VindKör - Wind Choir

Verktyg för strategisk planering genom bedömning av vindkraft kumulativa miljöeffekter

Sverker Molander, Environmental Systems Analysis, Chalmers University of Technology

Tryggve Sigurdson, Ecogain

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COMPARING WIND POWER LOCATIONS

- Such a comparison needs to consider
  - the distribution of the wind resource, the technology used and techno-economic factors,
  - cumulative environmental impacts of wind farms and **all other significant stressor sources**
- The tool aims to enable comparisons of
  - wind power sites,
  - effects of existing stressors and wind power stressors,
  - various wind power technologies.

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COMPARING WIND POWER LOCATIONS

– techno-economic factors

- The wind resource
  - Geographical distribution
  - Temporal distribution
  - Other factors (turbulence due to topography…?)
- The technology
  - Hight
  - Construction/design (?)
- The location
  - New roads (distance to existing)
  - New power lines and stations (distance to existing and type of lines)

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COMPARING WIND POWER LOCATIONS

– cumulative environmental impacts

- Extensive range of "stressors" - e.g. noise, pollution, toxins, land use change…
- High resolution map of "endpoints"
  - Habitats (based on the EUNIS classification)
  - Key fauna such as raptors, bats, reindeer and also - humans
- A simple model connecting the existance of stressors and endpoints ("Regional and relative risk model", Landis and Wiegers, 1997, "cumulative effect mapping" Halpern et al. 2008)
- A GIS, using the same method as HELCOM HOLAS and HaV's SYMPHONY

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25 Stressors

Chemical mechanisms

- Plant nutrients, eutrophication
  - Emissions to water
- Acidification
  - In water
  - On land
- Toxicants
  - In water
    - Pesticides
    - Metals
  - In air
    - Tropospheric ozon
    - NOx

Biological mechanisms

- Predation
  - Hunting
  - By pets - cats
- Invasive/domestic species
  - Animals
  - Plants
  - Pathogens

Physical mechanisms

– with diffusion

- Noise
  - 50-200 Hz
  - 200-2000 Hz
- Light
  - Visible light

– without diffusion

- Barriers
  - On land
  - In water
- Buildings
  - Visibility
- Collisions
  - Cars, trains
  - Hydrokinetic turbines
  - Wind turbines
- Water construction, driving damages
  - Ditching
  - Damming
  - Driving damages
- Complete removal of original vegetation
  - Temporary
  - Permanent

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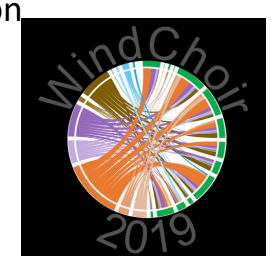

48 Endpoints for habitats (EUNIS)

Coastal habitats

- Coastal dunes and sandy shores
- Coastal shingle
- Rock cliffs, ledges and shores, including the supralittoral

Inland surface waters

- Permanent oligotrophic lakes, ponds and pools
- Permanent mesotrophic lakes, ponds and pools
- Permanent eutrophic lakes, ponds and pools
- Permanent non-tidal, fast, turbulent watercourses
- Permanent non-tidal, smooth-flowing watercourses
- Littoral zone of inland surface waterbodies

Mires, bogs and fens

- Raised bogs
- Valley mires, poor fens and transition mires
- Aapa, palsa and polygon mires
- Base-rich fens and calcareous spring mires
- Sedge and reedbeds, normally without free-standing water

Grasslands and lands dominated by forbs, mosses or lichens

- Dry grasslands
- Mesic grasslands
- Seasonally wet and wet grasslands
- Alpine and subalpine grasslands

Inland unvegetated or sparsely vegetated habitats

- Screes
- Inland cliffs, rock pavements and outcrops
- Snow or ice-dominated habitats
- Miscellaneous inland habitats with very sparse or no vegetation

Regularly or recently cultivated agricultural, horticultural and domestic habitats

- **Intensive unmixed crops**

Heathland, scrub and tundra

- Subarctic and alpine dwarf Salix scrub
- Subarctic and alpine dwarf Salix scrub
- Lowland to montane temperate and submediterranean Juniperus scrub
- Temperate Rubus scrub
- Corylus avellana scrub
- Arctic, boreal and alpine riparian scrub
- Salix fen scrub

