Open European Location Services (Open ELS)

EuroRegionalMap Vector Tile

A prototype of a vector tile service using ERM

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Change Summary

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0.0	08/05/2019	Emilio López, Paloma Abad	Baseline

References

Ref.	Title/Version/Publication Date/Author
[1]	Insert here

Contents

1 Introduction

1.1 Scope

This document defines the development of European topographic and administrative reference data (ERM) vector tile service at regional level. It facilitates the visualization of data set that is produced in cooperation by the National Mapping and Cadastral Agencies (NMCAs).

1.2 General information

1.2.1 EuroRegionalMap Concept

EuroGeographics, in collaboration with the National Mapping and Cadastral Agencies, has created EuroRegionalMap (ERM), a Pan-European Dataset at Medium Scale.

ERM is a pan-European seamless topographic database at regional level of detail; ERM is a vector-based product and is designed to support GIS applications and background display.

It contains topographic information at the scale 1:250 000 in Geographical coordinates in decimal degrees (longitude, latitude) and based on the ETRS89 spatial reference system (which corresponds to WGS84 reference system). This information comes from 35 data producers, including all EU Members States and EFTA states.

It covers 28 EC member states, 4 EFTA states, Republic of Moldova, Serbia and Kosovo, The Former Yugoslav Republic of Macedonia and Georgia and the small states of Andorra, Liechtenstein, Monaco, Vatican City State and San Marino, Faroe Islands and Isle of Man.

ERM was created for a wide range of uses, including spatial analysis, cartographic publishing and backdrop visualization, or in combination with other datasets for marketing planning and socio-economic analysis, environmental analysis, and transport management.

It contains 7 themes:

- Administrative Boundaries
- Hydrography
- Miscellaneous
- Named Location
- Settlement
- Transportation
- Vegetation and Soils

1.2.2 Reference documents

- EuroRegionalMap. Pan-European Dataset at Medium Scale. User Guide - ERM release 11.1
    - ERM_v11-1_UserGuide.pdf
- EuroGeographics_topographic_European_mapping.pdf
- EuroRegionalMap release 11.1 Pan-European Database at Medium Scale. Specification and Data Catalogue
    - ERM_v11-1_DataSpecification.pdf
- ESRI File Geodatabase v10.1.
- ERM_niceview.mxd
- Cartographic specification for the basemap Arctic SDI
    - 20190301_Kopi av ASDI_Cartography_data_model_v2 0Beta4.xlsx

1.2.3 Vector Tile

A vector tile is a vector representation of geographic data covering a spatially contiguous and rectangular extent. They are similar to raster (image) map tiles in their intent, namely to provide support to fast map services which can take advantage of pre-rendering, caching and concurrent requests. They are different because instead of providing a pre-styled fixed image depiction of the geographic data, they are a vector representation which can be manipulated, e.g. styled, client-side. It is important to highlight that they are a representation of data intended for visualization, and thus they belong to view services and not to download services; the underlying data, i.e. the geographic features, will be selected, combined, simplified and cropped to generate small vector tiles that can be quickly delivered to relatively simple client devices and applications, where they will be styled.

From the point of view of the service interface, vector tiles are no different to image tiles, they just happen to be in a different format (i.e. instead of PNG, they may be encoded in GeoJSON or Protocol Buffers). This means that they can be served through any view service interface that supports raster tiles (e.g. OGC WMTS, TMS or WMS-C), although the server which implements those interfaces must provide at least certain support for them.

2 The process

2.1 Study of the ERM v12 ArcGIS File Geodatabase

The information about Data Model and Structure ERM v12 is based on «ERM Specification and Data Catalogue» and «ERM Technical Producer Guide».

