Streaming sensor network data for optimized environmental resource management

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Presentation for OSIRIS Sensor Web Workshop, March 2009

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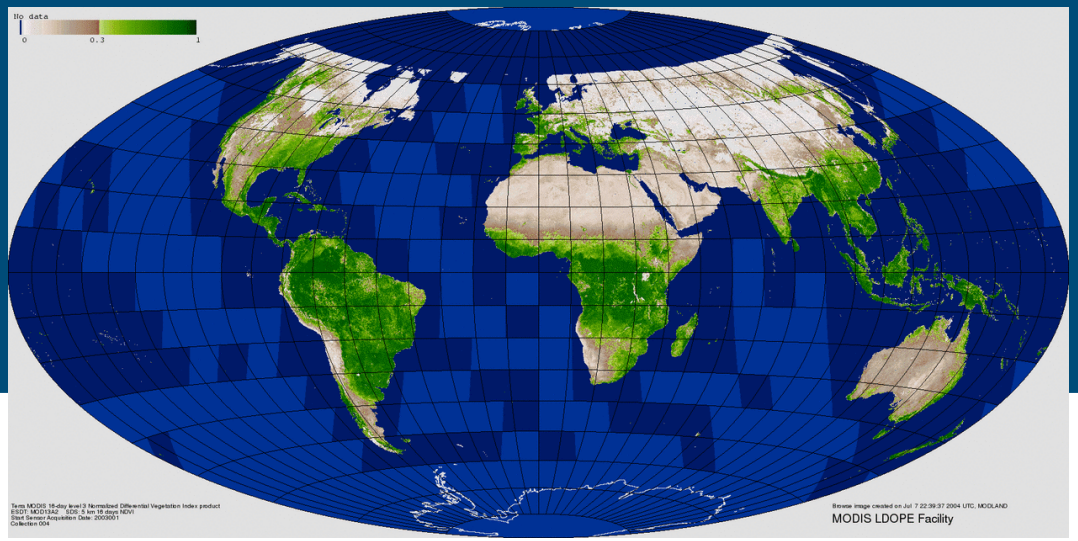
Centre for Geo-information

Overview

- Introducing Centre for Geo-Information
- Research focus
- Prototype Streaming sensor network data
- Contact

Introducing the Centre for Geo-Information

- Centre for Geo-Information, Wageningen University
- Two chair groups (staff: 30):
  - Geo-information systems (prof. Arnold Bregt): SDI, spatial modeling, geo-visualization
  - Remote sensing (prof. Michael Schaepman till Marc 2009): remote ‘measurement’, data-assimilation, data-fusion
- Closely affiliated with Alterra research institute (staff: 50)
- Focus on applications for environmental resource management: ecosystems, landscape, agriculture, soil



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Track record CGI (selection)

