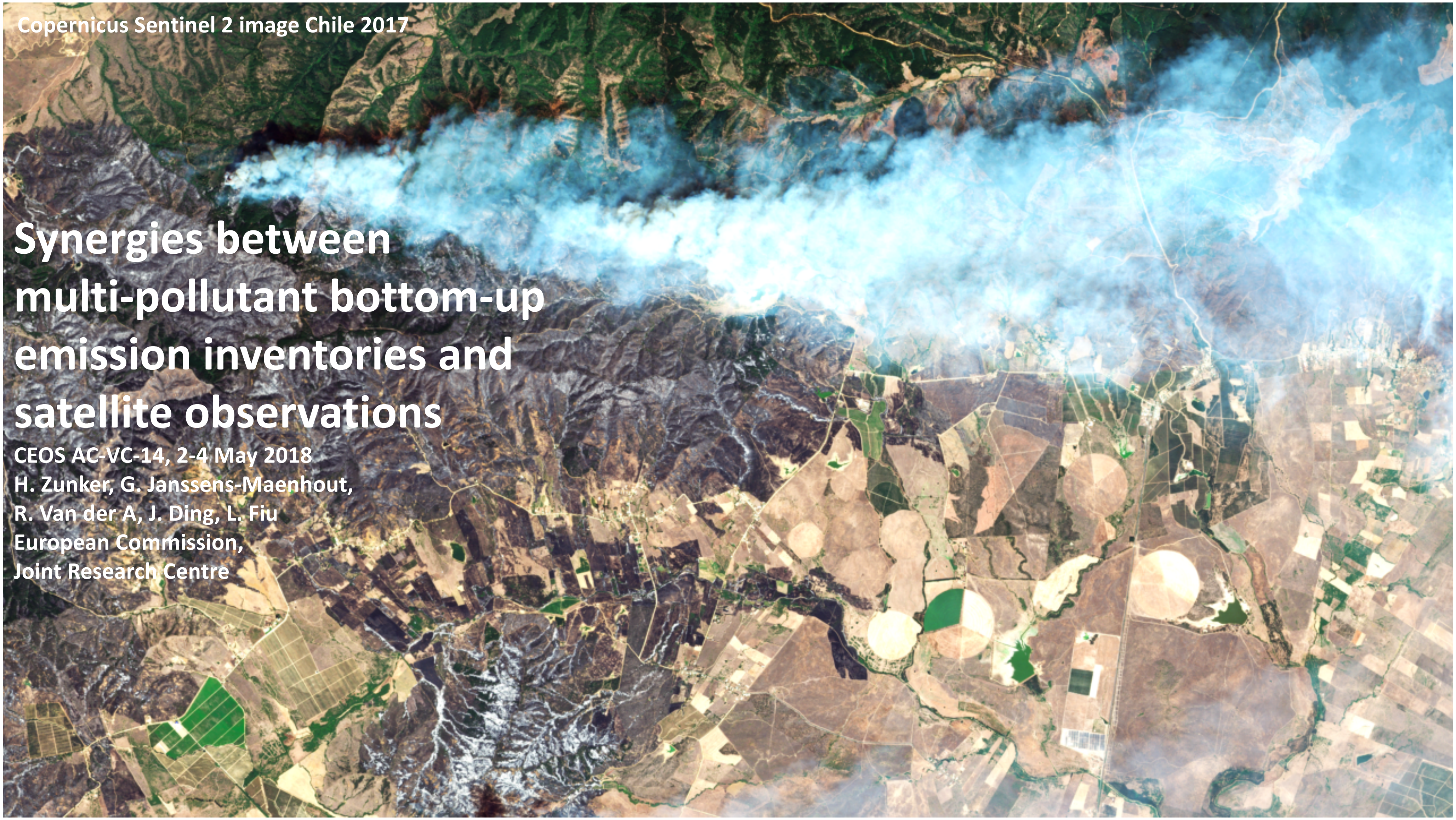
Copernicus Sentinel 2 image Chile 2017

Synergies between multi-pollutant bottom-up emission inventories and satellite observations

CEOS AC-VC-14, 2-4 May 2018

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Joint Research Centre

Extract of available long-term supply of public inventories

Data source	1. EMEP (+ CEIP gapfill)	2. UNFCCC	3. US EPA	4. MICS-ASIA (⊃ REAS 2.1)	5. EDGARv4.3
CO	grid /yr	voluntary	grid /m /height	grid /m (no AWB)	grid /m or /yr
NOx	grid /yr	voluntary	grid /m /height	grid /m (no AWB)	grid /m or /yr
SO2	grid /yr	voluntary	grid /m /height	grid /m (no AWB)	grid /m or /yr
NMVOC	grid /yr	voluntary	grid /m /height/species	grid /m	grid /m or /yr
NH3	grid /yr		grid /m /height	grid /m	grid /m or /yr
CH4	voluntary	/yr		grid /yr	grid /m or /yr
PM2.5	grid /yr		grid /m /height	grid /m (no AWB)	grid /m or /yr
PM10	grid /yr		grid /m /height	grid /m (no AWB)	grid /m or /yr
OC			grid /m /height	grid /m (no AWB)	grid /m or /yr
BC			grid /m /height	grid /m (no AWB)	grid /m or /yr
geo-coverage			USA, also Canada?		

Strengths/weaknesses of bottom-up/top-down inventories

	Bottom-up inventory	Top-down inventory
strength	consistency over multiple polluting gases	completeness for single polluting gas
	long time-series	no time-lag
	country well confined with the national statistics	real location of hotspots
weakness	incompleteness for certain sectors	not solely the human activity
	2 years time-lage	no long historic time-series
	The assumed representative geospatial proxy has large uncertainty and its updates are work-intensive	country totals are subject to relative large border issues