These documents describe the conceptual data schema of ERM defining the features, their attributes, their geometrical representation and their topological associations. The implementation of this conceptual data schema into different logical data schemas applied by the GIS software and has the following features class:

Administrative Boundaries (BND)	Settlement (POP)
POLBNDL Administrative boundaries	BUILTUPP built-up area Point
POLBNDA Administrative areas	BUILTUPA Built-up area Area
	URBANP Named Location Point
Hydrography (HYDRO)	**Transportation (TRANS)**
AQUEDCTL Aqueduct Line	AIRFLDA Airport/Airfield Area
COASTA Coast Area	AIRFLDC, AIRFLDP Airport/Airfield Point
COASTL Coastal Line	EXITC Border Crossing Point
DAML Dam / Weir / Lock Line	FERRYC Ferry station Point
DAMC Dam Point	FERRYL Ferry crossing line
LAKERESA Lake / Reservoir Area	HARBORA Port Area
LANDICEA Land Ice Area	HARBORC, HARBORP Port Point
ISLANDA Island Area	HARBORL Harbour Line
SEAA Sea Area	HELIP Heliport Point

SEASTRTL Shoreline Construction SPRINGP Spring Point SPRINGC Spring Point SWAMPA Wetland Area RAPIDSL Waterfall Line RAPIDSC Waterfall Point WATRCRSA Watercourse Area WATRCRSL Watercourse Line WELLP Well Point LANDMASKA Landmask Area SHOREL Inland Shoreline Line HYNODEC Hydrographic Network Node Point	INTERCC Interchange Point LEVELCC Level Crossing Point MISAEROP Miscellaneous Aero Point RAILRDL Railroad Line RAILRDC Railroad Point RESTC Rest Area Point ROADL Road Line RUNWAYL Runway Line
Miscellaneous (MISC)	Points of Interest (POI)
BUILDP Building Point CTOWERP Communication Tower Point EXTRACTP Extraction Facilities Point INDPRODL Industrial Production Line INDPRODP Industrial Production Point LANDMRKP Landmark Point F PARKA Nature Park Area PHYSL Physiography Line PHYSP Physiography Point POWERL Power Transmission Line POWERP Power Transmission Point TOWERP Tower Point	GOVSERVP Governmental Services point FACILP Facility point WELLP Well Point LANDMASKA Landmask Area SHOREL Inland Shoreline Line HYNODEC Hydrographic Network Node Point
Named Location (NAME)	Vegetation and Soils (VEG)
Named Location	SOILA Ground Surface Element Area VEGA Vegetation Area

2.2 Technical characteristics of the infrastructure

The technology is based on:

- Virtual Machine on Linux, 14GB de RAM y 6 cores.
- PostGIS 2.4.4 on Postgres PGSQL “9.5”

- GeoServer 2.10.0 is an open source software server written in Java that allows users to share and edit geospatial data. Extensions:
  - GeoWebCaché[1]
  - MapBoxVector (MVT)[2]

2.3 Exportation of the Geodatabase into PostGIS and GeoServer

The ERM v11 data was hosted in Geodatabase for ESRI and it had to be converted PostGis version databases through SQL queries.

ERM data base on Postgres is connected by GeoServer 2.15.0 server which offers the view service WMS. In addition, the GeoWebCache tile creation solution creates and stores the files that will later be offered in the WMTS. It is necessary to add an extension on GeoServer about the tile management vectors created by the developer community of the platform.

2.4 Installation and configuration GeoServer

GeoServer has the advantage that it has developed various extensions to provide the ability to offer tiles in a great amount of formats, including MapBox. This allows creating more services web with the same tool (WMS, WMTS and WFS)

The process on how to create is outlined below:

1. Creating a workspace for the data called «vectortile». A workspace is a container used to group similar layers together.
2. Creating a store to publish PostGIS ERM data base with GeoServer.
3. Publishing the 85 layers of administrative boundaries, hydrography, transportation, points of interest, vegetation and soils, settlement and miscellaneous

   Specifying the coordinate reference system

   Although, the native CRS and declared CRS are equals, within the options provided about Coordinate Reference Systems (CRS), we select the default option, “Force Declared”. This option, the declared SRS is forced upon the data, overwriting the native one.

   Styles

   The layers’ styles are “Default style”. The styles for layers aren´t defined on GeoServer like Styled Layer Descriptor (SLD) format.

