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World Urban Forum

TE25 – INNOVATIONS IN MAPPING THE DIVERSITY OF URBAN SLUMS WITH FREE OPEN-SOURCE SOLUTIONS

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ULB UNIVERSITÉ LIBRE DE BRUXELLES

ITC UNIVERSITY OF TWENTE.

UNIVERSITÉ DE NAMUR

Welcome!

Training event organized in the framework of research projects

SLUMAP

http://slumap.ulb.be

REACT

http://react.ulb.be

Funded by

Belgian Science Policy Office

belspo

Trainers

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Monika Kuffer
Assistant Professor
ITC (University of Twente)

Assistant Prof. Catherine Linard

Department of Geography

University of Namur

Programme 9:00 – 12:00

1. Introduction (35 min.)

- Short introduction round : getting to know the participants
- Overview of the SLUMAP research project
- Short introduction to the process of mapping deprived areas with satellite images and machine learning
- Additional datasets
- Getting started with QGIS

2. Hands-on training using own laptop (120 min.)

- Exercise 1: Producing slum indicators in administrative units and creating maps
- Exercise 2: Enriching slum characterization with open data from other sources (e.g., OpenStreetMap)
- Exercise 3: Mapping population at risk of flooding in slums with open datasets (e.g., WorldPop, SRTM)

3. Discussion and conclusions (25 min.)

- Potential and limitations of the results
- Participants' feedback

Getting to know the participants

Who is in the room?

What are your expectations?

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SLUMAP – Remote Sensing for Slum Mapping and Characterization in sub-Saharan African Cities

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SLUMAP

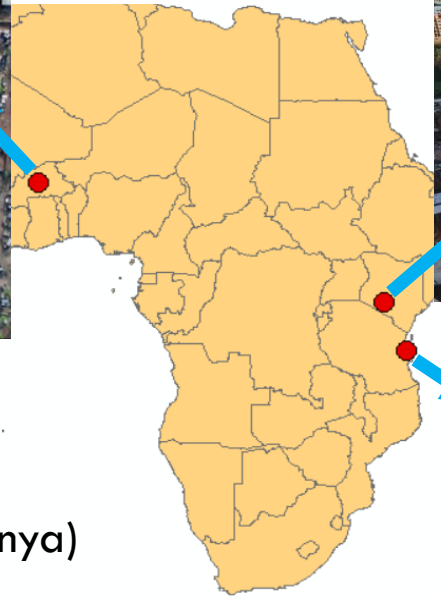
Rationale

- About 1 billion people are slum dwellers (30% of urban population)
- In sub-Saharan Africa, slums keep growing
- Spatial data on slums are needed at different levels
  - International level : SDG 11 + New Urban Agenda (UN)
    '*By 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums*'
  - Local level: City planning and slum upgrading programs
  - Community level: Local communities and NGOs
- But data often incomplete, outdated, and/or inconsistent

  ⇨ Slum dwellers are excluded from the benefits of urbanization
- Assessment of the potential and limitations of EO to tackle this issue

Case studies

Source: IRD



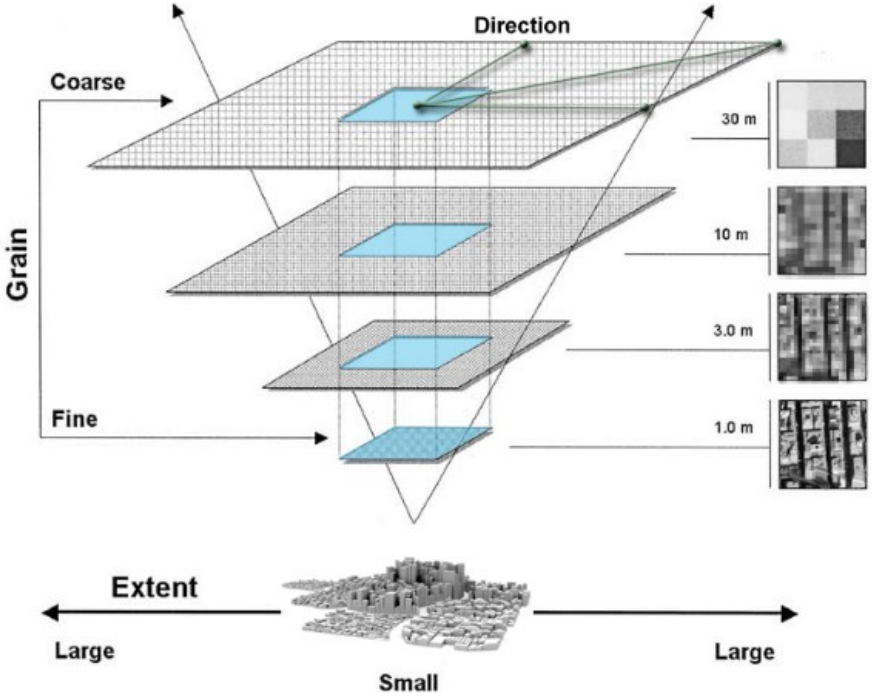
Source: Johnny Miller – http://unequalscenes.com

Source: Johnny Miller – http://unequalscenes.com

+ 1 secondary city (Kisumu, Kenya)