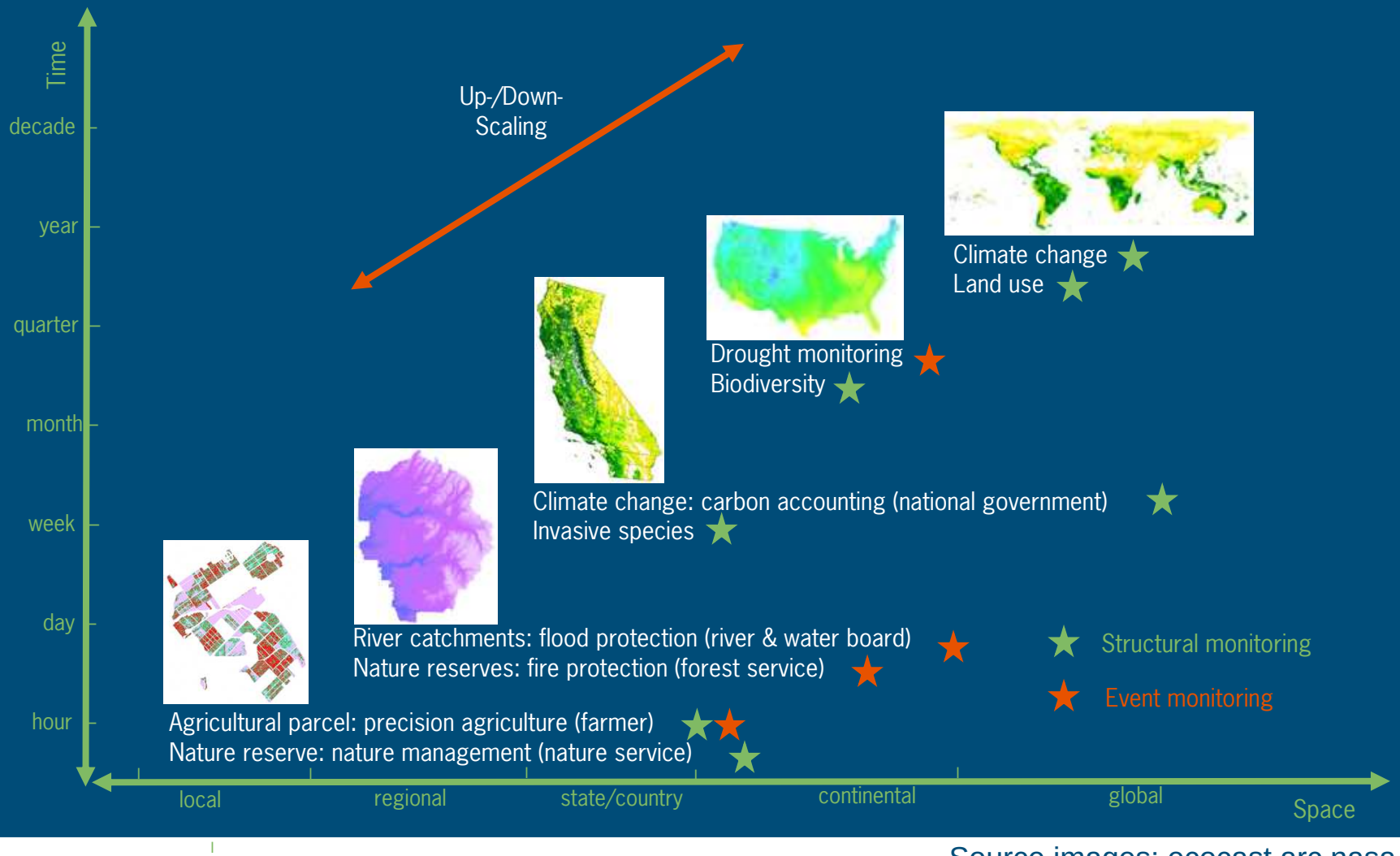
Environmental resource management

- FP6/7: Ecochange, Geoland2, Sensor, Seamless, E-SOTER
- JRC: MARS and MARSOP: crop monitor and yield forecast
- National funding: soildata.nl, natura2000 monitor, eururalis etc.
- Application -> architecture -> implementation (-> operationalisation)

Sensor networks and sensor web enablement

