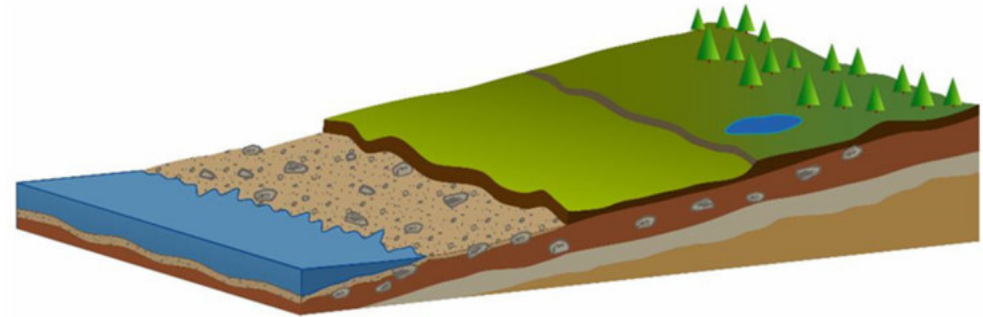# Coastal wetlands – example of ecosystem services mapping for decision making

The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

Wetlands
INTERNATIONAL

Object of the study – coastal marshes

Natural ecosystem functions of coastal marshes

biodiversity

carbon

water

resilence

Wetlands INTERNATIONAL

Object of the study – coastal marshes

Hazards and threats

Infrastructure impact

contamination

erosion

Waste polution

Photo©Sergey Uvarov

Coastal wetlands – example of ecosystem services mapping for decision making
The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

Wetlands
INTERNATIONAL

Goals and objectives of the study

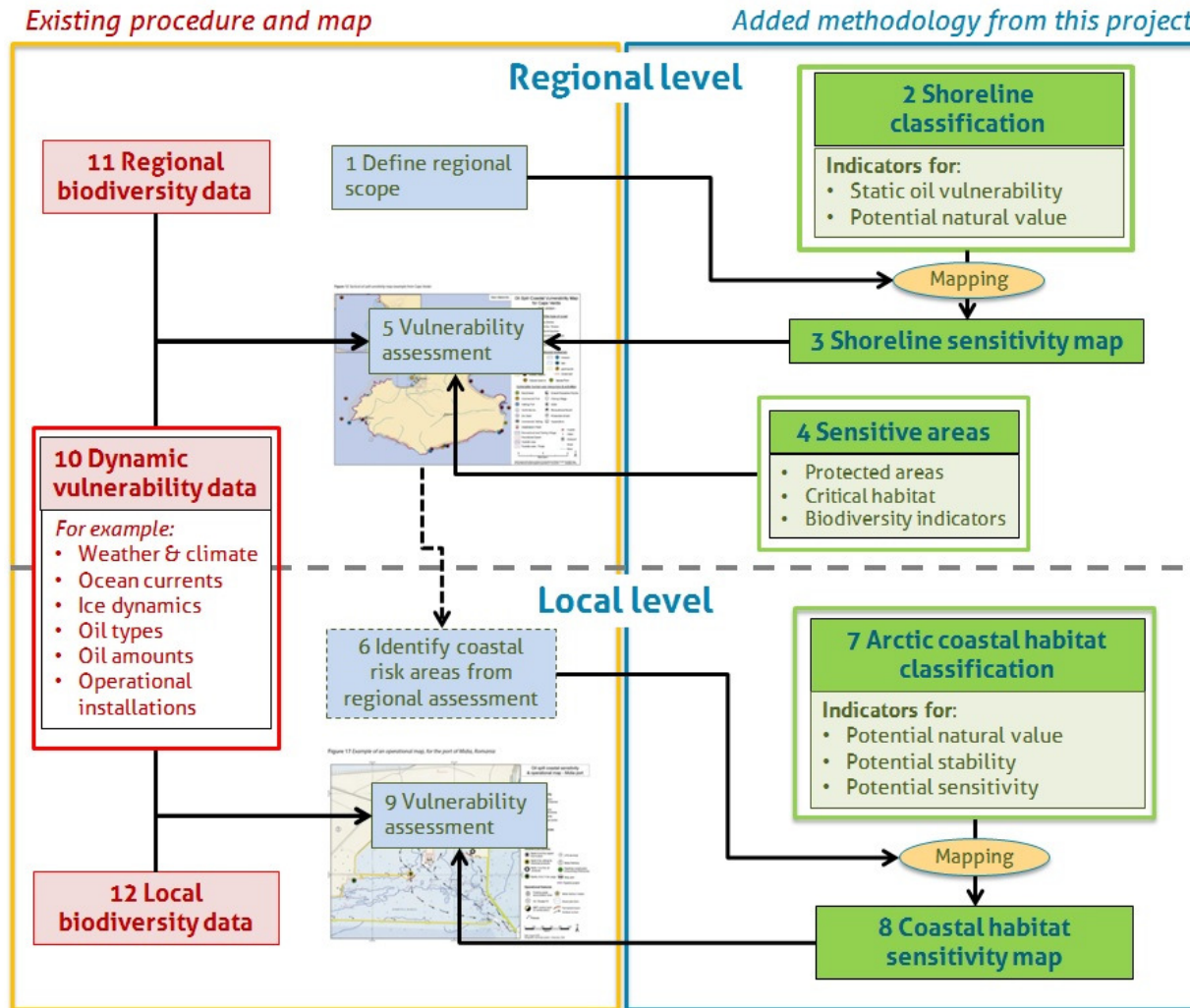Assessing the sensitivity and vulnerability of Arctic coasts for oil spill response planning