[1] https://docs.geoserver.org/stable/en/user/geowebcache/index.html
[2] https://docs.geoserver.org/latest/en/user/extensions/vectortiles/tutorial.html

Tipo	Title	Nombre de la capa	Almacén	Habilitada?	SRS nativo
	airflda	vectortiles:airflda	erm	✔	EPSG:4258
	airfldc	vectortiles:airfldc	erm	✔	EPSG:4258
	airfldp	vectortiles:airfldp	erm	✔	EPSG:4258
	aquedctl	vectortiles:aquedctl	erm	✔	EPSG:4258
	buildp	vectortiles:buildp	erm	✔	EPSG:4258
	builtupa	vectortiles:builtupa	erm	✔	EPSG:4258
	builtupp_ba	vectortiles:builtupp_ba	erm	✔	EPSG:4258
	builtupp_pp	vectortiles:builtupp_pp	erm	✔	EPSG:4258
	coasta	vectortiles:coasta	erm	✔	EPSG:4258
	coastl	vectortiles:coastl	erm	✔	EPSG:4258
	ctowerp	vectortiles:ctowerp	erm	✔	EPSG:4258
	damc_d	vectortiles:damc_d	erm	✔	EPSG:4258
	damc_l	vectortiles:damc_l	erm	✔	EPSG:4258
	daml_d	vectortiles:daml_d	erm	✔	EPSG:4258
	daml_l	vectortiles:daml_l	erm	✔	EPSG:4258
	exitc	vectortiles:exitc	erm	✔	EPSG:4258
	extractp	vectortiles:extractp	erm	✔	EPSG:4258
	ferryc	vectortiles:ferryc	erm	✔	EPSG:4258

Figure 1: Some layers of ERM Data Base on GeoServer

4. Publishing the one layer groups. This layer is a container in which layers and other layer groups can be organized in a hierarchical structure.

<< < 1 > >> Resultados 1 a 1 (de un total de 1 ítems)

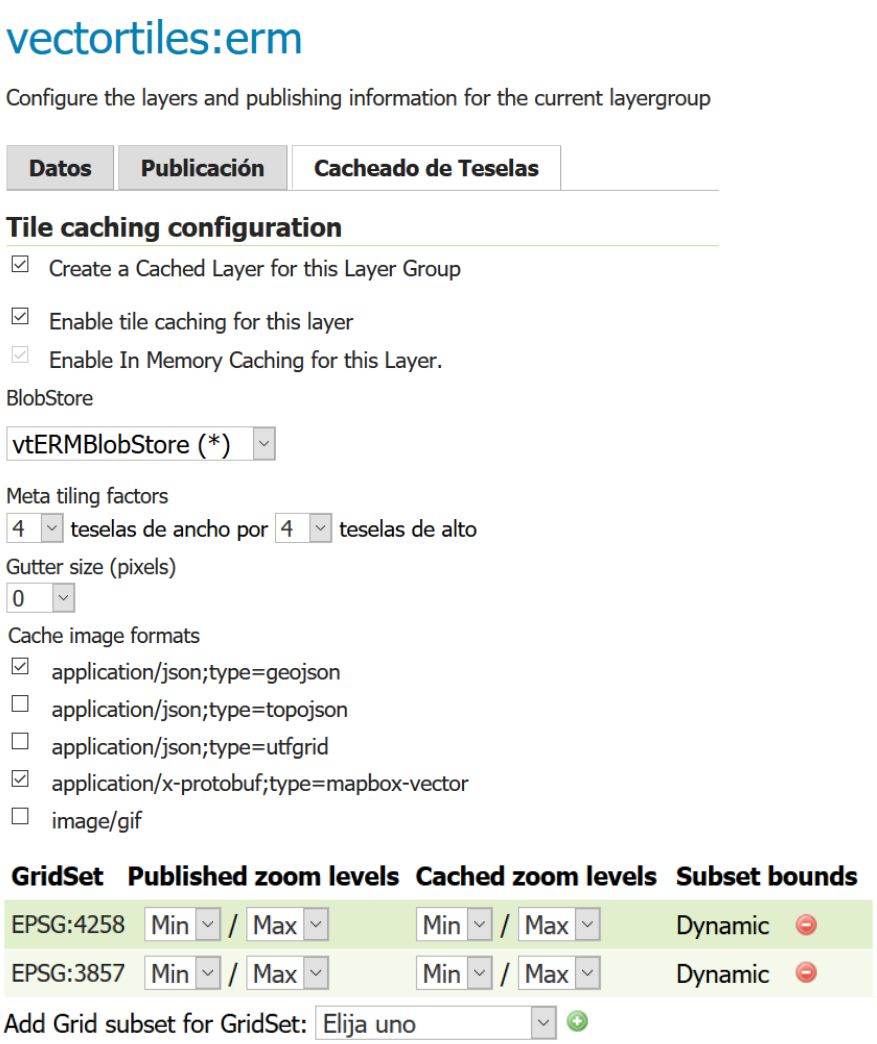
Grupo de capas	Espacio de trabajo
erm	vectortiles

The last step is previewing the layer to verify that the layers are published correctly.