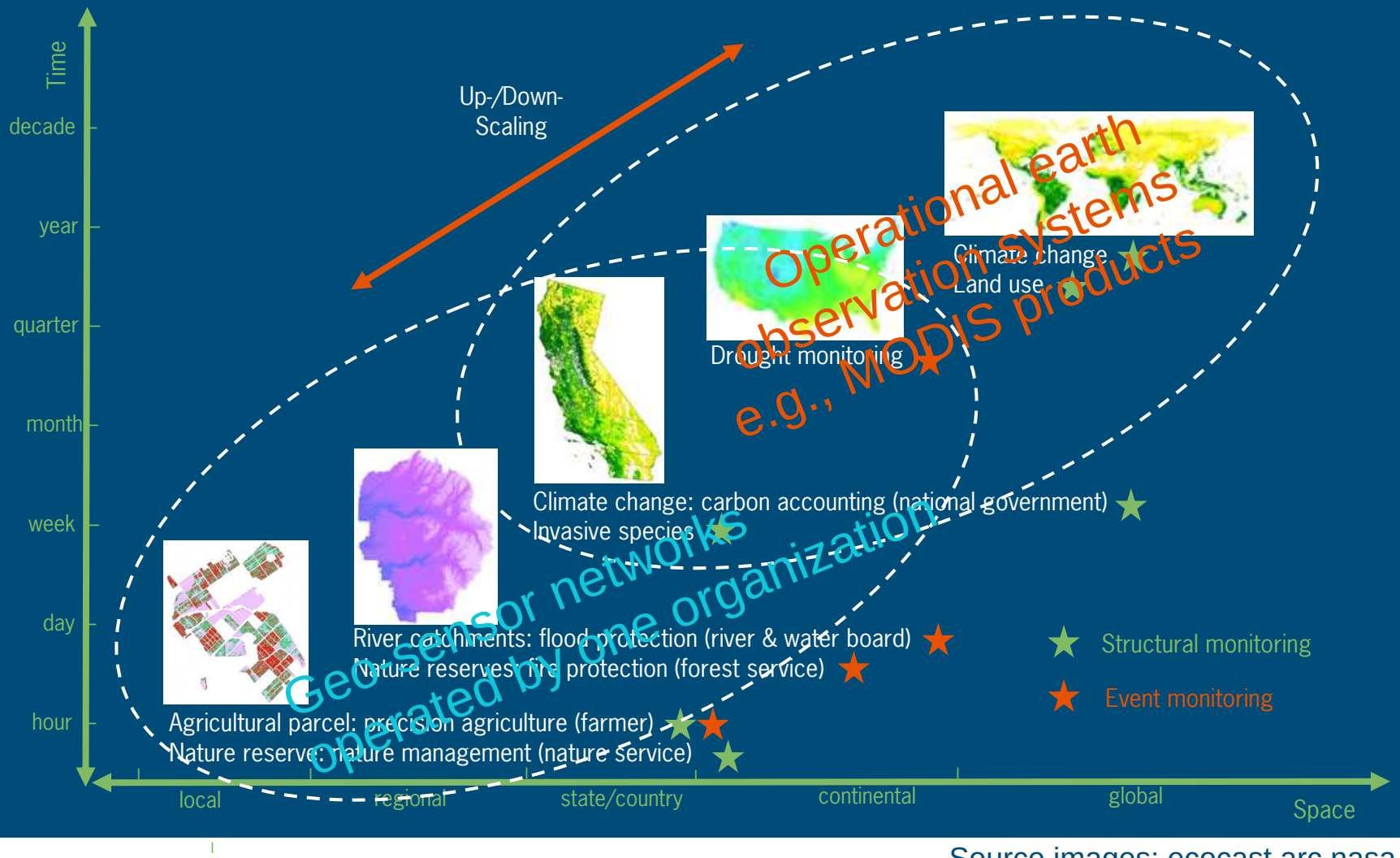
- Within NL program Space for Geo-Information:
  - People in Motion: mobile sensor data & behavior of people
  - Sensors for the Dutch GII: geo-sensors & OGC-SWE & use cases
- Workshop Sensing a Changing World, November 2008
  - Proceedings on web + special issue Sensor journal
- Focus 2009: network + use cases + toolboxes (education & research)

