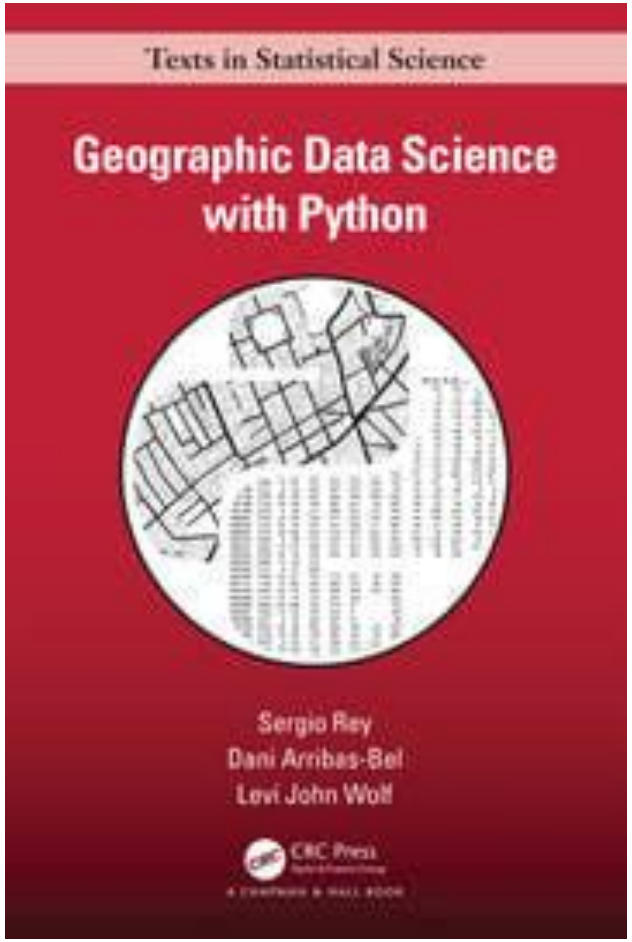
The Geo Context

References

- https://geographicdata.science/book/intro.html
- https://pythongis.org/index.html



What is geospatial data?

