

R for maps & spatial analysis

Anto Aasa

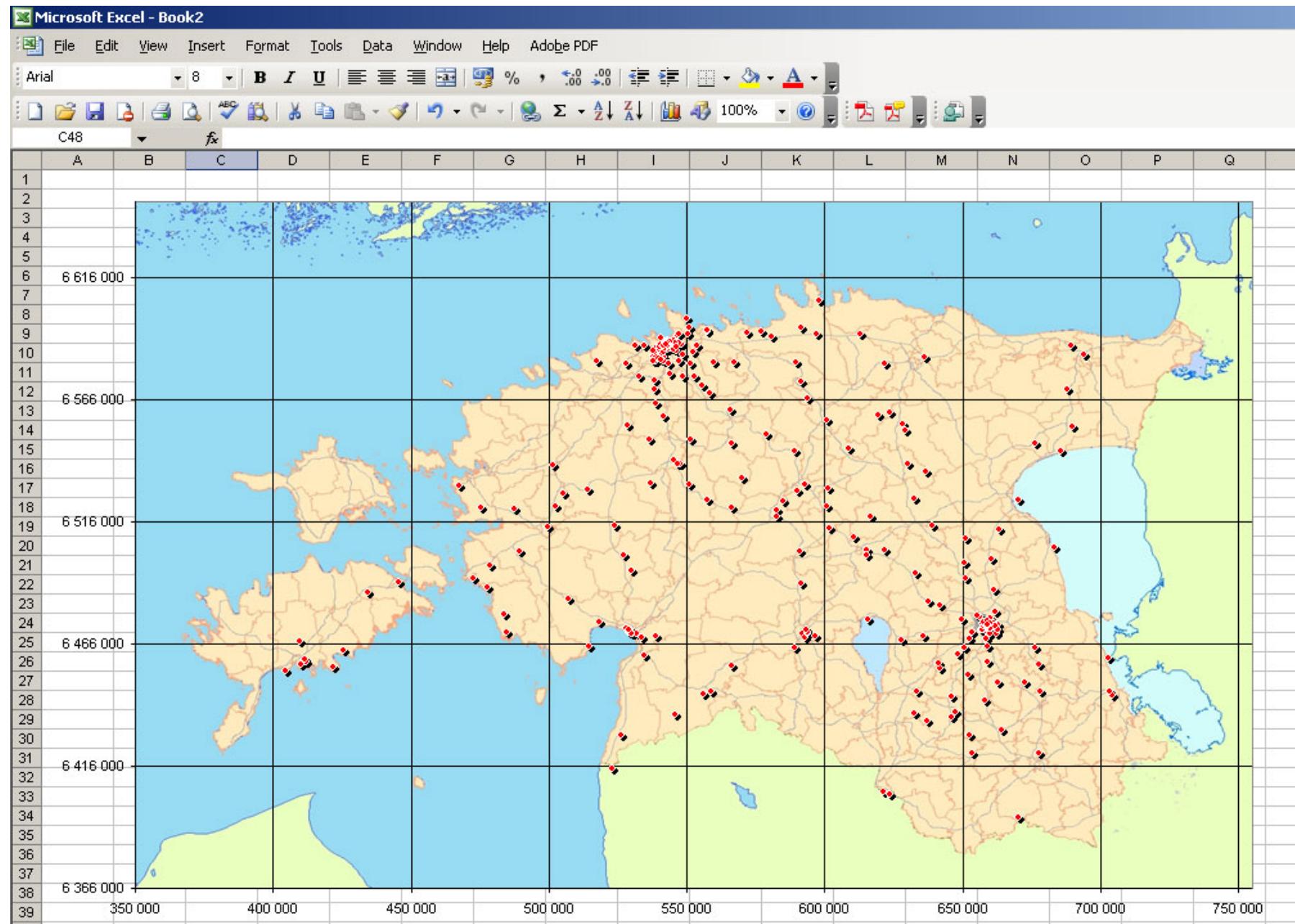
Associate Professor

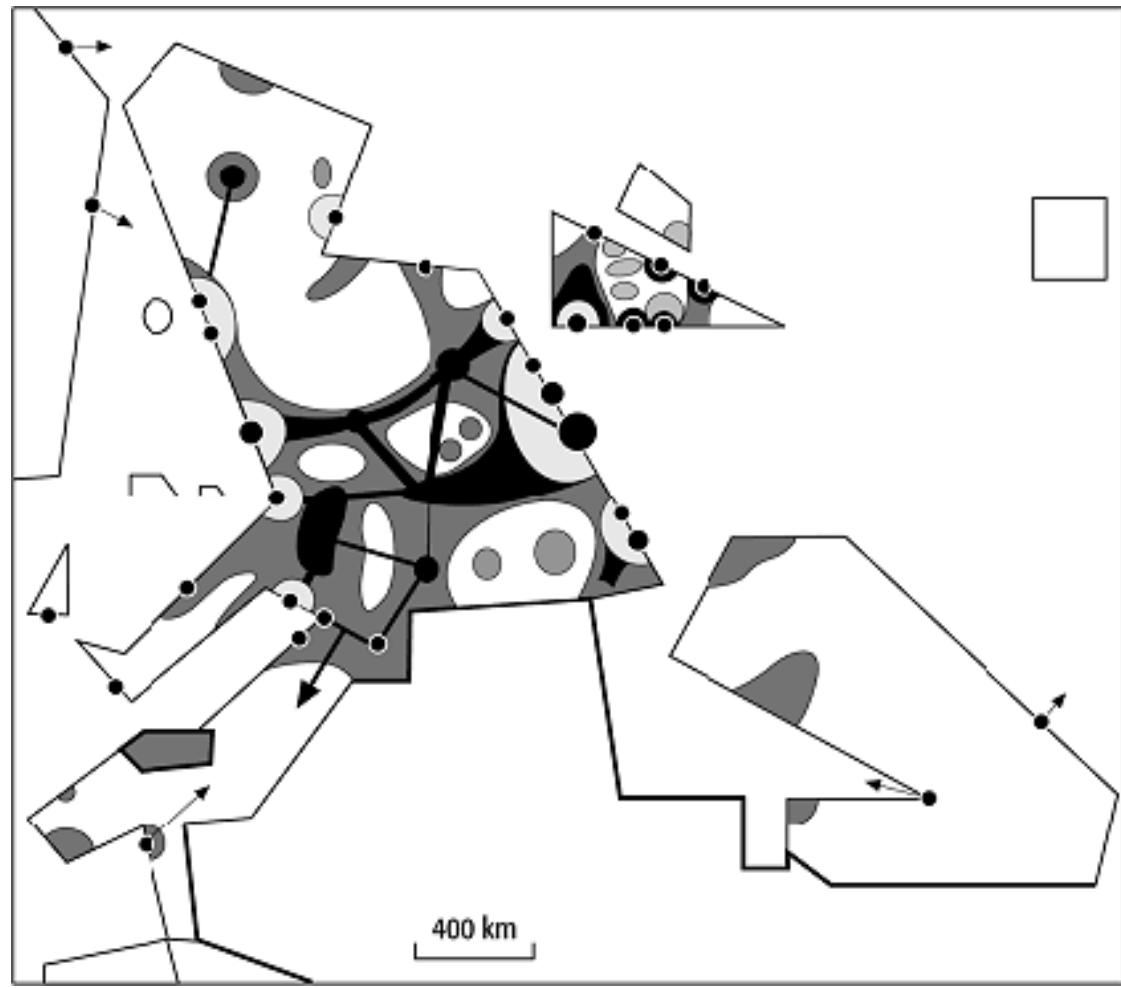


UNIVERSITY OF TARTU
Mobility Lab

My first automatic map

ca 2001





Shape file!

 ne_10m_admin_0_countries.cpg	21.05.2018 10:24	CPG File	1 KB
 ne_10m_admin_0_countries.dbf	21.05.2018 10:24	DBF File	586 KB
 ne_10m_admin_0_countries.prj	21.05.2018 10:24	PRJ File	1 KB
 ne_10m_admin_0_countries.README.html	21.05.2018 10:24	Vivaldi HTML Doc...	24 KB
 ne_10m_admin_0_countries.shp	21.05.2018 10:24	SHP File	8 595 KB
 ne_10m_admin_0_countries.shx	21.05.2018 10:24	SHX File	3 KB
 ne_10m_admin_0_countries.VERSION.txt	21.05.2018 10:24	Text Document	1 KB

Structure of shp

Mandatory files

- `.shp` — shape format; the feature geometry itself {content-type: `x-gis/x-shapefile`}
- `.shx` — shape index format; a positional index of the feature geometry to allow seeking forwards and backwards quickly {content-type: `x-gis/x-shapefile`}
- `.dbf` — attribute format; columnar attributes for each shape, in dBase IV format {content-type: `application/octet-stream` OR `text/plain`}

Other files

- `.prj` — projection description, using a well-known text representation of coordinate reference systems {content-type: `text/plain` OR `application/text`}
- `.sbn` and `.sbx` — a spatial index of the features {content-type: `x-gis/x-shapefile`}
- `.fbn` and `.fbx` — a spatial index of the features that are read-only {content-type: `x-gis/x-shapefile`}
- `.ain` and `.aih` — an attribute index of the active fields in a table {content-type: `x-gis/x-shapefile`}
- `.ixs` — a geocoding index for read-write datasets {content-type: `x-gis/x-shapefile`}
- `.mxs` — a geocoding index for read-write datasets (ODB format) {content-type: `x-gis/x-shapefile`}
- `.atx` — an attribute index for the `.dbf` file in the form of `shapefile.columnname.atx` (ArcGIS 8 and later) {content-type: `x-gis/x-shapefile` }
- `.shp.xml` — geospatial metadata in XML format, such as ISO 19115 or other XML schema {content-type: `application/fgdc+xml`}
- `.cpg` — used to specify the code page (only for `.dbf`) for identifying the character encoding to be used {content-type: `text/plain` OR `x-gis/x-shapefile` }
- `.qix` — an alternative quadtree spatial index used by MapServer and GDAL/OGR software {content-type: `x-gis/x-shapefile`}

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III SPATIAL DATA

[Estonian Topographic Database +](#)[Orthophotos +](#)[Elevation Data +](#)[Cadastral Data +](#)[Address Data +](#)[Administrative and Settlement Division ✕](#)[Wall Map 1:350 000](#)[Estonian Soil Map](#)[Geo3D +](#)[Geological Data +](#)[Geodetic Data +](#)[ESTPOS](#)[Topographic Maps +](#)[ESTHub satellite data +](#)[Map Sheet Indexes and Coordinate Systems +](#)

Administrative and Settlement Division

Data of administrative and settlement units is derived from the Land Cadastre. Attribute data is derived from the official [Estonian Administrative and Settlement Classification](#) (EHAK) maintained by the [Statistics Estonia](#). A regular snapshot is taken on January 1 each year, but intermediary snapshots are taken when the changes in the Cadastre are significant.

Schematic maps of county and municipality borders for public use:

- [Municipalities and counties with name and EHAK classification \(PNG\)](#) (116.2 KB, 6.11.2020)
- [Municipalities and counties with name \(PNG\)](#) (104.3 KB, 5.11.2020)
- [Municipalities borders \(PNG\)](#) (58.9 KB, 5.11.2020)
- [Counties borders \(PNG\)](#) (42.2 KB, 5.11.2020)

The data is available at three levels: counties, municipalities and settlements. The data includes attributes as described below.

Data properties

Format	Esri SHP, MapInfo (TAB), AutoCAD (DXF), MicroStation (DGN)
Data structure	vector areas
Scale	1:10 000
Update frequency	Downloadable files are updated monthly (at the beginning of the month)

Free download

Counties

- [Counties DGN](#) (9.5 MB, 1.06.2021)
- [Counties DXF](#) (14.9 MB, 1.06.2021)
- [Counties SHP](#) (7.8 MB, 1.06.2021)
- [Counties MAP](#) (9.5 MB, 1.06.2021)

Municipalities

- [Municipalities DGN](#) (10.5 MB, 1.06.2021)
- [Municipalities DXF](#) (16.6 MB, 1.06.2021)
- [Municipalities SHP](#) (8.7 MB, 1.06.2021)
- [Municipalities MAP](#) (6.5 MB, 1.06.2021)

Settlements (towns, small towns, villages)

- [Settlements DGN](#) (16.7 MB, 1.06.2021)
- [Settlements DXF](#) (25.9 MB, 1.06.2021)
- [Settlements SHP](#) (14.3 MB, 1.06.2021)
- [Settlements MAP](#) (11 MB, 1.06.2021)

 > Spatial Data > Estonian Topographic Database

III SPATIAL DATA

[Estonian Topographic Database](#)

[Download Topographic Data](#)

[Generalized Estonian Topographic Data](#)

Estonian Topographic Database

The Estonian Topographic Database (ETD) together with the Cadastral Information System serves as a basis for the National Land Information System.

<https://geoportaal.maaamet.ee/eng/Spatial-Data/Estonian-Topographic-Database-p305.html>



Downloads

Data themes are available in three levels of detail. For each scale, themes are listed on Cultural, Physical, and Raster category pages.

Stay up to date! Know when a new version of Natural Earth is released by subscribing to our [announcement list](#).

Overwhelmed? The [Natural Earth quick start kit](#) (227 mb) provides a small sample of Natural Earth themes styled in an ArcMap .MXD document and in a QGIS document. Download all vector themes as [SHP](#) (279 mb), [SQLite](#) (222 mb), or [GeoPackage](#) (260 mb).

Natural Earth is the creation of many [volunteers](#) and is supported by [NACIS](#). It is free for use in any type of project. [Full Terms of Use »](#)

Large scale data, 1:10m



[Cultural](#) [Physical](#) [Raster](#)

The most detailed. Suitable for making zoomed-in maps of countries and regions. Show the world on a large wall poster.

1:10,000,000
1" = 158 miles
1 cm = 100 km

Medium scale data, 1:50m



[Cultural](#) [Physical](#) [Raster](#)

Suitable for making zoomed-out maps of countries and regions. Show the world on a tabloid size page.

1:50,000,000
1" = 790 miles
1 cm = 500 km

Small scale data, 1:110m



[Cultural](#) [Physical](#)

Suitable for schematic maps of the world on a postcard or as a small locator globe.

1:110,000,000
1" = 1,736 miles
1 cm = 1,100 km

Spatial objects in R

- Visualization
 - ggplot2
 - tmap
 - core R
- Analysis
 - Spatial Data Frame
 - Simple feature (sf)
 - Shp
 - Geopackage
 - Postgis
 - Geotiff
 - ...

Import / export spatial data to R

- Text (*.csv)
- Shapefile (*.shp)
- Raster
 - Geotiff
 - Rst
 - ...
- xml
- GeoJSON
- ...

