

enviroCar

A Citizen Science Platform for Analyzing and Mapping Crowd-Sourced Car Sensor Data

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52°North – Open Innovation Network

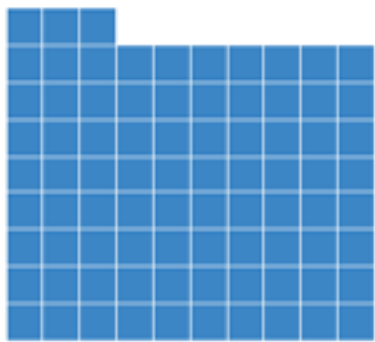
- + Open network with partners from industry, academia and public administration
- + Applied research in the field of Geoinformatics
- + 52°North is the network's legal body and service center, non-profit
- + All results published as open source SW





Amount of vehicles in Germany 2015

Total: **53.7** million vehicles on road
Continuously growing: +8.9% since 2008
539 cars / 1000 inhabitants



Passenger cars



Trucks



Motorcycles



Others..

A blue rectangle equals one %

Source: German Federal Motor Transport Authority



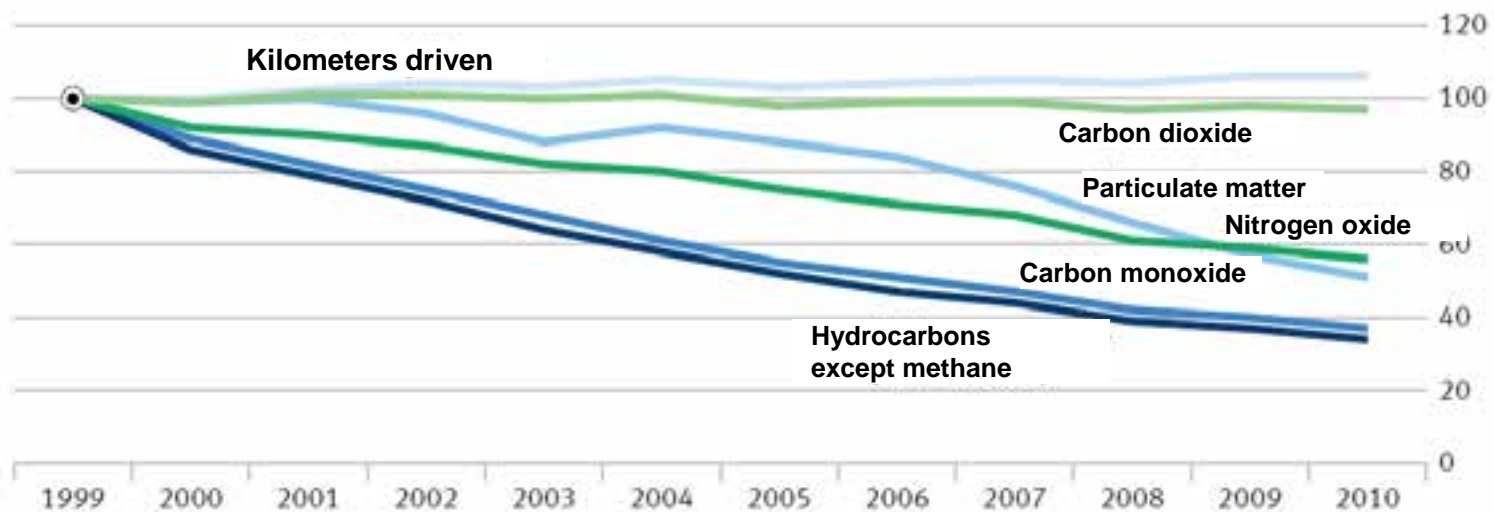
Annual fuel consumption
of cars in Germany:
44bn liter (2013)