GRAPHS

POINTS

POLYGONS

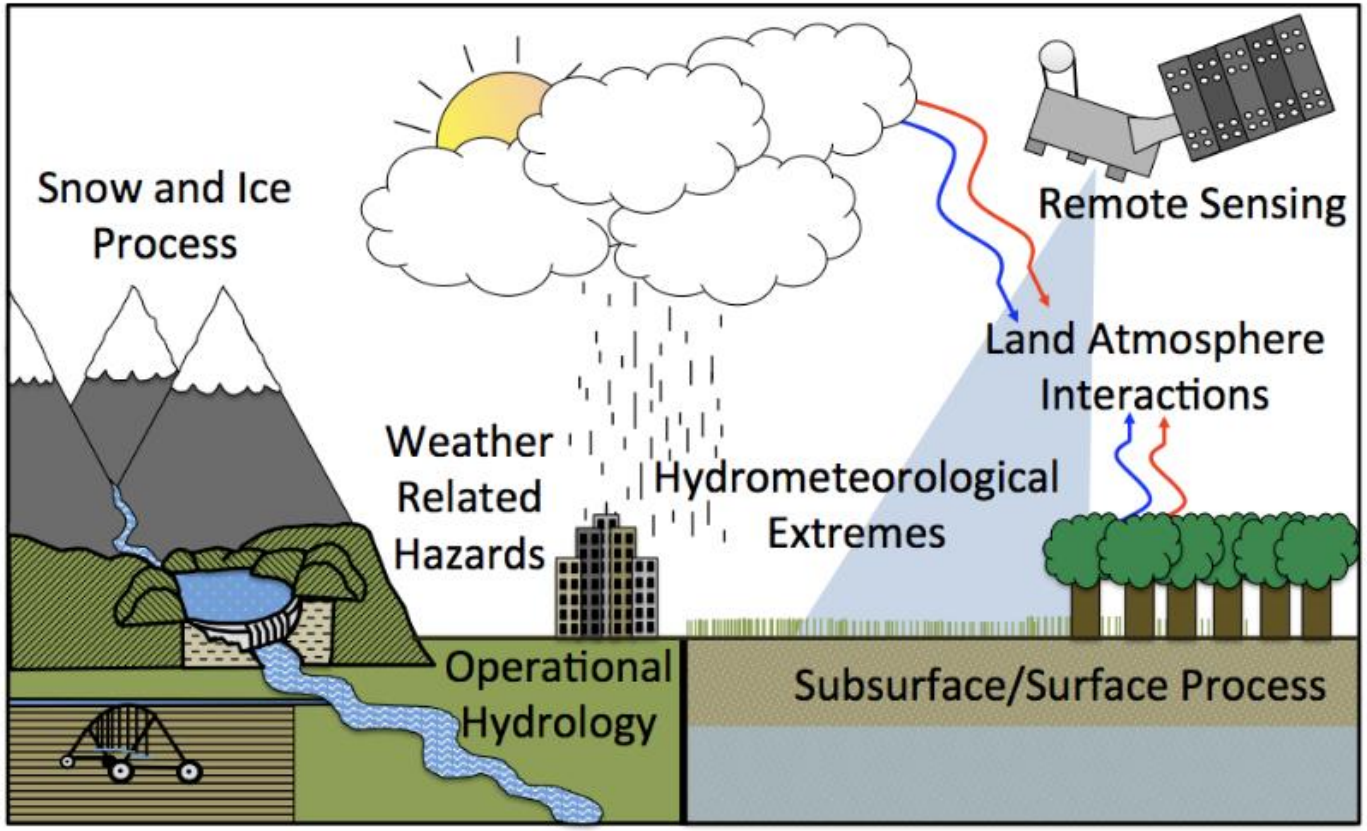
IMAGES/
FIELDS

All of the above!

For example, population density in a city

Geospatial processes

- Physics
  - Rivers, trees, tectonic plates, landslides, air (pollutants)
- Movement of people/vehicles
  - People traveling to work/for holidays/conferences/events
- Changing land use
  - Restaurants, Facilities, etc.



Geospatial data structures

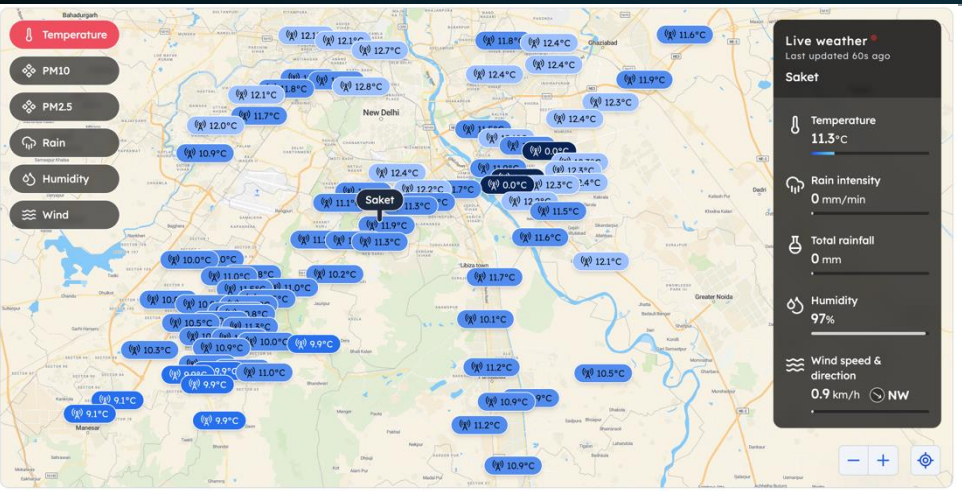
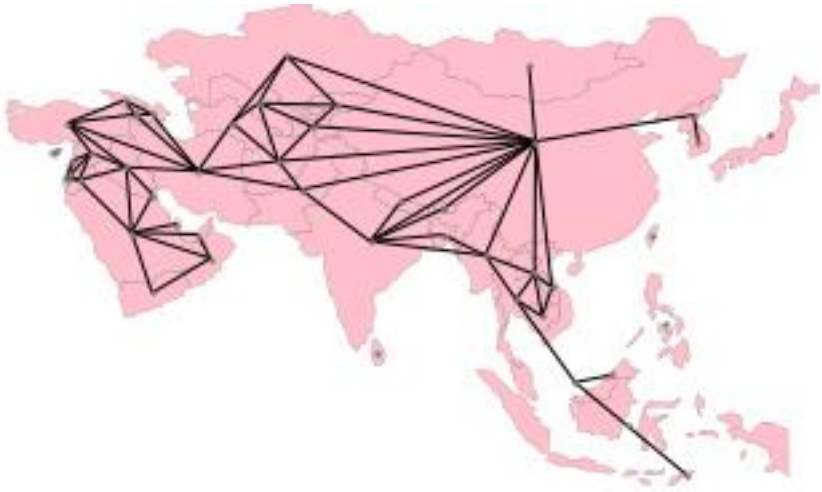


