

A cost-efficient riverscape methodology for GIS characterization and planning of river restoration in Scandinavia

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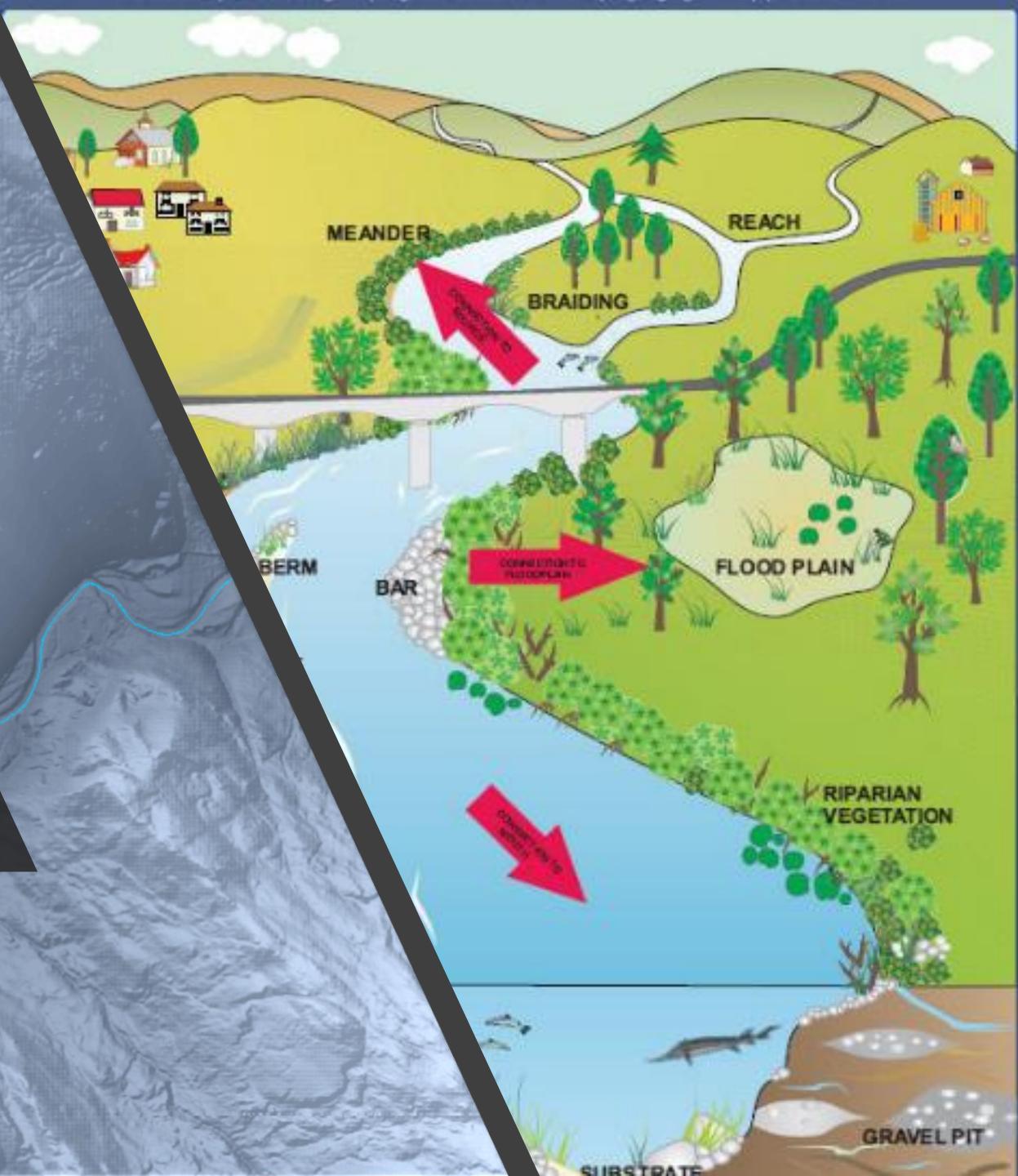


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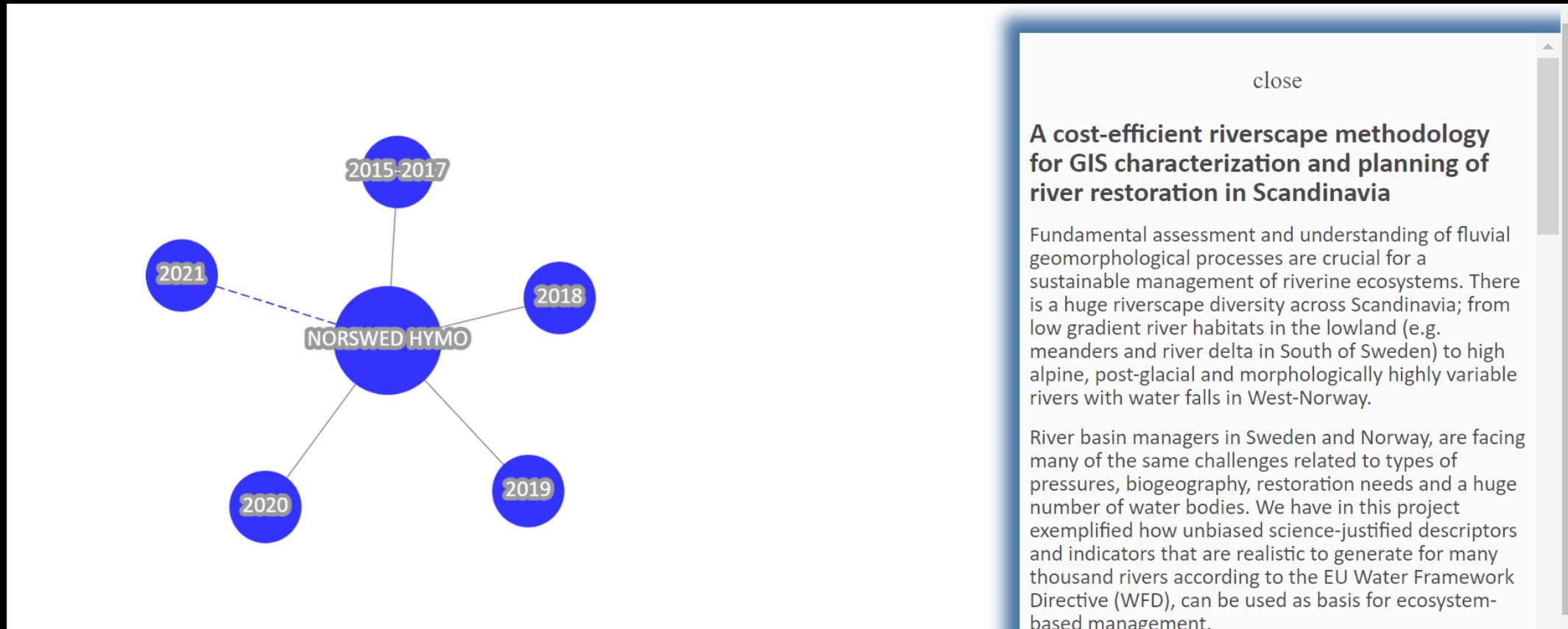
Why?