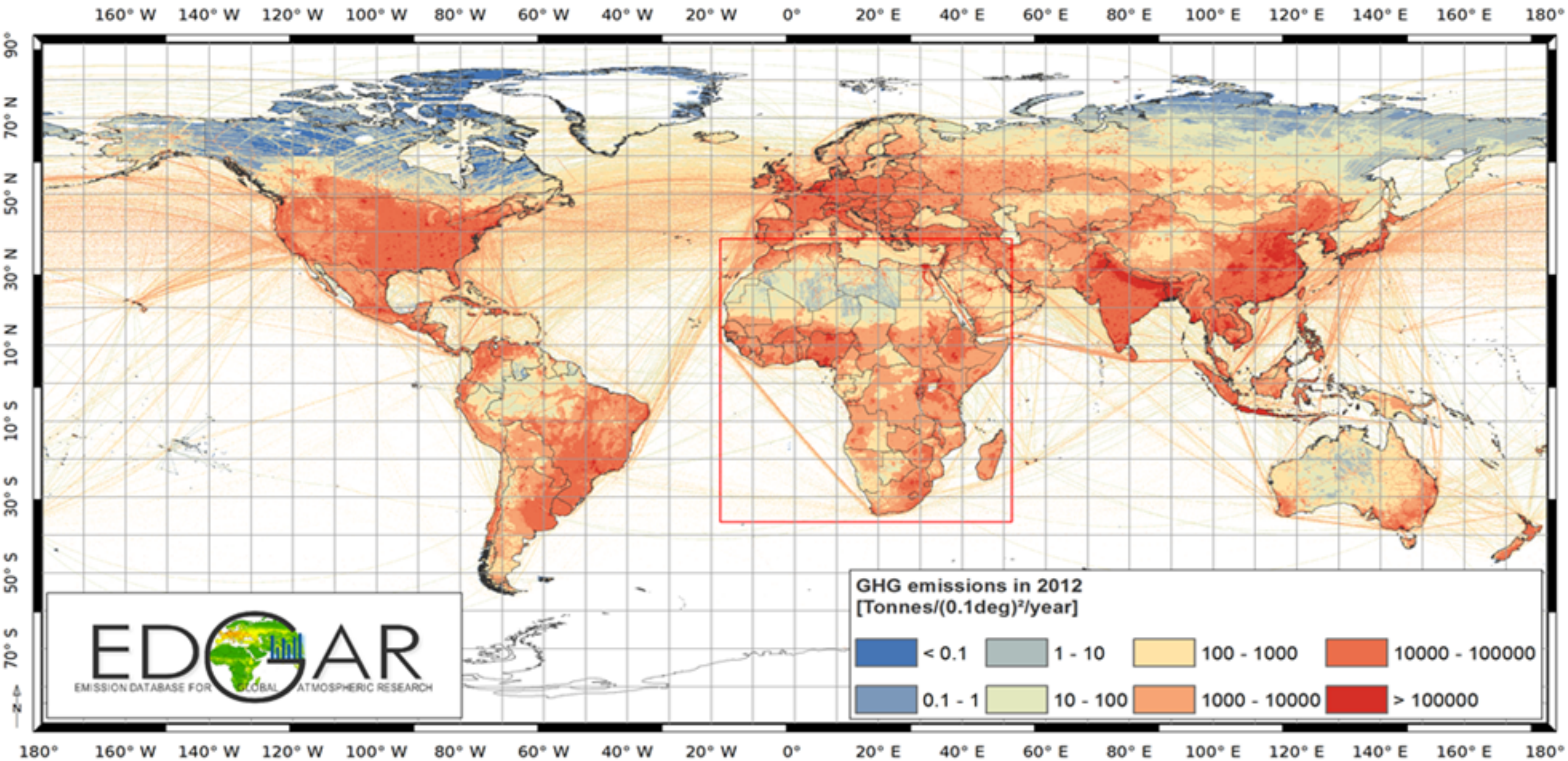
How to make best use of the combination bottom-up and top-down inventories ?

① Use of satellite-derived ancillary data to distribute the emissions geospatially more dynamically (for greenhouse gases)

② Compare & combine bottom-up and top-down derived inventories (for air pollutants)

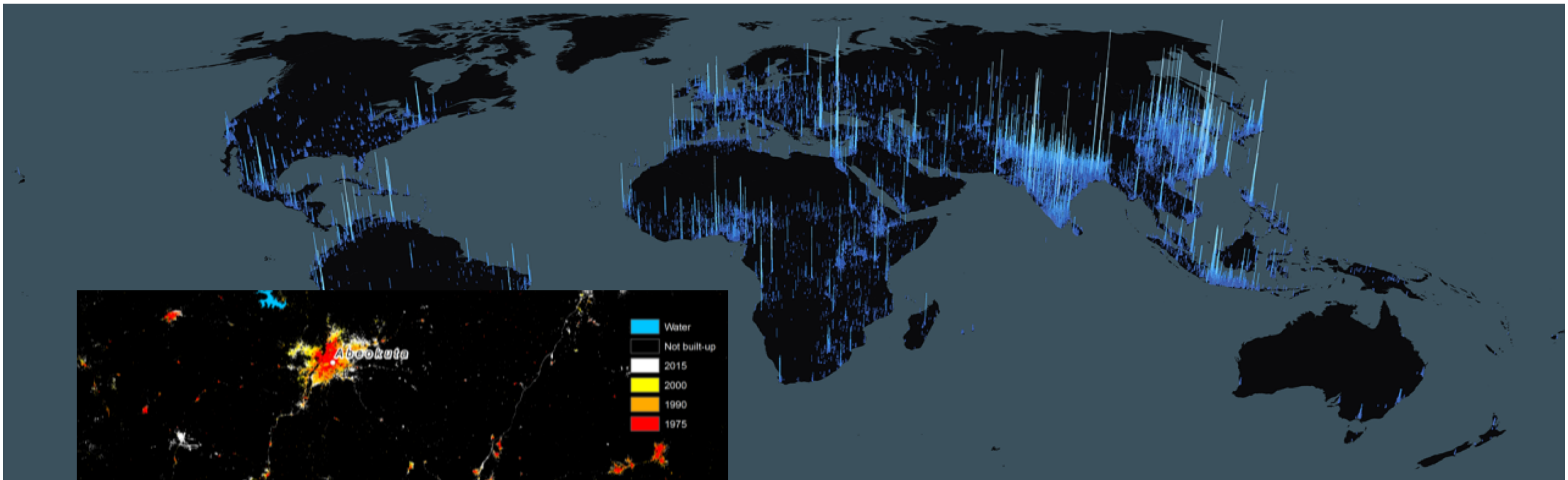
③ Use of emission ratios of air pollutants over greenhouse gases? Not evident…

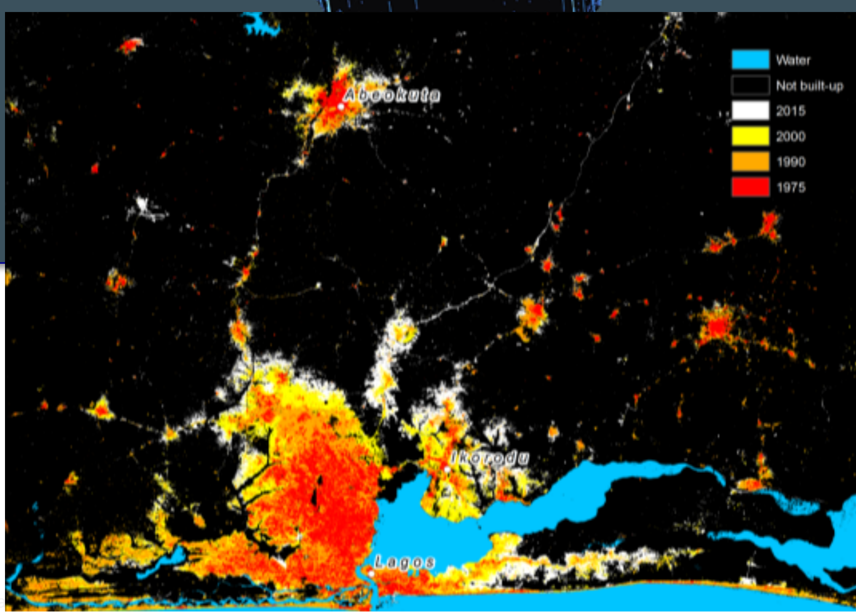
1. Improve bottom-up inventory with satellite-derived ancillary data



Source: Janssens-Maenhout et al. (2017) ESSDD

Global Human Settlements Layer





Global Human Settlement Layer (GHSL) for Lagos (Nigeria) and its hinterland.