Scaling between user requirements



Source images: ecocast.arc.nasa.gov

Scaling between user requirements



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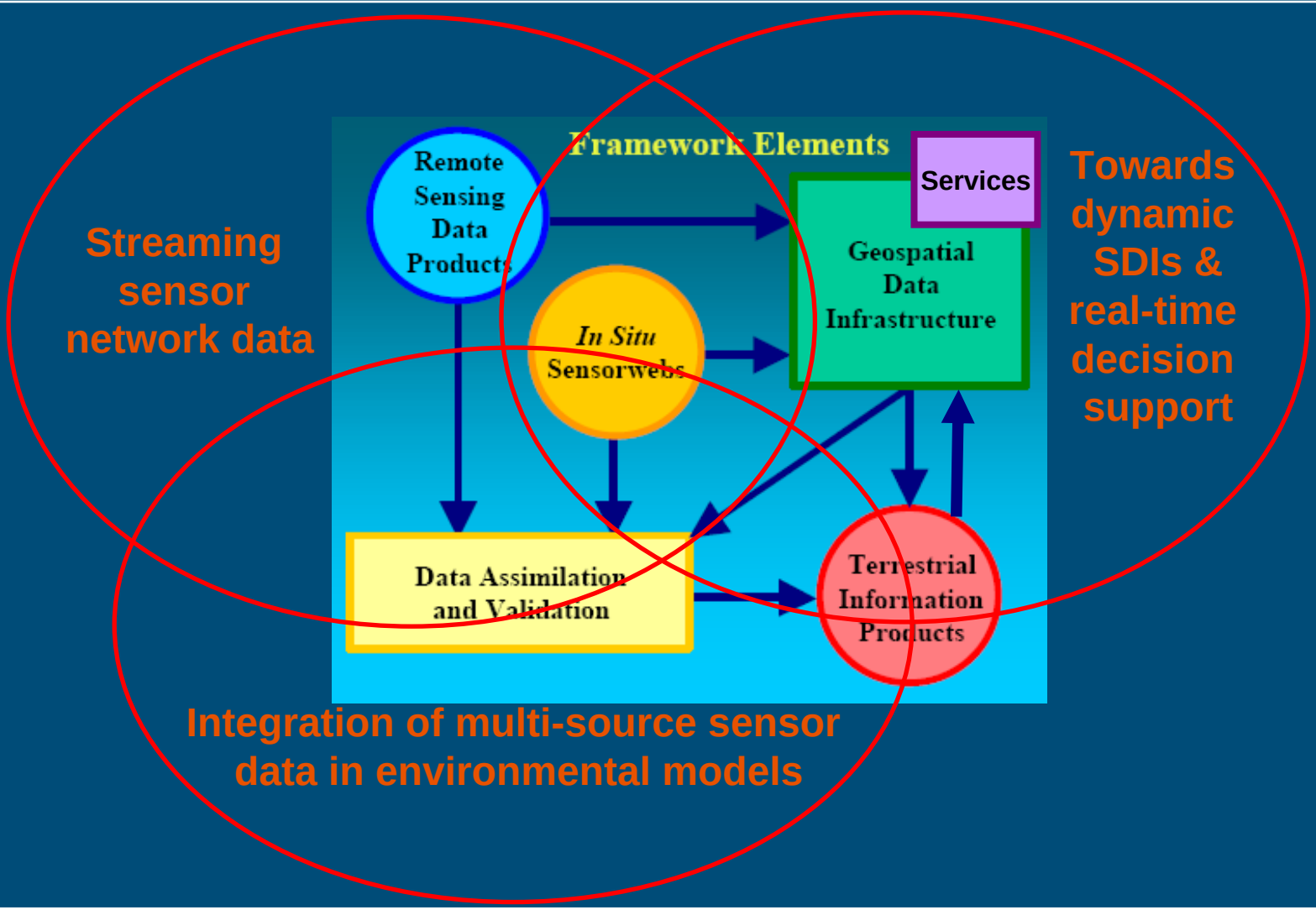
Research focus