Main objectives

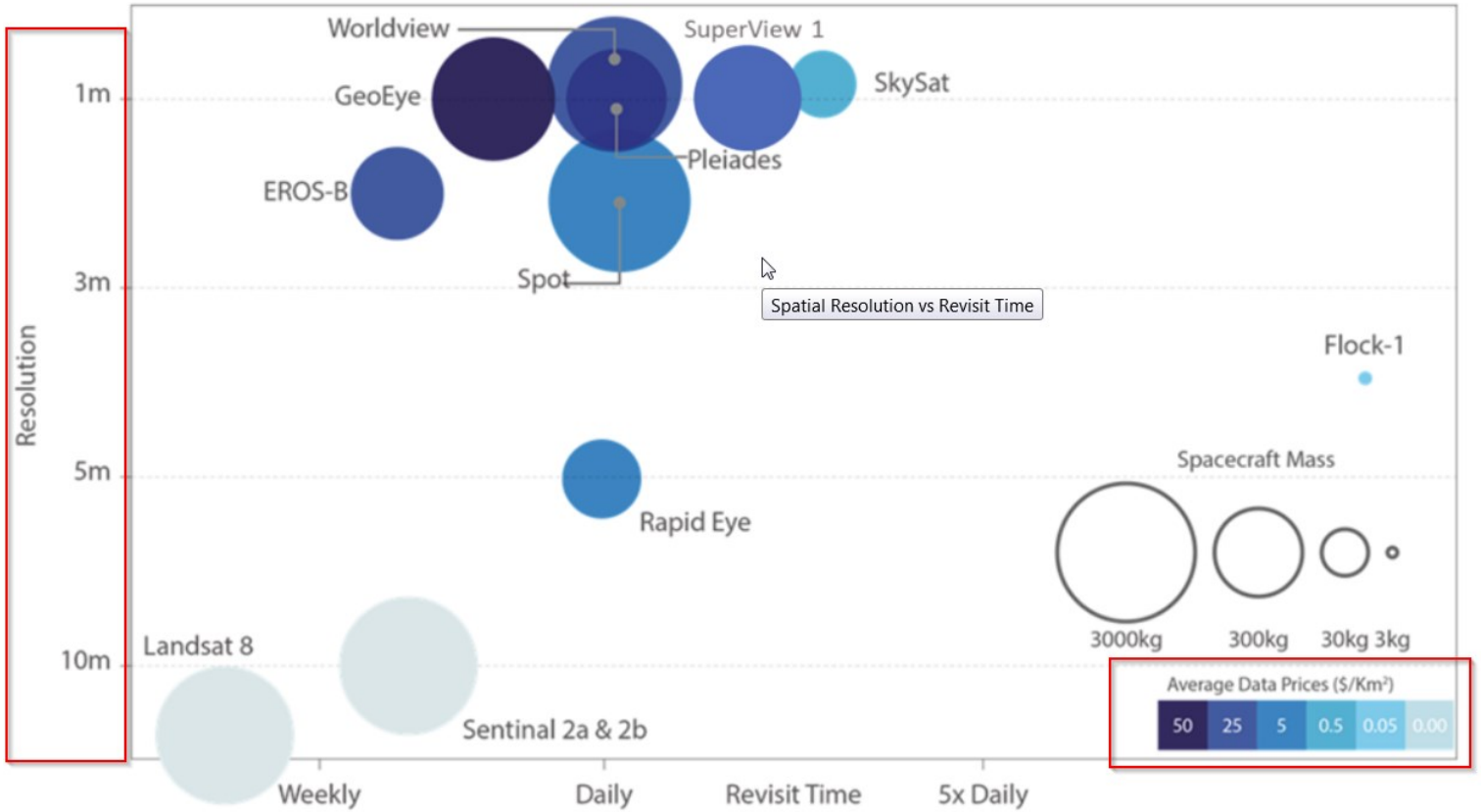
Free and
Open
Source
Software



Source : Wang, Kuffer and Pfeffer, 2018

- Developing methods for
  - producing citywide slum maps
  - characterizing slums
- Assessing the contribution of imagery with different spatial and spectral resolutions
- Evaluating their cost-efficiency
- Designing SoA scalable methods based on FOSS
- Assessing their transferability across several case studies
- Formulating recommendations on the most suitable methods, tools and data

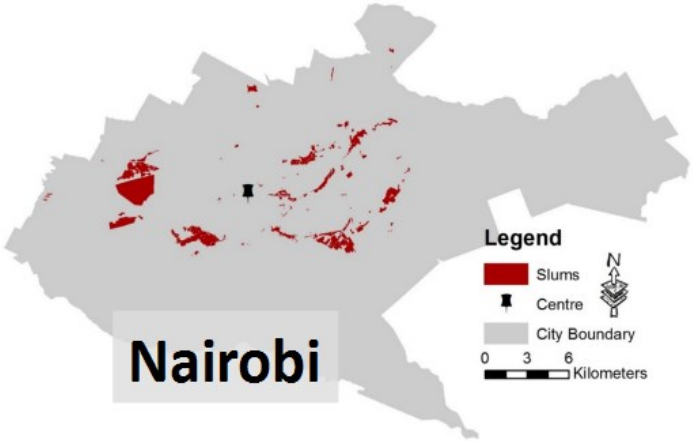
Why a cost-efficiency analysis?



(Source: Satellite Applications Catapult 2017, adapted from EO21 Project)

Citywide slum mapping

- Aim: Producing a delineation of slum-like areas in a city, with (semi-) automated methods
- Comparison of results obtained with different types of images



Slum environment characterization

- Aim: Focus on slums - Producing a set of indicators within slum-like areas, with (semi-) automated methods

  (e.g.: roof materials, built-up density, distance between structures, road network …)

  Requires images with a higher level of detail ('higher resolution'), more expensive

- Comparison of results obtained with different types of images

Framework / Compendium

- Outcomes summarized in compendium
- Most suitable scalable and transferable methods for mapping slums in sub-Saharan Africa
- Taking into account cost-benefits and user requirements

⇒ Open-access tool for science-based slum policy-making

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MAPPING DEPRIVED AREAS WITH SATELLITE IMAGES AND MACHINE LEARNING (A VERY BRIEF OVERVIEW)

Very-high resolution satellite image

Projection: WGS 1984 / UTM zone 30N (EPSG: 32630) © DigitalGlobe, Inc. All Rights Reserved