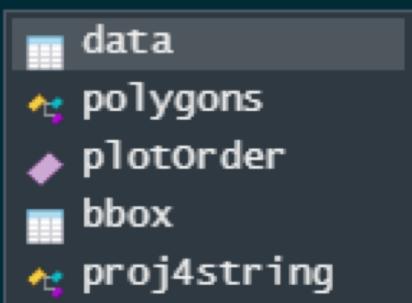
sf:

```
> glimpse(dat)
Rows: 4,712
Columns: 8
$ VID      <dbl> 56572851, 56572856, 56572690, 56573027, 56572871, 56572869, 56572859, 56
$ KOOD     <chr> "6679", "9770", "3178", "6233", "3642", "7719", "8318", "5913", "2360",
$ NIMI     <chr> "Raadivere küla", "Änkküla", "Kivijärve küla", "Pikkjärve küla", "Kurema
$ VAARTUS   <int> 61, 60, 61, 98, 280, 21, 44, 461, 20, 26, 279, 25, 66, 66, 56, 28, 23, 4
$ STAMP_CRE <date> 2019-11-13, 2019-11-13, 2019-11-13, 2019-11-13, 2019-11-13, 2019-11-13,
$ JUHUSLIK  <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
$ GEOKODEER8 <dbl> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
$ geometry   <MULTIPOLYGON [m]> MULTIPOLYGON (((645294.5 65..., MULTIPOLYGON (((645654.1 65
```

spatialpolygondataframe:

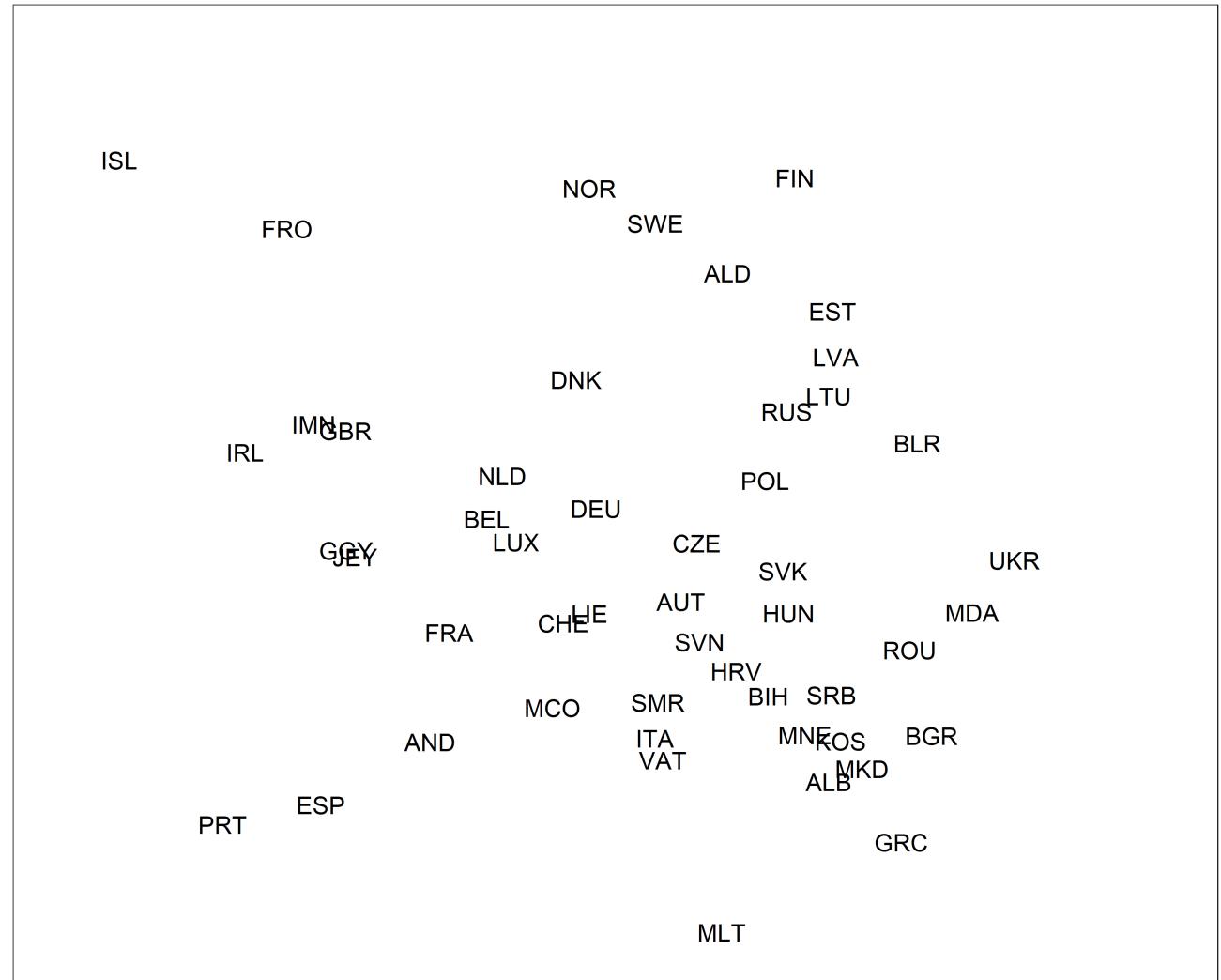
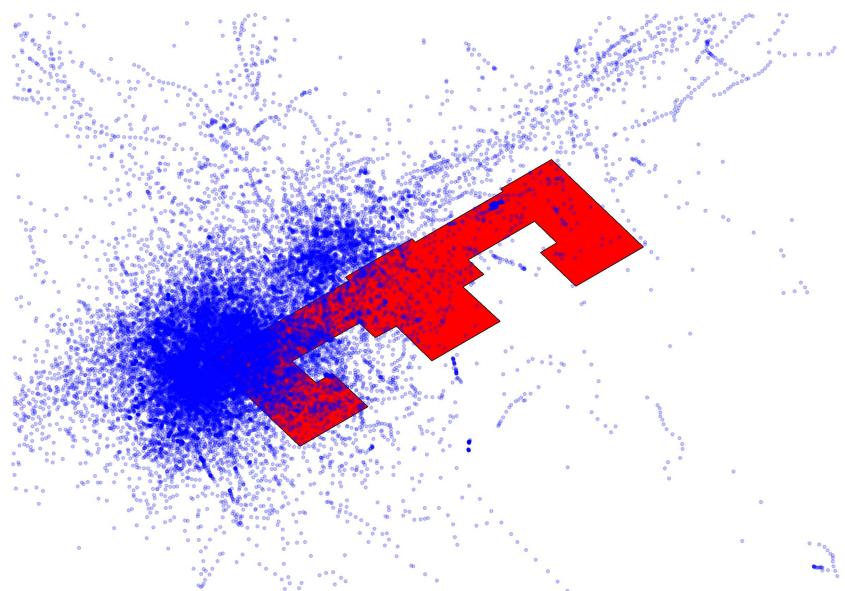
```
tmp <- dat %>% as("Spatial")
```

```
tmp@
```



Spatial context

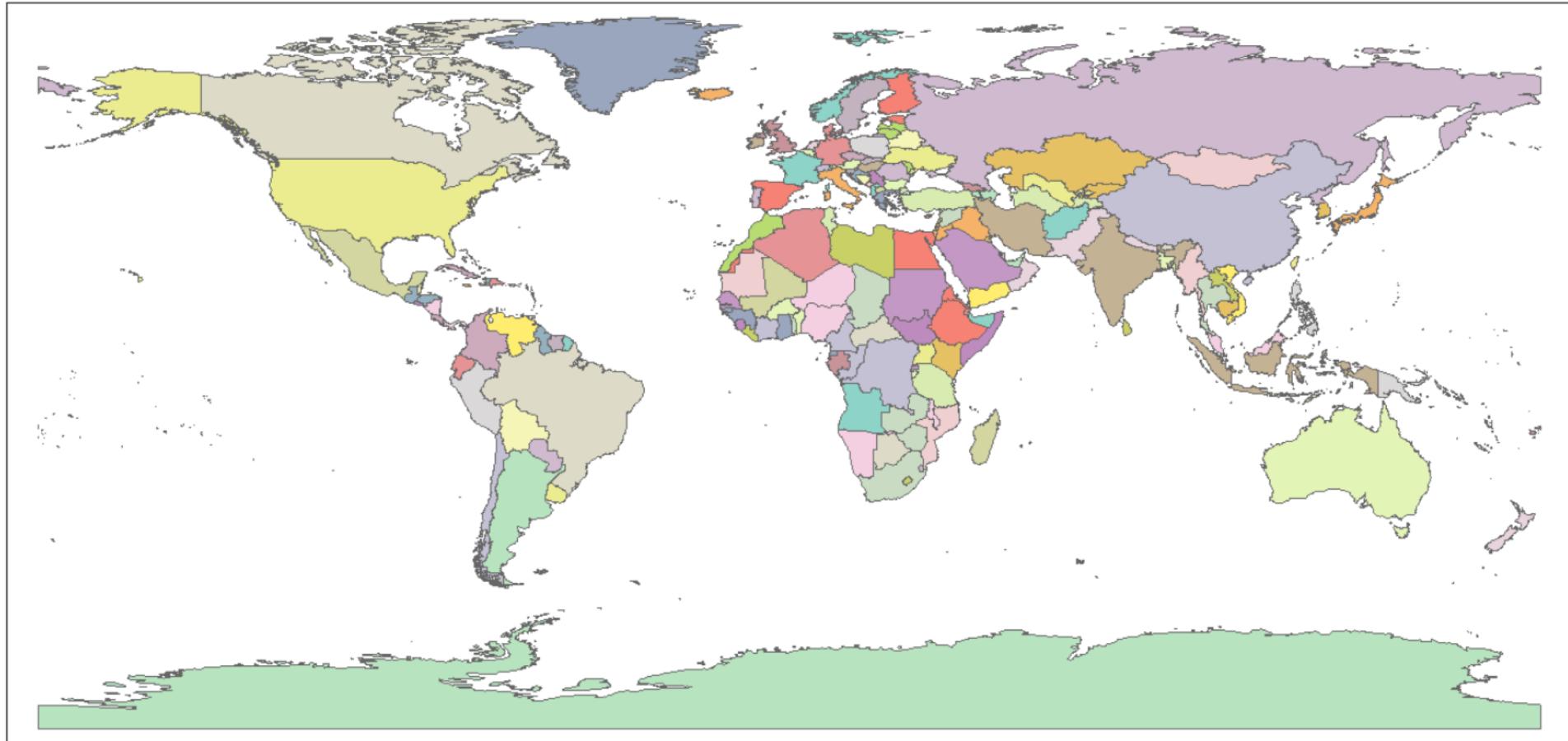
- Map scale
- Legend
- Base map



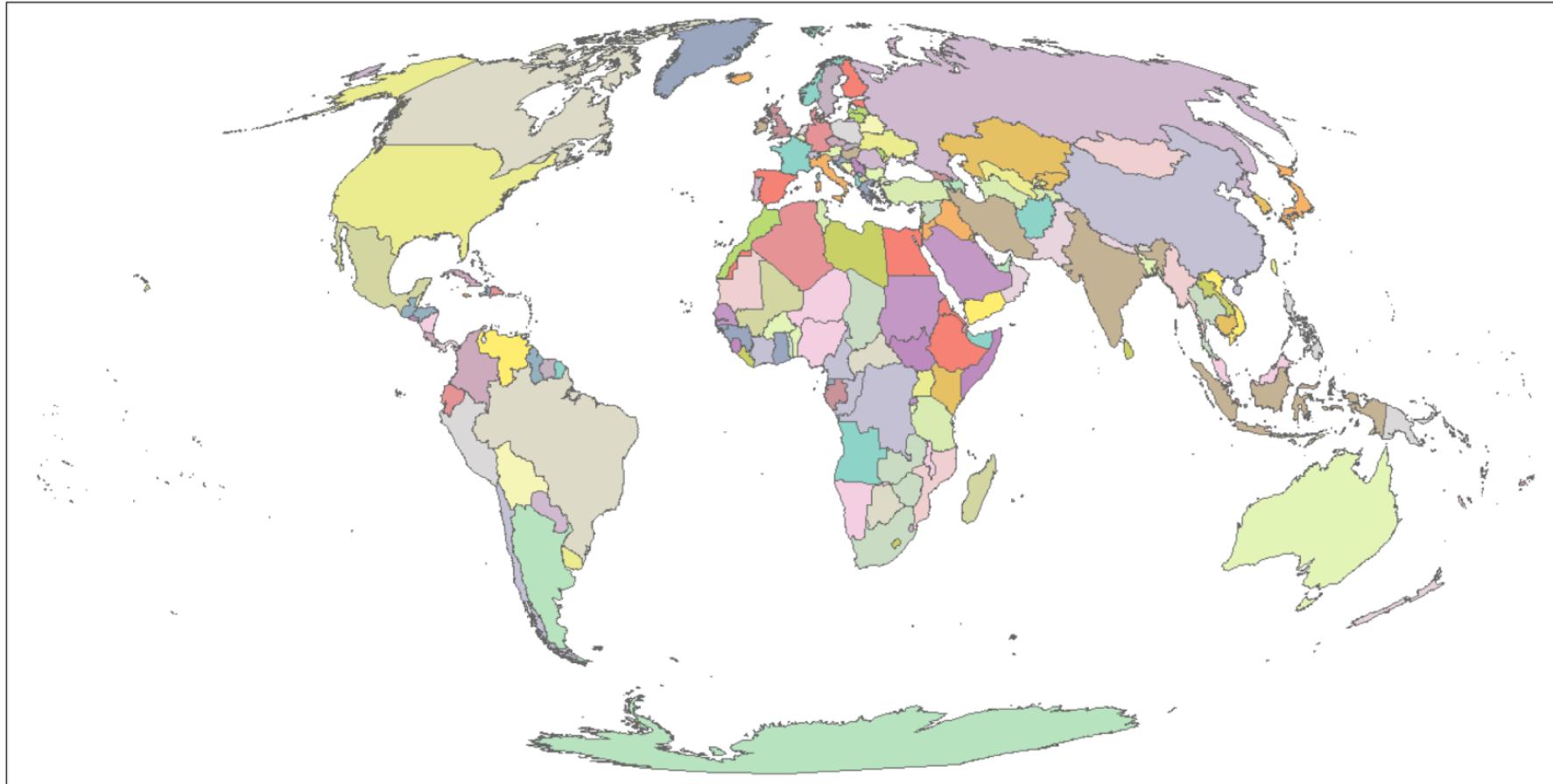
Projections

- CRS (Coordinate Reference System)
- Geographical coordinates: WGS-84; epsg:4326
- Estonian official CRS: LEST-97, epsg: 3301
- <https://epsg.io>

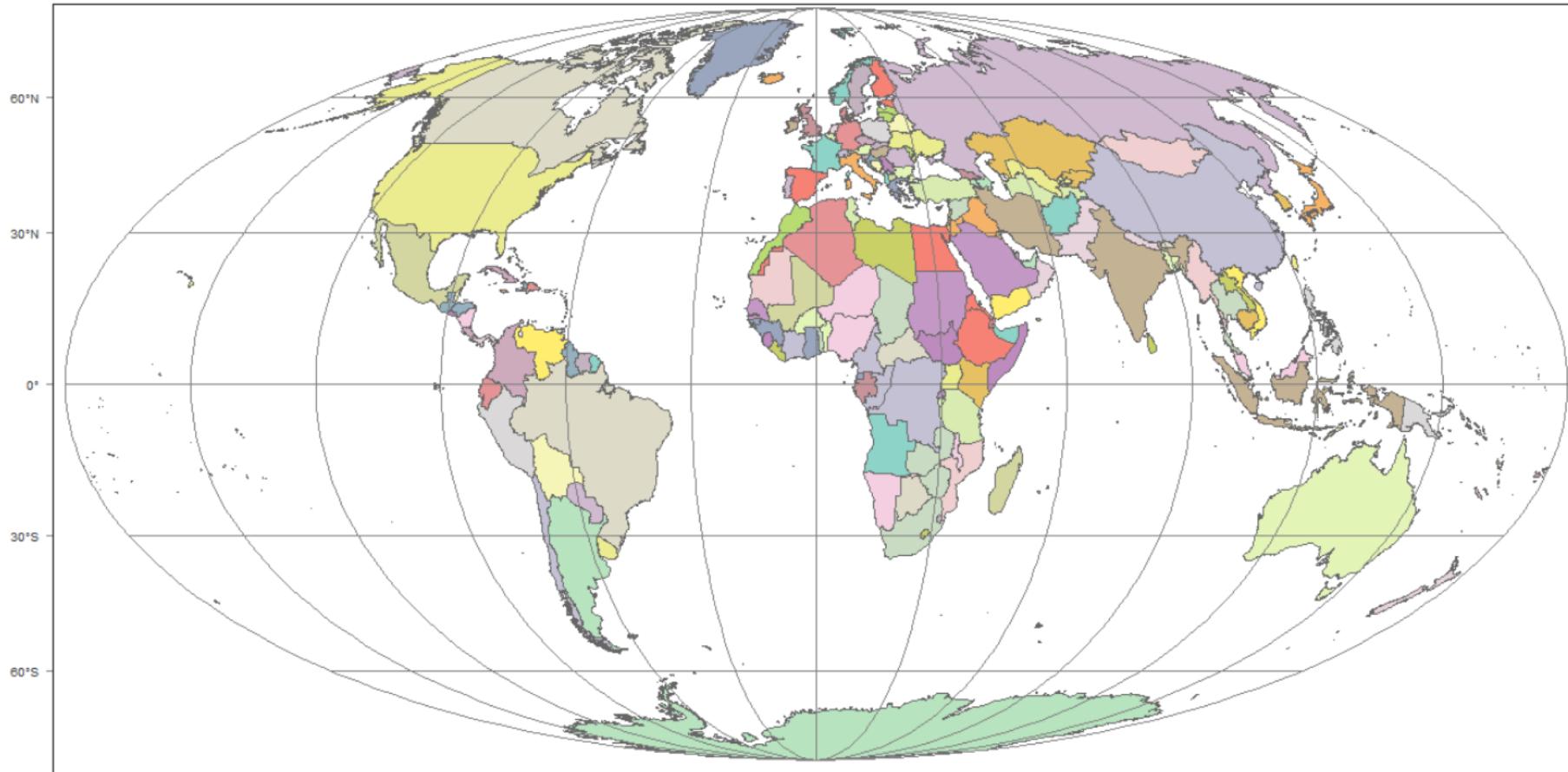
```
countries <- st_read("/FILE/PATH")  
  
tm_shape(countries)+  
  tm_polygons("ISO_A3") +  
  tm_layout(legend.show = F)
```