Federal Ministry of Transport and Digital
Infrastructure



Kilometers driven and emissions from passenger cars in Germany: 1999-2013

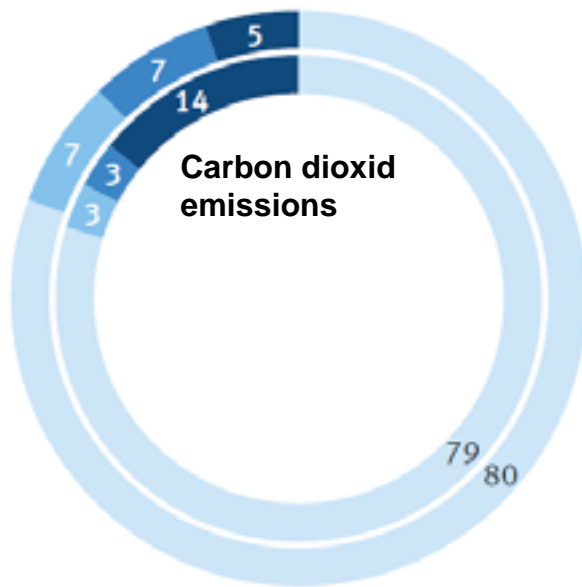
1999 = 100



Federal Statistical Office, Germany, „Verkehr auf einen Blick“, 2013



Kilometers driven



CO2 emission of passenger transportation in Germany 158m tons (2010)

- Individually by car or motorcycle
- .. by train
- Public transport on the road
- .. by airplane

Federal Statistical Office, Germany, „Verkehr auf einen Blick“, 2013



Mobility & Environment



Science

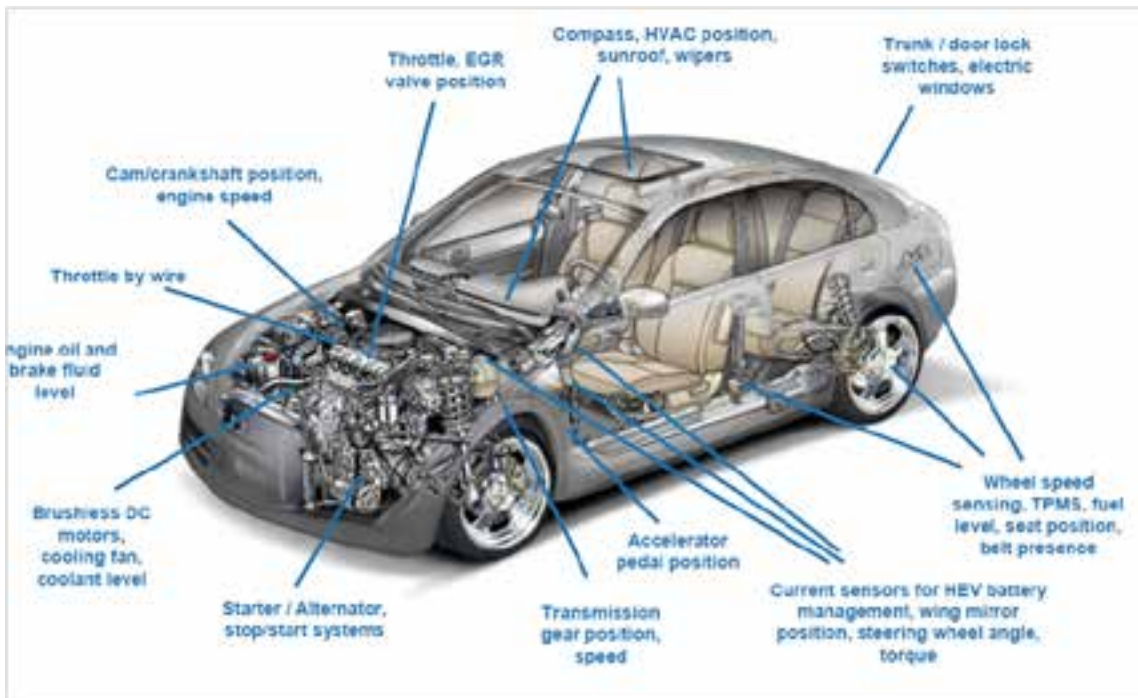
Citizens

Administration

Industry



Cars are turning into sensor platforms



- + On average more than 150 sensors in today's cars
- + Communication via Controller Area Network (CAN bus) message protocol
- + Access to on-board diagnostics via OBD2 interface

Picture: Solids.wii, Kodyath



Data collected from driving cars

+ Floating Car Data – FCD

- > Timestamp, location, speed, direction
- > Mostly from cellular network data, positioning via triangulation, high number of samples
- > Mainly used to determine information related to traffic flow

+ Extended Floating Car Data – XFCD

- > FCD + RPM, throttle position, mass airflow, ambient temperature, fuel consumption, CO2 emission, and many more...
- > Both by car-born and additional sensing devices, positioning via GPS
- > Mainly used for fleet management, driver assistance, .. traffic management (e.g. evaluation of traffic light circuits)

