NATURVIDENSKAB
KØBENHAVNS UNIVERSITET

HOBE

HOBE – the Danish Hydrological Observatory

Karsten H. Jensen
University of Copenhagen

Key objectives of HOBE – the Danish hydrological observatory

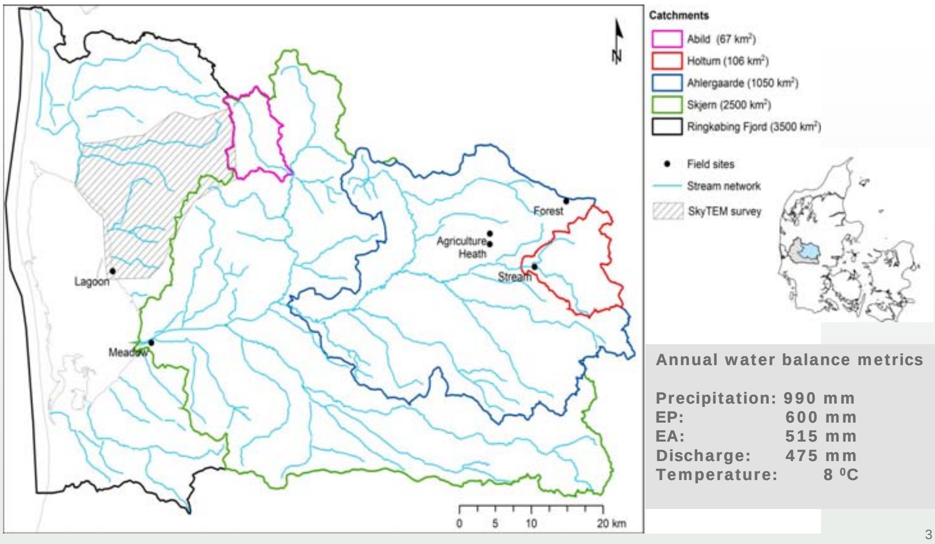
HOBE

- To establish an observational and experimental inter-disciplinary 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