Image from Weather Union Initiative:
https://www.weatherunion.com/now/delhi-ncr/000110/saket/007329/

	pop_est	continent	name	iso_a3	gdp_md_est	geometry
0	920938	Oceania	Fiji	FJI	8374.0	MULTIPOLYGON (((180.00000 -16.06713, 180.00000...
1	53950935	Africa	Tanzania	TZA	150600.0	POLYGON ((33.90371 -0.95000, 34.07262 -1.05982...
2	603253	Africa	W. Sahara	ESH	906.5	POLYGON ((-8.66559 27.65643, -8.66512 27.58948...
3	35623680	North America	Canada	CAN	1674000.0	MULTIPOLYGON (((-122.84000 49.00000, -122.9742...
4	326625791	North America	United States of America	USA	18560000.0	MULTIPOLYGON (((-122.84000 49.00000, -120.0000...
5	18556698	Asia	Kazakhstan	KAZ	460700.0	POLYGON ((87.35997 49.21498, 86.59878 48.54918...
6	29748859	Asia	Uzbekistan	UZB	202300.0	POLYGON ((55.96819 41.30864, 55.92892 44.99586...
7	6909701	Oceania	Papua New Guinea	PNG	28020.0	MULTIPOLYGON (((141.00021 -2.60015, 142.73525 ...
8	260580739	Asia	Indonesia	IDN	3028000.0	MULTIPOLYGON (((141.00021 -2.60015, 141.01706 ...
9	44293293	South America	Argentina	ARG	879400.0	MULTIPOLYGON (((-68.63401 -52.63637, -68.25000...



- GeoTables (shp, gpd, geojson)
  - think pandas dataframe with a geometry column (geopandas dataframe)
- Surfaces/Cubes
  - temperature in a city! (xarray, geotiff), CRS!
- Spatial Graphs
  - flight connectivity!

Where are we in the journey of geospatial data

- Increasingly smooth translation between formats for various kinds of ***analysis***
- Proprietary formats for smooth and uniform ***operations***
  - Uber's "Hierarchical Hexagonal Geospatial Index" – h3
  - S2 Earth Cube