The population of Lagos increased from about 2 million in 1975 to 13 million in 2015, as reflected in the increase in built-up areas. Note the growth corridors along the major arterial roads and the creation of large satellite cities.

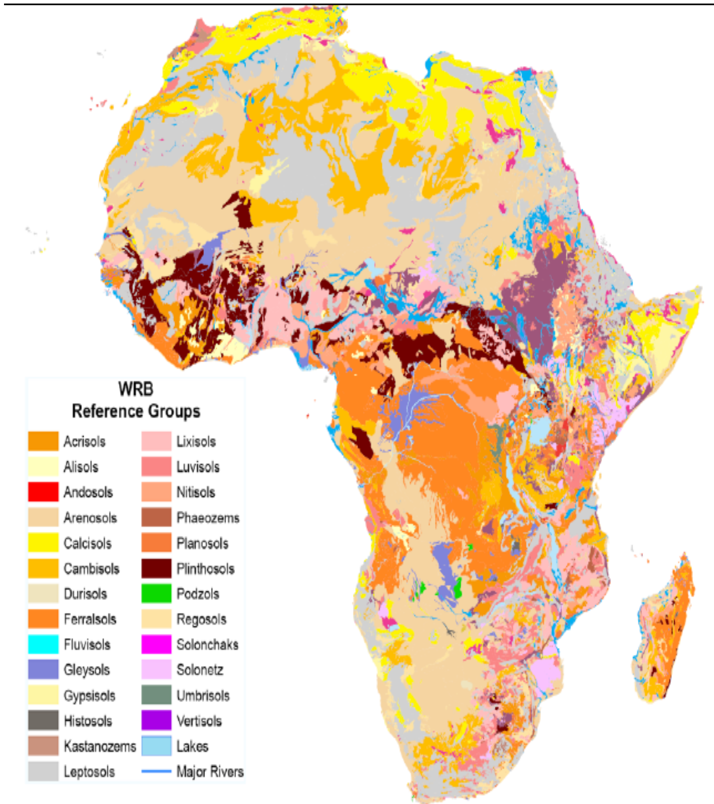
Source GHSL, 2016

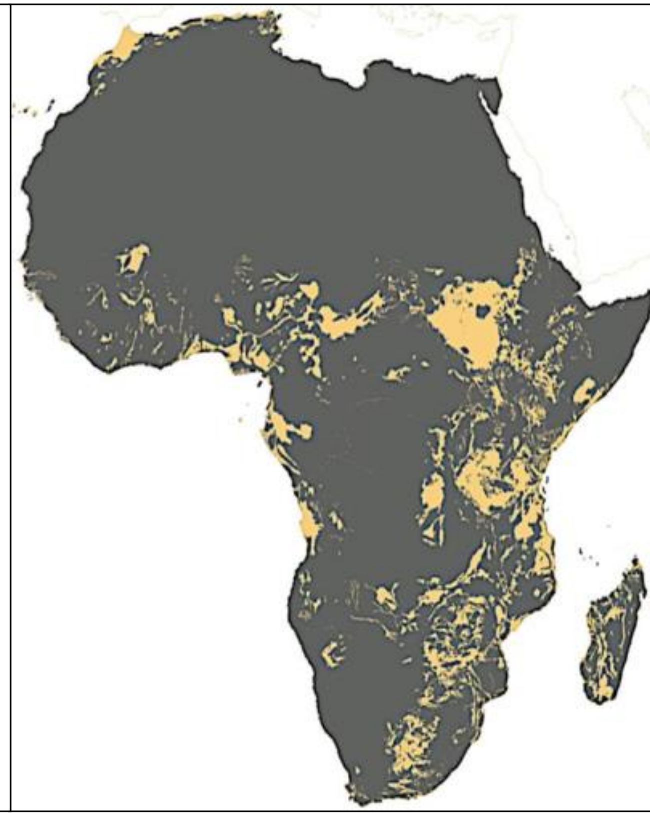
GHSL Contacts at JRC: Martino Pesaresi, Thomas Kemper