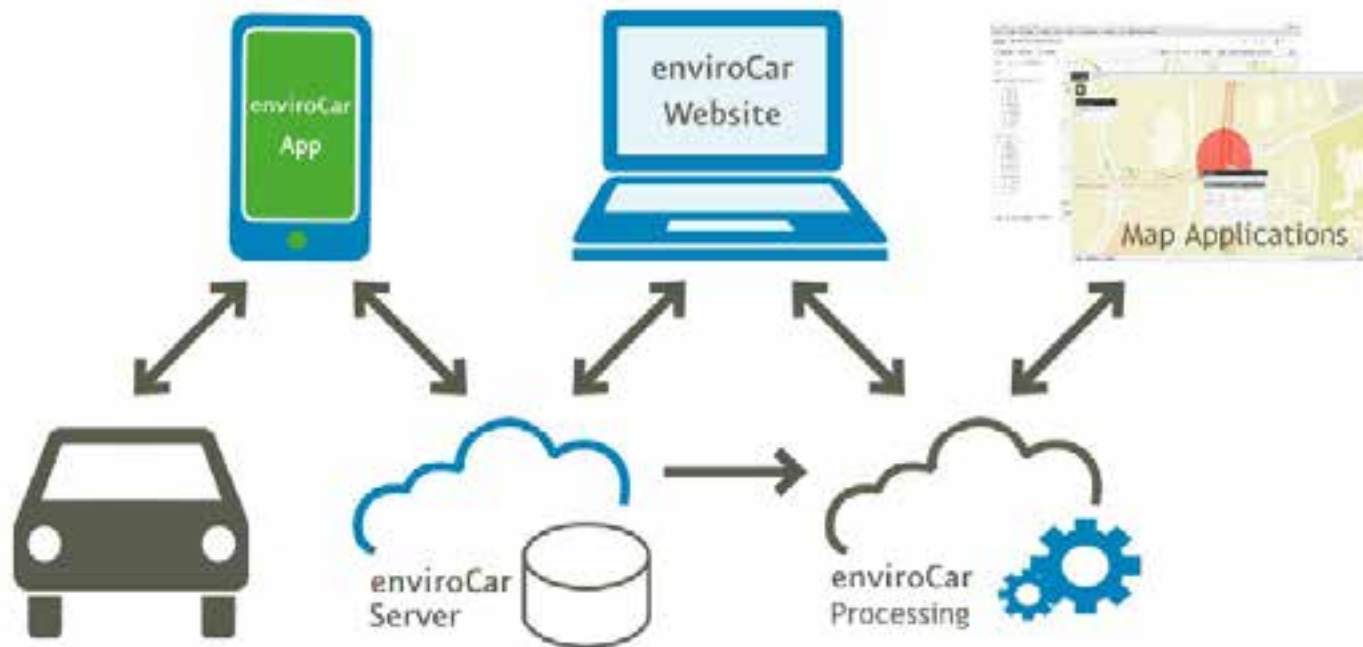


Prerequisites for a broader use of XFCD in traffic management

- + **Improved availability and accessibility**
 - > Existing sources (e.g. from fleet management applications) are typically not accessible for traffic management
- + **Availability of validated data analysis methods**
 - > Statistical methods for analyzing trajectories, standards and best practices for XFCD based analysis of traffic quality
- + **Availability of XFCD tools**
 - > XFCD data analysis is the business of experts today



The enviroCar platform for managing, analyzing and mapping crowd sourced XFCD





enviroCar App for Android - Accessing carSensor Data through OBD2



- OBD2 adapters
- accessible via bluetooth





Estimating fuel consumption and CO2 emissions from mass airflow sensor data (MAF)