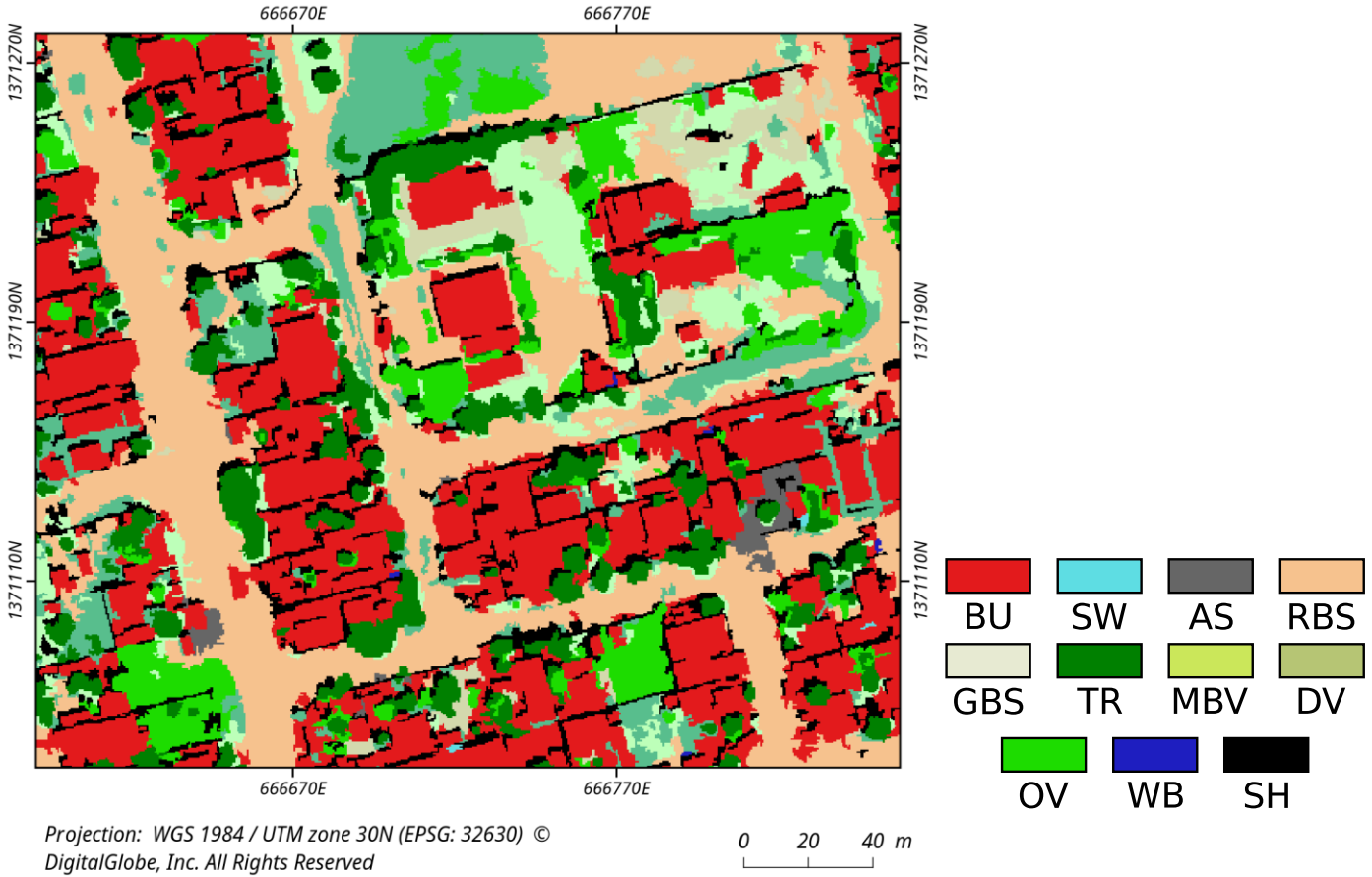
0 20 40 m

Segmentation

- Group "similar" pixels to form homogeneous segments

Land cover classification

- Statistics computed for each segment
- Sample used for training the Machine Learning classifier (Random Forest)
- Classification of all the objects



City blocks from OSM

WORKFLOW

Image

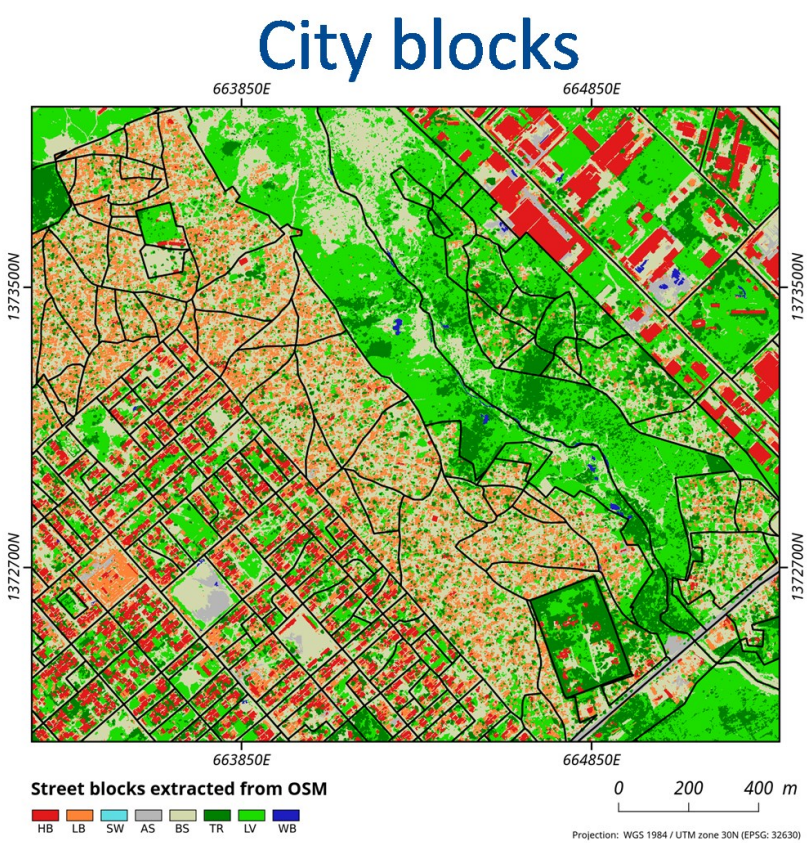
↓

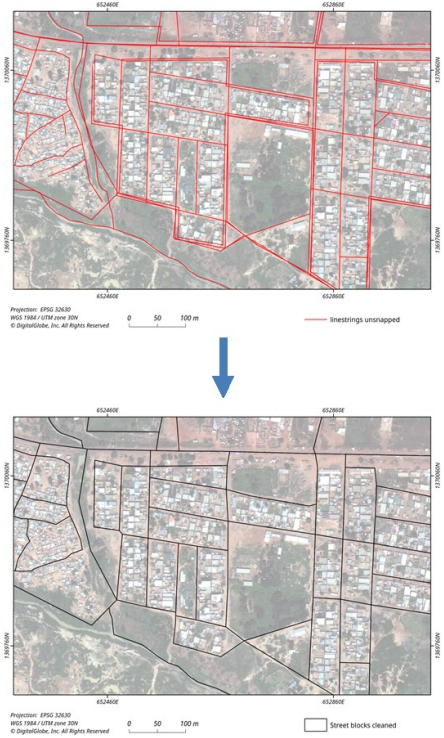
Land cover map (OBIA)

↓

Land use map at city block level

MAUPP





- OSM
- GIS processing

Land use classification

Land use

WORKFLOW

Image

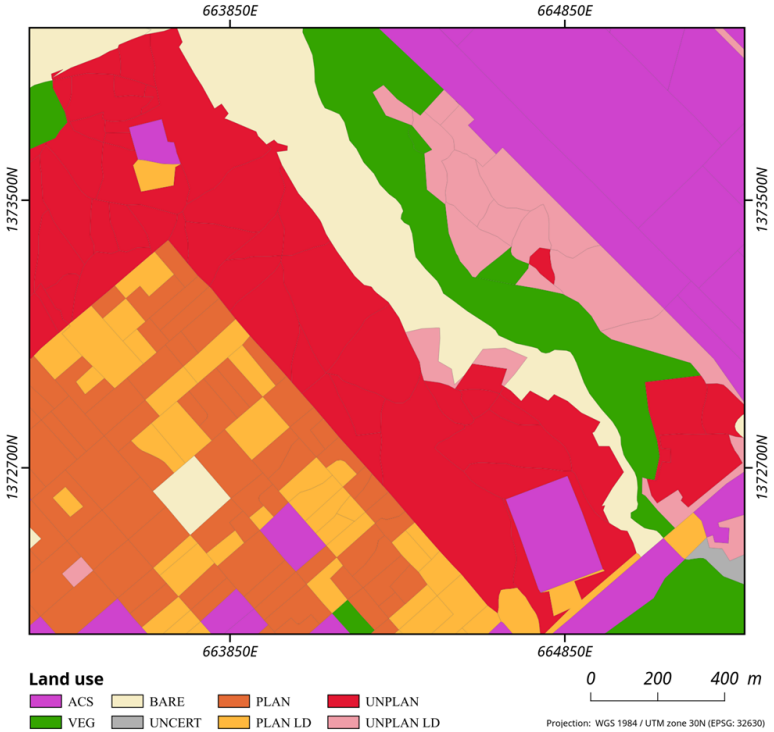
↓

Land cover map (OBIA)