Let us see some examples

Handling large data

STAC: Spatio temporal asset catalog

Reference: https://www.youtube.com/watch?v=Ugazf5bWsGE&ab_channel=opengeospatial

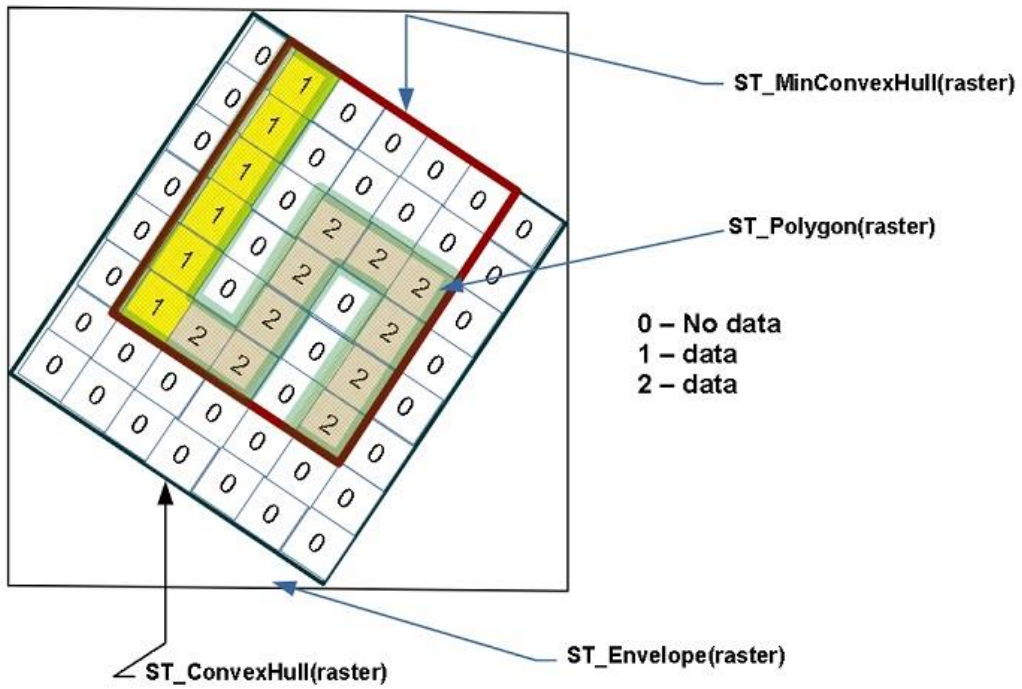
Flow for today

- PostGIS essentials
- Install and use postgis from python and QGIS
- Use Bunting Labs to find more data using OSM
- For the large number of villages we saw last time,
  - Set up a postgis database
  - Find villages near major city centers
  - Which villages have intersections with 3 or more roads?

PostGIS References

- https://docs.google.com/presentation/d/1qYXdeCIymLl32uoAHvAPrp1r-hK-_4Z8InG7sHEo6vc/edit#slide=id.gd85280829a_0_255
- https://postgis.net/workshops/postgis-intro/index.html

Rasters to vectors & more on PostGIS



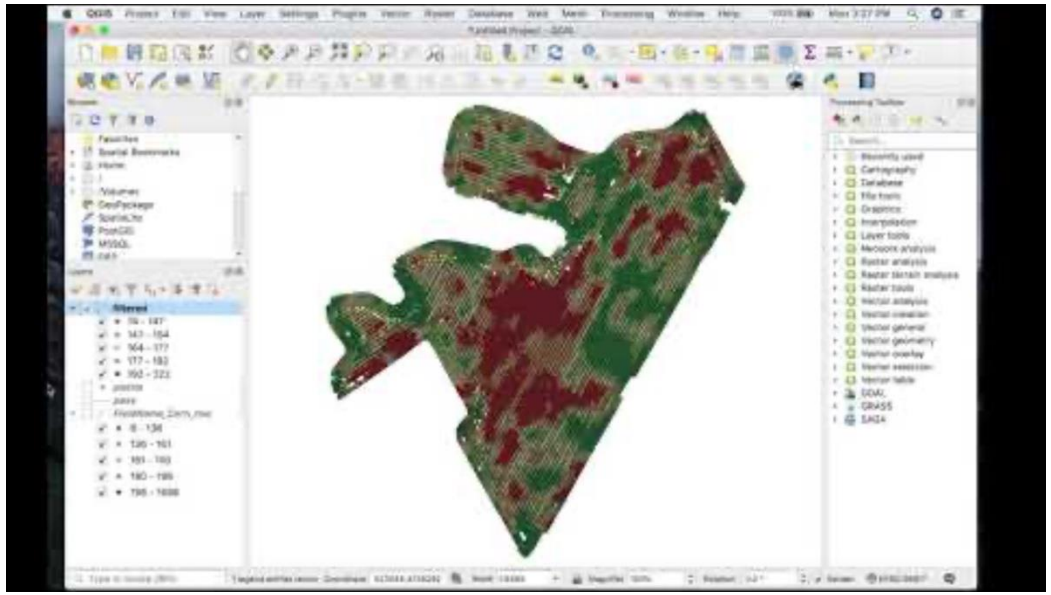
https://youtu.be/IMi5uKTT-x0?si=UsstbEp2vmPrukti

