Land cover-land use data for infectious disease modelling

Landscape structure and human land use can influence pathogen transmission by altering, among other things, **host and vector communities**, **hydrology**, **microclimates**, and **human-vector-wildlife contact**.

Often, we want to explore or test for these effects– which generally requires spatially-explict, earth observation data on land cover and land use.

Land cover and land use – what's the difference?

Image: Nicholas van Leekwijk, GeoWiki, https://www.geo-wiki.org/

Land cover and land use – what's the difference?

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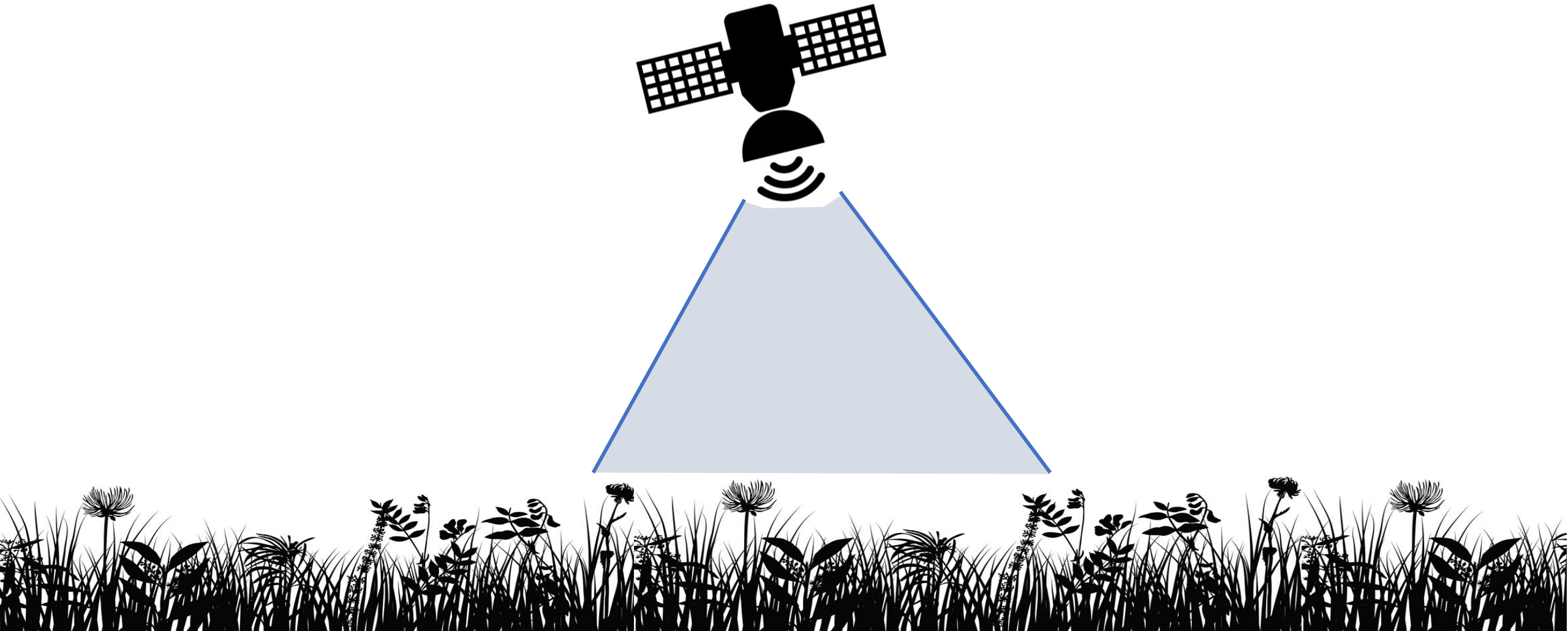
Land cover and **land use** – what's the difference?

Image: Nicholas van Leekwijk, GeoWiki, https://www.geo-wiki.org/

Earth observation satellites generally measure land *cover*



Earth observation satellites generally measure land *cover*

Satellite sensing

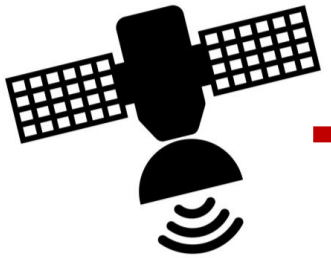
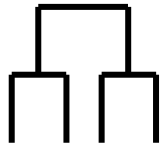