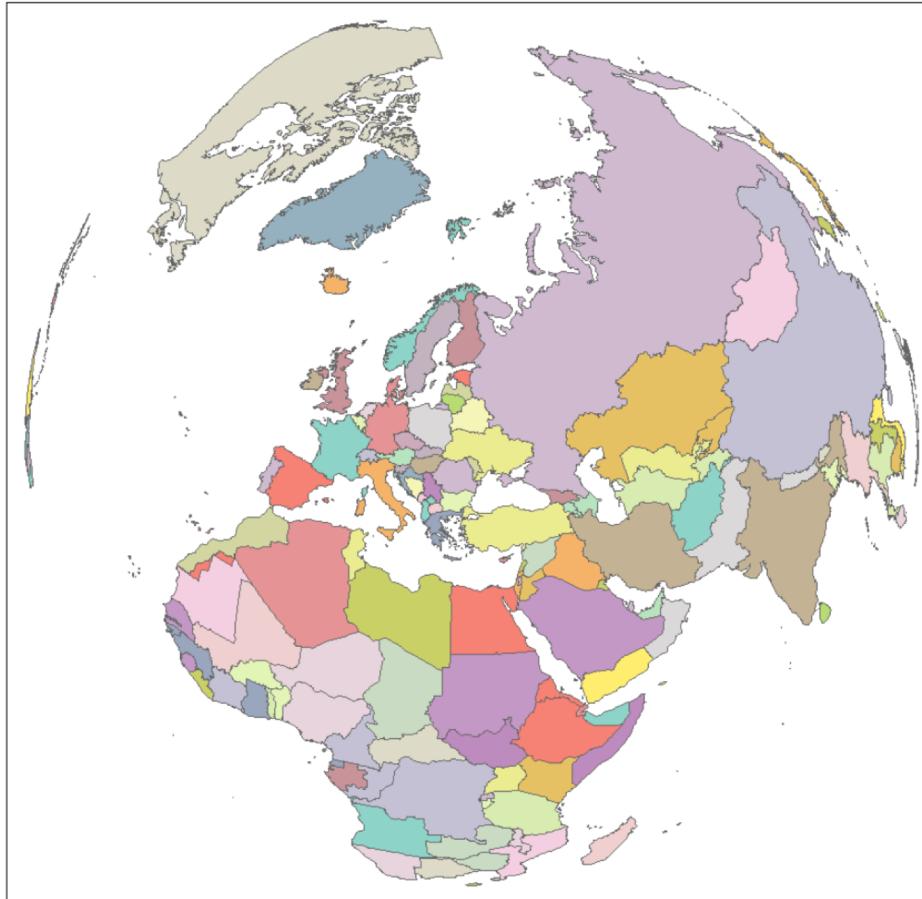
```
countries_mw = st_transform(countries, crs = "+proj=moll")  
  
tm_shape(countries_mw)+  
  tm_polygons("ISO_A3") +  
  tm_layout(legend.show = F)
```



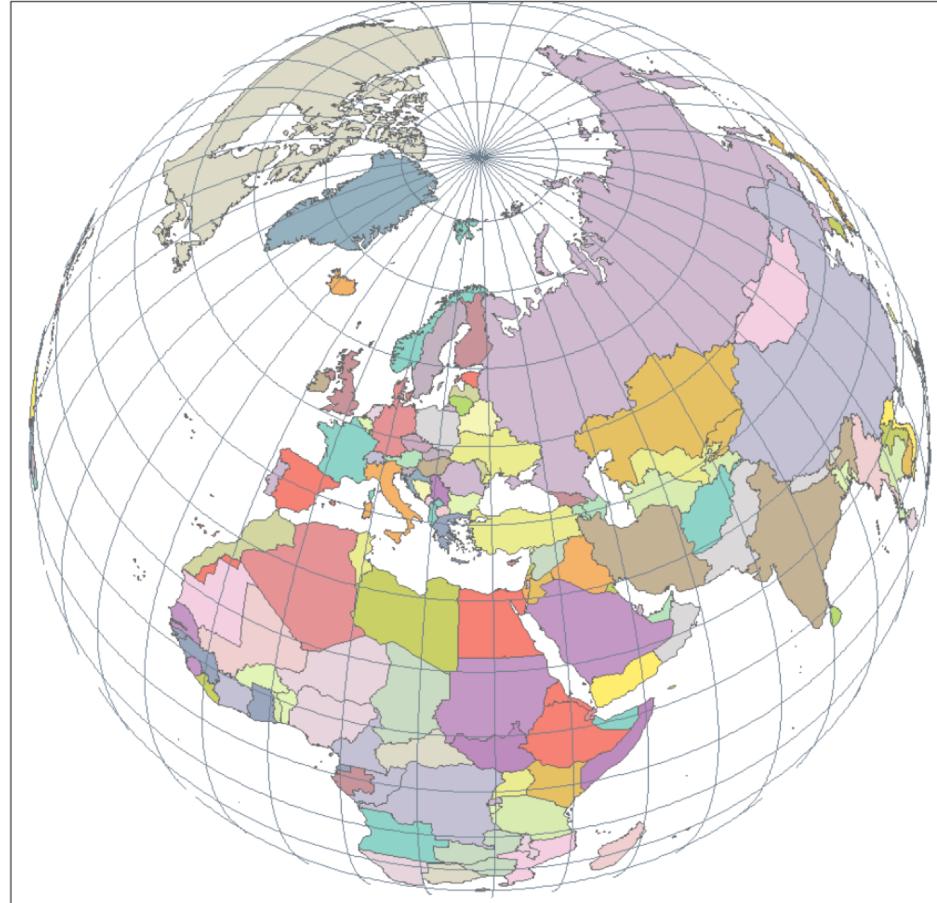
```
tm_shape(countries_mw)+  
  tm_polygons("ISO_A3") +  
  tm_layout(legend.show = F) +  
  tm_graticules()
```



```
countries_globe = st_transform(countries, crs= "+proj=ortho +lat_0=50 +lon_0=28")  
  
tm_shape(countries_globe)+  
  tm_polygons("ISO_A3")+  
  tm_layout(legend.show = F)
```

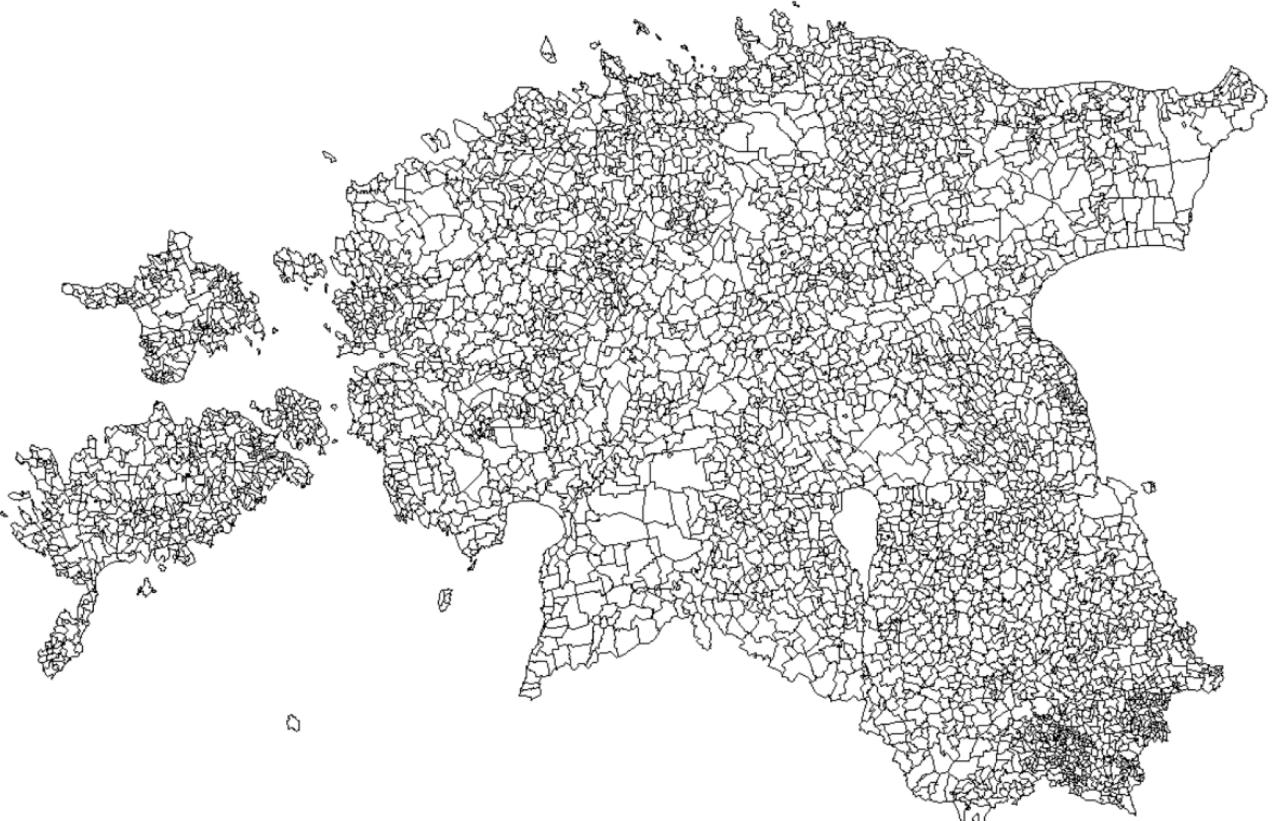


```
graticule_g1 <- st_read("/ANTO/anto_DATA/NaturalEarth/ne_50m_graticules_10/ne_50m_graticules_10.shp")  
  
tm_shape(countries_globe)+  
  tm_polygons("ISO_A3")+  
  tm_layout(legend.show = F)+  
  tm_shape(graticule_g1)+  
  tm_lines("slategrey")
```