Project Goal: mitigation and prevention of potential long-term damage to coasts and wetlands from oil and gas developments in the Arctic

Objectives:

- Development of a two-level classification system for Arctic coasts, valid for the entire Arctic:

    A shoreline classification (primarily) applicable at regional levels, based on static features;

    An Arctic coastal habitat classification applicable at local levels, based on static features.

- Development of methodologies to assess natural values, sensitivity and (static) vulnerability to oil spills for Arctic shorelines and coastal habitat types.

- To assess the values of the indicators for shore line types

- Mapping of sensitivities and vulnerability on two levels

- The management solutions based on the outcomes of the mapping

Wetlands
INTERNATIONAL

Methodology

Assessing the sensitivity and vulnerability of Arctic coasts for oil spill response planning

Coastal wetlands – example of ecosystem services mapping for decision making
The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

A shoreline classification

Applicable at regional levels, based on static features

The requested features of the classification:

- It should provide a formal and useful tool for planners and experts working with satellite images and existing spatial data and maps (soil, vegetation, permafrost, topography) to identify shoreline types.
- Mapping should be based on a user-friendly, consistent and replicable procedure, with as few uncertainties as possible.
- It should connect to, or be able to be integrated into, well-established oil spill response procedures, such as ESI or Environment Canada standards, rather than replacing them.

Physical parameters used in the classification of shoreline:

- <u>Exposure</u> of the coastline: how exposed, open or closed the shore is to the sea and waves.
- <u>Substrate</u>: the dominant type of substrate or sediment of a shoreline, e.g. rock, clay, sand or peat.
- <u>Slope</u>: the slope or steepness of a stretch of shoreline.

Wetlands
INTERNATIONAL

A shoreline classification

Applicable at regional levels, based on static features

Exposure of coastline
1 Exposed coast
2 Channel
3 Delta
4 Bay
5 Estuary and fjord

Outline of the actual coastline, and defining the landward extent of the coastal zone. The USGS shoreline vector data verified manually using Landsat-8 images at low tide.

Substrate
1 Mud-clay
2 Sand and coarse sand
3 Mixed sand, pebbles
4 Cobbles, boulder
5 Peat
6 Ice
7 Rock outcrop

The SoilGrids database with filling up gaps by a proximity analysis

Slope
1 Flat=Slope angle <1%
2 Gentle=Slope angle ≥ 1 - < 10 %
3 Steep=Slope angle ≥ 10 - < 100 %
4 Vertical cliff=Slope angle ≥ 100 %
5 Cliff with talus and drop-off=slope angle ≥ 100 %

The Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010) dataset; built-in slope calculation function of ArcGIS

t Anthropogenic transformation of the coast
**Examples of classes: 1-7-5; 4-1-1; 3-2-2; 5-5-2; 4-t**

Wetlands
INTERNATIONAL

A shoreline classes valuation

Applicable at regional levels, based on static features - value

| Shoreline type			Potential value for plants	Potential value for birds	Generic mammal preferences	Overall natural value
Exposure	1	Exposed coast	8	2	10	9
	2	Channel	8	3	4	6
	3	Delta	8	10	1	9
	4	Bay	10	6	5	10
	5	Estuary and fjord	1	1	7	1
Substrate	1	mud-clay	10	8	1	6
	2	sand and coarse sand	8	8	7	9
	3	Mixed sand, pebbles, cobble	8	10	6	10
	4	Cobble, boulder	4	2	7	2
	5	Peat	5	8	2	3
	6	Ice	1	1	10	1
	7	Rock outcrop	4	2	7	2
Slope	1	Flat	10	10	10	10
	2	Gentle	7	7	10	8
	3	Steep	2	3	1	2
	4	Steep cliff	1	1	1	1
	5	cliff with talus and drop-off	1	1	6	3