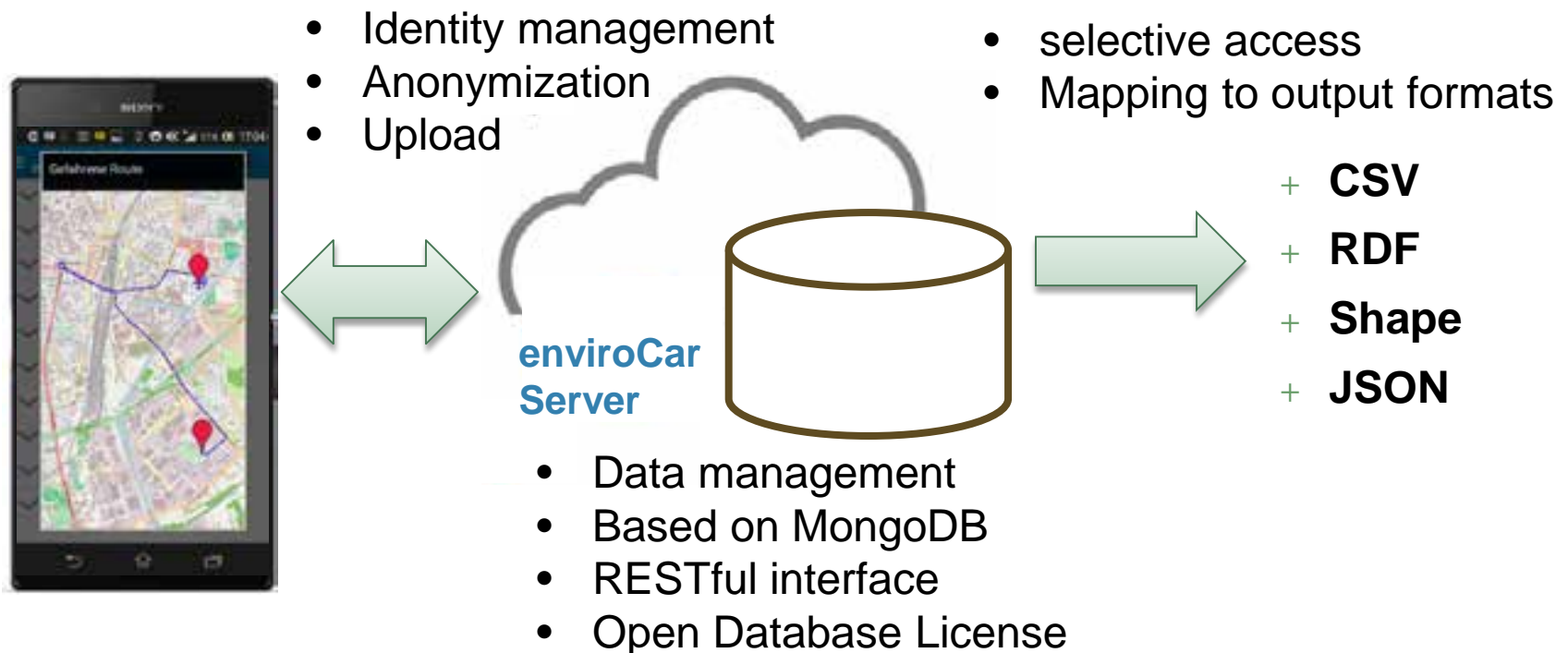
$$\frac{\text{fuel weight}}{s} \left(\frac{g}{s} \right) = \frac{MAF \left(\frac{g}{s} \right)}{AFR}$$

$$\text{fuel consumption} \left(\frac{l}{s} \right) = \frac{\frac{\text{fuel weight}}{s} \left(\frac{g}{s} \right)}{\text{fuel density} \left(\frac{g}{dm^3} \right)}$$

- + engine keeps the air fuel ratio close to 14.7 to produce a combustible mixture
- + enviroCar assumes a density of 745 g/l
- + CO2 emissions are in a linear relationship with the fuel mass that is combusted; in case of gasoline, combusting 1 liter results in 2.35 kg of CO2