Adapted from Teillet, 2002

Prototype for streaming sensor data

- Vegetation productivity: management variable for farmers + essential Climate Variable (ECV) within Global Climate Observing System (GCOS)
- Develop a sensor web based approach which combines earth observation and *in situ* sensor data to derive daily maps of vegetation productivity for regional to national scale
- Implementation in dynamic Web Mapping Service
- Evaluate current limitations and future research requirements

Calculation of vegetation productivity

- $GPP = \downarrow PAR \times FPAR \times (\varepsilon_{g\text{-}max} \times S_{Tmin} \times S_{VPD})$

- GPP = gross primary production (g C m^{-2} day^{-1})
- $\downarrow$PAR = incoming photosynthetically active radiation
- FPAR = fraction of $\downarrow$PAR absorbed by the plant canopy
- $\varepsilon_{g\text{-}max}$ = maximum light use efficiency (land use specific)
- S_{Tmin} = minimum temperature scalar
- S_{VPD} = vapor pressure deficit scalar

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☻ meteo data
☻ remote sensing

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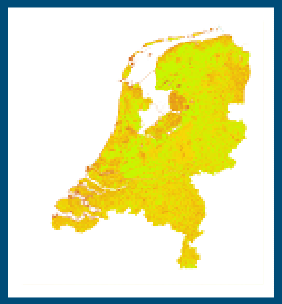
Implementation: automated processing chain

MODIS surface reflectance

NASA MODIS FTP

Automated download & processing

FPAR



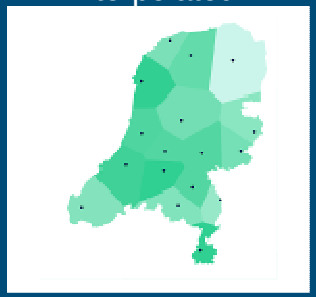
FPAR time-series

KNMI SOS server

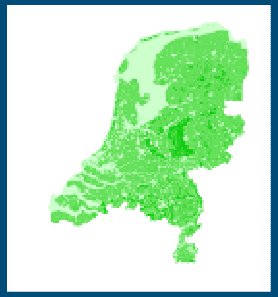
Get Obser-vation & processing

meteo time-series

interpolated PAR



Potential LUE



Calculation of GPP per 250 m pixel (python)