- Fluvial geomorphological processes are crucial for a sustainable management of riverine ecosystems
- Physical habitat degradation among the main pressures on riverine and riparian biodiversity
- Implementation of the WFD require common understanding of common pressures
- The need to intensify restoration efforts also in Scandinavian rivers



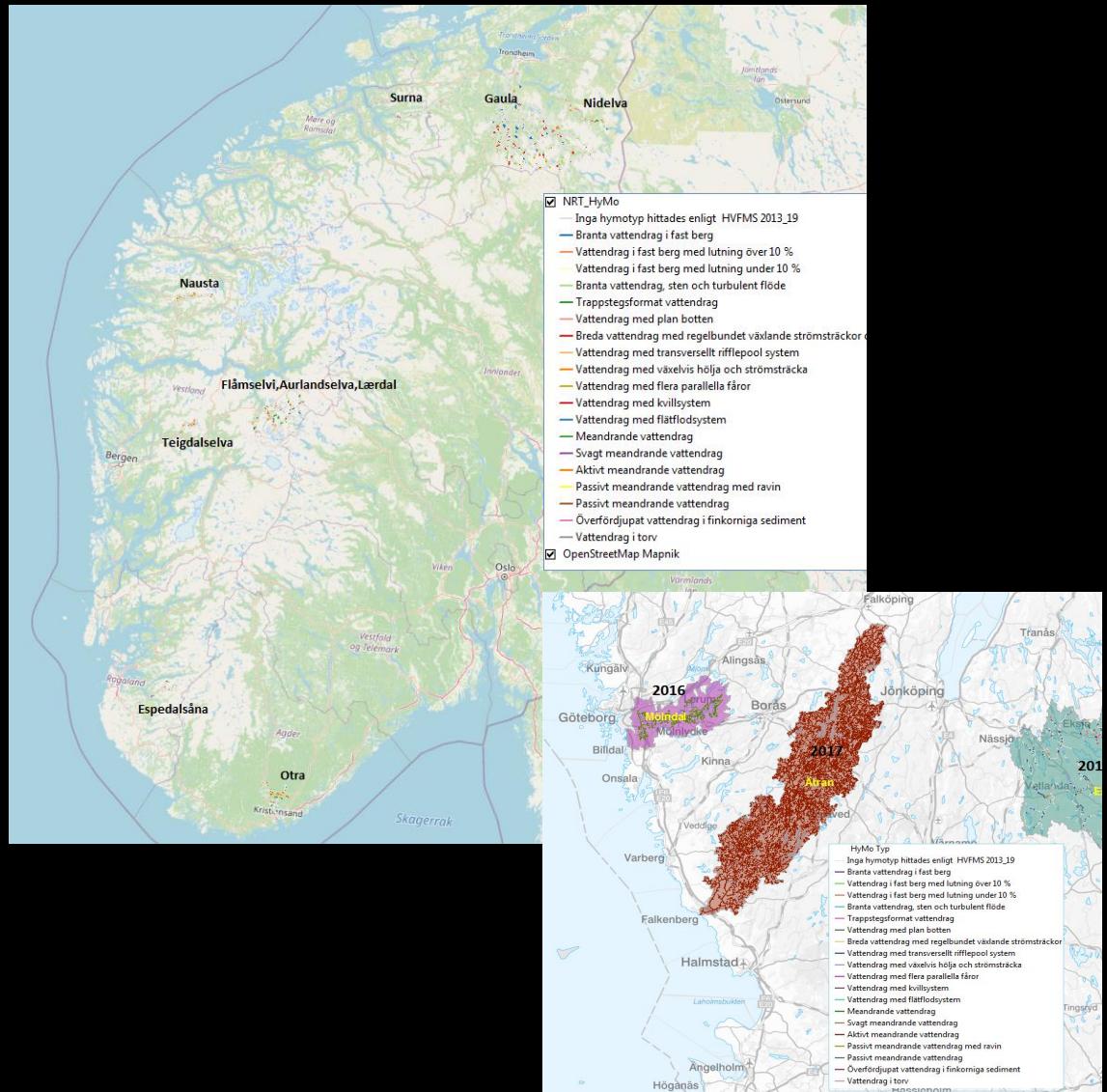
The NORSWED HYMO water management collaboration on riverscape year by year

<https://mapcat.net/hymograph/>



Material and Methods

- Semiautomatic desktop characterization of hymo parameters
 - Generated riverscape features from topographic (gray) LIDAR into database
 - Characterisation not dependent of field work or present flow conditions
 - Pristine to severely regulated/fragmented rivers in the two countries
 - 10 + 3 diverse catchment in Norway (NO) and Sweden (SE)
 - 2041 + 1930 km of river lengths
 - Reach scale: 7100 + 11 000 segments (river reaches)



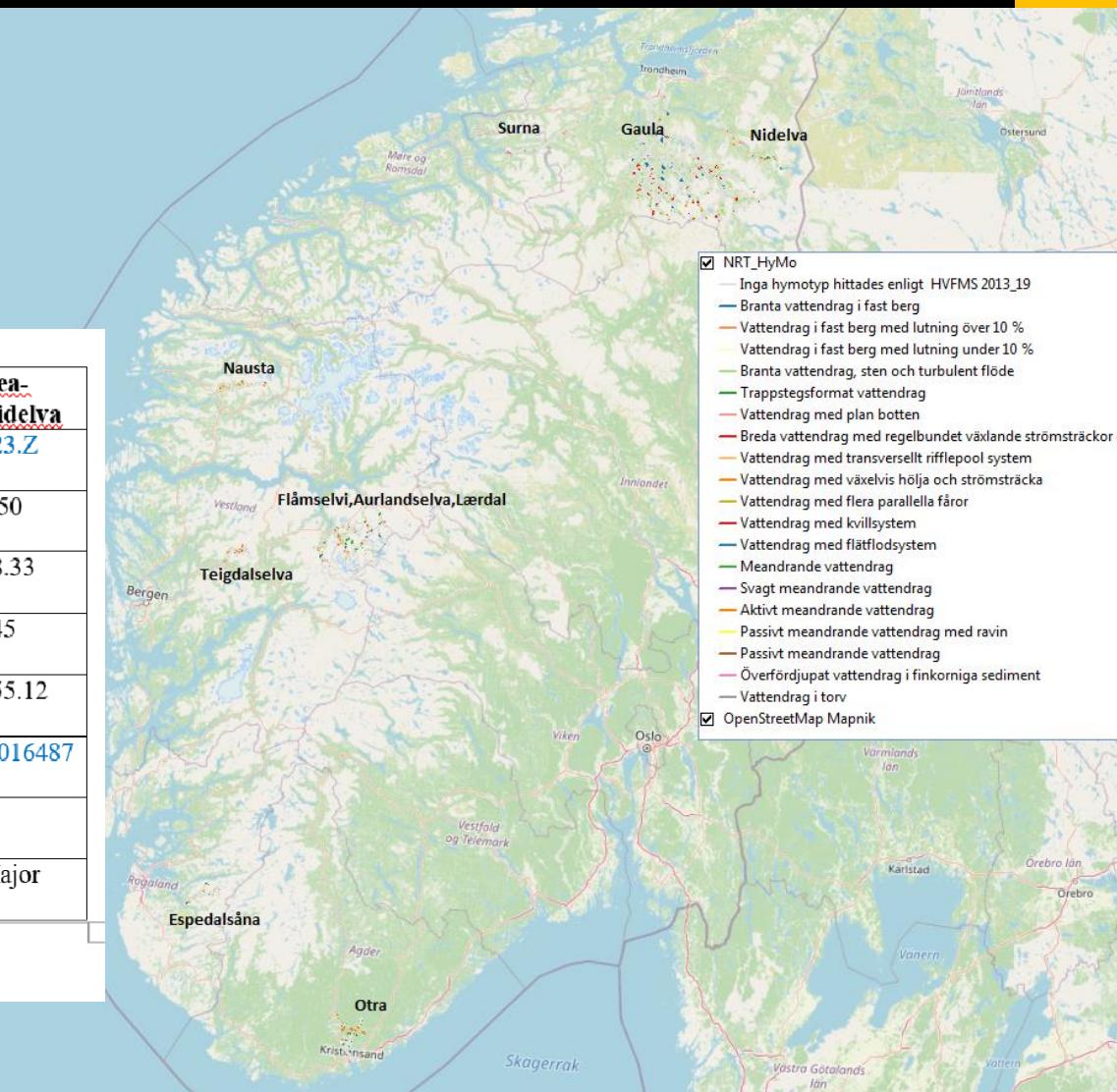
Riverscape assessment of catchment in Southern Norway

⊕ Tabell. Key characteristics from the analysed water sheds

Description	Otra	Espedalsåna	Teigdalselva	Flåmselvi	Aurlandselva	Lærdal	Surna	Gaula	Nea-Nidelta
Regine nr	021.Z	030.Z	062.Z	072.Z	072.Z	073.Z	112. Z	122.Z	123.Z
Catchment area (Km ²)	310.39	138.69	146.39	281.91	803.84	366.18	2.90	3660.63	7.50
River length (km)	90.26	37.03	44.30	65.36	194.99	62.68	62.75	1394.82	88.33
No of segments	406	154	253	330	939	322	404	3774	345
Altitude (masl)	213.08	636.51	864.12	1183.21	1345.60	1203.91	64.88	672.68	155.12
Mean gradient	0.047089	0.073173	0.092512	0.085796	0.099052	0.084455	0.010135	0.047509	0.016487
Management regime		PPC		PPC, NSL		NSL	NSL	PPC, NSL	
Hydropower impact	Major		Major		Major	Major	Major	Minor	Major

