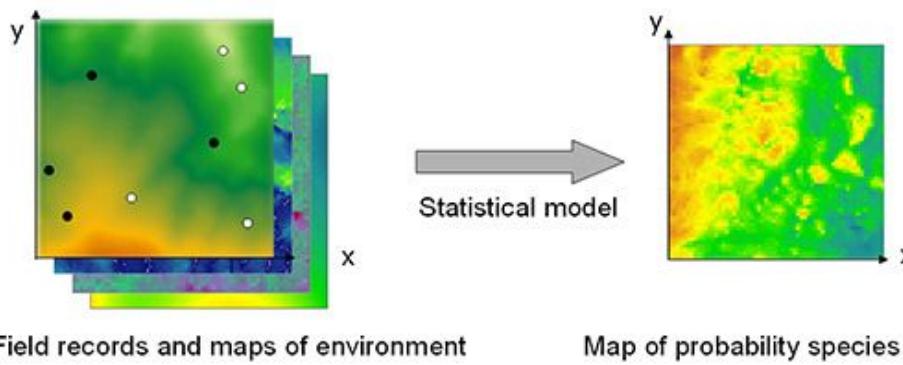


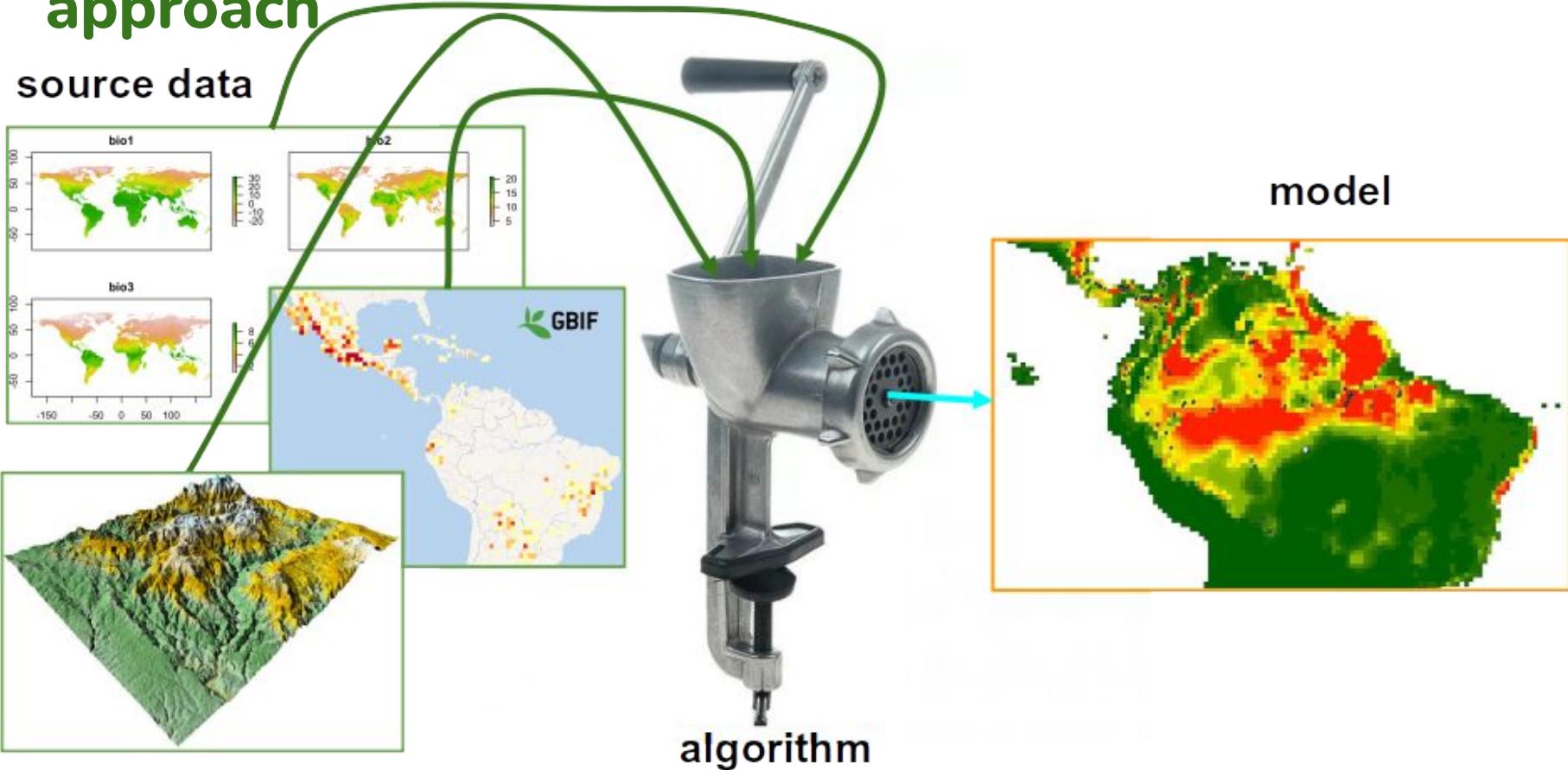
# Environmental Predictors for Species Distribution Modelling



Maxim Shashkov  
Karaganda Buketov University

Karaganda - 2025

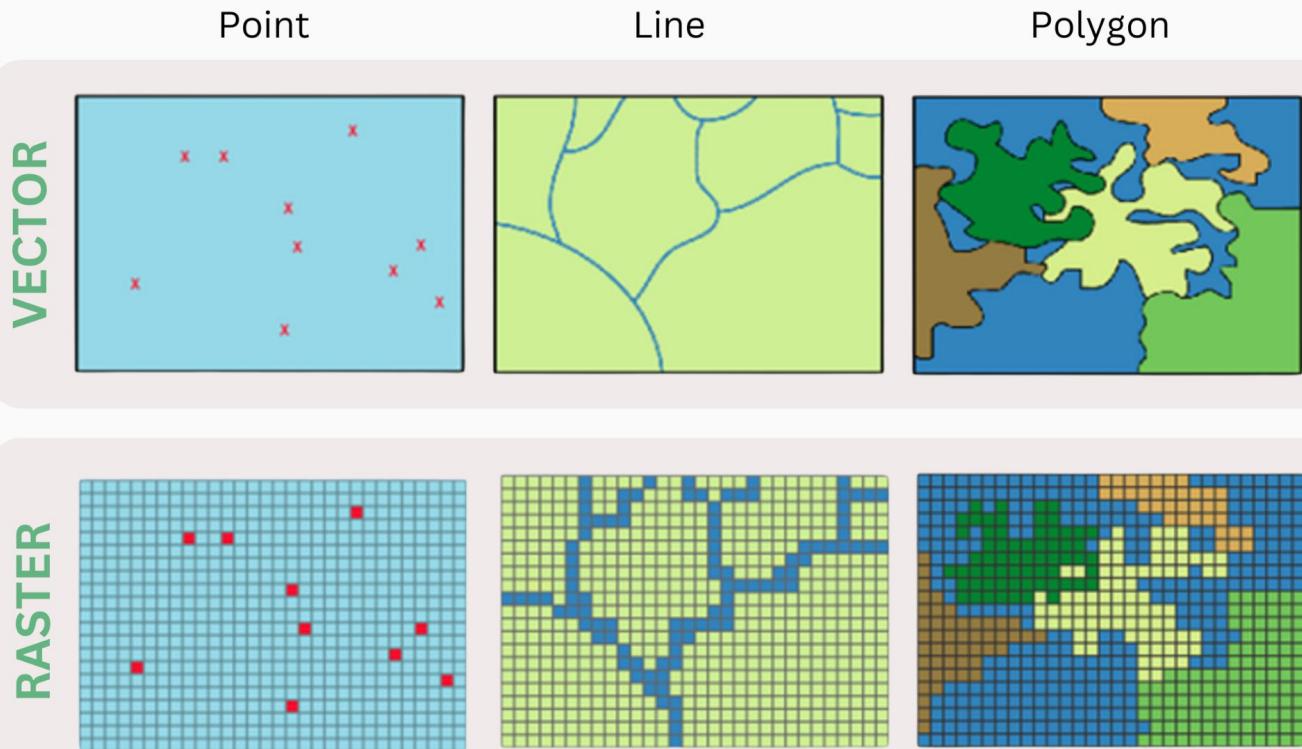
# Species Distribution Modelling, the first approach



# Spatial Layer Types

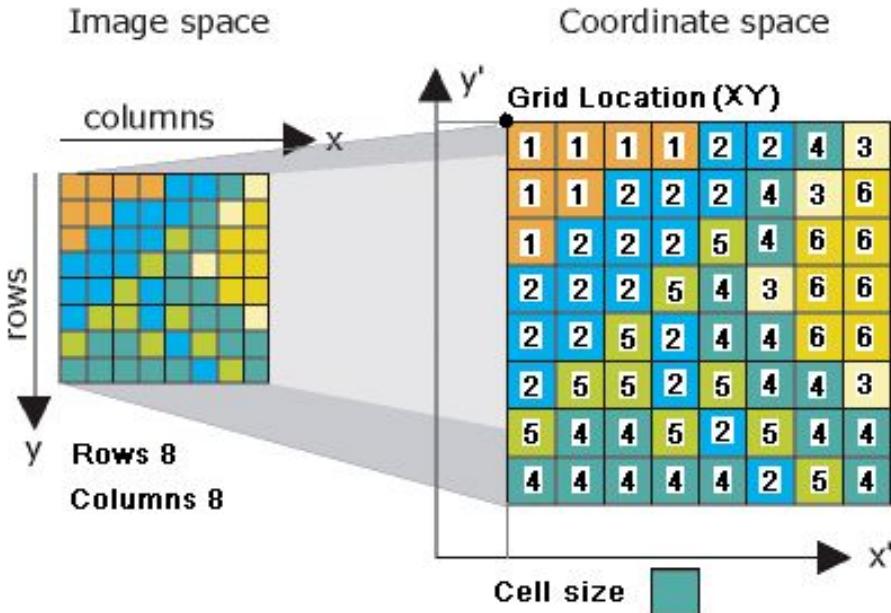
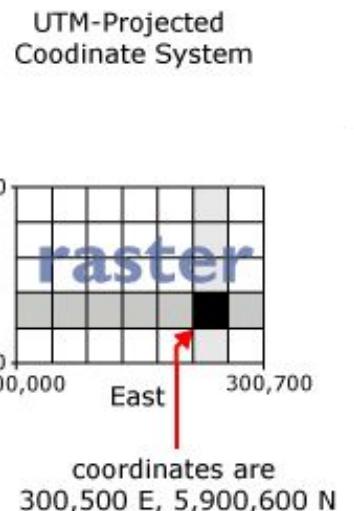
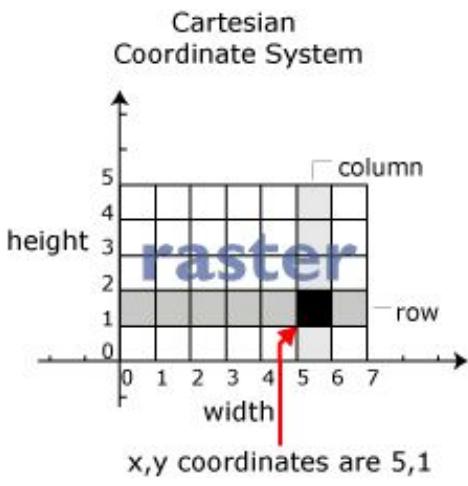
spatial data structure that represents geographic features points, lines and polygons