Wetlands
INTERNATIONAL

A shoreline classes valuation: nature value

Applicable at regional levels, based on static features - value
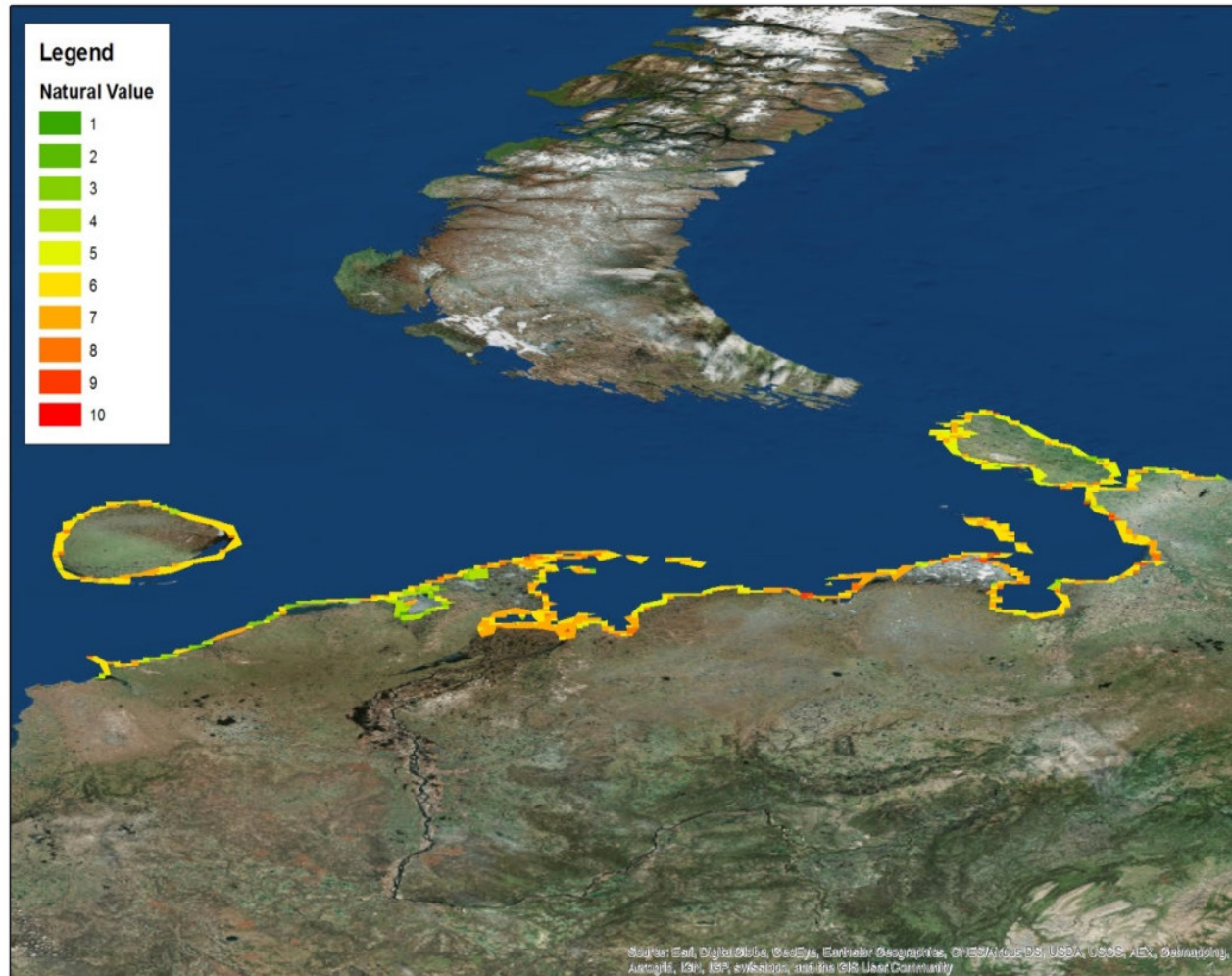
A shoreline classification: additional static information

