

# Assisting countries to Monitor the Sustainable Development Goals: Tonne-Kilometres



## Key messages

- Understanding how goods are transported within and between countries is crucial for transport planning, transport access and environmental policy reasons. **Consistent and reliable tonne-kilometre (tkm) statistics** for all modes of inland transport are thus necessary to implement evidence-based policies.
- Countries report important differences on their modal choice for freight transport, though **road transport remains the dominant mode for inland freight transport in many ECE countries**.
- Reported rail and inland waterway tkm are substantial in some countries and network usage statistics highlight where non-road inland transport usage could increase in many others.
- These statistics feed directly to measuring **the Sustainable Development Goals, in particular Goal 9, on resilient infrastructure, and specifically indicator 9.1.2 (passenger and freight volumes, by mode of transport)**.
- Activity data can be combined with economic, infrastructure and other datasets to derive further conclusions on the importance of different modes of transport given the size of a country's economy, land area and level of infrastructure development.

## Summary

Given the complexity of monitoring the over 240 indicators across many Sustainable Development Goals, UNECE has decided to publish a series of short articles on how our existing transport statistics can be used to directly monitor transport-related SDG progress. This paper focuses on UNECE's **tonne-kilometre statistics**. Through the Web Common Questionnaire (WebCoQ) in collaboration with the International Transport Forum and Eurostat, UNECE collects data on goods transport as measured by tonne-kilometres (tkm). This document brings together tkm data on road, railway and inland waterway transport from the UNECE's transport statistics database, in order to calculate inland modal shares. Freight volumes by mode are required for tracking progress for SDG 9, in particular indicator 9.1.2 on passenger and freight volumes.

### Box 1.

A tonne-kilometre (tkm) is a unit of measurement that represents the transport of one tonne over one kilometre. This unit of measurement serves as an indication of the overall level of freight transport activity as it takes into account both the amount of goods transported and the distance transported.

These numbers can also be the basis for calculating indicators on energy efficiency, infrastructure usage, environmental impact or safety levels of different modes of transport. For example, combining energy consumption data with activity data can give an idea of the energy intensity, and also the carbon intensity, of moving one tonne of goods one kilometre by different transport modes.

## Data Availability

The following summary statistics and analyses are based on data received as of August 2018 through the aforementioned WebCoQ. The data relevant for freight modal split calculations are under road traffic (*Goods transport on national territory by road*), railway traffic (*Carriage of goods by rail*) and inland waterway traffic (*Carriage of goods by inland waterways*).

Data were taken for 2016 or the latest year available (going back no further than 2013). Under this criterion 47 countries from the ECE region had at least some of the data needed to be included in the below analyses. UNECE conducted an outreach to all member States in January 2018 and it is hoped that continued engagement will improve the response rate in the future.

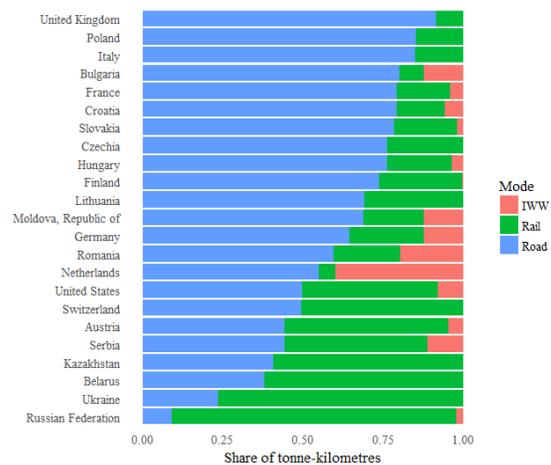
It is important to consider all metadata when contextualizing these analyses. For example, some countries report tkm only for heavy goods road vehicles. As another example, several countries report only total international transport rather than categorizing this transport as loaded or unloaded. While differences in collection such as these are sometimes obvious to spot, many others that may not be documented in the reported metadata could also be present.

