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Automated Linking of SDMX and OGC Web Services

A Feasibility Study by the GEOSTAT 3 project on the implementation of principles 4 and 5 of the Global Statistical Geospatial Framework

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Foreword

This report presents the result of a proof of concept on automated linking between SDMX tables and an OGC web service by means of a Table Joining Service (TJS), conducted as part of WP 1 of the GEOSTAT 3 project (2017-2018). The aim of the work has been to research the fitness for purpose of a number of requirements and recommendations of the GSGF-Europe regarding interoperability and machine-based integration of geospatial and statistical data.

The proof of concept has been conducted by Niek van Leeuwen and Pieter Bresters, Statistics Netherlands, who also complied this report.

The Hague, November 18, 2018

Content

Executive summary

This report presents the result of a proof of concept (POC) on automated linking between SDMX tables and an OGC web service by means of a Table Joining Service (TJS), conducted as part of WP 1 of the GEOSTAT 3 project (2017-2018).

The purpose of this study has been to the feasibility of a number of requirements (Requirement 4.3 - Publish data once and leave it at its source to be reused many times, Requirement 4.4 - Increase use of services for merging geography and statistics and in parts Requirement 5.2 - Use service-oriented data portals supporting dynamic integration of data) proposed by the GEOSTAT 3 project in *GSGF Europe – Implementation guide for the Global Statistical Geospatial Framework in Europe*.

The working assumption of this study has been that the concept of Table Joining Services (TJS) was an interesting candidate for testing the practical implementation of these requirements. The TJS offers a potential solution for machine-to-machine based transformation and integration of data having the following benefits in terms of interoperability and accessibility:

- It is based on OGC standards, INSPIRE data models and SDMX (a key element of Principle 4)
- It operates on machine-to-machine readable data (a key element of Principle 4)
- It supports the idea to leave geospatial and statistical data at its source (with enclosed meta data and proper maintenance schemes) using established protocols for automated data integration whenever called for by a user (elements of both Principle 4 and 5)
- It uses common geographies as defined by INSPIRE SU-grid but in principle it can be configured for use of any common geographies (Principle 3)

The results from the POC largely confirmed the feasibility of the requirements proposed and showed that the conditions to meet the requirements with machine-to-machine services are fairly good, considering existing data models, standards and technical solutions at hand.

There are still technical and methodological issues to solve to improve the use of tools like TJS for increased automation and interoperability, but none of these seem impossible to overcome. A number of recommendations are provided covering conditions for input and output data, metadata as well as improved performance and operation of the TJS. These recommendations are not part of the European implementation guide (GSGF Europe), however they can still provide valuable input for further work on TJS.

On the basis of the result from the POC in combination with related activities on European level and national practices, a number of recommendations were consolidated for the European implementation guide (GSGF Europe).

1 Introduction

One of the main objectives of INSPIRE is to reduce inefficiencies in the collection, handling, storing and distribution of geospatial information. Drawing on this objective, reducing the need to duplicate information is an important objective also for the Global Statistical Geospatial Framework and particularly for the ambition to increase interoperability in accordance with Principle 4. In essence, all data, both geospatial and statistical, should ideally be collected and published only once. In a federated ecosystem of data it can (and should) be published separate of each other but in a way that enables interaction between datasets with low or no technical or semantic barriers.

Geospatial and statistical data and metadata are shared using different data formats, exchange methods and dissemination standards. Within EU, geospatial information is shared using the spatial data infrastructure INSPIRE, while statistical information is exchanged following Standard for Data and Metadata eXchange (SDMX). Defining a mapping between these two standards is essential to support the combination of these two types of information and to maximise the re-use of existing and accepted data infrastructures for statistics and geospatial data respectively. Such progress could also lead to a more efficient, service-oriented exchange of data between institutions on a national level and between the national and European level.

In order to test the feasibility of Requirement 4.3 - *Publish data once and leave it at its source to be reused many times* and Requirement 4.4 - *Increase use of services for merging geography and statistics*, a proof of concept (POC) was conducted with the GEOSTAT 3 project on automated linking between SDMX tables and OGC Web Services (OWS), by means of a Table Joining Service (TJS).The overall goal of this POC was to determine which conditions are necessary to create new web services (WMS and WFS) automatically combining the content of the tabular SDMX data and web services containing statistical geographies. For the POC it was decided to use Census grid data statistics. The INSPIRE roadmap requires Member States to fully comply with INSPIRE by the end of 2021. This means that for the 2021 round of population and housing censuses in the EU, statistical offices will have to share census data according to INSPIRE legislation in addition to the existing statistical dissemination infrastructure based on SDMX. The goal for the EU wide 2021 census has been to minimise the effects of this double obligation on Member States and to maximise the usability of the census information for the statistical and geospatial community.

The basic idea of a Table Joining Service (TJS) is to automatically combine a web service containing geospatial features (geographies) with a dataset containing tabular data (statistics), using a unique identifier found in both datasets. The result of the operation is a new web service containing both the geospatial features and the statistical or tabular data.

The purpose of this study has also been to identify issues when performing this operation and to solve them as far as it fits within the time available for this part of the project.

Previous research on OGC TJS has proven that this service can successfully produce OGC compliant Web Mapping Services (WMS) and Web Feature Service (WFS)[1]. There are a number of different ways at hand to technically implement the OGC TJS standard.

[1] https://www.efgs.info/wp-content/uploads/news/2016/NL_ImpactAnalysisTJS_v1.0.docx-1.pdf

2 What is a Table Joining Service?

A Table Joining Service is a web service protocol that enables joining tabular and geographic data. The TJS is an official standard from the Open geospatial Consortium[2]. TJS provides a standardised web interface (so called API) to expose data to other computers through the internet. The data can be easily found and dynamically joined from source databases for mapping and further processing in spatial analysis models or other spatial applications.

The output generated by the TJS is a web service that can be consumed as an image, as a feature data set (vector data) or as a web service (WMS, WFS) to be included in online applications or GIS systems. The output services generated are assumed to be available for a restricted period of time, for instance a week, a month or whatever is specified by the service host. Keeping all the services generated by the TJS alive, would be a large burden for the service host. However, since the source data will always be available, the same join can be created over and over again whenever it is needed and therefore persistent provision of services created by the TJS is not needed.

The concept of TJS is particularly well suited for use where multiple themes of statistical data share the same reference geographies and/or when statistical tables from different years refers to stable geographies (like grid cells, national geographies or NUTS areas). Instead of publishing the same geometries over and over again each time a new statistical theme or variable is added to the statistical data, the geometry is published only once and multiple statistical contents can be added on demand.

3 Work schedule

The POC is about linking a SDMX data to an OGC web service in an automated way. The following activities have been undertaken:

- research on the feasibility of the SDMX format for TJS,
- publishing an OGC compliant web service (WFS) of statistical geographies (1 x 1km grids) on the web,
- using the TJS to automatically combine the content of the tabular SDMX data and the web service containing the statistical geographies to generate new web services (WMS and WFS) and
- creating metadata for the services

The Census 2021 request grid data of thirteen different subjects per 1 x 1 kilometre grids as output geography.

3.1 Suitability of the SDMX-file

The SDMX[3] is a standard that statistical offices and institutions use to exchange statistical data. Part of SDMX content is metadata information on the data content.

Normally automated linking of statistical and geospatial data is performed on a straight forward table layout with rows and columns, i.e. CSV-format, where the columns contain the data of a specific

[2] http://www.opengeospatial.org
[3] https://sdmx.org/

subject. One of the columns contains a unique region identifier, which may be linked to the geospatial data.

For this study, research was conducted on the format of the SDMX encoded data and the suitability to use it in a direct way for linking with an OGC web service. The SDMX format used in this POC has been designed by Eurostat for the census 2011 and is based on the INSPIRE data model for Population Distribution.

SDMX is ready to contain metadata information on one cell value of the table. Therefore, values in SDMX format are published cell by cell. Each record in the SDMX file contains one value of one cell and metadata information on the content.

3.1.1 Multiple records in the statistical database

When an item is published in SDMX, the grid-code can be accompanied by multiple attributes. One attribute may have several instances for “Observation status”, thus the combination of geo-code and attribute may be used in different rows, where for instance the “Observation status” of the observed value differs. For instance multiple CL_OBS_STATUS may be applied within that km2 grid cell for total population.

It is important to note that the TJS will only combine the first instance of a grid value pair and ignore subsequent pairs with different attributes.

Figure 1: Part of content Data Structure Definition SDMX

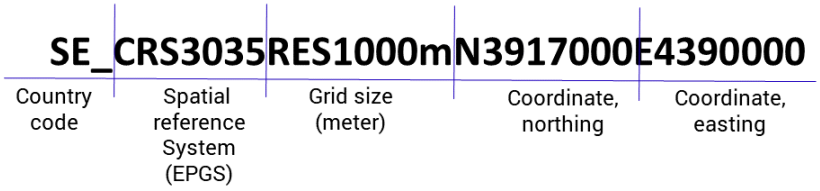
Another issue arises when combining grid values of different countries of grid cells hovering country borders. Each country will publish content of that part of the country which is in that grid cell defined by CL_GRID_1KM_COUNTRY. When compiling a European map the cell values of that specific grid must be compiled by summing the values from two or maybe three countries.

3.1.2 Grid identifier

A unique code is demanded by the Census 2021 for each grid cell. Not only for the grid itself but also for the country reporting data on the grid. Therefore a country code has been added to the proposed

grid coding as reported in the Statistical Units data model v3.0. The INSPIRE definition of the grid-code will be altered to ensure INSPIRE compliance.

The coding of a grid cell in Sweden then will contain 34 characters and will be like:



In case a grid cell is crossing a country border, two or more values of for instance population, will be reported for the same grid cell. To produce a pan-European population grid service, the multiple values occurring in cross-border grid cells, will have to be summarised to present the total population value of the grid cell.

3.1.3 Recommendations

- One should be aware of SDMX records with the same geocode but with different observations. For the time being, the TJS standard does not support multi-observations properly. It can be solved by splitting up these SDMX files and making separate joins and services. These services can be combined at a later stage in a GIS.
- If data from neighbouring countries are combined, one should also combine the layers in a later stage in a GIS, by adding up the observations in the cross-border grid cells.
- This combining of data to be ready to be disseminated should preferably be executed by the Table Joining Service to preserve the requirement “Leave data at its source”.

3.2 Publish grid data on the web

Although not part of this POC, a 1 km^2 grid web service covering all of the GEOSTAT 3 countries and Belgium (in the same service), has been published as OGC WMS and WFS during this project. Multi-country web services of this type have proven to be performing in Table Joining services for NUTS2 regions, but the large number of features in a 1 km^2 grid service provides substantial challenges in terms of performance.

3.2.1 Conversion of grid data shape files

Grid cell data covering each separate country published at the EFGS website[4] have been used to construct a dataset covering countries of the GEOSTAT 3 consortium.

First the grid data had to be converted to the INSPIRE compliant data model. This operation was performed using HALE[5]. HALE is a stand-alone application allowing polygons to be converted into INSPIRE compliant GML. From GML, data can be served as WMS, WFS, GeoJson etc.

Input are the grid data as published on the EFGS website. Columns containing the grid code with the country prefix were added. The shape files already contain the grid code without the country prefix.