↓

Land use map at city block level

MAUPP

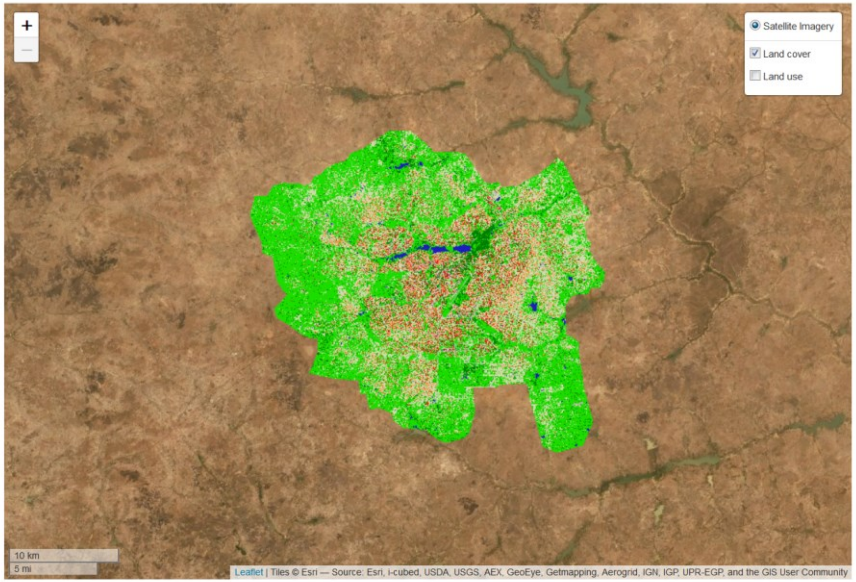


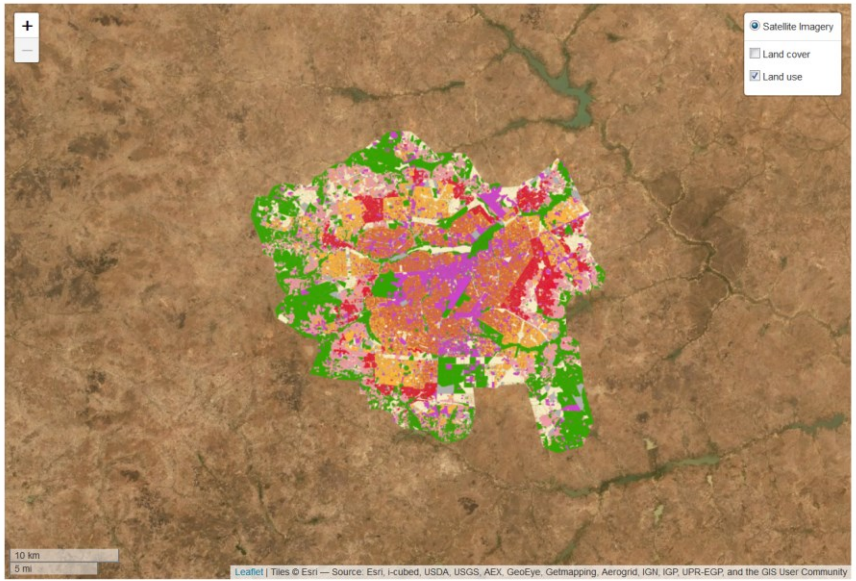
- Statistics computed for each city block
- Sample used for training the Machine Learning classifier (Random Forest)
- Classification of all the city blocks

Grippa, Taïs, Stefanos Georganos, Soukaina Zarougui, Pauline Bognounou, Eric Diboulo, Yann Forget, Moritz Lennert, Sabine Vanhuysse, Nicholus Mboga, and Eléonore Wolff. 2018. "Mapping Urban Land Use at Street Block Level Using OpenStreetMap, Remote Sensing Data, and Spatial Metrics." *ISPRS International Journal of Geo-Information* 7 (7): 246. https://doi.org/10.3390/ijgi7070246.

View and download LC & LU

https://maupp.ulb.ac.be/page/grippa2018/





Land cover

- High buildings
- Medium buildings
- Low vegetation
- Trees
- Bare soils
- Asphalt surfaces
- Water bodies
- Swimming pools

Land use

- Planned residential
- Planned residential (low density)
- Bare soils
- Non-residential
- Unplanned residential
- Unplanned residential (low density)
- Vegetation
- Uncertain

