Geographische Informationssystem zur Ermittlung von Ökosystemleistungen in der Küstenzone

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Company for Environment and Coast

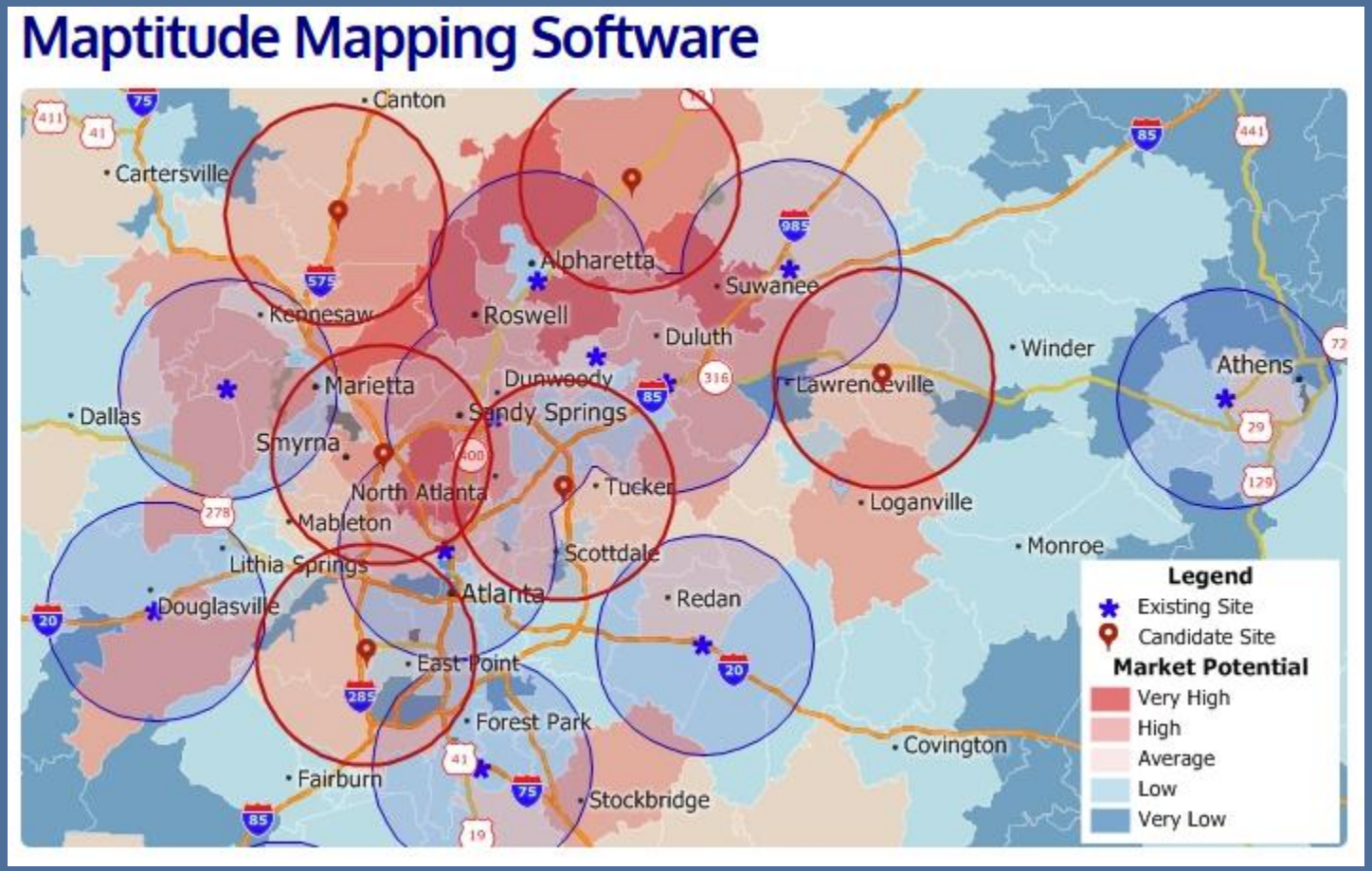
Ausgangslage:

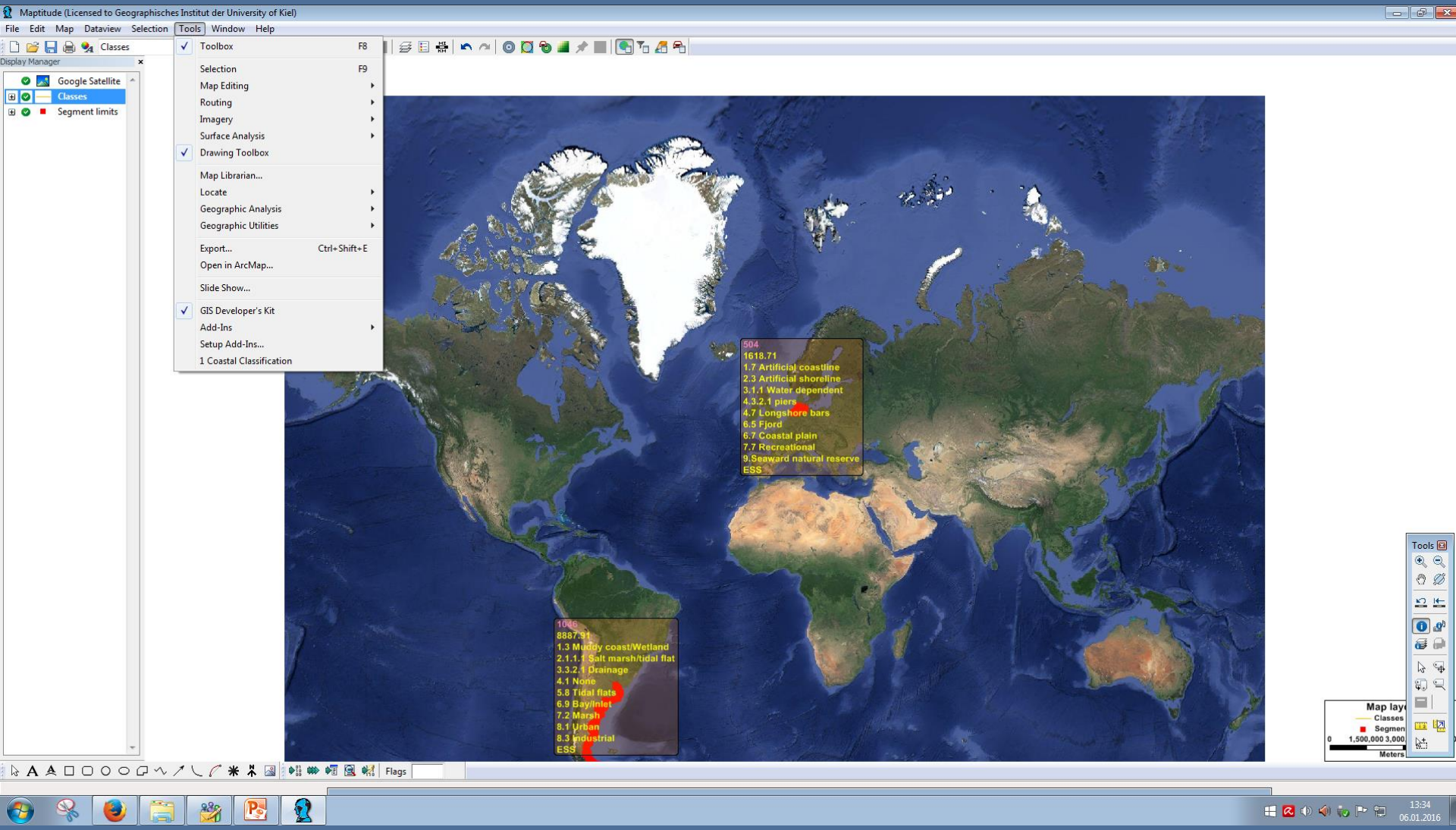
- Unterschiedliche Küstenklassifikationen für unterschiedliche Fragestellungen
- Z. B. geologische, geomorphologische etc.
- Hydrologische (tidal range, hazard index, Ω)
- Biotische
- Sozio-ökonomische