Applicable at regional levels, based on static features: additional features
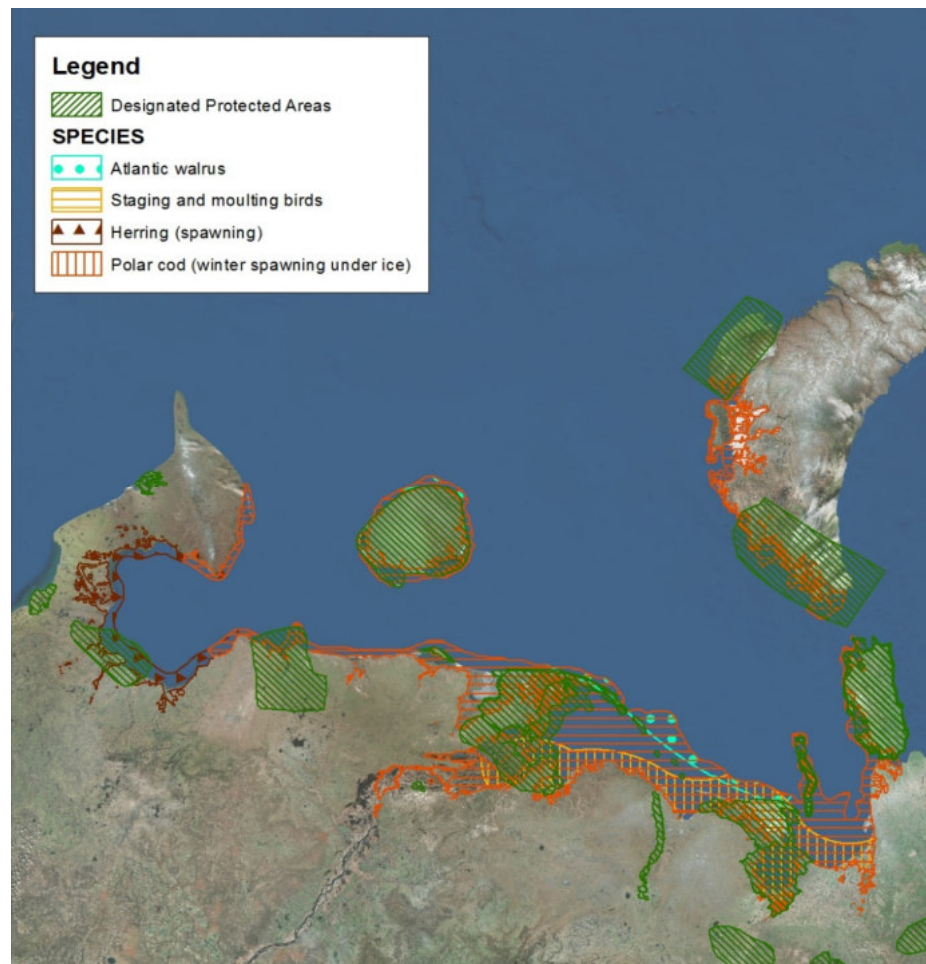
A shoreline classification

## Applicable at regional levels, based on static features - vulnerability

Shoreline type			Oil static vulnerability rank	Weighting factor	Weighted oil vulnerability rank
Exposure	1	Exposed coast	1	2	2
	2	Channel	4	2	8
	3	Delta	10	2	20
	4	Bay	6	2	12
	5	Estuary and fjord	8	2	16
Substrate	1	Mud-clay	4	3	12
	2	Sand and coarse sand	5	3	15
	3	Mixed sand, pebbles, cobbles	6	3	18
	4	Cobbles, Boulder	7	3	21
	5	Peat	6	3	18
	6	Permanent ice	3	3	9
	7	Rock outcrop	1	3	3
Slope	1	Flat	10	1	10
	2	Gentle	7	1	7
	3	Steep	3	1	3
	4	Vertical cliff	1	1	1
	5	Cliff with talus and drop-off	2	1	2

Examples of data as input for assessing dynamic vulnerability to oil.

Spill source and operational data	Physical, meteorological and oceanographic data	Sensitive biological resources (actual and/or predicted locations)
Actual locations of operations	Climate, storm frequencies, including extremes	Bird colonies and other bird congregations
Pipelines	Ocean currents	Mammal concentrations
Drilling locations	Seasonal ice data	Fish spawning/nursery locations
Shipping routes	Weather (actual and scenarios)	Coral reefs, mussel banks etc.
Oil type	Water and sea level, tidal regimes	Ecosystem services sites: e.g. fishing grounds, herding areas, hunting locations
Oil amount	River and estuary discharge cycle	
	Wave height	

Coastal wetlands – example of ecosystem services mapping for decision making
The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