Units and abbreviations used in the table:

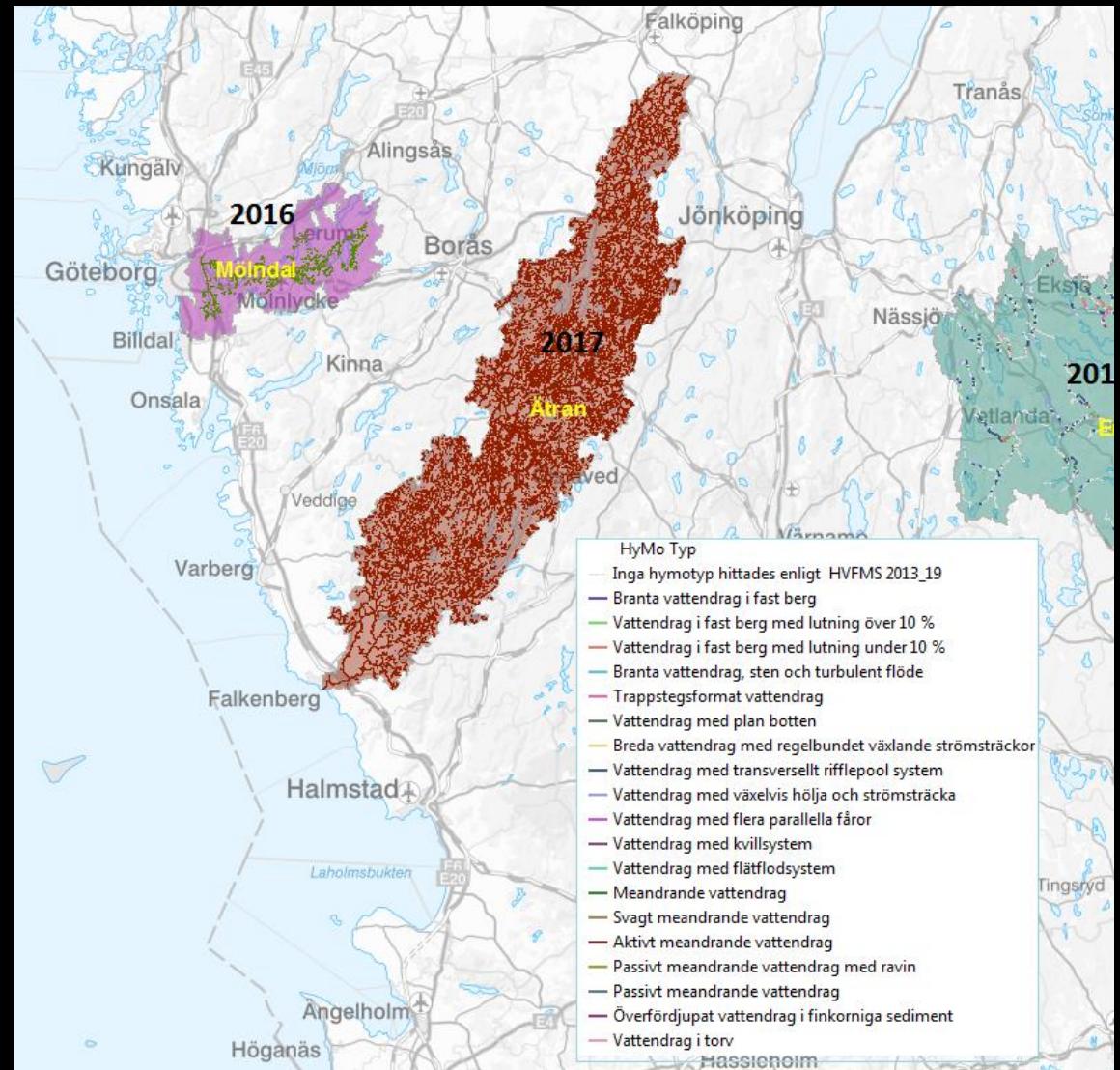
Management regime: NSL – National Salmon River; PPC – Permanent Protected Catchment



Riverscape assessment of catchment in Southern Sweden

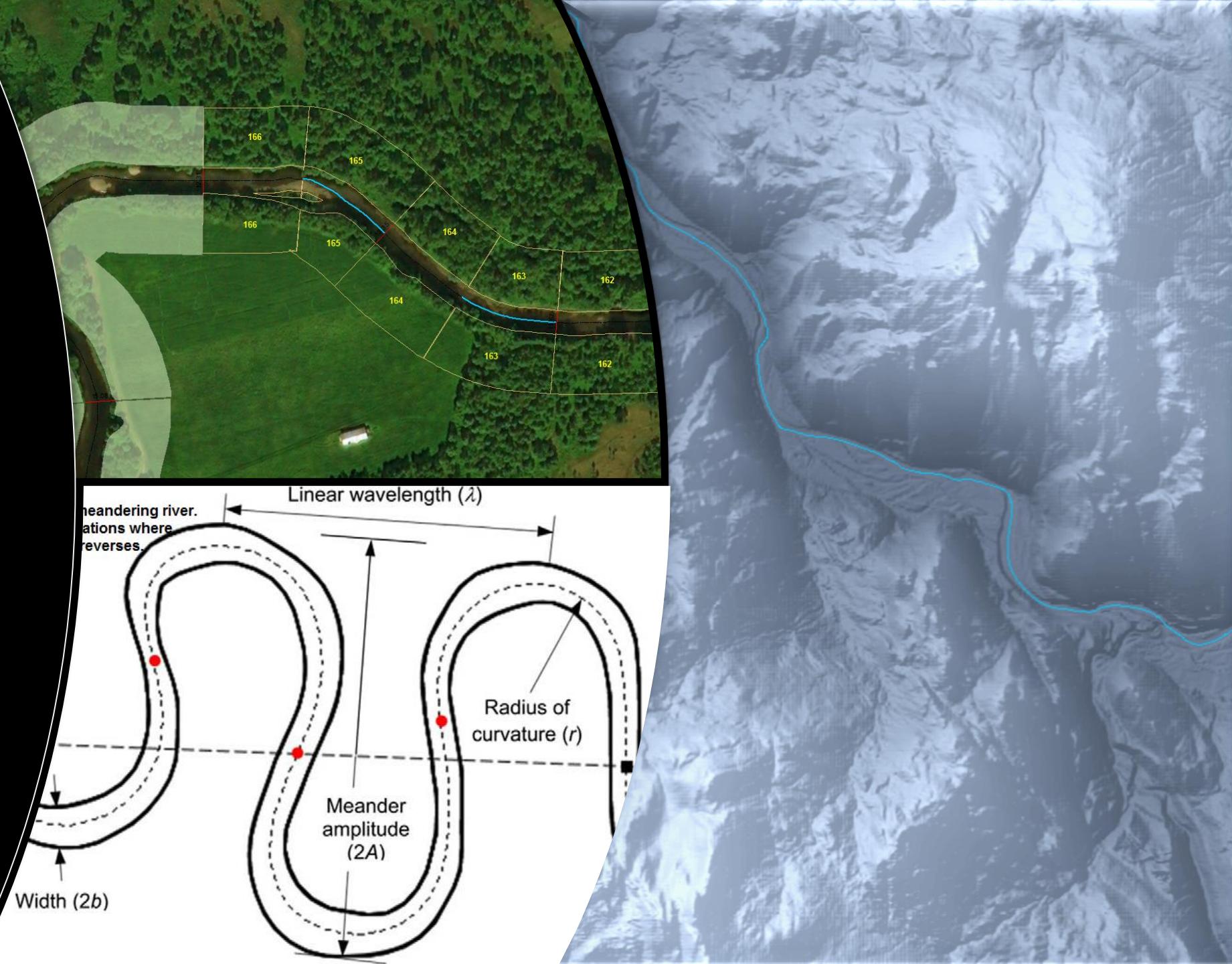
Key characteristics from the analyzed watersheds in Southern Sweden.