Probleme:

- Keine fächerübergreifende Klassifikation
- Keine Klassifikation die die Reaktion des Systems auf den Klimawandel berücksichtigt
- keine ES integriert

Ansatz: GIS gestützte Analyse von Küstensegmenten




Maptitude (Licensed to Geographisches Institut der University of Kiel)
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Map Editing
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Surface Analysis
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Locate
Geographic Analysis
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Export... Ctrl+Shift+E
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GIS Developer's Kit
Add-Ins
Setup Add-Ins...
1 Coastal Classification
Display Manager
Google Satellite
Classes
Segment limits
504
1618.71
1.7 Artificial coastline
2.3 Artificial shoreline
3.1.1 Water dependent
4.3.2.1 piers
4.7 Longshore bars
6.5 Fjord
6.7 Coastal plain
7.7 Recreational
9.Seaward natural reserve
ESS
1048
8887.31
1.3 Muddy coast/Wetland
2.1.1.1 Salt marsh/tidal flat
3.3.2.1 Drainage
4.1 None
5.8 Tidal flats
6.9 Bay/Inlet
7.2 Marsh
8.1 Urban
8.3 Industrial
ESS
Tools
Flags
13:34
06.01.2016

Drei grundlegende Schritte:

- Einteilung der Küste in Segmente +/- gleicher Struktur
- Erfassung der bestimmenden Naturraumelemente sowie der sozio-ökonomischen Bedingungen für jedes Segment
- Ermittlung und Bewertung der Ecosystem Services (ES)

9 Kategorien für die Segmente:

- DOMINANT FEATURE
- SUBSTRATE
- DOMINANT MANMADE FEATURES
- ADDITIONAL MANMADE FEATURES
- NEARSHORE ENVIRONMENT
- SEAWARD ENVIRONMENT
- LANDWARD ENVIRONMENT
- PREDOMINANT LAND USE
- OTHER LAND USE
- ECOSYSTEM SERVICES (ES) für jede Kategorie

Beispiel: DOMINANT FEATURE

1 Beach and dunes
2 Beach
3 Muddy coast/Wetland
4 Spit/beach ridge
5 Cliffs
  5.1 Soft Cliff
  5.2 Rocky Cliff
6 Barrier island
7 Artificial coastline
8 Montaineous coast
9 Reef/Atoll
10 Estuary, Rivermouth, Delta
99 Other

Beispiel: SUBSTRATE

1 SOFT COASTLINE
1.1 Muddy
 1.1.1 Salt marsh/tidal flat
 1.1.2 Marshes
 1.1.3 Mangroves
 1.1.4 Swamps
 1.1.5 Sabkha
 1.1.6 Chenier
 1.1.7 Veneer
 1.1.8 Other muddy
1.2 Clastic sediments
 1.2.1 Compact sediment
  1.2.1.1 Soft cliff
  1.2.1.2 Beachrock
 1.2.2 Loose sediment
  1.2.2.1 Beach Gravel
  1.2.2.2 Beach Sand
  1.2.2.3 Mixed sand/gravel
  1.2.2.4 Dunes
  1.2.2.5 Stones and rocks
  1.2.2.6 Dune cliff
 1.2.9 Other Clastic
 1.2.3 Soft artifical shoreline
2 HARD COASTLINE
 2.1 Rocky Cliff
 2.1.1 Vertical
 2.1.2 Inclined
 2.2 Abrasion platforms
 2.3 Mountain slope
 2.4 Uplifted/fosil platform
 2.5 Other hard coast
 2.6 Biologic concretions
  2.6.1 Coral reef
  2.6.2 Bivalves concretions
 2.7 Permafrost
3 Artificial shoreline
 3.1 Hard
 3.2 Soft (nourishment/biotecnic)

Beispiel: DOMINANT MANMADE FEATURES

1 Economically functional structures
 1.1 Water dependent
 1.1 Non water dependent
2 Canalization structures
3 Coastal protection structures
 3.1 Parallel to the shoreline
  3.1.1 Seawall/promenade/steal piling
  3.1.2 Revetment
  3.1.3 Rip rap
  3.1.4 Dike
  3.1.5 Artificial reef/breakwaters
  3.1.6 Road and bridge structures
  3.1.7 Surge Barrier
  99 Other
 3.2 Perpendicular to the shoreline
  3.2.1 Groins
  3.2.1 Jetties
  3.2.1 Drainage
  3.2.1 piers
  3.2.1 Slips
  3.2.1 Road and bridge structures
  99 Other
4 Residential and urban infrastructure
5 Nourished/Artificial beach
6 No artificial structures present
7 Land reclamation structures
99 Other type of artificial structure

Beispiel: NEARSHORE ENVIRONMENT

1 Lagoon
2 Stream mouth
3 Spit
4 Stream
5 Bay/Inlet/Gulf
6 Shoal
7 Longshore bars
8 Tidal flats
9 Mangroves
10 Coral reefs
11 Marshes
12 Rocky platform
13 Continuous slope
steep slope
99 Other

Beispiel: PREDOMINANT LAND USE

1 Urban
2 Rural (includes forestry and agriculture)
3 Industrial
4 Transport
5 Scattered settlement (villages)
6 Nature Reserve
    Landward natural reserve
    Seaward natural reserve
    Landward and seaward natural reserve
7 Recreational
8 Military
8 None
99 Other

Beispiel: Ecosystem Service (ES)

ES Provisioning

ES Regulating

ES Cultural

0-100

ES Auswahl und Ergänzung

Provisioning Services

P1: Food; products derived from plants, animals and microbes

P2: Fiber; wood, jute, cotton, hemp, silk, and wool, materials serve as sources of energy

P3: Genetic resources; genes and genetic information used for animal and plant breeding and biotechnology, bio-chemicals, natural medicines, and pharmaceuticals

P4: Mineral resources (Sand, gravel, stones etc.), Wave- and/or Thermo energy

Regulating Services

R1: Climate regulation; climate both locally and globally

R2: Water regulation; timing and magnitude of runoff, flooding, and aquifer recharge

R3: Erosion regulation; Vegetative cover plays an important role in soil retention and the prevention of landslides

R4: Water purification and waste treatment; source of impurities but also can help filter out and decompose organic wastes

R5: Natural hazard; such as mangroves and coral reefs can reduce the damage caused by hurricanes or large waves, longshore bars, active cliffs, Erosions-platform (tilt ridge), pebble, stones (on beach and foreshore), beach ridge, spit, beach wrack etc.