[4] https://www.efgs.info/data/
[5] https://www.wetransform.to/products/halestudio/

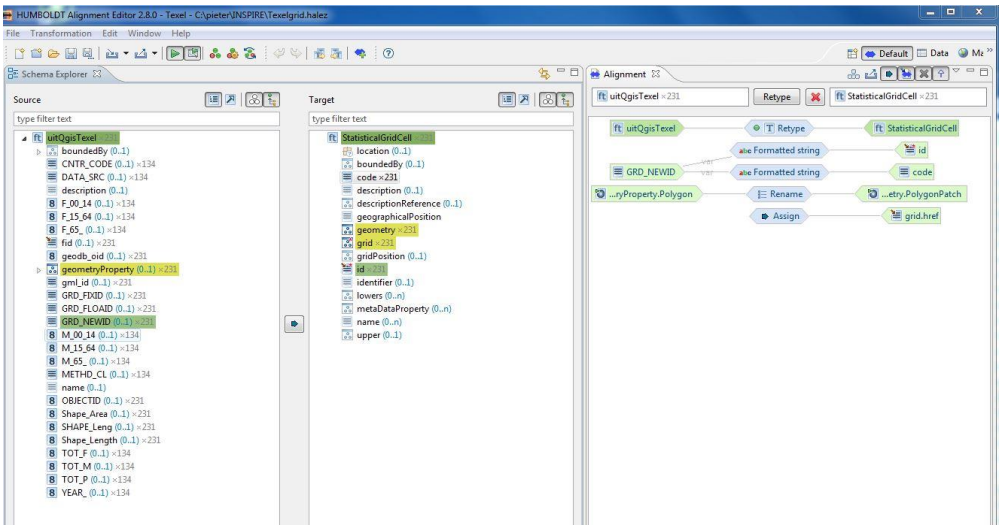
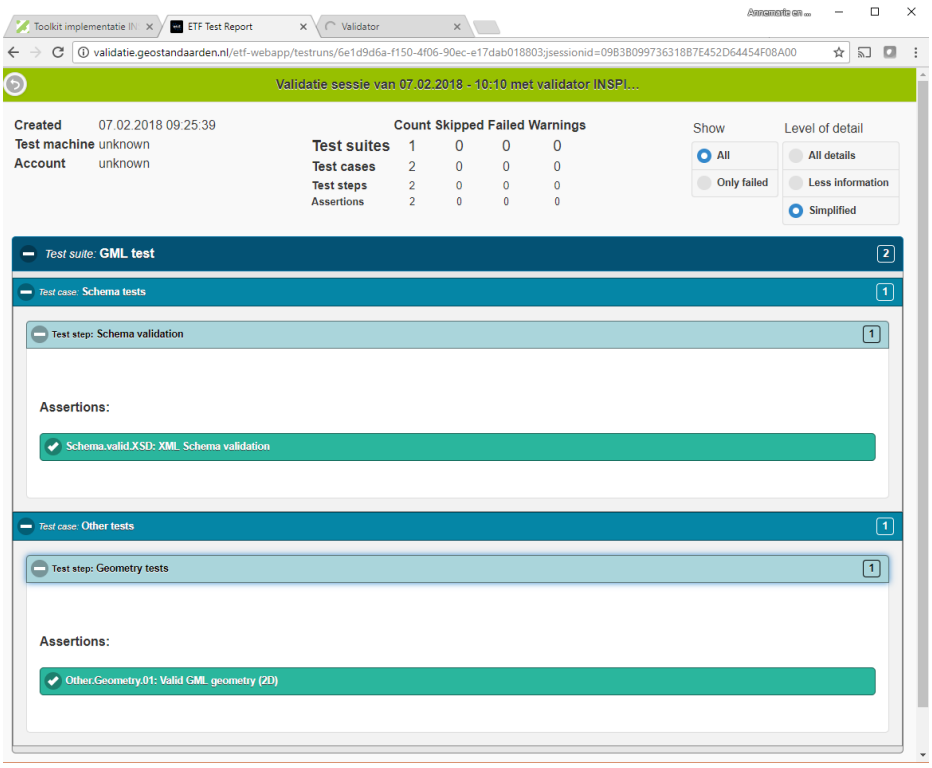


Figure 2: Conversion schema grid into INSPIRE compliant data model

Fel! Hittar inte referenskälla. *presents a conversion application of the column names using HALE. Results have been checked and validated by the Dutch INSPIRE validator (*

Figure 3: Result Dutch INSPIRE validator on grid GML



).

Figure 3: Result Dutch INSPIRE validator on grid GML

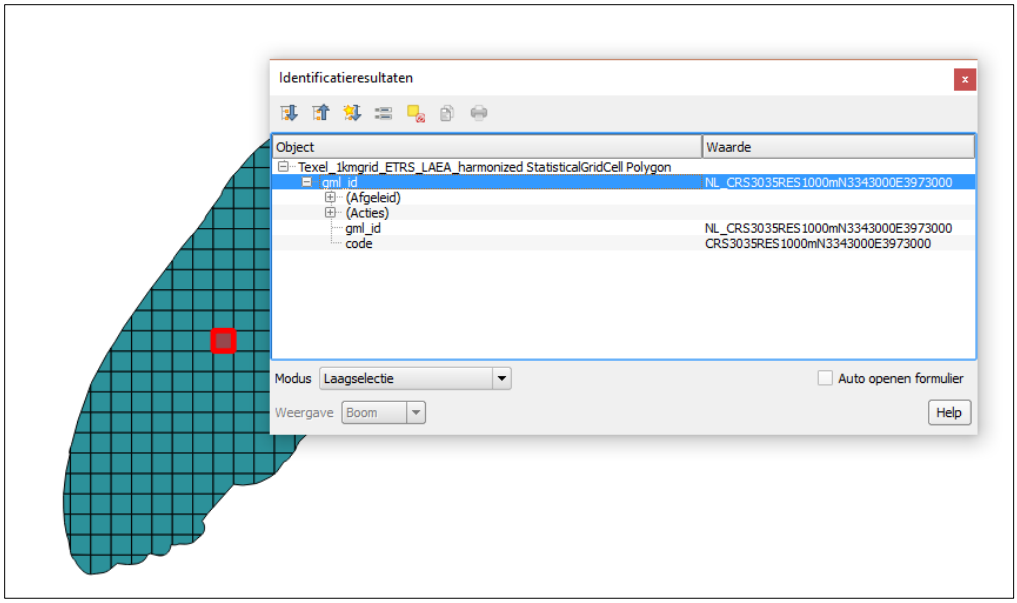


Figure 4: Example WMS after conversion

From the created GML files, two services were created, a viewing service (WMS) and a download service (WFS) hosted via www.PDOK.nl. These services are machine-readable and can be used in a browser, in web-applications and in GIS applications. Data can also be served in other formats, such as GeoJson.

3.2.2 Web Mapping Service

To view the WMS in QGIS: Use the following URL to view the WMS in QGIS with the “ad WMS” button: http://geodata.nationaalgeoregister.nl/inspire/su-grid/wms?&request=GetCapabilities

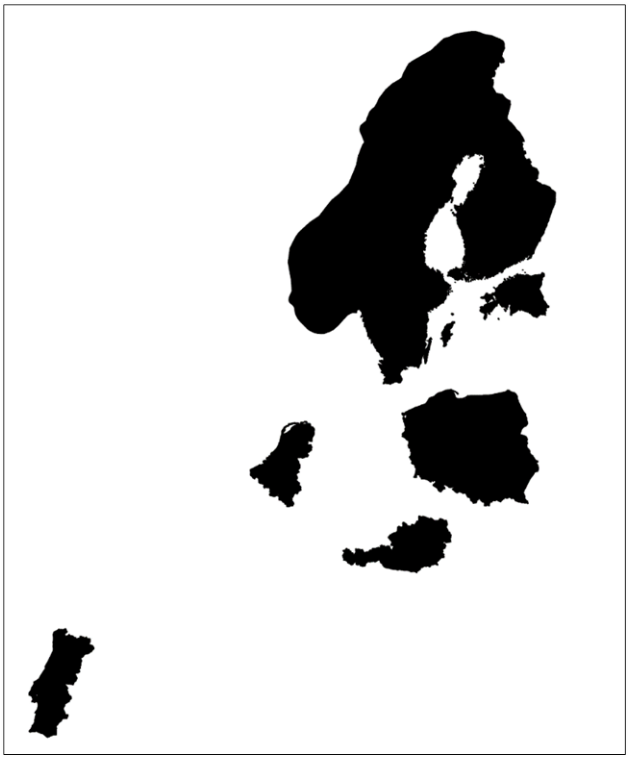


Figure 5: Available INSPIRE 1 kilometre grid service for the proof of concept of TJS as a WMS

To view the WMS in the browser:

http://geodata.nationaalgeoregister.nl/inspire/su-grid/wms?request=GetMap&CRS=epsg:3035&width=1500&Height=2000&layers=SU.StatisticalGridCell&Format=image/png&bbox=2500000,1600000,5500000,5600000

The service will show all the 9 countries (GEOSTAT 3 participants and Belgium). Adjust the bounding box to your location of interest. The used xmin, ymin, xmax, ymax are in the ETRS89, LAEA projection.

3.2.3 Web Feature Service

Unfortunately, The Dutch provider PDOK allows a maximum download of number of grid cells features per request in one call. So the only way to download is in parts, of for instance 15.000 records. The next 15 thousand features can be acquired by calling the WFS again and raising the start index with 15.000 each time. For the Netherlands, this means 3 downloads, but for other countries this can be a lot and cumbersome. This limit is caused by the performance of Geoserver, currently used to create the WFS. Other software, like Mapserver, has a higher performance without this limit of 15.000 records per call.

The WFS in GML:

https://geodata.nationaalgeoregister.nl/inspire/su-grid/wfs?version=2.0.0&request=GetFeature&typenames=su-grid:SU.StatisticalGridCell&CRS=EPSG:3035&cql_filter=%28href=%27%23NL%27%29&count=15000&startindex=0

The WFS in JSON (6x faster download than GML):

https://geodata.nationaalgeoregister.nl/inspire/su-grid/wfs?version=2.0.0&request=GetFeature&typenames=su-grid:SU.StatisticalGridCell&CRS=EPSG:3035&OutputFormat=JSON&cql_filter=%28href=%27%23NL%27%29&count=15000&startindex=0

Explanation of the WFS URL:

Projection

CRS=EPSG:3035
Change your projection by EPSG number

Outputformat

&OutputFormat=JSON& (fastest download)

for default GML download, which performs up to 6 times slower, change this part of the URL to & only

Request a country

NL, PT, AT, PL, EE, FI, SE, NO, B

Number of records downloading

count=15000, this is the maximum # of records for each call, make more calls using another startindex, The number 0 is bottom left grid of each country.

Start of polygons downloaded

startindex=0 The start of the grid cell per country. ‘startindex=0’ is the left lower corner. For the next call you may use startindex=15000

Change NL in your own country code and you will get records of your own country. If you use the above URL’s in a browser, it will show the contents of the file in the requested format. A GML example of a grid in Poland is shown below.


```
- <wfs:member>
  - <su-grid:SU.StatisticalGridCell gml:id="SU.StatisticalGridCell.PL_CRS3035RES1000mN2967000E5214000">
      <su-grid:gid>PL_CRS3035RES1000mN2967000E5214000</su-grid:gid>
      <su-grid:code>CRS3035RES1000mN2967000E5214000</su-grid:code>
      <su-grid:href>#PL</su-grid:href>
    - <su-grid:geometry>
      - <gml:Polygon srsDimension="2" srsName="urn:ogc:def:crs:EPSG::3035">
        - <gml:exterior>
          - <gml:LinearRing>
              <gml:posList>2967000 5215000 2968000 5215000 2968000 5214000 2967000 5214000 2967000 5215000</gml:posList>
            </gml:LinearRing>
          </gml:exterior>
        </gml:Polygon>
      </su-grid:geometry>
    </su-grid:SU.StatisticalGridCell>
  </wfs:member>
```


Figure 6: Example geometry and grid-code as WFS

If you want to use the data in QGIS, you need a different approach than you might be used to. Do not use the special designed tool for downloading a WFS, but use the simple add file tool like shown in figure Figure 7. Copy the URL into the location for the file, and it will start loading after pressing the “open” button.

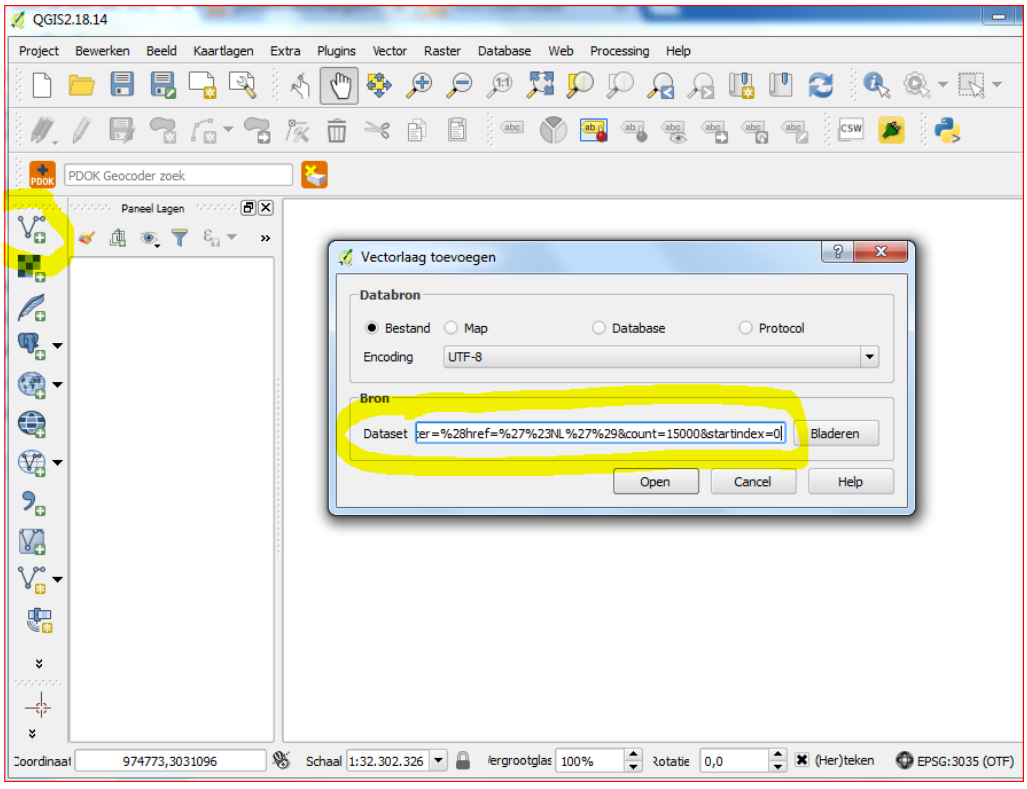


Figure 7: Other loading a WFS in Qgis

Meta data (figure Figure 8, mostly in English) on the dataset and service of the grid map can be found via:
http://www.nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/search?any_OR__title=su-grid%5C&isChild='false'&fast=index

