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Traffic censuses and geospatial statistics:
Other geospatial applications in transport statistics

Visualising Inland Water Data

Note by the secretariat

Summary

This document describes efforts by the secretariat in improving the visualization of inland waterway statistics, in particular by producing a census-like traffic output using origin-destination tonnage data collected by Eurostat. This was based on a request from the Working Party on Inland Water Transport (SC.3) to produce a census for the E-Waterway Network.

I. Background

1. The UNECE E-Road and E-Rail censuses collect infrastructure and traffic information on the main highways and rail lines of international importance, as defined in the European Agreement on Main. International Traffic Arteries (AGR) and European Agreement on Main. International Lines (AGC) agreements respectively. This allows an international view on traffic levels, enabling an understanding of key international connections, identification of potential bottlenecks and better infrastructure planning.

2. A similar exercise has not yet been done on the E Waterways network, as defined in the European Agreement on Main Inland Waterways of International Importance (AGN) agreement, which spans for more than 29,200 km. In recent years, the Working Party on Inland Water Transport (SC.3) agreed that an E Waterway census could be a useful analytical tool for policymakers in member States and will give a better understanding of the international inland waterway sector, also allowing to complement information for inland transport modes. SC.3 has requested that the Working Party on Transport Statistics (WP.6) explore this idea (ECE/TRANS/SC.3/210). Member States preferred not to consider an additional statistics collection exercise for this purpose, therefore the secretariat explored ways to produce census-like outputs for the E-Waterway network using existing data sources.

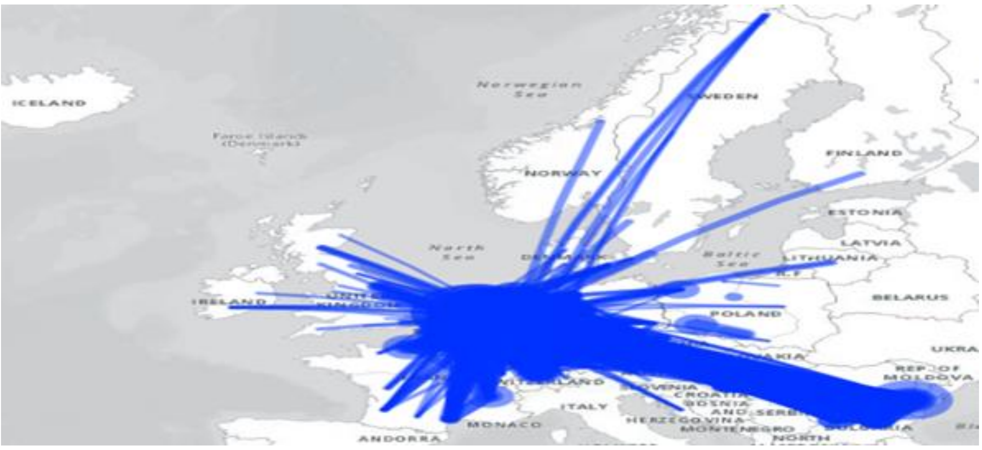
II. Activity data

3. For European Union countries, Eurostat conducts data collection of many aspects of inland water transport, including regional origin-destination goods flows. These data are available in the *iww_go_atygofl*[1] table which gives data for NUTS2[2] region origin-destination flows, on both a tonne and tonne-kilometre basis, and breaks the data down by type of good. Data are not available for Italy, Lithuania, or Sweden (nor for the United Kingdom historically), but otherwise cover all European Union states with meaningful inland water transport volumes.

III. Geospatial Network Data

4. To complement their extensive sub-national data collection, Eurostat publish the geospatial shapes of the NUTS2 regions. These can easily be combined with the activity data described above. And from this point it is somewhat straightforward to combine the activity data with the geospatial features, and plot tonnage as straight lines between the centroids of each origin-destination (Figure 1).

Figure 1
Origin-Destination plot of Inland Water tonnage, 2020. Activity data: Eurostat. Based on administrative boundaries: © EuroGeographics. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations



5. This first visualization is too noisy to provide meaningful insights. With sufficient filtering, the main routes can be ascertained, but this will still leave the challenge of understanding the magnitude of each route, as similar trajectories will overlap with each other and not give a full understanding of tonnage.

6. An additional geospatial data source is available from SC.3, namely the Shapefiles of the E Waterway network available from the Blue Book database[3]. Using these Shapefiles based on the real shapes of canals and rivers, the Eurostat data can be manipulated and summarized so tonnage is projected onto the likely routes that the traffic will pass on, for a more realistic map.

[1] https://ec.europa.eu/eurostat/databrowser/view/iww_go_atygofl/default/table?lang=en.
[2] https://ec.europa.eu/eurostat/web/nuts/background.
[3] https://apps.unece.org/AGN/1Default.aspx.

IV. Process

7. The following is a simplification of the process to visualize the inland water traffic on the real network[4].

- Turn the Shapefile into a network. A shapefile is not a network in the mathematical sense. Networks have nodes and edges, and each node knows what it is connected to.
- Translate each origin and destination point onto the nearest node of the network (based on geographical distance).
- Break each origin-destination pair into multiple edges.
- Sum up the tonnage on each edge of the network.
- Plot these results with thickness based on total tonnage passing through each edge.

V. Data Quality

8. There are many caveats to consider with visualizing these data using this approach, as the output will not necessarily agree with reality. Some are listed below, but there may be others too.