Wetlands
INTERNATIONAL

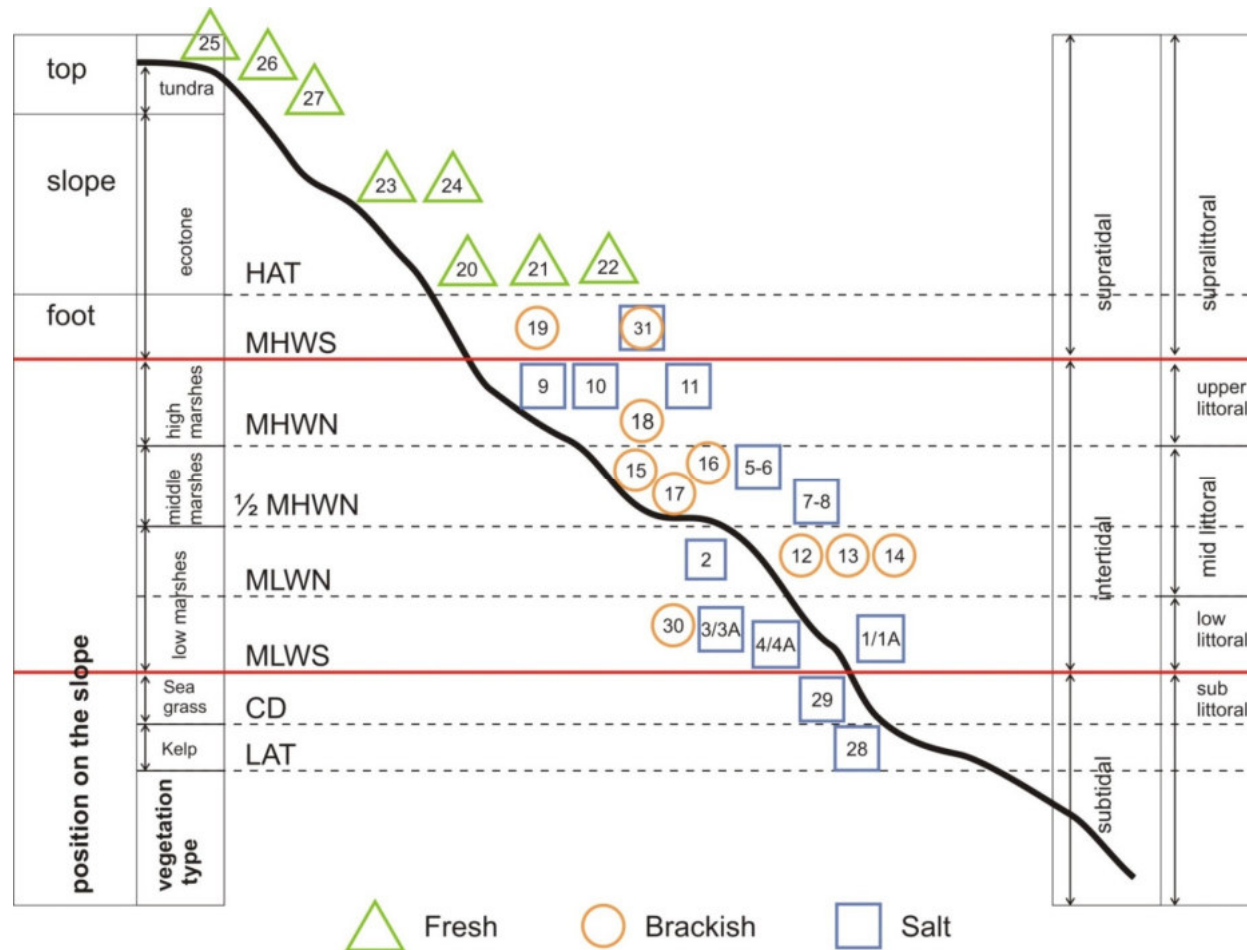# A shoreline classification: weighted vulnerability