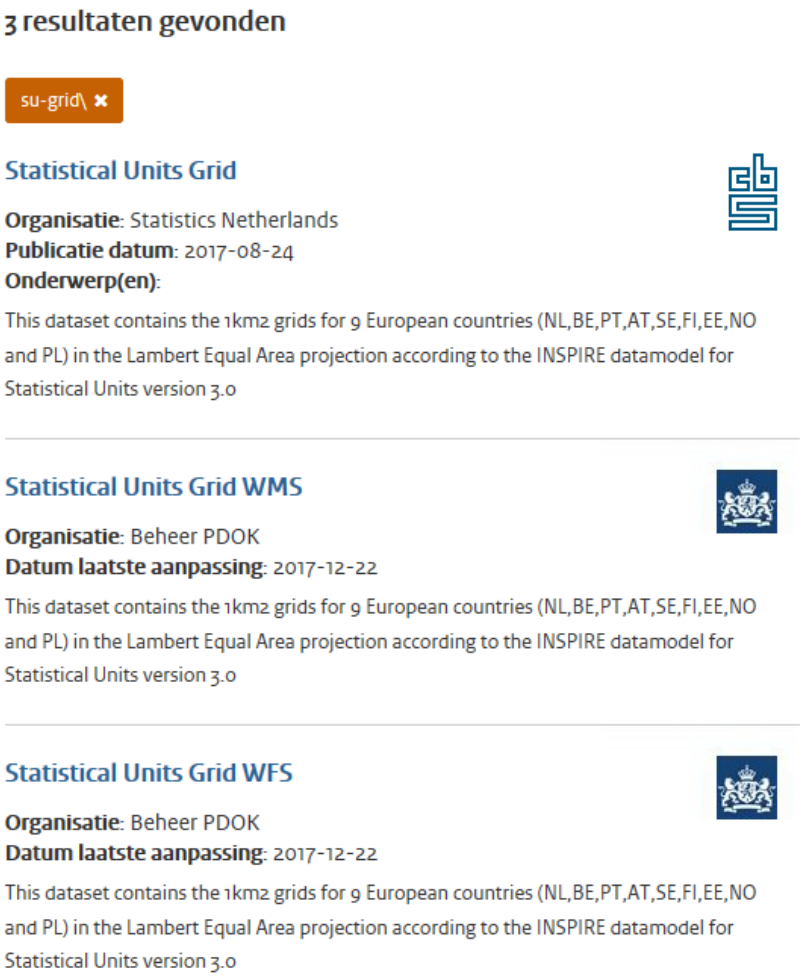


Figure 8: Result searching the European grid (su-grid) in www.natinaalgeoregister.nl

3.2.4 Recommendations

- As the number of geospatial features in a grid cell service is large, only grid cells covering land area should be published to avoid unnecessary slow-down of performance.
- Regional identifiers (both at national and European scale) used in OGC web services and SDMX tabular data should be defined and used in practical cases extensively before implementing them in large-scale automation solutions. This POC can be considered a contribution to this work but additional practical cases are recommended.
- Next to the country-distinctive identifier one should also be able to use identifiers that do not distinguish for a country, because in that case observation values of cross-border grid cells can be added up in future versions of the TJS with this functionality. In this case the prefix of the country accompanying the grid-code should left out, thus leaving us a country independent grid-coding only; i.e. **CRS3035RES1000mN3917000E4390000.** An example of this is shown in Figure 4.

3.3 Survey on automated data joining services in use

Other good practices may be applied in Europe or our partners in the Global Forum for Geography and Statistics (GFGS).Therefore a survey was conducted to inventory the use of map generation by automation.

Questions of this survey are included in the appendix (**Fel! Hittar inte referenskälla.**).

3.3.1 Some results from the questionnaire[6]

17 European countries and Eurostat responded to the survey. Publication of tabular data with regional breakdown is well developed (figure Figure 9).

On the web	12		1		1	1	1	1		1	1		1	1	1	1	1		
Machine readable	9		1		1	1		1			1		1	1	1		1		
Non-proprietary format	14	1	1	1	1	1		1	1	1	1	1	1	1				1	1
RDF standards	1	1																	
Linked RDF	0																		

Figure 9: Answers to question 1: "What is the ranking level of published tabular data"?

A variety of data formats are used for dissemination of tabular data. Among them the formats CSV, XLS, SDMX, TSD, GML, PX web exports were recognised as well as open data formats such as JSON and XML. In addition to these pure tabular data formats, also shape files were used as a combination of tabular data and geometry data.

The use of automation in generating web services on the web on the other hand is very scarce (figure Figure 10). Although automation of publishing services has many benefits, there is not a widespread use. One of the reasons may be because this subject is quite technical.

Yes	4		1	1													1	1	
No	11	1			1	1		1	1	1	1	1	1	1	1				
In test	2						1												1

Figure 10: Answers to question 6: "Do you use an automated updating of geoservice now"?

3.4 Automated linking of SDMX content and geospatial data

Development of a Table Joining Service has not been within the scope of this feasibility study. Hence, in the progress of testing the automatic generation of web services, a version of the Table Joining Service under construction by the Netherlands has been used in the project. However, integration of WFS for geometries and SDMX services for tabular data to produce output WMS and WFS was the first application to be developed within the Dutch platform. This provided the possibility to adjust the features of the TJS to the needs of the GEOSTAT 3 project, i.e. using SDMX as input.

Although the input and the output of the TJS will have to be OGC compliant, machine-readable open data formats for tabular data and geometries, the TJS itself is only the intermediate service and may be developed for any platform in any programming language. Existing open source software to operate the TJS is based on Geoserver[7]. The Dutch hosting company (PDOK) decided to build the new TJS software on Mapserver[8] because of performance reasons. By developing a new software using Mapserver, PDOK have more flexibility to let the TJS fit in their infrastructure.

At this moment the specification of the TJS is not yet fully conform to the OGC standard. This is mainly because the OGC TJS standard is currently under revision. The revised standard is expected to

[6] For a full summary of the result from the survey, see: https://www.efgs.info/wp-content/uploads/conferences/efgs/2017/Presentations/1-19-3.pdf
[7] http://geoserver.org/
[8] https://mapserver.org/

be more flexible in terms of input and output formats and enhanced in terms of data joining capability etc.[9]. After this new standard is in a final version, PDOK will look how their solution can adjusted to comply with the standard. The use of the API of the developed TJS is explained in the manual (appendix 3).

3.4.1 Manuals

For the purpose of configuring the TJS, two manuals (provided with this report as appendix **Fel! Hittar inte referenskälla.** and 3) were produced within the GEOSTAT 3 project.

The first manual explains how to convert data in CSV format into a SDMX format. This manual describes using the SDMX convertor as published by Eurostat. The product of this manual is an SDMX file to be published on the internet. All the countries in the consortium, and also Belgium, not being part of the consortium, succeeded in producing the SDMX file. For those countries that could not provide a test site to publish the SDMX file, the Netherlands provided test space on an external server.

The second manual describes how to use the APIs of the Table Joining Service set up by PDOK which leads to publishing WMS and WFS services as a combination of the published SDMX dataset on the external server and the WFS of grid polygons published as open data via the Netherlands.

All participating countries and Belgium succeeded in generating WMS and WFS services using their tabular data, in most cases published at their own servers, and using the Table Joining Services to generate the services. A URL for use in a web browser with a SLD-body for Austria is provided in Appendix 3.

3.4.2 Updating the web services

If the tabular SDMX data is altered and republished, the following actions need to be performed:

- The SDMX data needs to be updated on the web
- Deactivation of the running web services
- A new join has to be made
- The new web services has to be activated, usually under the same name with the same join

[9] https://efgs2018.fi/wp-content/uploads/sites/196/2018/10/AARNIO_Abstract2_EFGS2018.pdf

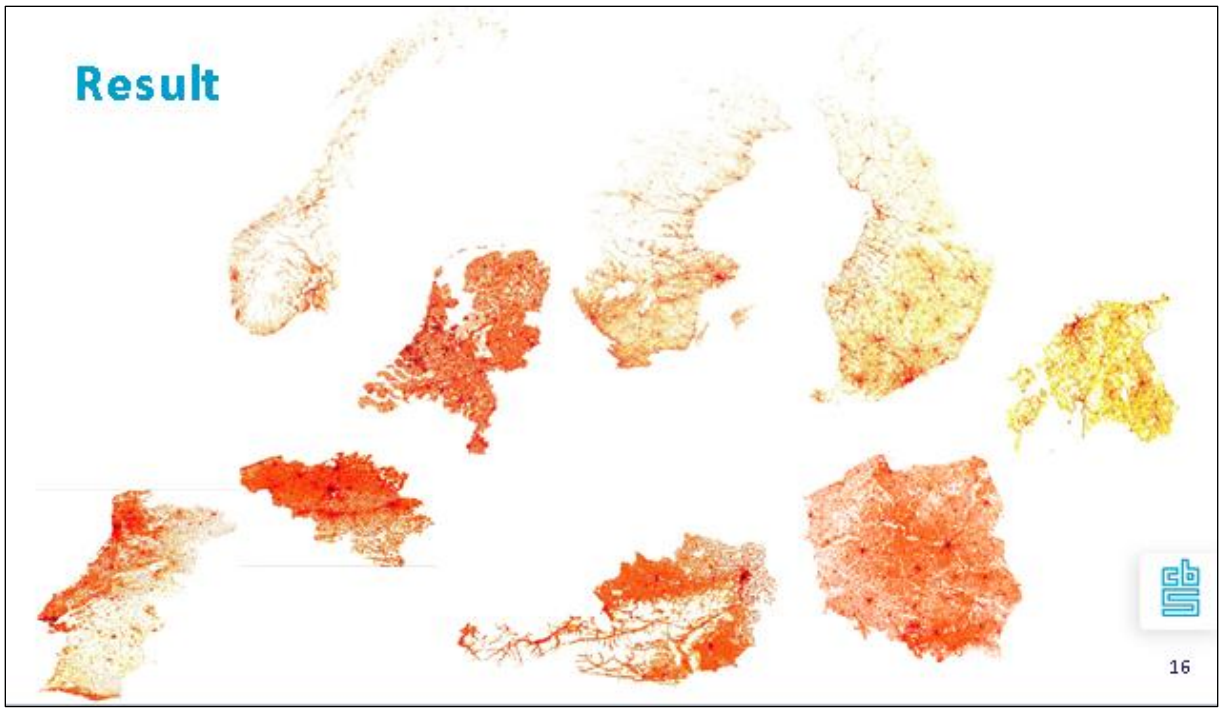


Figure 11: WMS of different countries generated with the Table Joining Service

3.4.3 Recommendations

- OGC Web Coverage Services (WCS) should be considered as an alternative output service since performance of WFS is not good enough for very large datasets
- The reporting should be enhanced on the result of the join operation (e.g. number of (mis)matches)
- The TJS should be developed to support more input formats starting with CSV and Odata[10] format.
- The TJS should be developed to support joining of multiple variables in the same operation
- When a revised and extended OGC TJS standard is published, further development of TJS should be compliant with this standard
- Developing APIs to manage the TJS will facilitate the use of automation. Such APIs should include management tools, for instance deleting existing entries in the list of actions on the TJS. Also application of user accounts to the TJS to register the users is good practice.

3.5 Metadata

Using a TJS to automate linking of geometries and tabular data potentially generates thousands of new services based on the same common sources, i.e. the geometry of the service containing statistical units and the tabular data published by NSIs. Therefore providing metadata on the TJS itself together with metadata on the services containing the geometries and on the tabular data in the national repositories should cover the meta data needs. It does not make much sense to make metadata for all the services generated by the TJS, especially when these output services are temporary.

Within the SDMX files there is some metadata in the header, but that does not make it findable for the geospatial community, because it is not an ISO 19115 or INSPIRE standard. Therefore, it is recommended to provide ISO 19115 metadata for the SDMX file conform INSPIRE standards. Within

[10] https://www.odata.org/

this metadata, one should add links to the TJS resulting services within the <distributionInfo> tag, when these services are supposed to be a more permanent service, like services for INSPIRE themes. Concerning temporary output services, one should at least refer to the metadata of the TJS itself, so the user can regenerate the output services. In this case, it should be open for use to the public.

