ESSnet pilot AIS data

Anke Consten, Eleni Bisioti and Olav Grøndal
(23 February 2017, Sofia)
Overview

1. Introduction
2. Deliverables ESSnet pilot AIS data
3. Data access and handling
4. Quality of AIS data
5. Results so far
6. Improving quality of current maritime statistics
7. To do
8. Discussion/Questions
1. Introduction
Participants

- GUS (Central Statistical Office of Poland)
- Statistics Office of Denmark
- Statistisk sentralbyrå (Statistics Norway)
Objective AIS data

Can real-time measurement data of ship positions (measured by the so-called AIS-system) be used:
1) to improve quality and internal comparability of existing statistics
2) for new statistical products relevant for the ESS

Pilot consists of two phases:
**Phase 1:** February 2016 - July 2017
**Phase 2:** August 2017 - May 2018
The **Automatic Identification System** (AIS) is an automatic tracking system on ships to identify and locate vessels by electronically exchanging data with nearby ships, AIS base stations, and satellites.

International voyaging ships with gross tonnage (GT) of 300 or more tons, and all the passenger ships regardless of size transmit Automatic Identification Signal (AIS) every 2 – 10 sec their position.

Terrestrial Stations, Cost Guards and Satellites receive AIS data. AIS data has the same structure worldwide.

Contributes to the
- safety of navigation
- traffic management
## AIS data

<table>
<thead>
<tr>
<th>FIELD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMESTAMP</td>
<td>Time of ship position detection / reception (in UTC)</td>
</tr>
<tr>
<td>MMSI</td>
<td>Ship's MMSI number sent with the AIS notification</td>
</tr>
<tr>
<td>Lat</td>
<td>Latitude of the ship position (in decimal degrees)</td>
</tr>
<tr>
<td>Lon</td>
<td>Longitude of the ship position (in decimal degrees)</td>
</tr>
<tr>
<td>Speed over ground</td>
<td>Speed over ground (in knots)</td>
</tr>
<tr>
<td>Course over ground</td>
<td>Course over ground (in degrees)</td>
</tr>
<tr>
<td>Heading</td>
<td>True heading (in degrees (0-359))</td>
</tr>
<tr>
<td>IMO number</td>
<td>Ship's IMO number sent with the AIS notification</td>
</tr>
<tr>
<td>Shipname</td>
<td>Ship's vessel name sent with the AIS notification</td>
</tr>
<tr>
<td>Callsign</td>
<td>Ship's Callsign sent with the AIS notification</td>
</tr>
<tr>
<td>Type of ship</td>
<td>Ship type</td>
</tr>
<tr>
<td>Draught</td>
<td>Maximum Present Static Draught (in meters)</td>
</tr>
<tr>
<td>Destination</td>
<td>Destination</td>
</tr>
</tbody>
</table>
AIS messages

Location records -> every 2-10 secs (dep. on speed), 3 mins at anchor contains MMSI

Static records -> every 6 mins contains MMSI & IMO (also type of ship, not very detailed)

MMSI -> 9 digits

IMO -> 7 digits: 6 digits + check digit (e.g. 9074729: (9*7) + (0*6)+(7*5)+...=139)
2. Deliverables ESSnet pilot AIS
Deliverables (phase 1)

AIS data access
investigate possibilities of obtaining raw and processed AIS data at European level

Data Handling
process and store the data in database so it can be used for consistent multiple outputs

Methodology and Techniques
• build a reference frame of ships in European waters
• linking maritime statistics to AIS-data
• using AIS to improve current statistics
• calculate the number of ships in a certain area
• visualising results
3. Data access and handling
Data access

- Dirkzwager
- Marine Traffic
- Kystverket
- Hellenic Coast Guard
- JRC
- European Maritime Safety Agency (EMSA)
Data access

Raw AIS data on European level from Royal Dirkzwager (October 2015 - April 2016)

- Data from land based stations only, covering Europe and some non-European countries

- Satellite data not included
Data handling: programming language and environment

Raw AIS Data -> Decoding/Conversion -> Data Processing -> Data Reduction -> Analysing data

Alternatives:
- AISLIB (Java)
- Python

Alternatives:
- Hadoop
- Spark (Python/Scala)

Alternatives:
- SAS
- SPSS
- R
- SQL
4. Quality of AIS data
4.1 First Results on Quality of AIS data
General remarks on quality of AIS data

- Radio signal: sensitive to meteorological or magnetic factors
- Receivers on land: signals ~40 sea miles
- Does not contain time of reception of the receiver, timestamp not always reliable
- Receivers have limited timeslots
- AIS transponder can be switched off; information entered by hand not always reliable
First insights into the quality of AIS data (coverage)

https://maartenpouwels.carto.com/viz/8d319f16-8195-11e6-af04-0ec1babd8e5/public_map
First insights into the quality of AIS data (following a ship)

https://maartenpouwels.carto.com/viz/8d2f3bde-8197-11e6-bf3f-0ee66e2c9693/public_map
4.2 Quality of AIS data – Denmark preliminary results
Based on live streaming data from Danish Maritime Authority