LUE static p. year

download most actual LU & processing

SDI-NL

LUT

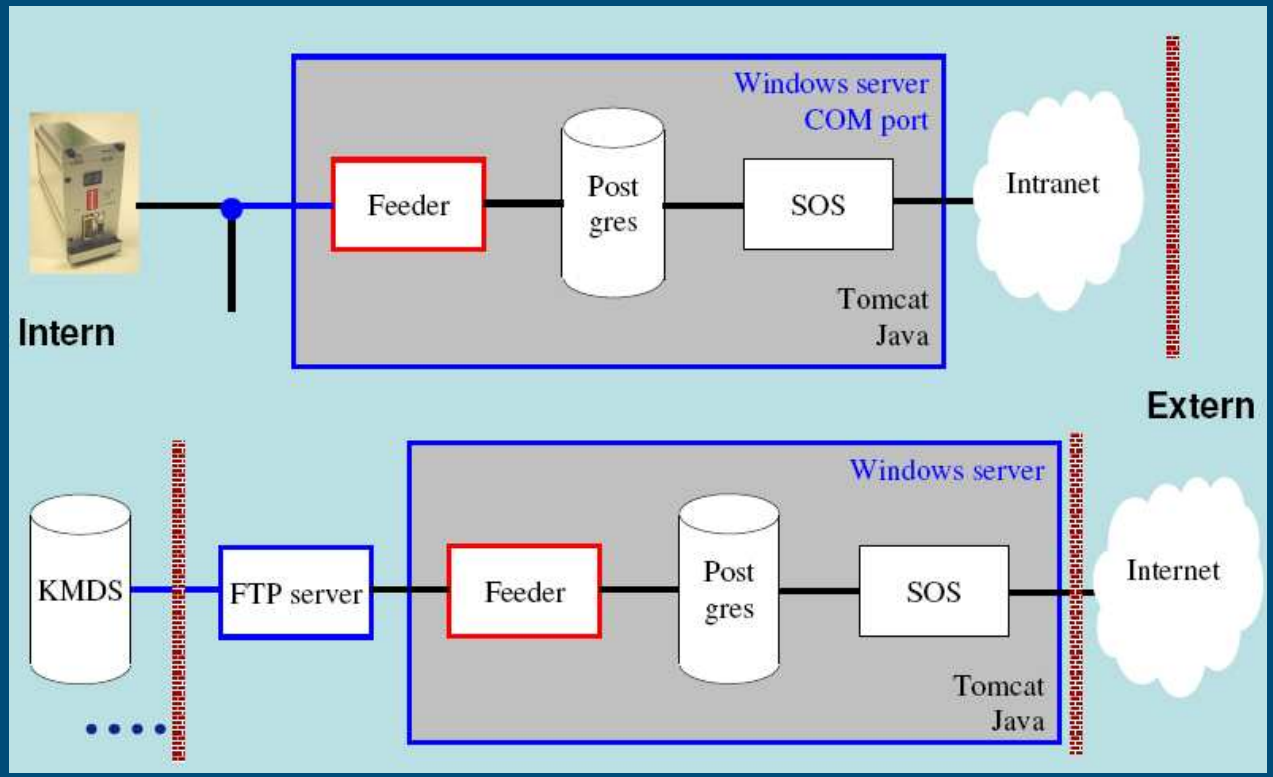
Web Mapping Service (pmapper)

End user

SWE – KNMI set-up

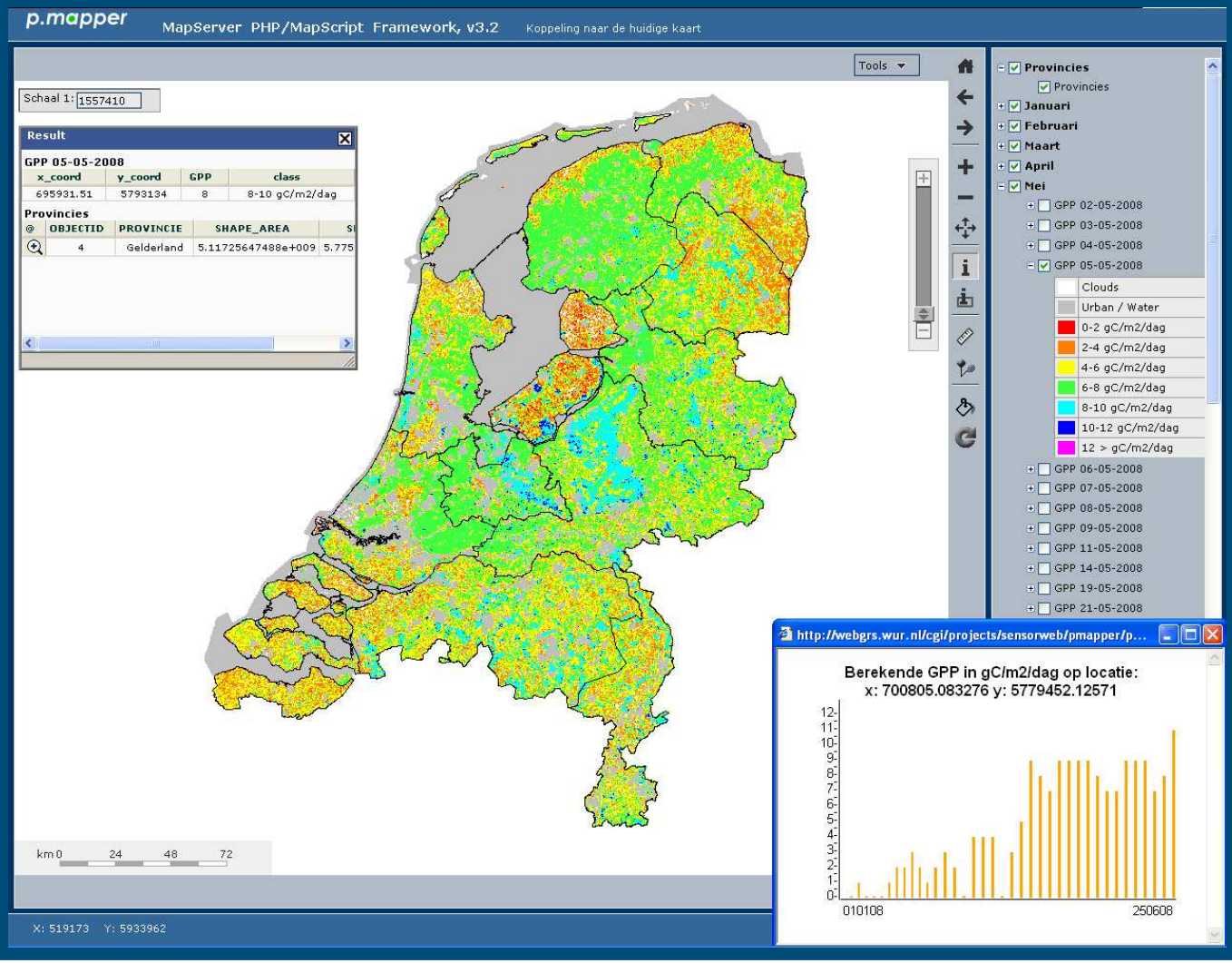
- 16 stations (KMDS)
- WMO set-up
- Prec; temp; rel hum; glob sol rad; wind dir & speed;
- 10 minute data
- OGC-SWE implementation