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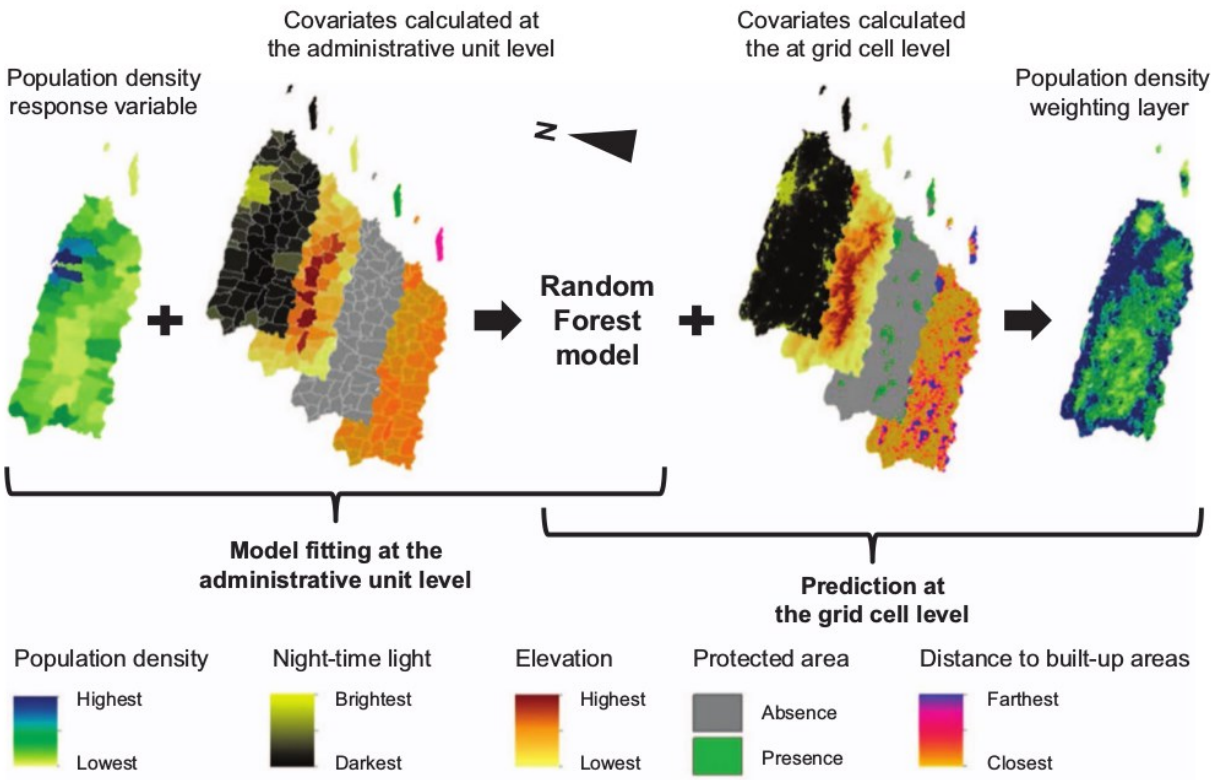
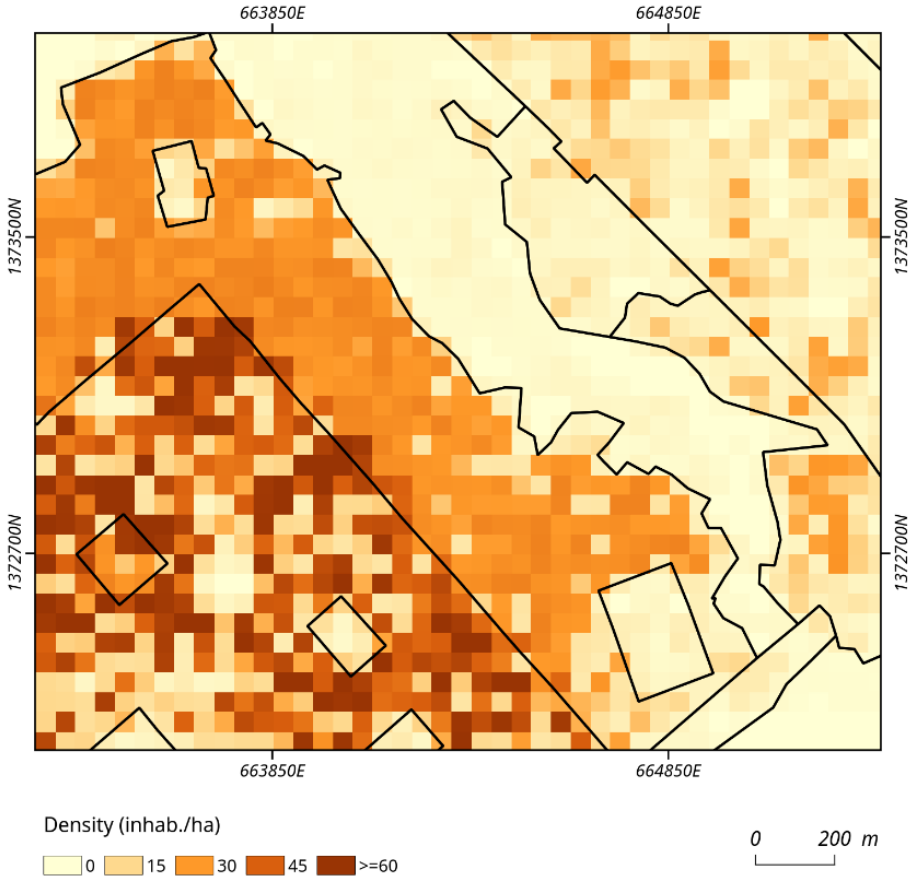
Population density modelling



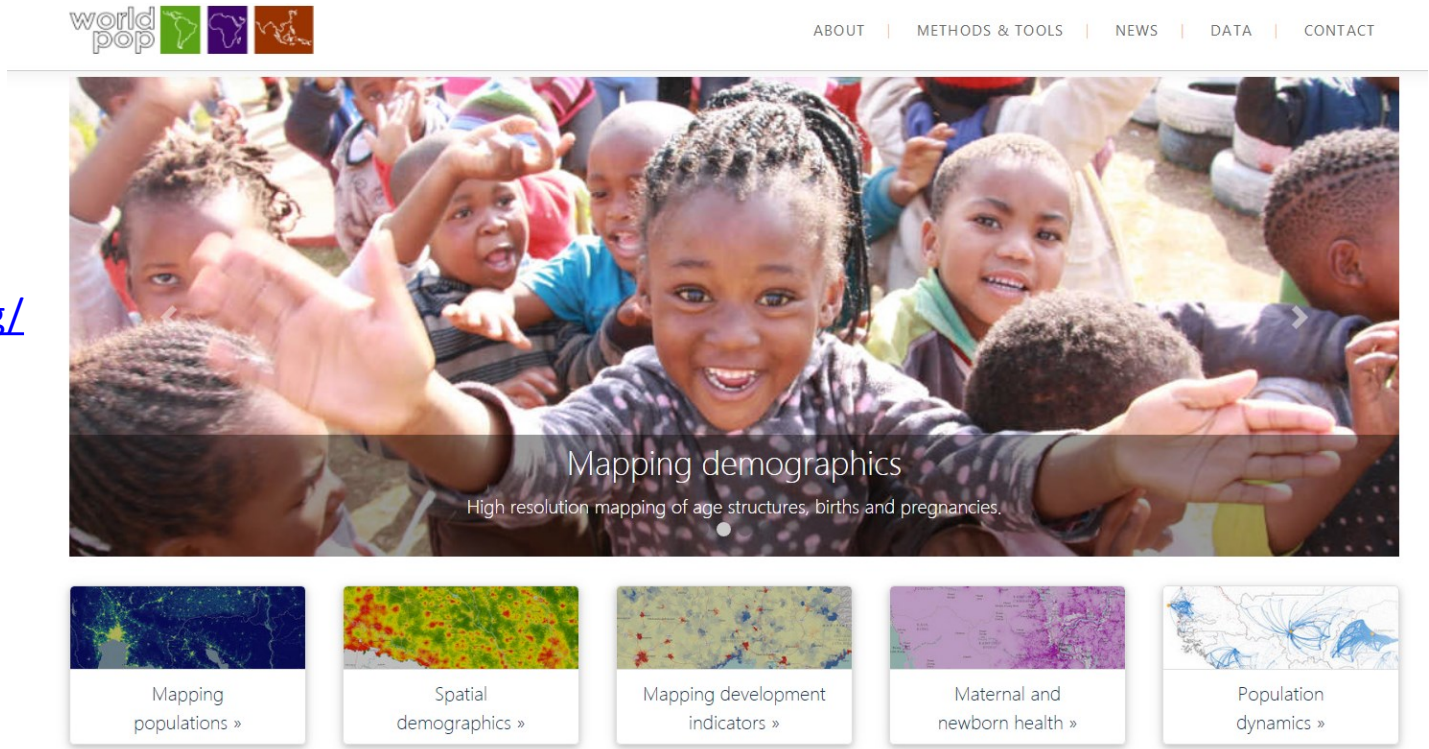
Source: Sorichetta, Alessandro, Graeme M. Hornby, Forrest R. Stevens, Andrea E. Gaughan, Catherine Linard, and Andrew J. Tatem. 2015. "High-Resolution Gridded Population Datasets for Latin America and the Caribbean in 2010, 2015, and 2020." *Scientific Data* 2 (September): 150045. doi:10.1038/sdata.2015.45.