The TJS itself can be considered as a Spatial Data Service. According to INSPIRE, this should also have its own metadata. In the future, when the Dutch TJS is fully operational, it will be considered to provide this metadata. One could discuss, if this is also needed for a TJS that is not open for use to the public.

To sum up we recommend to provide 4 types of metadata:

1. INSPIRE metadata for the geometry / geographies
2. INSPIRE metadata for the SDMX files
3. INSPIRE metadata for the TJS if open to the public
4. SDMX metadata within the SDMX file

A metadata example of type one for the service containing geometry (grid):

http://nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/metadata/db8d613f-5edc-4467-9cc0-e2dcfb9d64a8

A metadata example of type two for the SDMX file with INSPIRE Population Distribution data:

http://nationaalgeoregister.nl/geonetwork/srv/dut/catalog.search#/metadata/219e49e1-a5fd-4d00-9b85-6f6e50678560

3.5.1 Recommendations

- The metadata of the input services, SDMX tables (both INSPIRE and the SDMX enclosed metadata) and the web service for geometry, should be used. No new metadata for the output services generated by the TJS should be constructed.
- In accordance with INSPIRE, metadata for the TJS itself should be provided when open for public use

4 Conclusions

The aim of this POC has been to make a practical test of the feasibility of Requirement 4.3 - *Publish data once and leave it at its source to be reused many times*, Requirement 4.4 - *Increase use of services for merging geography and statistics* and in parts Requirement 5.2 - *Use service-oriented data portals supporting dynamic integration of data* proposed by the GEOSTAT 3 project for the European implementation guide.

From the start of the project it was concluded that the concept of Table Joining Services (TJS) was an interesting candidate for testing. The TJS offers a potential solution for machine-to-machine based transformation and integration of data having the following benefits in terms of interoperability and accessibility:

- It is based on OGC standards, INSPIRE data models and SDMX (a key element of Principle 4)
- It operates on machine-to-machine readable data (a key element of Principle 4)

- It supports the idea to leave geospatial and statistical data at its source (with enclosed meta data and proper maintenance schemes) using established protocols for automated data integration whenever called for by a user (elements of both Principle 4 and 5)
- It uses common geographies as defined by INSPIRE SU-grid but in principle it can be configured for use of any common geographies (Principle 3)

The results from the POC largely confirmed the feasibility of the requirements proposed and showed that the conditions to meet the requirements are fairly good, considering existing data models, standards and technical solutions at hand.

There are still technical and methodological issues to solve to improve the use of tools like TJS for increased automation and interoperability, but none of these seem impossible to overcome. Recommendations regarding technical and methodological aspects of TJS, covering conditions for input and output data, metadata as well as improved performance and operation of the TJS, are provided in Chapter 3 (section 3.1.3, 3.2.4, 3.4.3 and 3.5.1). These recommendations are not part of the European implementation guide (GSGF Europe), however they can still provide valuable input for further work on TJS.

On the basis of the result from the POC in combination with related activities on European level and national practices, the following recommendations were consolidated for the European implementation guide (GSGF Europe):

- Recommendation 4.3.1 - Countries should intensify their efforts on service-oriented dissemination through APIs to provide machine-readable open data format for national geospatial statistics - Spatial Statistics as a service.
- Recommendation 4.3.2 - The adaption of SDMX for INSPIRE implementation, successfully developed and tested by Eurostat in the context of population grids for the Census 2021, should be used as solution for INSPIRE harmonisation of Population distribution in the ESS. It is assumed to minimise the effects of double obligation on ESS Member States and to maximise the usability of the census information for the statistical and geospatial community.
- Recommendation 4.3.3 - SDMX is evolving as data exchange format for a growing number of statistical domains. NSIs and Eurostat should work closely together to explore further applications of SDMX beyond the context of Census 2021.
- Recommendation 4.3.4 – Open, centralised, INSPIRE compliant services with NUTS geographies and 1km and other sized grids should be set up by the ESS (or by other European body through agreement with ESS) for the whole of Europe, to avoid unnecessary duplication and efforts by the member states. Preferably this is done at different levels of detail. These services could be used for cross border mapping of Statistics when joined with the SDMX services.
- Recommendation 4.4.1 - European bodies, national geospatial agencies and NSIs should work closely together on developing and applying services using automated and dynamic linking of geographies and statistical services and on deciding on an underpinning governance on the provision of these services. This will enable more flexible and open statistical-geospatial integration providing more value for users.

- Recommendation 4.4.2 - Though OGC Table Joining Services until now has not been widely implemented, the geospatial and statistical community should jointly involve in developing the standard and to consolidate and industrialise its implementation.
- Recommendation 4.4.3 - For harmonised European data under the INSPIRE themes Population distribution and demography, a combined European action should be considered by means of a TJS operating on the Eurostat SDMX web service instead of setting up numerous different national services. This would also be a good business case and a large scale test, possibly paving way for application of the same technology also within other statistical domains.
- Recommendation 4.4.4 - Existing services using SDMX datasets should not be modified to additionally implement INSPIRE data models. Also no parallel INSPIRE download service should be implemented, as SDMX and the SDMX services already meet INSPIRE requirements as they are already machine readable and harmonised.
- Recommendation 5.2.1 - Countries should explore use of service oriented dissemination platforms, providing a greater flexibility in terms of usability and supporting data access through a variety of interfaces via APIs. OGC compliant services and non-proprietary formats should be used (e.g. OGC Geopackage for file deliveries) for dissemination in order to ensure flexibility also from an end-user perspective.
- Recommendation 5.2.2 - The ESS should increase its efforts to facilitate common concepts and shared solutions on service-oriented and dynamic linking of data. Good practise and current progress made in individual Member States or elsewhere need to be consolidated and better exploited to stimulate development in the whole of Europe.

Appendix 1 - Survey questions

[Short email text:
Topic: Invitation to short survey on
As part of the ESSnet GEOSTAT 3 project I welcome you to take part in a survey about the use of automated generation of web map services based on tabular statistics.

Please do forward to appropriate person if you find it hard to fill out the survey.
The survey will take 5-10 minutes. Results will be published on www.efgs.info.

Thank you in advance.

Link to survey]

Background

Traditionally a digital map based on statistics is generated by making a join between a map of the area delineations and the tabular data which you want to present. This is often done by hand by a GIS-specialist. The next step is to convert this map into a WMS and a WFS map service using an appropriate program and most preferably according to INPIRE standards

This workflow may be very tedious when many maps have to be generated or when data tables, which are already published, are often subject to minor changes in the data and have to be re-joined again and republished.

Automated map generation is the process doing this automatically instead of manually. It is about generating these map services (WMS and WFS) on the fly by automation.

Meaning that:

- a WMS and WFS are generated using predefined open datasets joined to predefined maps using corresponding area codes when a service is not yet available.

- a change in the dataset may generate the restart of the geoservices adjusted to the new dataset.

For instance, a Table Joining Service is providing this utility of starting a new service when a user calls a predefined URL naming: the TJS service, the URL of the dataset and the URL of the map service. Thus, the TJS is generating the new geoservices (WMS and WFS service) when it does not already exist when it is called. The tabular data and the map have to be published according to a predefined data format.

Survey on best practises of automated generation of WMS and WFS map services

Contact person:

Name:
e-mail:
Institution:
Country:

1. Open data can be ranked at 5 star levels.
   What is the open data ranking level of the tabular data used for your mapping?
   [radio buttons]
   1. [ ] It is on the web
   2. [ ] It is machine readable
   3. [ ] In a non-proprietary format
   4. [ ] RDF standards
   5. [ ] Linked RDF (linked data)

2. What formats are used (Eg. just xls download or Odata protocols with Json and XML as output or protocols used by Eurostat (REST and SOAP) with output format SDMX)?
   [radio buttons]
   - [ ] csv or xls download
   - [ ] Odata protocols with Json and XML
   - [ ] REST and SOAP protocols with SDMX
   - [ ] RDF
   - [ ] Something else: [..Open text box..]

3. If you are not using Linked data, are you intending to use Linked data in the future?
   [radio buttons]
   - [ ] Yes [..How many years?..]
   - [ ] No

4. Do you agree with the next statement concerning INSPIRE themes Population Distribution (PD) and Human Health (HH) :
   " One of the INSPIRE goals is interoperability of geodata across boarders in Europe. In order to do that, you need semantically and technically harmonized and machine readable data. The SDMX files as the member states deliver to Eurostat fulfil these requirements. Therefore there is no need to again harmonize this data into the data models as described in the INPIRE data specifications for the themes Population Distribution (PD) and Human Health (HH). Not doing this would save the NSI's of the member states a lot of money. INSPIRE goals can still be reached by joining these SDMX files to harmonized Statistical Units, most preferably by means of an automated mapping procedure like mentioned in this survey.
   Only for new deliveries like the census 1km2 grid, it makes sense to use the INSPIRE models for PD and HH, but then we should still use the SDMX encoding, since we are familiar with them."
   [radio buttons]
   - [ ] Yes
   - [ ] No because [..Open text box..]
   - [ ] Partly because [..Open text box..]

5. If you answer on the previous question was "No": How will you fulfill the INSPIRE obligations for the themes PD and HH?

[..Open text box..]

6. Do you use an automated updating of geoservice now?
   [radio buttons]
   - [ ] Yes
   - [ ] No
   - [ ] In test

If YES or "in test", please fill out **section A**. If NO, please skip section A and go to **section B**.

Section A:

7. What is the program used?
   [radio buttons]
   - [ ] Geoserver with TJS
   - [ ] Something self-build
   - [ ] Something else: [..Open text box..]

8. Is it available as
   [radio buttons]
   - [ ] open source,
     or as
   - [ ] commercial product?

9. Are there any other services published that generate maps automatically?
   [radio buttons]
   - [ ] Yes [Please describe shortly]
   - [ ] No

10. Do you expect using the SDMX services from Eurostat in combination with geometry for mapping purposes in the future?
    [radio buttons]
    - [ ] Yes
    - [ ] No

Section B:

If you don't use an automated updating of the services published:

Are you planning to do this in the future?
[radio buttons]

- [ ] Yes [..How many years?..]
- [ ] No

11. If yes:
    what program do you intend to use?
    [radio buttons]
    - [ ] Geoserver with TJS

- [ ] Something self-build
- [ ] Something else: [..Open text box..]
- [ ] Don’t know

12. Are you intending to use the SDMX services from Eurostat in combination with geometry for mapping purposes?
    [radio buttons]
    - [ ] Yes
    - [ ] No
    - [ ] Don’t know

13. Any other comments?
    [Open text box]

Appendix 2 – Manual for grid data, CSV to SDMX conversion

1. Introduction

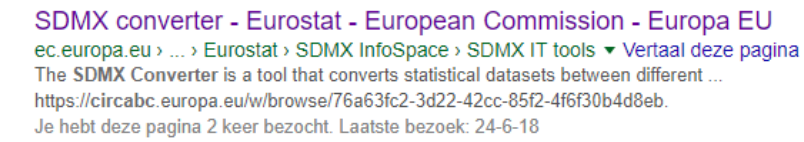
Purpose of this document is to convert an existing data file in CSV-format into a data file in SDMX XML-format to be used by a table joining service.

An SDMX file containing data of population per grid will be part of the proof of concept for the table joining service (TJS) for grids. This manual will demonstrate the steps in the conversion of data. The converter is a Eurostat converter derived from the CIRCA website. This document will demonstrate how to use it with grid data.

A table joining service is a service that connects a table in a predefined format on the internet with a map service on the internet to establish a web mapping service (WMS) of the content of the combination of both inputs. The purpose of this TJS is to perform an automated update of the WMS when the tabular data changes, thus establishing a new and updated mapping service.