## Analyses

The value in this dataset is not just in the top-level figures, but also in seeing the breakdown of different comparisons between countries relative to the size of their economies and land area, and also comparing the relative use of different transport modes. Figure 1 shows that of the 23 countries reporting data for all three inland transport modes, road transport accounts for more than 50 per cent of total tonne-kilometres in all but 8 countries (Russian Federation, Ukraine, Belarus, Kazakhstan, Serbia, Austria, Switzerland, United States). In general, rail transport is the next most prominent with inland waterways accounting for a substantial share of freight transport in several other countries (more than 10 per cent in the Netherlands, Romania, Bulgaria, Republic of Moldova, Germany and Serbia). By contrast, road transport accounts for more than 80 per cent of freight transport in the United Kingdom, Poland and Italy.

While some differences between countries are due to geography (particularly for island countries or countries with few navigable waterways), policy decisions on infrastructure spending also explain much of the variation. Further comparisons are set out in the following sections.

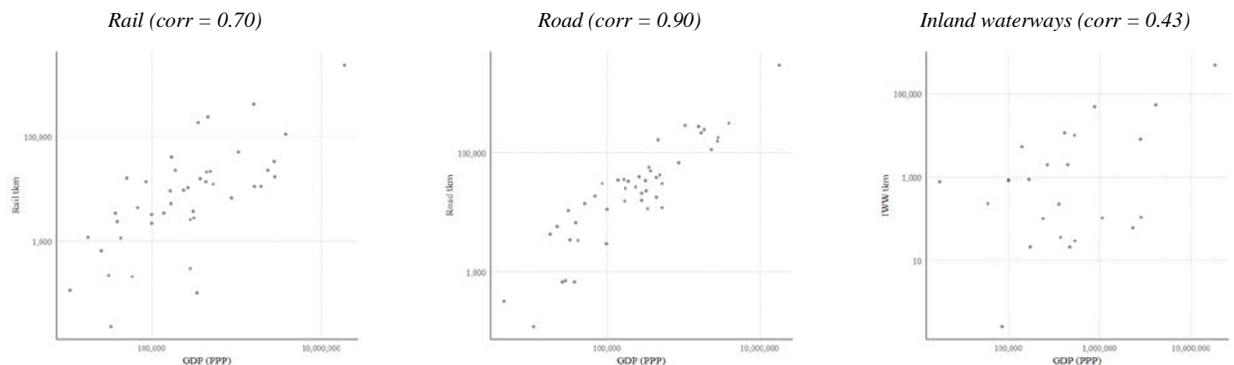
**Figure 1**  
Share of total tonne-kilometres by transport mode and country, 2016 or most recent year



Note: IWW = inland waterways. 2014 data for Germany, Republic of Moldova, Romania and Serbia. 2015 data for Italy, the Russian Federation and the United States. Data only for countries providing data for all three inland transport modes.

## Tonne-kilometres by mode with gross domestic product (GDP)

**Figure 2**  
Tonne-kilometres vs unit of gross domestic product (GDP) by transport mode and country, 2016 or most recent year



Note: Data shown in log scale. GDP shown in US dollars and purchasing power parity (PPP) of current year. 2013 data for Liechtenstein (road). 2014 data for Albania (road), Germany (rail), Republic of Moldova (all modes), Romania (inland waterways), Serbia (road), Tajikistan (road). 2015 data for Albania (rail), Canada (road and rail), Germany (road), Greece (rail), Italy (inland waterways), Luxembourg (rail and inland waterways), Norway (road), Romania (road and rail), Serbia (rail and inland waterways), Spain (rail), Turkey (road), the United States (road and inland waterways) and Uzbekistan (road and rail).

Freight transport volume is generally known to have a strong relationship with the gross domestic product (GDP) in countries. However, Figure 2 shows differences between transport modes in the strength of the relationship between transport volume and economic size. Specifically, while road transport tkm has a very close relationship with GDP, the relationships for rail and inland waterway tkm are somewhat weaker, most likely due to lack of infrastructure.

### Tonne-kilometres per unit of GDP by mode

The relative magnitude of transport in various countries normalized by the size of their economies is shown in Figure 3. By this measure, the reported road tkm usage in Lithuania is more than 15 times greater than Montenegro, Georgia and Switzerland. In most countries, road tkm usage was higher than rail and inland waterway tkm usage. For countries providing these data only Kazakhstan, Canada, Ukraine, Belarus and Russian Federation reported higher rail than road tkm usage. This shows the value of freight rail transport for countries with large land areas and populations centered in several big cities. For inland waterways tkm usage, only Netherlands and Serbia reported tkm as much as 80 % that of road tkm indicating the geographic limitations and/or lack of emphasis on inland waterways transport for freight in many countries.