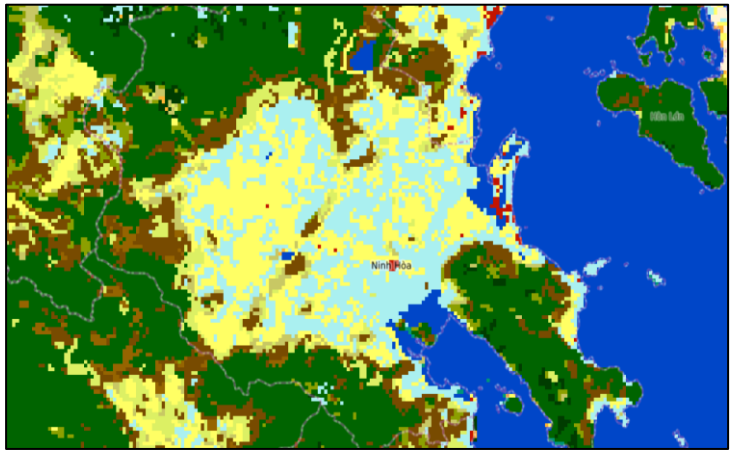
Image of Earth's surface

Image processing and classification pipeline



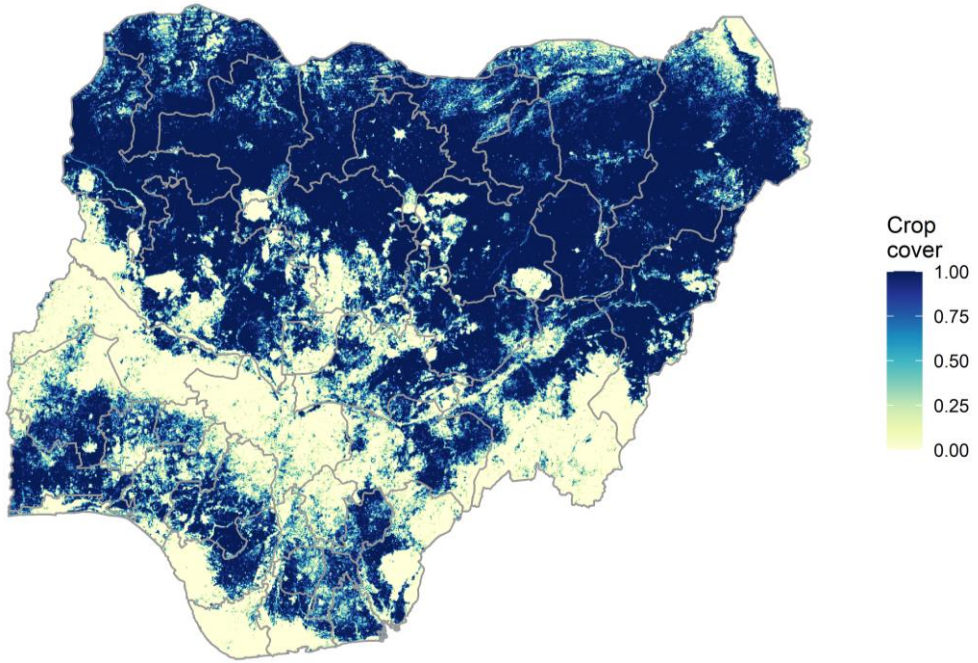
e.g. random forest, neural network

Land cover class/proportion raster



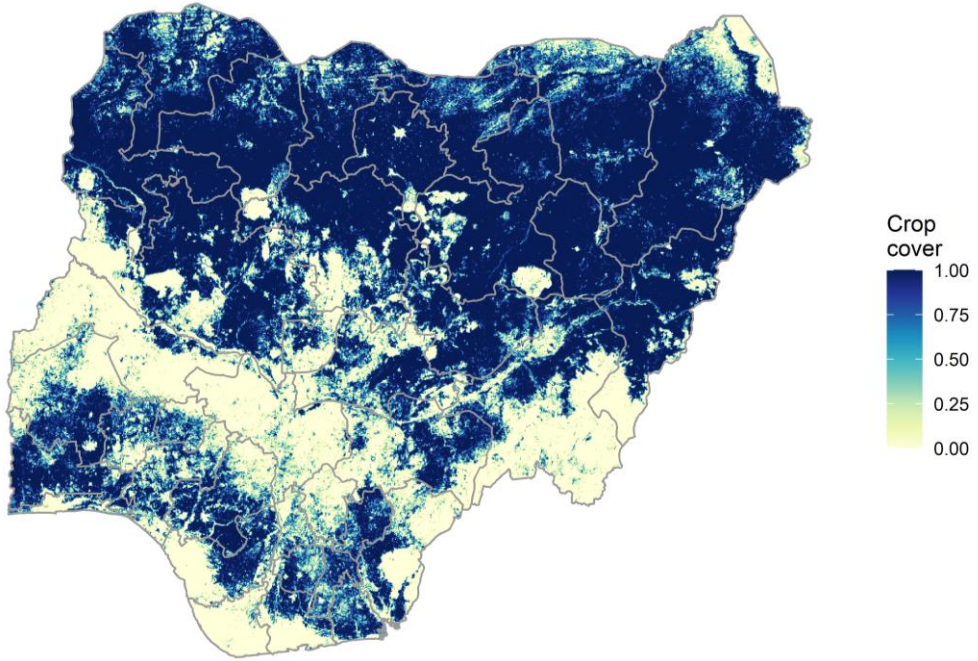
Earth observation satellites generally measure land *cover*

Nigeria cropland (2018 ESA-CCI)

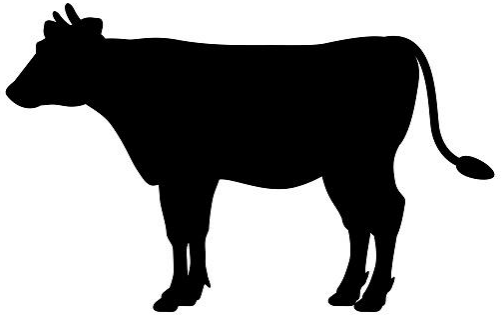


Earth observation satellites generally measure land *cover* – in some cases this can be used as a proxy for land *use*

Nigeria cropland (2018 ESA-CCI)

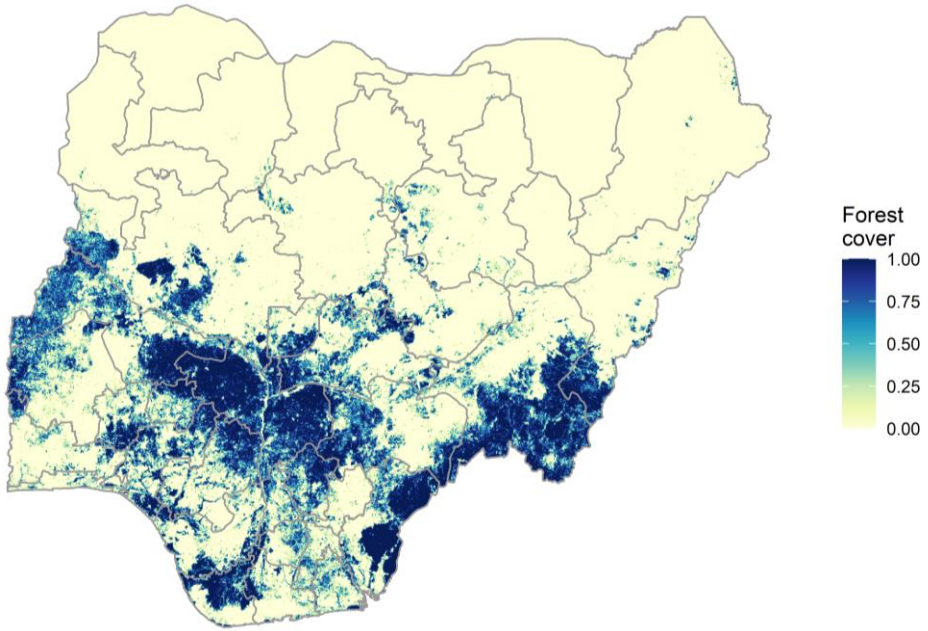


What about pasture grazing, cropping intensity, nutrient inputs, land management regimes?