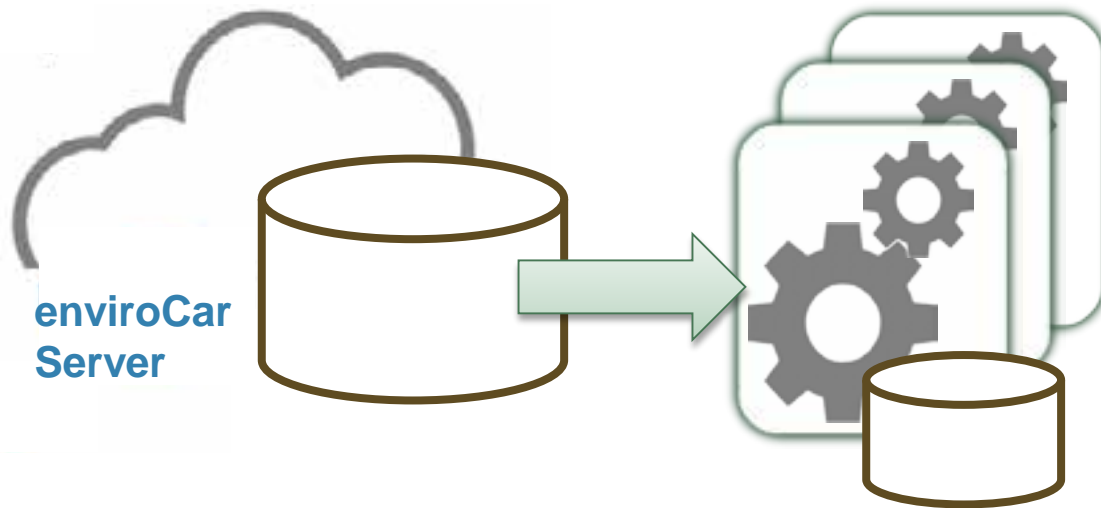


Managing the XFCD data pool with the enviroCar Server





Organizing functional data views and on demand processing services

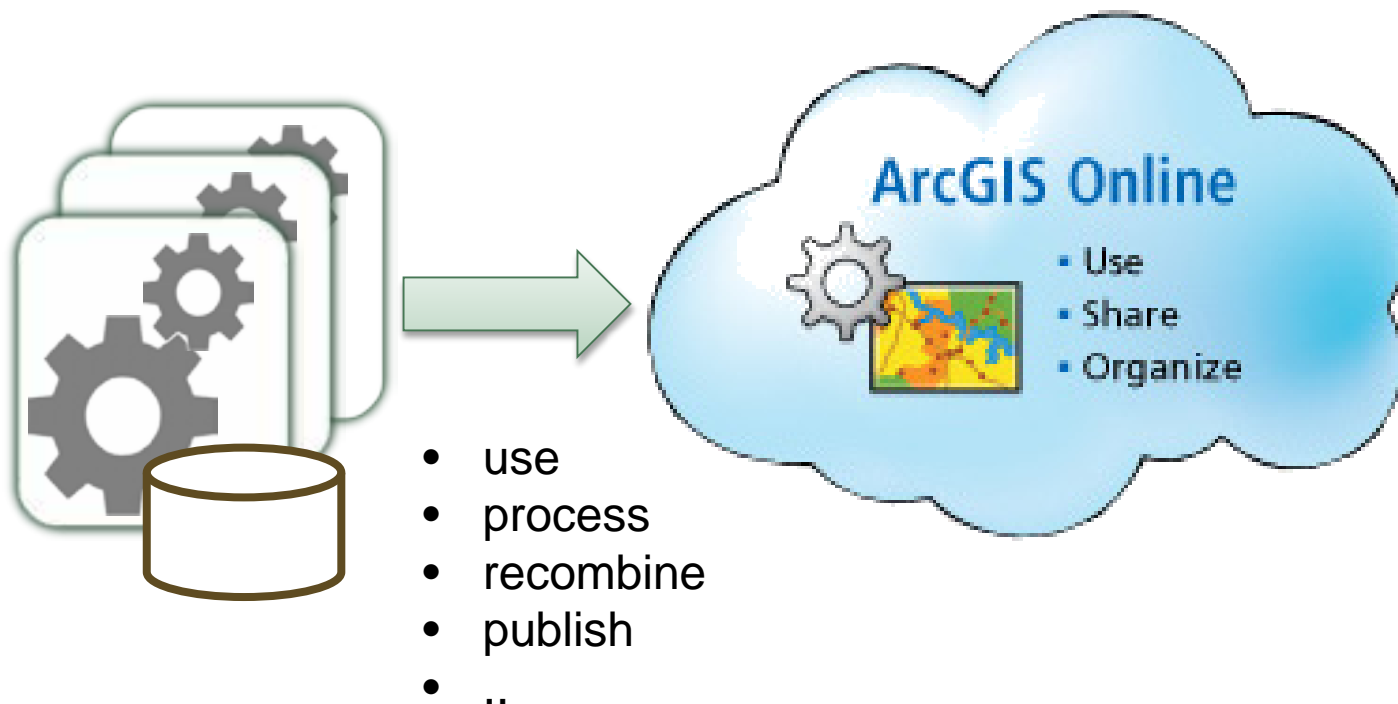


- Goevent Processor
- PostGreSQL
- ArcGIS Server
- 52N WPS
- R
- ..