2

Study area - Skjern catchment and associated subcatchments – nested approach

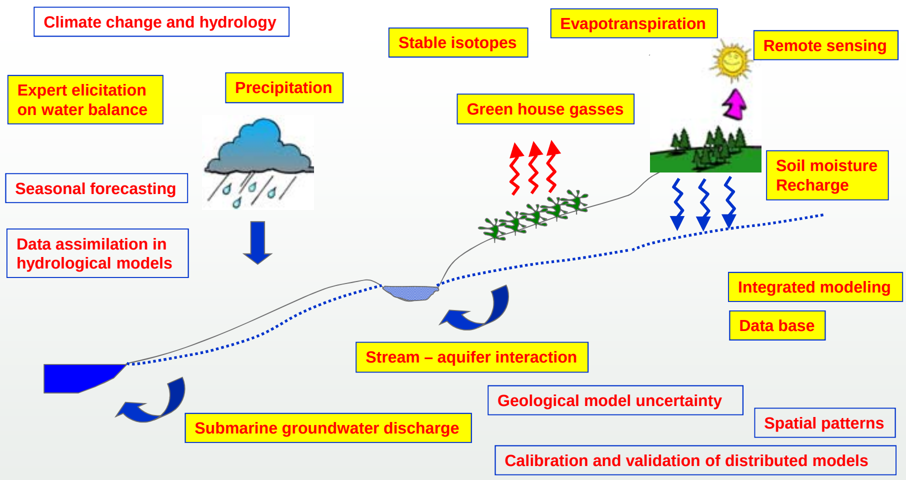


Annual water balance metrics

Precipitation: 990 mm
EP: 600 mm
EA: 515 mm
Discharge: 475 mm
Temperature: 8 °C

3

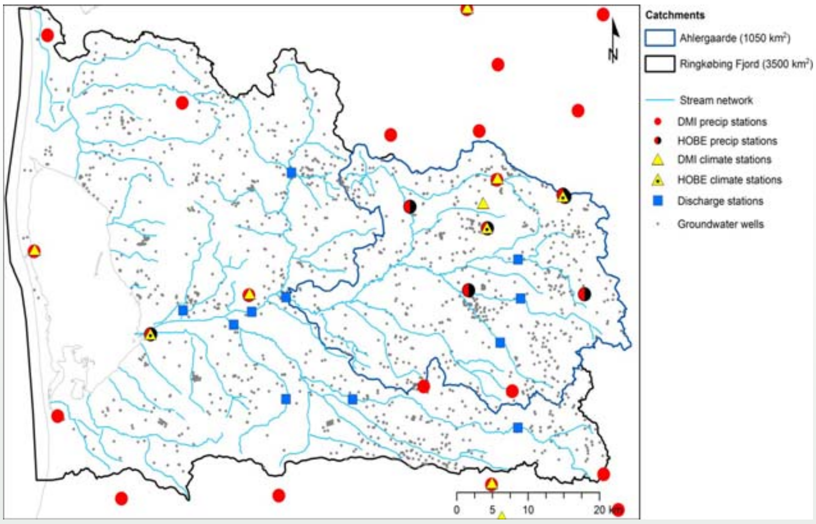
Project components



4

HOBE

Basic monitoring



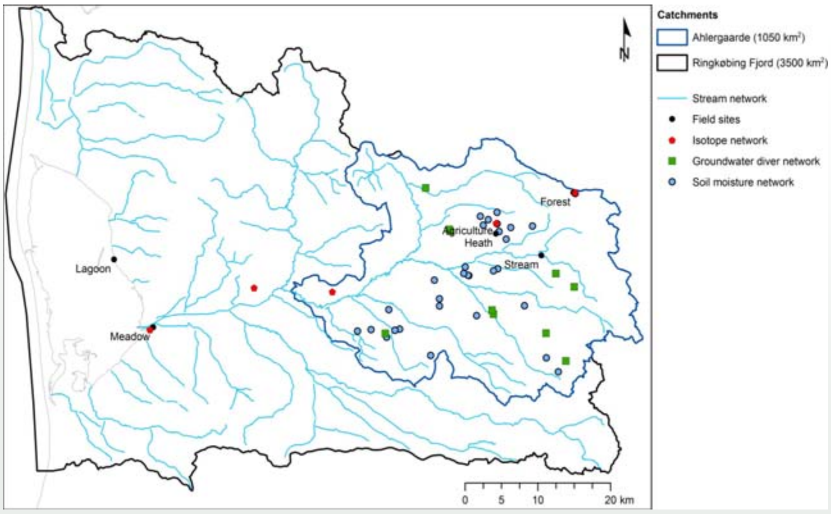
HOBE

Basic monitoring

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

HOBE

Special monitoring



7

HOBE

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 distrometers 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 (12 m covariance flux tower)
   a. Latent heat
   b. Sensible heat
   c. CO_2 gas
   d. N_2O gas
5. Recharge
   a. Outflow from four underground lysimeters (3.2 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. Moderated cosmic ray sensor and an associated network of soil moisture probes (30 Decagon 5TE) and suction probes (5)

8

Agricultural site

8. Soil moisture
   a. 70 soil moisture probes (TDR and Decagon 5TE) 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 5TE 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, 2.4, 3.4, 4.5 and 5.5 m
    g. 15 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