Earth observation satellites generally measure land *cover* – in <u>some</u> cases this can be used as a proxy for land *use*

Nigeria forest (2018 ESA-CCI)



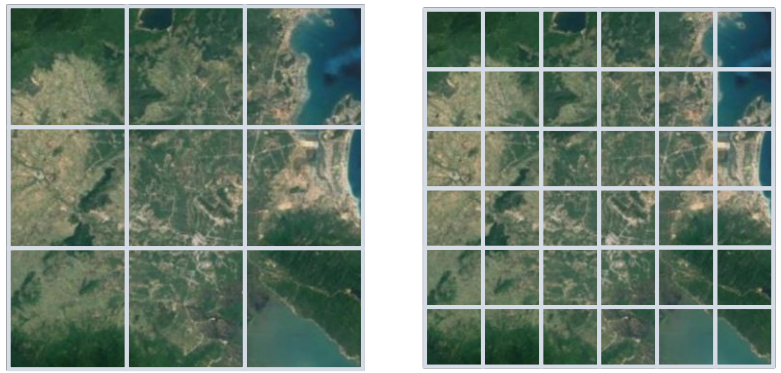
What about selective logging, agroforestry, hunting pressure, timber plantations?

Geo-Wiki

https://www.geo-wiki.org/

Three axes of land cover data resolution

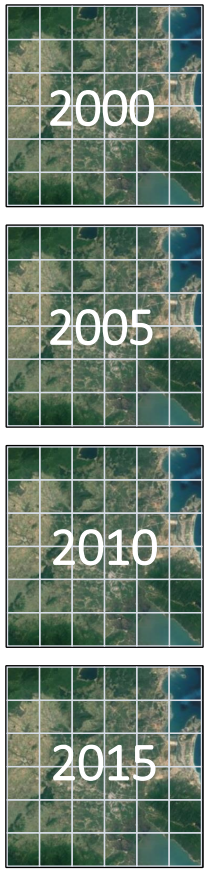
Spatial



Low ⟷ High

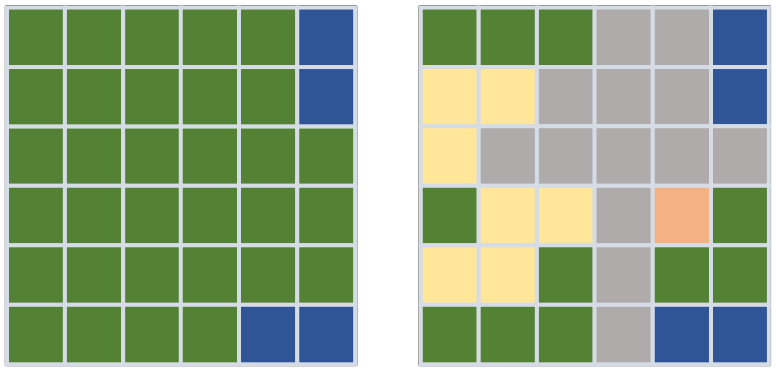
How finely resolved is the grid?
(30m <-> 5km)

Temporal



How many years?
At what time intervals?

Thematic



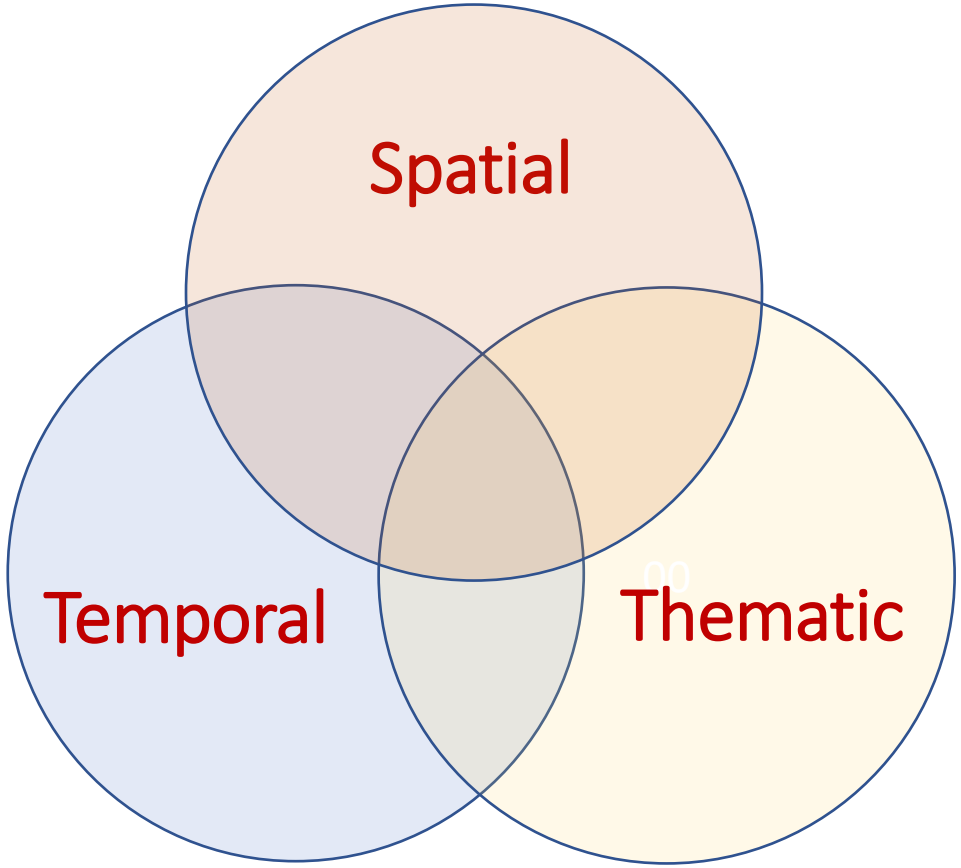
Low ⟷ High

How finely resolved are land cover classes?