### International-loaded tonne-kilometres per unit of exports of goods by mode

Freight transport data can also show important differences in the transport of goods across borders. Again, somewhat substantial differences between countries in the relevant use of inland transport in international transport are observed. For international transport (loaded in reporting countries), the reported road tkm usage normalized by the level of exports of goods in FYR Macedonia and Latvia was more than 10 times greater than the same for Switzerland, Cyprus and Ireland. Data on tkm for international transport (unloaded in reporting country) normalized by the level of imports of goods depict similarly large differences between the same countries. In some cases, particularly for countries with extensive coastal areas, this is likely indicative of the existence of other transport options such as maritime transport for exports and imports.

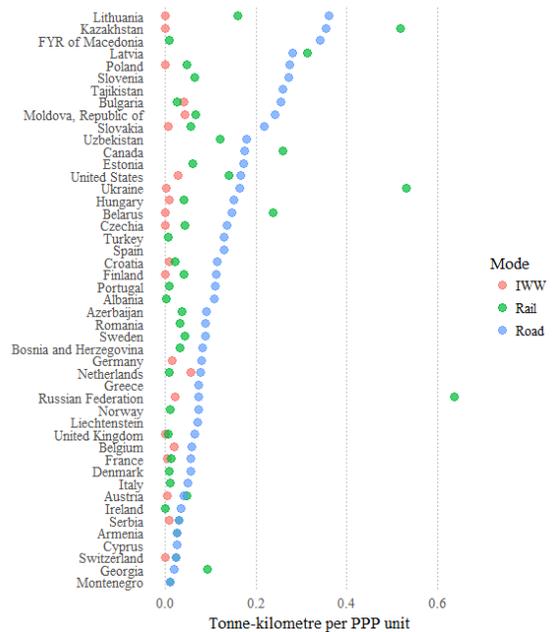
For both unloaded and loaded international transport, reported road tkm usage relative to imports and exports, respectively, was higher than rail and inland waterway tkm usage in almost all cases. For countries providing these data only Latvia, Lithuania, Finland (unloaded), Sweden (loaded) and Austria (both) reported higher rail tkm usage than road. For inland waterways tkm usage, only Netherlands (loaded) reported tkm higher than that of road tkm.

### Tonne-kilometres per km<sup>2</sup> of land area by mode

Another factor that could account for goods transport differences between countries is the relative size of countries. To analyse from this perspective, tkm are normalized relative to land area (measured in km<sup>2</sup>). Comparing countries in this manner shows a different story with densely populated countries such as Netherlands, Belgium and the United Kingdom increasing in prominence as measured by the road tkm per km<sup>2</sup> of land area (see Figure 4). Conversely, large and relatively sparsely populated countries such as Canada, Kazakhstan and the Russian Federation report much lower freight transport usage figures when compared relative to land area.

**Figure 3**

Tonne-kilometres per unit of gross domestic product (GDP) by country and mode of transport, 2016 or most recent year



Note: IWW = inland waterways. FYR of Macedonia = former Yugoslav Republic of Macedonia. GDP in US dollars and purchasing power parity (PPP) of current year. 2013 data for Liechtenstein and the Russian Federation. 2014 data for Albania, Republic of Moldova, Serbia and Tajikistan. 2015 data for Azerbaijan, Bosnia and Herzegovina, Canada, Germany, Norway, Romania, Turkey, the United States and Uzbekistan.

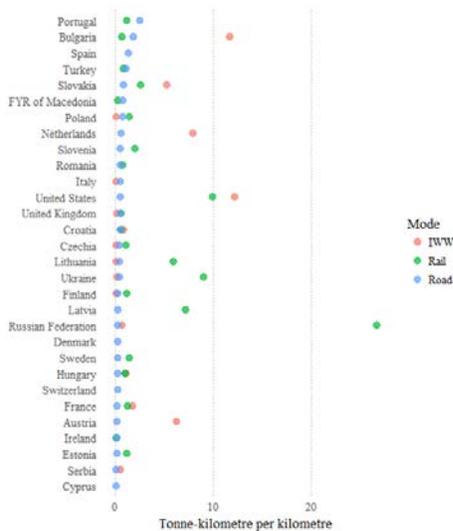
This view on freight transport usage shows how intensely transport is used in densely populated areas such as Liechtenstein, Netherlands and Belgium, where road tonne-kilometres usage per square kilometre of land area is more than 50 times that of Montenegro, Georgia and the Russian Federation. Conversely, the reported importance of rail freight transport relative to land area in Ukraine, Switzerland, the United States, Austria and Latvia shows how extensive freight rail networks are in these countries, even for large countries such as Ukraine and the United States.