Cultural Services

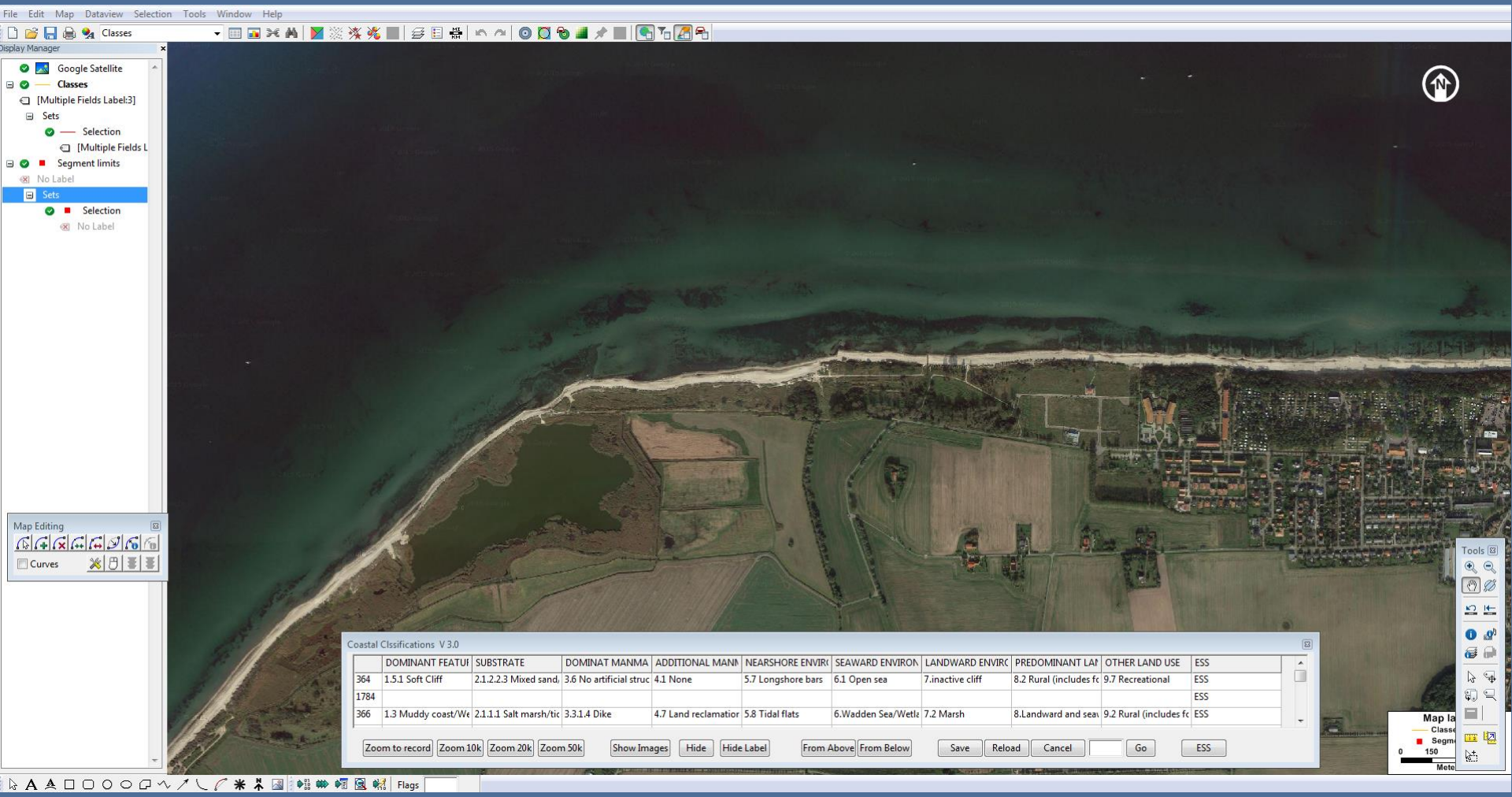
C1: Aesthetic values; beauty or aesthetic value in various aspects of ecosystems

C2: Cultural heritage values; Many societies place high value on the maintenance of either historically important landscapes (“cultural landscapes”) or culturally significant species

C3: Recreation and ecotourism; spend leisure time based in part on the characteristics of the natural or cultivated landscapes in a particular area (bathing, diving, angling, sailing etc.)

Indicators of ecosystem integrity	**Abiotic heterogeneity** The diversity of abiotic sructures and the capacity of an ecosystem to provide suitable habitats for different species, for functional groups of species and for processes. It is essential for the functioning of ecosystems.
	Biodiversity The presence and absence of selected species, (functional) groups of species, biotic habitat components or species composition.
	Biotic water flows The water cycling affected by plant processes in the system; ratio of transpiration/evapotranspiration
	Metabolic efficiency The amount of energy necessary to maintain a specific biomass or to contribute to biomass increase
	Exergy capture The capacity of ecosystems to enhance the input of usable energy. Exergy is derived from thermodynamics and measures the energy fraction that can be transformed **into mechanical work. In ecosystems, the captured exergy is used to build up biomass (e.g. primary production) and structures.**
	Reduction of nutrient loss The capacity of an ecosystem to prevent the irreversible output of elements from the system; referring also to nutrient and matter cycling; nutrient retention
	Storage capacity The capacity of an ecosystem to store nutrients, energy and water when available and to release them when needed.
Indicators of provisioning services	**Crops (human nutrition)** Cultivation of edible plants and harvest of these plants on agricultural fields and gardens which are used for human nutrition.
	Biomass for energy Plants used for energy conversion (e.g. sugar cane, maize)
	Crops (fodder) Cultivation and harvest of fodder for domestic animals.
	Livestock Production and utilization of domestic animals for nutrition and use of related products (e.g. dairy, wool).
	Timber Wood used for construction purposes.
	Fibers Cultivation and harvest of natural fibre (e.g. cotton, jute sisal, silk, cellulose) for, e.g. cloths, fabric, paper.
	Wood fuel Wood used for energy conversion and/or heat production.
	Wild food Harvest of berries, mushrooms, (edible) plants, hunted wild animals, fish catch from recreational fishing
	Fish and Seafood Catch of fish, seafood/algae for food, fish meal and fish oil.
	Beach wrack, Flotsam **Organic M**aterial from submerged macrophytes (e.g. seaweed and algae) which is accumulated regularly along the coast.
	Ornamentals* collection of natural ornaments (e.g. seashells, stones/amber, leaves and twigs for ornamental or religious purposes).
	Drinking water Used freshwater for drinking
	Abiotic energy* Sources used for energy conversion (e.g. solar power, wind power, water power and geothermic power)
	Minerals* Minerals excavated close from surface or above surface (e.g. sand for construction, lignite, gold)
Indicators of regulating services	**Groundwater recharge, water flow** Maintaining of water cycle features (e.g. water storage and buffer, natural drainage, irrigation and drought prevention).
	Local climate regulation Changes in local climate components like wind, precipitation, temperature, radiation due to ecosystem properties.
	Global climate regulation Long-term storage of greenhouse gases in ecosystems.
	Flood protection Protection and mitigation of floods.
	Air quality regulation Capturing/filtering of dust, chemicals and gases.
	Erosion regulation,wind Soil retention and the capacity to prevent and mitigate soil erosion by wind.
	Erosion regulation, water Soil retention and the capacity to prevent and mitigate soil erosion and landslides.
	Nutrient regulation The capacity of an ecosystem to store and recycle nutrients, e.g. N, P.
	Water purification The capacity of an ecosystem to purify water, e.g. from sediments, pesticides, disease-causing microbes and pathogens.
	Pest and disease control The capacity of an ecosystem to control pests and diseases due to genetic variations of plants and animals making them less disease-prone and by actions of predators and parasites.
	Pollination Bees, birds, bats, moths, flies, wind, non-flying animals contribute to the dispersal of seeds and the reproduction of lots of plants.
Indicators of cultural services	**Recreation and tourism** Outdoor activities and tourism relating to the local environment or landscape, including forms of sports, leisure and outdoor pursuit.
	Landscape aesthetics + inspiration Visual quality of the landscape/ecosystems or parts of them which influences human well-being and the need to create something, esp. in art, music and literature. The sense of beauty people obtain from looking at landscapes/ecosystems as ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture, advertising and technology.