Pick two

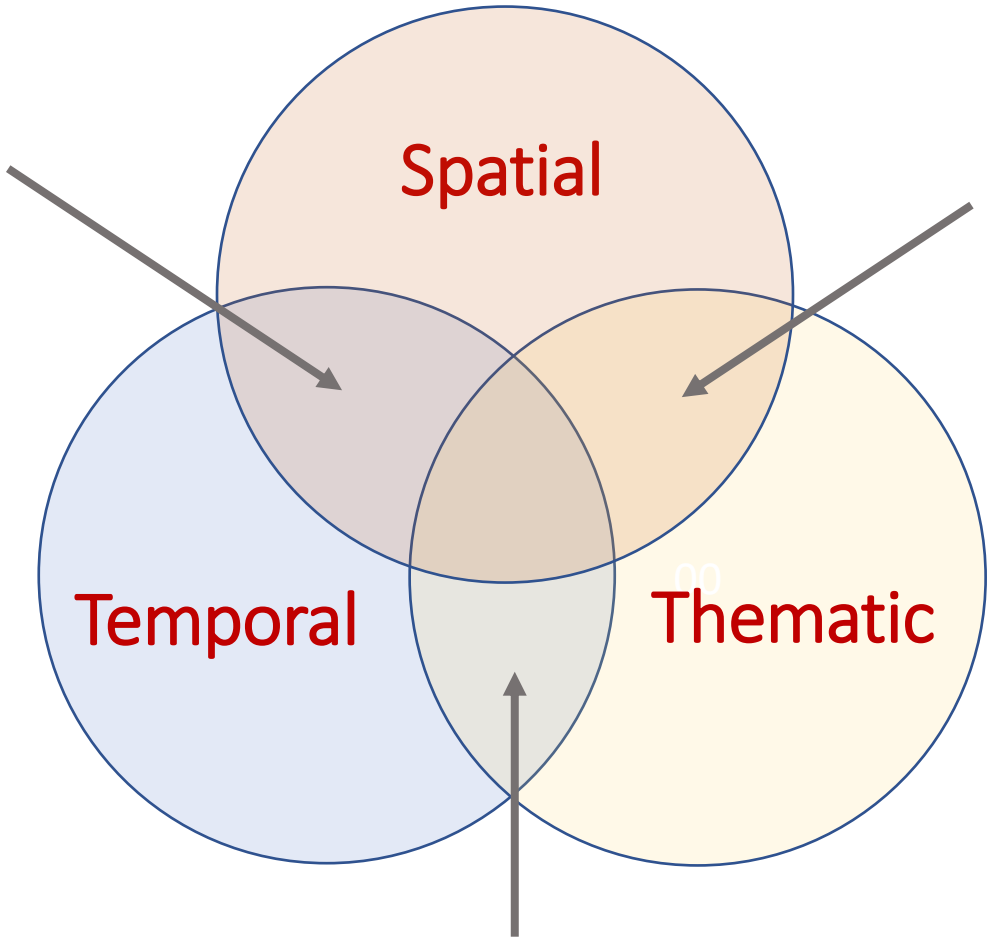
https://medium.com/@devsociety_/good-cheap-fast-pick-two-and-how-ngos-can-play-the-triangle-like-a-pro-20d1380884a8

Pick two



Pick two

Global Forest Change ("Hansen") – 30m, annual since 2000, <u>but</u> only tree cover

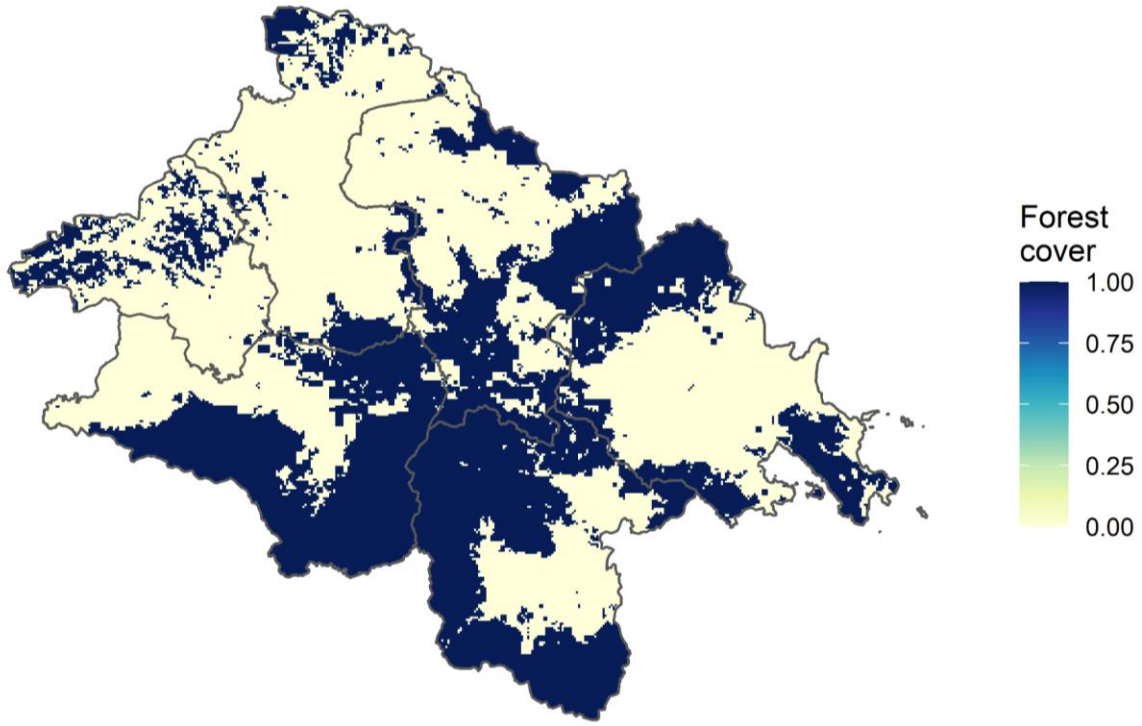


COPERNICUS Global Land Cover – 100m, 23 classes and fractional cover, <u>but</u> only for 2015 onwards

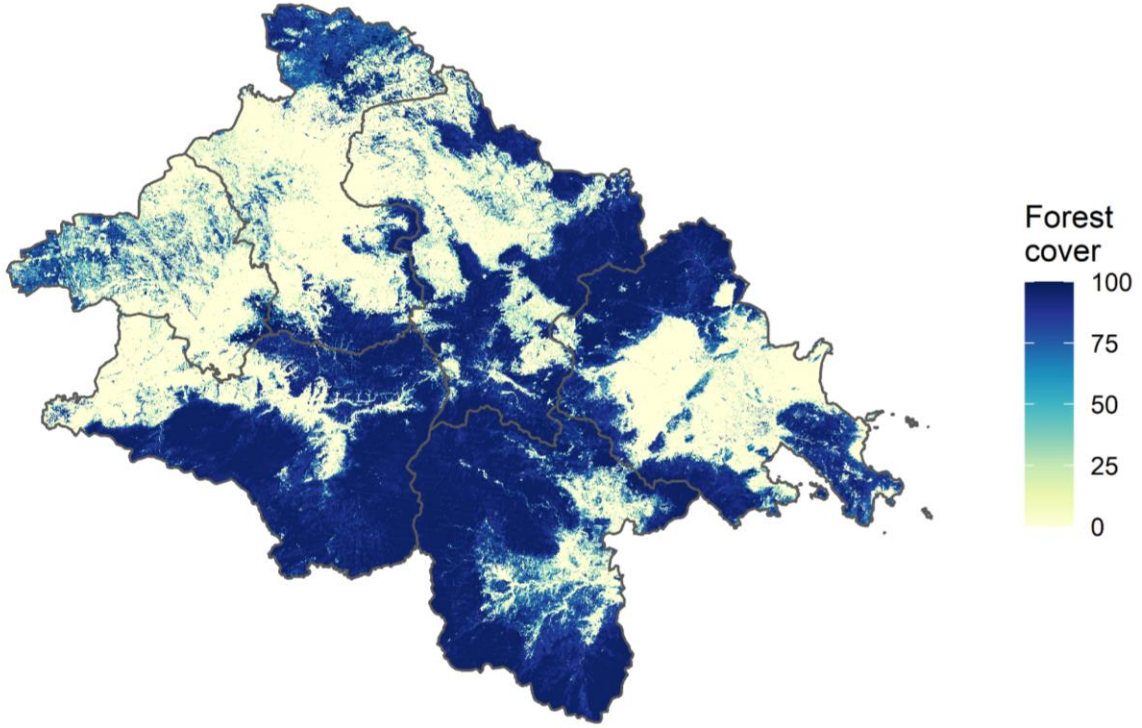
ESA-CCI and MODIS land cover – annual since 2000, >30 classes, <u>but</u> >300m spatial resolution