### Tonne-kilometres per length of network by mode

Further detail on the usage of inland transport for freight comes from an analysis of tkm normalized by the length of transport networks in various countries. Comparing countries in this manner shows how some countries make greater use of inland waterway networks and rail networks than road networks relative to their overall length (see Figure 5). This is particularly notable for data reported by Bulgaria, Netherlands, Serbia and Austria for inland waterway tkm and for Poland, Slovenia, Lithuania, Ukraine, Latvia, Sweden, Hungary, Estonia, Slovakia, the United States, Russian Federation, France and Hungary for both.

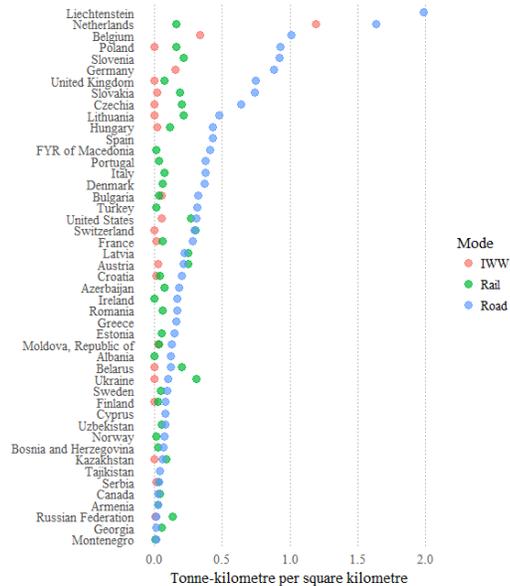
These differences show that much of the difference between road and other inland transport modes may be due to network availability.

**Figure 5**  
Tonne-kilometres per length of network (km) by country and mode of transport, 2016 or most recent year



Note: IWW = inland waterways. FYR of Macedonia = former Yugoslav Republic of Macedonia. 2014 data for Austria, Serbia and Tajikistan. 2015 data for France, Italy, Romania, the Russian Federation, Turkey and the United States.

**Figure 4**  
Tonne-kilometres per square kilometre of land area by country and mode of transport, 2016 or most recent year



Note: IWW = inland waterways. FYR of Macedonia = former Yugoslav Republic of Macedonia. 2013 data for Liechtenstein. 2014 data for Albania, Republic of Moldova, Serbia and Tajikistan. 2015 data for Azerbaijan, Bosnia and Herzegovina, Canada, Germany, Norway, Romania, the Russian Federation, Turkey, the United States and Uzbekistan.

However, it should be considered that reported road tkm data are scaled relative to *all* roads in Figure 5. While this is a sensible comparison, since one of the advantages of road freight transport is the capability of addressing the “last mile” problem on smaller roads, motorways are the primary conduit for long-distance freight transportation on roads. Comparing the reported road tkm in countries relative to only the length of motorways reverses some of the findings as road tkm per kilometre of motorway was greater than rail and inland waterways usage for freight transport relative to the length of their respective networks for all countries reporting data.

### Tonne-kilometre trends

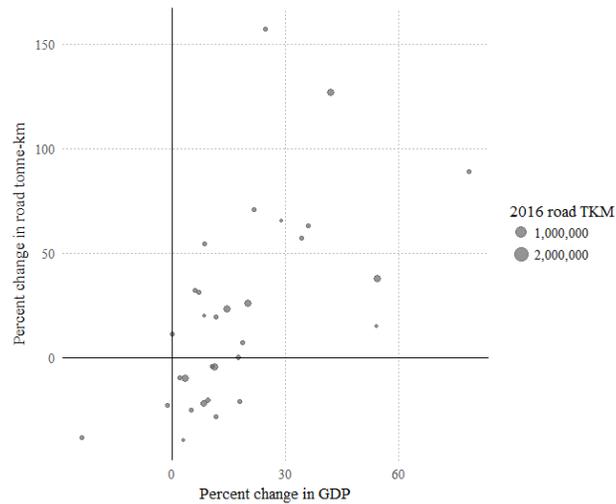
The trend in the change in reported tonne-kilometres over the past decade helps again to clarify differences between different modes of freight transport. Figure 6 shows that the change in reported road tkm is strongly associated with increased GDP over the same period.