Forest and other wooded land

- Temperate and boreal Salix and Populus riparian forest
- Riparian Alnus forest
- Temperate and boreal hardwood riparian forest
- Broadleaved swamp forest on non-acid peat
- Broadleaved swamp forest on acid peat
- Fagus forest on non-acid soils
- Fagus forest on acid soils
- Acidophilous Quercus forest
- Boreal-nemoral mountain Betula forest on mineral soils
- Carpinus and Quercus mesic deciduous forest
- Ravine forest
- Picea taiga forest
- Pinus sylvestris taiga forest
- Pinus bog forest
- Picea mire forest
- **Coniferous planted forests of non site-native trees**
- **Coniferous planted forests of site-native trees**
- Lines of trees, small anthropogenic forests, recently felled forest, early-stage forest and coppice

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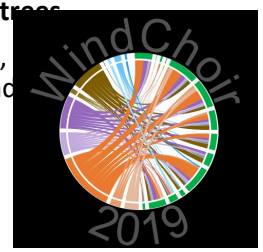

25 endpoints for fauna species/groups

Bats
- Occurrence
- Hibernation areas

Birds
- Eagle habitat
- Birds breeding habitat
- Birds resting and wintering areas

Herptiles
- Amphibians
- Reptiles

Terrestrial fauna
- Ungulates
- Big predators
- Rodents

Aquatic fauna
- Fish
- Benthic insects
- Molluscs

(Insects, spiders)
- Beetles
- Butterflies
- Hymenopterans
- Hemipterans
- Dipterans
- Orthopterans
- Spiders

Reindeer
- Reindeer calving areas
- Reindeer grazing areas
- Reindeer migration routes

Humans
- Disturbance/Noise

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A SIMPLE MODEL APPLIED IN EACH PIXEL

The cumulative environmental impact (P) in a location is the sum product of all existing stressors (B), endpoints (E) on the location and the sensitivity (K) of each endpoint for each pressure:

$$P_{sum} = \sum_{i=1}^{n} \sum_{j=1}^{m} B_i \times E_j \times K_{i,j}$$

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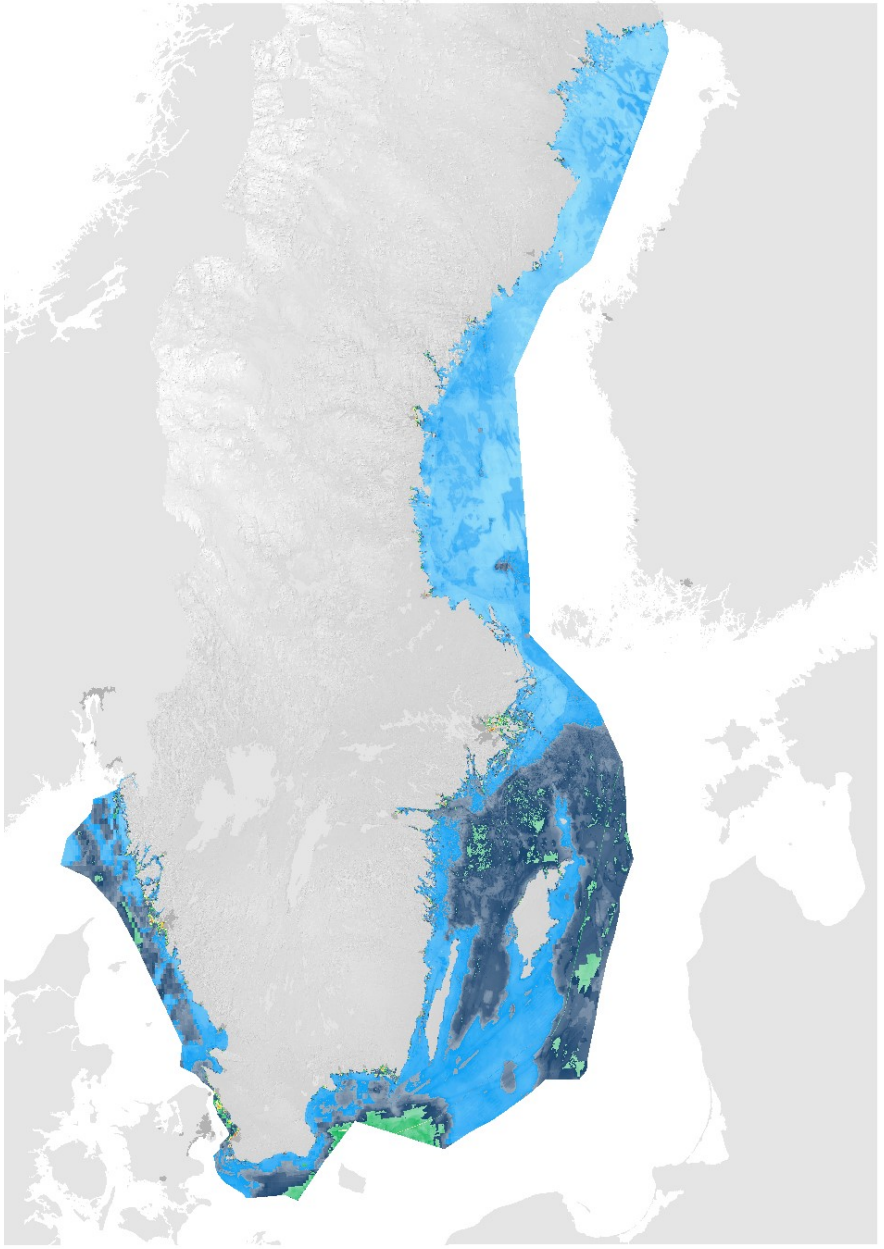
Current cumulative environmental impact map from Symphony