2. Obtaining the converter

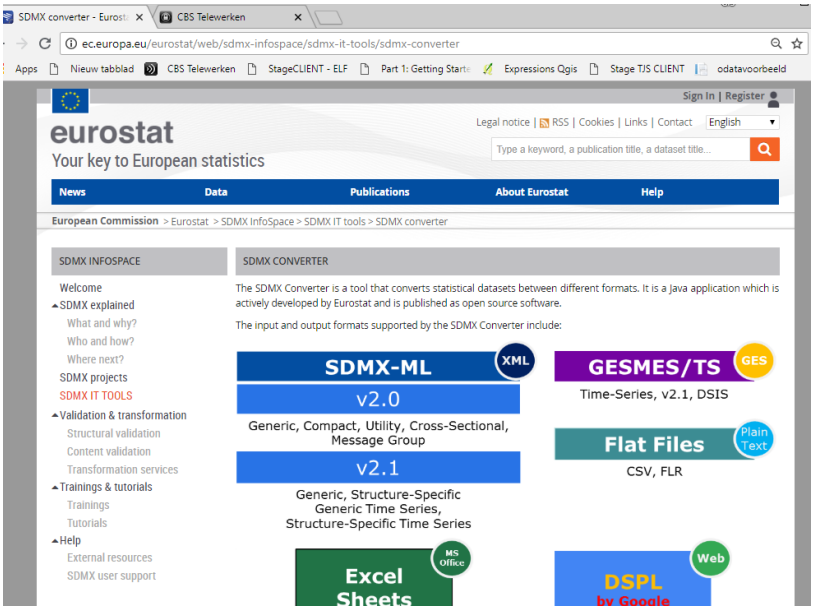
First you will need to download the converter installation package. Use Google and search for the page using the keywords: *circabc sdmx converter*. This will lead you to the first suggestion on the google result page:



Or use this link:

http://ec.europa.eu/eurostat/web/sdmx-infospace/sdmx-it-tools/sdmx-converter

On the page exposed by this link you must scroll down to the bottom of the page



Here you will find the link to the SDMX converter download environment:

https://circabc.europa.eu/w/browse/76a63fc2-3d22-42cc-85f2-4f6f30b4d8eb

This manual describes the version of 2017: **5.4.4. Ultimate SDMX 2.1**

Using the link of **5.4.4. Ultimate SDMX 2.1** expands the page where you can obtain the 5.4.4. Converter for various platforms.

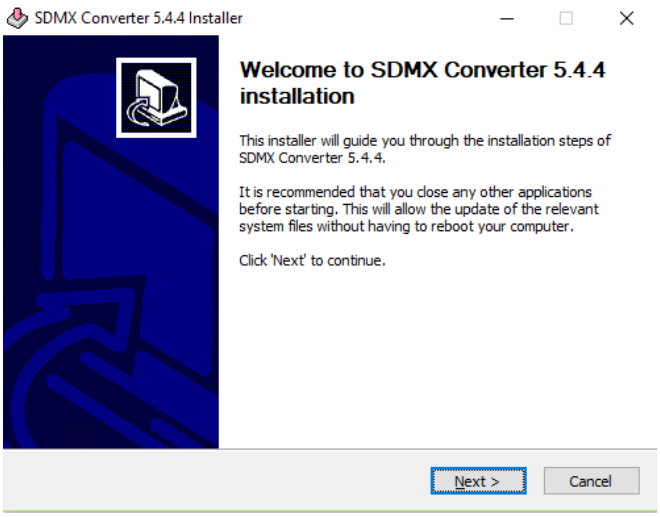
I will use the version for a stand-alone computer, which is the version:

SDMX_Converter_win32_v5.4.4_2017.02.16-ultimate-sdmx21.zip

2.1 Installing the converter

Extract the ZIP file and start the installation using: **SDMX_Converter_v5.4.4.exe**

The following bitmap shows up.



Follow these steps:

1. Choose Next (Install for anyone using this computer)
2. Agree (accept the license agreement, of course without reading it like everyone)
3. Next (Accepting the installation folder)
4. Next (Accepting the repository location)
5. Install (Creating Start menu folder)

Installing should start now to unpack the ZIP file.

6. Next (after unpacking/installation is completed)
7. Finish

There is a folder “SDMX converter 5.4.4” in your start menu containing the link “SDMX converter 5.4.4.”

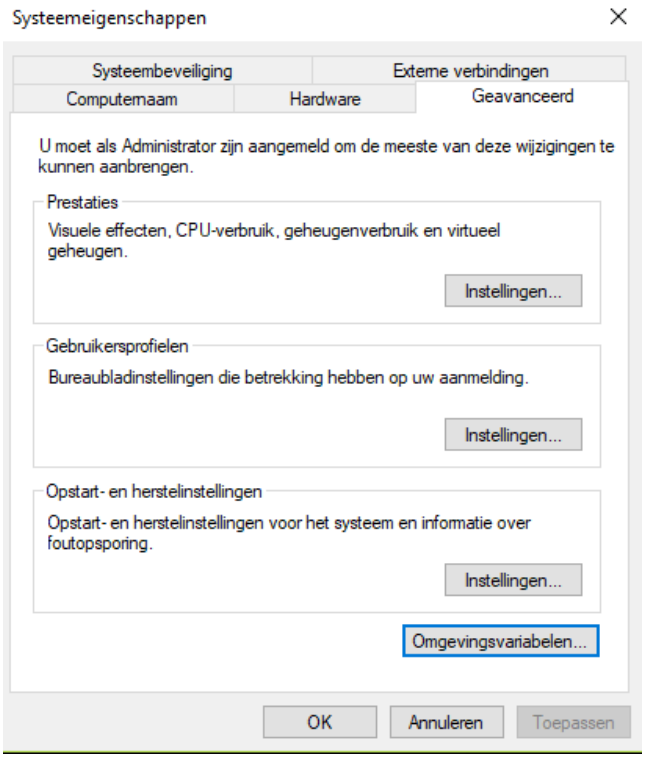
Start the program with this link. When a screen is opening up there is already Java installed so you may continue with chapter 0. But what if the Converter is not starting?

2.2 Preparing the java environment

If you have Java on your computer, but the program does nor start you probably have to prepare the java environment, which is setting of a user variable for Java.

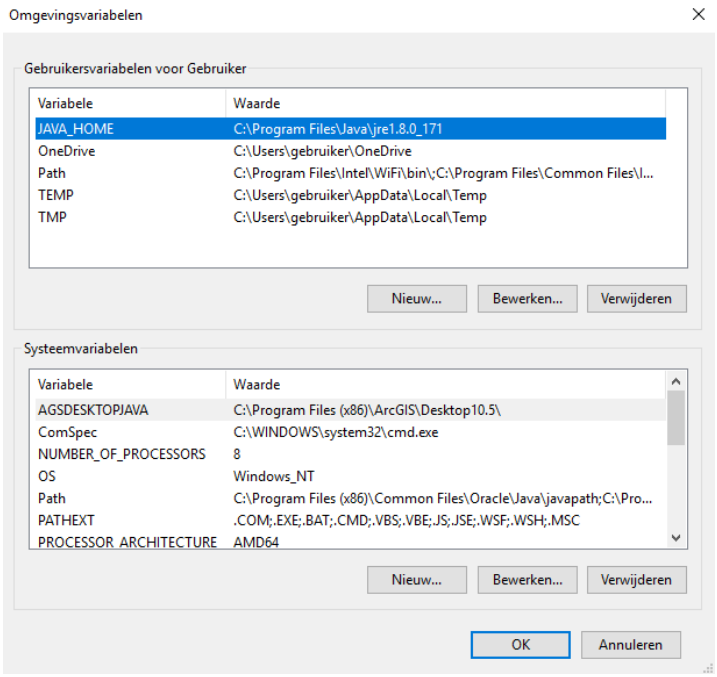
Go to the Windows “system properties” and choose the tab “Advanced”

Choose “Environment variables” at the lower right of the tab.



A new window pops up containing system and user variables.

When the list doesn’t contain a variable “JAVA_HOME” add this user variable by making a new variable with the name “JAVA_HOME” and the value which is the map containing your latest Java installation. For example “C:\Program Files\Java\jre1.8.0_171”. Usually this map contains the maps “bin” and “lib”.



This should solve your problem starting the converter.

3. Preparing the CSV datafile

In this example figures of a single subject are given, the total population per 1 km grid. Columns in this example are given in the order the DSD has defined, but that doesn't have to be the case. Columns do not have a header.

Column A: **FREQ**. The frequency of the observation, according to the codelist CL_Freq this is "A" (Annual).

Column B: **GM_SURFACE**. The code of the grid, which is written in the format:
<Country code><_><EPSG projection code><Resolution><North><value><East><value>.
For instance: **NL_CRS3035RES1000mN3079000E4028000**

Column C: **STAT**. Subject of statistics. In this case "T" (Total population) according to CL_STAT.

Column D: **MEASURE**. Type of subject. In this case "populationAtResidencePlace"

Column E: **PERIOD_OF_REFERENCE**. In this case the year "2012". Which actually for the Dutch case is the beginning of the year (1/1/2012).

Column F: **OBS_VALUE**. The number of inhabitants.

The layout of the CSV file, after compiling the adjusted grid coding, is.

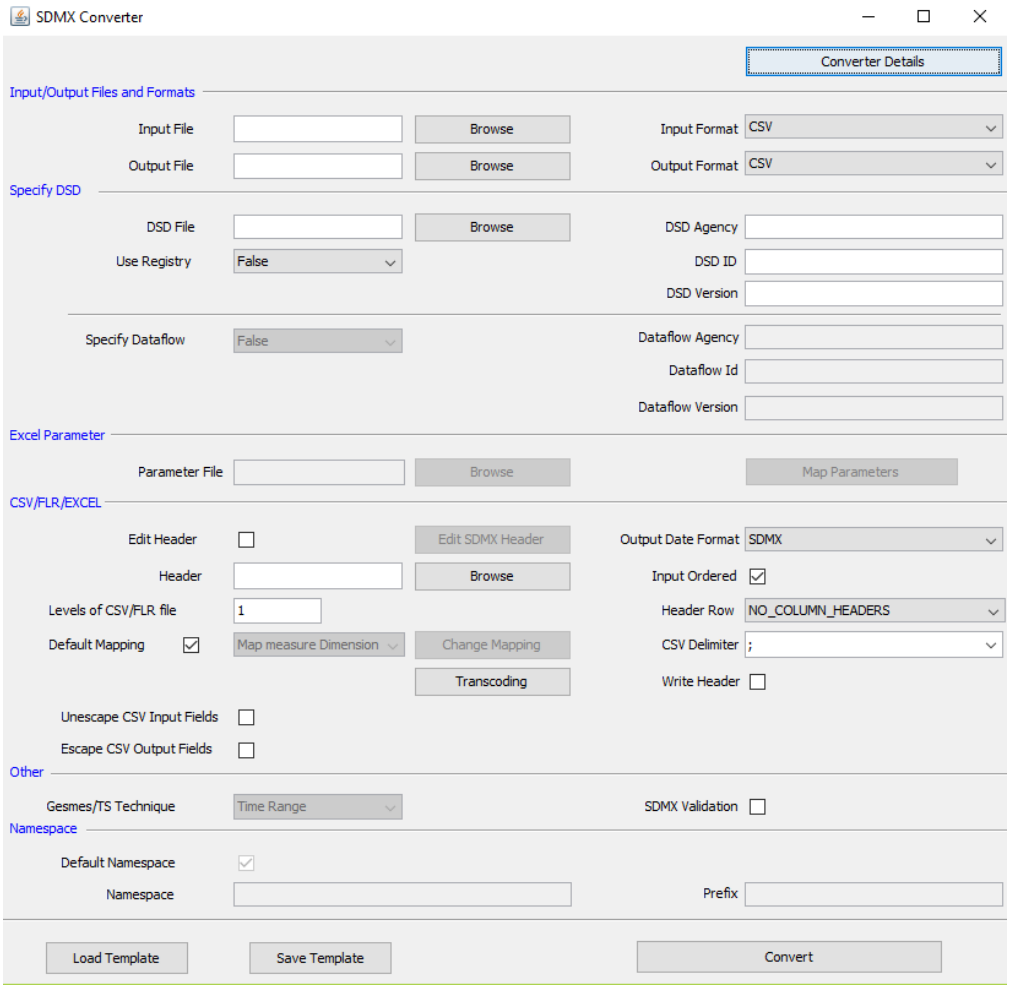
	A	B	C	D	E	F	G
1	A	NL_CRS3035RES1000mN3079000E4028000	T	populationAtResidencePlace	2012	2	
2	A	NL_CRS3035RES1000mN3079000E4032000	T	populationAtResidencePlace	2012	14	
3	A	NL_CRS3035RES1000mN3079000E4033000	T	populationAtResidencePlace	2012	32	
4	A	NL_CRS3035RES1000mN3079000E4034000	T	populationAtResidencePlace	2012	8	
5	A	NL_CRS3035RES1000mN3079000E4038000	T	populationAtResidencePlace	2012	87	
6	A	NL_CRS3035RES1000mN3079000E4039000	T	populationAtResidencePlace	2012	69	
7	A	NL_CRS3035RES1000mN3079000E4040000	T	populationAtResidencePlace	2012	4	

There are other possible ways of presenting the data to the converter in CSV format. Look in section "Change mapping" in "Header information", paragraph 0.

4. Performing the conversion

Start the converter with the link "SDMX converter 5.4.4." from the Start menu.

The following menu pops up



4.1 Input

Choose the input file made up in CSV-format as explained in the previous section. Use “Browse” to point to the file.

4.2 Output

Give a name and location for the Output File. The Output Format is set to “COMPACT_SDMX”. The output filename must have the extension .xml.