Geoserver

- https://geoserver.org/about/

Whitebox tools: Yield

- https://www.whiteboxgeo.com/manual/wbt_book/intro.html



Whitebox: Breaklines

✅ **Accurate Terrain Representation**

- Defines ridges, valleys, and slopes for **snow accumulation & melt modeling**
- Aids in **avalanche risk assessment** and **glacier/ice sheet mapping**

✅ **Hydrology & Water Flow Modeling**

- Supports **snowmelt runoff simulation** and **flood risk prediction**
- Helps in **watershed delineation** for water management

✅ **Infrastructure Planning & Safety**

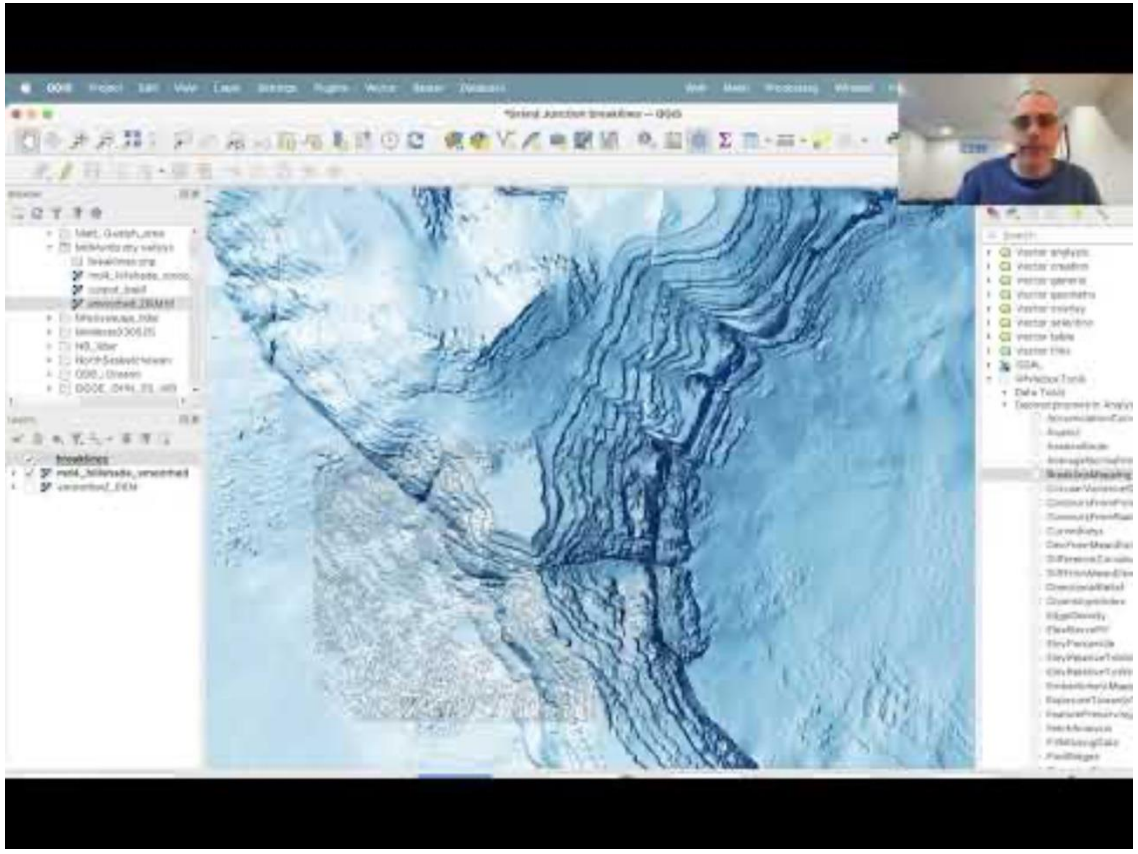
- Guides **winter-resilient road & railway design**
- Supports **ski resort planning & utility infrastructure routing**

✅ **Remote Sensing & Snow Depth Measurement**

- Enhances **LiDAR-derived DEM accuracy**
- Helps in **snowpack monitoring & drift analysis**