- Good quality link with port records
- Possible to produce more timely and new statistics
- Coverage problems with national data
- Detected lots of issues with manual information updates
4.3 Quality of AIS data – Greek preliminary results
Exploring AIS data - Quality issues

National AIS Data

- Started from scratch
- Received encoded raw AIS data from HCG
- Data Decoded - uploaded to ELSTAT servers
- National Dataset

Dirkzwager AIS Data

- Connected to Sandbox
- Understand and explore AIS Data
- Re-use developed Scala code and produce some new
- National Frame

National AIS Data

- National Dataset

Dirkzwager AIS Data

- National Frame

Compare
Type of Ship in European Waters (*AIS data from Dirkzwager*)

- Cargo: 31%
- Tankers: 18%
- Other Vessels: 12%
- Special craft: 6%
- Passenger Ships: 5%
- High speed craft (HSC): 1%
- Wing in ground (WIG): 1%
- Unvalid or zero: 21%
- Other Type of ships: 5%
Ship flags and type of ship in national AIS data

Figure 1: Ship flags in Greek Seas

Figure 2: Ship types in Greek Seas
Preliminary Results – Following a ship
(Comparison of AIS data from Dirkzwager to National AIS data)
5. Results so far
Building a preliminary reference frame of maritime ships in European waters

- Selecting valid MMSI-IMO couples from static messages

- Scala code to make this European reference frame -> 20 minutes for 6 months of data
Linking European AIS data to maritime statistics

Port visits by maritime ships for Poland (Świnoujście) and the Netherlands (Amsterdam) for one day:

– Linking MMSI’s from reference frame of maritime ships to location messages, selecting specific locations (ports)

– Compare these ships with ships from the maritime port statistics
Linking European AIS data to maritime statistics (Poland)

All ships from maritime data present in AIS
Linking European AIS data to maritime statistics (the Netherlands)

All ships from maritime data present in AIS
Linking European AIS data to maritime statistics (the Netherlands)

Too many ships..
Port visits by maritime ships for Poland (Świnoujście) and the Netherlands (Amsterdam) for one day:

- All ships from maritime stats in AIS

- AIS contains more ships than maritime stats:
  - Ships missing from maritime statistics (e.g. Velsen versus Amsterdam)
  - Random errors due to incorrect MMSI-IMO couples -> improve reference frame of ships by selecting most frequent couples
  - Inland/other ships (tugs)
  - (multiple) Arrivals -> improve algorithm to count visits
Linking European AIS data to maritime statistics

Algorithm for port visits (dealing with multiple entries and glitches):

- Select ships in area using reference frame of ships
- Median filter over 10 mins for the location files
- Define block of visit (connect intervals)
- Speed <0.2 knots
Linking European AIS data to maritime statistics

AIS data as a backbone for maritime statistics: number of port visits can yield more detail than maritime statistics (e.g. time and distance in port)

Issues:
- Type of ship too restricted
- No direct information on goods loaded/unloaded (tugs)
6. Improving quality of current maritime statistics
European AIS data can solve current problems in maritime statistics

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Problem</th>
<th>Idea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Information on the next destination of departing ships is incomplete. This can also be used to construct new tables with to and from traffic matrixes</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>2.</td>
<td>Not all ports are well-specified, they are sometimes misclassified by port authorities</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>3.</td>
<td>Distance travelled per ship is now based on an inaccurate average distance matrix for ports</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>4.</td>
<td>Fluvio-maritime transport is incomplete</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>5.</td>
<td>Investigate relationship between maritime and inland waterway transport</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>6.</td>
<td>Intra-port travel distances are unknown</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>7.</td>
<td>Missing Information on travel routes for goods to estimate unit prices for transit trade statistics</td>
<td>Determining ship routes</td>
</tr>
<tr>
<td>8.</td>
<td>Current statistics on fuel consumption and emissions are not accurate enough.</td>
<td>Improve existing statistics on fuel consumption and emissions.</td>
</tr>
<tr>
<td>9.</td>
<td>Small ports experience response burden from the survey</td>
<td>Reduce response burden for some ports</td>
</tr>
<tr>
<td>10.</td>
<td>Customers need faster information on maritime statistics</td>
<td>Accelerate publishing speed for some maritime statistics</td>
</tr>
<tr>
<td>11.</td>
<td>Experimental ideas: now-cast economic time series on the basis of AIS</td>
<td>Experimental: linking AIS data to economic statistics</td>
</tr>
</tbody>
</table>
7. To do
To do in near future (July 2017)

- Optimize algorithm for port visits
- Quality report
- Optimize and check algorithm for traffic analyses
- Execute PoC’s for ideas to improve statistics
- European questionnaire:
  - reduce response burden
  - speeding up publication of maritime statistics
  - other ideas (current/new statistics)
To do in SGA-2 (deliverables)

- Report on estimating emissions: description of methodology for calculating emissions, model to be created and results of testing the model
- Report on possible new statistical output based on European AIS data
- Consolidated report on project results including a cost-benefit analysis of using AIS data for official statistics
8. Discussion/Questions

Email: acon@cbs.nl
Site: https://webgate.ec.europa.eu/ fpfis/mwikis/essnetbigdata/