Applicable at regional levels, based on static features
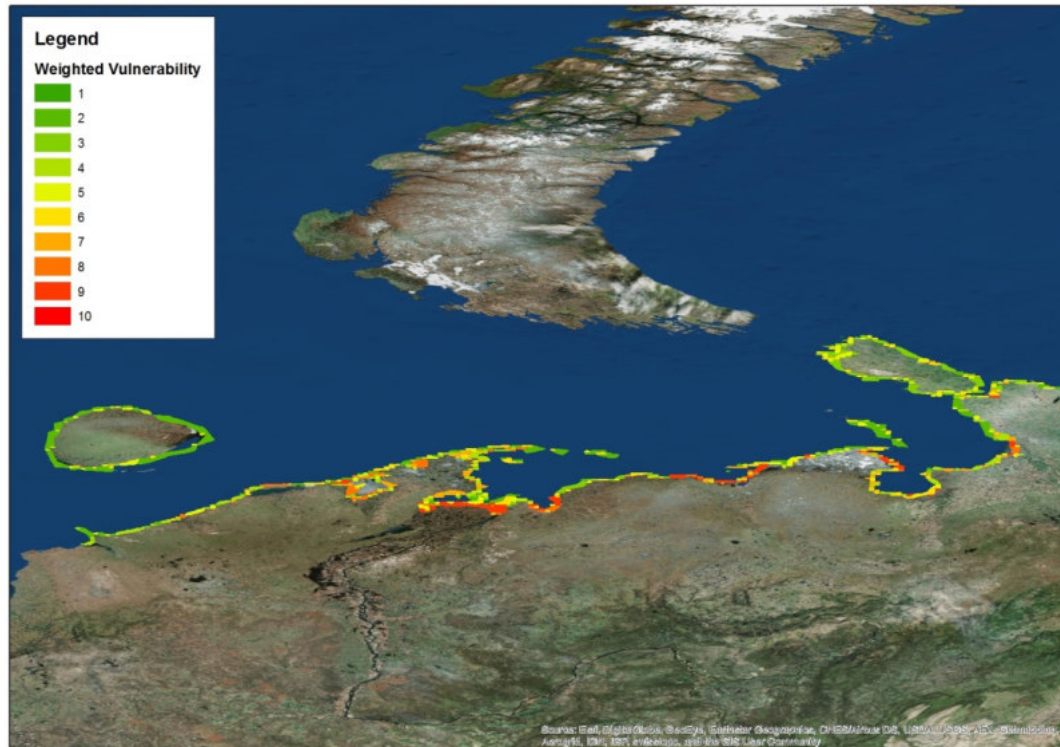
Management solution:
for red lines more detailed
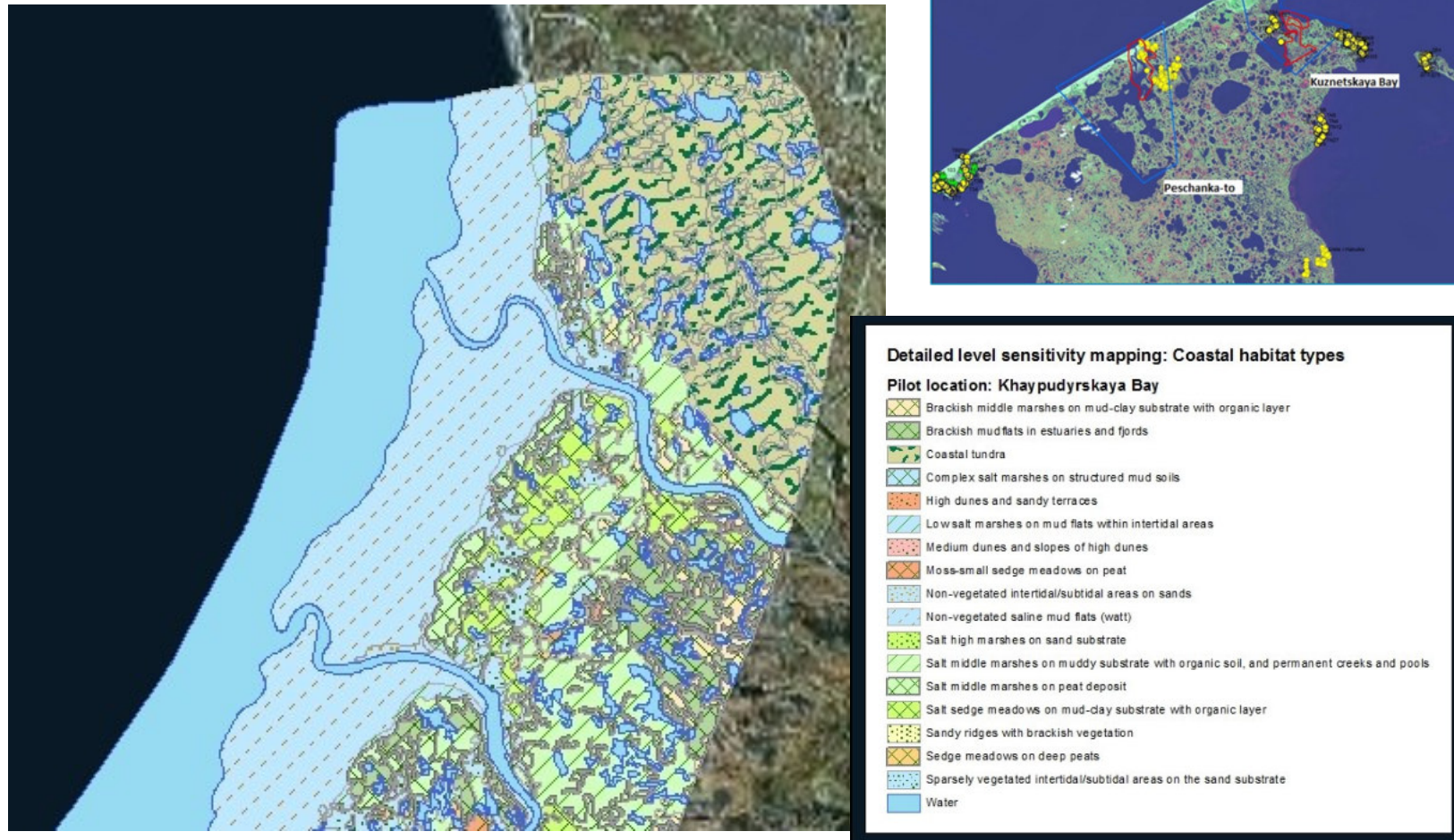high resolution mapping
of ecosystem values and
sensitivities

