Hi-g-resolution modelling and monitoring of water and energy transfers in wetland ecosystems (HiWET)

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OUTLINE

HiWET project
  Hypothesis
  Goals
  Methodology

Preliminary results
Wetlands show high thermal variability

Doode Bemde Wetland - Land Surface Temperature
Need for wetland ecosystem monitoring

Wetlands are beneficial for society, but suffer from degradation → monitoring
Evapotranspiration good indicator?

- ET dominant hydrological process in wetlands

- Hypothesis: ET variation is good indicator for ecosystem health status
Combination RS, MODELING and FIELD

FIELD
FUNCTIONING

PARAMETERISATION
VALIDATION

ECOSYSTEM HEALTH INDICATORS

PLANT FUNCTIONAL
MAPPING

HIGH-RESOLUTION ET

RS BASED
MODELING

INTEGRATION
WATER & ENERGY
Study sites: Temperate freshwater wetlands

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Size</th>
<th>Type</th>
<th>Data Availability</th>
<th>Familiarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Biebrza</td>
<td>140.0 km²</td>
<td>Peat Sedge</td>
<td></td>
<td></td>
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<tr>
<td>Hautes Fagnes</td>
<td>45.0 km²</td>
<td>Peat Bogs Moorlands</td>
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<tr>
<td>Upper Alzette</td>
<td>10.5 km²</td>
<td>Humid Sedge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doode Bemde</td>
<td>2.5 km²</td>
<td>Humid Meadows</td>
<td></td>
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</tbody>
</table>
A multi-resolution approach

Consistent ET estimates across spatial and temporal scales

**WATER BALANCE**

- 3000 – 5000 m
- 100 – 1000 m
- 30 m

**SURFACE ENERGY BALANCE**

- LOW: continuous
- MODERATE ASSIMILATION: seasonal
- HIGH: instantaneous
Preliminary Results (1)

Airborne acquisitions

- TELOPS Hyper-Cam (Thermal) – July 2016
- APEX (Hyperspectral) – July 2015
Hyper-Cam installation to Cessna
Biebrza site – Northeast Poland

Morning – Noon – Evening
12 flight lines
Radiometric Surface Temperature [°K]

WETLAND   BARE

9:00 local time

13:30 local time

COOL      HOT

18:00 local time
Preliminary Results (2)

Airborne acquisitions > thermal, hyperspectral
Field mapping > Plant Functional Traits (PFT)
  e.g. LAI
Plant Functional Traits

Whole plant related traits

- E.g. earliest flowering month, max plant height, water loss on drying, plant N/P ratio

Leaf traits

- E.g. stomata, Leaf Dry Matter Content, leaf surface

Stem & root traits

- E.g. stem hollowness, aerenchyma presence

→ 32 traits in total
Stem Hollowness (categorical)
1 = <25% hollow
2 = 25-50% hollow
3 = 50-75% hollow
4 = >75% hollow

Leaf N/P ratio (mg N/ng P)

Reference fen
Molinion
Calthion

Increasing drainage

Significant relation PFT - degradation
LAI mapping in field

South direction

LAI SunScan

Spectra ASD FieldSpec

pag. 16
Matching airborne & satellite RS data
Vegetation dynamics

NDVI Proba V - 5 July

0.2 0.4 0.6 0.8 1

0 0.2 0.4 0.6 0.8 1

NDVI Apex - 16 July

dry meadow

pristine fen

forest

bush / tree encroachment

meadow

sedge
Capturing natural dynamics

Biebrza WETLAND site

Field measurements (●) of Leaf Area Index (LAI) give similar values like Proba-V (▬)

- Sedge community: $H > 0.8$ m
- Dry meadow: $H > 0.4$ m
- Pristine fen: $H > 0.3$ m

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Field measurements of Leaf Area Index (LAI) give similar values like Proba-V.
Capturing management practices

WETLANDS Biebrza site

Proba V allowed to capture a moment of mowing

Graph showing LAI over time from 30/mei to 7/sep with a peak after mowing on 9/jul.
Preliminary Results (3)

Airborne acquisitions > thermal, hyperspectral
Field mapping > Plant Functional Traits (PFT)
e.g. LAI

\textit{ET estimation through modeling}

\textit{Hydrological (water balance)}
\textit{Surface Energy Balance}
Period-specific high-resolution ET maps

2012

2013
ET timeseries from different models show similar ranges but considerable variation.

**ET [mm/d]** - June & July 2015 @ Rogozynek EC station

- Observed (EC tower)
- Energy balance (SEB)
- Hydrological (WB)
INTRODUCTION

Wetlands are linking terrestrial and aquatic ecosystems, therefore they are of great value and play a significant role in the natural environment. Wetlands are the source of sweet water and act as filters between upstream and rivers estuaries. They are also characterized by high biodiversity and for being an important part of animal migration routes. Often, due to very high biomass production, wetlands are also responsible for recycling and storing large amount of methane, nitrogen, phosphorus, biogenic silica and carbon. Wetland ecosystems are...