Information System as a Tool for Marine Spatial Planning

The SmartSea Vision and a Prototype

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Context and motivation

- Finland is investing in strategic research with an emphasis on strong societal impact.
- Seas and oceans are recognized as drivers for European economy and having great potential for innovation and growth.
- "SmartSea" is a joint effort to take a multi-disciplinary look at the Gulf of Bothnia of the Baltic Sea.

Gulf of Bothnia is a shallow, relatively undeveloped sea area that has an area of 117,000 km².
Maritime Spatial Planning (MSP)

Environmental sustainability
- e. health, production, resiliency

Security

Public, collaborative process

Social needs

Political process

Economic development
- Offshore wind energy
- Seabed mining
- Marine biotechnology
- Aquaculture
- Coastal tourism
- Transportation
- ...

Climate change

Long-term perspective

Integrated assessment

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Requirements for an information system supporting MSP

- Access to existing spatial data
- Understanding spatial interactions
- Management of multiple objectives
- Collaborative/participatory data collection
- Site selection
- Impact assessment
- Understanding and assessing cumulative impacts
- Environmental valuation
- Conflict assessment
- Collaborative conflict resolution
- Embracing change, learning, and adapting
- ...

=> no one tool satisfies all requirements
Information environment

- A concept for user-centered analysis
- Preferred tools
- Organization policies
- Standards for data access/transfer
- Internet
- Open access to data, Free and open source software

- MSP
  - Communities: Planners, Researchers, Stakeholders, Public
  - Platforms: Collaboration, Participatory Mapping, Decision Support
Characteristics of MSP

- Dynamics
- Multiple levels of planning
- Planning is still unstructured
- Sectoral ambitions are strong
- Spatial focus can be on large areas or local
- Temporal horizon can vary considerably
Prototype

- Integrative database
  - Datasets
  - Planning (spatial modeling)
  - Model for environmental impact
- Dataset development
- Database design
- Services
  - Modeling API
  - WMTS
- Browser client
- Desktop GIS client
Integrative database

- The planning process: what is being done?
- The input datasets: from where?, how they are produced?
- Presentation styles
- Spatial modeling: where are good locations for this? what is this location good for?
- Activities cause pressures on the environment, pressures cause impacts on ecosystem components

... work in progress:
- Impact modeling, spatial impacts
- Combination of pressures and impacts
- Risk assessment
Two levels of planning:
1. define types of uses and layers
2. allocate areas for uses

Use class = what uses are allowed / disallowed in a zone

Layer class = "Suitability", "Allocation", "Value", "Impact", etc.

Rule system = how the suitability/value/something else is computed and from what data
From results To data
A specific use class implies specific activities will take place.

A specific activity causes a specific pressure in a given range.

A specific pressure causes a specific impact on a given ecosystem component.

Impacts on ecosystem components can be combined.
All classes

- **Show all Plans edit this one**
  - id: 13
  - name: test
  - Extra datasets
    - Lohiträät
    - Etäisyys asutuiseen
    - Distance to house

- **Show all Uses edit this one**
  - id: 29
  - name: test. Active recreation
  - plan: test
  - use_class: Active recreation
  - Activities
    - Vacation homes
    - Motor sports on water
    - Fishing, which affects the seafloor
    - Beach restoration
    - Boat traffic in shallow water
    - Buoys, anchoring, seatmarks
    - Motorboating
    - Atmospheric deposition
    - Hunting
    - Climate change

- Ecosystem impacts
  - Coastal fish < 0 m: 2.19 < 500 m: 2.36 < 1 km: 2.33 > 20 km: 2.11
  - Pelagic fish < 0 m: 1.70 < 500 m: 1.95 < 1 km: 1.89 > 20 km: 1.48
  - Seabirds < 0 m: 3.07 < 500 m: 3.96 < 1 km: 3.96 > 20 km: 3.05
  - Seals < 0 m: 3.06 < 500 m: 3.11 < 1 km: 3.11 > 20 km: 3.00
  - Spawning grounds < 0 m: 3.00 < 500 m: 3.05 < 1 km: 3.05 > 20 km: 3.00
  - Vegetated muddy bottoms < 0 m: 3.82 < 500 m: 3.97 < 1 km: 3.97 > 20 km: 3.12
  - Vegetated rocky and stony bottoms < 0 m: 3.96 < 500 m: 3.99 < 1 km: 3.99 > 20 km: 3.80
  - Vegetated sandy bottoms < 0 m: 3.94 < 500 m: 3.99 < 1 km: 3.99 > 20 km: 3.68

- Layers
  - test. Active recreation. Allocation edit
  - test. Active recreation. Suitability edit
  - test. Active recreation. Impact edit
  - Utility create
Impacts on ecosystem components should be combined spatially.
Database technology stack

- RDBMS (PostgreSQL) (SQLite for tests)
  - > 30 tables, heavy use of foreign keys
- ORM (DBIx::Class)
  - Classes for each table
  - Objects represent rows in tables or selects on tables
  - Automates references and relationships
- Wrapper class for a "generic" web-page (HTML) oriented CRUD (create-read-update-delete) API
  - Conceptual "parent-child" relationship can take many forms in the RDBMS and ORM is not (at least a full) a solution
  - A RESTful API may be what is needed a little further down the line
Web Map Tile Service (WMTS)

- Service of map tiles of predefined content, extent, and resolution
- Limited set of resolutions
  - One step finer resolution tile is $\frac{1}{4}$ of a tile of coarser resolution
- Very good user experience in a browser
- WMTS is commonly viewed as a service of predrawn tiles
  - In this work we implemented a plugin mechanism to modify or create the requested tiles
- Depending on the client library (QGIS: no, OpenLayers: yes) the "predefined content" rule can be relaxed
WMTS 1/2

- Serving a map tile can happen according to several standards but has a typical pipeline
- Typically tiles are stored as files in a file system
- With some additional code tiles can be generated on-the-fly by, e.g., clipping a single (or virtual) file
WMTS 2/2

- Hooking a plugin into specific locations in the service, it can be turned into a dynamic service.

- Even more dynamism can be added to the service by user identification (cookies, user authentication).

- OpenLayers WMTS client does not query capabilities, QGIS does => less flexibility with QGIS.
Conclusions, Open Questions

- Is our analysis, and thus the vision (spatial modeling), and thus the software development correct?
- The required computing power of dynamic map service?
- Impact modeling, integrated risk assessment are complex tasks
- The end user community is still emerging/organizing itself
- What will be important:
  - Stakeholder/citizen participation?
  - Spatial design?
Thank you!

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