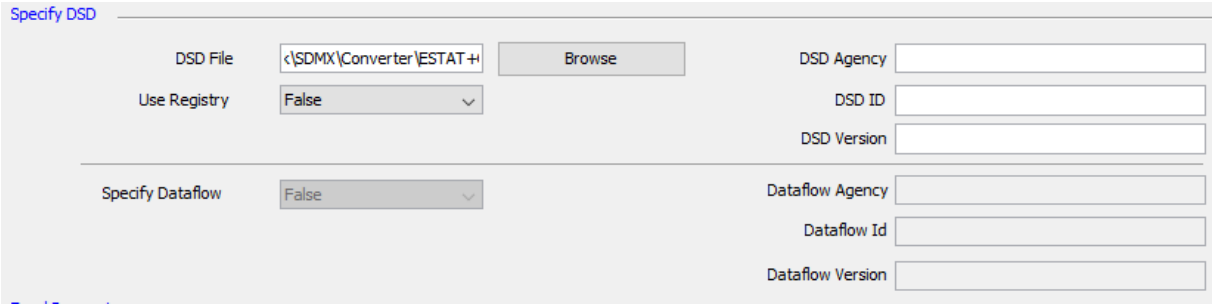
4.3 Specify DSD

A DSD is included in this document.

ESTAT+CENSUS-GRID+1.0-SDMX21.xml

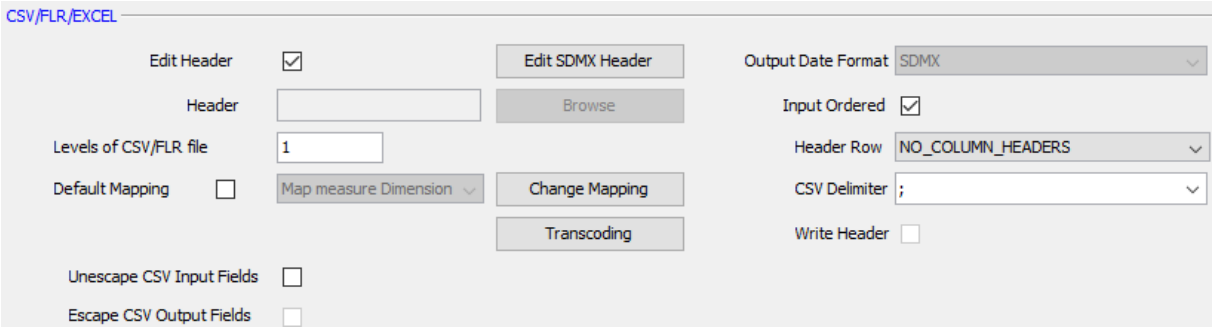
Copy the ESTAT+CENSUS-GRID+1.0-SDMX21.XML file to a location on your hard drive and use browse to point to this .xml file.

Ignore the other parameters in this chapter.

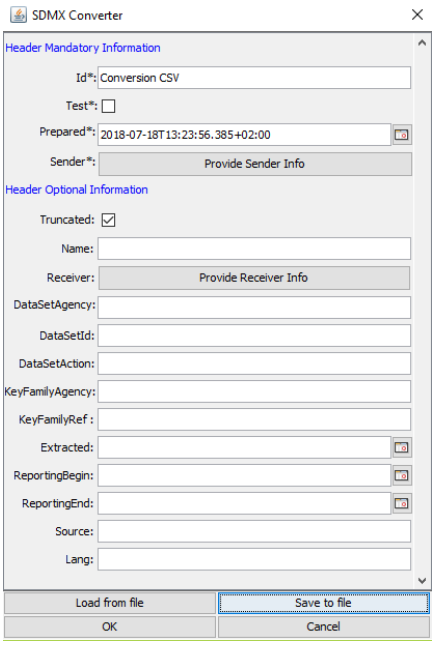


4.4 Header information

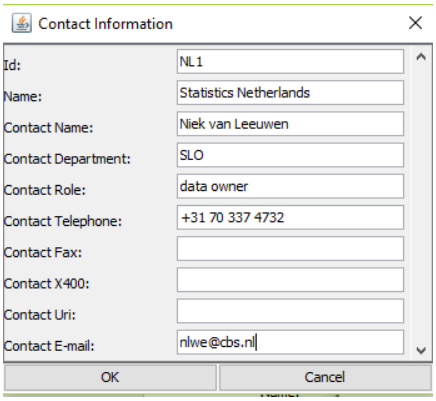
In the next section “CSV/FLR/EXCEL” check “Edit header” and uncheck “Default mapping”.



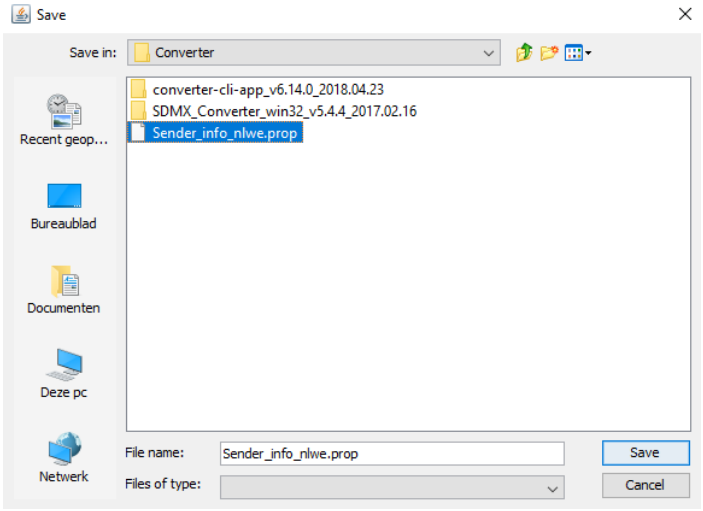
Use the “Edit SDMX Header” button to produce mandatory information on the file. When pressing the button a window pops up.



The fields with an asterix are mandatory. Use the ID field to give the file a name, uncheck test, prepared is already filled. When pressing the button “Profile sender info”, a new window for contact information pops up. Fill these fields for as far as appropriate.



Press OK, and optionally save the file with sender info to be used the next time. The file must have the extension .prop to be used the next time.



The next part is the mapping of the fields in the input CSV.

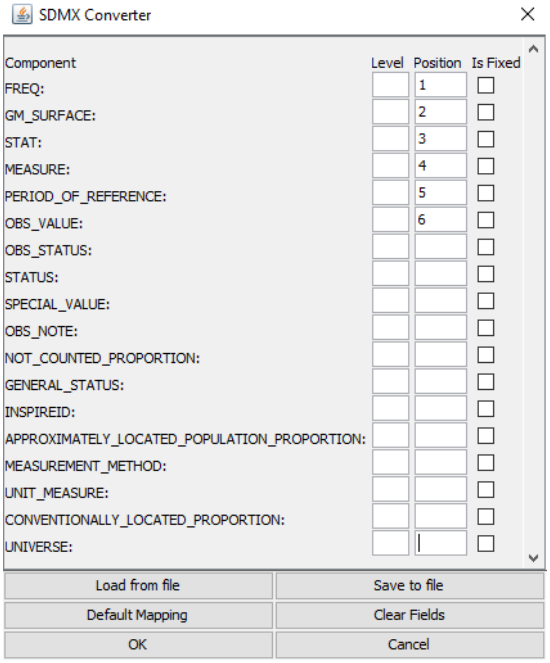
The checkbox “Default mapping” is unchecked, so you may press the button “Change mapping”.

A new, rather small, window pops up. Enlarge the window to see the “Level”, “Position” and “Is Fixed” fields.

These are the different subjects a SDMX file can process. We will use only the first six.

For a CSV-file the number in “Position” is the column number in the CSV file. You will see this is the same occurrence as the layout of the CSV-file, so positions does not have to be changed.

More position numbers for each subject are presented by default, but remove them if you don’t need them.



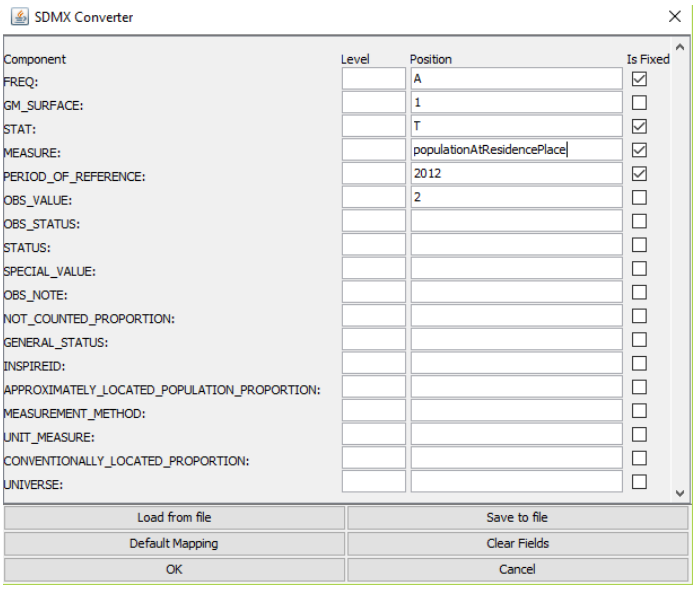
Press OK.

If you have fixed values for all records in the dataset you may present the data in a simpler format. In this test dataset actually only the grid code and the number of inhabitants will change, all other values are the same for all records.

So in this example we use a two column dataset.

	A	B	C	D
1	NL_CRS3035RES1000mN3079000E4028000	2		
2	NL_CRS3035RES1000mN3079000E4032000	14		
3	NL_CRS3035RES1000mN3079000E4033000	32		
4	NL_CRS3035RES1000mN3079000E4034000	8		
5	NL_CRS3035RES1000mN3079000E4038000	87		
6	NL_CRS3035RES1000mN3079000E4039000	69		
7	NL_CRS3035RES1000mN3079000E4040000	4		
8	NL_CRS3035RES1000mN3080000E4017000	7		
9	NL_CRS3035RES1000mN3080000E4026000	33		
10	NL_CRS3035RES1000mN3080000E4027000	7		
11	NL_CRS3035RES1000mN3080000E4028000	11		
12	NL_CRS3035RES1000mN3080000E4029000	12		
13	NL_CRS3035RES1000mN3080000E4032000	93		
14	NL_CRS3035RES1000mN3080000E4033000	22		
15	NL_CRS3035RES1000mN3080000E4034000	25		

In that case you may check “Is Fixed” and give the value of that subject in the “Position” field. Note that unchecked columns still contain the column number of the CSV-file.



Furthermore does the header row not contain Columns Headers.

Check the CSV delimiter, which is default ';'

4.5 Other information

Ignore the next session "Other". In the section "Namespace" the box Default namespace is checked.

So that's it, press convert!!