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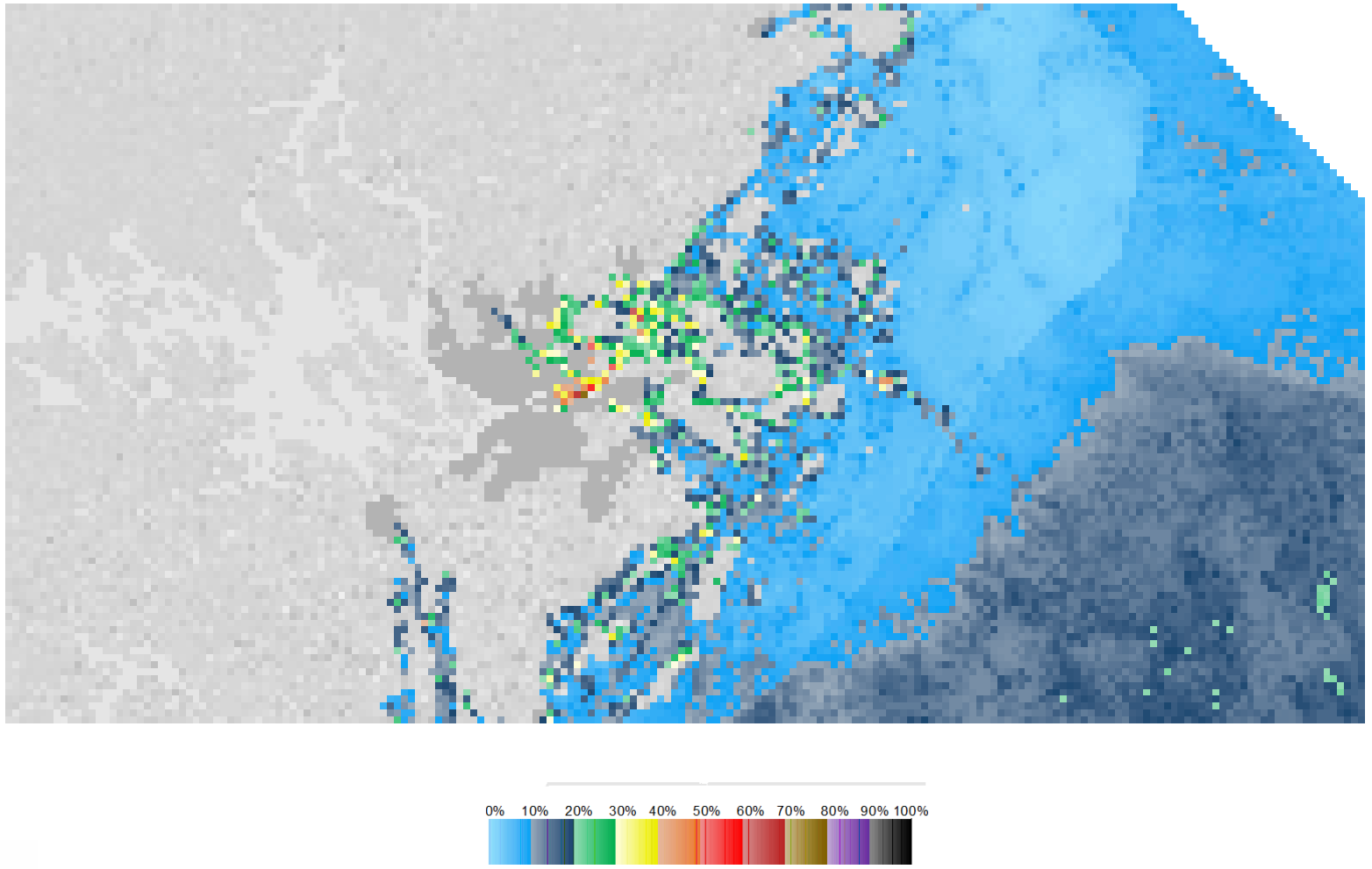
Current impact map from Symphony