matrix of pixels



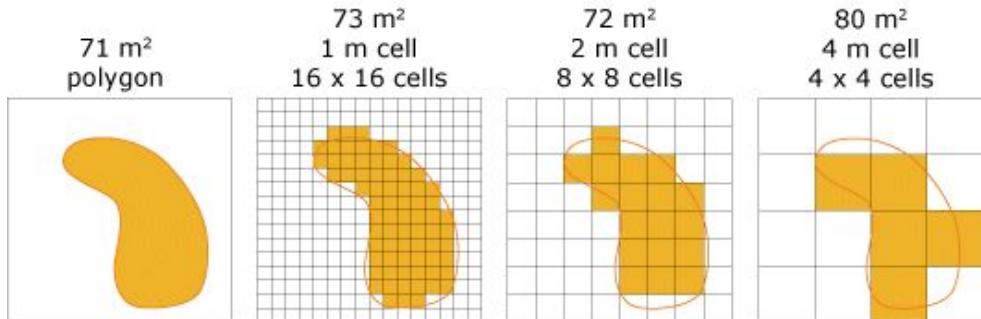
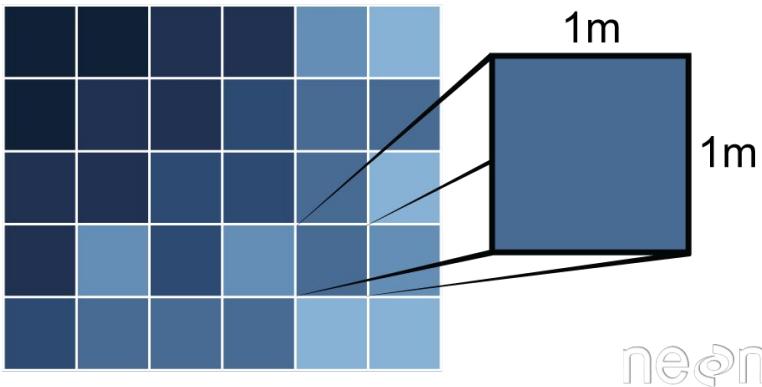
Source: Humboldt State University

# Raster Georeferencing



# Resolution

## Pixel Size

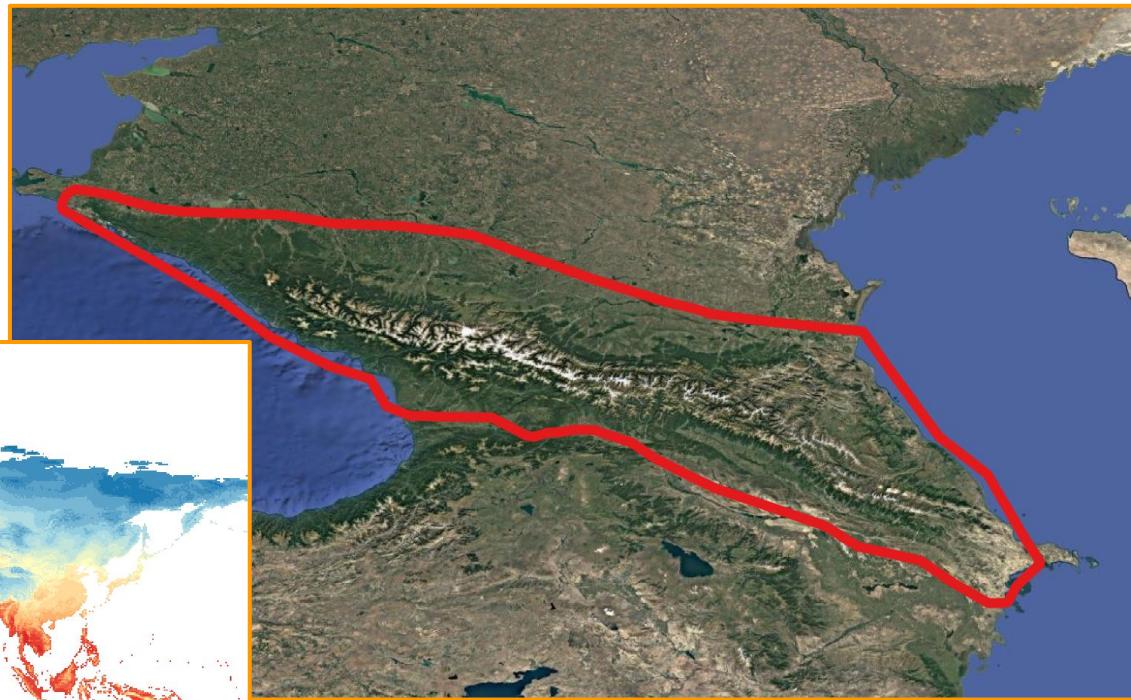
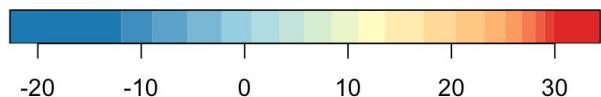


- Smaller cell size
  - Higher resolution
  - Higher feature spatial accuracy
  - Slower display
  - Slower processing
  - Larger file size
- Larger cell size
  - Lower resolution
  - Lower feature spatial accuracy
  - Faster display
  - Faster processing
  - Smaller file size