Austin airport (TX) 17th January 2018 Landsat USGS / NASA

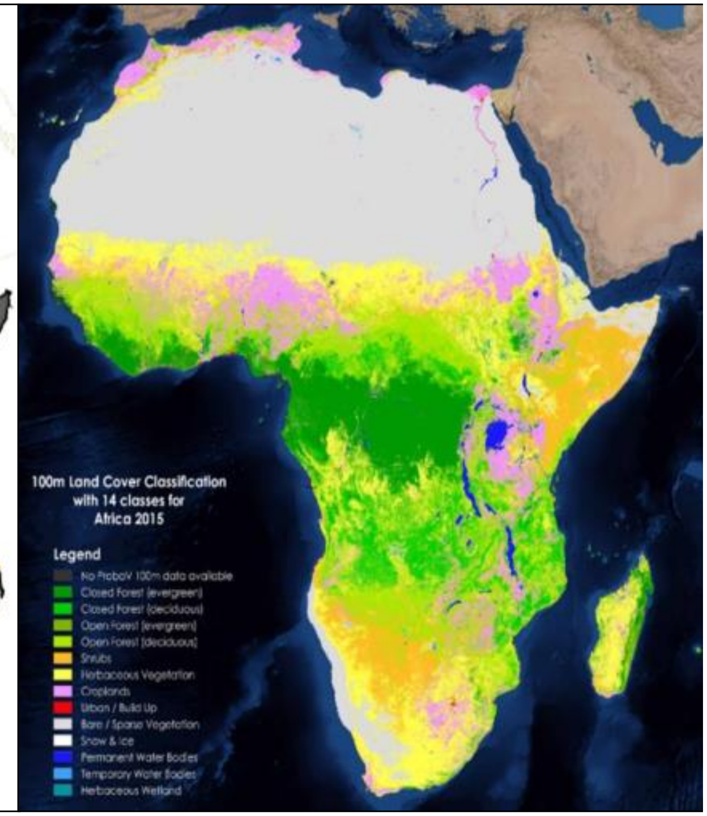
Current land use in Africa

A.R. Jones et al., JRC 2013 Soils Atlas of Africa





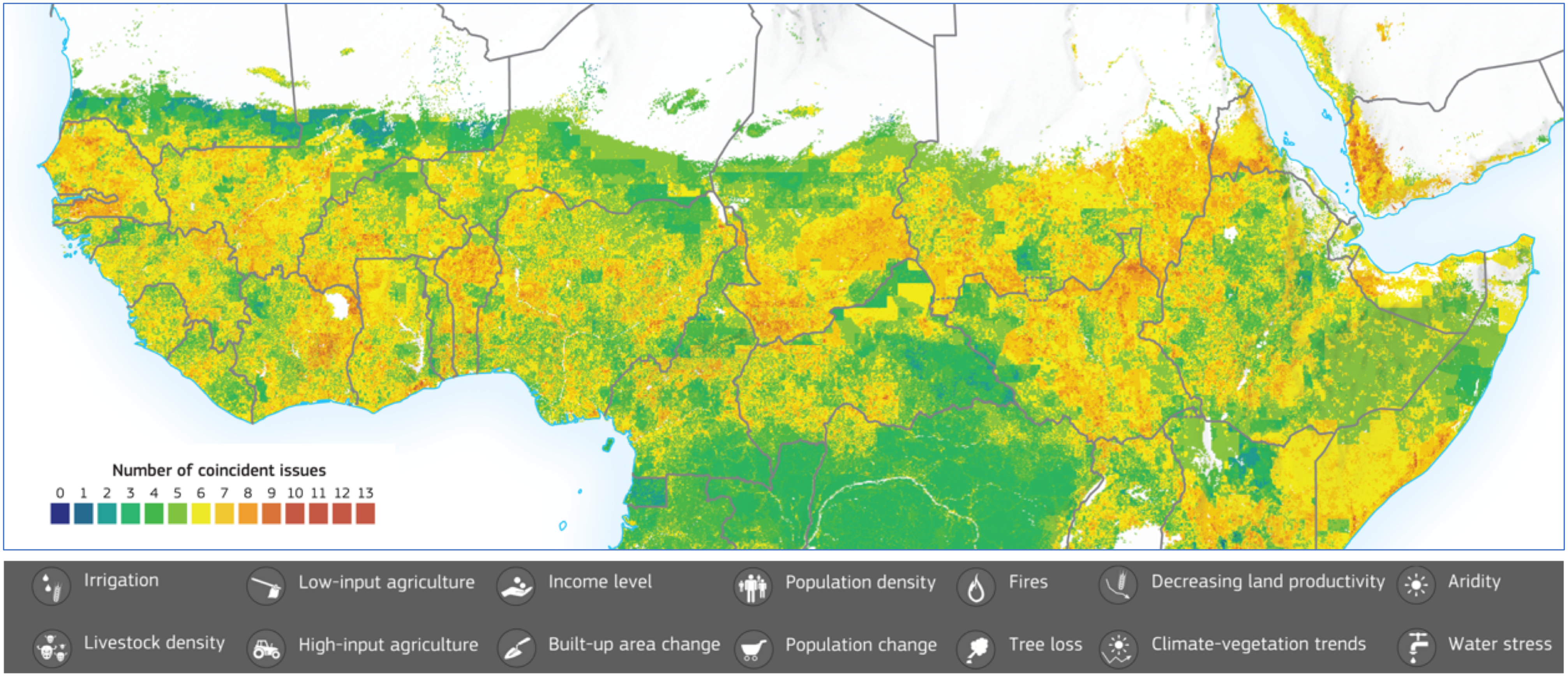
M. Cherlet et al., Copernicus Land cover maps 2018



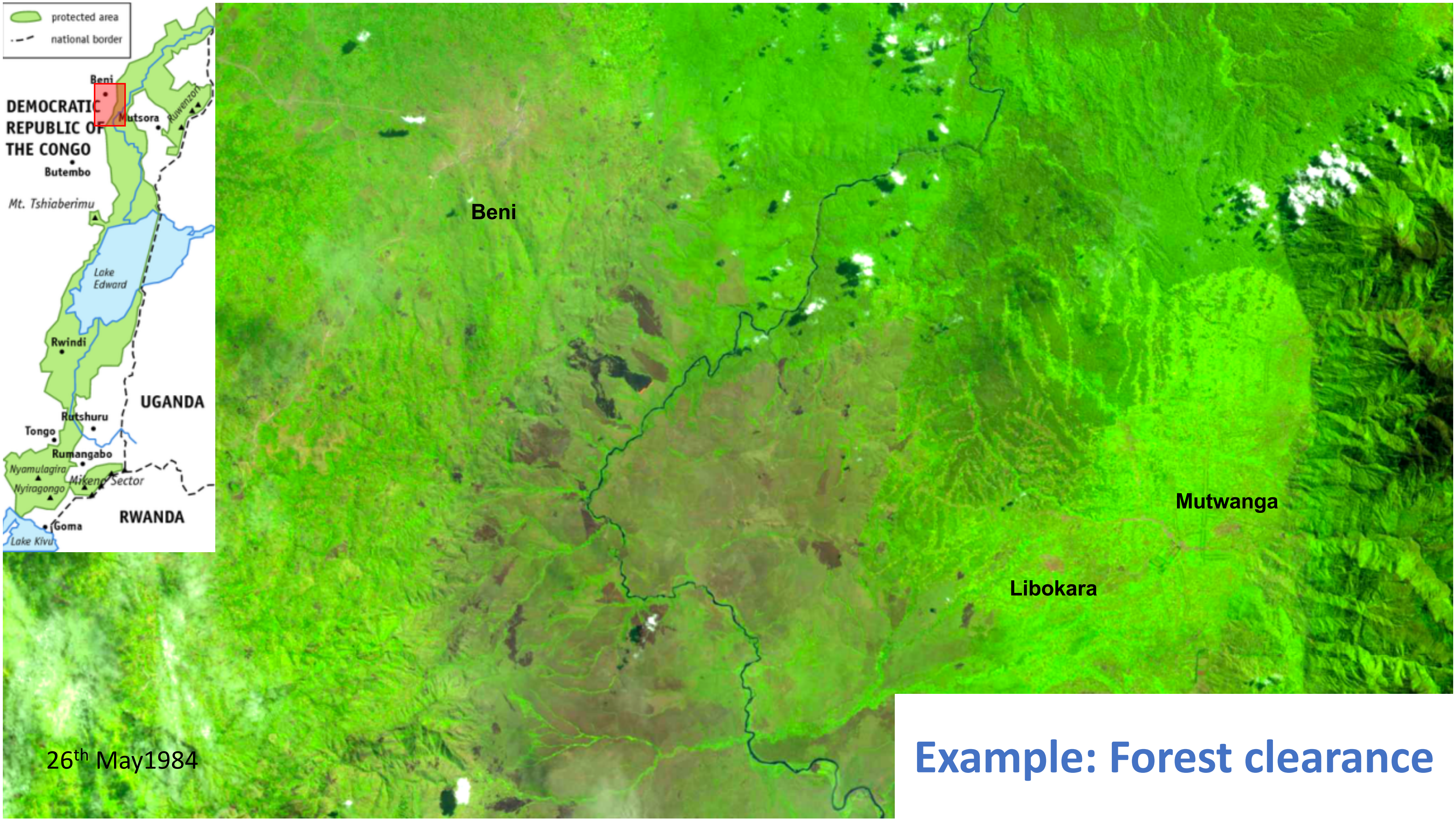
8% of Africa’s soils are optimal for crop production, but 98% of the calories come from the land