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”DEPENDENTS”

- Our aim
  - A functional, user-friendly GIS tool
    - Different needs for different user categories
- Project reference groups
  - Geodata providers
  - End-users (wind power developers, authorities)
  - ”Endpoint stakeholders”
  - Techno-economic experts

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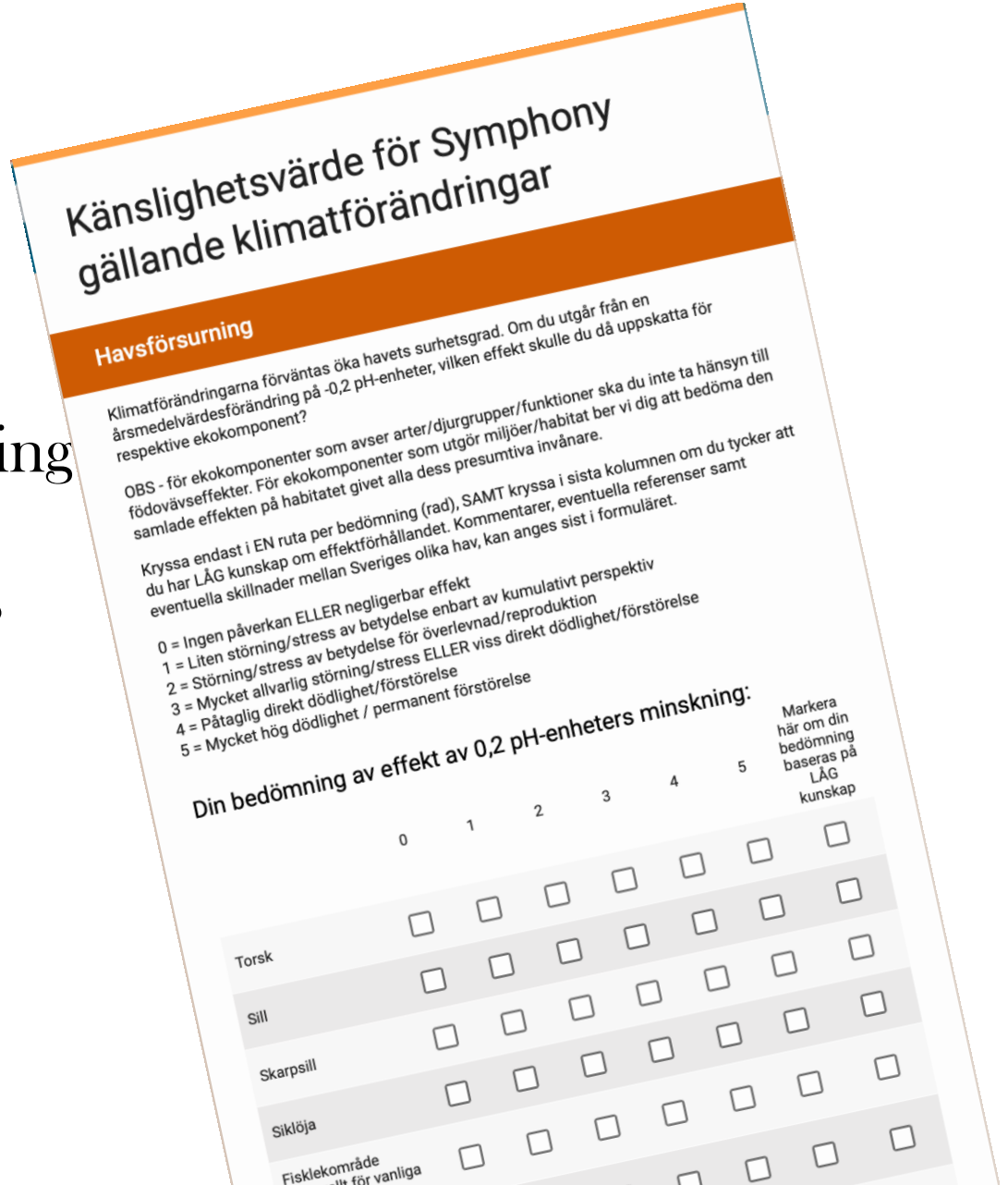
DATA SOURCES