Fundamentals of georeferencing a raster dataset ESRI

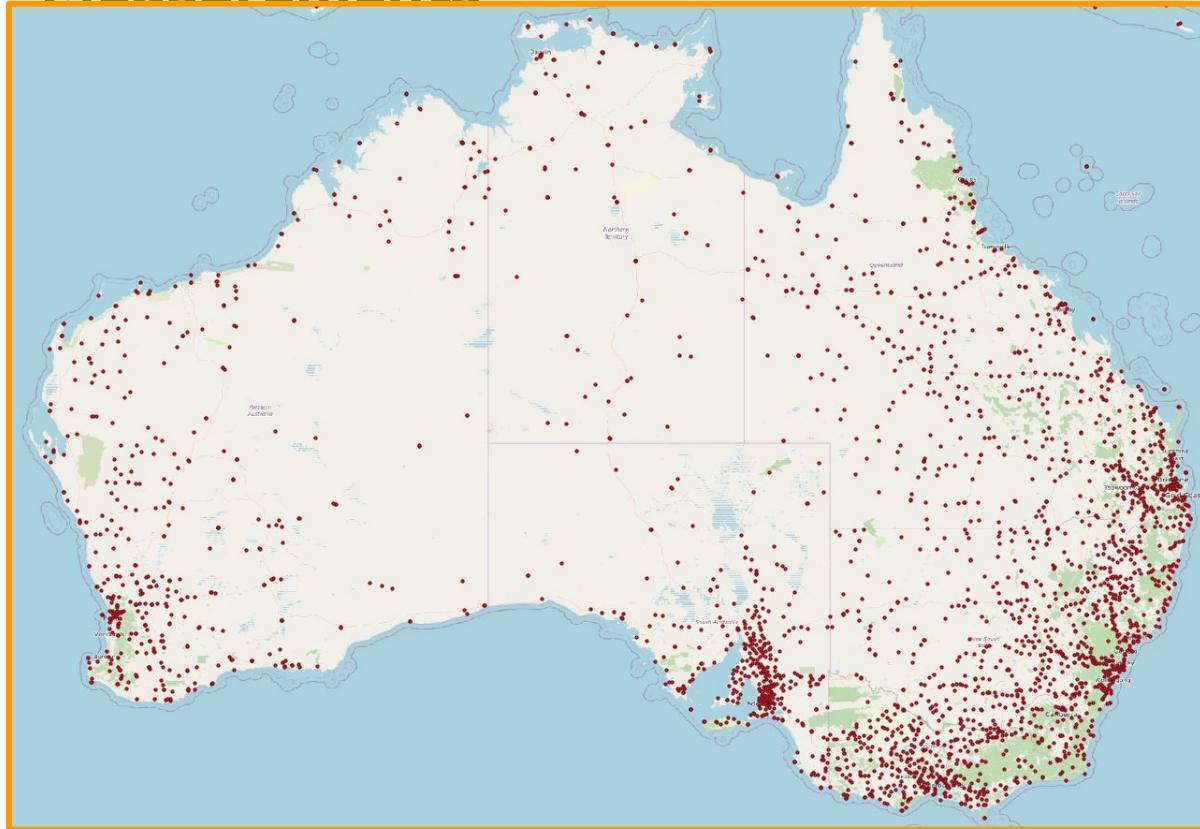
# Extent

global

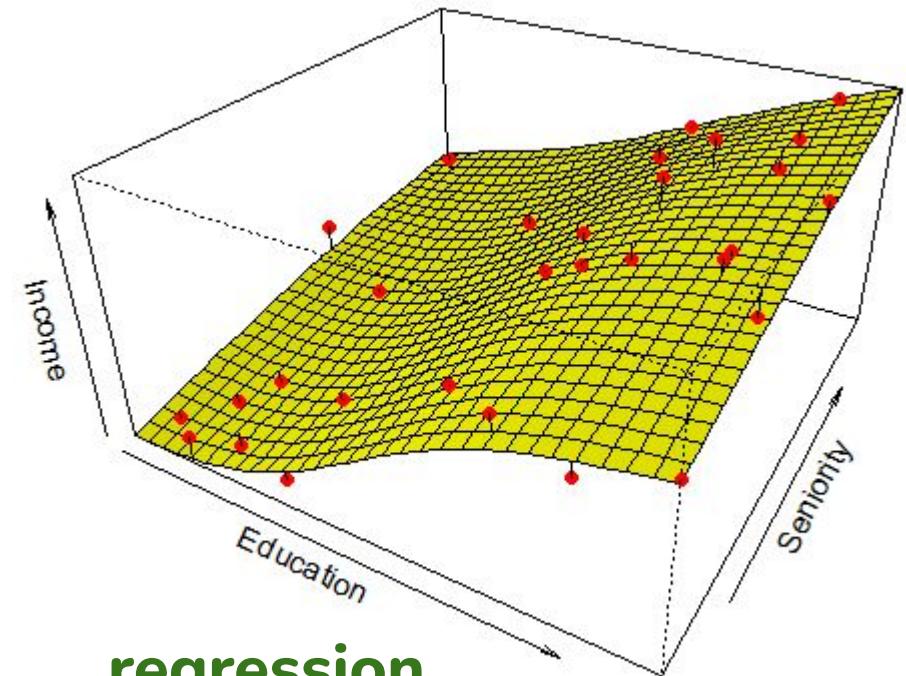


regional

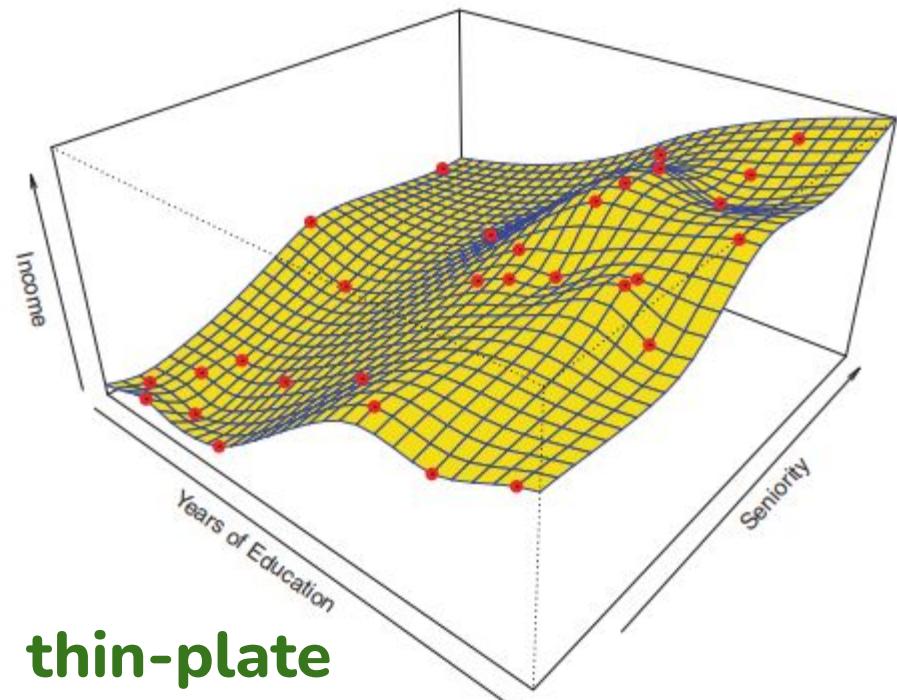
# Climatic Data - the Results of Spot Surface Measurements



# Interpolation



**regression**



**thin-plate  
spline**

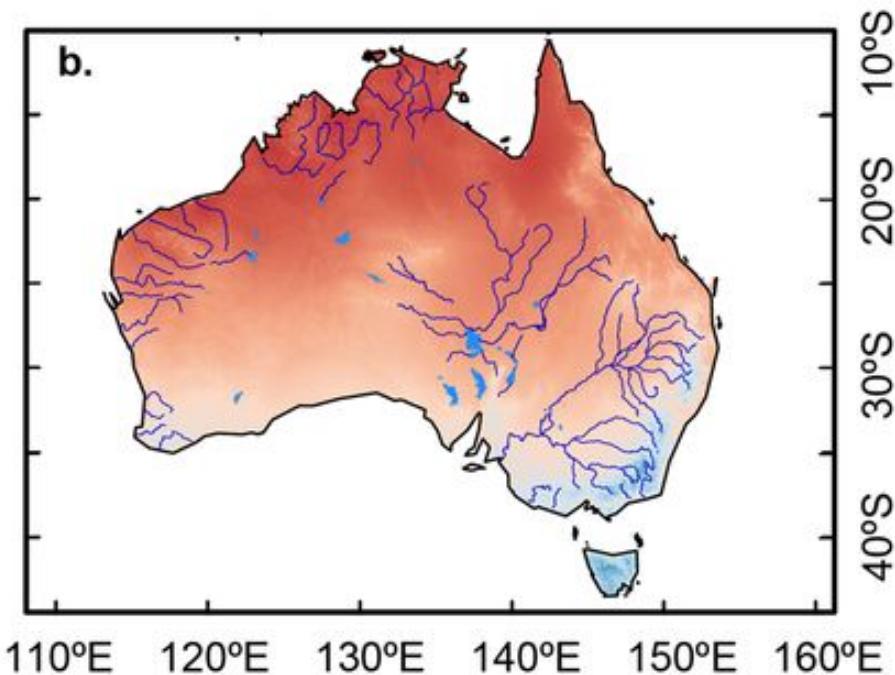
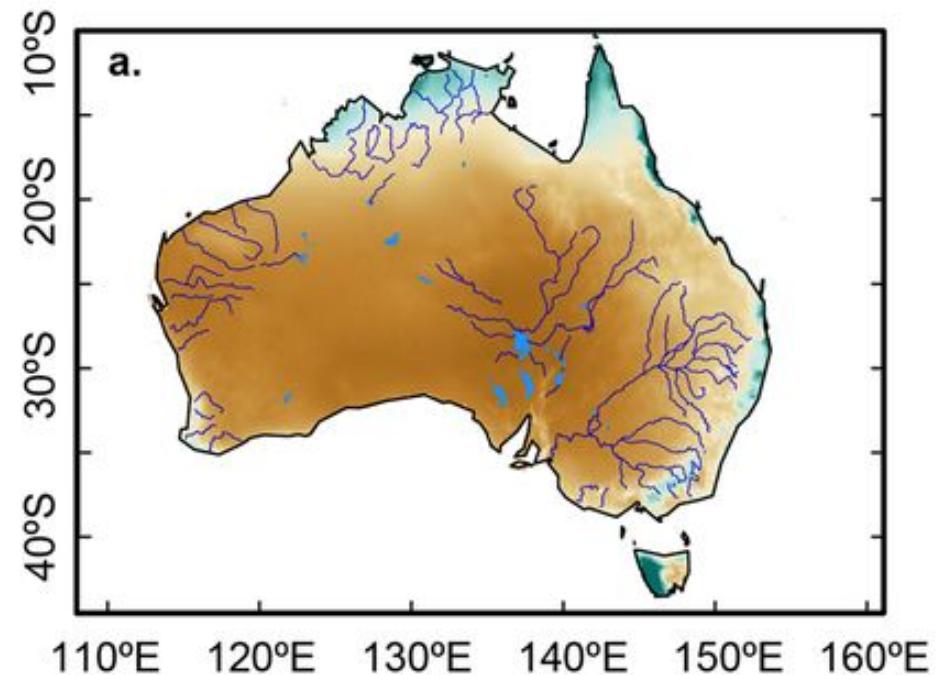
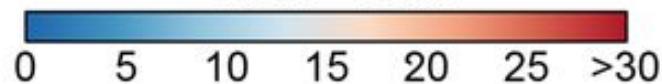
**Average annual precipitation (mm/year)**

1980 – 2010

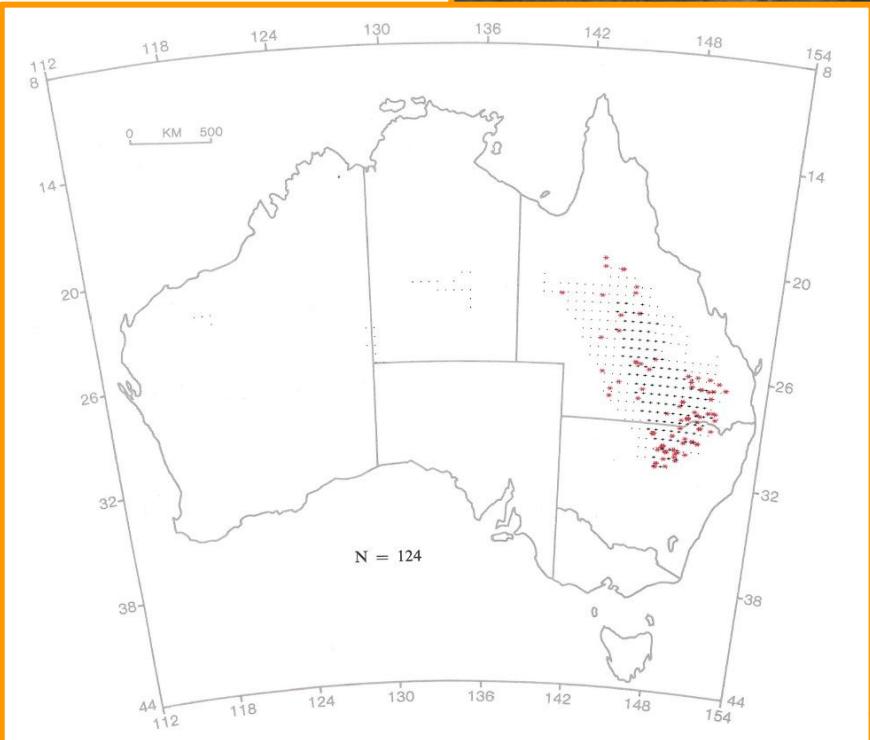


**Average annual temperature ( $^{\circ}\text{C}$ )**

1961 – 1990



# BIOCLIM (env. envelope) - the first SDM



records map (624 records)