However, it is important to note that 13 of the 31 countries reporting data show decreases in road tkm over the past decade even while only two countries reported a decrease in GDP over this period. In addition, as there is no clear negative relationship between trends in reported rail and road tkm, it seems that this decrease is not due to substitution between rail and road freight transport. Further analysis would be useful to determine if this is part of a trend in some countries to produce goods closer to the place of their eventual consumption or if this is due more to the relatively lower economic growth in industry (particularly heavy industry) in many countries in comparison to growth in services.

The relationship with GDP trends over the past decade is not nearly as strong for the trends in reported rail and inland waterway tkm. Again, this shows that changes in rail and inland waterway freight transport levels depend as much as if not more so on geography and/or policy decisions than on economic changes.

**Figure 6**

Percent change in road tonne-kilometres vs percent change in real gross domestic product (GDP) by country, 2006 to 2016 or most recent year



*Note:* GDP growth in real US dollars and purchasing power parity (PPP). Growth to 2013 for Liechtenstein and the Russian Federation, Growth to 2014 for Albania, Republic of Moldova, Serbia and Tajikistan. Growth to 2015 for Azerbaijan, Bosnia and Herzegovina, Canada, Germany, Norway, Romania, Turkey, the United States and Uzbekistan.

## Transport-related SDG Measurement

By publishing these data, UNECE hopes to provide policy-makers in member States with the necessary information on the relative share of all transport modes, to make informed decisions about how to make future transport systems safe, efficient, accessible and sustainable.

### Relevance to SDG 9

Sustainable Development Goal 9 is to build resilient infrastructure, promote sustainable industrialization and foster innovation, and on the transport side is measured by indicator 9.1.2, measuring passenger and freight volumes by mode. Thus tkm data for each mode directly measure this indicator. As a partner agency UNECE can provide these statistics for all ECE countries to the nominated custodian organization, the International Civil Aviation Organisation, along with the other partner organization, the International Transport Forum.

*Note: the indicator as defined is not structured to have an achievable target as such, but rather can be used more as a guiding metric when a modal split is calculated.*

### Relevance to SDG 7

If these activity data were combined with energy consumption data, energy efficiency indicators could be calculated which would give insights into carbon intensity, local pollution impact and other crucial policy questions for each mode of transport, allowing detailed analysis and tailored policy formulation. This may be explored in more detail in future analyses.



## Relevance to SDG 3

These activity data combine with accident data to allow the calculation of transport safety indicators, which can highlight the safest and least safe (from a user's perspective) freight transport modes, allowing the tracking of indicator 3.6.1. This allows policy makers to target the most dangerous modes, or even to plan future transport developments around relatively safer forms of transport.



## Other data sources to consider

Detailed energy efficiency information combined with this goods transport data could provide further insights into the energy efficiency of freight transport, allowing a better measurement of Goal 7. Data on trends in the average length of trips would also allow for a better understanding of the utility of indicator 9.1.2 in achieving Goal 9, building resilient infrastructure, promoting sustainable industrialization and fostering innovation.

**UNECE statistics and country-specific footnotes on tonne-kilometres can be viewed at <http://w3.unece.org/PXWeb/en>.**

**Information on UNECE's transport-related SDG capacity-building activities can be viewed at [unece.org/trans/transport-and-the-sustainable-development-goals.html](http://unece.org/trans/transport-and-the-sustainable-development-goals.html), and general details on measurement of the Sustainable Development Goals can be found at [unstats.un.org/sdgs/iaeg-sdgs/](http://unstats.un.org/sdgs/iaeg-sdgs/).**

**For further information on how to collect transport statistics or to discuss statistical collaboration, please contact [Stat.Trans@un.org](mailto:Stat.Trans@un.org).**