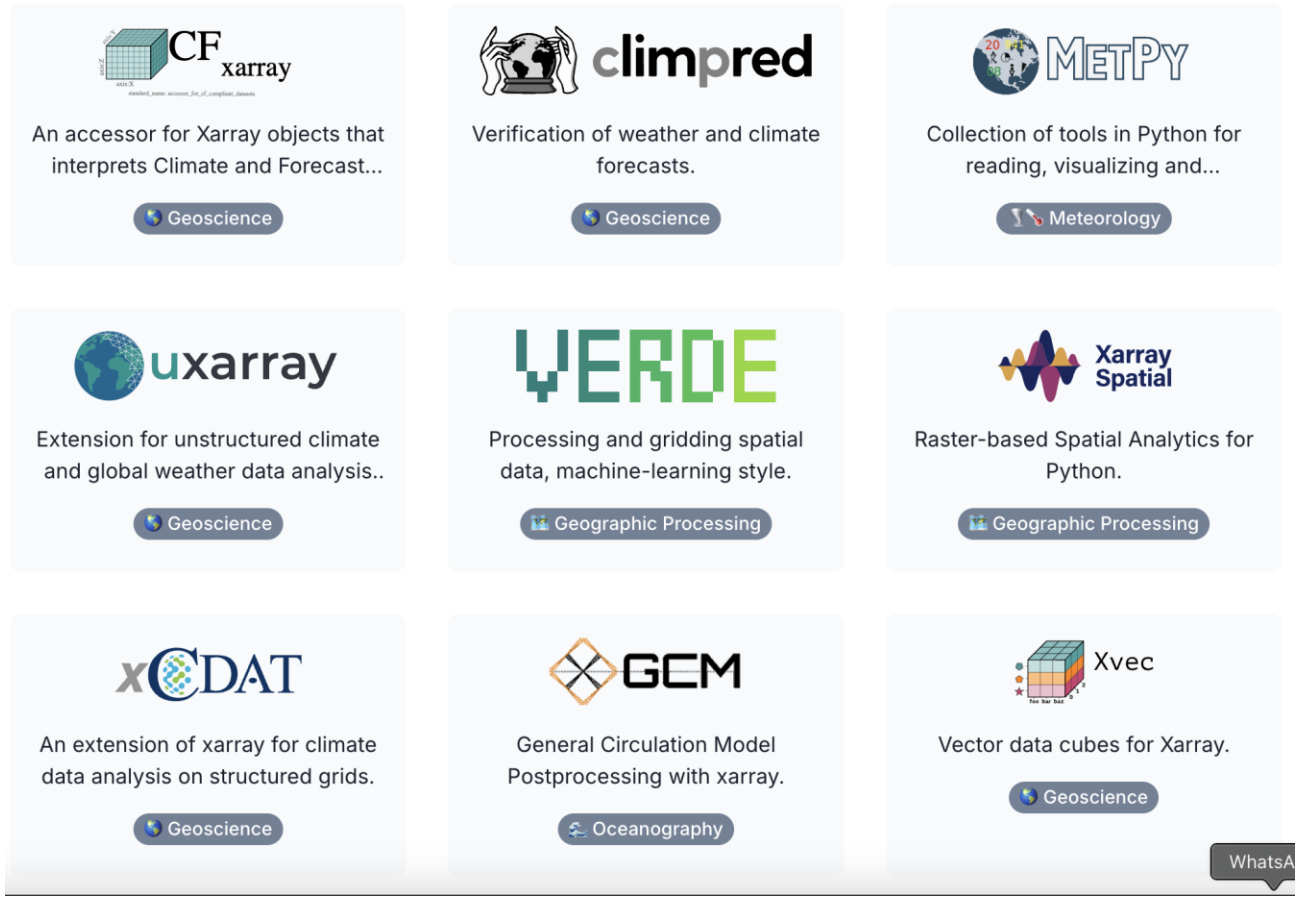
✅ **Climate & Environmental Monitoring**

- Tracks **permafrost & glacial retreat**
- Supports **wildlife habitat analysis in snow-covered regions**



Climate tools: PanGeo

https://github.com/google/Xee



Deep Learning tools

- https://github.com/microsoft/torchgeo
  - Released 2022
  - https://arxiv.org/pdf/2111.08872