Why resolution matters: two views of the same area

ESA-CCI 2000 (300m res)



Global Forest Change 2000 (30m res)



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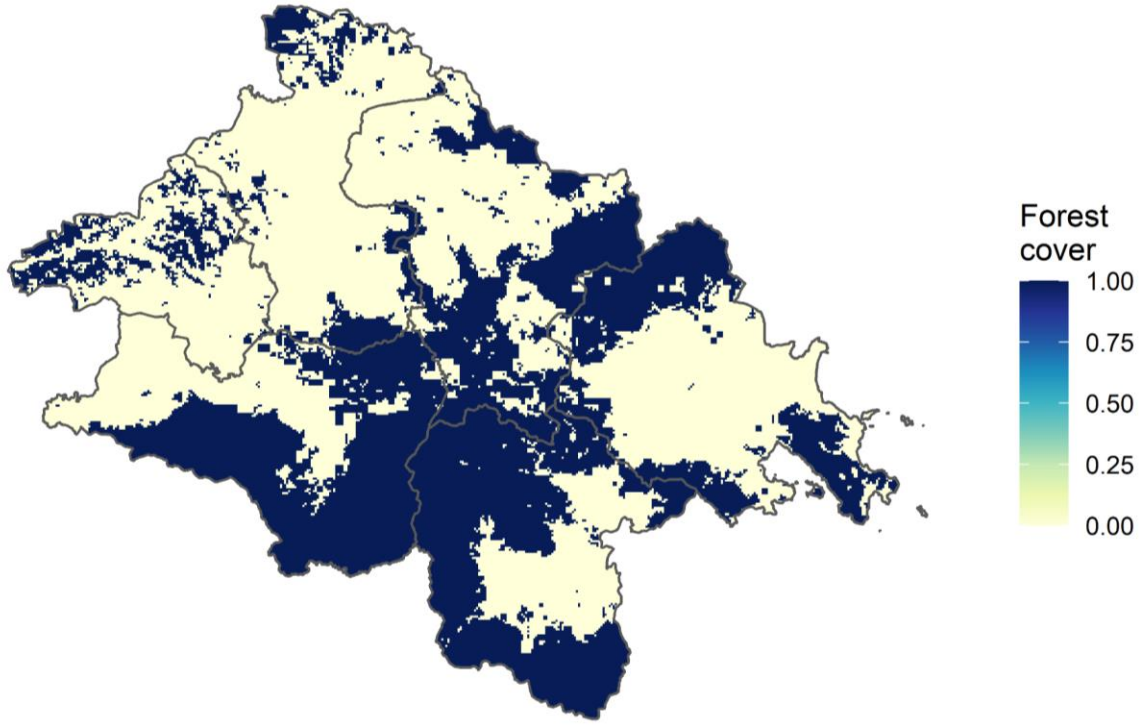
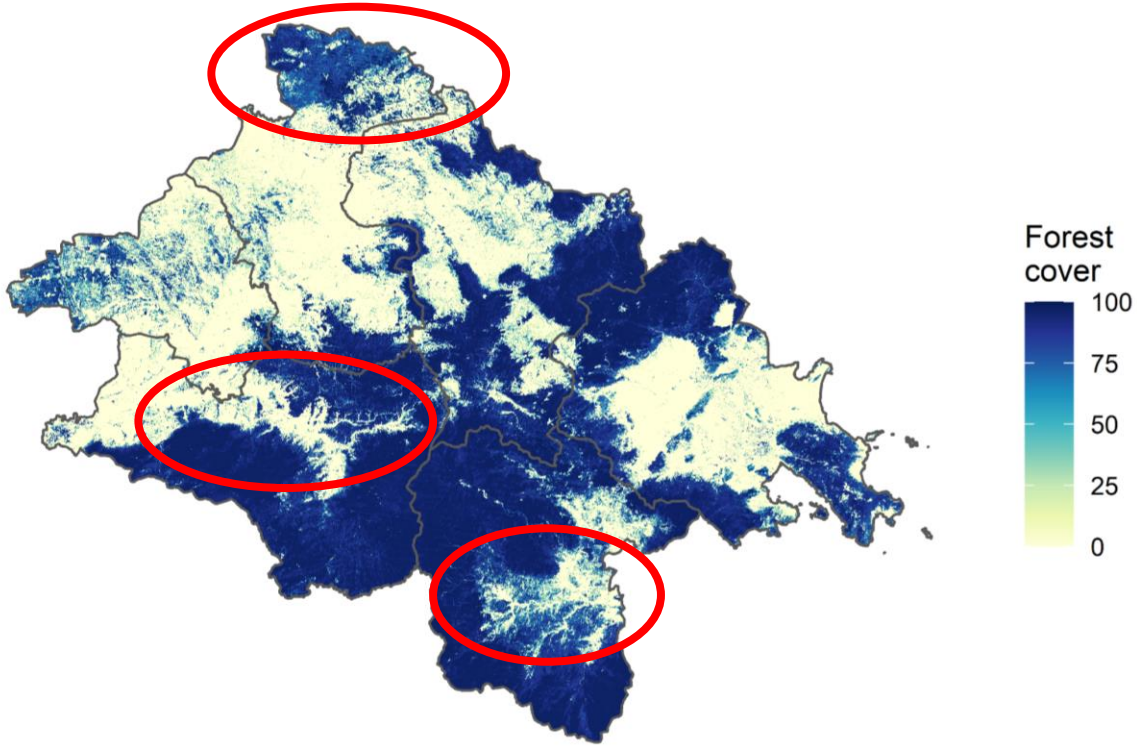