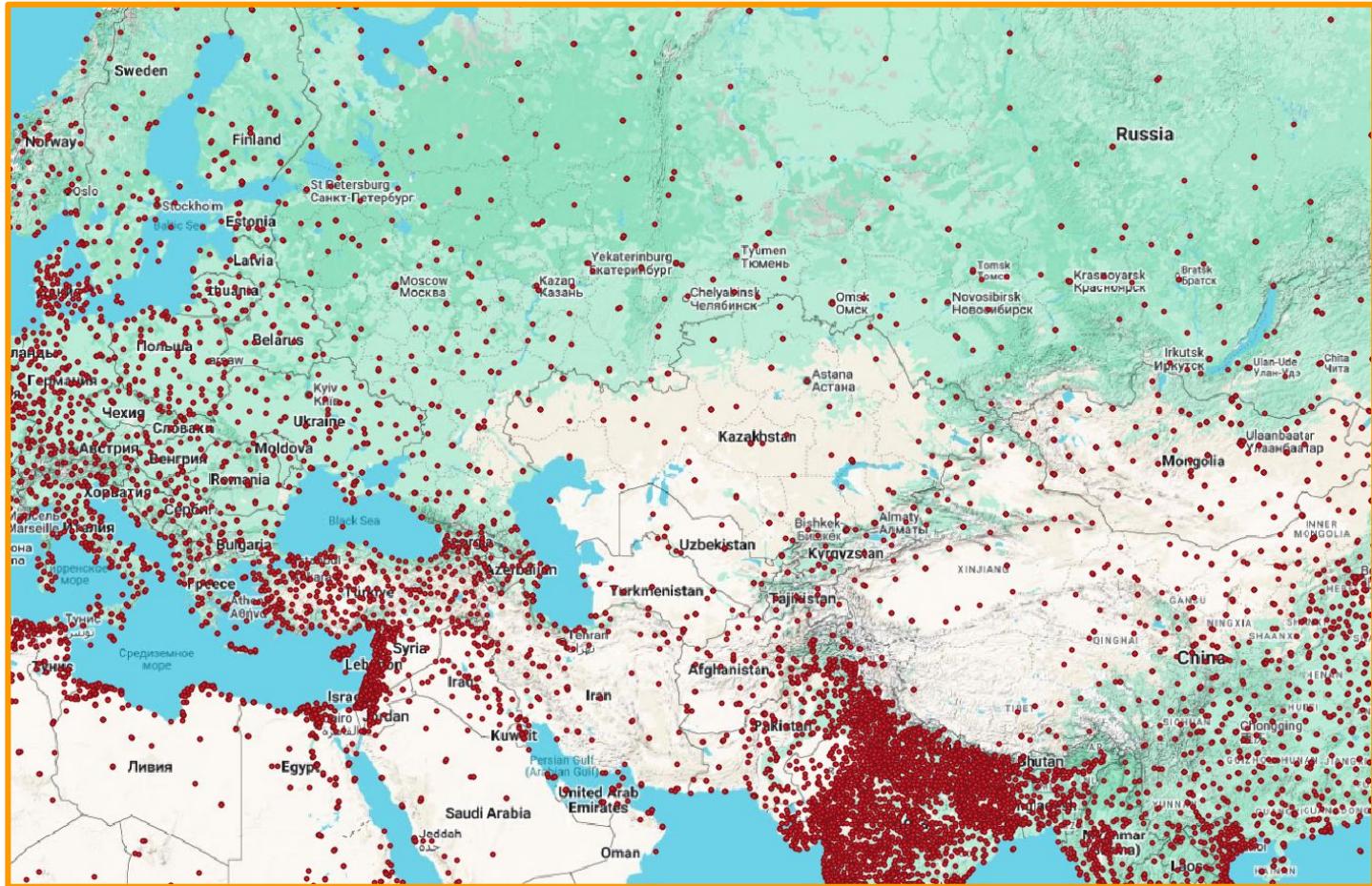
[csiropedia.csiro.au/bioclim](http://csiropedia.csiro.au/bioclim)

# World Climate Weather Stations

variables were processed from 9,000 to 60,000 weather stations

a few covariates were used to improve the coverage, including MODIS data

cross-validation was performed

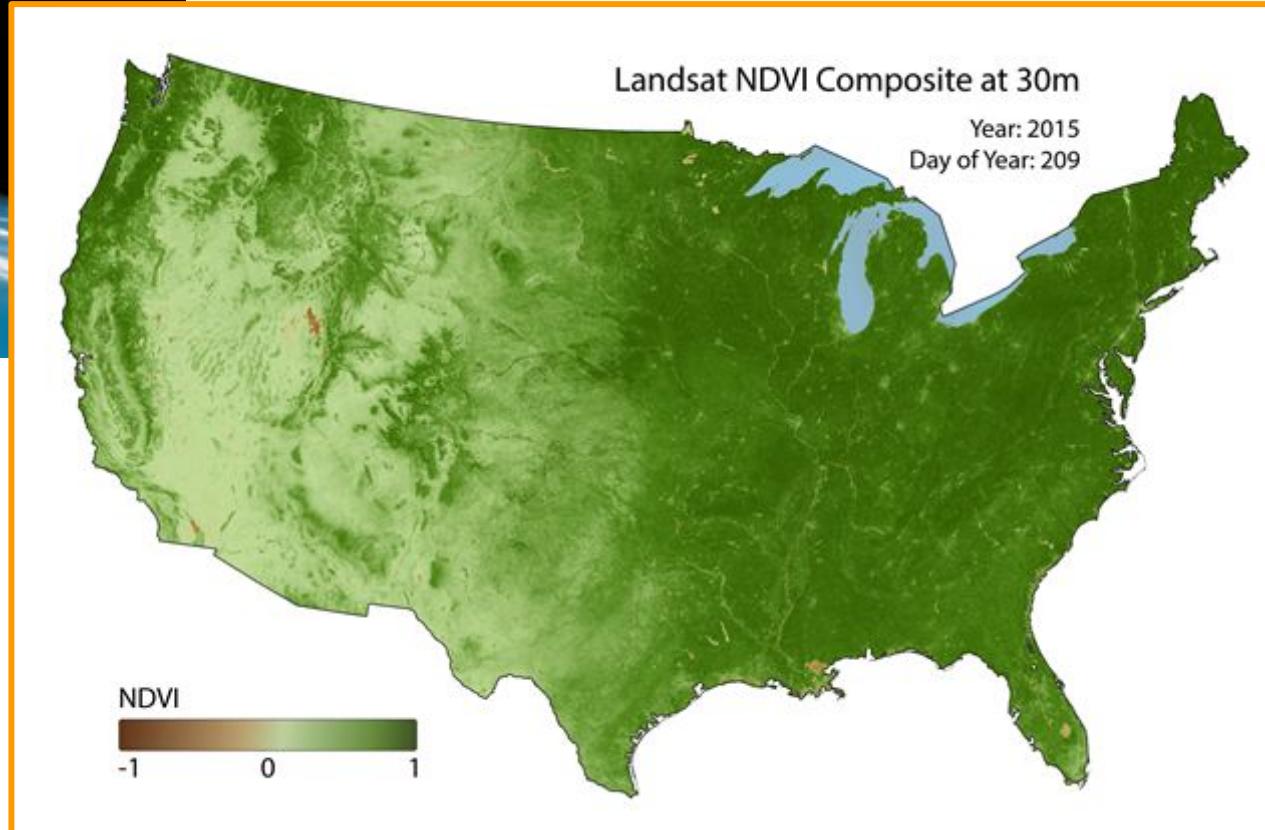




# Remote Sensing Data

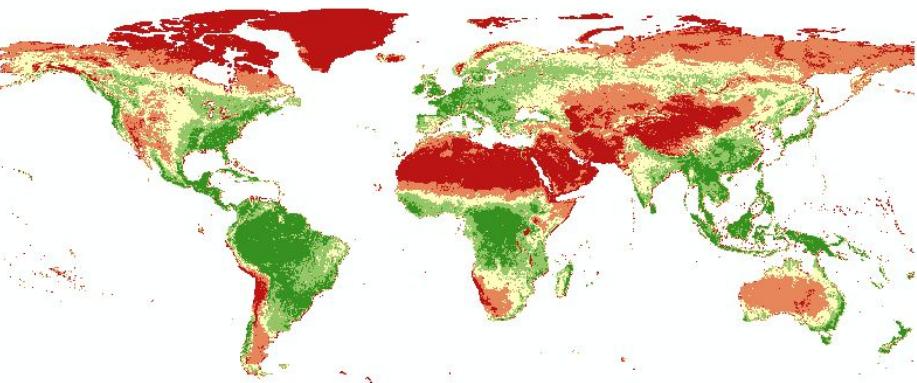
we can assess each point  
of the Earth at a certain  
resolution

such layers could be  
used to improve  
interpolated layers



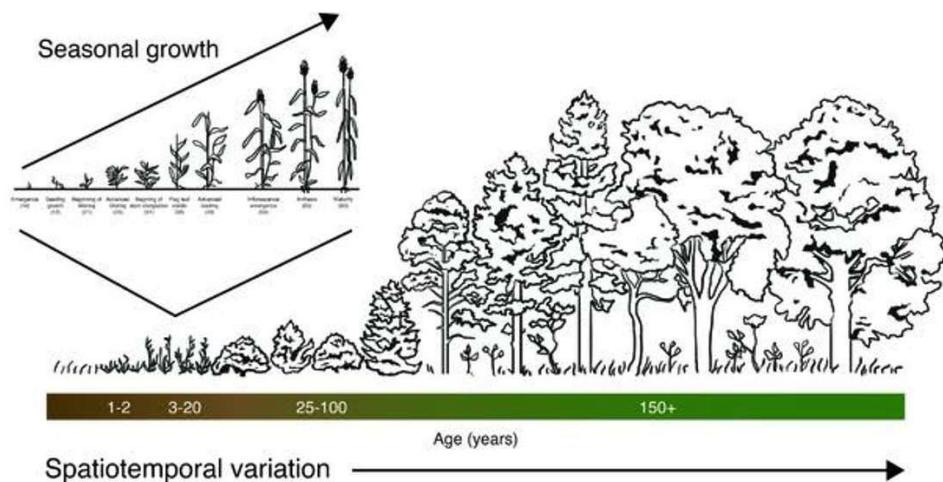
# NDVI - Normalized Difference Vegetation