2.5 GeoWebCache

The version of GeoWebCache that is embedded in GeoServer automatically configures every layer served in GeoServer with the two projections: EPSG 4258 and EPSG 3857.

BlobStores allow us to configure how and where GeoWebCache will store its cashed data on a per-layer basis. There are any different BlobStore types to use different ways of storage and we configure one, called «vtERMBlobStore».



2.6 MapBox

Vector data could be supplied through existing standard services, but in recent years specialized alternatives for vector tiles have been emerging. The alternative selected to develop the vector tile service of the "ERM" is the one offered by the company MapBox, an open specification that has become a de facto standard for vector tile services.

MapBox is a client capable of interpreting Google Protobuf binary data files (PBF) and apply a simple style file on client side, which allow for serializing structured data.

The style file is on JSON format that indicates, among other aspects, the addresses of the map servers, the layers and details of drawing characteristics: how to draw them (colour, thickness, use of icons...) and when (maximum and minimum scales, filters based on attributes of object geographic...). This file implements Mapbox Style Specification, an open specification that defines its structure. It has been checked that this specification is quite competitive, although is a bit behind, in terms of possibilities, compared to the SLDs used in GeoServer.

After the creation of the Vector Tile Service, more than 80 layers pointed to the tables that stored the different data were hosted in GeoServer. These data will be filtered, not only its display, but also the features to show, using the style applied by the client (using the JSON file).

The GetMap operation is performed through an HTTP GET request with the following structure:

http://URL/{z}/{x}/{y}.pbf

where:

- "z" represents the zoom level
- "x" the column of the tile
- "y" the row of the tile
- PBF is the extension of the requested file

This operation offers files of 256x256 pixels that are organized in the following file structure: z → folder, x → sub-folder, y → file

The client uses Mapbox GL JS[3], and the vector tiles are served using T-Rex[4] (XYZ interface) which shows the created vector tile service.

Finally, one file of style where created taken as a reference:

- The cartographic specification for the basemap Arctic SDI 20190301_Kopi av ASDI_Cartography_data_model_v2 0Beta4.xlsx
- ERM defined styles by Eurogeographics