Startmaske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366 1.3 Muddy coast/We 2.1.1.1 Salt marsh/tic 3.3.1.4 Dike 4.7 Land reclamatior 5.8 Tidal flats 6.Wadden Sea/Wetla 7.2 Marsh 8.Landward and seav 9.2 Rural (includes fc ESS
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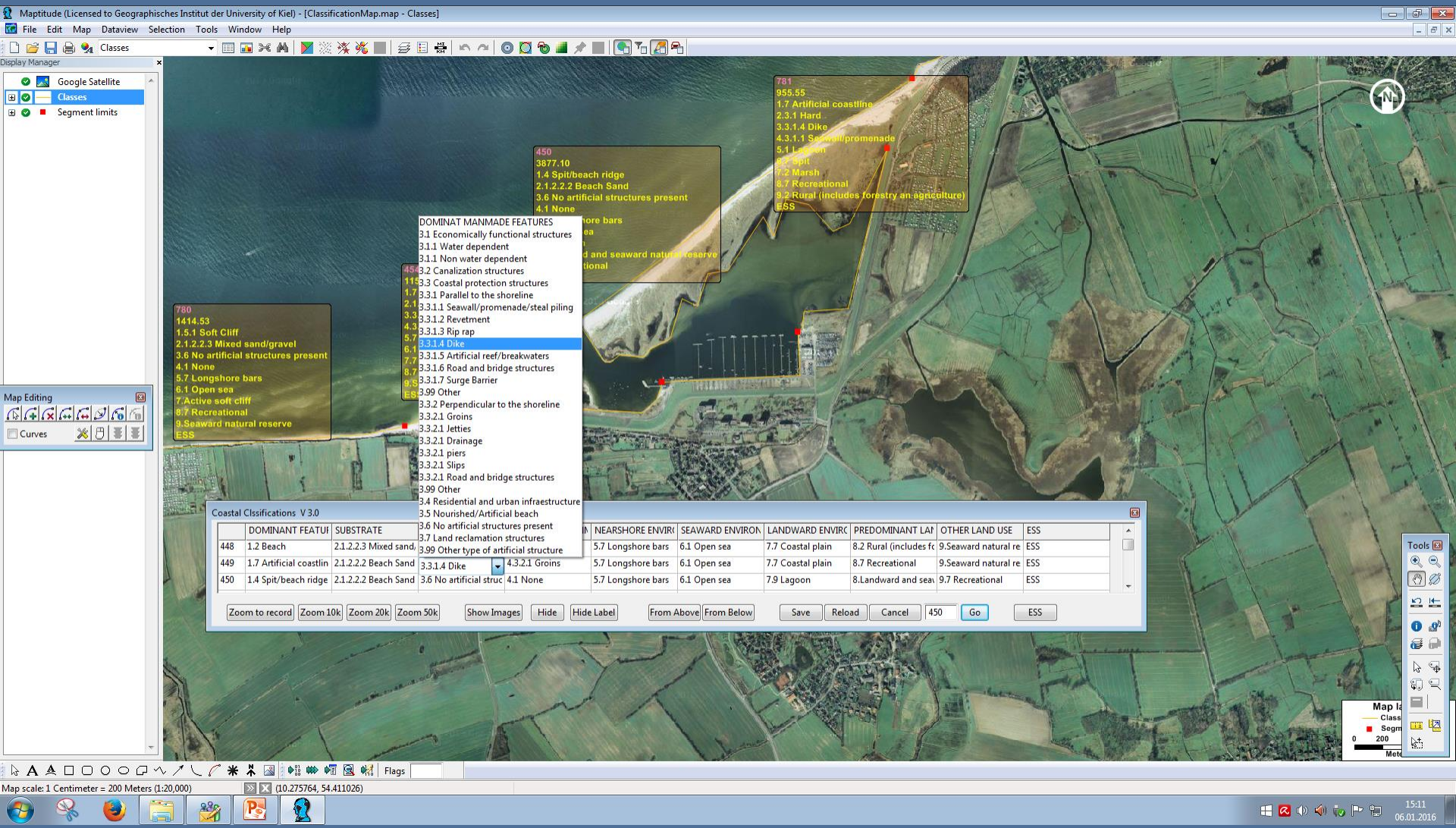
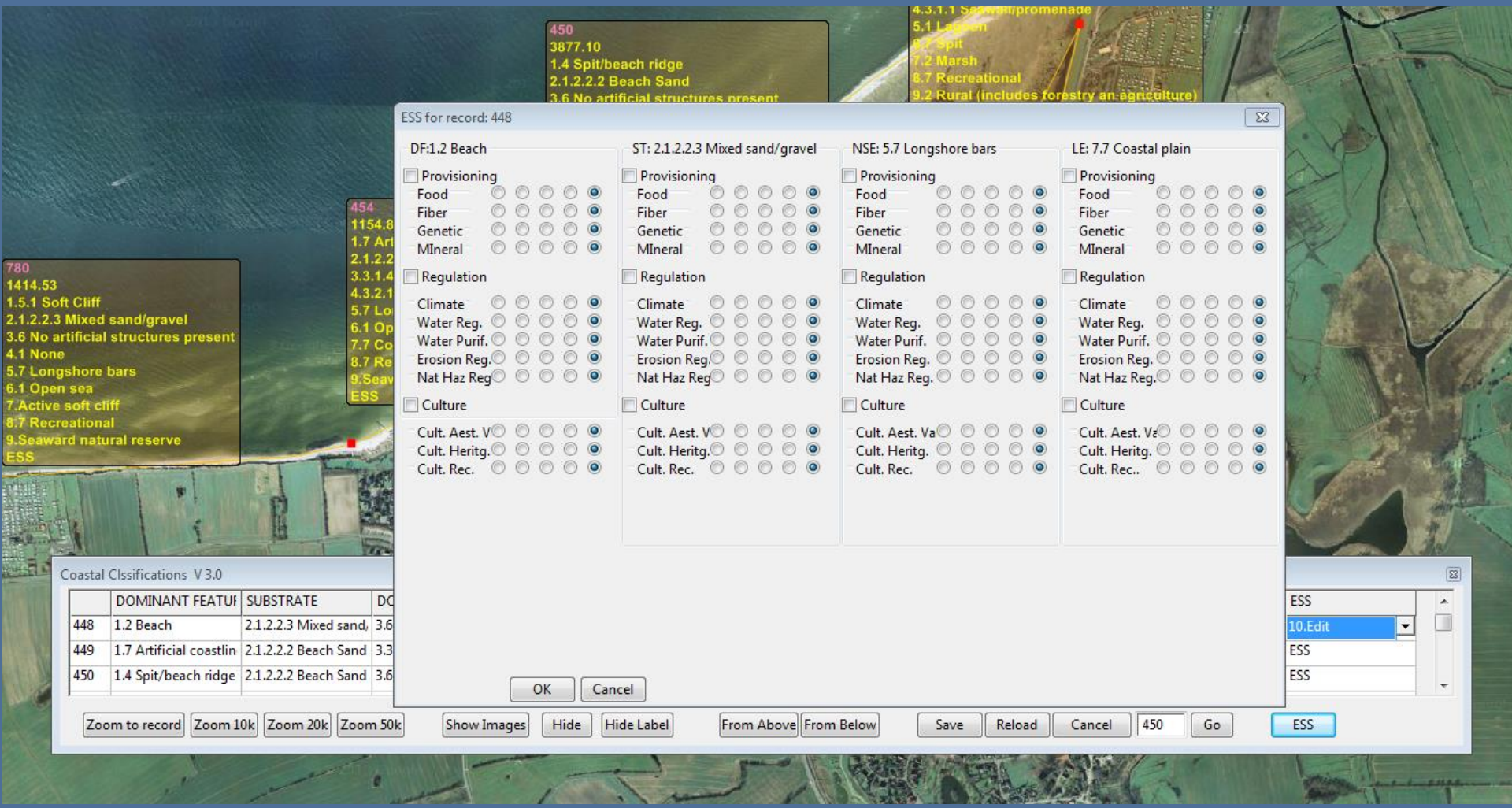
Schritt eins: Segmentierung