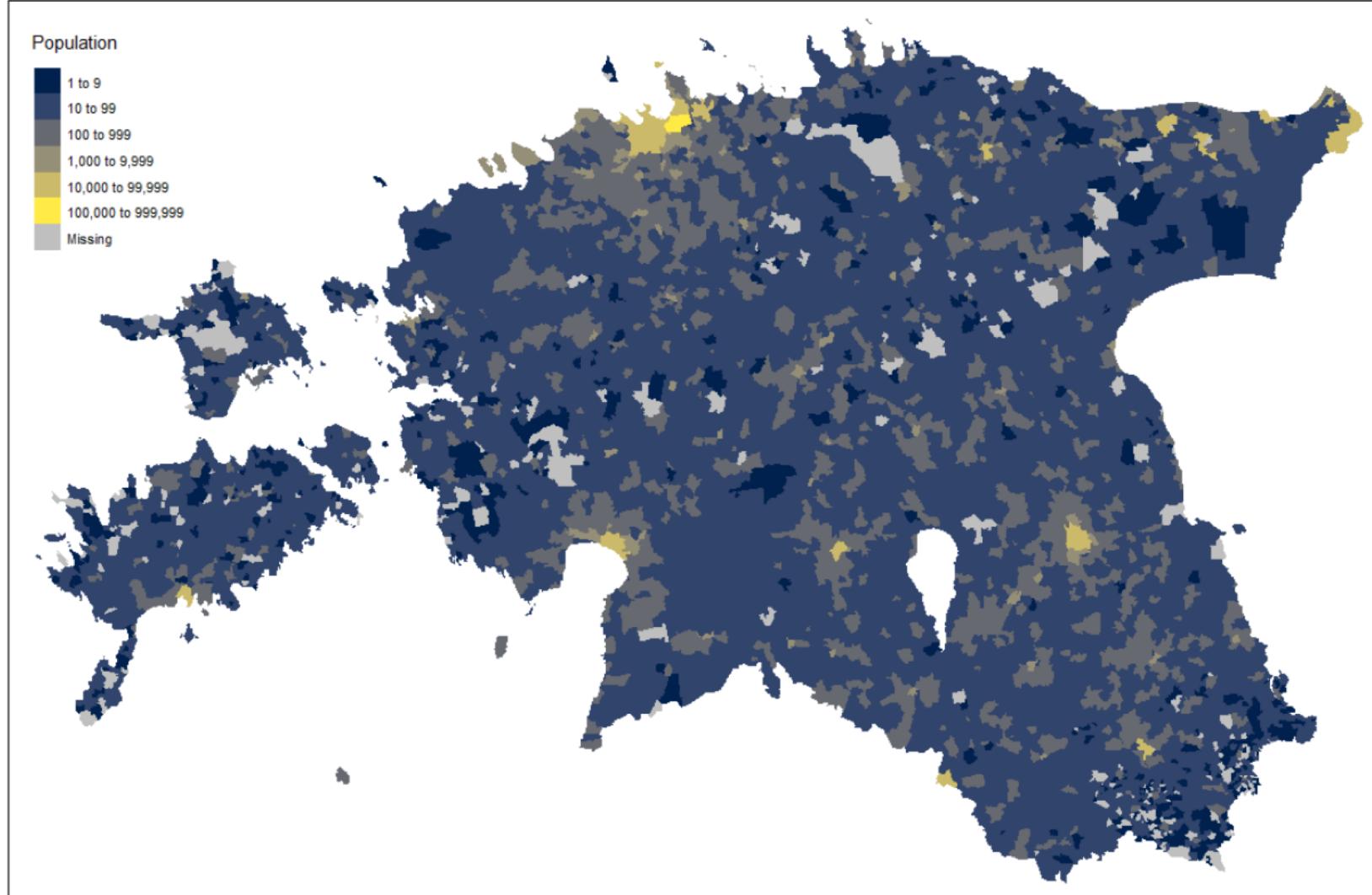


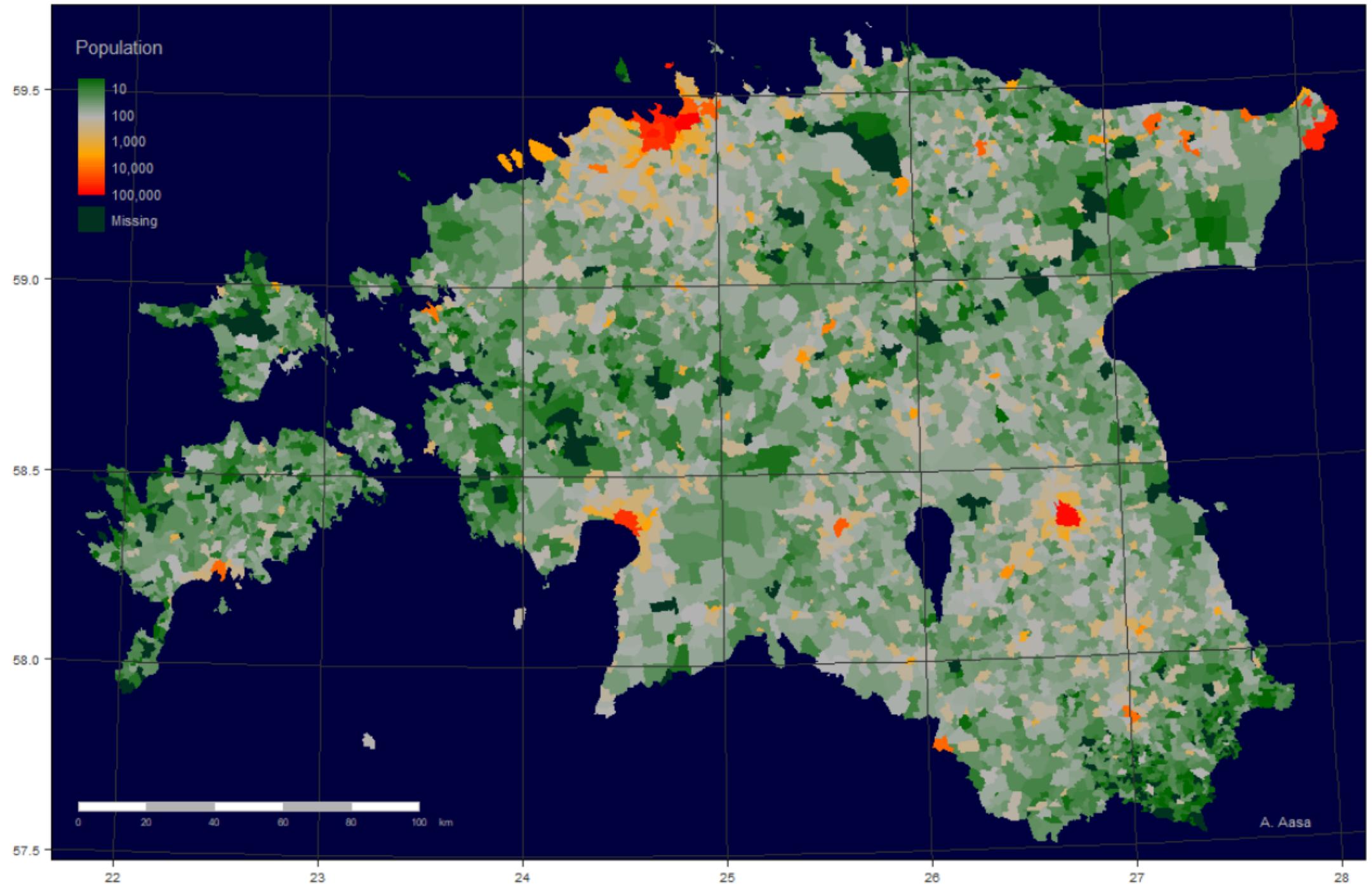
Estonian population

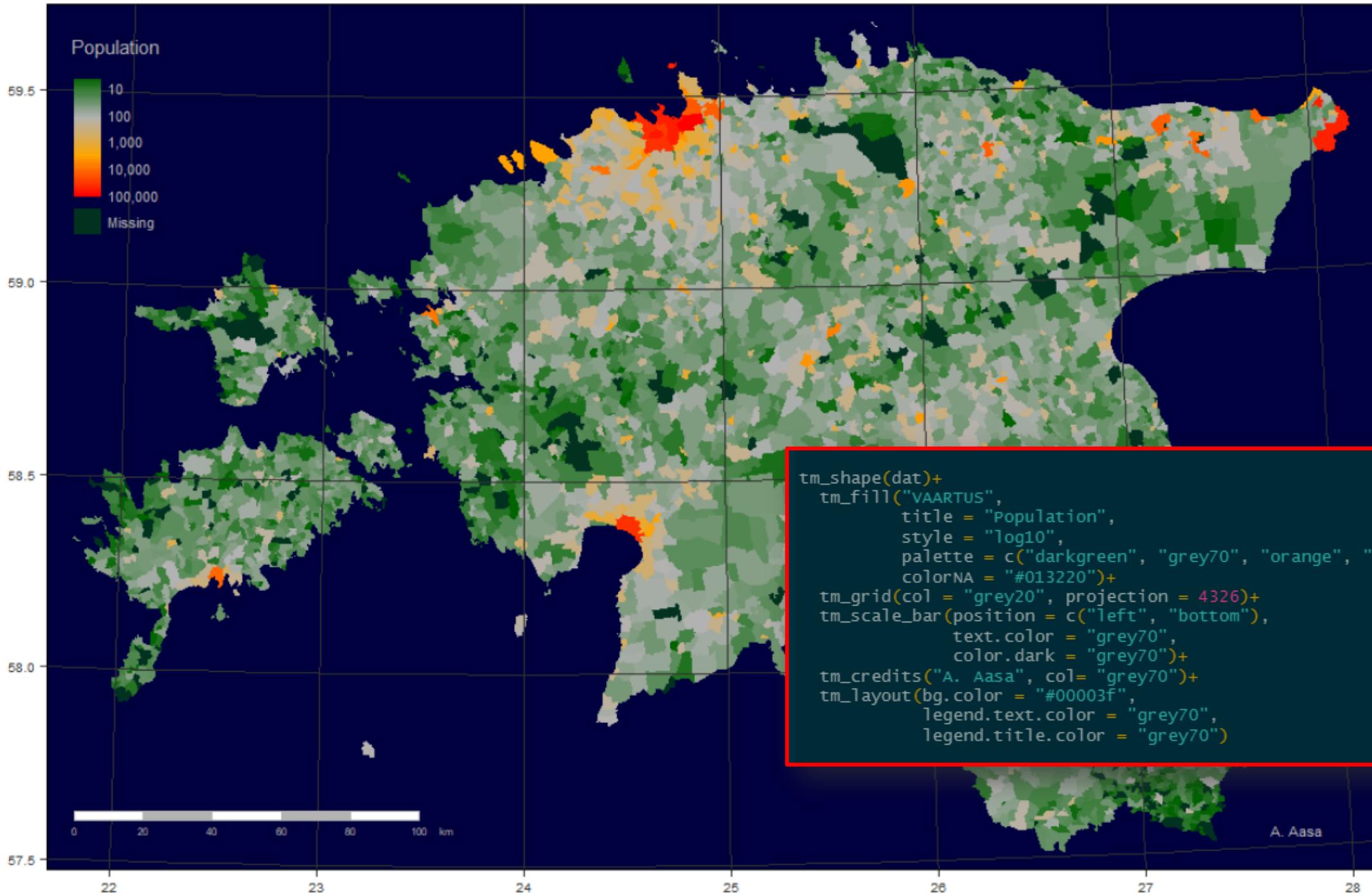
```
dat <- st_read("/ANTO/anto_DATA/Eestistatistika/kaardirakendus/asustus_rahvaarv_2019.shp")
glimpse(dat)
plot(st_geometry(dat))
```



```
tm_shape(dat)+  
  tm_fill("VAARTUS",  
          title = "Population",  
          style = "log10_pretty",  
          palette = "cividis")
```







Base map

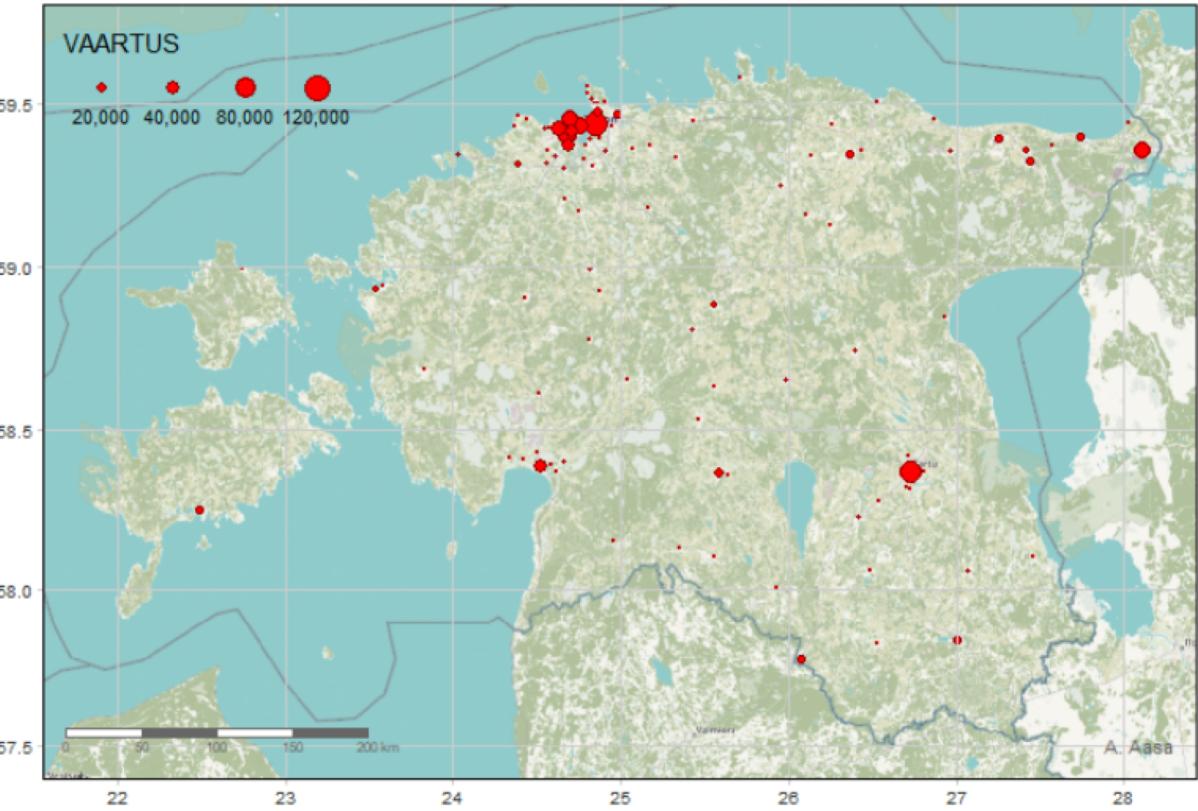
- OSM

```
library(osm)
osm.types()

est_box <- st_bbox(st_transform(dat, 4326))

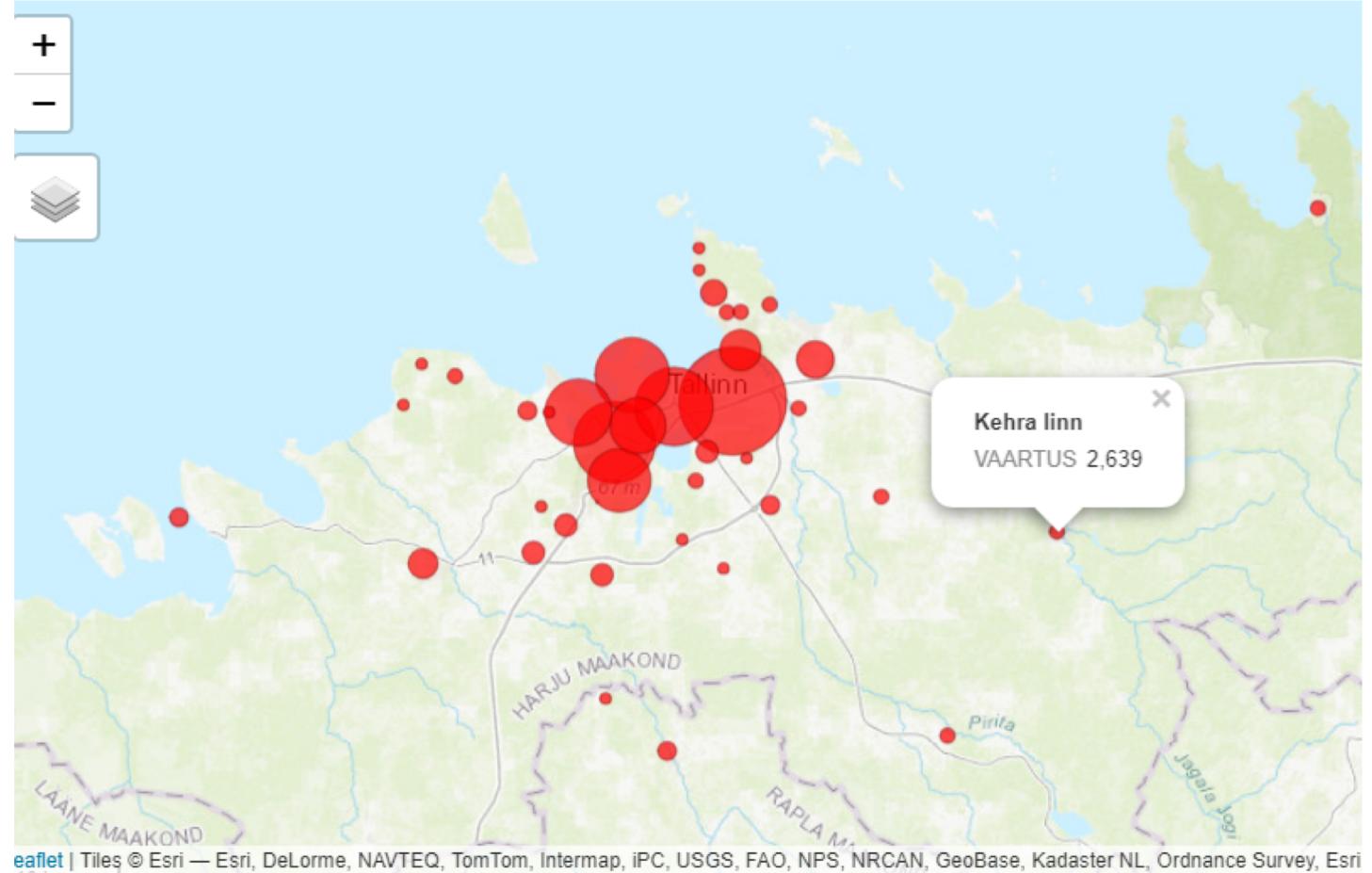
bg <- osm.raster(est_box, crop = T, forcedownload = T, type = "hotstyle")

tm_shape(bg) +
  tm_rgb()+
  tm_shape(dat_cntr_t10)+|
    tm_symbols(size= "VAARTUS",
               col = "red",
               border.col = "red4")+
  tm_layout(legend.outside = F)+
  tm_grid(col = "grey80", projection = 4326)+
  tm_scale_bar(position = c("left", "bottom"),
                text.color = "grey40",
                color.dark = "grey40")+
  tm_credits("A. Aasa", col= "grey40")
```



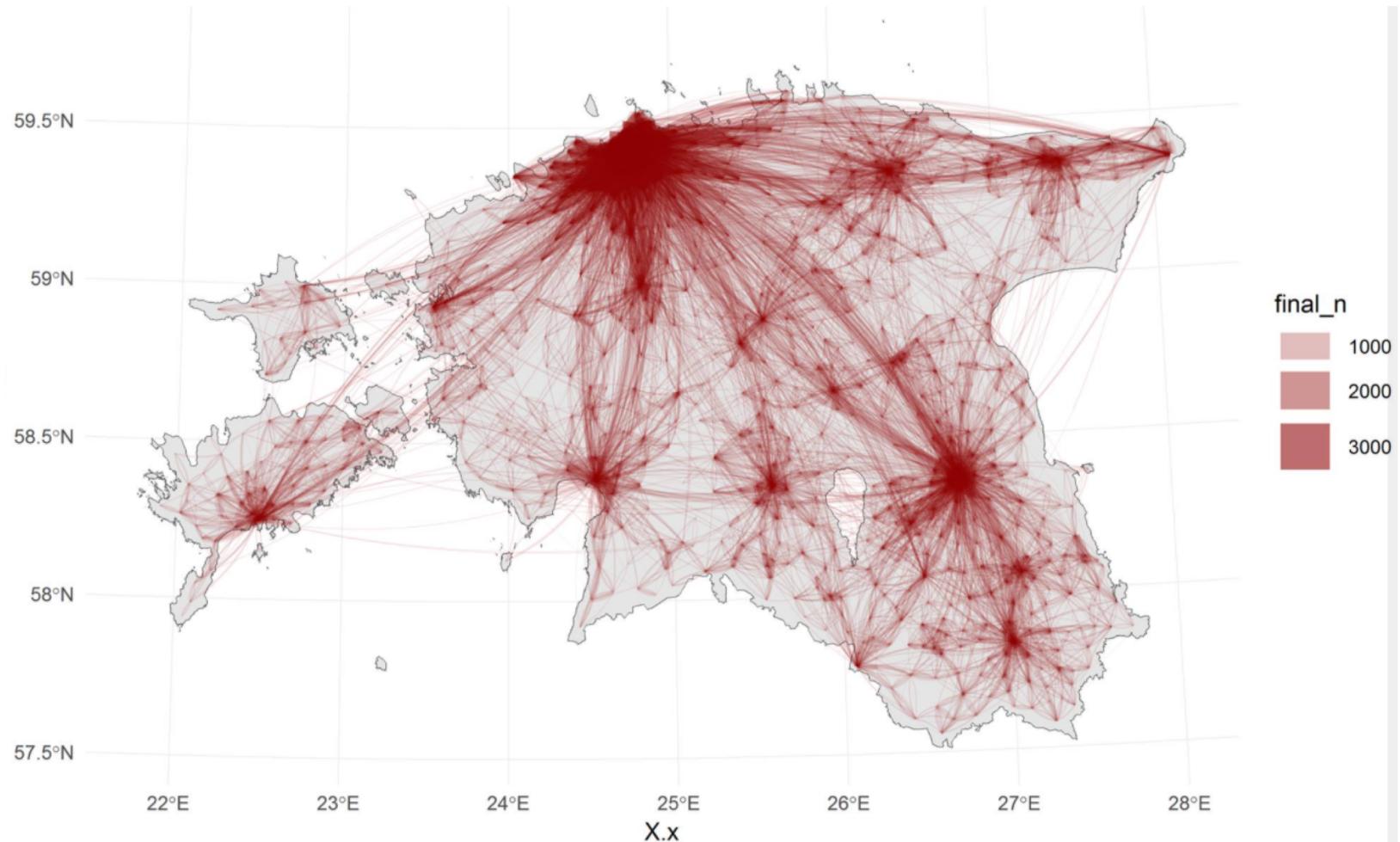
Interactive map

```
tmap_mode("view")  
  
dat_cntr_t10 <- dat_cntr_t10 %>%  
  select(NIMI, VAARTUS)  
  
tm_shape(bg) +  
  tm_rgb() +  
  tm_shape(dat_cntr_t10) +  
  tm_symbols(size = "VAARTUS",  
             col = "red",  
             border.col = "red4",  
             alpha = .7) +  
  tm_layout(legend.outside = F) +  
  tm_grid(col = "grey80", projection = 4326) +  
  tm_scale_bar(position = c("left", "bottom"),  
                text.color = "grey40",  
                color.dark = "grey40") +  
  tm_credits("A. Aasa", col = "grey40")
```