Population density



Download population data

https://www.worldpop.org/



Dakar https://zenodo.org/record/2525672#.Xj1AfPZFwjg

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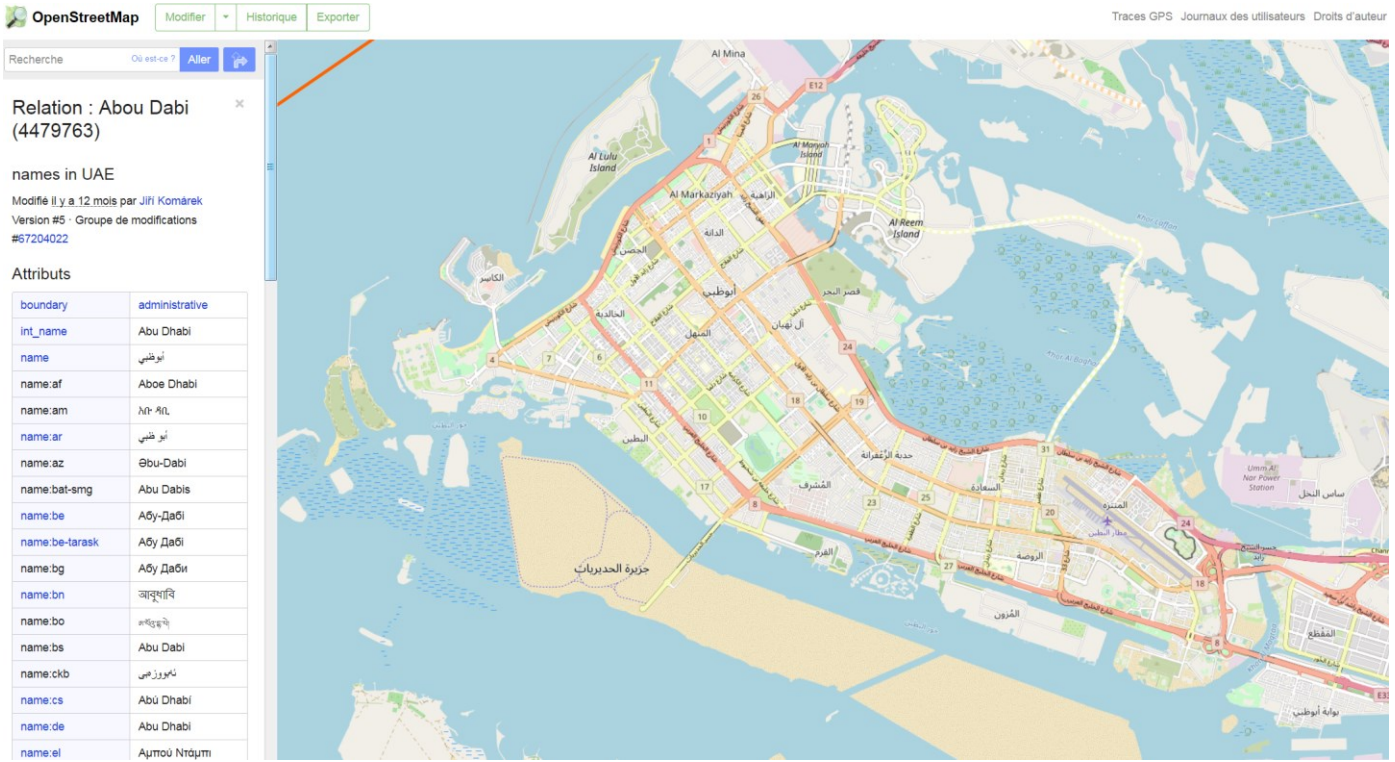
ADDITIONAL DATASETS

Download OpenStreetMap data



http://download.geofabrik.de/

Download administrative boundaries

GADM Maps Data About

Download GADM data (version 3.6)