Schritt zwei: Klassifizierung



Schritt drei: Ermittlung der ES



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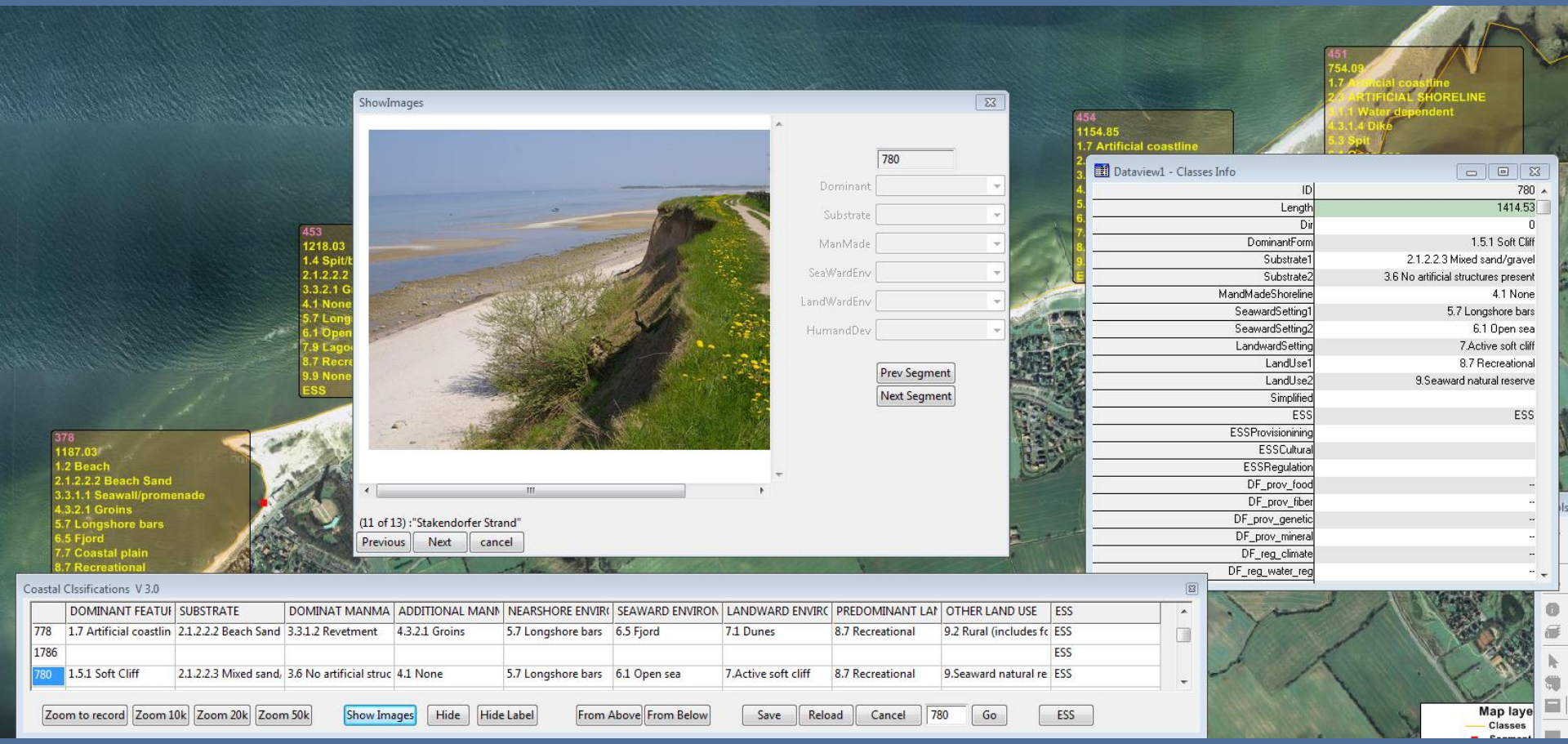