4.6 Results

The results of the conversion is an XML-file containing observed number of inhabitants at populationAtResidencePlace per grid for the annual figures of the year 2012.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Created with SDMX Converter v5.4.4 -->
- <CompactData xsi:schemaLocation="http://www.SDMX.org/resources/SDMXML/schemas/v2_0/message SDMXMessage.xsd
urn:sdmx:org.sdmx.infomodel.keyfamily.KeyFamily=ESTAT:CENSUS-GRID:1.0:compact ESTAT_CENSUS-GRID_Compact.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:cen="urn:sdmx:org.sdmx.infomodel.keyfamily.KeyFamily=ESTAT:CENSUS-GRID:1.0:compact"
xmlns="http://www.SDMX.org/resources/SDMXML/schemas/v2_0/message">
  - <Header>
      <ID>Conversion CSV</ID>
      <Test>false</Test>
      <Truncated>true</Truncated>
      <Prepared>2018-07-18T13:23:56.385+02:00</Prepared>
    - <Sender id="NL1">
        <Name xml:lang="en">Statistics Netherlands</Name>
      - <Contact>
          <Name xml:lang="en">Niek van Leeuwen</Name>
          <Department xml:lang="en">SLO</Department>
          <Role xml:lang="en">data owner</Role>
          <Telephone>+31 70 337 4732</Telephone>
          <Email>nlwe@cbs.nl</Email>
        </Contact>
      </Sender>
  </Header>
  - <cen:DataSet>
    - <cen:Series MEASURE="populationAtResidencePlace" STAT="T" GM_SURFACE="NL_CRS3035RES1000mN3079000E4028000" FREQ="A">
        <cen:Obs OBS_VALUE="2" PERIOD_OF_REFERENCE="2012"/>
      </cen:Series>
    - <cen:Series MEASURE="populationAtResidencePlace" STAT="T" GM_SURFACE="NL_CRS3035RES1000mN3079000E4032000" FREQ="A">
        <cen:Obs OBS_VALUE="14" PERIOD_OF_REFERENCE="2012"/>
      </cen:Series>
    - <cen:Series MEASURE="populationAtResidencePlace" STAT="T" GM_SURFACE="NL_CRS3035RES1000mN3079000E4033000" FREQ="A">
        <cen:Obs OBS_VALUE="32" PERIOD_OF_REFERENCE="2012"/>
      </cen:Series>
    - <cen:Series MEASURE="populationAtResidencePlace" STAT="T" GM_SURFACE="NL_CRS3035RES1000mN3079000E4034000" FREQ="A">
        <cen:Obs OBS_VALUE="8" PERIOD_OF_REFERENCE="2012"/>
      </cen:Series>
    - <cen:Series MEASURE="populationAtResidencePlace" STAT="T" GM_SURFACE="NL_CRS3035RES1000mN3079000E4038000" FREQ="A">
        <cen:Obs OBS_VALUE="87" PERIOD_OF_REFERENCE="2012"/>
      </cen:Series>
```

Appendix 3 – Manual for Table Joining Services using SDMX and grids

1. Introduction

Managing WMS and WFS services by using a Table Joining Service requires three types of input.

1. A web service of the delineations of the regions, this delineations have a GEO-code only.
   In this case a 1km grid according to INSPIRE qualifications. This grid delineations have the GEO-code as described in the Act on the EU census 2021.
2. A table on the web, containing data per region, were the region code is the GEO-code
3. A table Joining Service performing the generation of the WMS and WFS services using the map (1) and the table (2) as input.

Ad 1. The web service of the 1km2 grids for the 8 participating countries and Belgium is on-line and available for the TJS.

Ad 2. A manual for generating a table from CSV format into SDMX format for grids has already been provided. Once generated, the SDMX-file needs to be published on the web to be available to the TJS. You will need the URL of the published table.

The table needs to be freely available so the data you publish needs to be free of charge and disclosure control has to be performed. You may publish the SDMX on an external server, or you may send it to statistics Netherlands, then we will publish it on a Dutch server for geodata.

Ad 3. A Table Joining Service is provided. This manual is about how to use it.

2. Publishing SDMX tables

2.1 On the Dutch server “PDOK Geodatastore”

In the case of Netherlands and Portugal the SDMX files have been uploaded to the PDOK geodatastore. PDOK is a Dutch abbreviation and means Public Services using Maps.

If you don’t use your own server, send the data to us and we will publish it on the Dutch server.

When searching published SDMX tables go to: http://www.nationaalgeoregister.nl

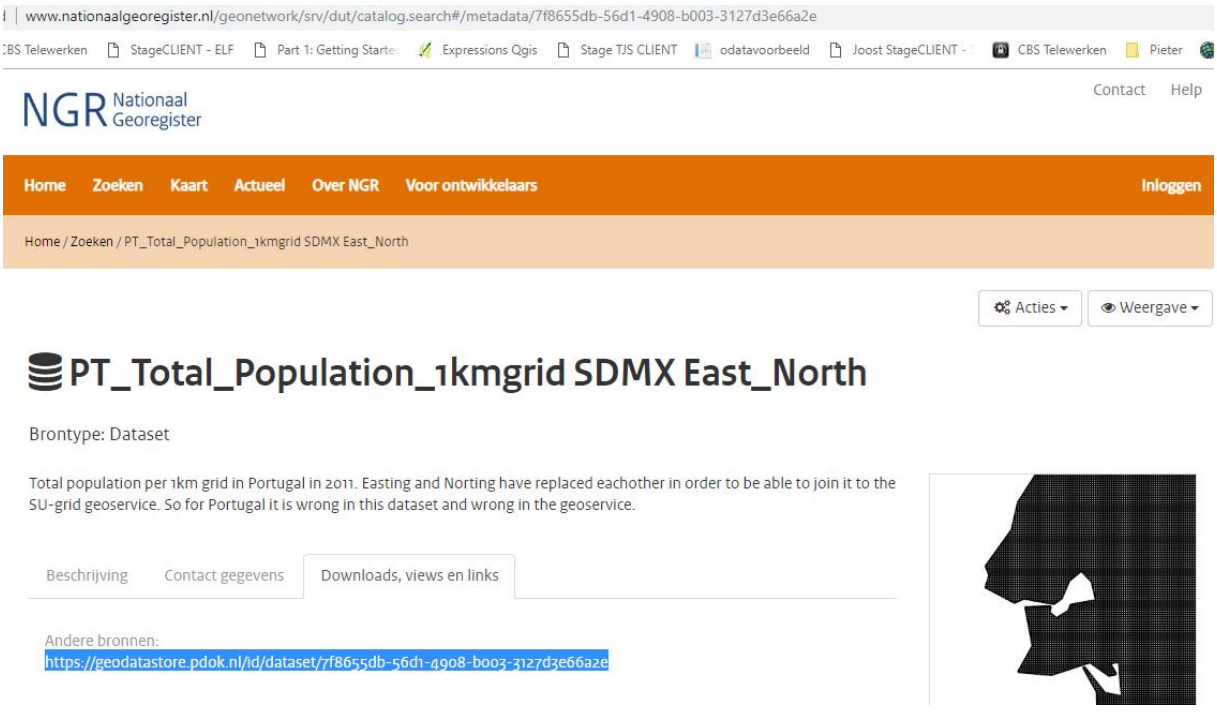
Since this website is for Dutch use I will translate some Dutch words.

Type at the search window “Welk onderwerp” the search string “SDMX” and a popup lists the available datasets with SDMX as keyword in the name of the service. Choose the one you of which you need the URL and metadata and press the button “Zoeken” on the right.

You will see the listing in the browser. In this manual we use the example of Portugal.

Click on the result: **PT_total_population_1kmgrid SDMX east_north**

The page with metadata on the specific file will open:



At the bottom of the tab “Downloads, views and links” which usually is presented as a first tab you see the link to where the data file is published. In this case: https://geodatastore.pdok.nl/id/dataset/7f8655db-56d1-4908-b003-3127d3e66a2e

You will need this link to refer to the table location to when using the Table Joining Service.

2.2 Publishing SDMX data on another server

You may want to publish the SDMX dataset on your own server as in the case of Sweden: http://share.scb.se/MI0813/XML/PopGrdSE2017.xml

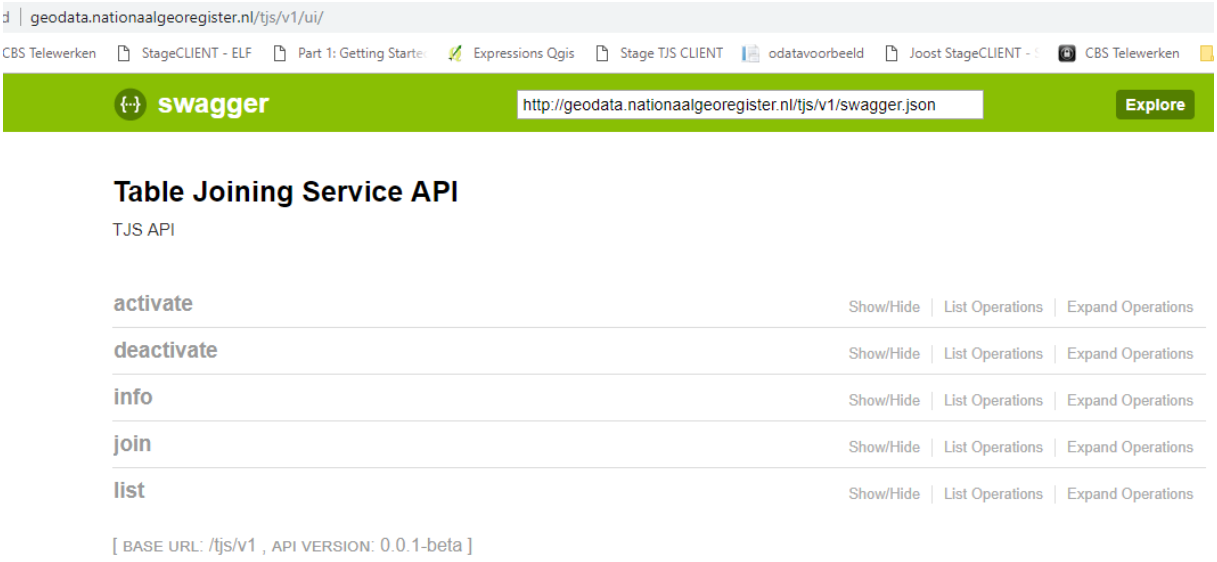
This link refers to the name of the XML, which is not a problem for the performance of the TJS.