Index  
$$\text{NDVI} = \frac{\text{NIR}-\text{RED}}{\text{NIR}+\text{RED}}$$
  
AVERAGE



local level - plants health

global level - ecosystems productivity



# Remote Sensing Data: Landsat and Sentinel satellites

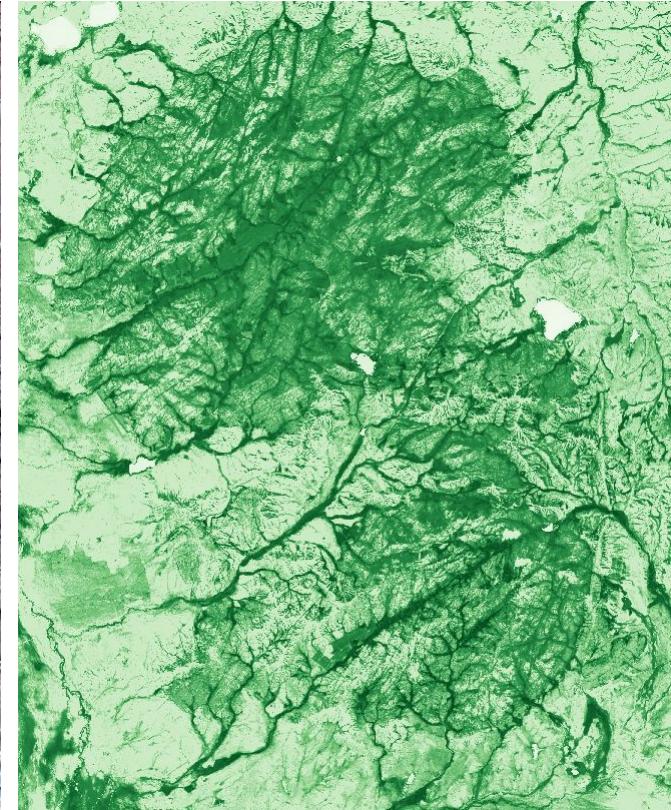
multispectral imaging of land cover

**Landsat-4** since 1982  
(30 m resolution)

**Landsat-7** since 1999,  
terminated on June 4,  
2025

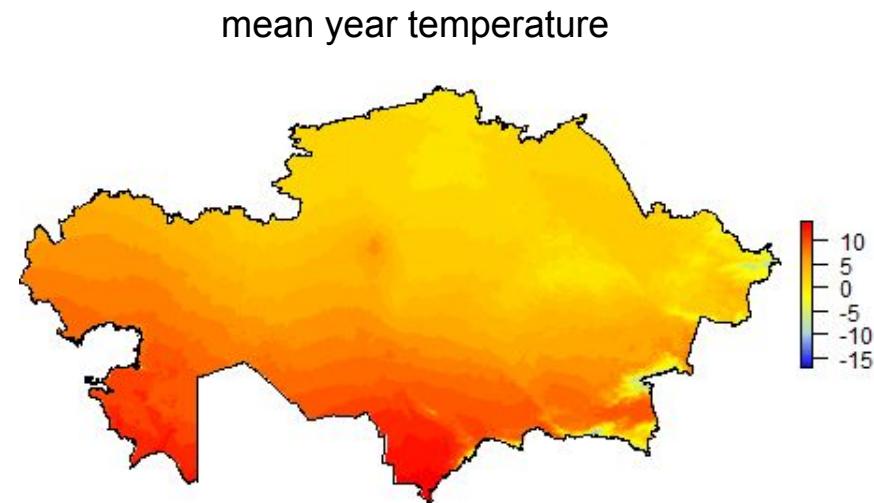
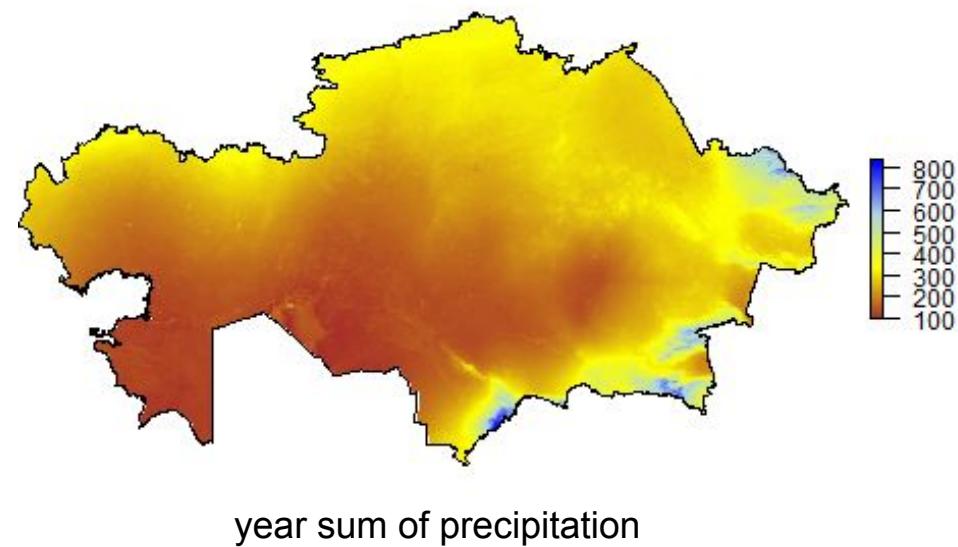
**Landsat-9** from  
the beginning of 2022

**Sentinel** since 2014  
(10 m resolution)



# WorldClim - the most used spatial dataset for SDM

at the regional scale we are expected distribution to be according to climatic conditions



at the local scale we need to take into account habitats, land use, urbanisation, etc

# SRTM - Shuttle Radar Topography Mission

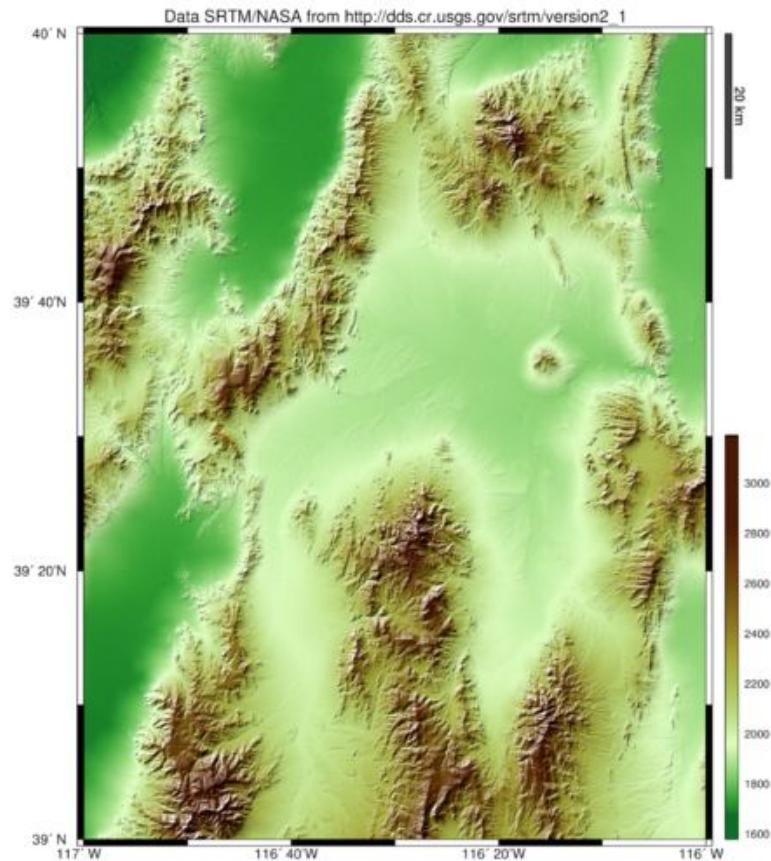
the main variable is elevation

resolution: 90m, 250m, 500m, 1km

v 1.0  
2003

v 3.0  
2019-11

v 4.1  
actual



# Habitat Types: Global Land Cover 2000



Global land cover 2000, 250m

- [Dark Green] Tree Cover, broadleaved, evergreen
- [Medium Green] Tree Cover, broadleaved, deciduous, dosed
- [Light Green] Tree Cover, broadleaved, deciduous, open
- [Brown] Tree Cover, needle-leaved, evergreen
- [Orange] Tree Cover, needle-leaved, deciduous
- [Light Blue] Tree Cover, mixed leaf type
- [Dark Blue] Tree Cover, regularly flooded, fresh water
- [Medium Blue] Tree Cover, regularly flooded, saline water
- [Grey] Mosaic: Tree cover/Other natrual vegetation
- [Black] Tree Cover, bunt
- [Orange] Shrub Cover, dosed-open, evergreen
- [Yellow] Shrub Cover, dosed-open, deciduous