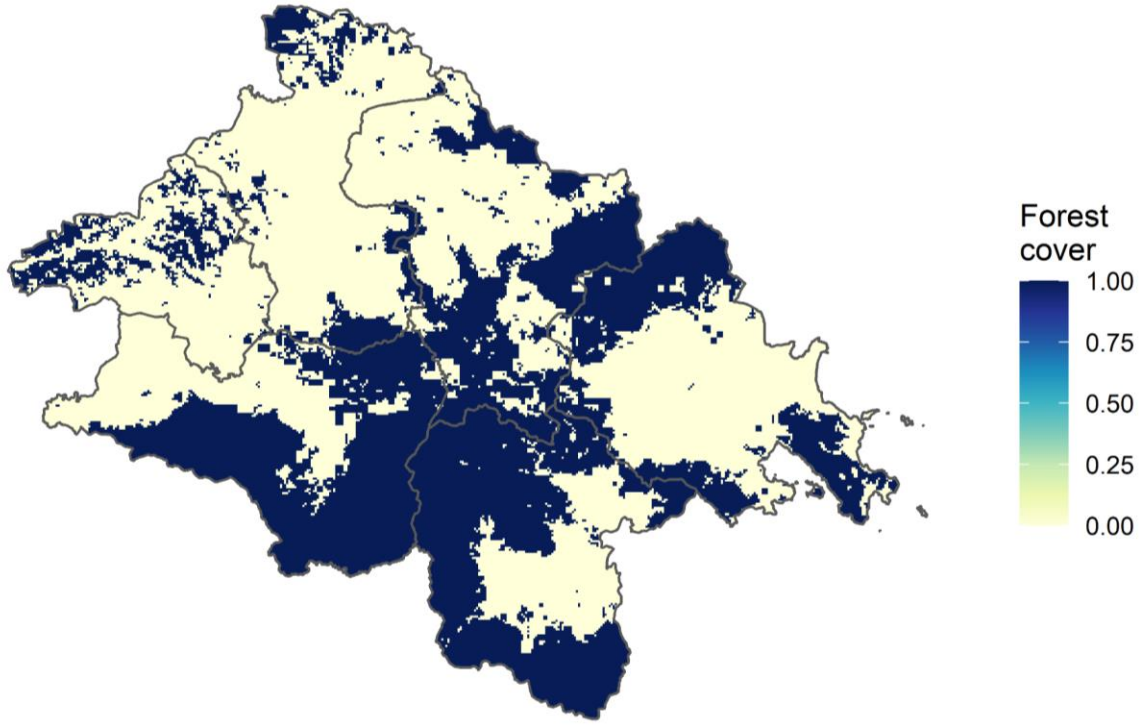
Global Forest Change 2000 (30m res)



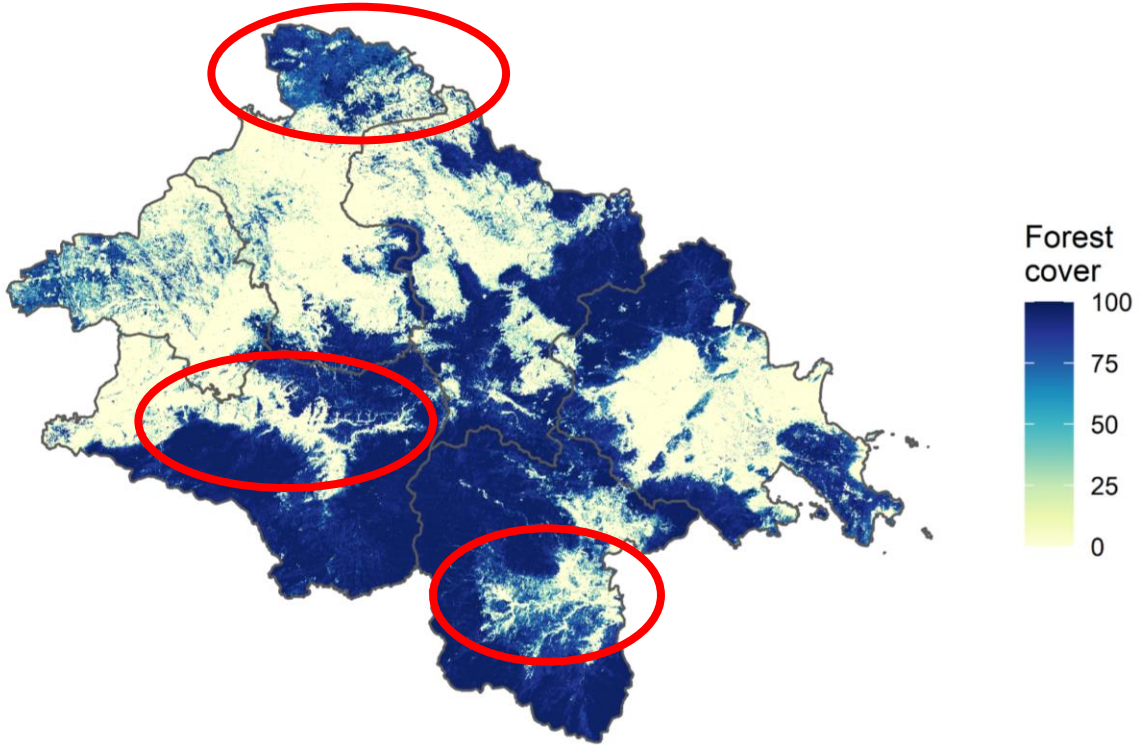
The lower spatial resolution and discrete land cover class scheme of ESA-CCI classifies many areas with substantial tree cover as “non-forest”

Why resolution matters: two views of the same area

ESA-CCI 2000 (300m res)

