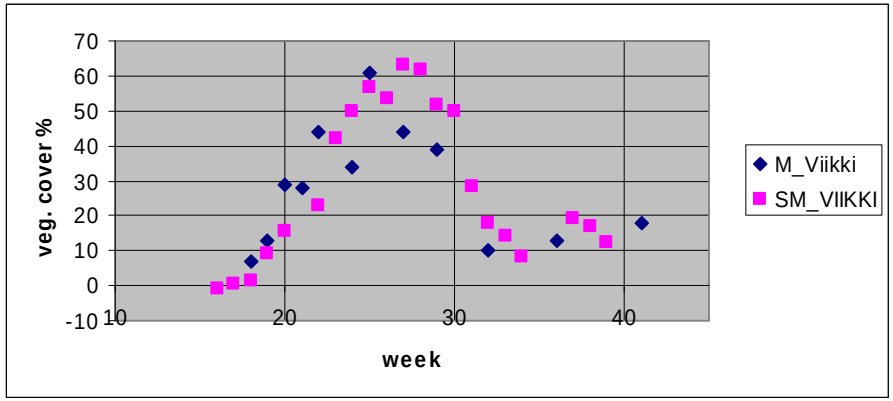
- NDVI was transformed to Proportion of Vegetation Cover (PVC)
  - locally developed statistical quadratic model
- Ground measurements for model development and validation
  - taking digital photos for agricultural fields
  - estimating the PVC for each field
  - PVC estimated for each MODIS pixel as areally weighted average of PVCs of individual fields
- Some example time-series from different parts of Finland

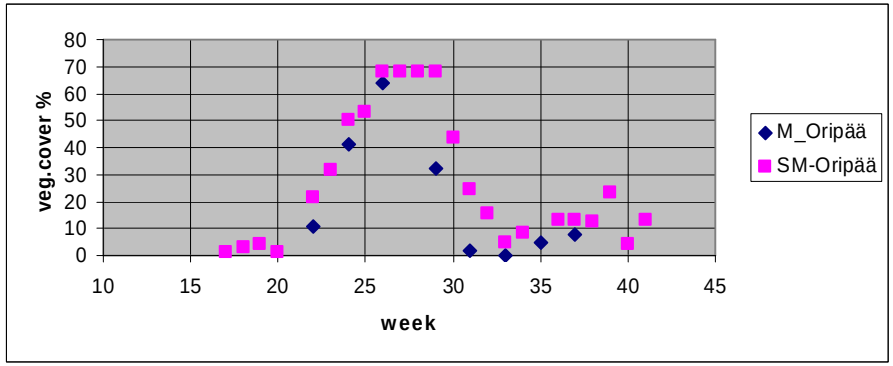




VALIDATION: RS DATA

- Relationship between PVC estimated on the ground (blue dots) and estimated from NDVI mosaicks (red dots) for Viikki and Oripää agricultural areas
  - ground and satellite estimates follow each other rather well, but are smaller than satellite estimates
- Sources for error
  - some parts of plants are in shadow in digital photos
  - during senescence ground estimate of PVC decreases much faster than satellite estimate





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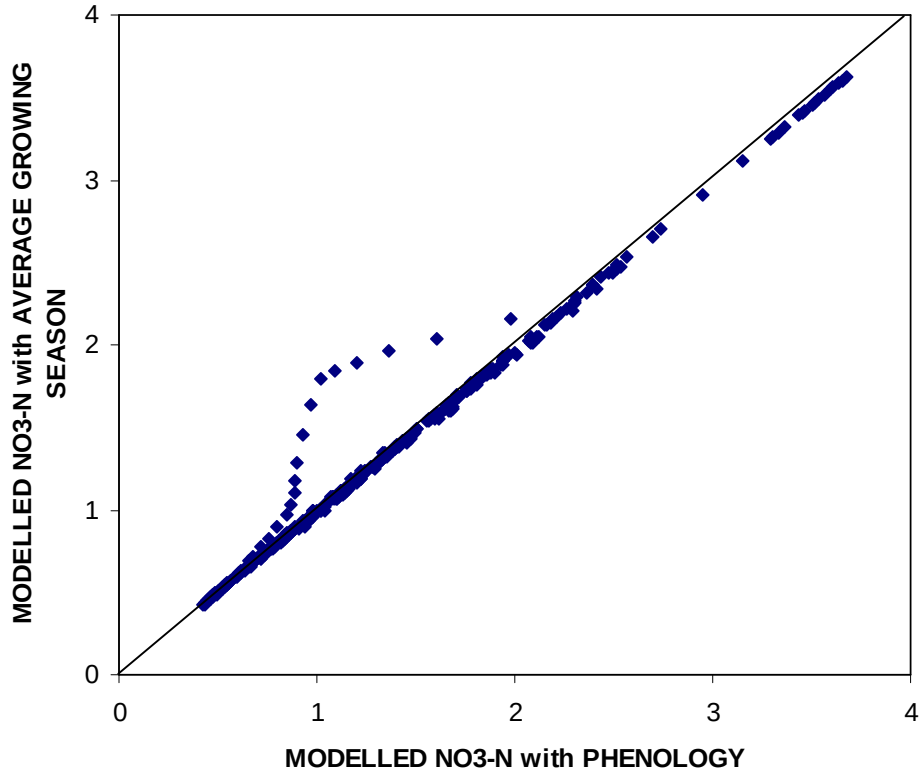
VALIDATION: MODELING RESULTS

Difference in NO3-N output between average growing season and information derived from MODIS time-series



Improvement seen in modeled inorganic N concentrations in spring when growing season started

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CONCLUSIONS

- Predictions from Nitrogen leaching model improved due to remote sensing derived information
  - improvement happened in spring in the beginning of growing season
  - in northern countries crucial time for nutrient leaching due to high runoff after snowmelt
- Things that could be made better
  - better model for the proportion of vegetation cover
  - the growth curve of vegetation used in model could be calibrated against observed phenological time series
  - the estimated variable could be Leaf Area Index (LAI) or Fraction of Photosynthetically Absorbed Radiation (FPAR)

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