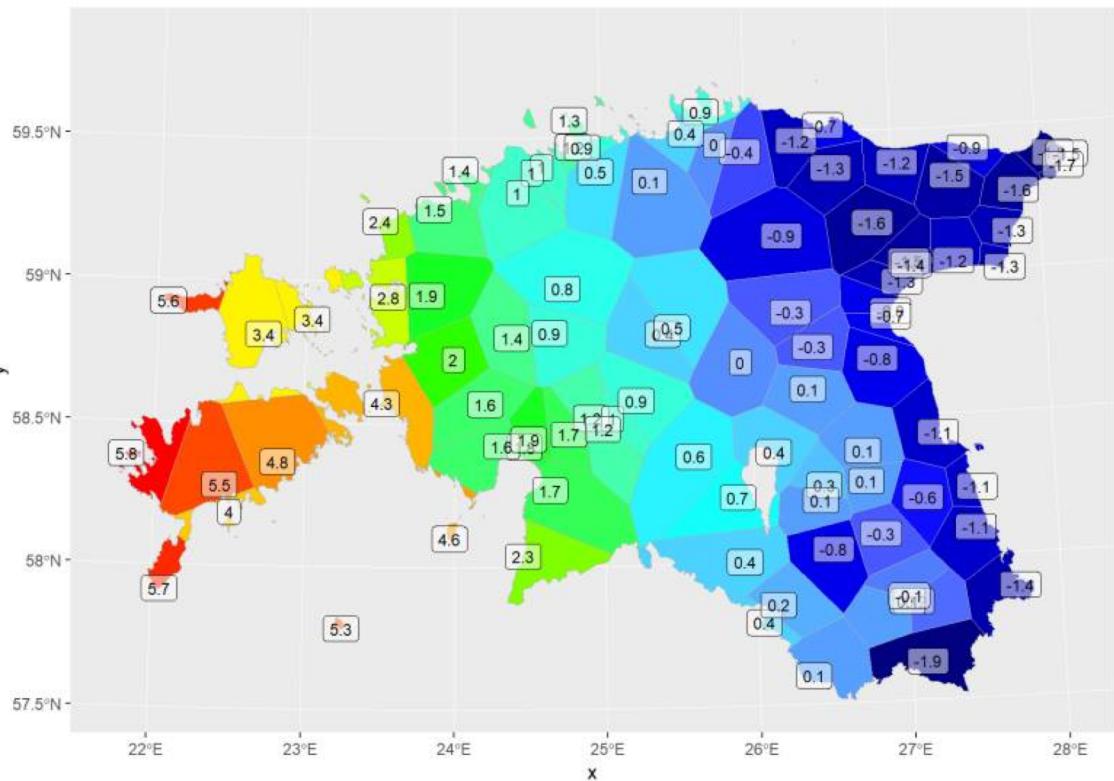
ggplot2

- **geom_sf()**
- **geom_point()**
- **geom_path()**
- **geom_curve()**
- **geom_polygon()**

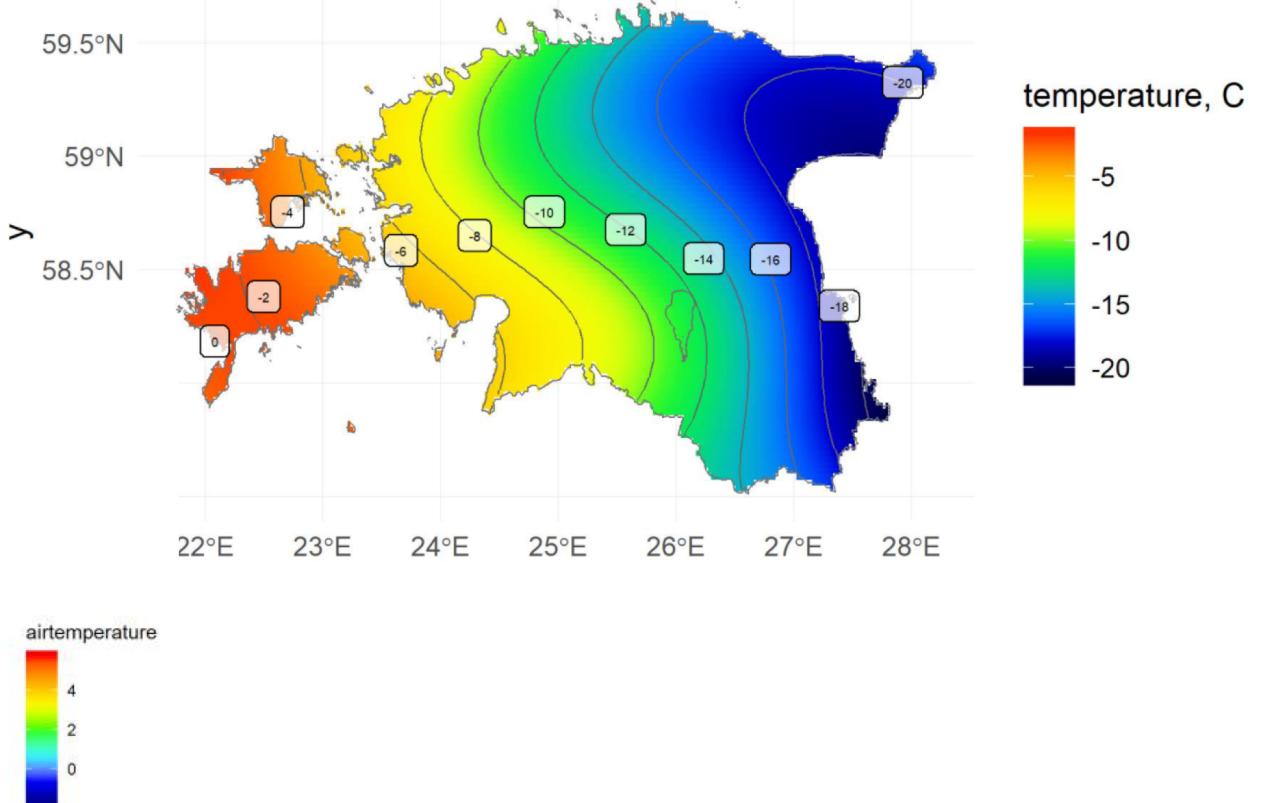


```
geom_curve(aes(x = start_x, y = start_y, xend = end_x, yend = end_y))
```

Spatial interpolation

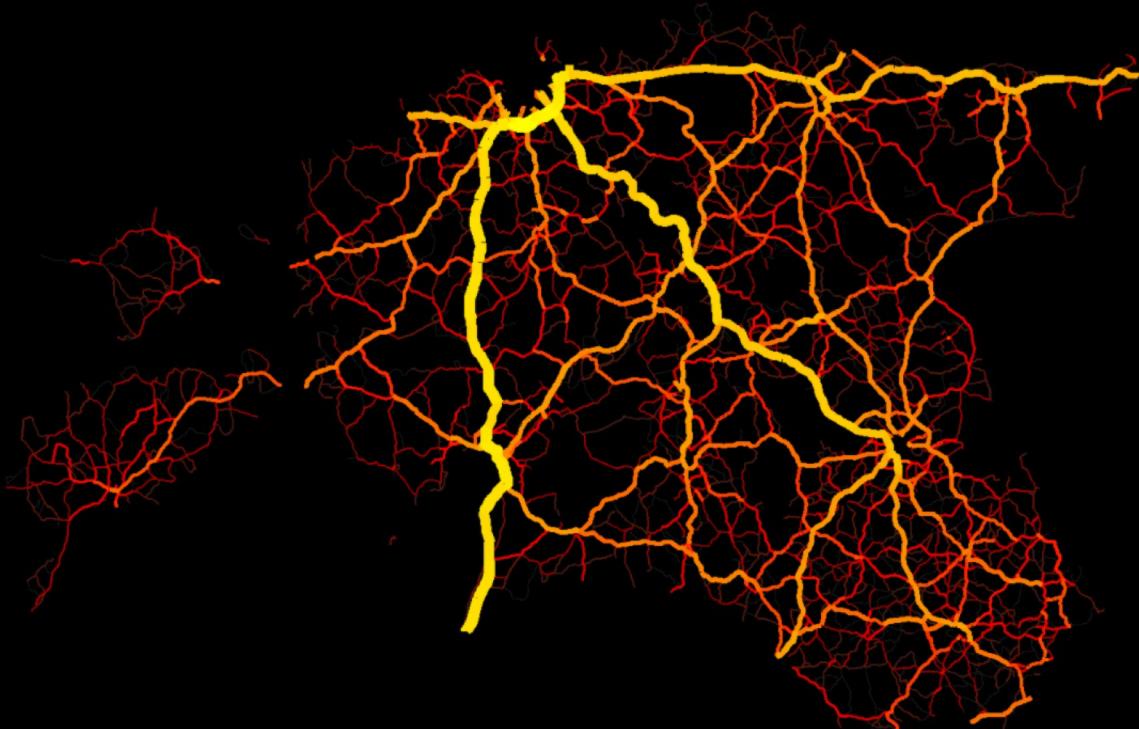


Air temperature in Estonia
2019-01-23 00:00

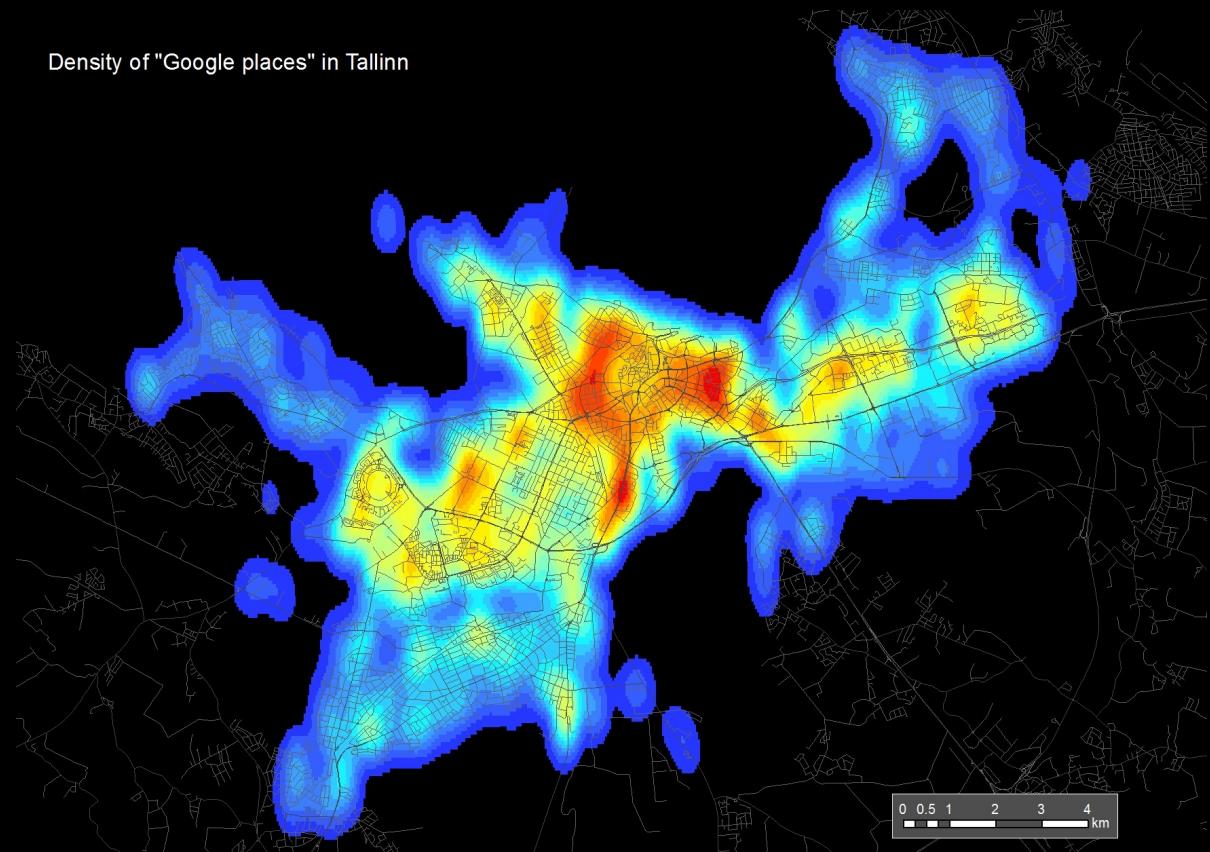


liiklussagedus

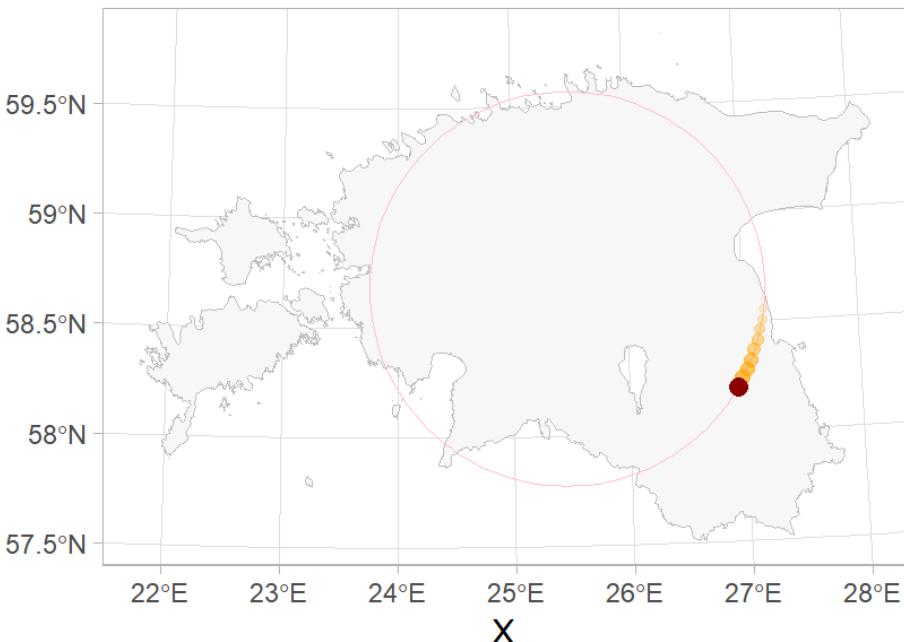
andmed: Teeregister



Density of "Google places" in Tallinn



- Animations
 - ganimate
 - magick
 - ffmpeg



Create animation frames as png-files:

```

for(i in 1: nrow(est_cntr_buf_df)){
  est_cntr_buf_df_tmp2 <- est_cntr_buf_df %>%
    filter(rnk > i - 1 & rnk < i +10)

  est_cntr_buf_df_head <- est_cntr_buf_df %>%
    filter(rnk == i + 10)

  ggplot()+
    theme_light()+
    geom_sf(data= est_cont_3301_smpl, col = "grey", fill = "grey97", size = 0.25)+
    geom_path(data = est_cntr_buf_df, aes(x = X, y = Y), col = "pink", size= 0.1)+
    geom_point(data = est_cntr_buf_df_tmp2, aes(x= X, y = Y, alpha = rnk, size= rnk), colour = "orange")+
    geom_point(data = est_cntr_buf_df_head, aes(x= X, y = Y), colour = "darkred", size= 2.5)+
    scale_alpha(range = c(0, 0.7))+
    scale_size(range = c(0.2, 2))+
    guides(alpha = F, size = F)

  frame_name <- paste0("airplane_", est_cntr_buf_df$frame_name[i], ".png")
  ggsave(filename = frame_name, dpi = 200, height = 3, width = 4.5)
}

}