- Calculation of daily mean



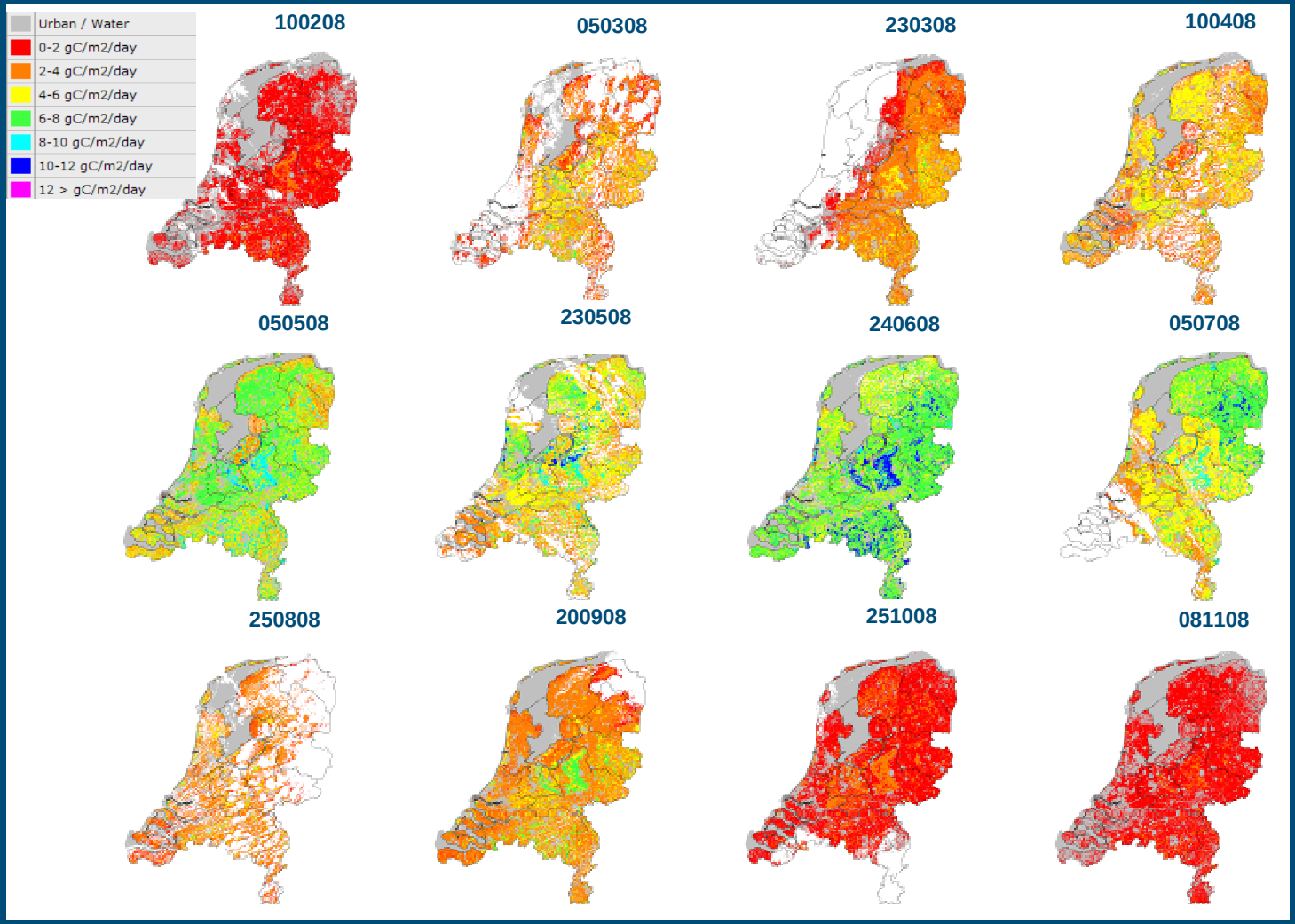
Source: KNMI, Wiel Wauben

Web Mapping Service Vegetation Productivity



Source: http://webgrs.wur.nl/cgi/projects/sensorweb/pmapper/pmapper_gpp/map.phtml

Annual vegetation productivity over NL



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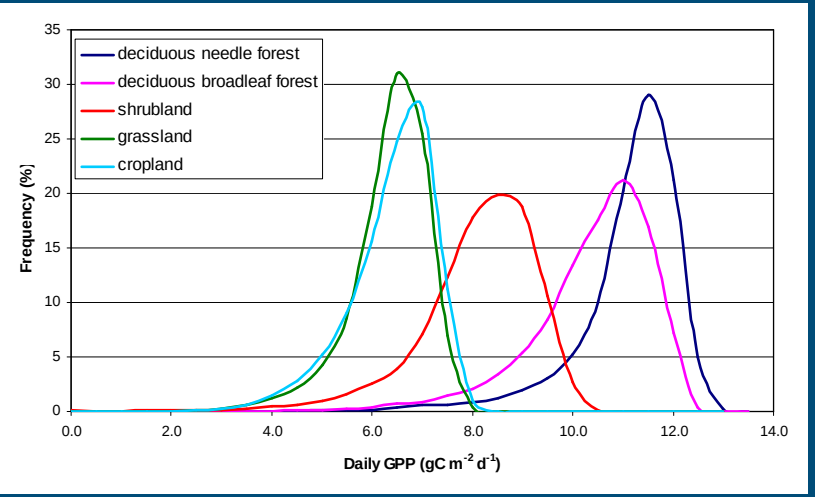
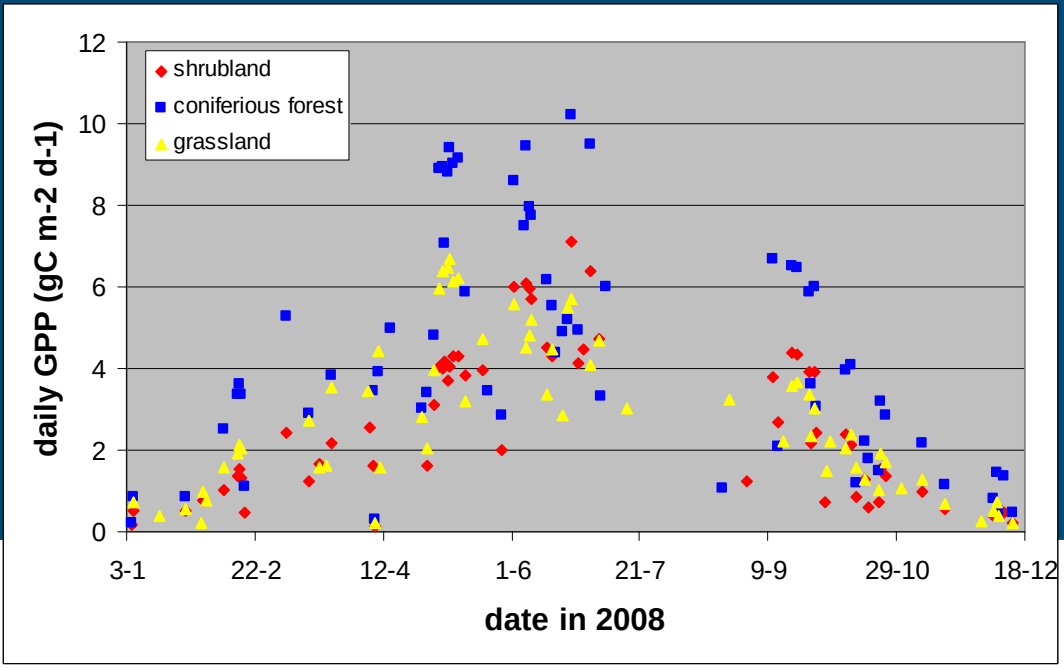
GPP statistics as input for management

- Derive statistics or indicators for management decisions (e.g., farmer): comparison with long term statistics
- Derive variables as input for environmental models: nowcasting or forecasting
- Feedback to optimize sampling strategies by improving spatial-temporal configuration of sensor networks





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Limitations and opportunities