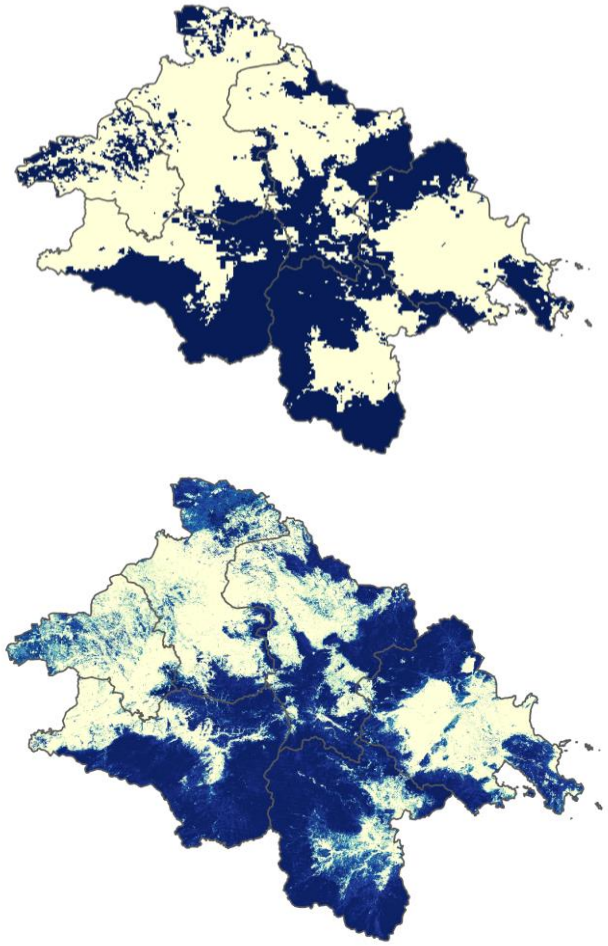


Global Forest Change 2000 (30m res)

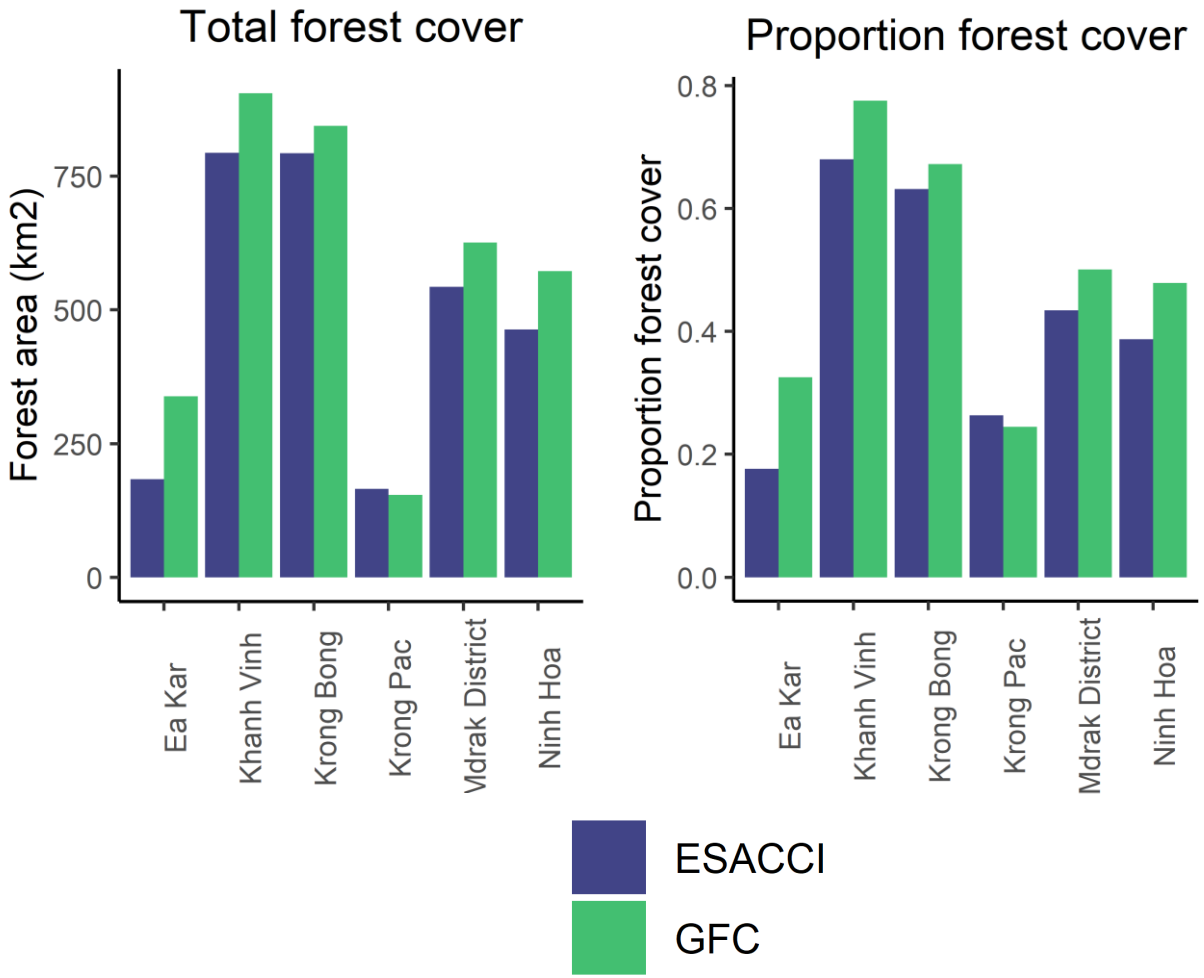


This could matter, especially for zoonotic and vector-borne disease – it's these kinds of boundary or fragmented areas that are often associated with human-wildlife-vector contact and spillover risk

Extracting land cover-land use metrics from raster data



Overlay polygons/points, extract and summarise…

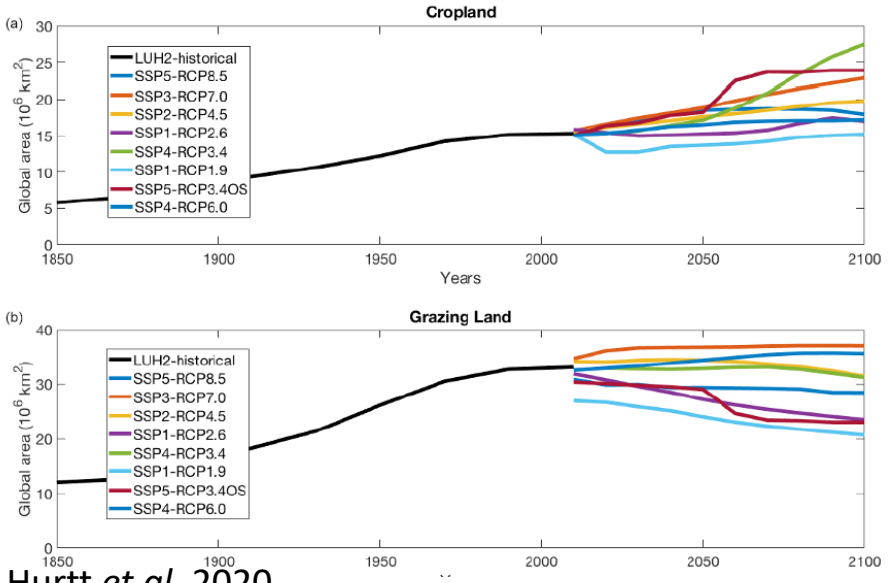


Examples of present-day land cover sources

Database	Spatial resolution	Temporal resolution	Thematic resolution	Time period
MODIS Land Cover Dynamics	500m	Annual	Up to 40 classes, categorical	2001-2019
MODIS Vegetation Indices (EVI/NDVI)	500m	16-day	1 class (vegetation greenness)	2000-2021
Global Forest Change (Hansen)	30m	Annual	1 class (tree cover, loss and gain)	2000-2019
Global Urban Footprint	12m	1 epoch	1 class (impervious or not)	1 year ("present day")
Landsat Urban Dynamics (Liu 2020)	30m	Annual	1 class (urban cover, loss and gain)	1985-2015
COPERNICUS Land Cover	100m	Annual	23 classes plus fractional cover	2015-2019
ESA-CCI Land Cover	300m	Annual	37 classes, categorical	1992-2019