Country

United Arab Emirates

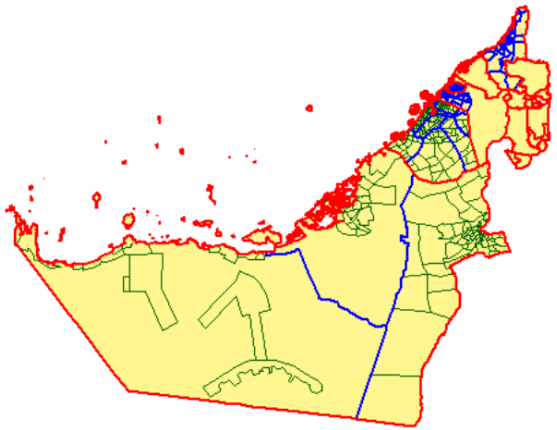
Geopackage

Shapefile

R (sp): level-0, level1, level2, level3

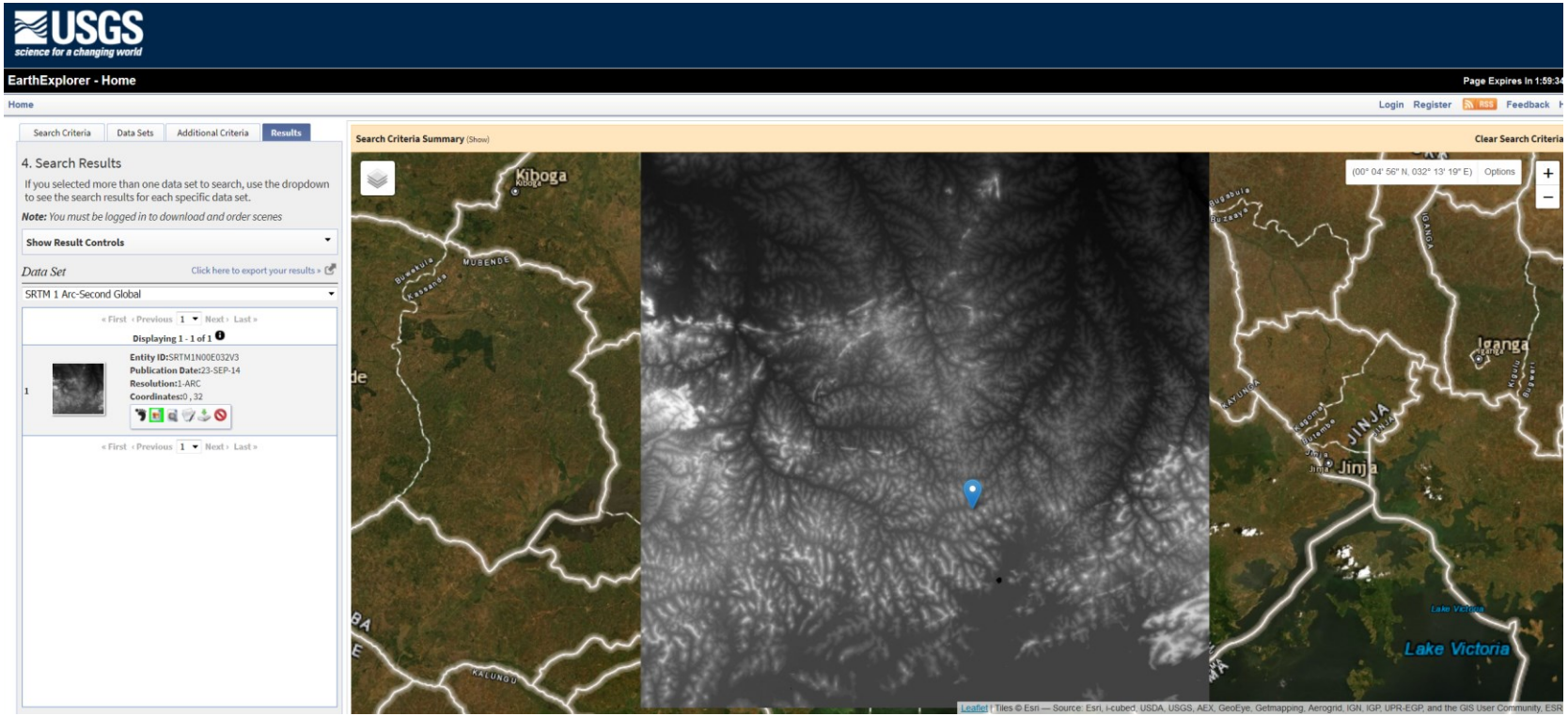
R (sf): level-0, level1, level2, level3

KMZ: level-0, level1, level2, level3



https://gadm.org/download_country_v3.html

Download elevation data (SRTM)



https://earthexplorer.usgs.gov/

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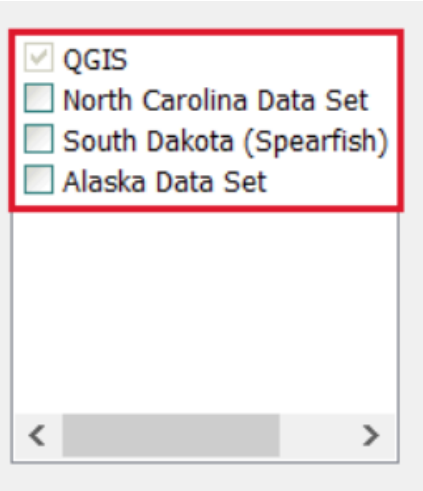
GETTING STARTED WITH QGIS

Install QGIS (v3.4.x Madeira)

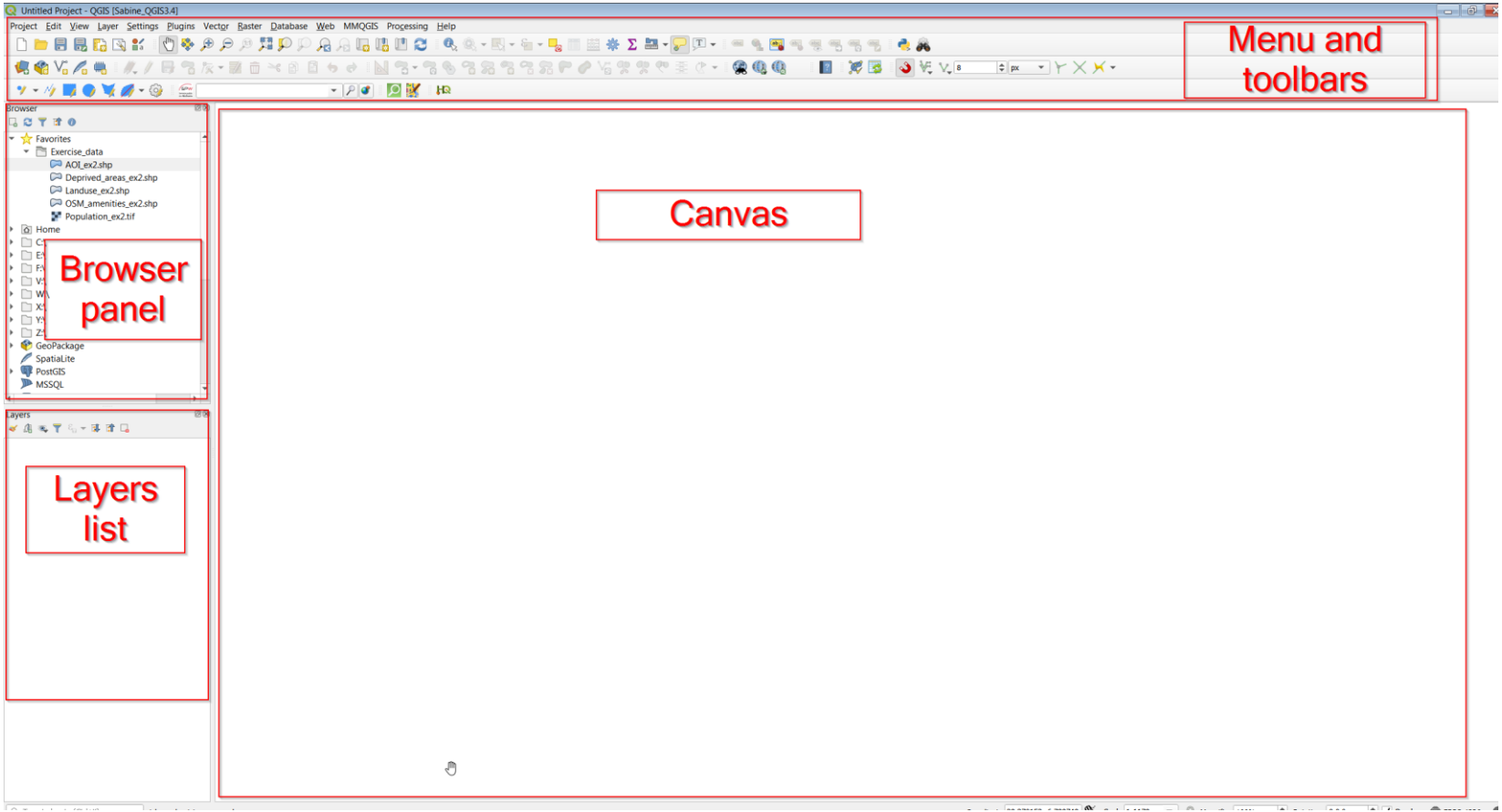
1. If not yet installed: Copy the appropriate installation file from USB flash drive to laptop (see folder 'QGIS_installation_files')