Wetlands
INTERNATIONAL

A habitat classification

Applicable at local level – predictive mapping

A habitat classification: visualisation of classes mapping

Applicable at regional levels, based on static features - value

Ground truthing

Detailed level sensitivity mapping: Coastal habitat types

Pilot location: Khaypudyrskaya Bay

- Brackish middle marshes on mud-clay substrate with organic layer
- Brackish mudflats in estuaries and fjords
- Coastal tundra
- Complex salt marshes on structured mud soils
- High dunes and sandy terraces
- Low salt marshes on mud flats within intertidal areas
- Medium dunes and slopes of high dunes
- Moss-small sedge meadows on peat
- Non-vegetated intertidal/subtidal areas on sands
- Non-vegetated saline mud flats (watt)
- Salt high marshes on sand substrate
- Salt middle marshes on muddy substrate with organic soil, and permanent creeks and pools
- Salt middle marshes on peat deposit
- Salt sedge meadows on mud-clay substrate with organic layer
- Sandy ridges with brackish vegetation
- Sedge meadows on deep peats
- Sparsely vegetated intertidal/subtidal areas on the sand substrate
- Water

Wetlands
INTERNATIONAL

A habitat valuation

Applicable at local level – predictive mapping of the sensetivity
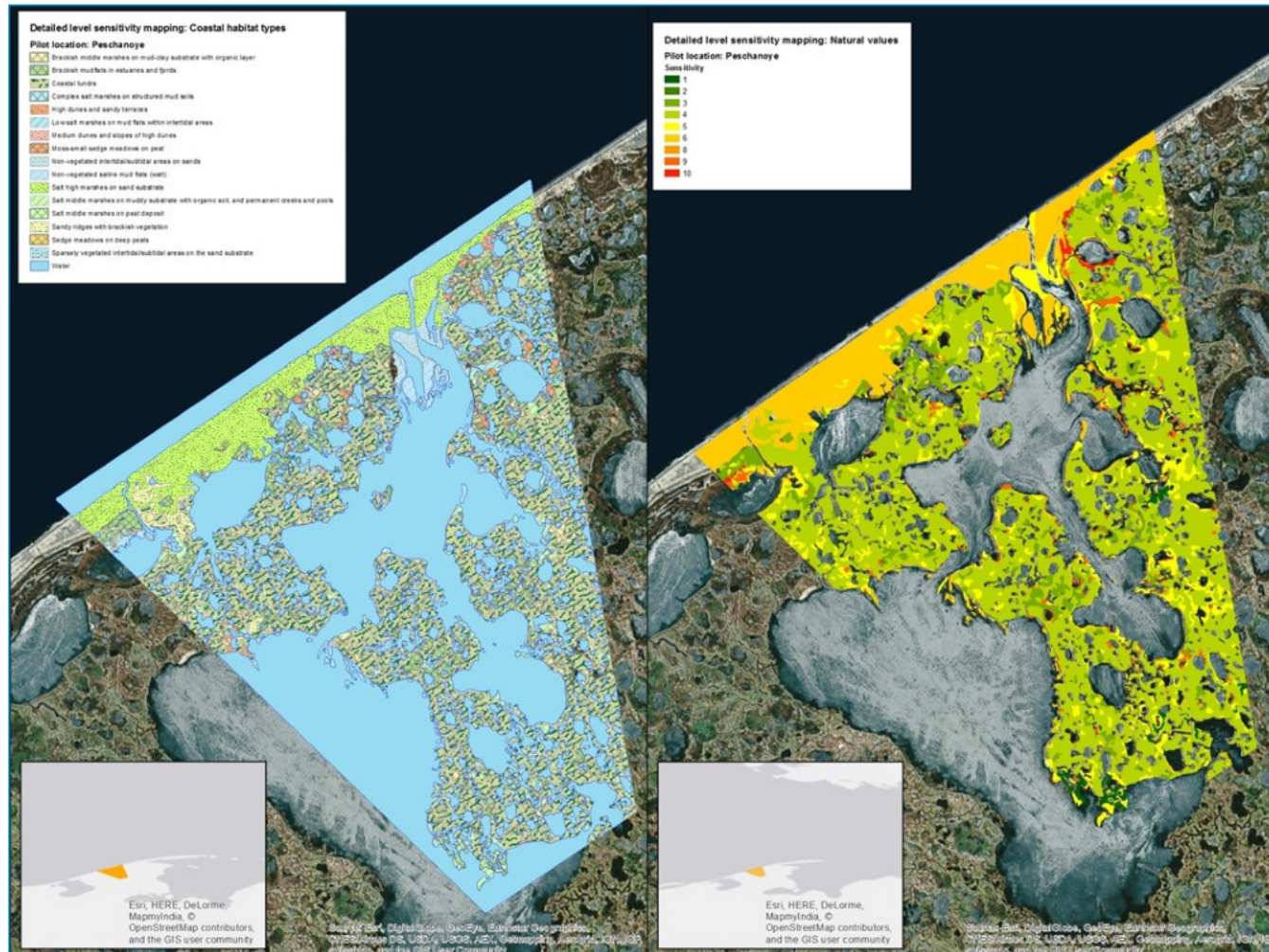
parameter	characteristic
number of vascular plant species	Species richness
number rare vascular plant species	Capacity for rare species
number of threatened vascular plant species	Capacity for threatened species
number of provisional vascular plant species	Capacity for provisional
number of vascular plant species with specific evolutionary connections (for ex Puccinellia phryganodes to grazing species)	Role for other species
number of bird species	Species richness
number rare bird species	Capacity for rare species
number of threatened species	Capacity for threatened species
number of provisional species	Capacity for provisional
Number of breeding migrating species	Role for flyway maintenance
Number of moulting migrating species	Role for flyway maintenance
Number of over stopping/concentrating species	Role for flyway maintenance
Number of species with other specific/unique functions	Role for other species/landscapes
number of marine mammal species	Species richness
number rare marine mammal species	Capacity for rare species
number of threatened marine mammal species	Capacity for threatened species
number of provisional marine mammal species (when allowed)	Capacity for provisional
Number of breeding marine mammal species	Role for maintenance of global population
Number of marine mammal species with specific/unique functions or evolutionary connections	Role for other species/landscapes
number of other mammal species	Species richness
number rare other mammal species	Capacity for rare species
number of threatened other mammal species	Capacity for threatened species
number of provisional other mammal species (when allowed)	Capacity for provisional
Number of breeding other mammal species	Role for maintenance of global population
Number of other mammal species with specific/unique functions or evolutionary connections	Role for other species/landscapes