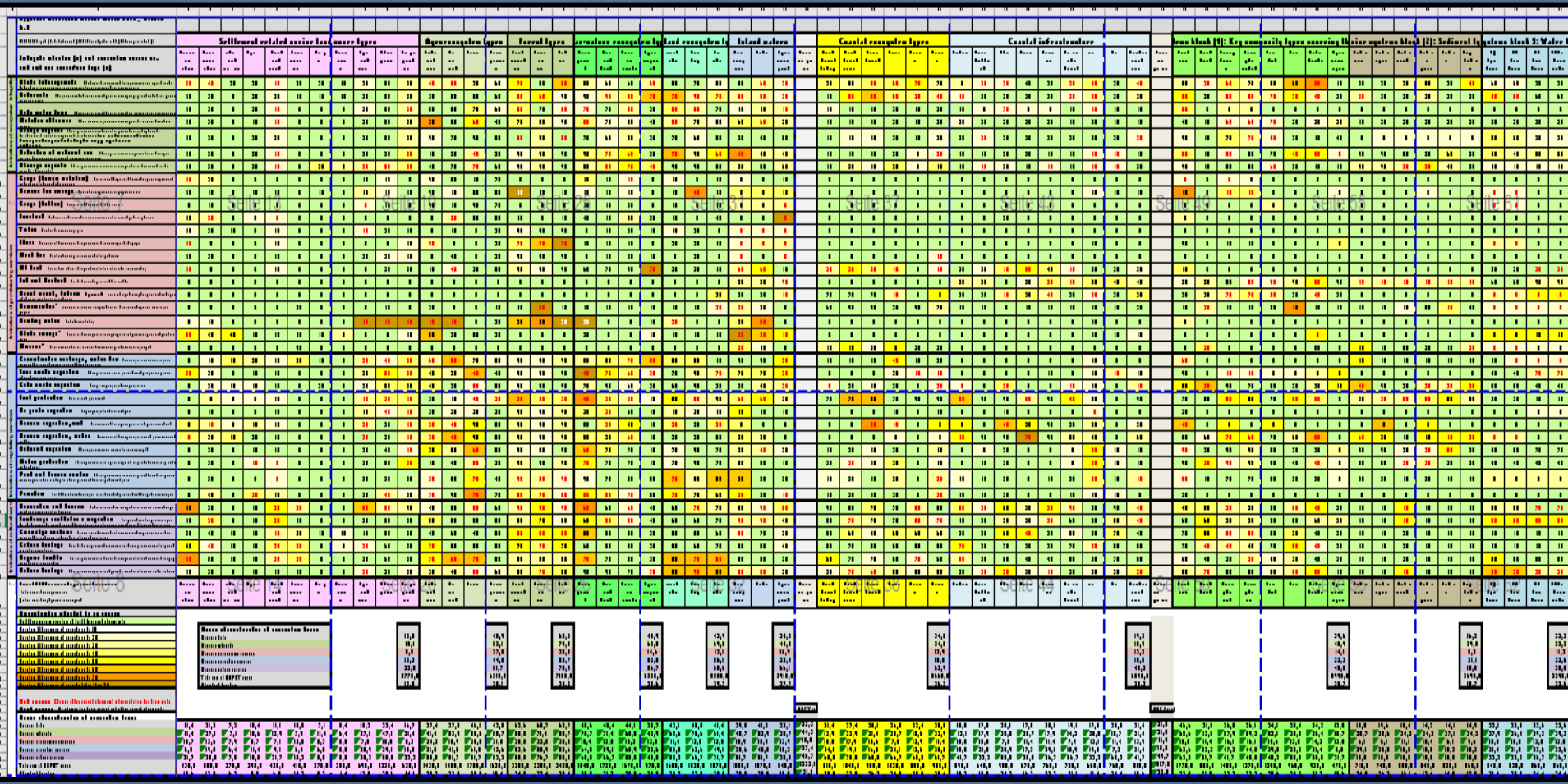

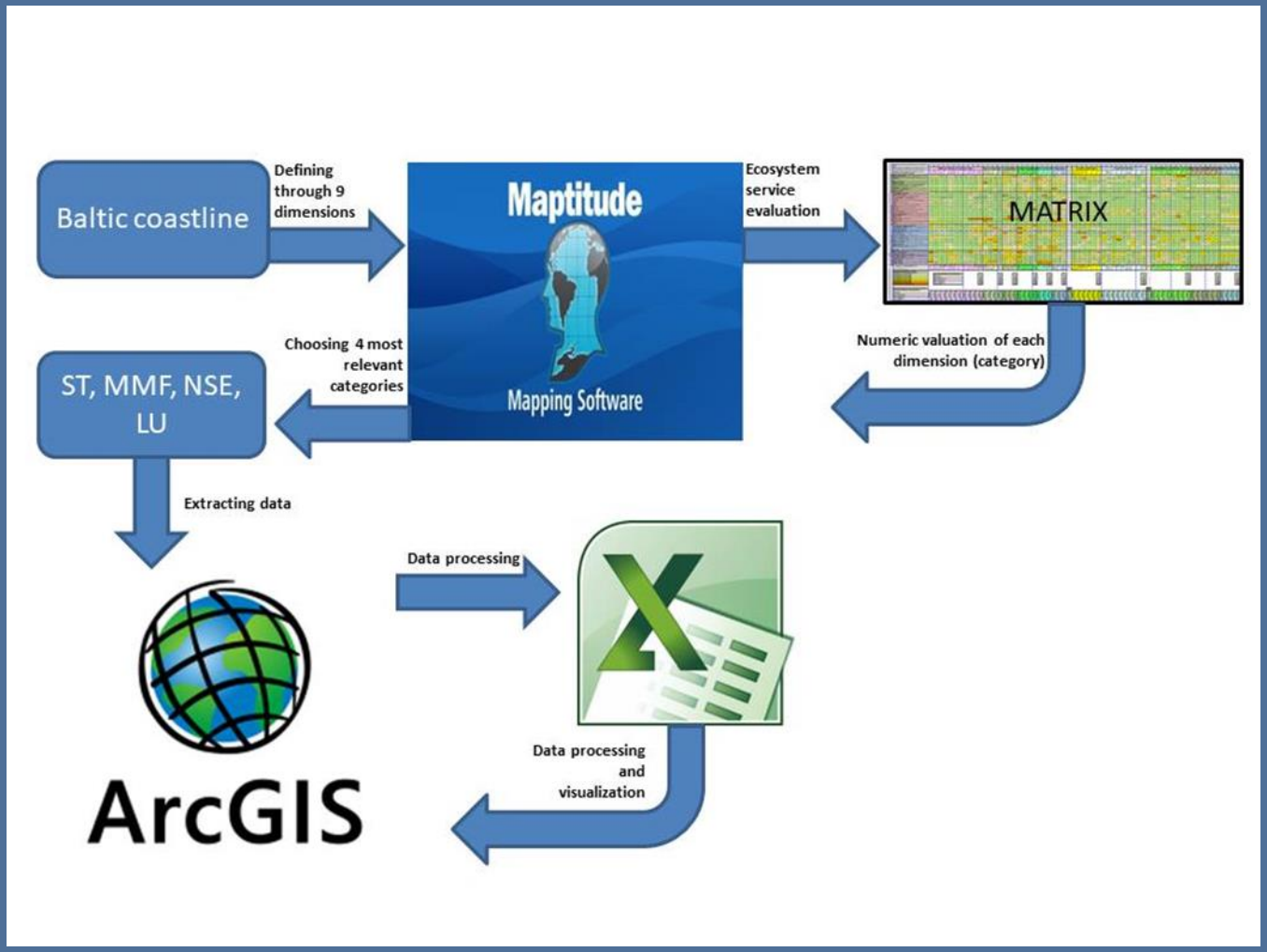

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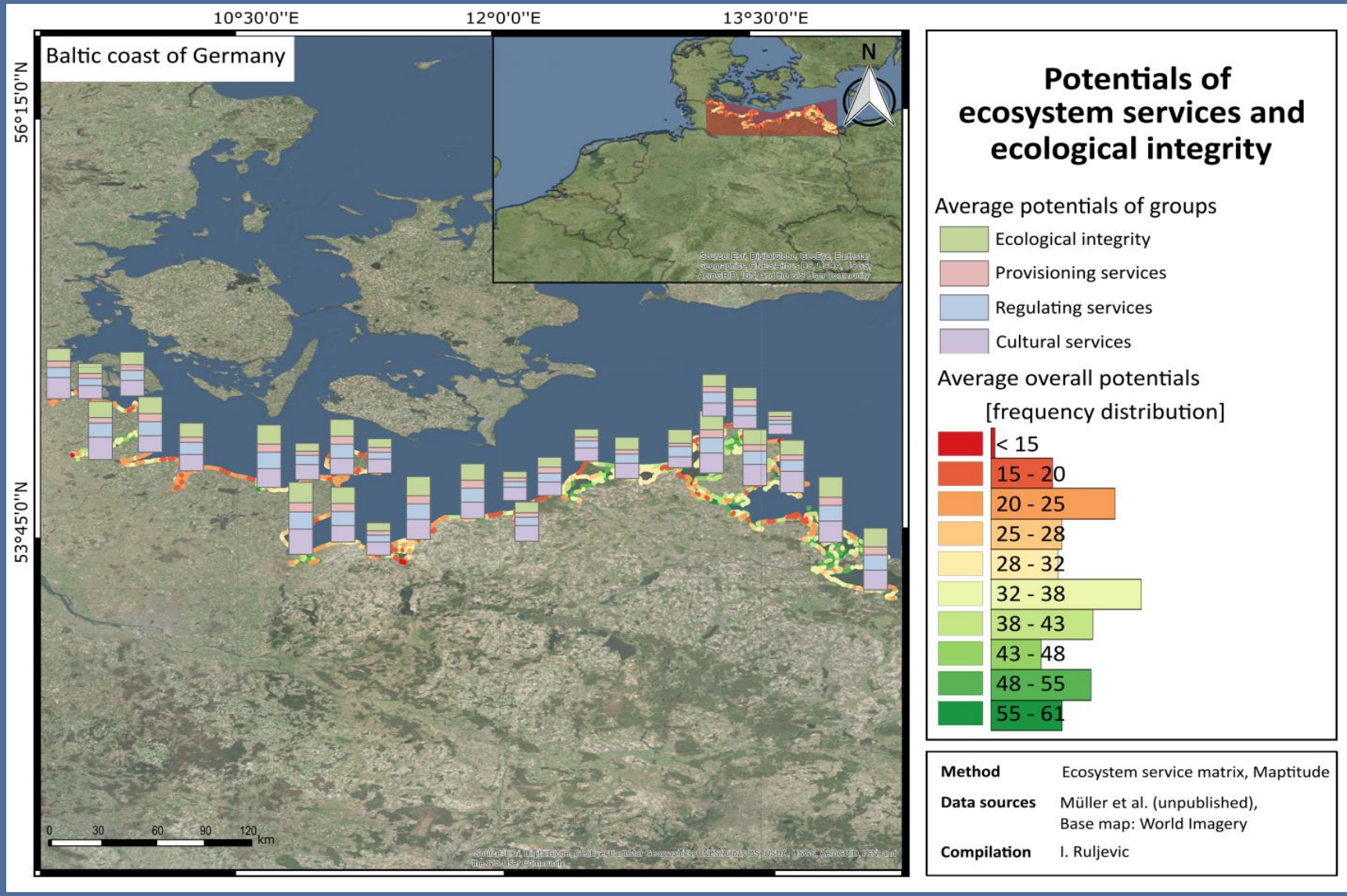
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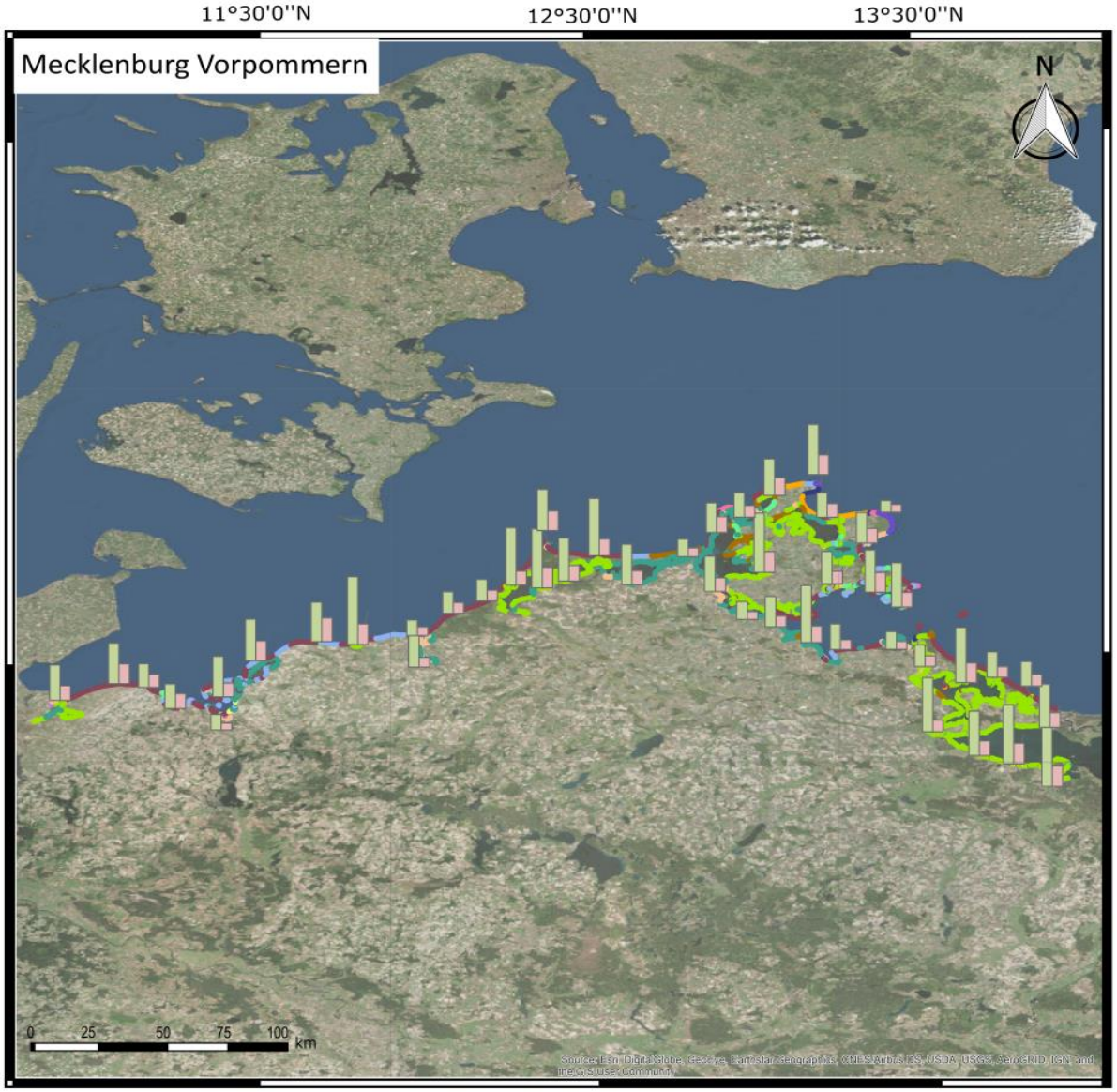
53°45'0"N
Baltic coast of Germany
N
0 30 60 90 120 km
Potentials of ecosystem services and ecological integrity
Average potentials of groups
Ecological integrity
Provisioning services
Regulating services
Cultural services
Average overall potentials
[frequency distribution]
< 15
15 - 20
20 - 25
25 - 28
28 - 32
32 - 38
38 - 43
43 - 48
48 - 55
55 - 61
Method Ecosystem service matrix, Maptitude
Data sources Müller et al. (unpublished), Base map: World Imagery
Compilation I. Ruljevic