2. Install QGIS : Follow the instructions in the Setup Wizard

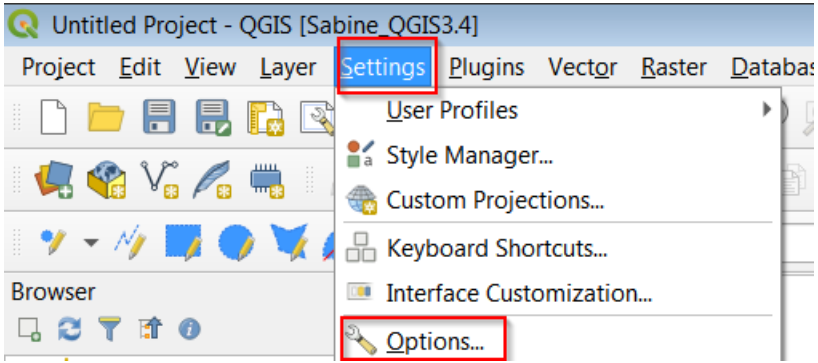


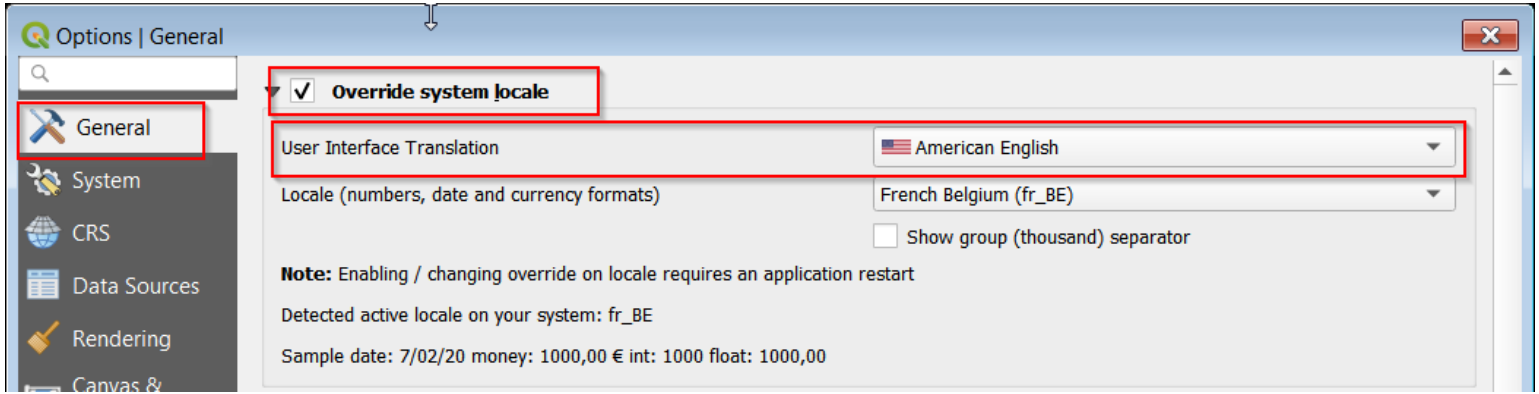
Selection components to install: check only QGIS

Start QGIS (v3.4.x Madeira)



Set language to English



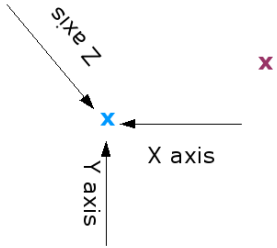


1. Click **OK**
2. Close and restart QGIS

Vectors

Vector Point Feature

Point Geometry (indicates the x,y and z position of the feature)

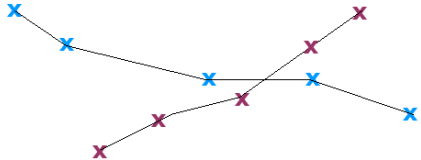


Point attributes (describe the feature)

Id, Name, Description
1, Tree, Outside our classroom 2, Light post, At the school entrance

Vector Polyline Feature

Polyline Geometry (a series of connected vertices that do not form an enclosed shape)

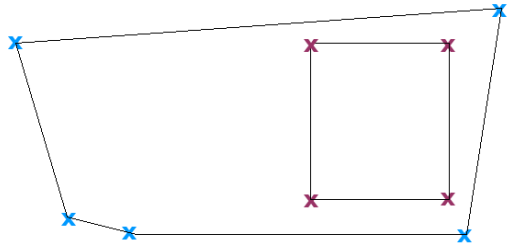


Polyline attributes (describe the feature)

Id, Name, Description
1, Footpath 1, From class to the playground 2, Footpath 2, From the school gate to the hall

Vector Polygon Feature

Polygon Geometry (a series of connected vertices that do form an enclosed shape)

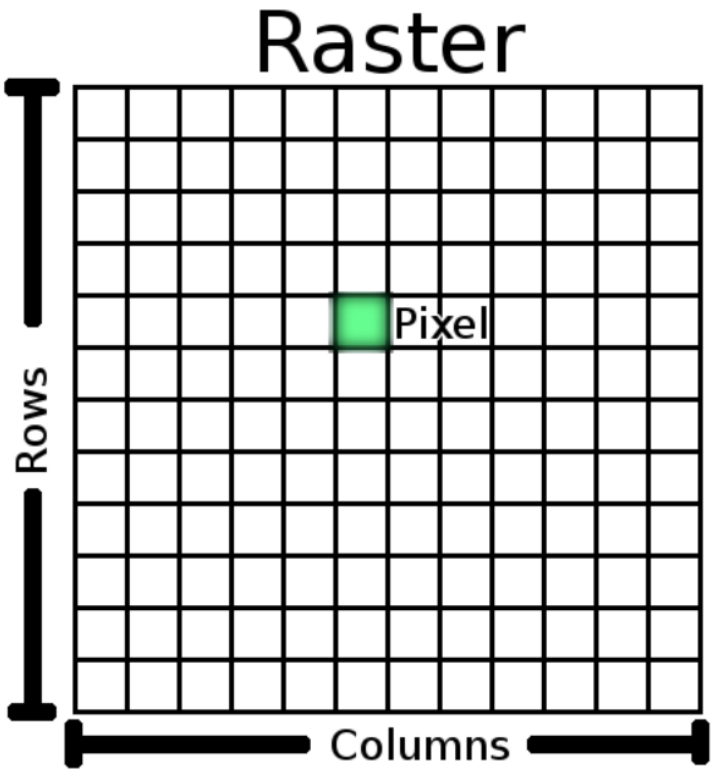


Polygon attributes (describe the feature)

Id, Name, Description
1, School Boundary, Fenceline for the school 2, Sports Field, We play soccer here

Rasters

Rasters are layers of pixels



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