- Time delay remote sensing data (5-10 days)
  - Direct broadcast (including facility for processing: NL organization)
  - SWE standards not used yet
- Limited revisit frequency of RS data (incl. clouds)
  - Multi-sensor approach: specific tasking
- Limited spatial resolution of RS data
  - Sensor data fusion: combine high (25 m) and low (250 m) resolution sources: e.g., Landsat and MODIS
  - Multi-sensor approach: specific tasking
- Limited number of point stations available as SOS
  - Plug and play services required to include other stations
  - However, KNMI evaluation shows not yet the case: incomplete, redundant information, security, tools for exploration and finding data

Conclusions and outlook

- Increasing need for (near) real-time (geo)-data sources to facilitate environmental resource management
- Required: multiple use of available sensor data sources
- Interoperability will be key to combine (multi-source) sensors in space and time: use of common standards and protocols
- For field of geo-information: how to scale and integrate multi-source sensor with different spatial and temporal extents: synergy by using a modeling approach

- Proof of concept shown in proto-type
- Combined use of in situ sensor and remote sensing data: dynamic continuous maps (as input for SDI)
- Multi-sensor data: extent use of (OGC) standards
- Further research & implementation to reduce limitations

Contact

- Centre for Geo-Information, Wageningen University
- www.geo-informatie.nl

- Contacts:
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- Lammert Kooistra: geo-sensor networks and ecological modelling
  e-mail: lammert.kooistra@wur.nl

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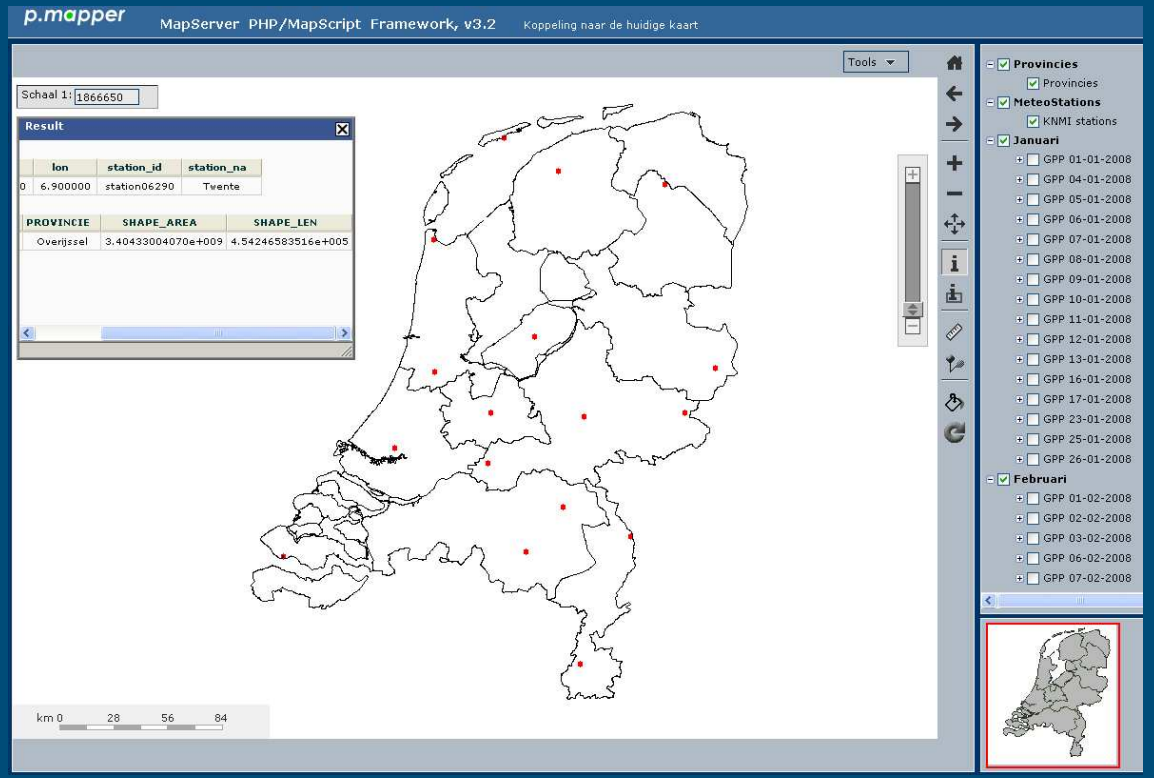
Functionality WMS KNMI Meteo Data

- Query most recent meteo data using KNMI SOS server using GetObservation request
- Example:

  Tuesday October 14 14:00:
  Leeuwarden (13:30): 14.1 °C
  Maastricht (13:30): 16.0 °C

- Additional functionality:
  - trajectories
  - other parameters
  - geographic selection
  - Etc.



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