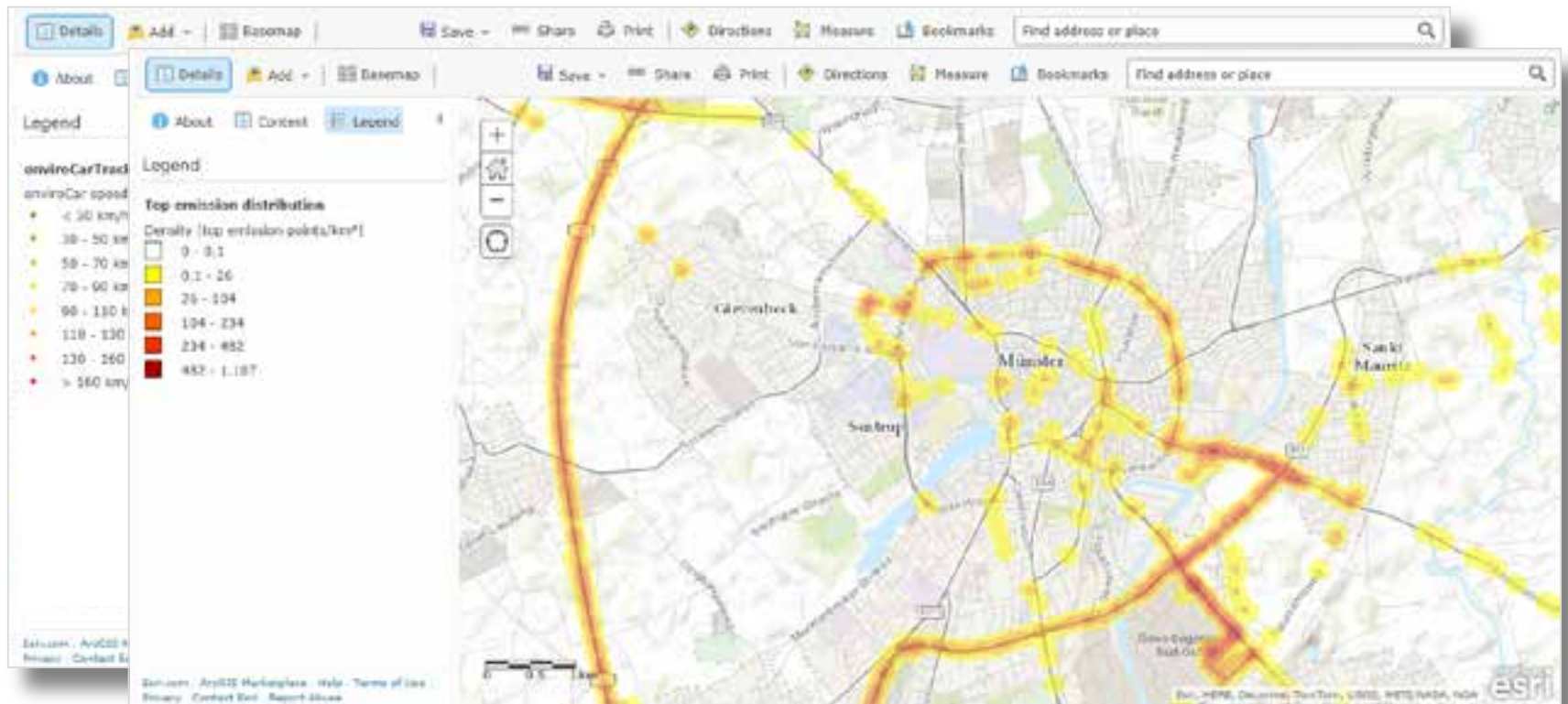


Sharing data and maps through ArcGIS Online





enviroCar - Shared Maps





Further Information

- § WebSite - www.envirocar.org
- § Mail - enviroCar@52north.org
- § ArcGIS Online - <http://52north.maps.arcgis.com>
- § Youtube – www.youtube.com/watch?v=LTSuUEOfWa0

Thanks for your attention..

enviroCar Partner