The result is document on Excel file called MappingERM_Styles.xlsx

[3] https://github.com/mapbox/mapbox-gl-js
[4] http://t-rex.tileserver.ch/

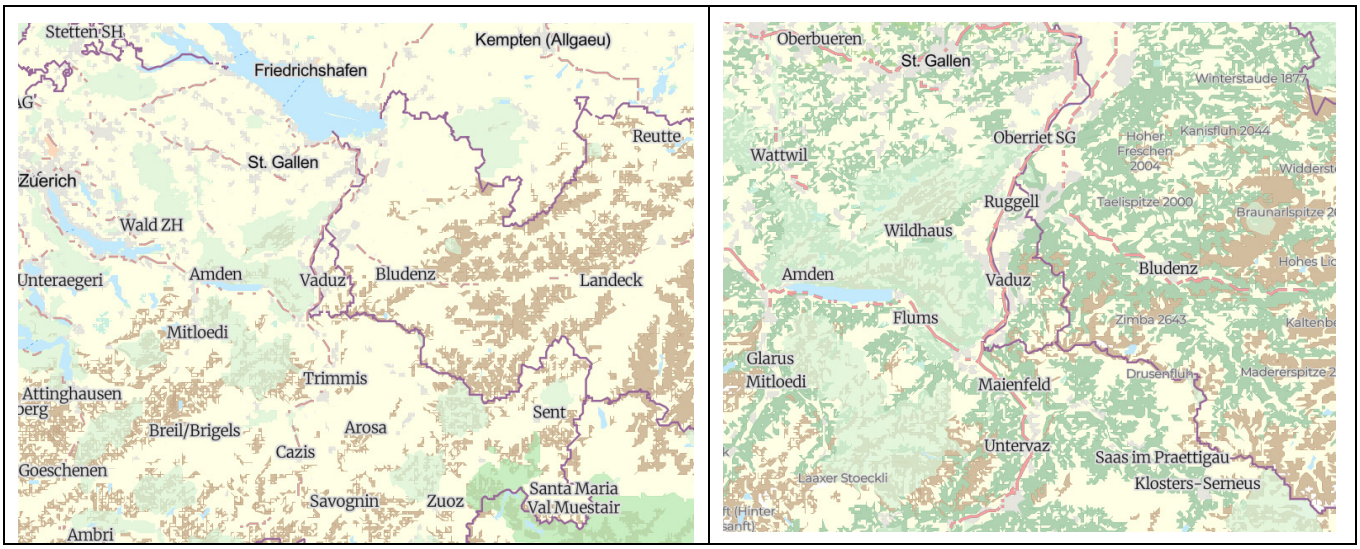


Figure 2. Visualization style for the "ERM" vector tile service.

Data in vector tile layers are stored in individual tiles containing geometry, attributes, and styles. With vector tile is possible to show the list of attributes of the layer

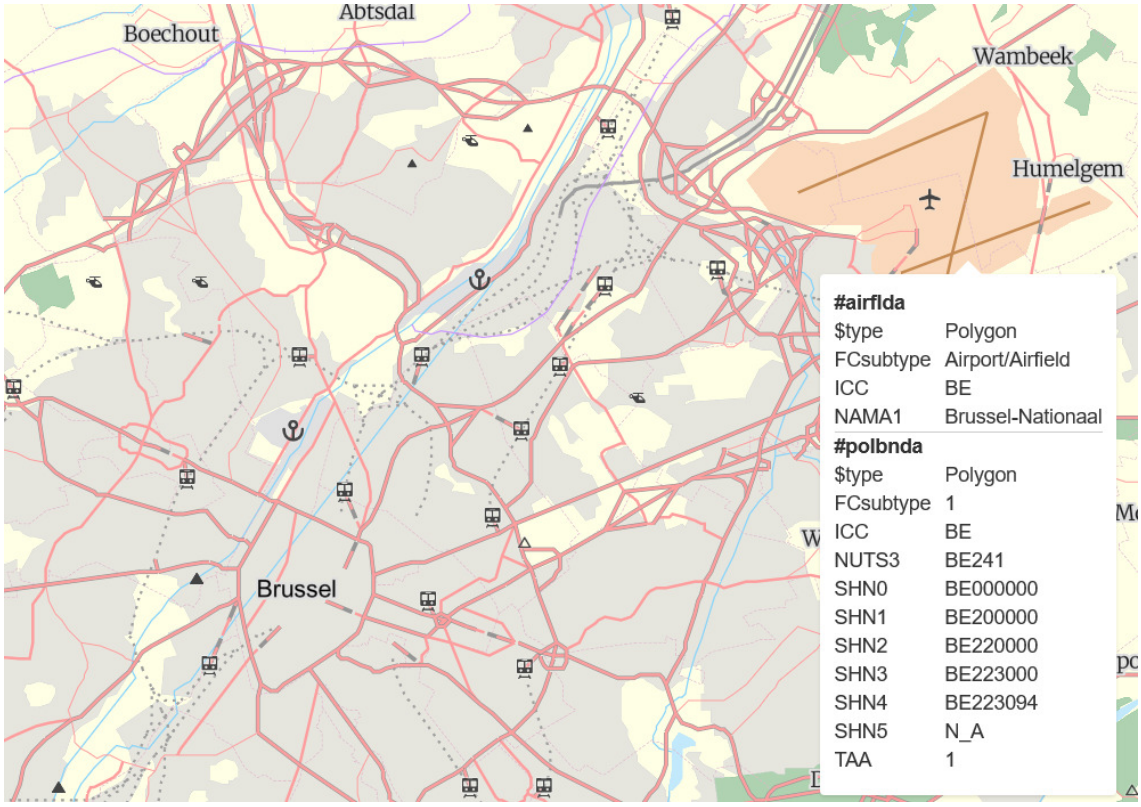


Figure 3: Airport/Airfield Area (airflda) and Administrative Areas (polbnda) features

Figure 4:Built-up area Point (builupp_ba) and wetland Area (swampa) features

3 Vector tile service

3.1 Characteristics and experience

The service has the tiles on two: SRS: EPSG 4258 and EPSG 3857. The tiles are cached from 0 until level 12.