HOBE

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

HOBE

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

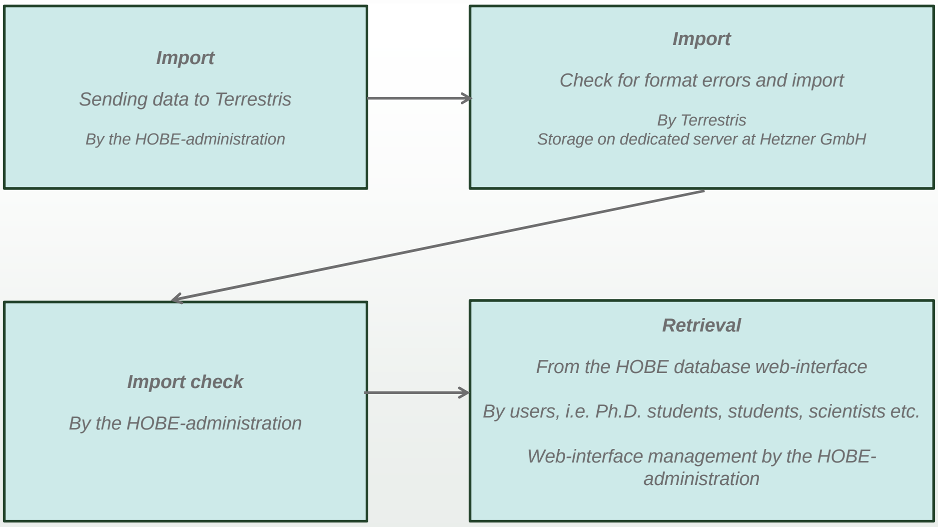
Conversion of format

From raw format to HOBE database import format

By the HOBE administration, Ph.D. students, and DMI

12

Dataflow



13

Data policy

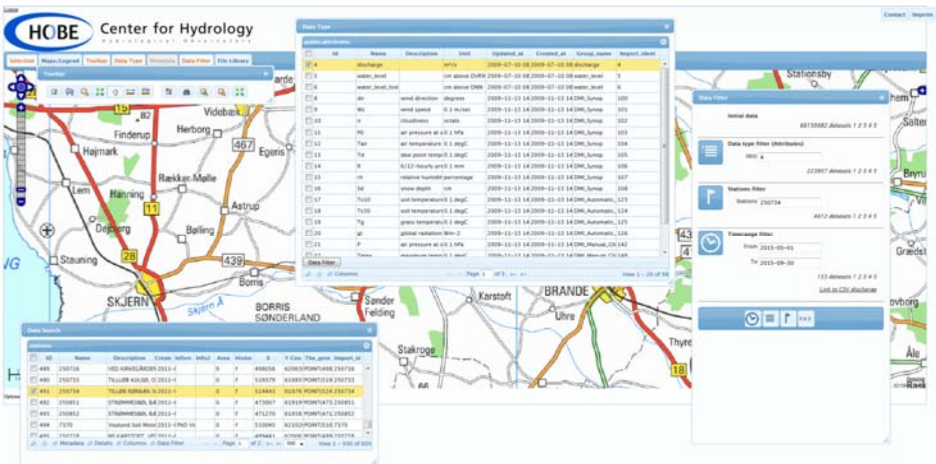
USER STATEMENT

concerning delivery of Meteorological and Climatological Information from the Danish Meteorological Institute for the use in Research and Educational projects, without payment of the Information value.