```

Bind the images together as animation:

```

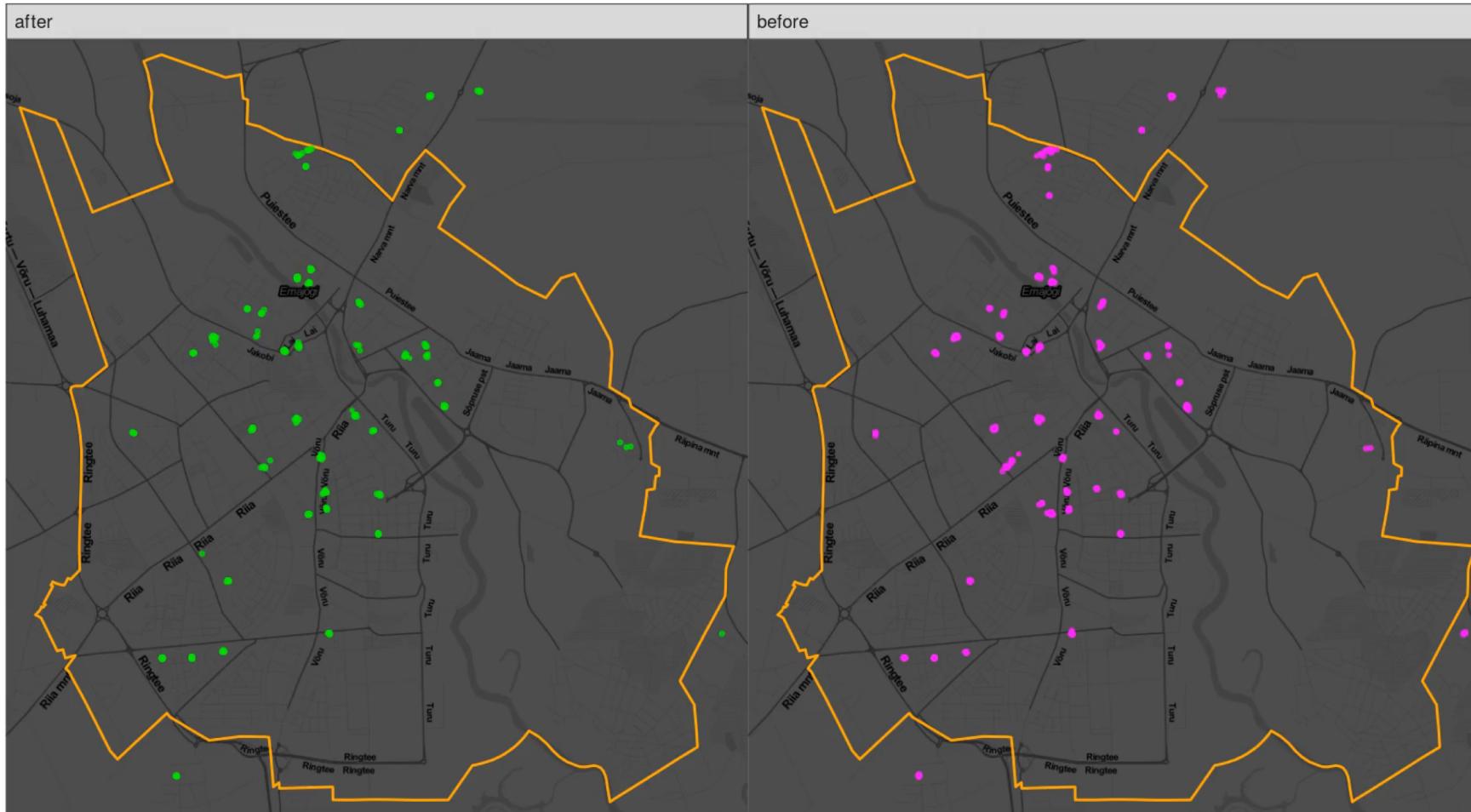
getwd()

list.files(pattern = "airplane_") %>%
  map(image_read) %>% # reads each path file
  image_join() %>% # joins image
  image_animate(fps = 25) %>% # animates ('fps' defines the speed of animation)
  image_write("est_UFO.gif") # write to current dir

```

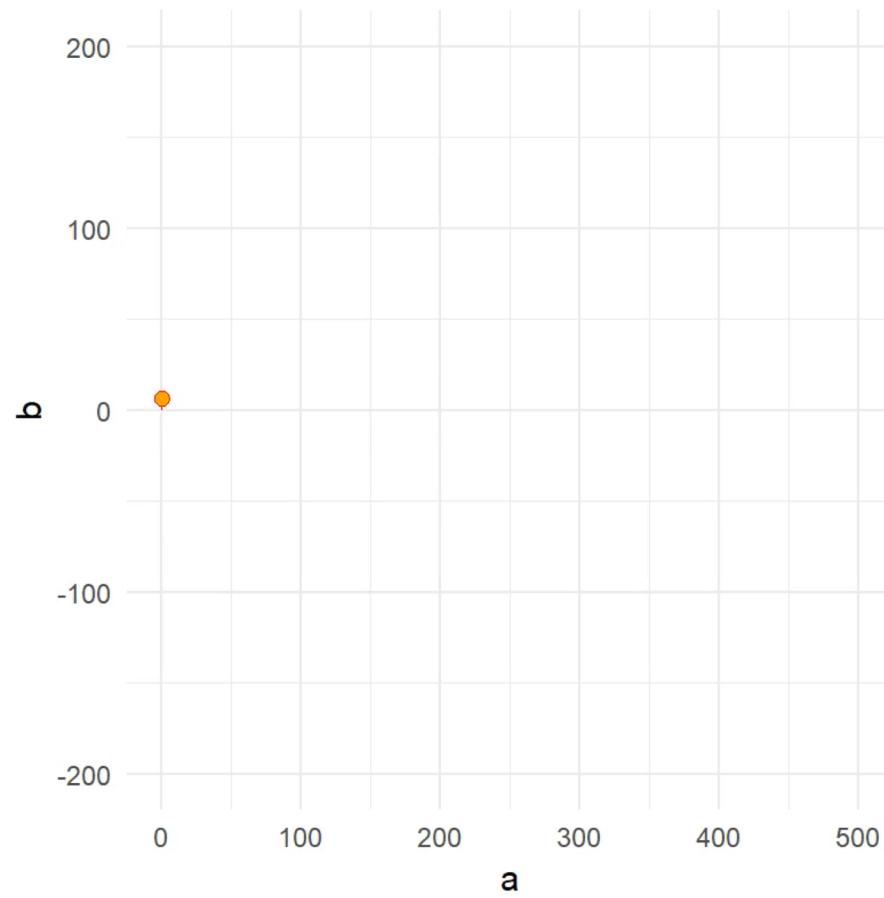
Mobility before and after the virus outbreak

06:00:53



A. Aasa

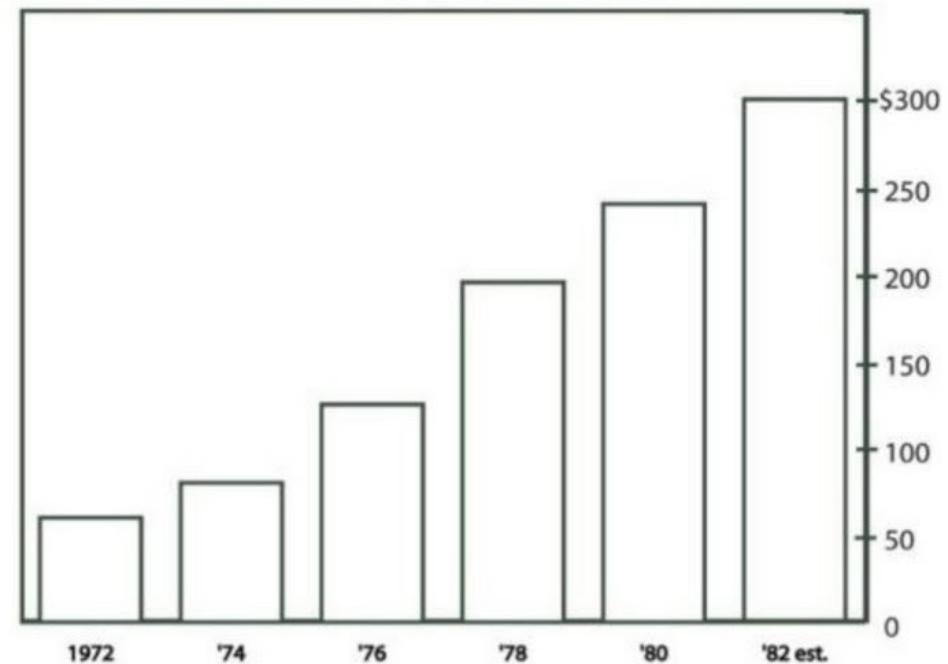
Fools trap



How to impress?

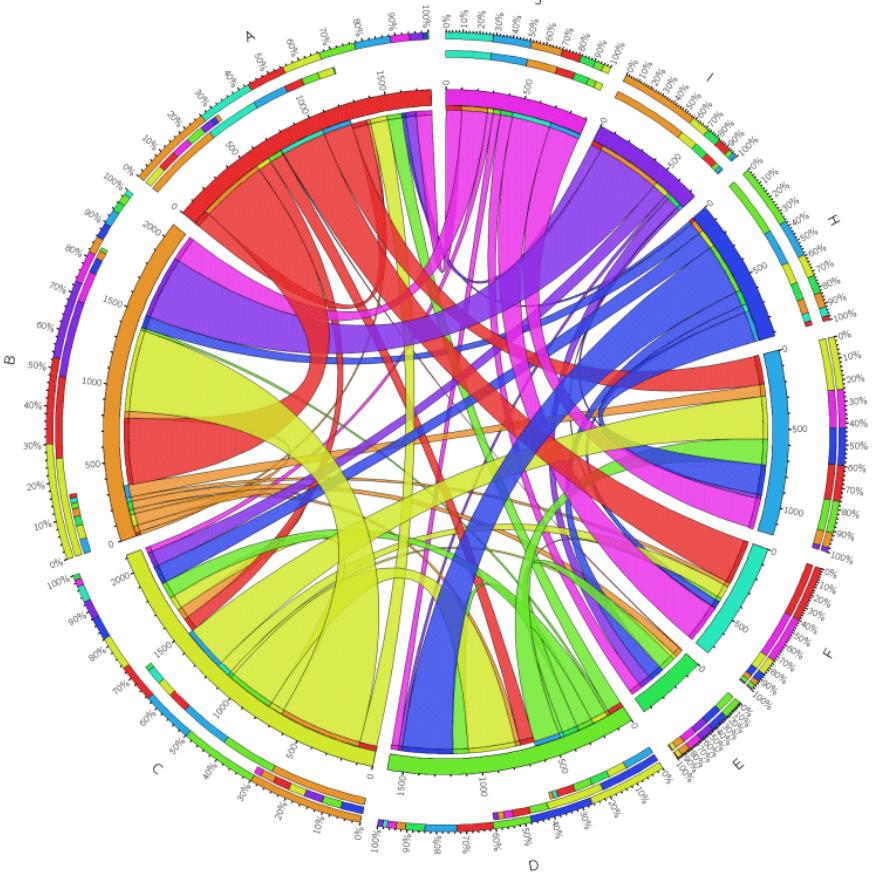


MONSTROUS COSTS
Total House and Senate campaign expenditures, in millions



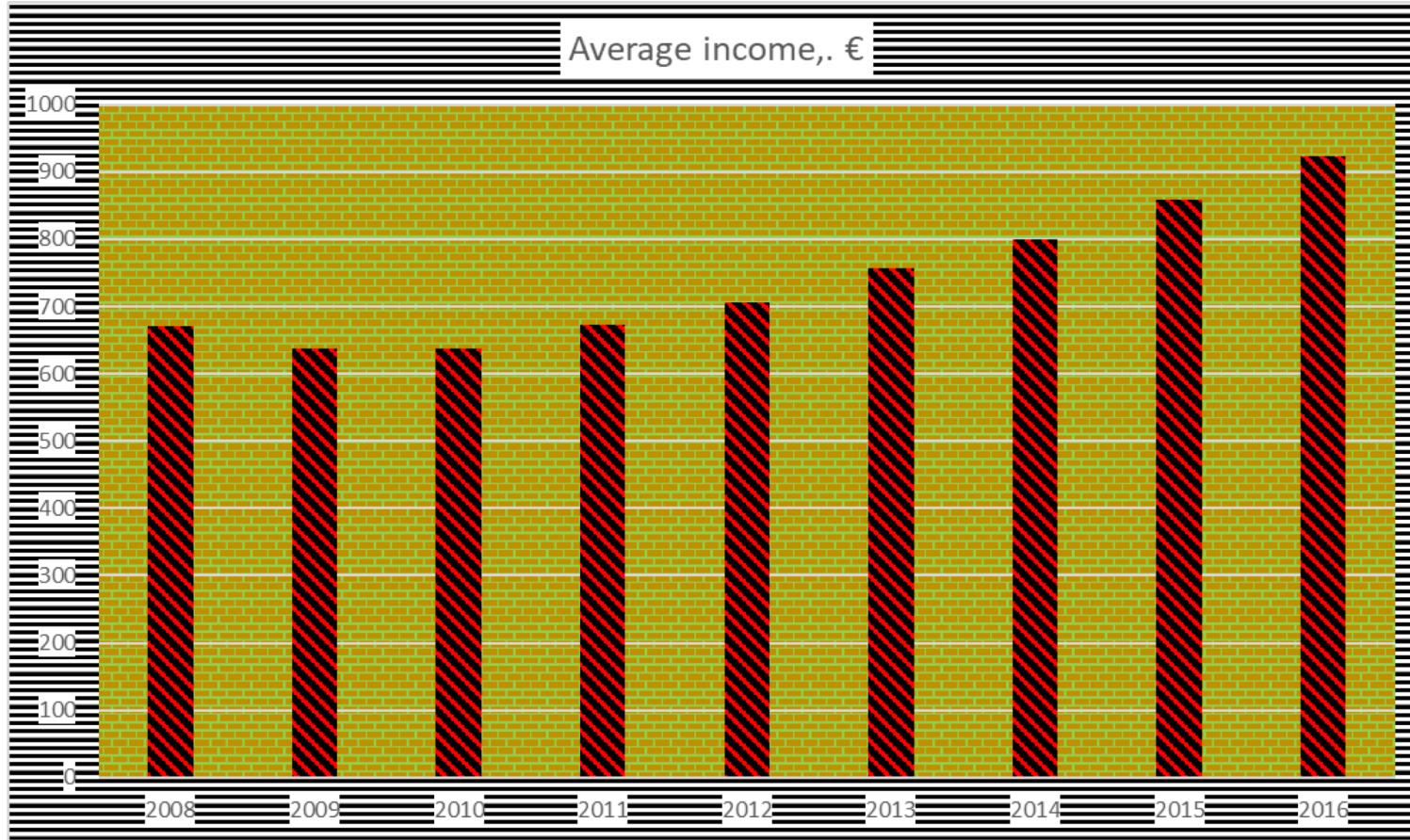
<https://eagereyes.org/criticism/chart-junk-considered-useful-after-all>

Chord diagram



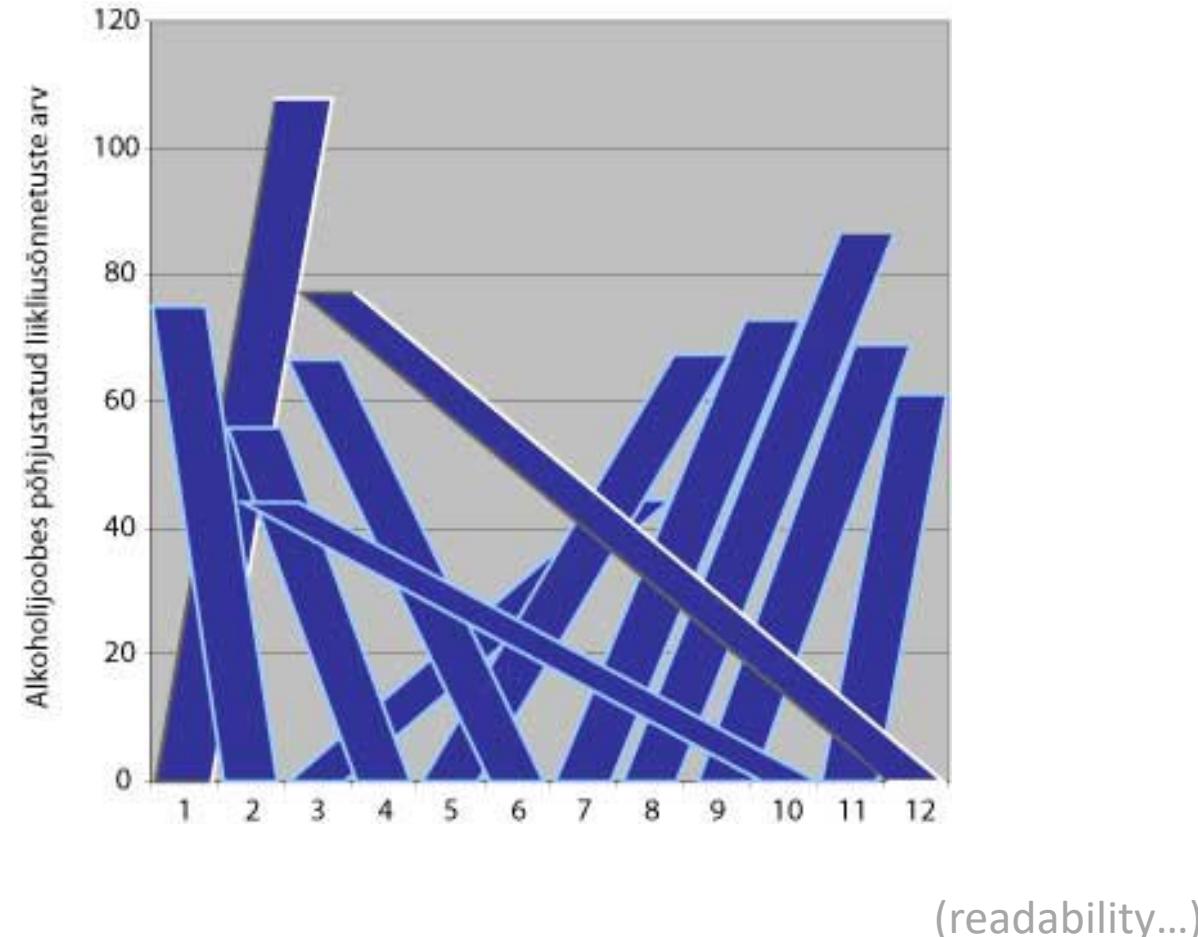
<http://mkweb.bcgsc.ca/tableviewer/samples/>