Substrate and potentials of ecosystem services and ecological integrity

Average potentials of groups

- Ecological integrity
- Provisioning services

Substrate

- Muddy
- Salt marsh/tidal flat
- Marshes
- Beachrock
- Beach Gravel
- Beach Sand
- Mixed sand/gravel
- Stones and rocks
- Dune cliff
- Soft (nourishment/biotecnic)
- Hard coastline
- Rocky Cliff
- Vertical
- Artificial shoreline

Method	Ecosystem service matrix, Maptitude
Data sources	Müller et al. (unpublished), Base map: World Imagery
Compilation	I. Ruljevic

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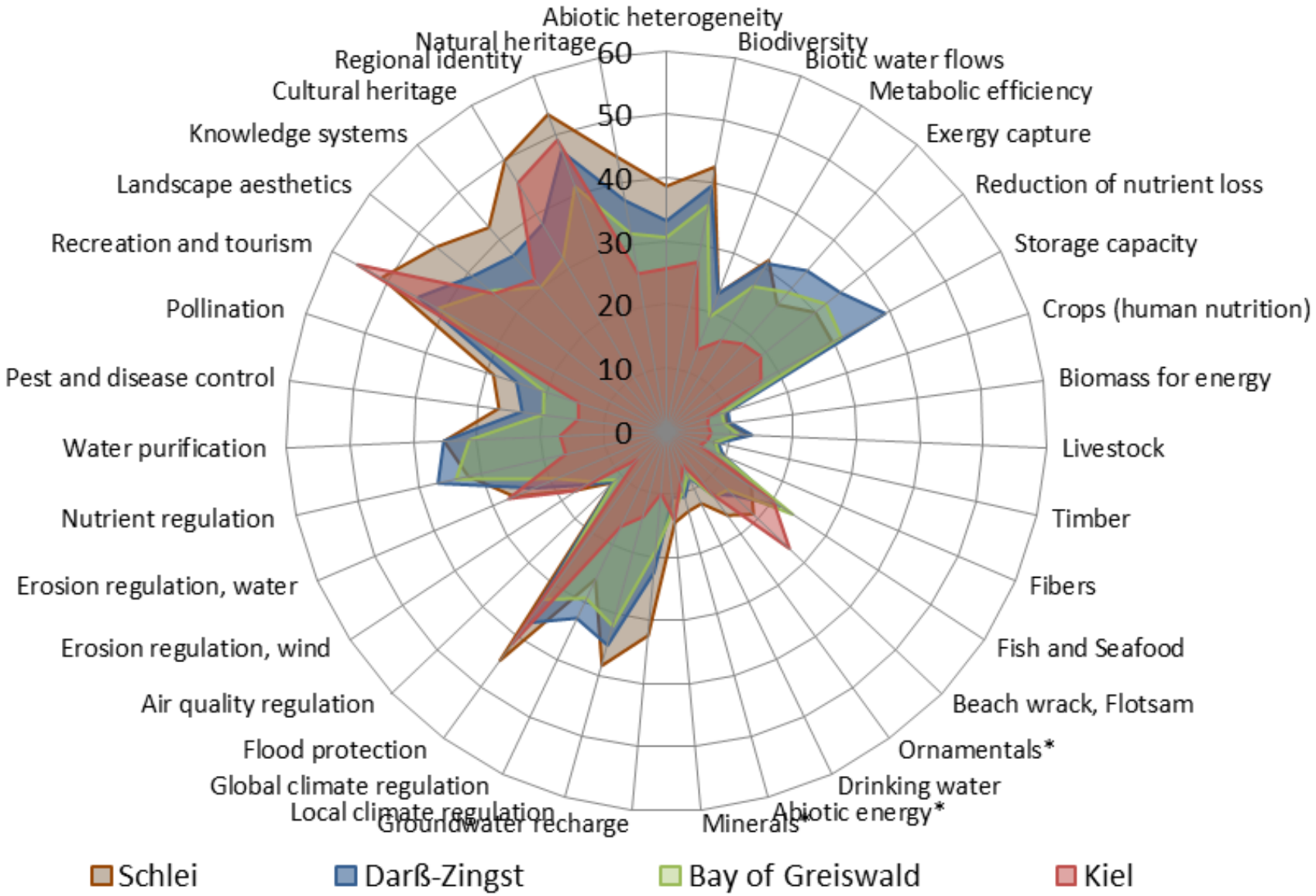
Averages values of ecosystem services of the four study



Weitere Schritte:

- Clusterung der Segmente im Ist-Zustand (bzw. Mittelwert)
- Szenarien über die Auswirkungen der Klimaänderungen im Jahre 2050 und 2100
- Szenarien für Landnutzung im Jahre 2050 und 2100 (demograph. Entwicklung)
- Abschätzung der ES im Jahre 2050 und 2100 basierend auf den Szenarien
- Clusterung der Segmente für die Jahre 2050 und 2100 (bzw. Mittelwert)
- Erstellung eines Vulnerabilitätsindex
- Ableitung von Managementplänen, Prioritätenliste
- (Erweiterung um Ergebnisse aus HN-Modellierungen, Sedimenttransport, Sedimentverfügbarkeit an sandigen Küsten etc.)

Ich danke für Ihre Aufmerksamkeit