Description	Emån	Ätran	Mölndalså
Watershed id-number	74000	103000	108000 (part)
Catchment area (Km ²)	4469	3339	337
River length (km)	1103	574	253
Number of segments	2260	5826	2831
Altitude (masl)	178	186	109
Altitude (std)	65	65	47
Mean gradient	0.010515	0.006617	0.03463

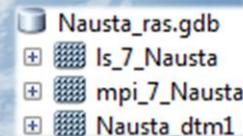
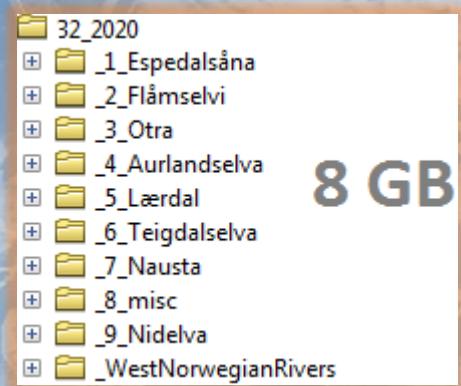


Spatial desktop GIS-analysis

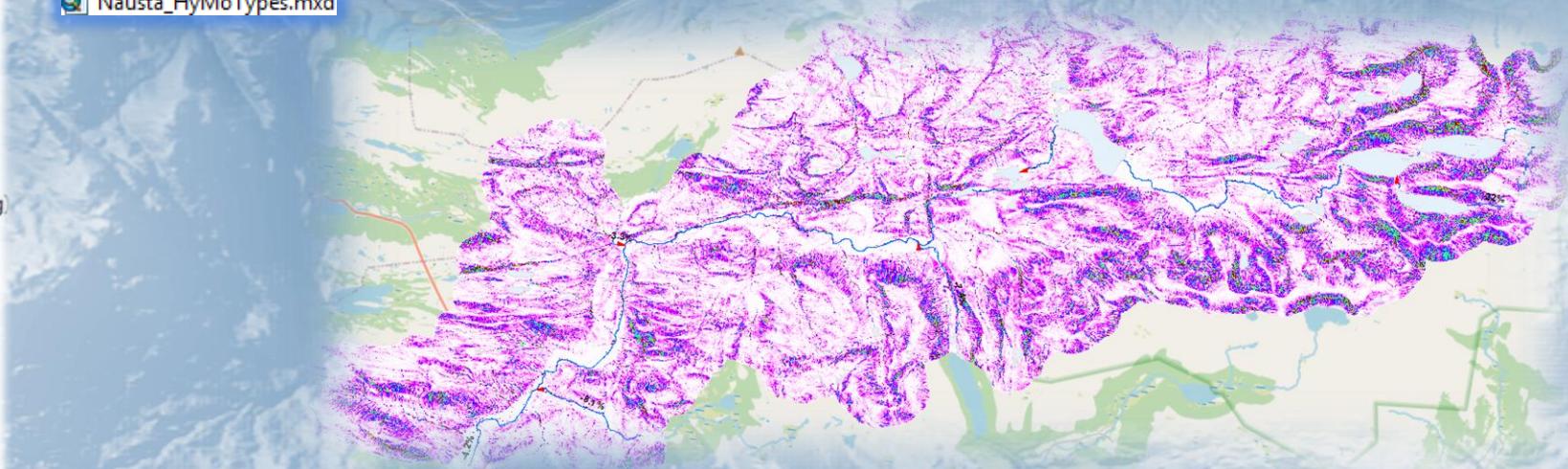
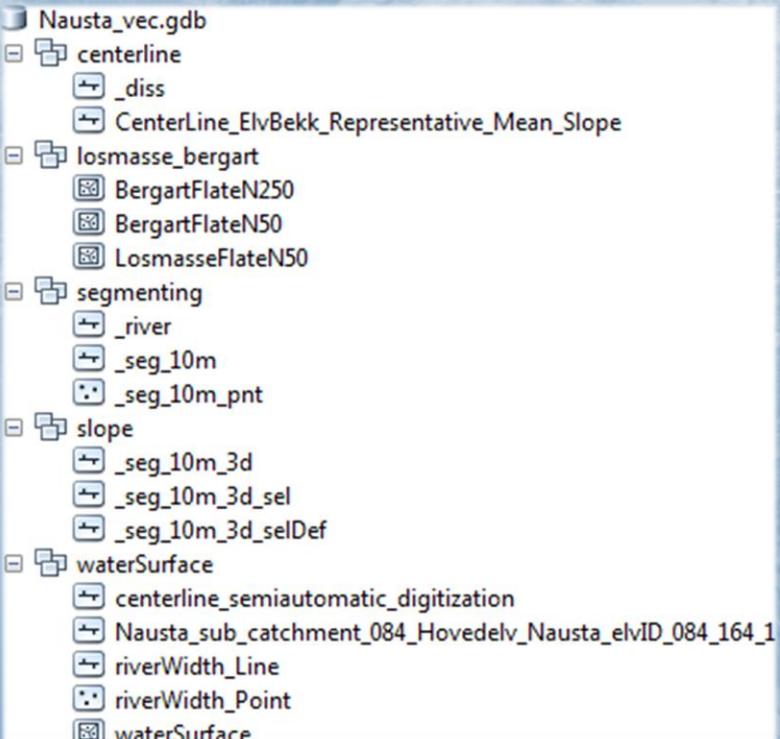
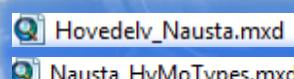
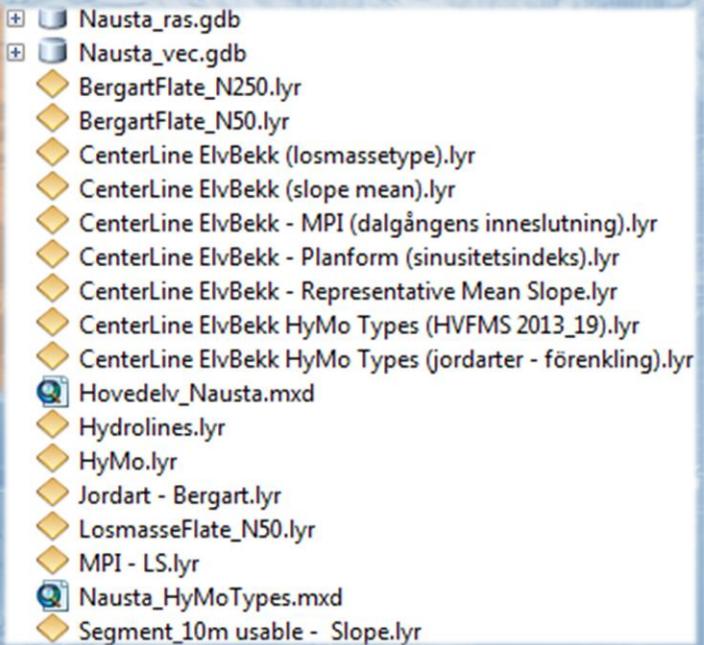
- Segmentation based on river centerline and river water surface
- Segmenting using “inflection points” method
- Calculation of the key characteristics for all reaches i) slope, ii) sinuosity, iii) valley confinement and iv) dominant substrate