World Atlas of Desertification Copernicus global land service proof-of-concept

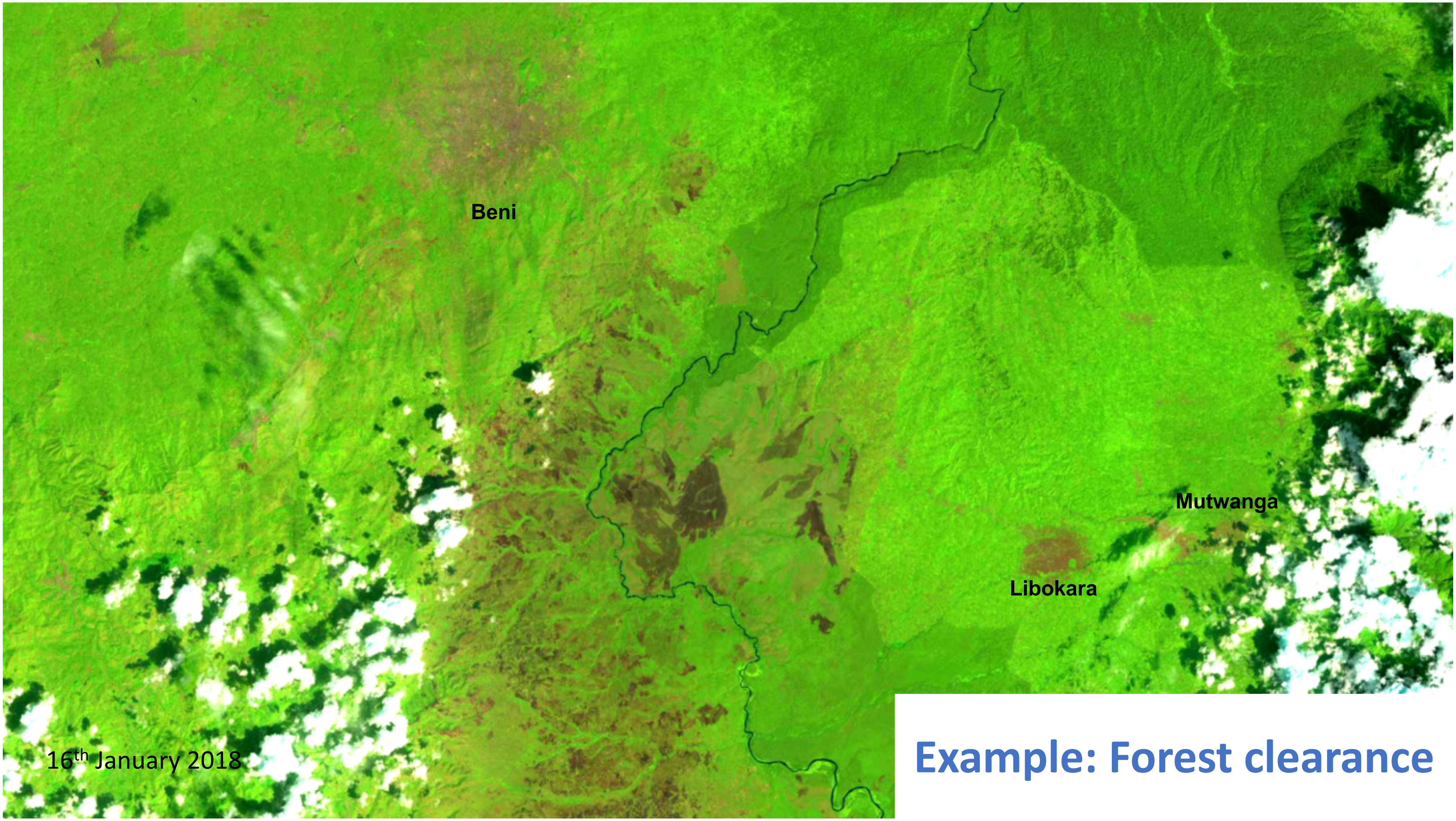
Source: JRC from World Atlas of Desertification, 3rd Edition, JRC/UNEP



Yield gaps, decreased productivity, livestock density and chronic low-income are putting pressure on much of the Sahel and East Africa in terms of Land degradation pressures



