HOBE – the Danish Hydrological Observatory

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Key objectives of HOBE – the Danish hydrological observatory

- To establish an observational and experimental interdisciplinary outdoor laboratory
- Test new innovative field instrumentation and observation techniques
- Establish scientific datasets to support fundamental research of hydrological processes
- Integrate monitoring, measurements, experiments, modeling and scaling
- Integrate knowledge across hydrological disciplines to help closing water balance at catchment scale
- Provide a basis for international research collaboration
**Study area - Skjern catchment and associated subcatchments – nested approach**

**Annual water balance metrics**
- Precipitation: 990 mm
- EP: 600 mm
- EA: 515 mm
- Discharge: 475 mm
- Temperature: 8°C

**Project components**

- Climate change and hydrology
- Precipitation
- Stream – aquifer interaction
- Submarine groundwater discharge
- Evapotranspiration
- Green house gasses
- Recharge
- Soil moisture
- Geological model uncertainty
- Seasonal forecasting
- Data assimilation in hydrological models
- Remote sensing
- Integrated modeling
- Data base
- Spatial patterns
- Expert elicitation on water balance
- Calibration and validation of distributed models
Basic monitoring

- Discharge: 11
- Precipitation: 22+3
- Climate: 7+3
- Groundwater wells: 3000
Special monitoring

Agricultural site

1. Precipitation
   a. Seven precipitation gauges of which one is placed at ground level as reference for liquid precipitation and one is shielded with a double fence as reference for solid precipitation.

2. Weather type
   a. Two disdrometers for measuring drop size distribution

3. Climatic variables
   a. Radiation (net radiation, in- and outgoing short- and long-wave radiation)
   b. Wind speed and direction
   c. Air temperature
   d. Relative humidity
   e. Soil temperature at three depths
   f. Soil heat flux at 5 cm depth

4. Energy and greenhouse gas fluxes (2 m covariance flux tower)
   a. Latent heat
   b. Sensible heat
   c. CO₂ gas
   d. N₂O gas

5. Recharge
   a. Overflow from four underground lysimeters (1.2 x 3.9 x 1.5 m) each holding nine probes for soil moisture measurements

6. Groundwater
   a. One deep well (36 m) with screens at 5-7 m, 7-9 m, 13-15 m, and 33-35 m depths
   b. Three shallow wells for measuring water table using pressure transducer

7. Cosmic ray
   a. Modified cosmic-ray sensor and an associated network of soil moisture probes (38 Decagon SFE) and suction probes (9)
Agricultural site

8. Soil moisture
   a. 70 soil moisture probes (Decagon and TDR) installed at depths 0.1, 0.2, 0.3, 0.4, 0.5, 1.0, 2.0, 3.0 and 4.0 m

9. Soil water pressure
   a. 15 probes installed at depths 0.1, 0.2, 0.3, 0.4 and 0.5 m

10. Suction cups for water sampling
    a. 4 cups at depths 1.0, 2.0, 3.0 and 4.0 m

11. Hydrogeophysics array
    a. Cross-borehole georadar array (4 x 6 m access tubes)
    b. Cross-borehole electrical resistivity array (5 x 6 m tubes with 24 electrodes in each tube placed every 25 cm)
    c. Temperature sensors placed every 25 cm
    d. 17 Decagon STF soil moisture sensors installed to a maximum depth of 3 meter
    e. 6 Decagon MPS soil suction sensors installed to a maximum depth of 3 meter
    f. 6 suction cups installed at depths 1, 2, 4, 6.4 and 5.5 m
    g. 35 unpolarizable electrodes for self potential measurements

Remote sensing and campaigns

- **Remote sensing products**
  - MODIS
  - SMOS

- **Campaigns**
  - Helicopter borne geophysical measurements over and near Ringkøbing lagoon
  - Airborne measurements with the L-band radiometer EMIRAD-2 for measurement of brightness temperature
  - UAV flight campaigns for measuring land surface characteristics
  - Point and distributed temperature sensing of groundwater-surface water interactions and sediment mobility
  - Areal measurements of cosmic rays intensity on different land use types
  - Measurements of hydraulic properties
  - Hydrogeophysical measurements at the agricultural field observatory
  - Measurements of migration of tracers at the agricultural field observatory
Datamodel

Station
- id, utmE, utmN, meta1, meta2
Metadata can be for instance link(s) to .pdf file(s). Give the opportunity to update/add metadata later.

Attribute
- id, name, description, unit, group
“group” is a “class” filter for data/stations. E.g. “stream data station”, “DMI weather station”, “DMI_GRID_10km2” etc. It will be used in the client to create different “layers” of stations, enabling view and selection data from only “class” of station.

Measurement
- station_id, year, month, day, hour, minute, (attribute_id, historical, quality, type, rights, z_terrain, z_sea, value) (repeat)
  - “station_id” & “attribute_id” links a measurement to a location in space (station) and to a data type (attribute)
  - “historical” defines whether a measurement is historical or “project data” (0 = “project data”, 1 = “historical”)
  - “quality” defines quality flags (0 = “not checked”, 1 = “checked and found uncertain, 2 = “checked and found OK”, 3 = Checked and gap-filled)
  - “type” defines type of measurement. 0 = instantaneous value, 1 = average since previous record, 2 = sum since previous record, 3 = max value since previous record, 4 = min value since previous record.
  - “rights” controls data access. Sets a user group number which for which access can be controlled by an admin interface. 1 = DMI-data before 2007, 2 = DMI-data from 2007 and onwards, 3 = HOBE-project data (restricted), 4 = DMU-data and the like, 5 = free and unrestricted data
  - “z_terrain” is the height of the measurement relative to the local terrain surface. E.g. +8m for in instrument atop a 8m mast, -0.25 for a sensor buried 25cm below the surface. Can be left blank if “z_sea” is filled.
  - “z_sea” is the height of the measurement relative to sea level. Is used instead of local surface reference for some geological measurements. Can be left blank if “z_terrain” is filled.

Dataflow

Collection
- E.g. at the agricultural site. Stored locally
  - Oversight by technicians, Ph.D. students, and the HOBE-administration

Transfer
- E.g. from fieldsite server to university server in Copenhagen with backup
  - Oversight by technicians, Ph.D. students and HOBE-administration

Quality assurance
- E.g. by Ph.D. students, DMI, and the HOBE-administration

Conversion of format
- From raw format to HOBE database import format
  - By the HOBE administration, Ph.D. students, and DMI
Dataflow

**Import**
- Sending data to Terrestris
  - By the HOBE-administration

**Import**
- Check for format errors and import
  - By Terrestris
  - Storage on dedicated server at Hetzner GmbH

**Import check**
- By the HOBE-administration

**Retrieval**
- From the HOBE database web-interface
  - By users, i.e. Ph.D. students, students, scientists etc.
  - Web-interface management by the HOBE-administration

Data policy
Web-interface

Web-interface
Output from HOBE’s database

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