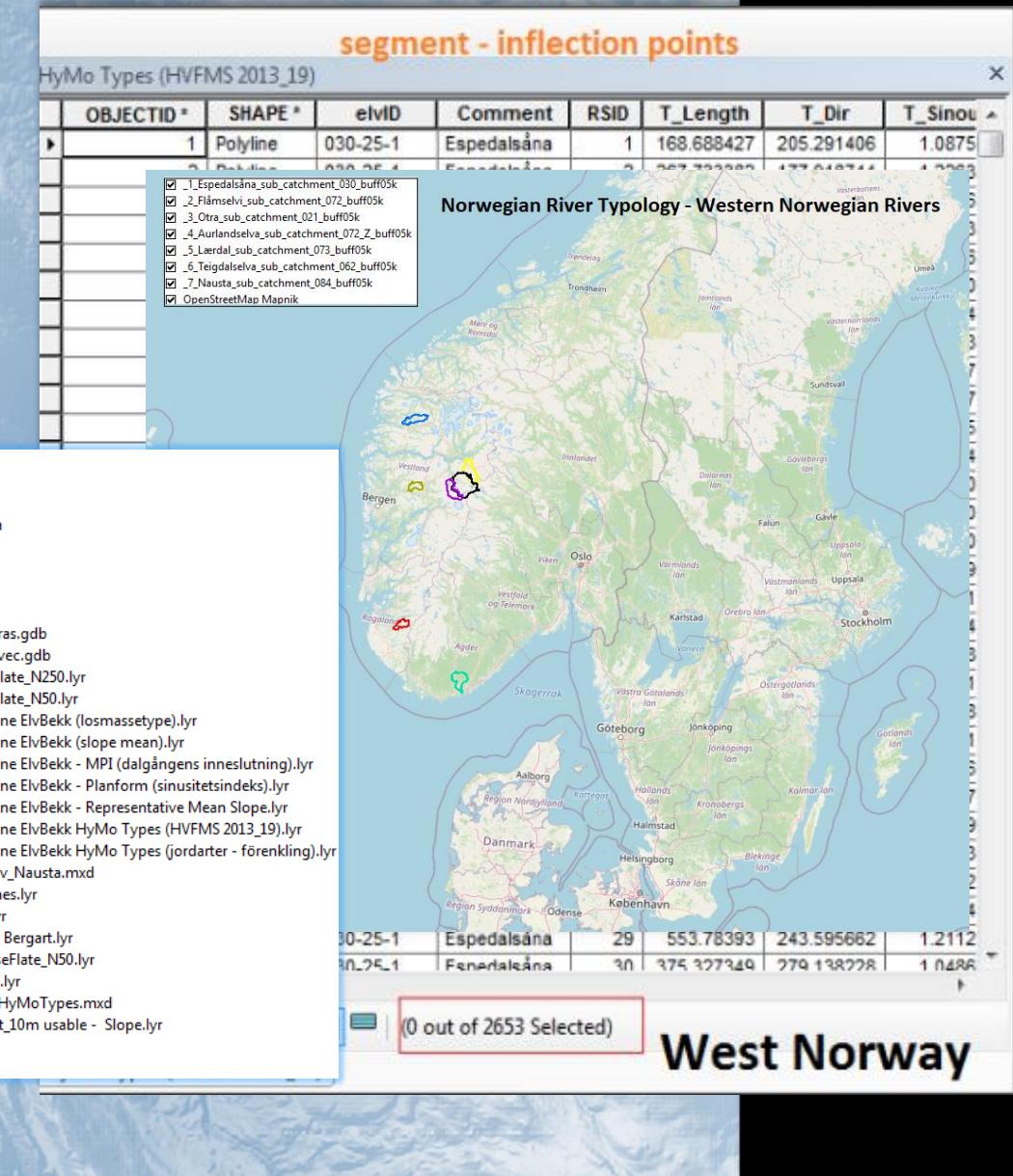
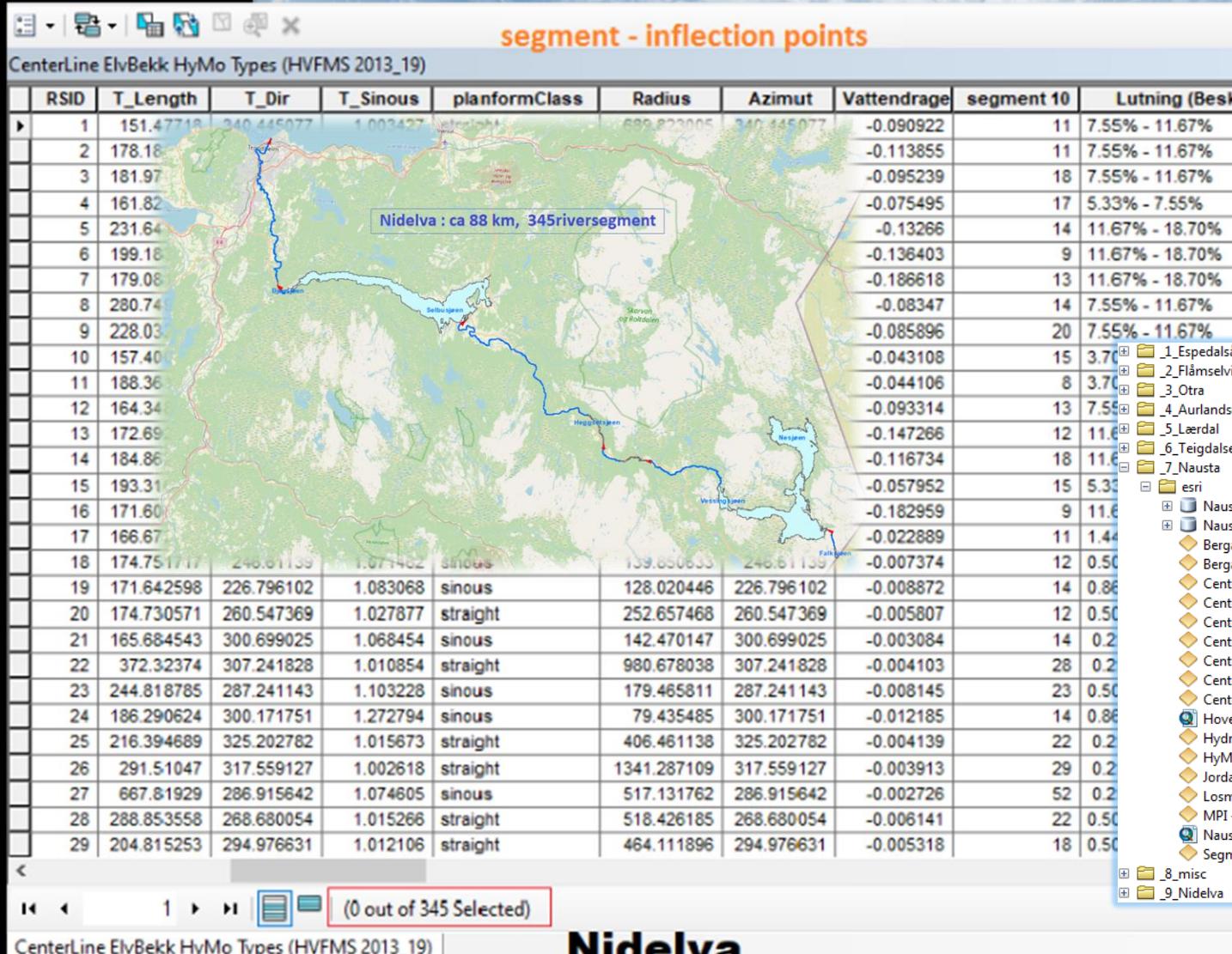
Identical database structure for all rivers



