Density mapping of ship traffic
FOSS4G – Boston 2017

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Introduction

Norwegian Defence Research Establishment (FFI) stores data from sensors like AIS$^1$, LRIT$^2$ and VMS$^3$ in databases. These historical data on ship positions and metadata, accumulated, enables the creation of density maps of the ship traffic.

Density maps give the opportunity to visually analyze and understand the ship traffic patterns and behavior.

$^1$AIS – Automatic Identification System (Position information and static/voyage related data)
$^2$LRIT – Long Range Identification and Tracking
$^3$VMS – Vessel Monitoring System (fishery related)
Ship traffic data used in the density maps

- **AIS** (*Messages 1, 2, 3, 18 and 19 – position messages*)
  - Norwegian land based AIS-network *(incl. Svalbard, Bear Island, Offshore installations etc.)*
  - Norwegian AIS-satellites
  - ISS (NORAIS)
  - EXACT EARTH
  - LUXSPACE
  - SPIRE SAT
  - Other North European AIS sources

- **Vessel Monitoring System (VMS)**
  - Position messages only

- **Long Rang Identification and Tracking (LRIT)**
  - Conveyed from Norwegian Costal Administration (NCA) as AIS-data to FFI
Organizing the data
Organizing the data

Organizing step 1
remove positions on land

Organizing step 2
implementing intermediate positions

Organizing step 3
Aggregate by unique mmsi in cell for every hour

Organizing step 4
aggregate selected values monthly


Summarize time in cell

Max registered speed, total seconds and sensors holding MMSI in cell
Organizing the data

Figure 3.1 Data reduction while organizing in time and space, June 2015
Organizing the data – step 2, intermediate pos.
Organizing the data – step 2, intermediate pos. & remove position segments on land
Calculating density

The following equation shows an example for a given area over the time period of January where the scale factor is 5. $\Omega$ represents the 5 x 5 basic cell area and the density is represented as constant over the time period January 1st ($T_1$)- January 31st ($T_2$). $M$ is total amount of hours in January (744).

$$
\rho_{\Omega}(T_1, T_2) = \frac{1}{(T_2 - T_1)\text{area}(\Omega)} \sum_{k=1}^{M} \sum_{i=1}^{5} \sum_{j=1}^{5} \left( \sum_{s=1}^{N(k,i,j)} \tau_{k,i,j}^s \right)
$$

Here $\tau_{k,i,j}^s$ is visit time of ship track $s$ in basic cell $(i, j)$ in area $\Omega$ at time step $k$. $N(k, i, j)$ is the number of ship tracks intersecting the space-time cell $(k, i, j)$. 
Creating the density map – scale factor

- 10x10
- 5x5

[Diagram showing different scale factors for creating a density map]
Density mapping

GeoPackage – vector

Create/merge etc. with:
- Spatialite
- GDAL/OGR

Ship types classified by StatCode 5 IHS Fairplay (Lloyds)
4 different levels
Web Processing Services (WPS)

- and executables

- creating GeoPackages
- merging GeoPackages
- extracting GeoPackage layers (i.e., creating a new GeoPackage based on desired attributes, e.g. a specific ship type, area)
Product example
March 2017
Only Satellite data
All ship types
Product example
March 2017
Only Satellite data
All ship types
WITHOUT Interpolated segments
Product examples – Offshore related traffic
Product examples – SAT coverage (no color styling)

AISSAT 1/2

NORAIS - ISS
Product examples – smaller area

Oslo Fjord January 2015
Product examples - Maximum registered speed
Product examples – reported/interpolated
Product examples – interpolated & maxsog
The “White, Grey and Black (WGB) list” presents the full spectrum, from quality flags to flags with a poor performance that are considered high or very high risk. It is based on the total number of inspections and detentions over a 3-year rolling period for flags with at least 30 inspections in the period.
Product examples – Voyage planning/Nav.plan.

- Traffic separation lanes
- Ferry traffic
- Speed
- Main traffic lanes
- Fishery areas
- ++

Desember 2015
Product examples – Voyage planning/Nav.plan.

Ferry (Ro-Ro carrier/passenger)

Ferry (Ro-Ro carrier/passenger)
At night: 22-04

Desember 2015
Product examples – Voyage planning/Nav.plan.

Max Sog > 30 kts

Night 22-04 Max Sog > 30 kts

Desember 2015
Analysis of transport ships

2016
Specific pre-selected MMSIs
FOSS(4G) experience

- In general C# support is good
- OGR write GPKG is very slow! (driver issue?)
- In Visual Studio NuGet gives most FOSS
- Used GISInternals (Tamas Szekeres) for GDAL/OGR C# drivers/wrappers (http://www.gisinternals.com)
FOSS(4G) used in project