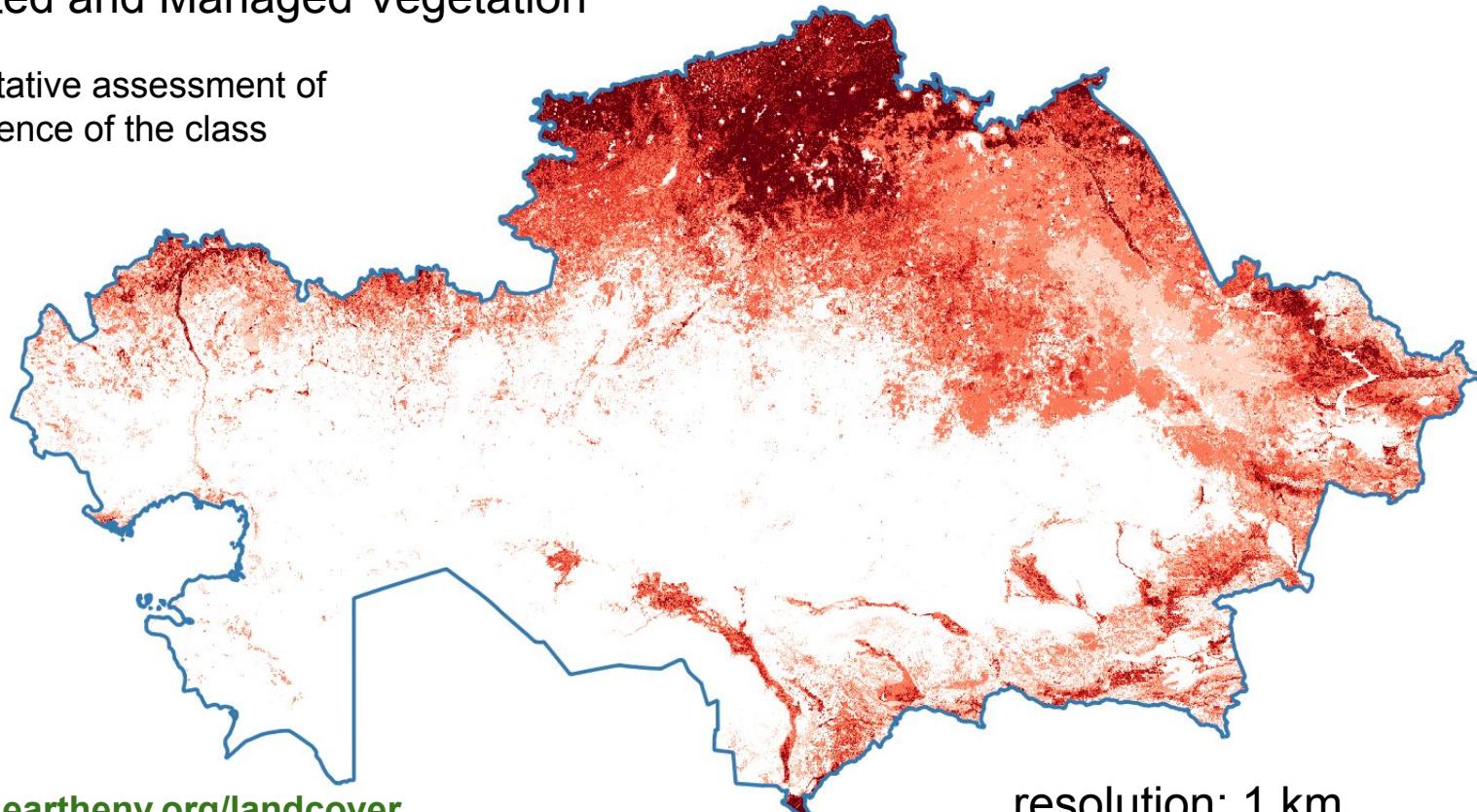
Categorical variable

[forobs.jrc.ec.europa.eu/glc2000](http://forobs.jrc.ec.europa.eu/glc2000)