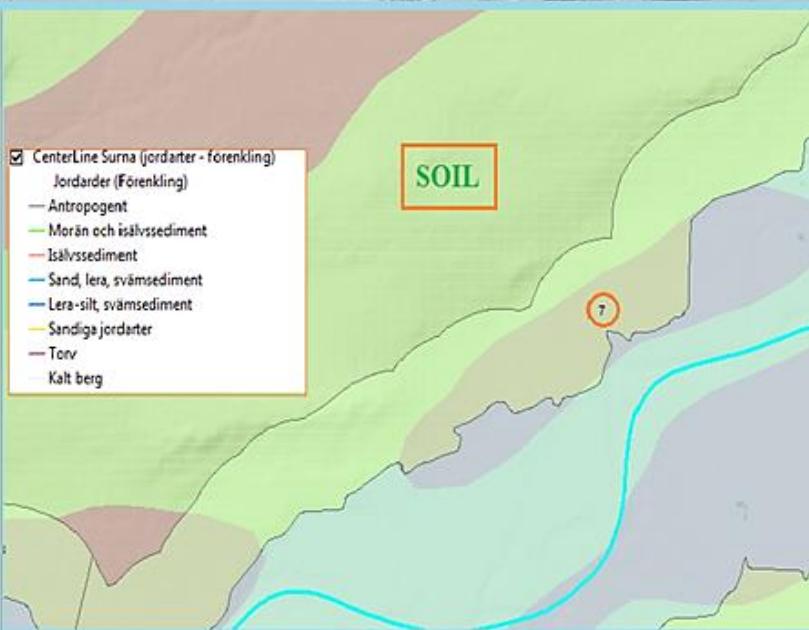
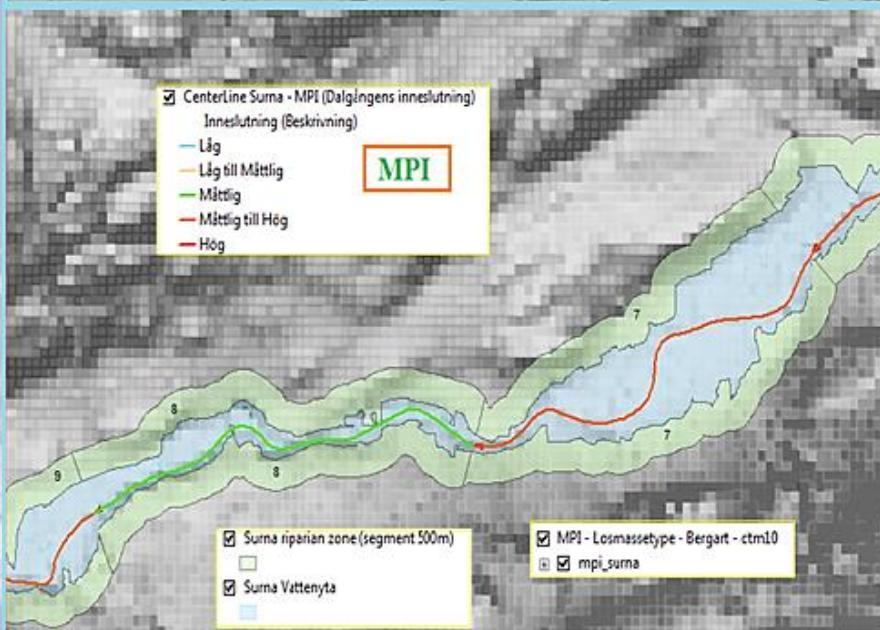
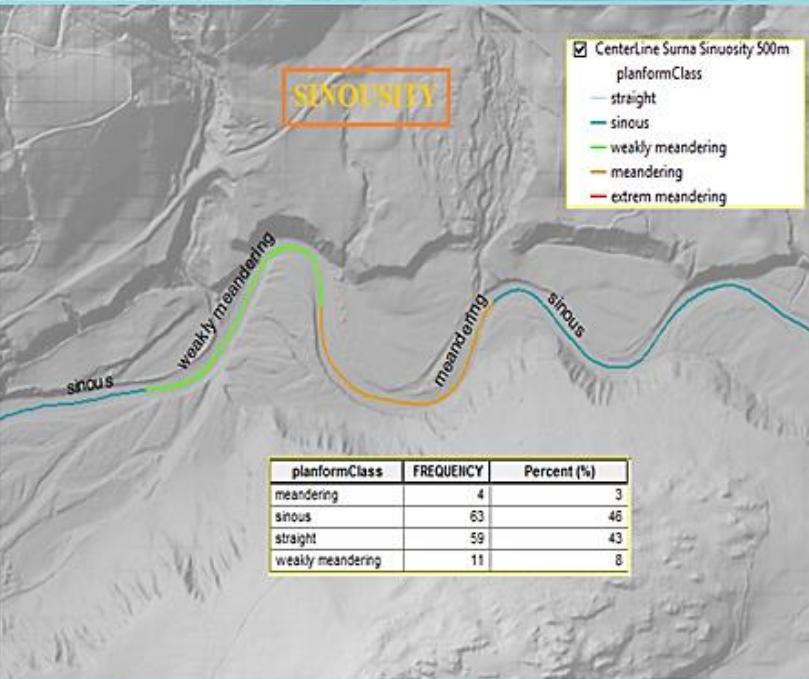
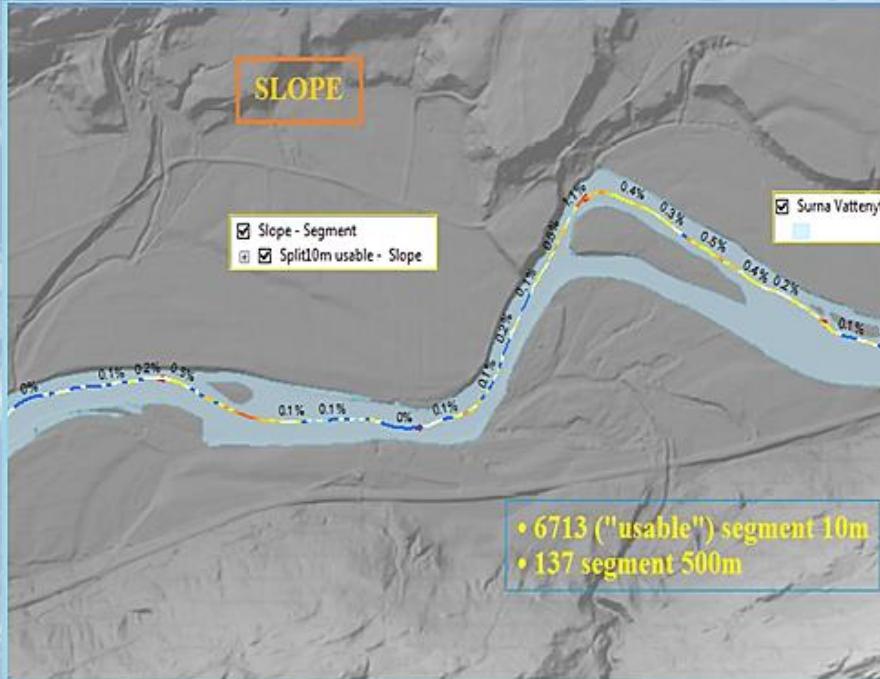
- Hydrolines
 - CenterLine ElvBekk - Representative Mean Slope
 - Segment_10m usable - Slope
 - Nausta_sub_catchment_084_Innsjo
- HyMo
 - CenterLine ElvBekk (slope mean)
 - CenterLine ElvBekk - Planform (sinusitetsindeks)
 - CenterLine ElvBekk - MPI (dalgångens inneslutning)
 - CenterLine ElvBekk (losmassetyp)
 - CenterLine ElvBekk HyMo Types (jordarter - förenkling)
 - CenterLine ElvBekk HyMo Types (HVFMS 2013_19)
- Jordart - Bergart
 - LosmasseFlate_N50
 - BergartFlate_N250
 - BergartFlate_N50
- MPI - LS
 - mpi_7_Nausta
 - Is_7_Nausta
 - Nausta_dtm1