Future scenarios of land use change

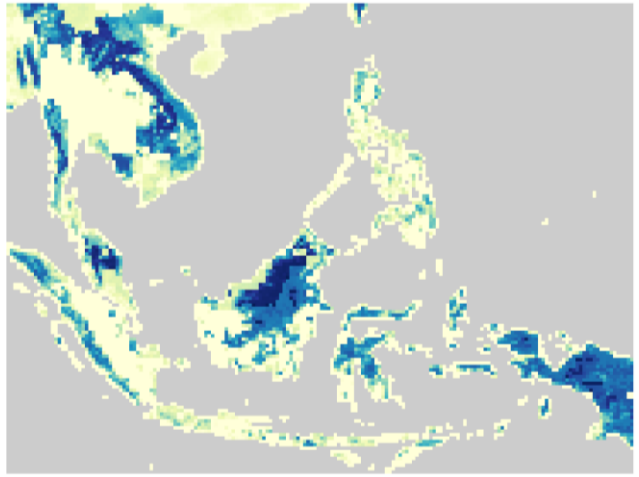
Land Use Harmonization v2



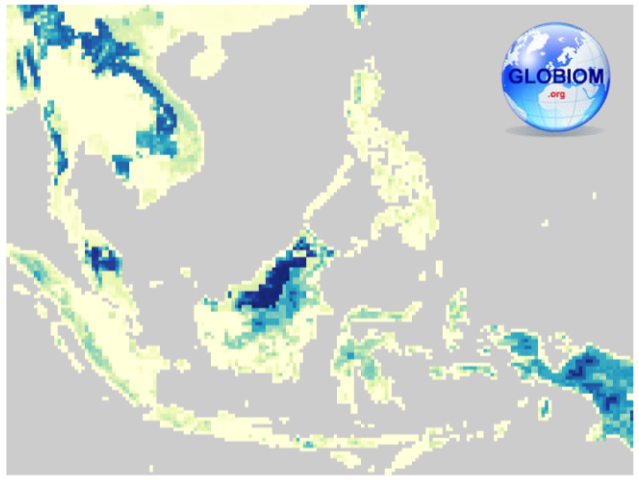
Hurtt *et al.* 2020

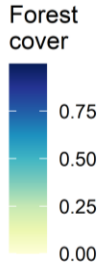
Time series of modelled future global land use trajectories, developed under Shared Socioeconomic Pathway (SSP) scenario assumptions for CMIP6 (available as 0.5-degree rasters).

Primary forest 2020



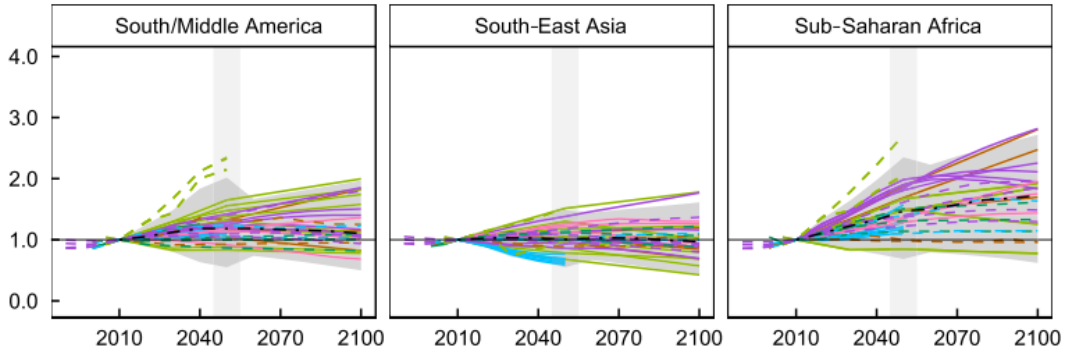
Primary forest 2070 (RCP4.5 SSP2)

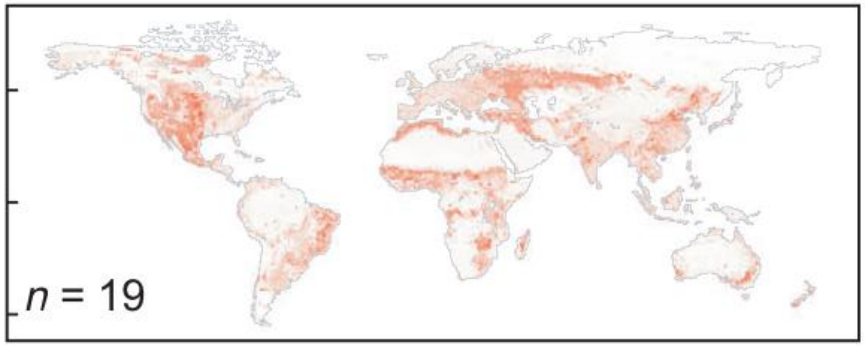




Big uncertainties and caveats for future land use data

Extremely high uncertainty in future **cropland area change (proportion change from 2010 baseline)** across multiple models and scenarios





Cropland uncertainty (grid cell s.d.) in 2050

- The global SSPs and Land Use Harmonization products were mainly produced and designed to feed into climate change models – not health impact modelling.
- RCP-SSP scenario pairs are each quantified for LUH using a different Integrated Assessment Model (each of which is structured very differently) – so different modelled LUH scenarios are not strictly comparable.

- What this means is that LUH SSP-RCP scenario projections describe only a very small region of possible futures, which are produced under very conservative economic assumptions – need to use and interpret with care for disease models.

Prestele *et al.* 2017

Now for the interactive bit…

https://github.com/rorygibb/landuse_phid

PHID Dropbox:
PHID > tutorials > gibb_landuse_20200217