- The method takes the shortest path along the network from the centroids of the NUTS2 regions. This will not always reflect the spatial reality of where industries and transport hubs are located. Similarly, as the method uses the shortest path, no account is taken of canal width, river depth, bridge height or other navigability issues, which may affect which path vessels of certain sizes and specifications take.
- The Shapefiles of the Inland Waterway network only cover inland waterways, therefore river-sea shipping quantities may either be misrepresented (taking complicated inland journeys rather than a simpler maritime route) or not shown at all (as there is no possible inland water route between e.g. the River Rhine and the River Thames.)
- Quantities shipped from and to the same region. Currently the origin and destination points for these cases are shifted to slightly different geographical locations so that at least the quantities should appear on the visualisation in some form. These special cases are not trivial; 2 of the top 10 origin-destination flows in 2020 relate to these cases (e.g. RO22>RO22 on the Danube and NL33 to NL33 close to Rotterdam on the Rhine).
- The Eurostat data are not complete, with Italy, Lithuania, Sweden absent, as well as the United Kingdom historically not included. (The countries that Eurostat does not cover in general are also missing).
- Other statistical differences.

9. Given these possible reasons for differences with reality, national sources were sought to make comparisons. There are only limited national sources that publish traffic data on specific parts of the network (that the secretariat is aware of). Two such sources are the French Voies Navigables de France (VNF) and the German Statistical Office Destatis. Data for regions within France are available[5] (but not in a tabular or Shapefile format). While Destatis publish a table with flows on named parts of their network[6].

10. The secretariat has conducted limited order-of-magnitude checks with these sources. There are significant differences in the French data in the Nord-Pas de Calais region, with

[4] For an understanding of how to conduct similar geospatial analyses using an existing Shapefile, see https://r-spatial.org/r/2019/09/26/spatial-networks.html. The code for the process as done by the secretariat is available on request.

[5] https://www.vnf.fr/vnf/regions/vnf-nord-pas-de-calais/.

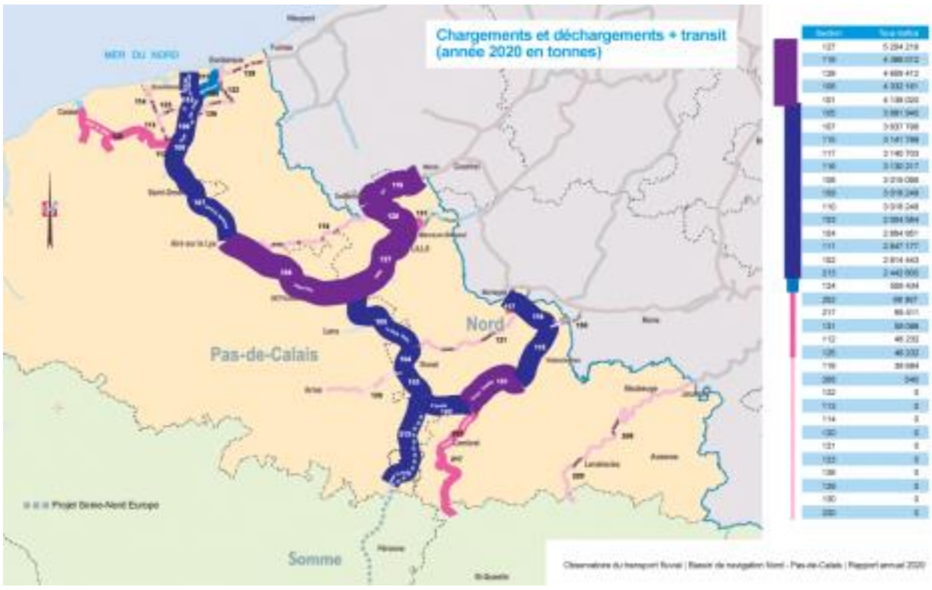
[6] www- genesis.destatis.de/ genesis/ online?language=en&sequenz=statistikTabellen&selectionname=46321#abreadcrumb.

the produced map only showing volumes between Cuinchy, Lille and the Belgian border at Deûlemont (Figure 2), while the map from VNF shows significant quantities also to the sea at Dunkerque (Figure 3). This is likely due to the data quality issues listed above (although the quantities shipped in Lille appear to be similar to the national statistics, with quantities from the national source of around 5204kt at Lille compared to 5808 kt on the map.)

Figure 2
France Nord-Pas de Calais IWW volumes from modelled map, 2020

Source: Eurostat

Figure 3
Nord Pas de Calais flows



Source: VNF

11. For Germany, the complexity of the canal network in the North of the country also led to larger differences between the sources; for example, on the Elbe Seitenkanal, Destatis reports 6357kt and the map shows 4082kt. Conversely, quantities on the start of the Rhine River close to Strasbourg show a much closer alignment, with just a 4% difference between the two sources between Strasbourg and Karlsruhe. This may highlight that the method works better where water networks are simpler.

12. Due to the above reasons, the map should not be considered an official statistics output. It is rather a visualisation of an official statistics dataset, that hopefully provides value in understanding the main flows on European waterways.

VI. Results

13. The map of 2020 inland water freight volumes can be browsed online[7]. In addition to the map, the secretariat used the results to feed into a data story (ECE/TRANS/WP.6/2023/3).

VII. Uses and further work

14. The secretariat hopes that the visualization can be useful in a number of ways. Understanding goods quantities on specific network segments allows the value of the network to national and regional economies to be ascertained. Having the statistics presented geospatially allows potential identification of modal shifting opportunities, especially when compared with other geospatial data from road and rail networks. Thus, further projects with SC.3 and/or the Working Party on Intermodal Transport and Logistics (WP.24) can be undertaken.

15. Further work in this field is possible, depending on the needs of member States. For example, trends over time or analysis by type of good can be produced. The data can of course be updated on an annual basis as well.

[7] The boundaries and names shown, and the designations used on this map do not imply official endorsement or acceptance by the United Nations. https://gis.unece.org/portal/apps/webappviewer/index.html?id=56e9186ac6e8400f8e3177957a72b9ab