Example of the semi-automatic characterisation



Key riverscape features



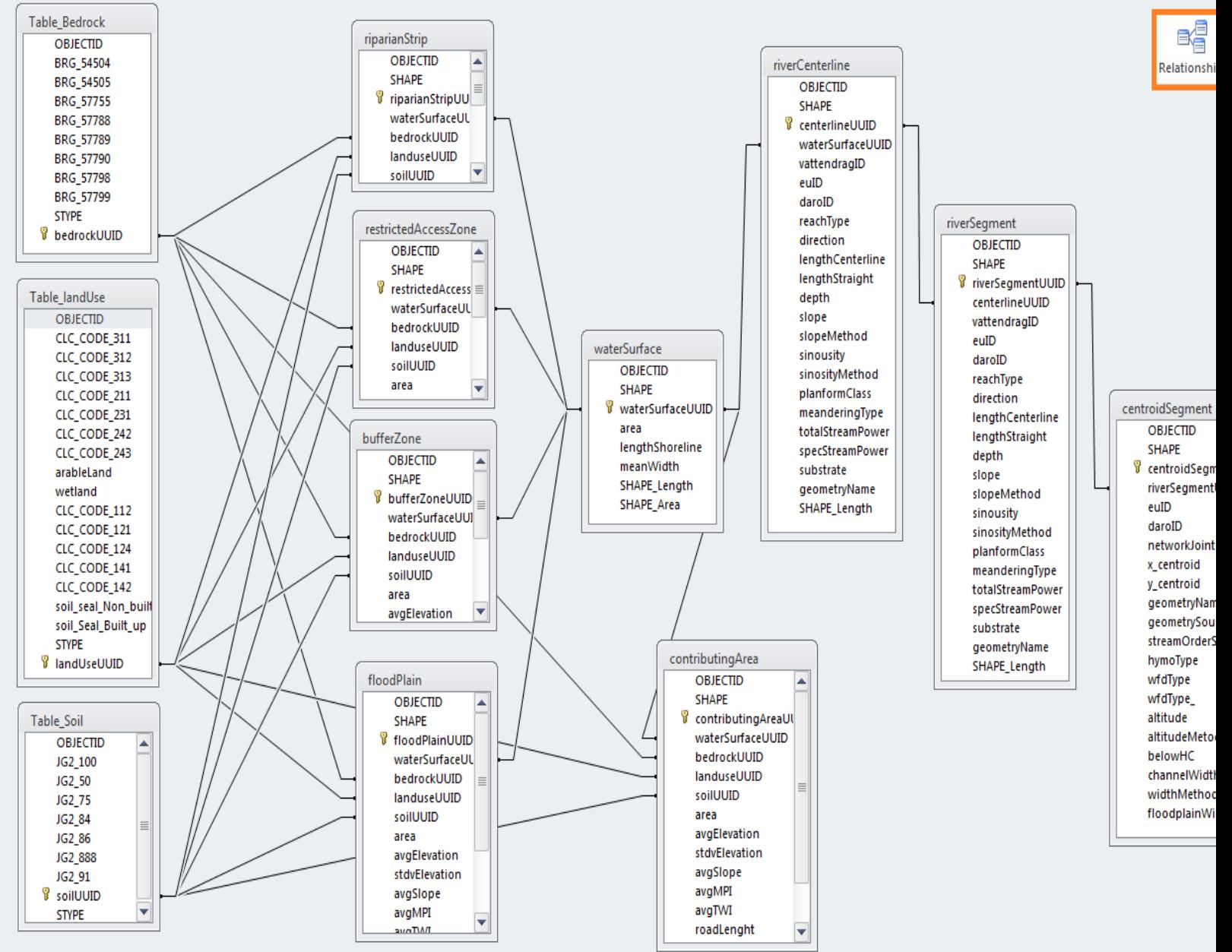
NRT - Norwegian River Typology

- Gaula (catchment)
- Surna (Huvudelv)
- Nidelva (Huvudelv)
- Espedalsåna (sub-catchment)
- Flåmselvi (sub-catchment)
- Otra (sub-catchment)
- Aurlandselva (sub-catchment)
- Lærdal (sub-catchment)
- Teigdalselva (sub-catchment)
- Nausta (sub-catchment)

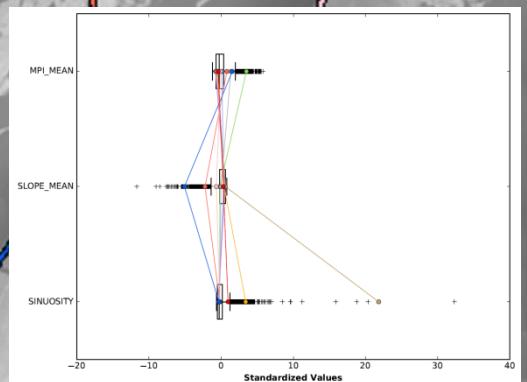
7176 riversegment | 2085696.302m

Møre og
Romsdal

An overview of the spatial GIS database structure established for the hymo characterization and riverscape assessment



- attribute similarity,
- k-means clustering
- no spatial constraints



Aurlandselva - Vassbygdi

Cluster	Otra	Espedalsåna	Teigdalselva	Flåmselvi	Aurlandselva	Lerdal	Surna	Gaula	Nea-Nidellya
R1	0	4	13	12	32	12	0	25	0
R2	0	0	0	0	0	0	0	4	0
R3	18	5	26	14	55	5	18	513	20
R4	16	15	23	35	143	34	0	133	3
R5	125	21	56	36	88	36	85	801	73
R6	0	0	0	0	1	0	3	211	0
R7	11	0	2	10	8	1	8	162	5
R8	59	26	51	70	226	55	0	369	9
R9	45	11	22	43	71	11	37	670	20
R10	132	72	60	110	315	138	253	886	215

Multivariable cluster analysis of river segments

- Multivariate Clustering – Similar river-segment-types based on feature attribute values.
- Objective alternative to find “digital twin and cousin rivers” or use predefined river typology

Analysis Factors

- a. slope_mean
- b. sinuosity
- c. morphology (mpi)

Clustering Method K-MEANS

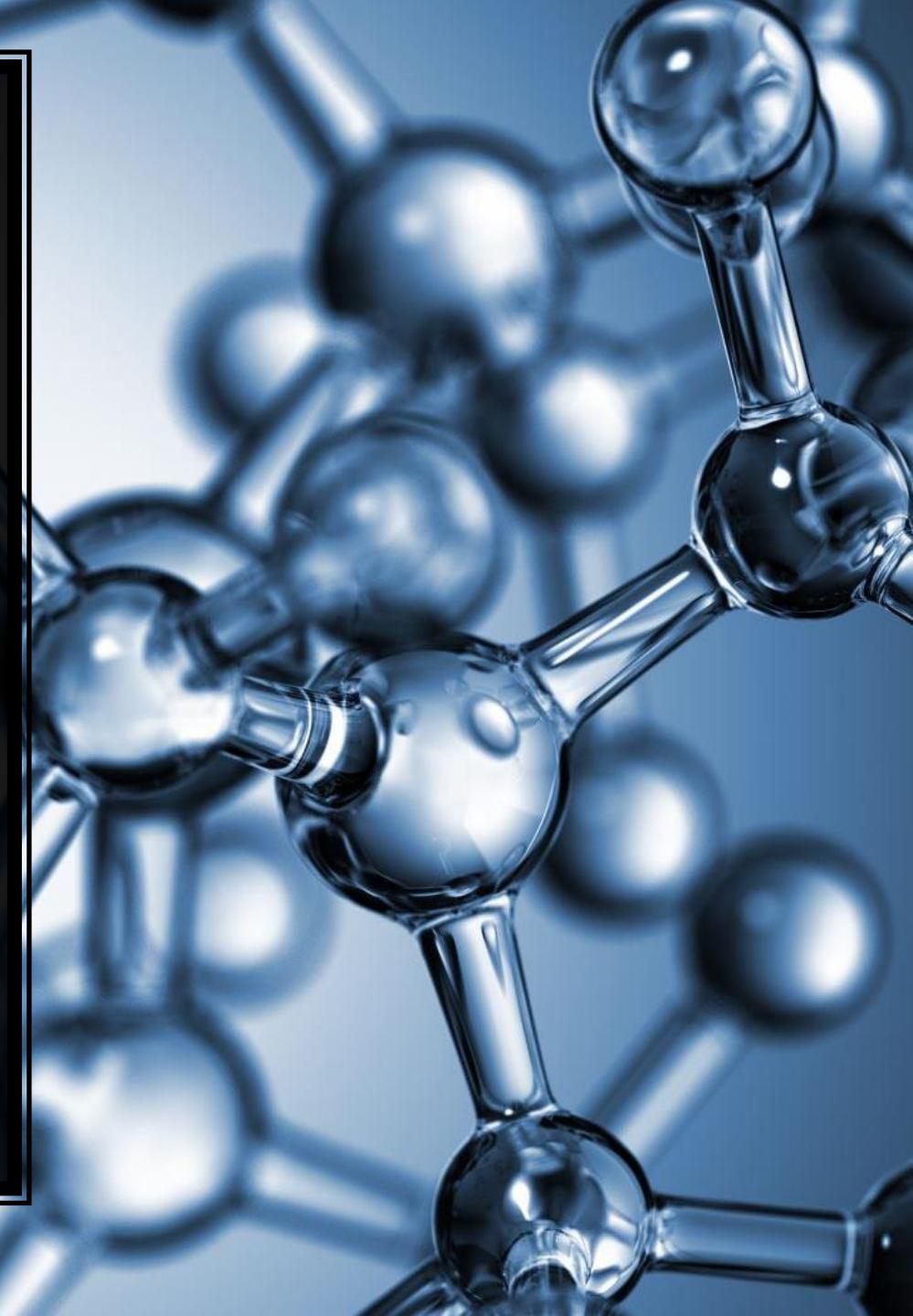
Number of Clusters

10

Key findings

By combining red lidar data with other publicly available georeferenced data like geomorphological maps, pressure data (e.g. road culverts), segmentations and semi-automatic GIS-techniques, huge areas (like catchments of several thousand km² and hundreds of river water bodies) can be characterized in an objective transparent way.