The following parameters are used for stability:

1. Plant life-forms
2. Plant ecological groups (humidity and salinity)
3. Substrate type (e.g. peat, sand, rock)
4. Slope type of a shoreline (flat, steep, etc.)
5. Tidal regime
6. Biogeographic representation (circumpolar species).

Wetlands INTERNATIONAL

A habitat classification and sensitivity visualisation

Applicable at local level – predictive mapping

Coastal wetlands – example of ecosystem services mapping for decision making
The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

Management solutions

Application on regional and local level

Level	Regional level	Local level
Scale	1: 250 000 – 1:3 000 000	1:10 000 – 1:100 000
Classifications	• Shoreline classification with indicators • Additionally: Guidance on inclusion of sensitive areas	• Habitat classification with indicators ("Arctic Coastal Habitat database")
Indicators	• Static vulnerability to oil • Natural value for habitats	• Natural value • Sensitivity (inherent)
Application	• Scoping • Strategic planning	• Oil spill response operations planning
Strategy	• Avoidance • Mitigation (based on the detailed mapping – see local level)	• Emergency response • Clean-up measures • Restoration • Compensation

Coastal wetlands – example of ecosystem services mapping for decision making
The Arctic Biodiversity Congress: October 9-12, 2018, Rovaniemi, Finland

Wetlands
INTERNATIONAL

Knowledge based planning

Is source of the inspiration and demands a hard work

Inspiration! ☺

Hard work. ☹

Project staff:

Ward Hagemeijer, Frank Hoffmann, Tatiana Minayeva, Taej Mundkur, Stephan Flink, Teresa Zuna, Tom Langendoen, Lammert Hilarides, Bart Steen, Paul Brotherton, Liudmila Sergienko, Igor Lavrinenko, Svetlana Deneva, Olga Lavrinenko, Oxana Cherednichenko, Narangerel Davaasuren, Ed Owens, Simon Delany, Rachel Grunberg, Mathijs Smit, Giancarlo Cesarello, Dick Williams

Wetlands INTERNATIONAL