- Stressors, GIS-layers 10*10m
- Endpoints, GIS-layers 10*10m
- Evidence-based sensitivities linking all stressors to all endpoints. Expert judgement of sensitivities by questionnaire.



Känslighetsvärde för Symphony gällande klimatförändringar

Havsförsurning

Klimatförändringarna förväntas öka havets surhetsgrad. Om du utgår från en årsmedelvärdesförändring på -0,2 pH-enheter, vilken effekt skulle du då uppskatta för respektive ekokomponent?

OBS - för ekokomponenter som avser arter/djurgrupper/funktioner ska du inte ta hänsyn till födovävseffekter. För ekokomponenter som utgör miljöer/habitat ber vi dig att bedöma den samlade effekten på habitatet givet alla dess presumtiva invånare.

Kryssa endast i EN ruta per bedömning (rad), SAMT kryssa i sista kolumnen om du tycker att du har LÅG kunskap om effektförhållandet. Kommentarer, eventuella referenser samt eventuella skillnader mellan Sveriges olika hav, kan anges sist i formuläret.

0 = Ingen påverkan ELLER negligerbar effekt
1 = Liten störning/stress av betydelse enbart av kumulativt perspektiv
2 = Störning/stress av betydelse för överlevnad/reproduktion
3 = Mycket allvarlig störning/stress ELLER viss direkt dödlighet/förstörelse
4 = Påtaglig direkt dödlighet/förstörelse
5 = Mycket hög dödlighet / permanent förstörelse

Din bedömning av effekt av 0,2 pH-enheters minskning:

	0	1	2	3	4	5	Markera här om din bedömning baseras på LÅG kunskap
Torsk							
Sill							
Skarpsill							
Siklöja							
Fisklekområde							

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DATA SOURCES

OUR TIMING IS PERFECT

- A perfect data storm
  - New national land cover (NMD) with 10 meter resolution
  - New national altitude and vegetation height model with 2 meter resolution
  - New compiled model over water bodies
  - New European Wind Atlas
- Exciting technological developments
  - Increased wind power potential (techo-economical development)
  - Technological breakthrough in calculation capacity

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TIME PLAN

- Total 2 years November 2018 - December 2020
- Identifying stressors and endpoints ~ Spring 2019
- Sensitivity matrix ~ From autumn 2019
- Technically functional base model December 2019, some data in place
- Prototypes with extended functionality implemented ~ June 2020
  - Parallel calculation of risk model and models for techno-economic factors
- Calculated impact from wind power scenarios ~ August 2020
- Future considerations, e.g lateral effects (connectivity), and threshold/stop values

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PROJECT TEAM

GÖTEBORGS UNIVERSITET

CHALMERS

ecogain living planet solutions

MEDINS HAVS OCH VATTENKONSULTER

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