Our GIS-techniques and the river continuum concept is a cost-efficient methodology for assessing river habitats and riverscapes for both riparian and riverine biota in riverscapes of Scandinavia, useful for ecosystem based management (see application on next slide)



Ecosystem based management applications

- a) Defining reference conditions
 - to classify ecological status/potential deficits
- b) Large scale assessment and analysis of habitat degradation of riverine and riparian biodiversity
 - consistent river typologies → "digital twin rivers"
 - identifying significance of physical alterations (hydro pressures - e.g. longitudinal barriers for fish) vs climate change effects
- c) Pinpoint and plan the most relevant and sustainable restoration strategies and measures, that also acknowledge climate adaptation (e.g. natural flow retention measures)
- d) Biodiversity management:
 - habitat fragmentation,
 - Assess rare vs common habitat types (as basis for nature conservation and management of red listed nature types and/or endangered riverine species)

→ Comparable implementation of the Water Framework Directive and common understanding of sustainable water use

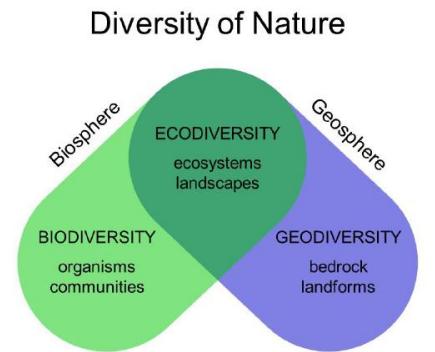
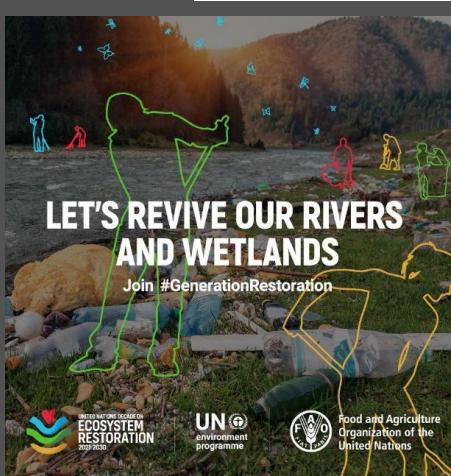


FIGURE 1 The three main aspects of natural diversity: the diversity of biotic characteristics (biodiversity); the diversity of abiotic characteristics (geodiversity); and the diversity of biotic, abiotic and combined characteristics (ecodiversity). Examples of diversity levels are given for each main aspect

Key messages

Riverscape features and river continuum are important for both rivine and riparian biodiversity

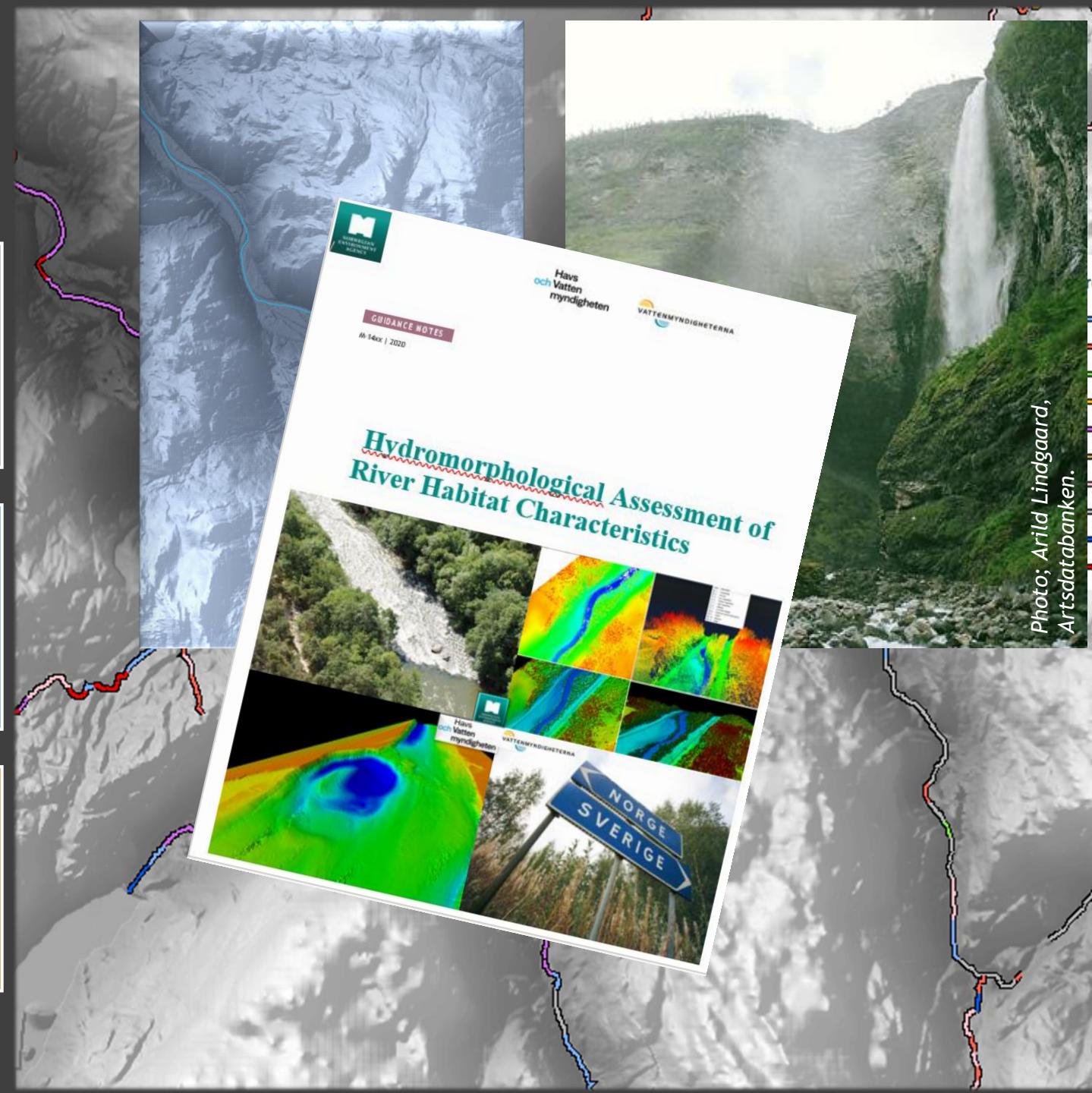
Red (topographic) lidar data are soon covering most of the Scandinavian rivers and have a great potential for ecosystem based management

Lidar + GIS contribute to a more knowledge based and precise river and nature management !

A consistent methodologies are needed to get useful desktop GIS results.

Realistic for improved river characterization and assessment of our huge amount of water bodies

Our results may contribute to a more comparable assessment of river types and restoration needs



Photo; Arild Lindgaard,
Artsdatabanken.

Deliverables and data from this project (to download)

Support to conceptual discussions

Keywords : Gaula, Avrinningsområde, Hypsometry, Formfaktorer, Metriker

[[Download](#)], 0.8 GB [[GoogleDrive](#)], [[RefDoc v1_2019](#)]

HyMo-typer (HVMFS 2013:19) in Gaula

Keywords : Centerline, Segmenting, Slope, Sinuosity, MPI, Soil, HymoTypes

[[Download](#)], 0.50 GB [[GoogleDrive](#)], [[RefDoc v34_2019](#)]

Hydro-morphological parameters

Keywords : Centerline, Segmenting, Barrier, Slope, Sinuosity, Sandbank, Oxbow, Landform, Riparian

[[GoogleDrive](#)], 1.5 GB, [[RefDoc v15_2019](#)]

Hydro-morphological types (HVMFS 2013:19) - Surna

Keywords: Centerline, Segmenting, Slope, Sinuosity, MPI, Soil, HymoTypes

[[Download](#)], 40 MB [[GoogleDrive](#)], [[RefDoc v36_2019](#)]

Keywords: GeoNet , Geomorphic Feature Extraction from High Resolution Terrain Data

[[Download](#)], 87 MB [[GoogleDrive](#)], [[RefDoc v16_2019](#)]

Hydro-morphological types (HVMFS 2013:19) - Scale

Keywords: RiverWidth, Segmenting, Slope, Sinuosity, Riparian, MPI, Soil, HymoTypes

[[Download](#)], 40 MB [[GoogleDrive](#)], [[RefDoc v40_2019](#)]

Geomorphic Feature Extraction from High Resolution Terrain Data

Keywords : GeoNet , Lansdscape grid 5x5 km

[[GoogleDrive](#)], 0.75 GB

Report (Agreement no: 18088090) Keywords : Datareport

- v42, 2019 - [[RefDoc v42_2019](#)]

Parameters Surna (Møre og Romsdals fylke)

Keywords: Centerline, Segmenting, Barrier, Slope, Sinuosity, RiverWidth, Erosion, Landform, Riparian

[[Download](#)], 0.60 GB [[GoogleDrive](#)], [[RefDoc v26_2019](#)]

Thanks for
your
interest in
our project

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