# Habitat Types: Global 1-km Consensus Land Cover

## Cultivated and Managed Vegetation

quantitative assessment of  
prevalence of the class

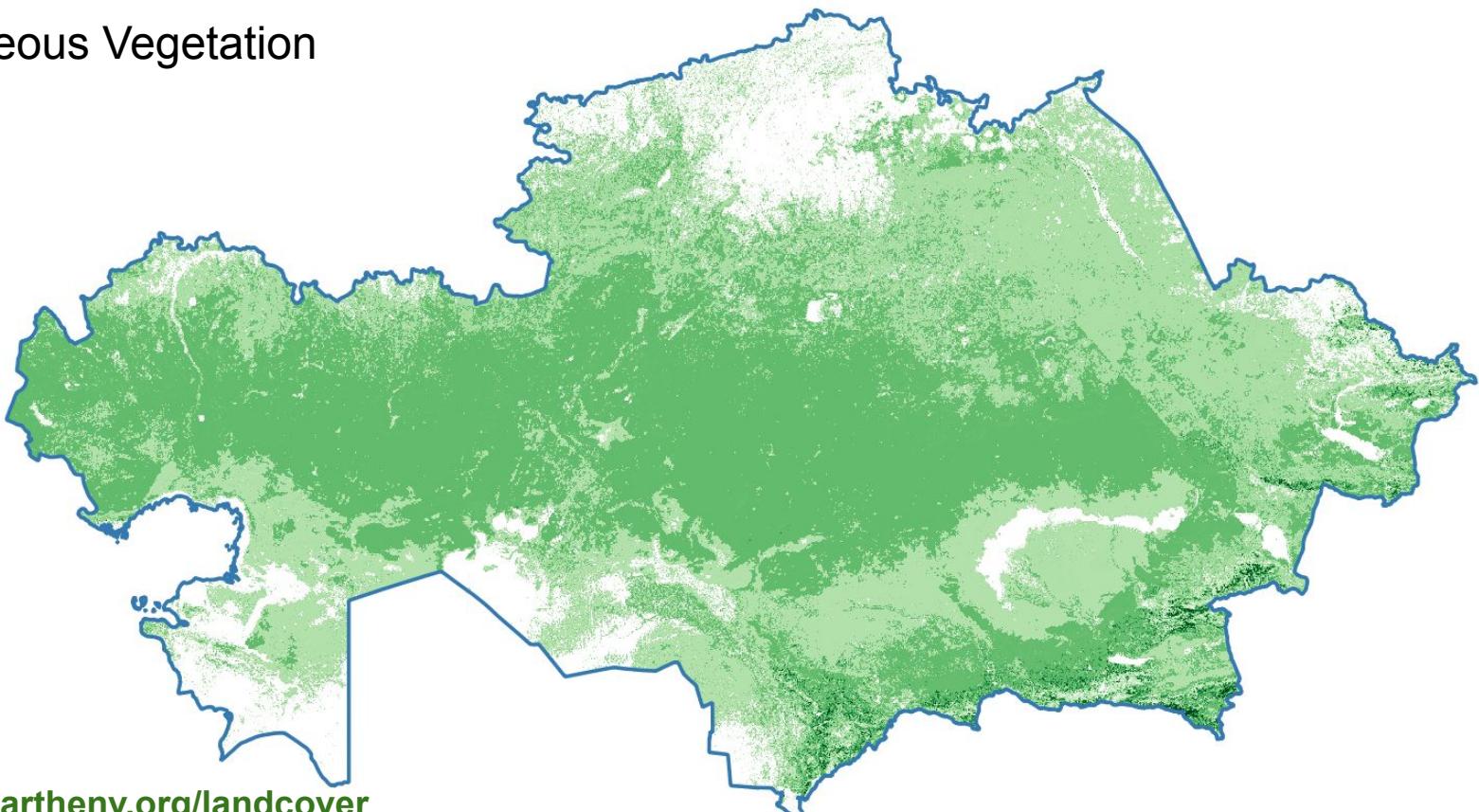


<https://www.earthenv.org/landcover>

resolution: 1 km

# Habitat Types: Global 1-km Consensus Land Cover

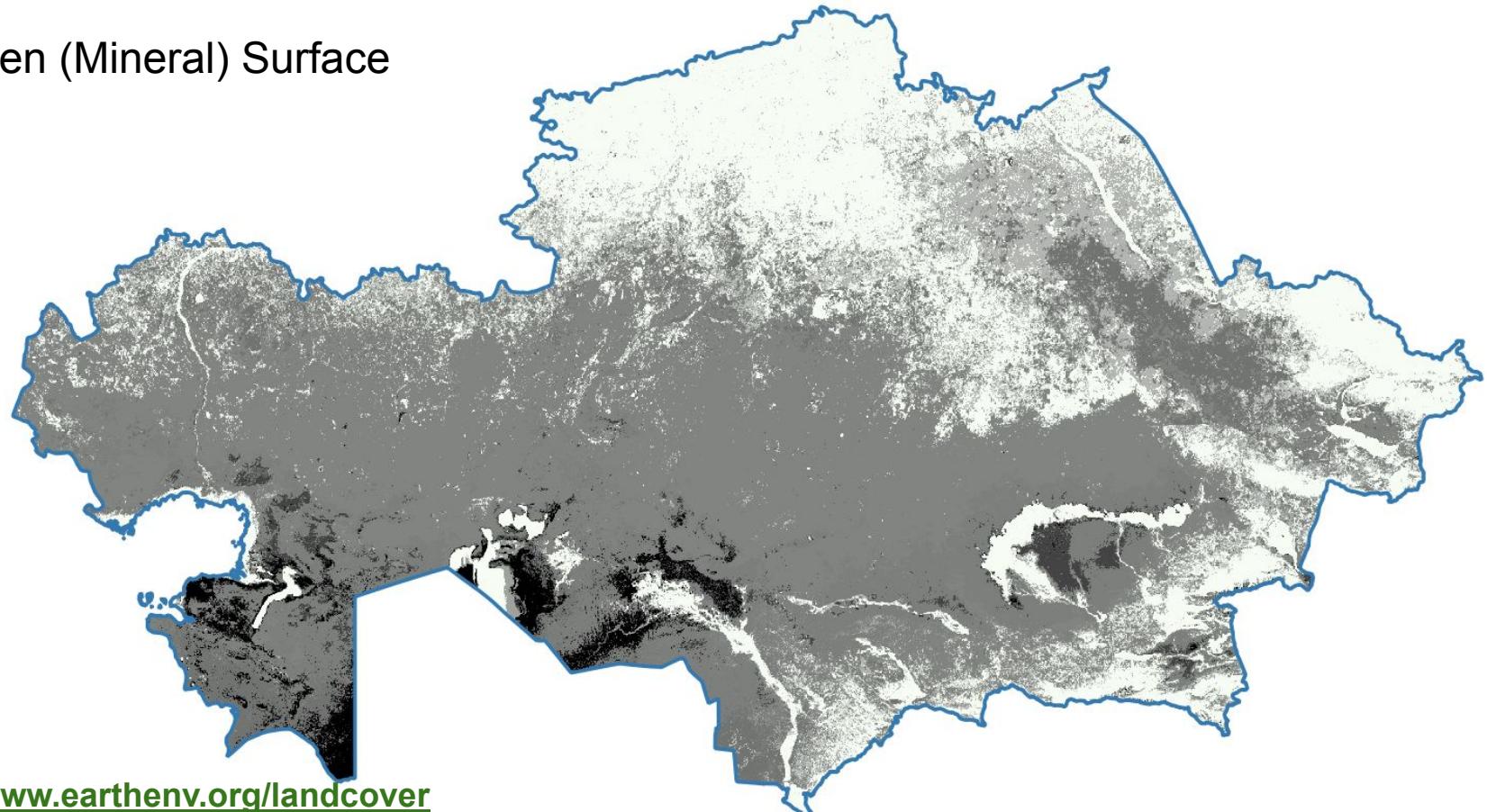
Herbaceous Vegetation



<https://www.earthenv.org/landcover>

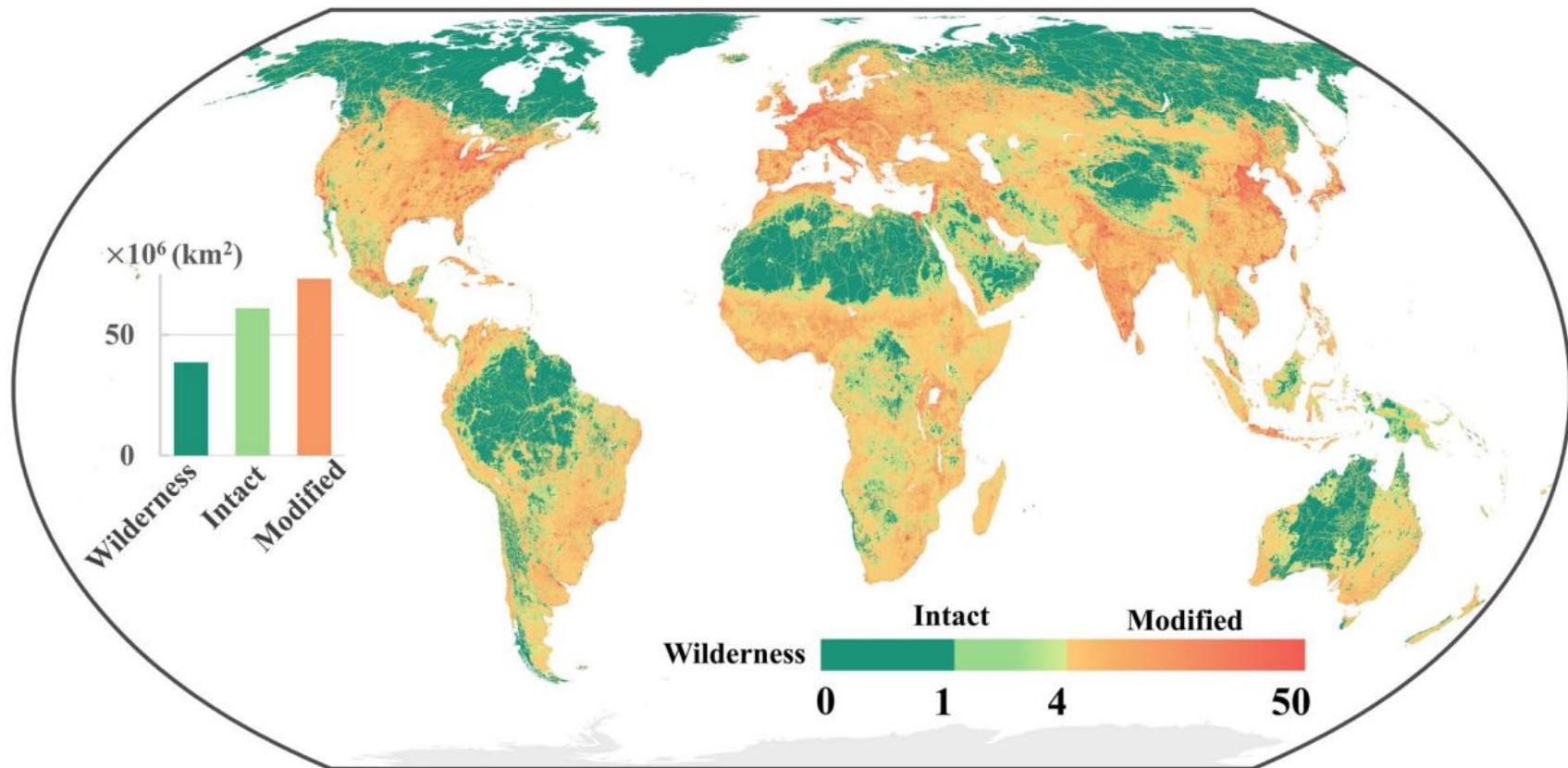
# Habitat Types: Global 1-km Consensus Land Cover

Barren (Mineral) Surface



<https://www.earthenv.org/landcover>

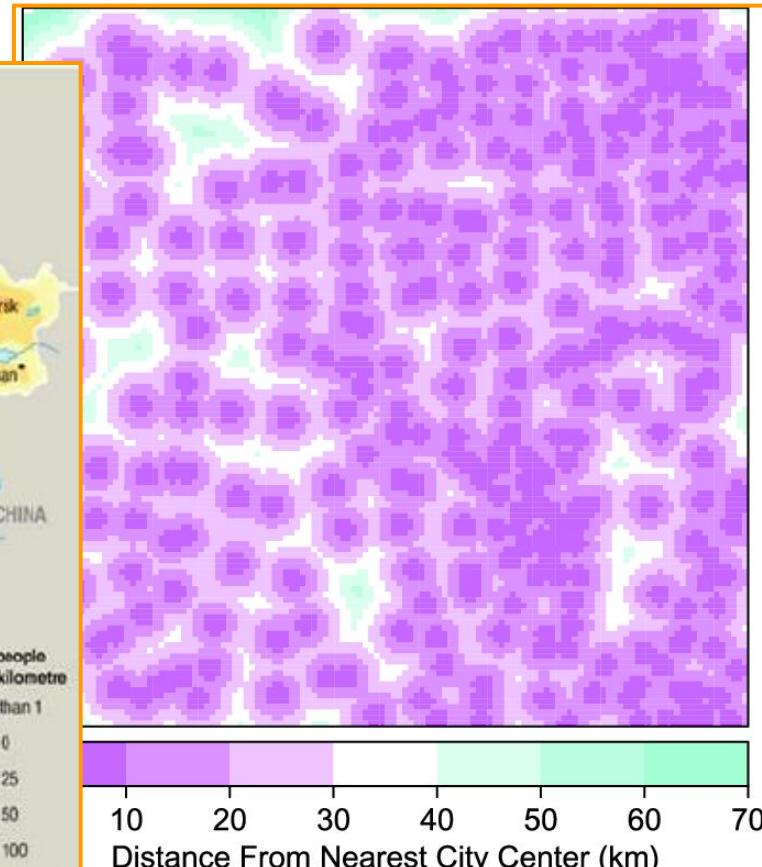
# Human Footprint Coverage



# Anthropogenic Influence and Infrastructure

human population density

## Population density



[10.1175/WCAS-D-12-00040.1](https://www.researchgate.net/figure/Population-density-in-Central-Asia_fig1_246547400)

# Soil Grid 250

bulk density

cation exchange capacity

volumetric fraction of coarse fragments

proportion of sand particles

proportion of silt particles

proportion of clay particles

pH

soil organic carbon content

total nitrogen

**horizons:** 0-5 cm

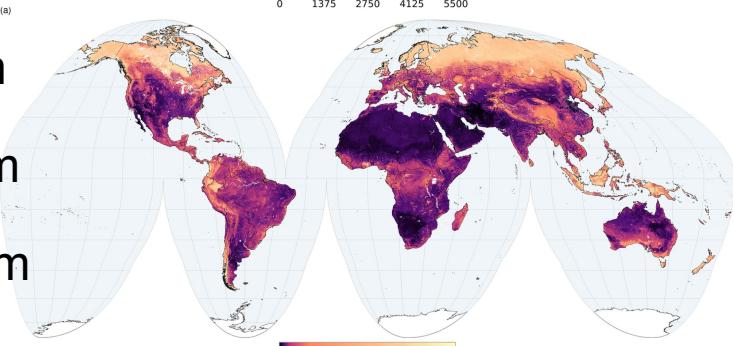
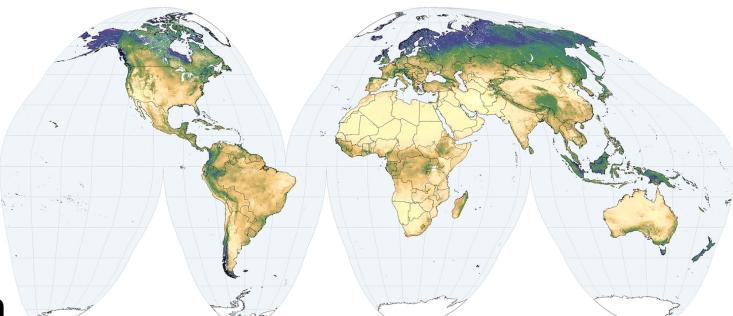
5-15 cm