We will continue this manual with the example of Portugal.

3. Table Joining Service

The TJS is operated by an API at the moment. The URL of the Table Joining Service is: http://geodata.nationaalgeoregister.nl/tjs/v1/ui/. The API is still under development. Once it is in a final version it will be published as open source.

Using this URL brings you to the TJS page with the API's to perform a publishing of WMS and WFS, where you will find five options available at the moment.



3.1 Generating a new OGC map service

When starting a new WMS and WFS service you need two options:

- Join
- Activate

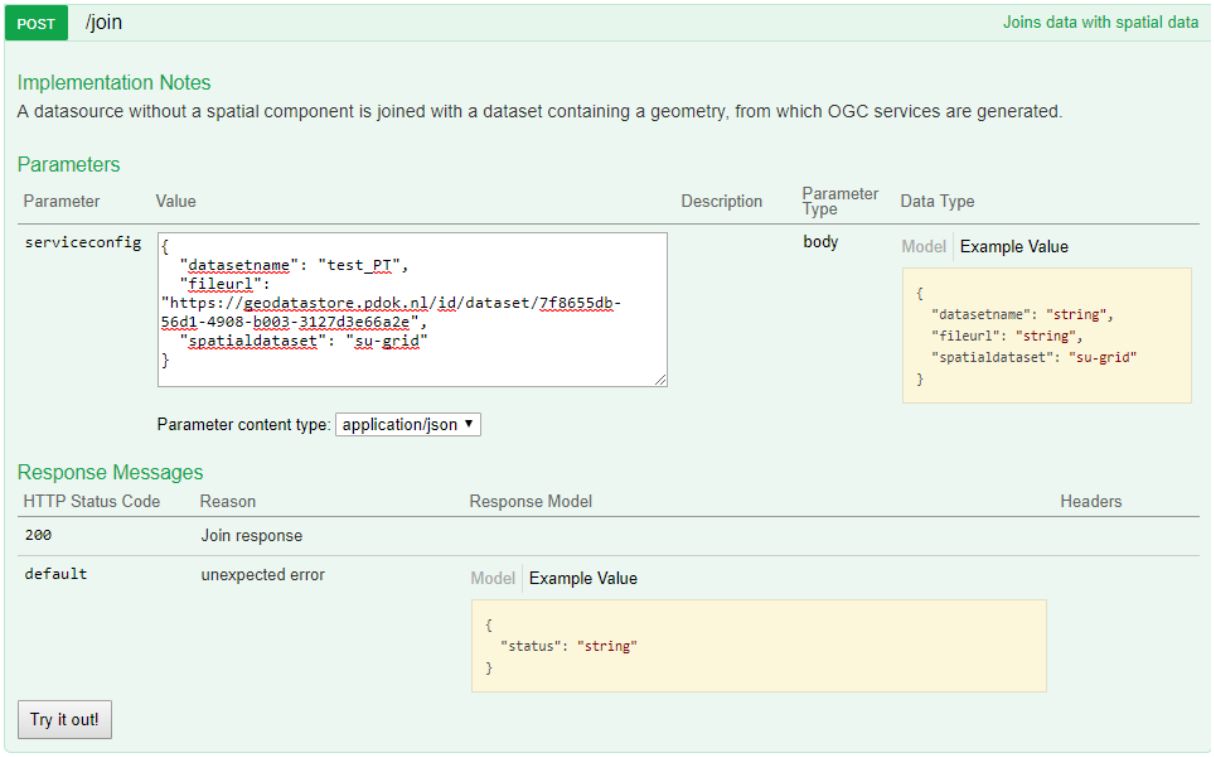
With the **Join** you define the join to be performed and is successful if both the table and the map services exists and the tables are uploaded into a database.

The next options **Activate** generates the new WMS and WFS services as defined with the Join option.

So let's start by generating services using the Portuguese dataset.

3.2 Join

Click on Join and "/Join" to open up the next screen.



On the right side you see an example of the three inputs the TJS need (datasetname, fileurl and spatialdataset).

You need to fill in the datasetname, fileurl and spatialdataset names in the left "serviceconfig" body. To avoid typing errors; If you click on this example text in the "Example value" window on the right, this text is copied into the "serviceconfig" body at the left and ready to be altered.

"datasetname"

This may be any name you provide and is the name of the WMS and WFS to be referred to later on, when you load your service for instance in Qgis. So let's use the name: "test_PT".

Alter as demonstrated in the "serviceconfig" body.

"fileurl"

This is the URL of the published SDMX file. Now for Portugal this is the URL as published in PDOK Geodatastore (0):

https://geodatastore.pdok.nl/id/dataset/7f8655db-56d1-4908-b003-3127d3e66a2e

"spatialdataset"

In the future the URL of the WFS containing the spatial areas will be referred to here.
For this testing purposes only one geodataset is available, the grid dataset of 1 square km. So you won't have to fill in a URL. At the moment this text string is dedicated. Leave it as it is.

Press the button “**Try it out!**”

This will generate a response of performing the join and the good response will return “Status: OK” in the Response body.

So now you know that the linking between the map and the table has been established and given the name in free text: “test_PT”.

But that doesn’t mean you have a map service at the moment, it means that the map and the table are present and are loaded to the TJS server.

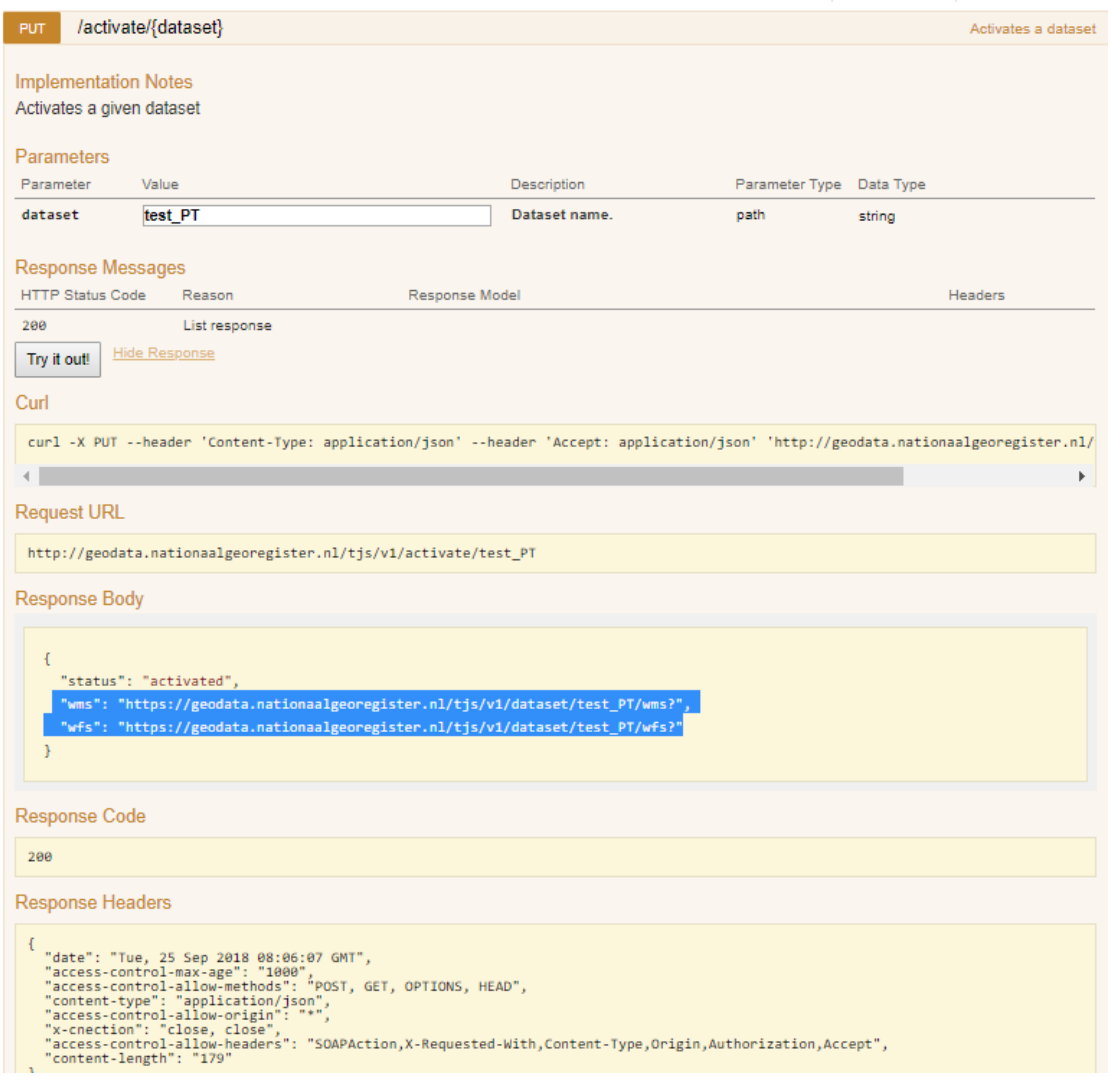
To get a running WMS and WFS you will need to use “Activate”.

3.3 Activate

When using activate it needs the name you gave to the service during the Join operation, in this case “test_PT”

Put this name in the “dataset” window and press “Try it out”.

When successful this will generate the response below.



The response body gives three messages, i.e. “activated” which means the WMS and WFS of the service “test_PT” are published and the URL’s of the Web Mapping Service and the Web Feature Service.

WMS: https://geodata.nationaalgeoregister.nl/tjs/v1/dataset/test_PT/wms

WFS: https://geodata.nationaalgeoregister.nl/tjs/v1/dataset/test_PT/wfs

The URL of the web services generated by the TJS consists of three parts:

- *https://geodata.nationaalgeoregister.nl/tjs/v1/dataset* : A location for WMS and WFS for this specific TJS.
- */test_PT*. The name of the service you created and
- */wms* or */wfs* which is the type of the service

These URL’s of the WMS and WFS you can use in a GIS for display.

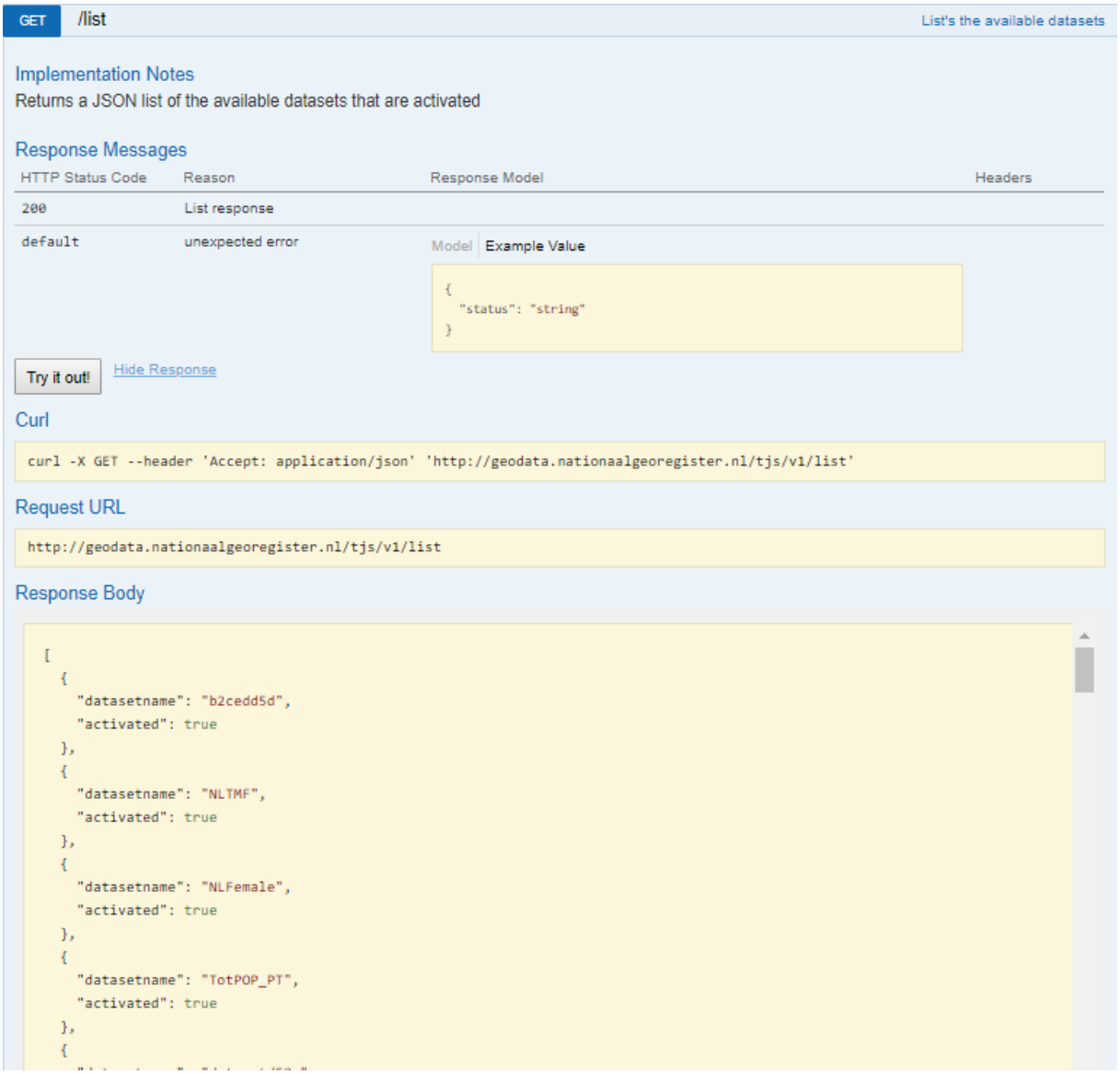
There seems to be some limitations somewhere underway in displaying the WFS. Although for countries as the Netherlands, Belgium and Portugal so far there seems not to be a problem in displaying the grids for the whole country.

Using the WFS for larger areas like Sweden it is recommended to zoom in to a smaller area before calling the WFS. Use for instance the WMS to navigate. Other functions of the API.

3.4 List

This will give a listing of actions on services since the beginning of the development. When you activate a new service this action may be found at the bottom of this listing.

The next feature to be developed for the TJS will be a possibility to clean up this list.



3.5 Deactivate

Deactivates a running service.

3.6 Info

Returns information about the version of the Table Joining Service and information about the spatial dataset, which is the 1 km grid only at the moment.

4. Using a SLD

When displaying the WFS in QGIS for instance you may want a legend for the values of total population. Otherwise the WFS displays in default colour only.

I provide a legend as Styled Layer Descriptor (SLD) to be used when you display the WFS.

style_popTotal_grid1km.sld

The colours may not exactly match the definition in the European colour scheme for the EFGS 2011 population dataset. Figure 1 below shows the WFS with SLD.

Figure 11: WFS; Total population per 1 km², Portugal (Mainland)

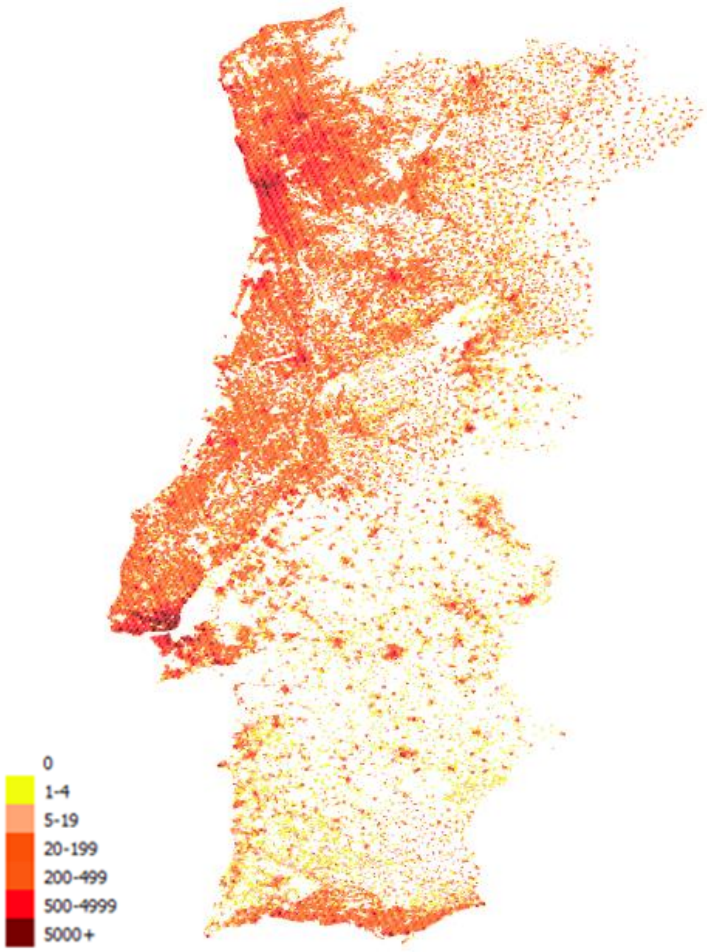


Figure 2 below shows the WMS with SLD.

Figure 12: WMS; Total population per 1 km², Sweden, inhabited km² only.