Chart junk

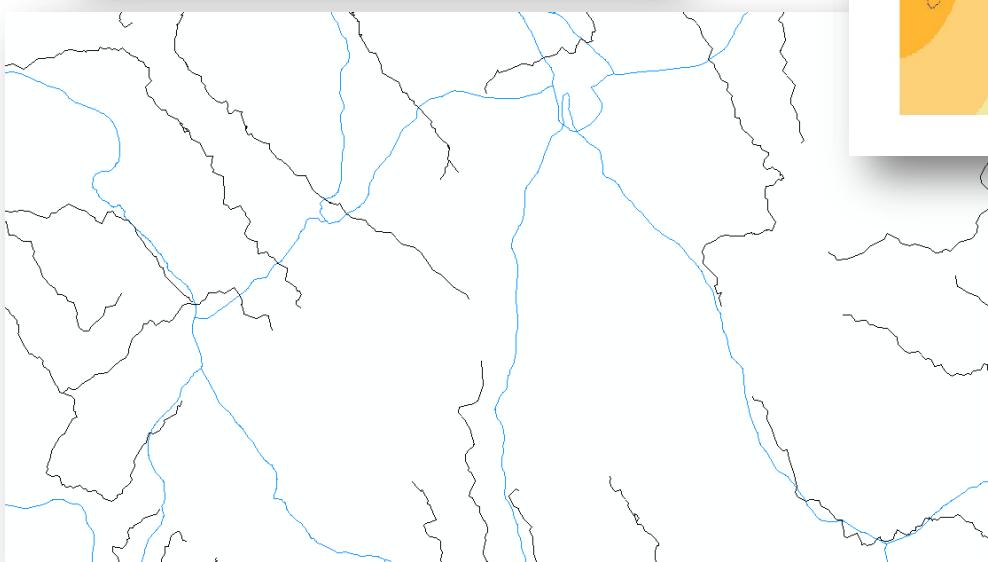
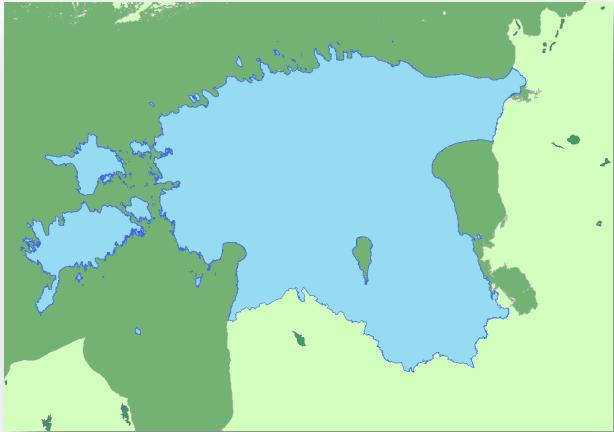


Try to be funny?

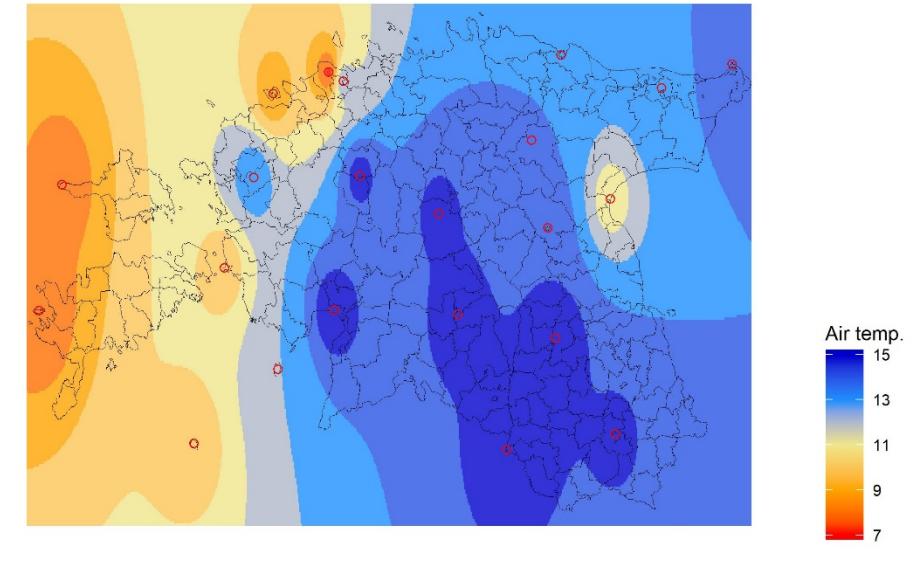
Crashes caused by drunk drivers



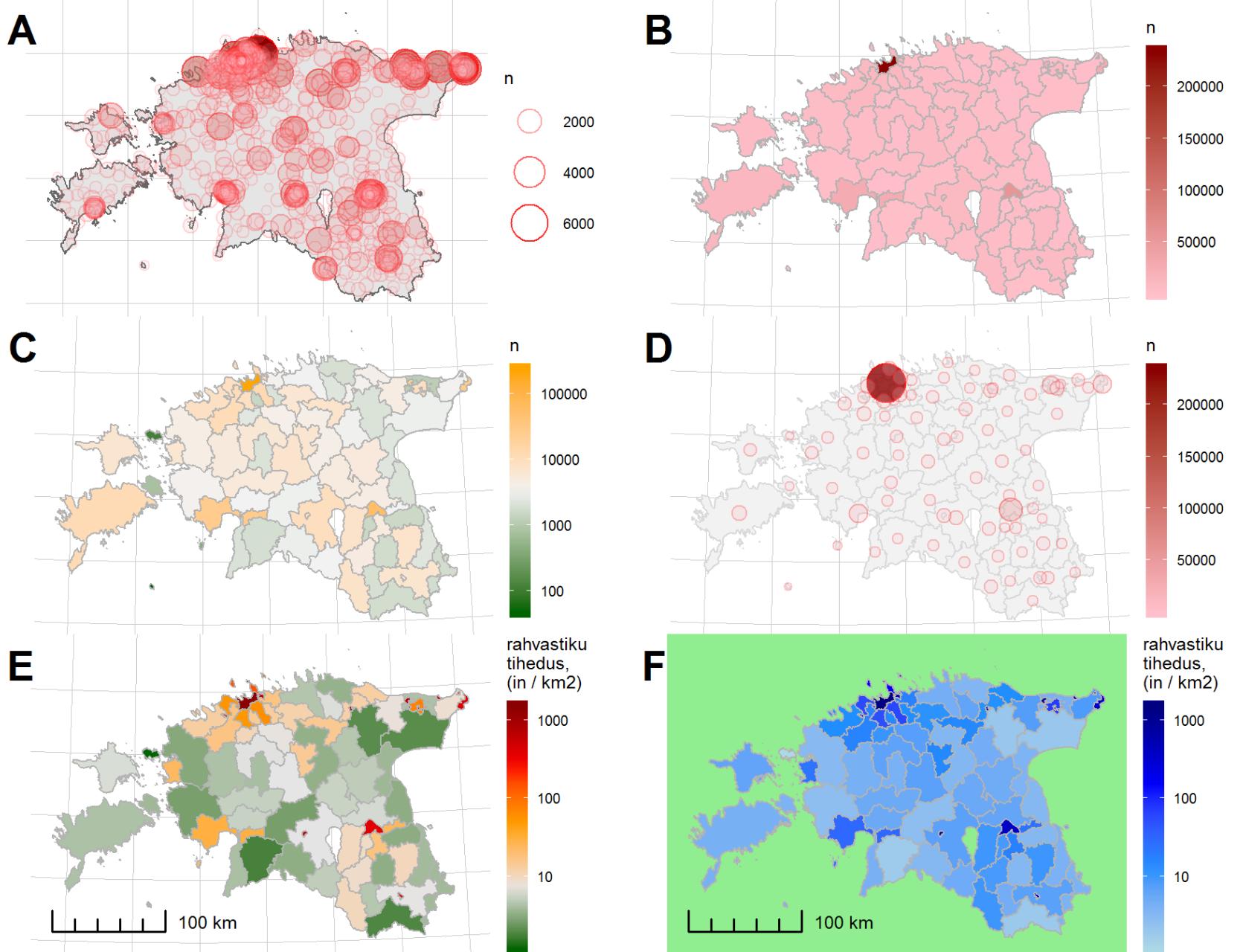
Follow the traditions



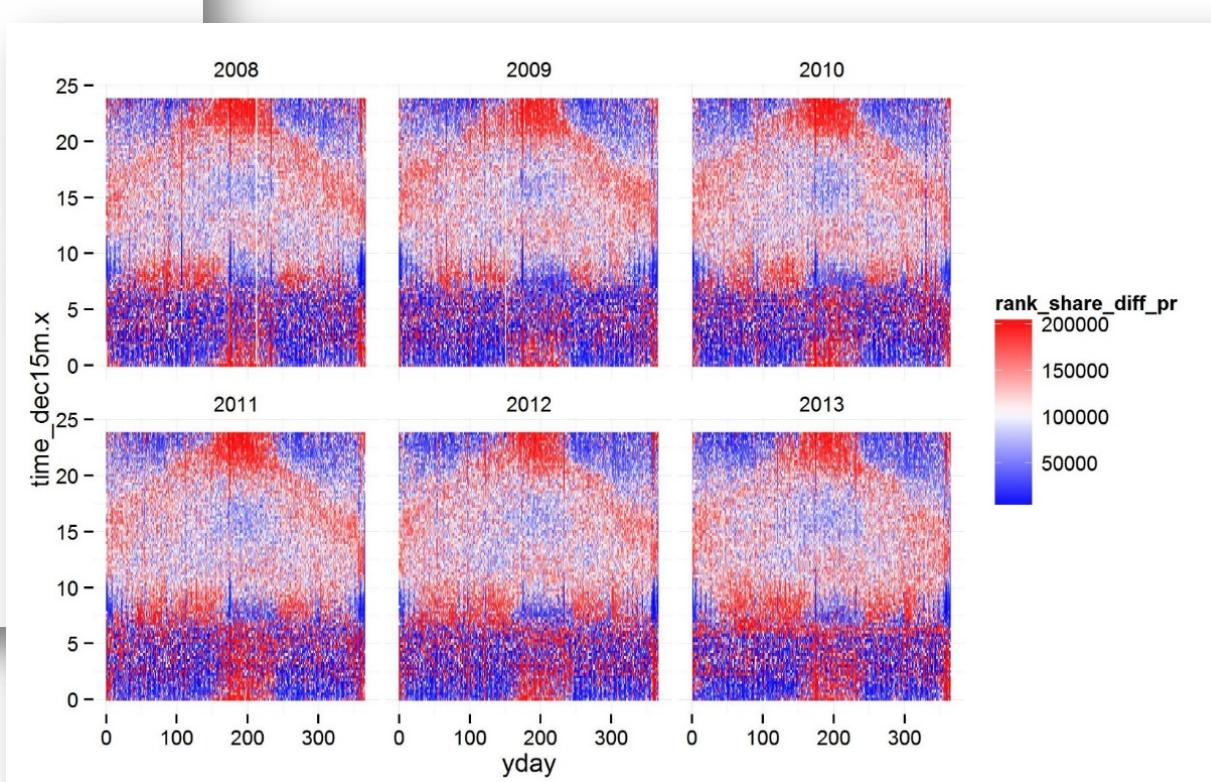
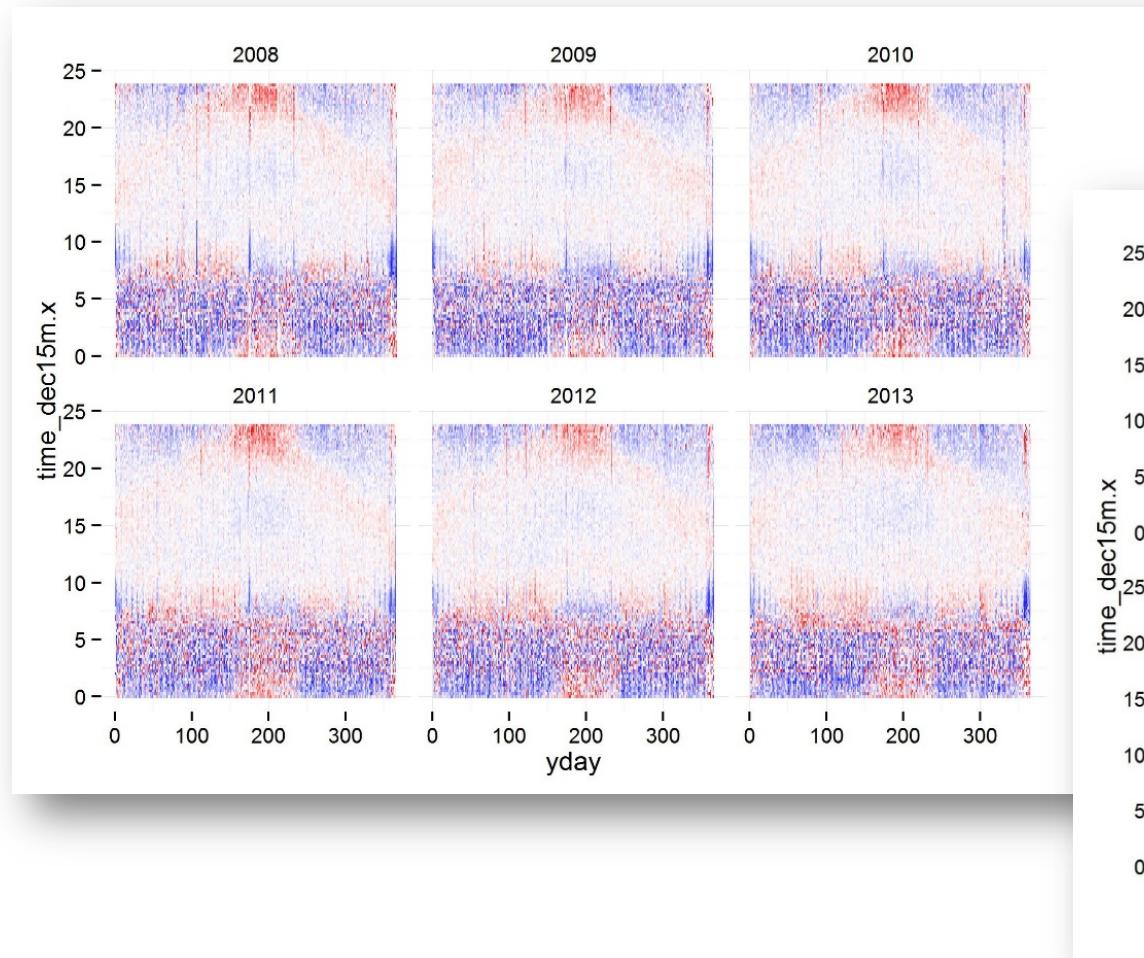
Air temperature in Estonia, 15/May/2010



Population map



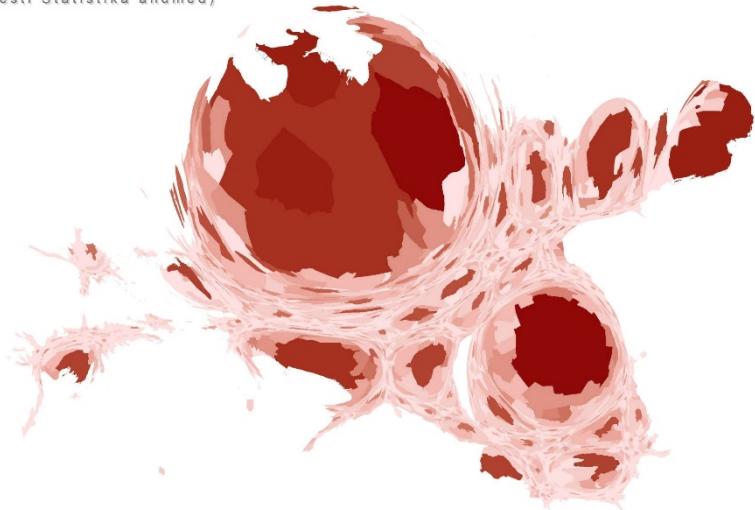
Tuning the picture



Magic something

FB shares: 4

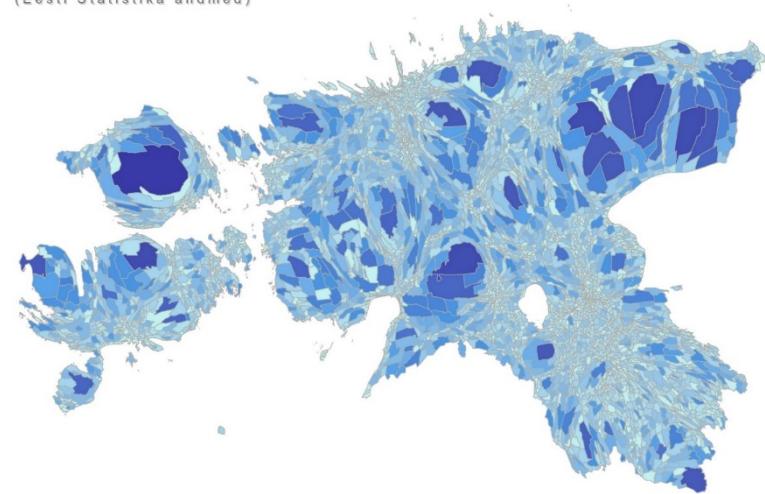
EESTLADE ARV ELUKOHA (ASULA) JÄRGI,
31. DETSEMBER 2011
(Eesti Statistika andmed)