15-30 cm

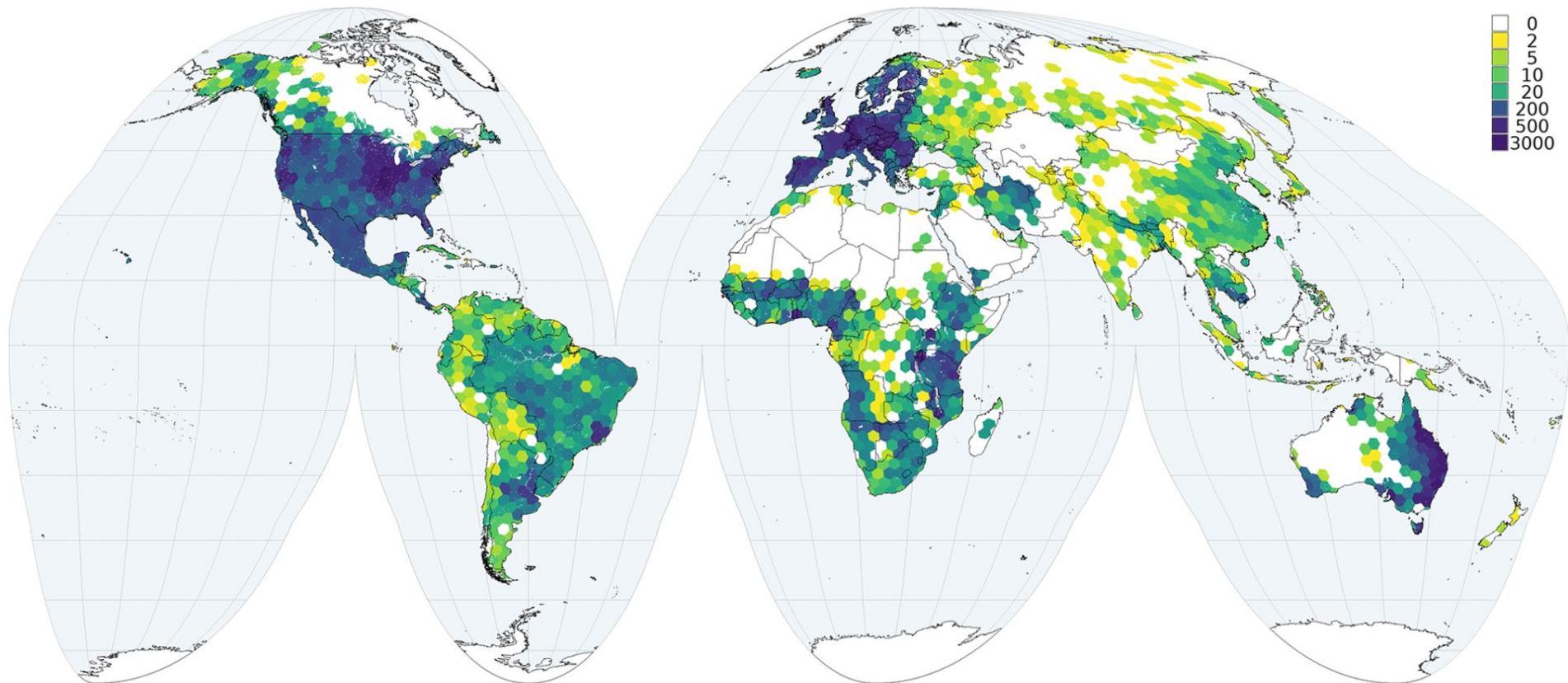
30-60 cm

60-100 cm

100-200 cm

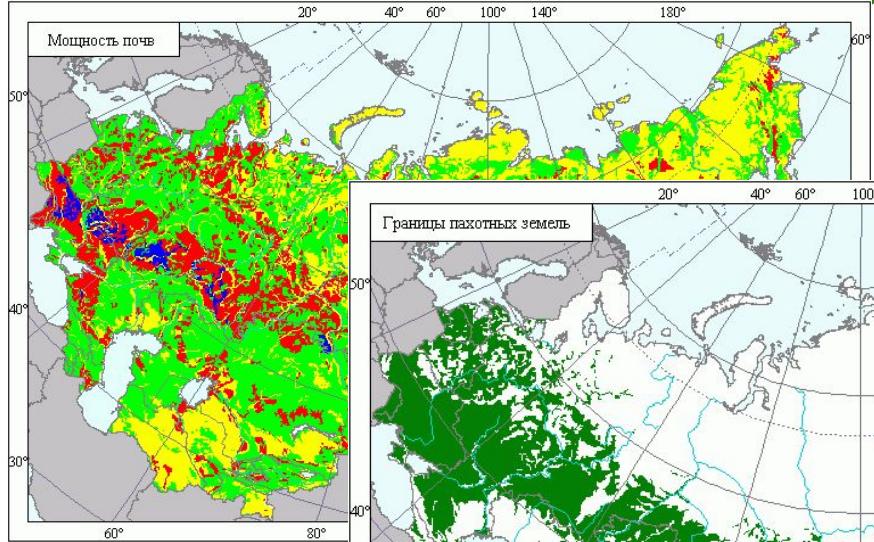


# Soil Grid 250 - input data density

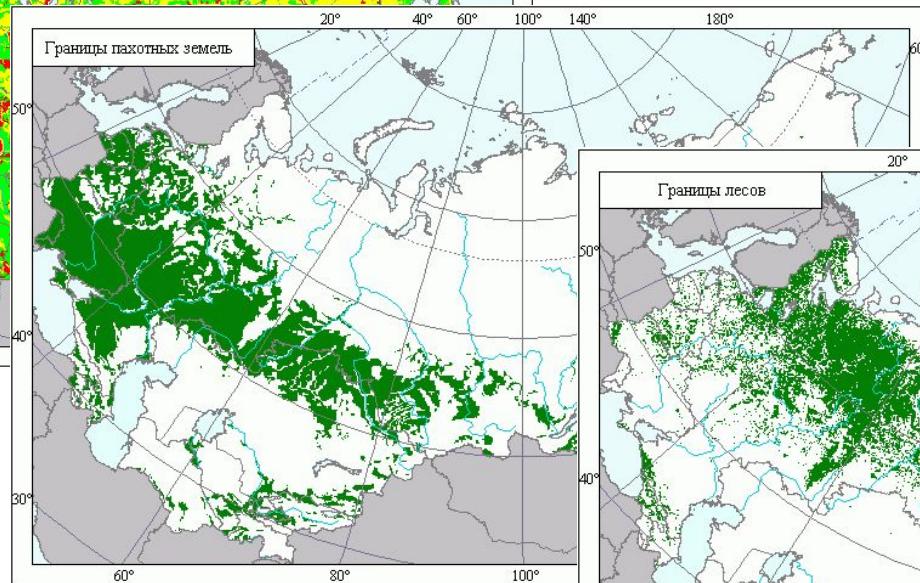


density of observations for soil pH (water)

# Agroecological atlas of Russia and neighbouring countries



Soil thickness  
quantitative discrete variable



Arable lands  
qualitative binary variable



# GADM - Global ADMInistrative database

## Download GADM data (version 4.1)

Country

Kazakhstan

Geopackage

Shapefile

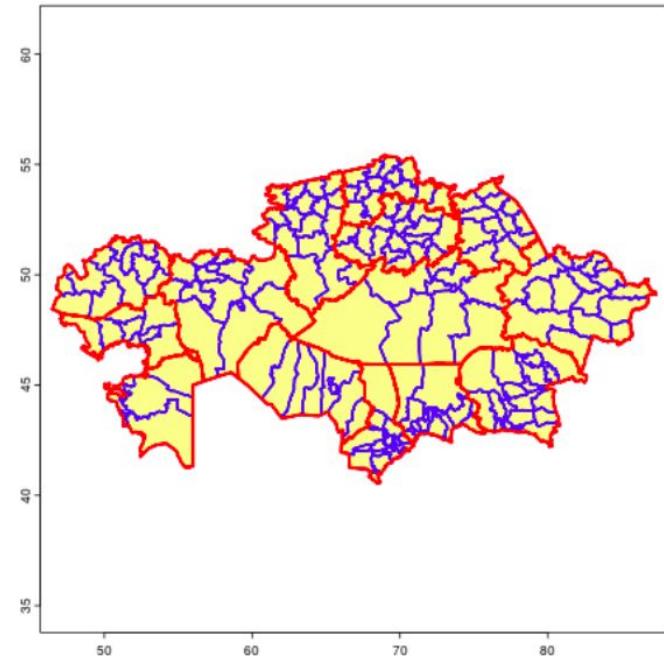
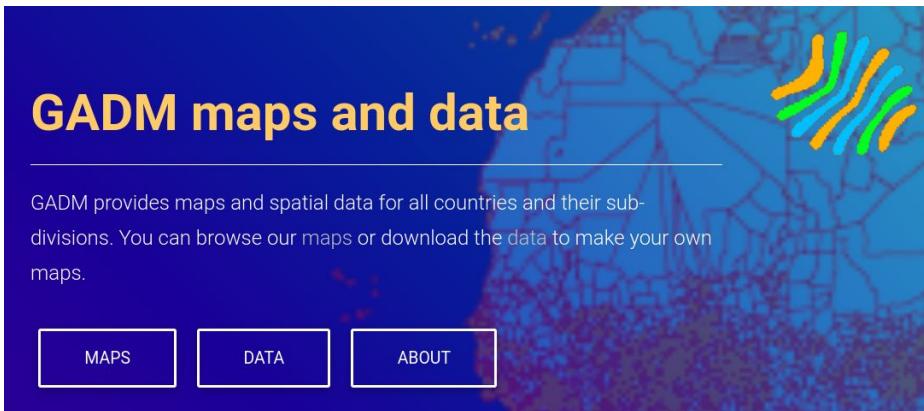
GeoJSON: [level-0](#), [level1](#), [level2](#)

KMZ: [level-0](#), [level1](#), [level2](#)

## GADM maps and data

GADM provides maps and spatial data for all countries and their subdivisions. You can browse our maps or download the data to make your own maps.

MAPS DATA ABOUT



# Cartographic Projections

**WorldClim, SRTM, Global 1-km Consensus Land Cover**

WGS84 (EPSG: 4326) - World Geographic System

**SoilGrids250**

Homolosine Good projection

**Human Footprint**

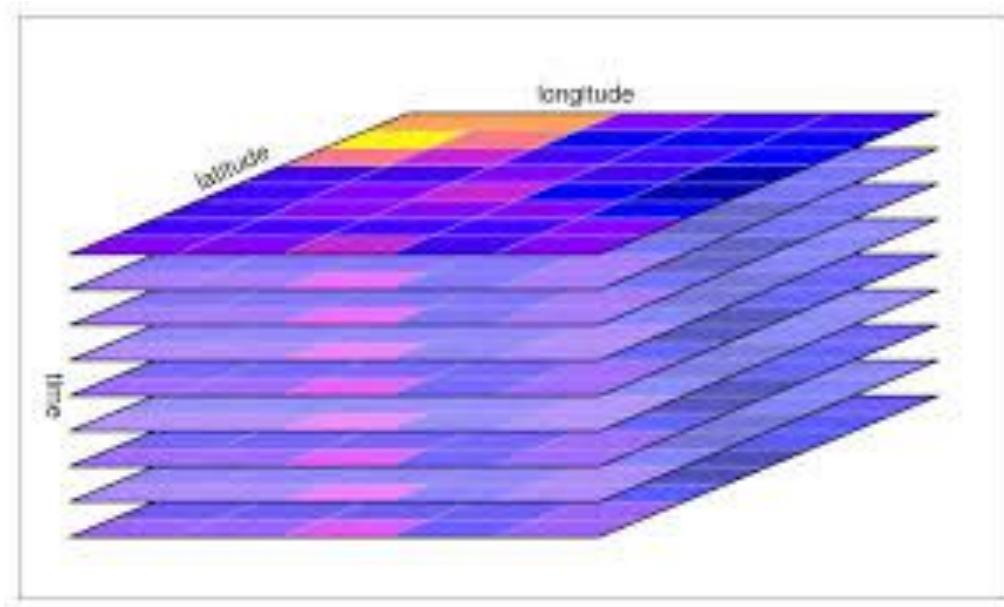
Mollweide equal-area projection (homalographic)

**Landsat, Sentinel**

Universal Transverse Mercator (UTM 43N - EPSG: 32643)

## Procedure for processing raster layers

1. Transform to the same cartographic projection
2. Resample to the same resolution  
(from coarser to finer)
3. Crop by the borders of the territory of interest
4. Combine into a stack  
(multi-layer raster)



**Thank you for your attention !**

**Спасибо за внимание !**

**Назар аударғаныңызға рақмет !**