The links (URL) of the pilot are:

GetCapabilities

http://desarrollo01.cnig.es/erm/geoserver/gwc/service/tms/1.0.0

The end point is:

http://desarrollo01.cnig.es/erm/demoVectorTiles/11/indexERM-PRO.html

The experience making styles demonstrates the potential of the MapBox Style Specification to filter and characterize data. What to show and when can be chosen. The JSON files could be as simple as a few lines or way more complex, reaching thousands of lines.

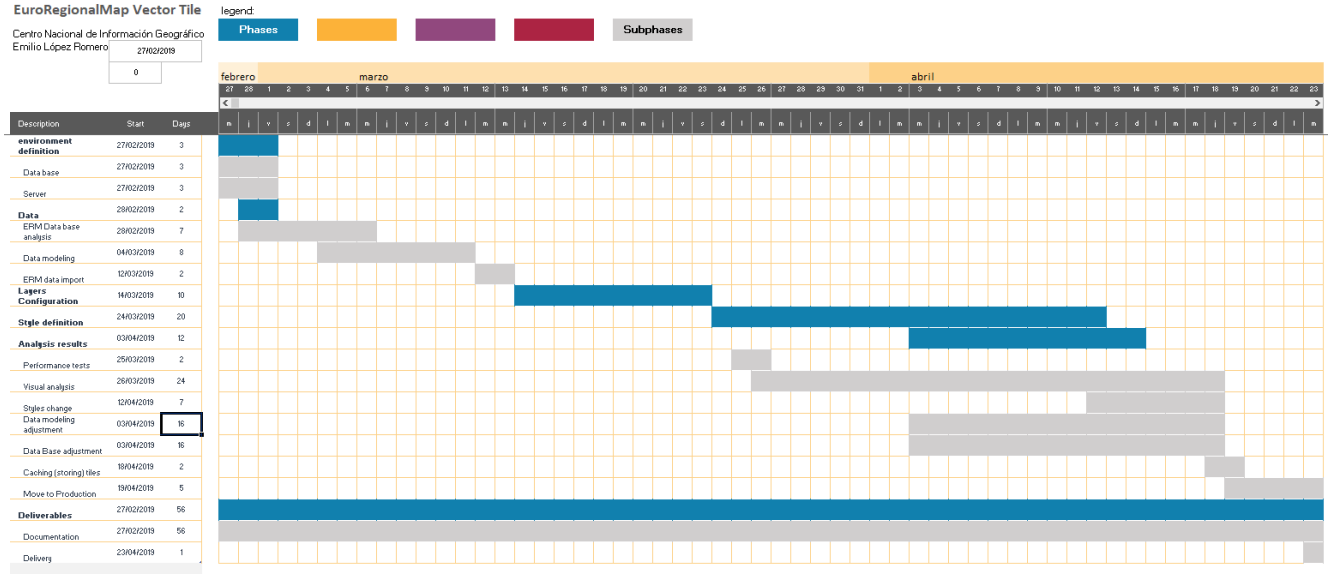
With the implementation of this service, vector tiles have displayed a number of advantages over fully rendered image tiles compared with raster WMTS:

- Styling: as vectors, tiles can be styled when requested, allowing for many map styles on global data
- Size: vector tiles are really small, enabling global high resolution maps, fast map loads, efficient caching and smaller storage space
- Greater processing capacity
- Faster response for queries on the map
- Greater display flexibility for end users

By contrast, this new type of service has a series of disadvantages, such as the increase in requirements for the users' machines which connect to services, simplification of polygons and lines:

The conversion from geographic coordinates (latitude and longitude) to vector tile coordinates (x, y) can cause another polygons and lines shapes and clipping between vector tiles: Mapbox clips features at a buffer around the tile. Any geometry within this buffer is assumed to carry over to another tile.

Annex A: Project timeline



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