Population

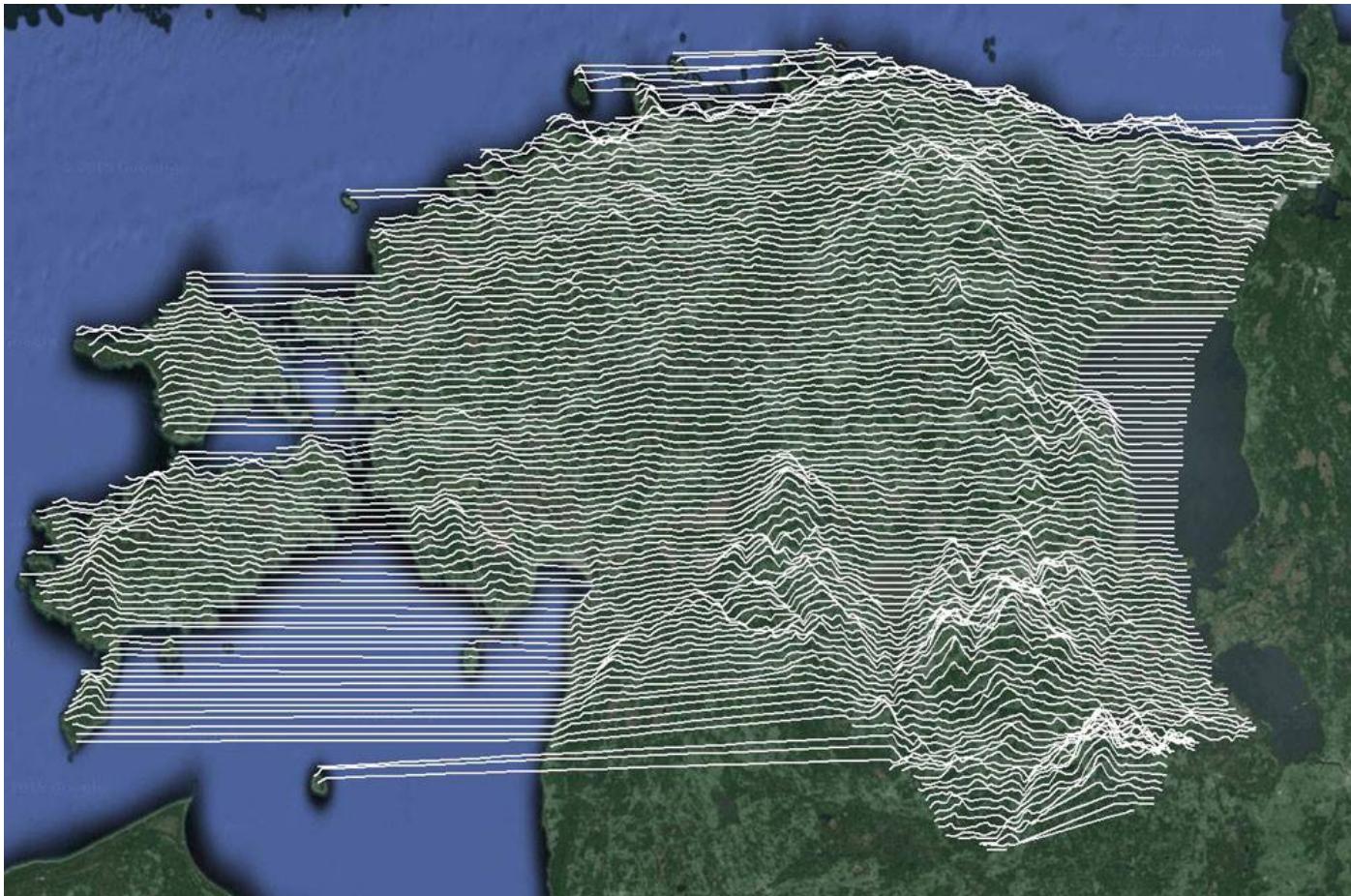
FB shares: 25

RUUMIKAD KOHAD
31. detsember 2011
(Eesti Statistika andmed)



„Empty space“

Out of the Box Thinking

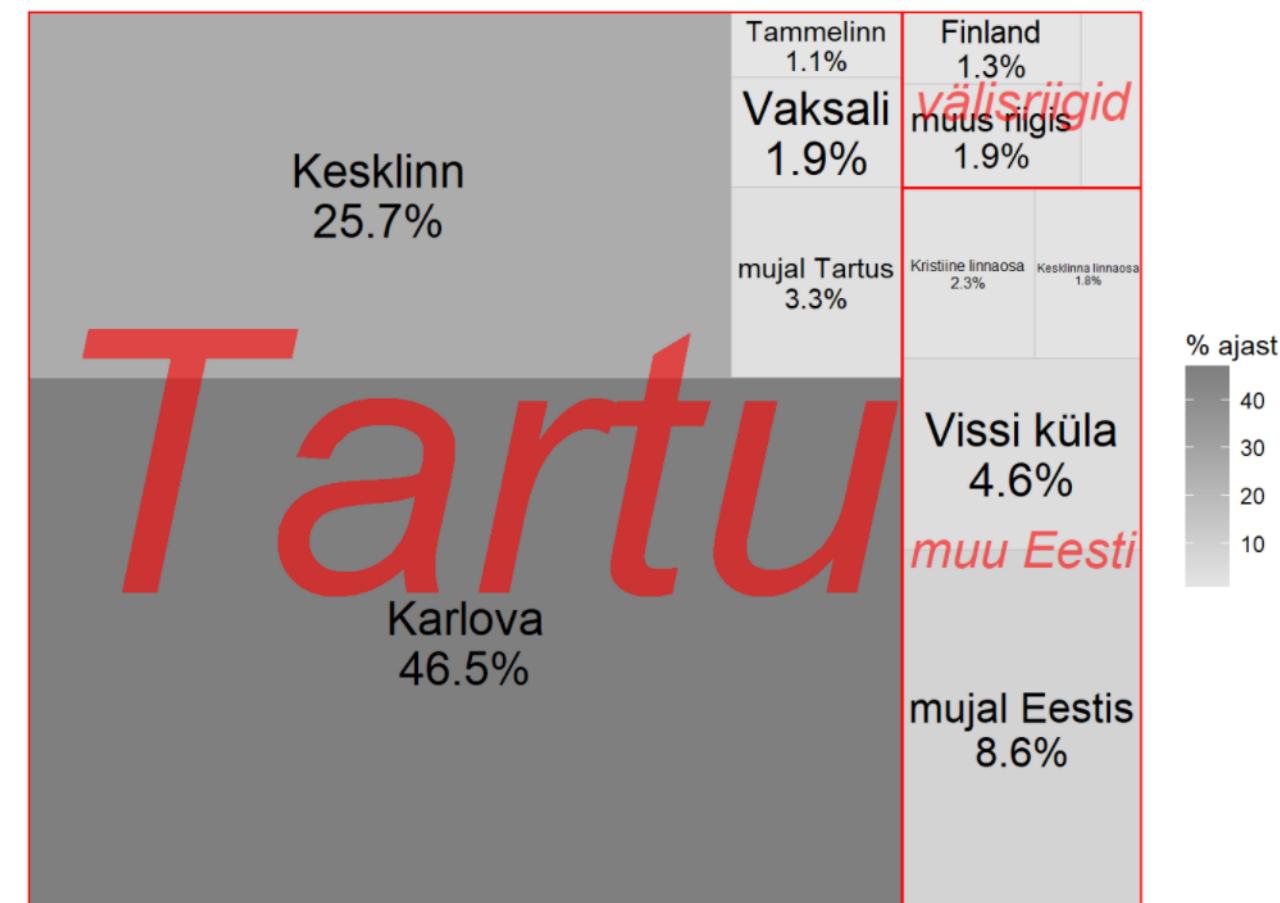


Elevation map of Estonia

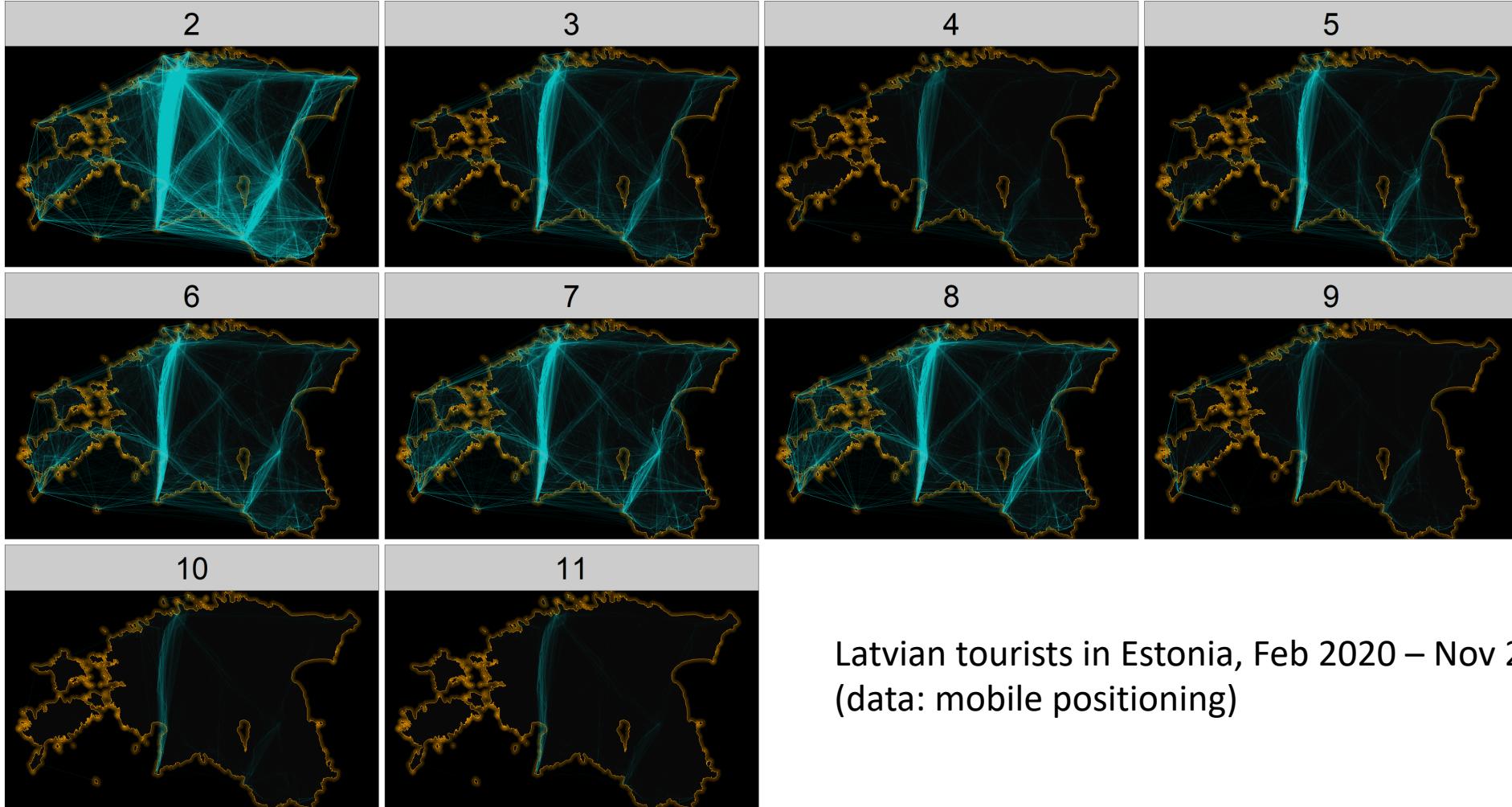
What is map?

Stays during the day

GPS-data



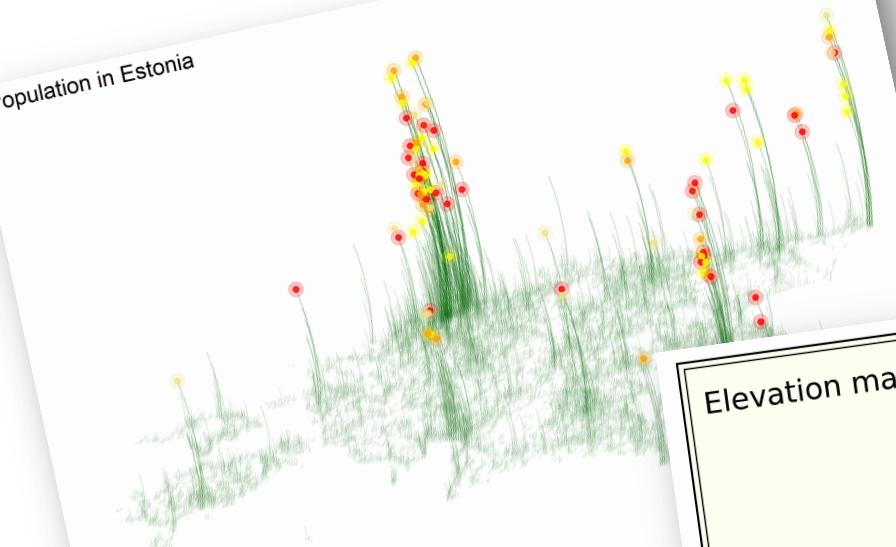
Bring out the message! Storytelling!



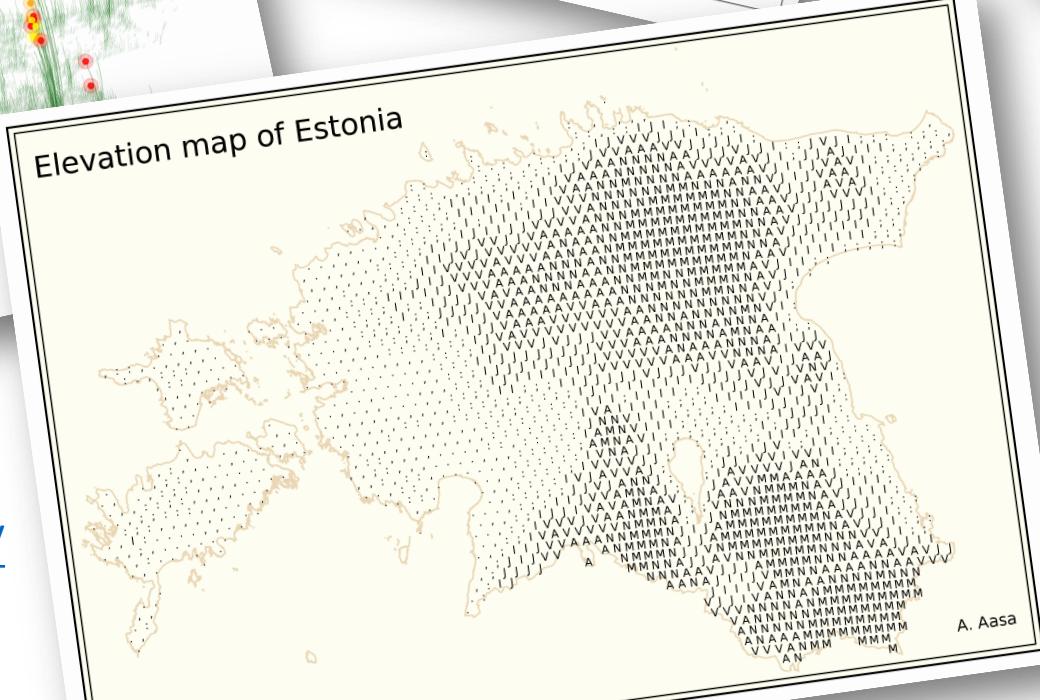
Thank you!

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Population in Estonia



Elevation map of Estonia



A. Aasa

Read more:

<https://aasa.ut.ee/Rspatial/>

Residential and non-residential housing in Tallinn