Example: Forest clearance

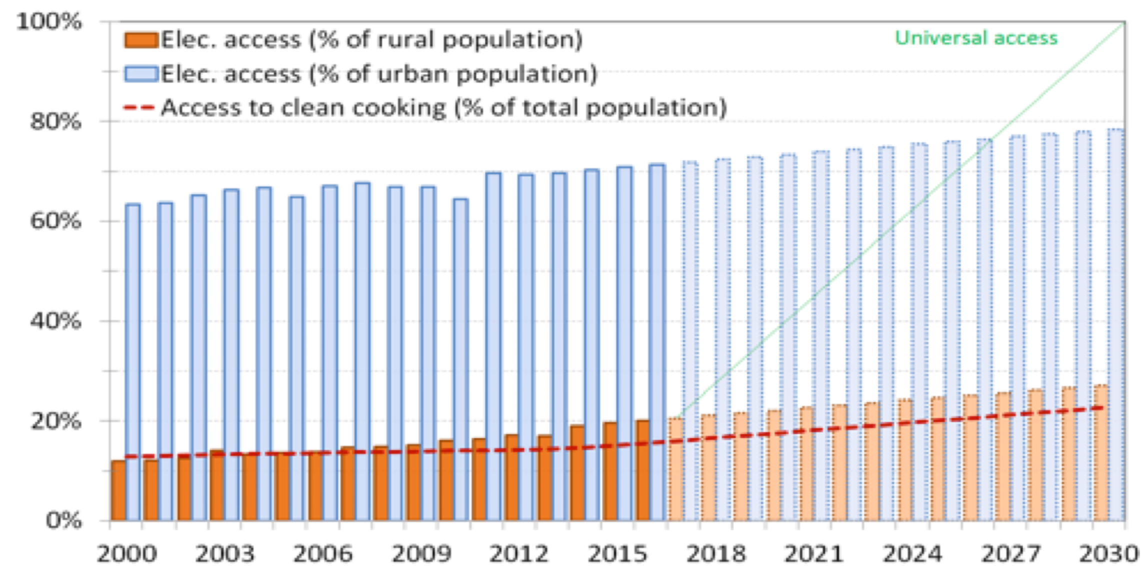


Example: Forest clearance

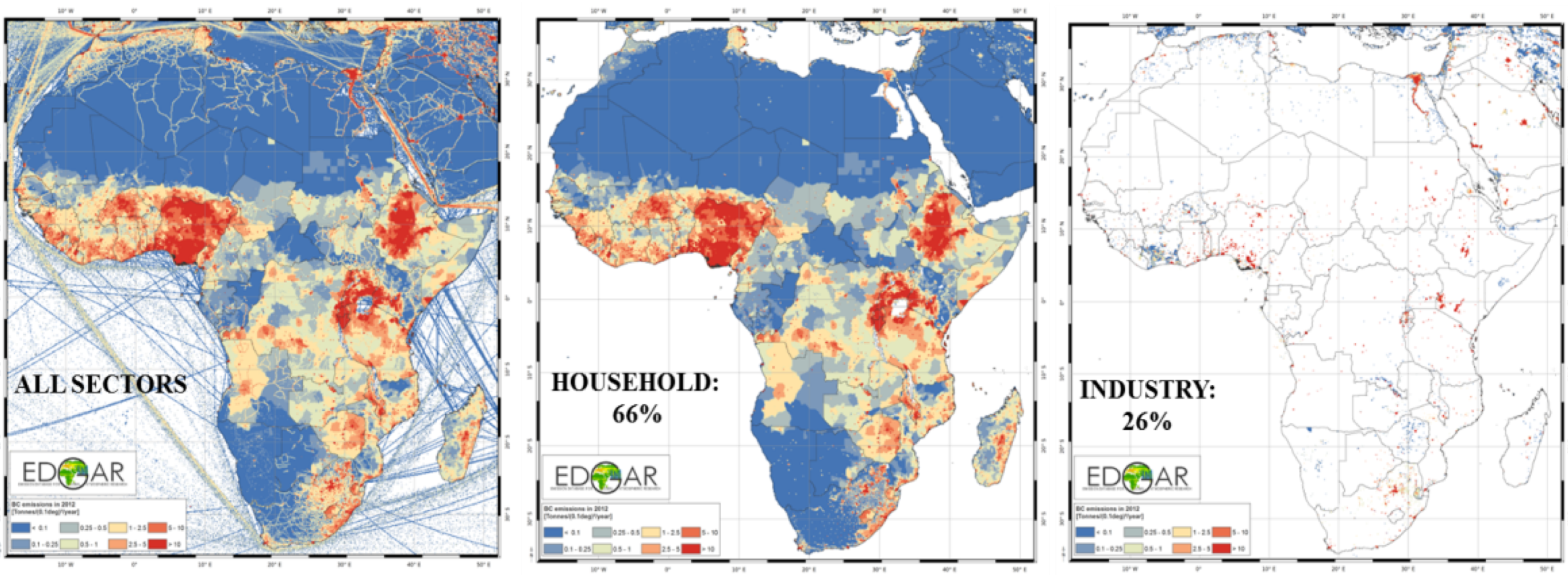
Understanding by linking the satellite monitoring with statistics

Source; The role of wood energy in Africa Samir Amousa, FAO
photo Andreas Brink JRC

Almost 90% of all wood removals in Africa are used for energy
Fuelwood meets 85% of rural energy demands, charcoal most of the rest
Charcoal and wood burning causes relative large BC emissions in the residential sector!



World Bank Open Data, 2017



Annual BC - Black carbon (elemental carbon) emissions in Africa:

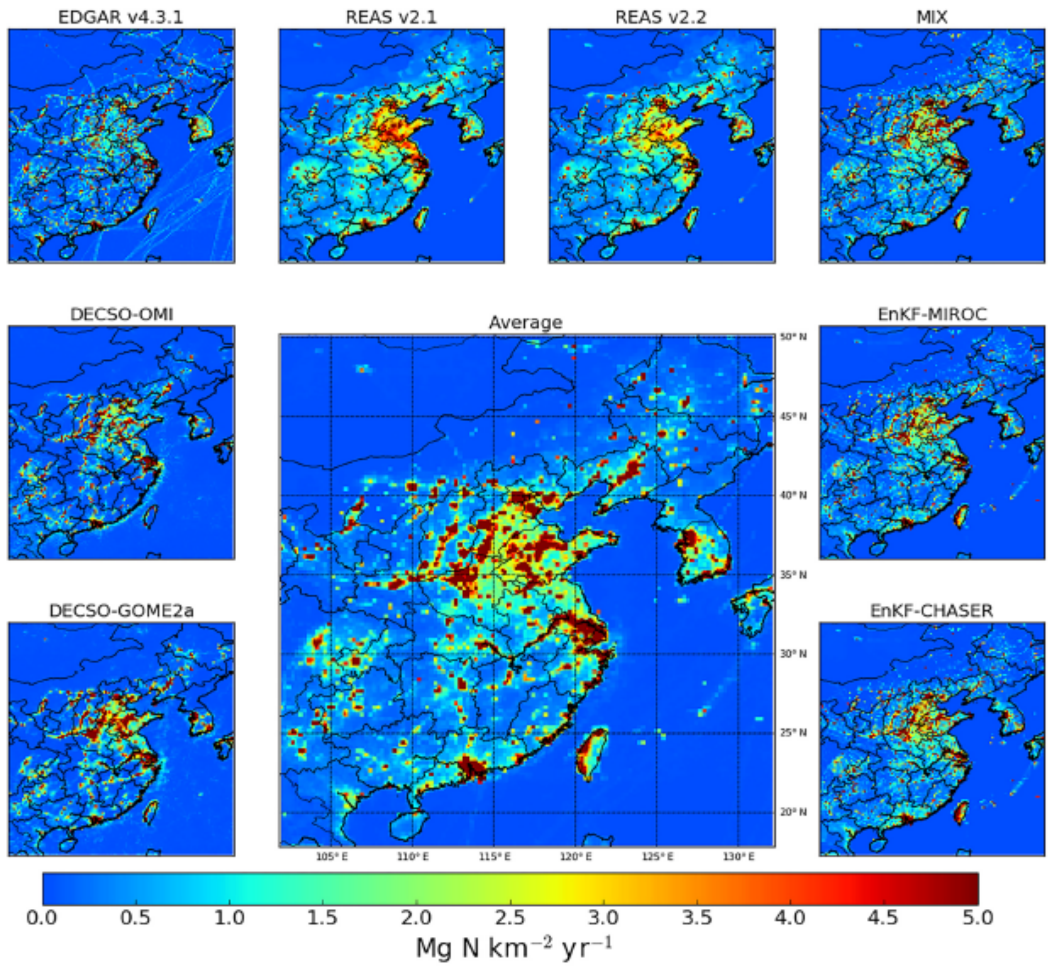
- In 2012, 66% of total African black carbon emissions were produced by only seven of Africa's 54 countries: Nigeria, Ethiopia, D.R. Congo, Tanzania, South Africa, Kenya, Uganda, Sudan.
- Africa has the highest annual per capita emissions of black carbon in the world (~0.8 kg/cap/yr/). (Mainly from household (0.46 kg /person/year) but also from industry).
- From 1970 to 2012, black carbon emissions increased by a factor of four in northern Africa, 2.8 in eastern Africa, 3 in western Africa and 1.7 in southern Africa.