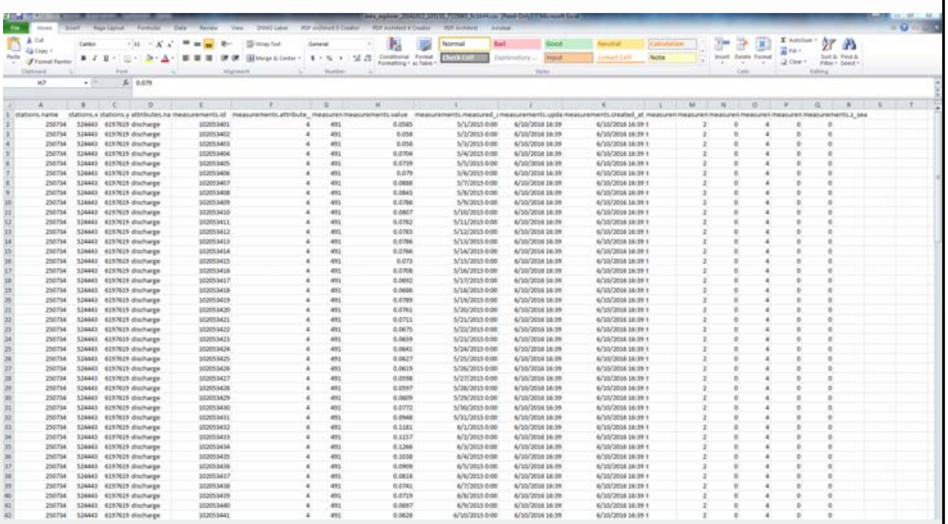
14

Web-interface

Web-interface



Output from HOBE's database



	stations.name	stations.x	stations.y	attributes.na	measurements.id	measurements.attribute_	measuren	measurements.value	measurements.measured_	measurements.upda	measurements.created_at	measuren	measuren	measuren	measuren	measuren	measurements.z_sea
2	250734	524443	6197619	discharge	102053401	4	491	0.0585	5/1/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
3	250734	524443	6197619	discharge	102053402	4	491	0.058	5/2/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
4	250734	524443	6197619	discharge	102053403	4	491	0.058	5/3/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
5	250734	524443	6197619	discharge	102053404	4	491	0.0704	5/4/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
6	250734	524443	6197619	discharge	102053405	4	491	0.0739	5/5/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
7	250734	524443	6197619	discharge	102053406	4	491	0.079	5/6/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
8	250734	524443	6197619	discharge	102053407	4	491	0.0888	5/7/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
9	250734	524443	6197619	discharge	102053408	4	491	0.0843	5/8/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
10	250734	524443	6197619	discharge	102053409	4	491	0.0786	5/9/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
11	250734	524443	6197619	discharge	102053410	4	491	0.0807	5/10/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
12	250734	524443	6197619	discharge	102053411	4	491	0.0782	5/11/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
13	250734	524443	6197619	discharge	102053412	4	491	0.0783	5/12/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
14	250734	524443	6197619	discharge	102053413	4	491	0.0786	5/13/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
15	250734	524443	6197619	discharge	102053414	4	491	0.0766	5/14/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
16	250734	524443	6197619	discharge	102053415	4	491	0.073	5/15/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
17	250734	524443	6197619	discharge	102053416	4	491	0.0708	5/16/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
18	250734	524443	6197619	discharge	102053417	4	491	0.0692	5/17/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
19	250734	524443	6197619	discharge	102053418	4	491	0.0686	5/18/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
20	250734	524443	6197619	discharge	102053419	4	491	0.0789	5/19/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
21	250734	524443	6197619	discharge	102053420	4	491	0.0761	5/20/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
22	250734	524443	6197619	discharge	102053421	4	491	0.0711	5/21/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
23	250734	524443	6197619	discharge	102053422	4	491	0.0675	5/22/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
24	250734	524443	6197619	discharge	102053423	4	491	0.0659	5/23/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
25	250734	524443	6197619	discharge	102053424	4	491	0.0641	5/24/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
26	250734	524443	6197619	discharge	102053425	4	491	0.0627	5/25/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
27	250734	524443	6197619	discharge	102053426	4	491	0.0619	5/26/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
28	250734	524443	6197619	discharge	102053427	4	491	0.0598	5/27/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
29	250734	524443	6197619	discharge	102053428	4	491	0.0597	5/28/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
30	250734	524443	6197619	discharge	102053429	4	491	0.0609	5/29/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
31	250734	524443	6197619	discharge	102053430	4	491	0.0772	5/30/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
32	250734	524443	6197619	discharge	102053431	4	491	0.0948	5/31/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
33	250734	524443	6197619	discharge	102053432	4	491	0.1181	6/1/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
34	250734	524443	6197619	discharge	102053433	4	491	0.1157	6/2/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
35	250734	524443	6197619	discharge	102053434	4	491	0.1266	6/3/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
36	250734	524443	6197619	discharge	102053435	4	491	0.1038	6/4/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
37	250734	524443	6197619	discharge	102053436	4	491	0.0909	6/5/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
38	250734	524443	6197619	discharge	102053437	4	491	0.0818	6/6/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
39	250734	524443	6197619	discharge	102053438	4	491	0.0741	6/7/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
40	250734	524443	6197619	discharge	102053439	4	491	0.0719	6/8/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
41	250734	524443	6197619	discharge	102053440	4	491	0.0697	6/9/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0
42	250734	524443	6197619	discharge	102053441	4	491	0.0628	6/10/2013 0:00	6/10/2016 16:39	6/10/2016 16:39	t	2	0	4	0	0

17