2a. Comparing bottom-up and top-down NOx inventories

Bottom-up emission inventories for Asia:

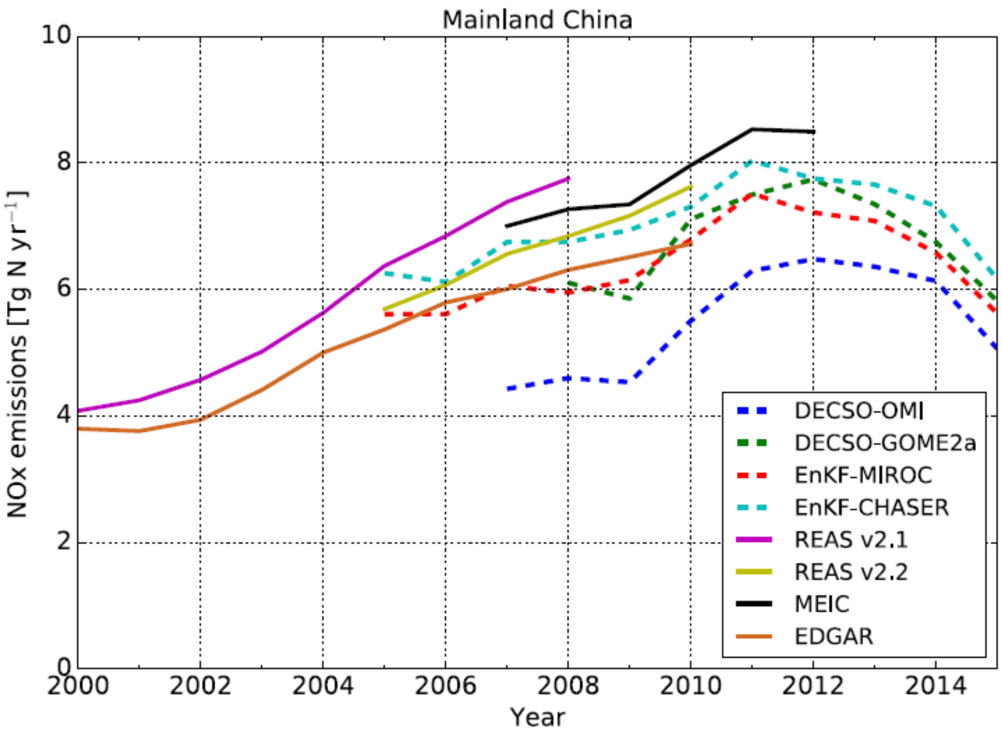
DECSO algorithm using data from one satellite instrument: OMI respectively GOME2

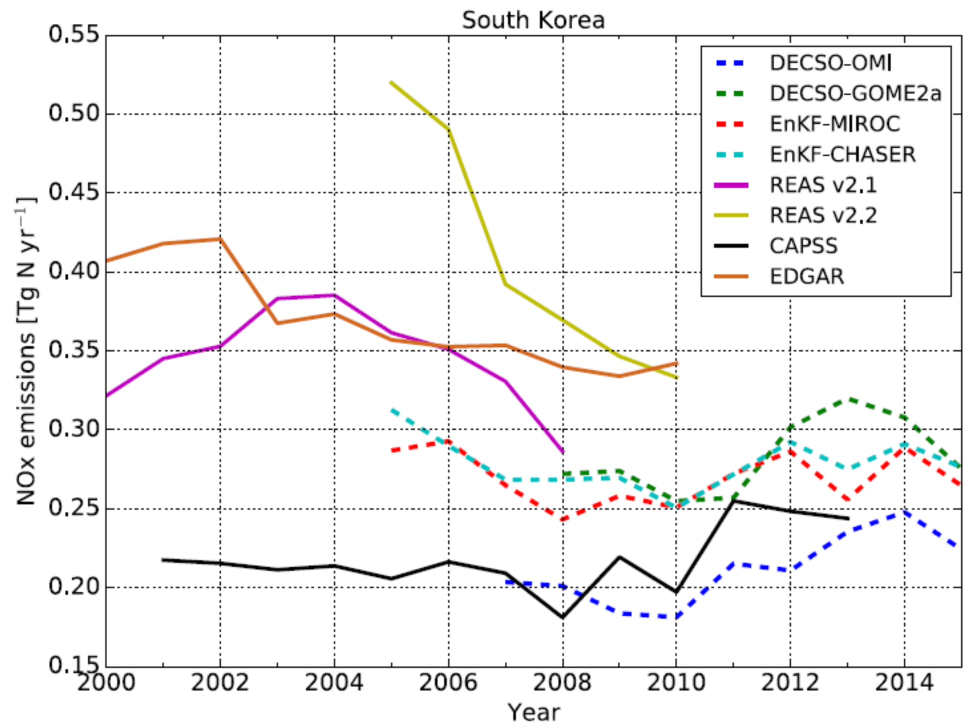
EnKF (Kalman Filter) algorithm optimising data from 3 satellite instruments: SCHIAMACHY, OMI and GOME2



Source: J. Ding al. ACP (2017)

Comparing OMI/GOME2 data with bottom-up NOx inventories



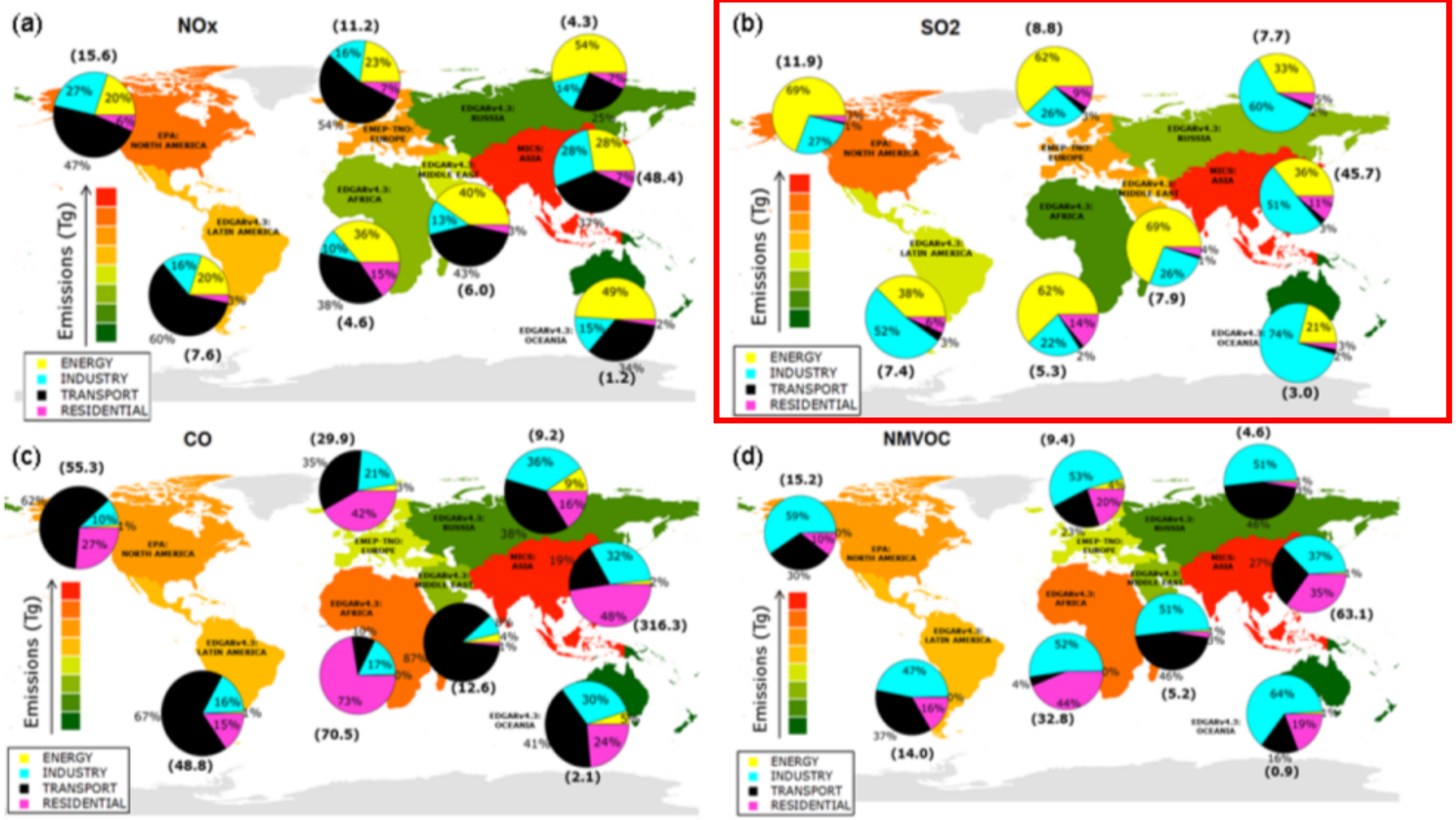


Source: J. Ding al. ACP (2017)

2b. Improving bottom-up SO2 inventory with top-down data

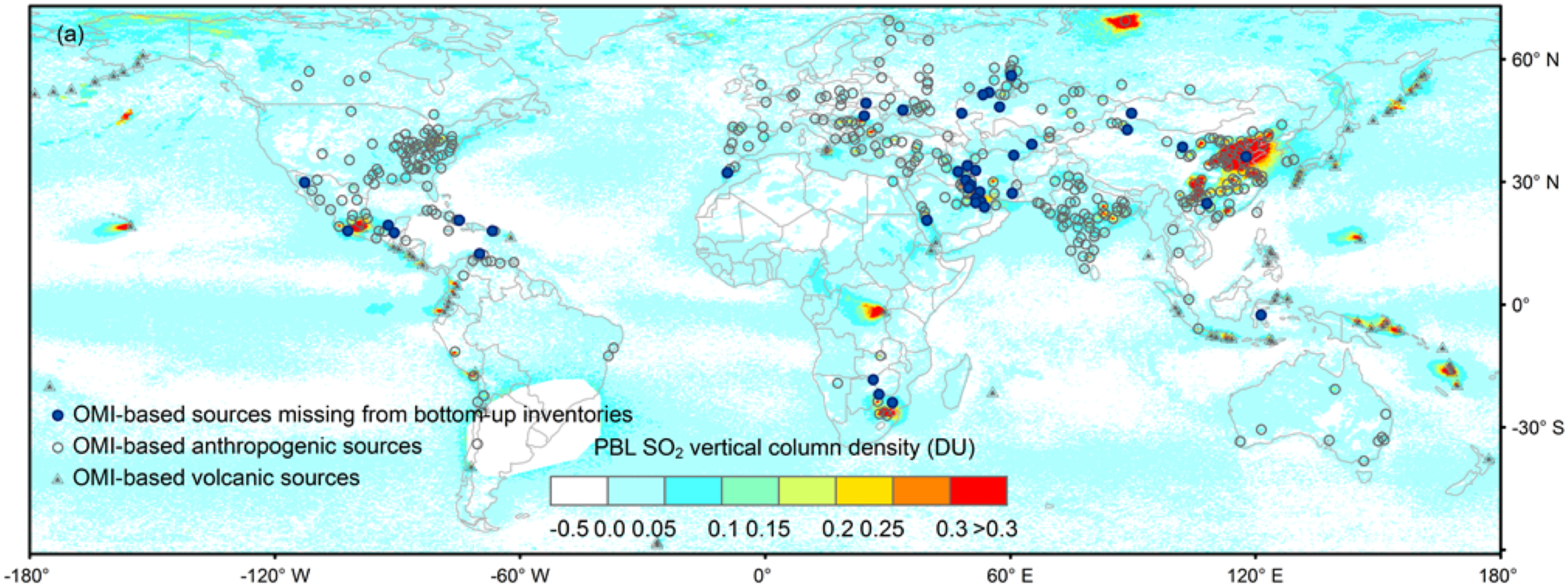
HTAPv2.2. inventory for gaseous and particulate air pollutants

SO2



Source: Janssens-Maenhout et al. (2015) ACP

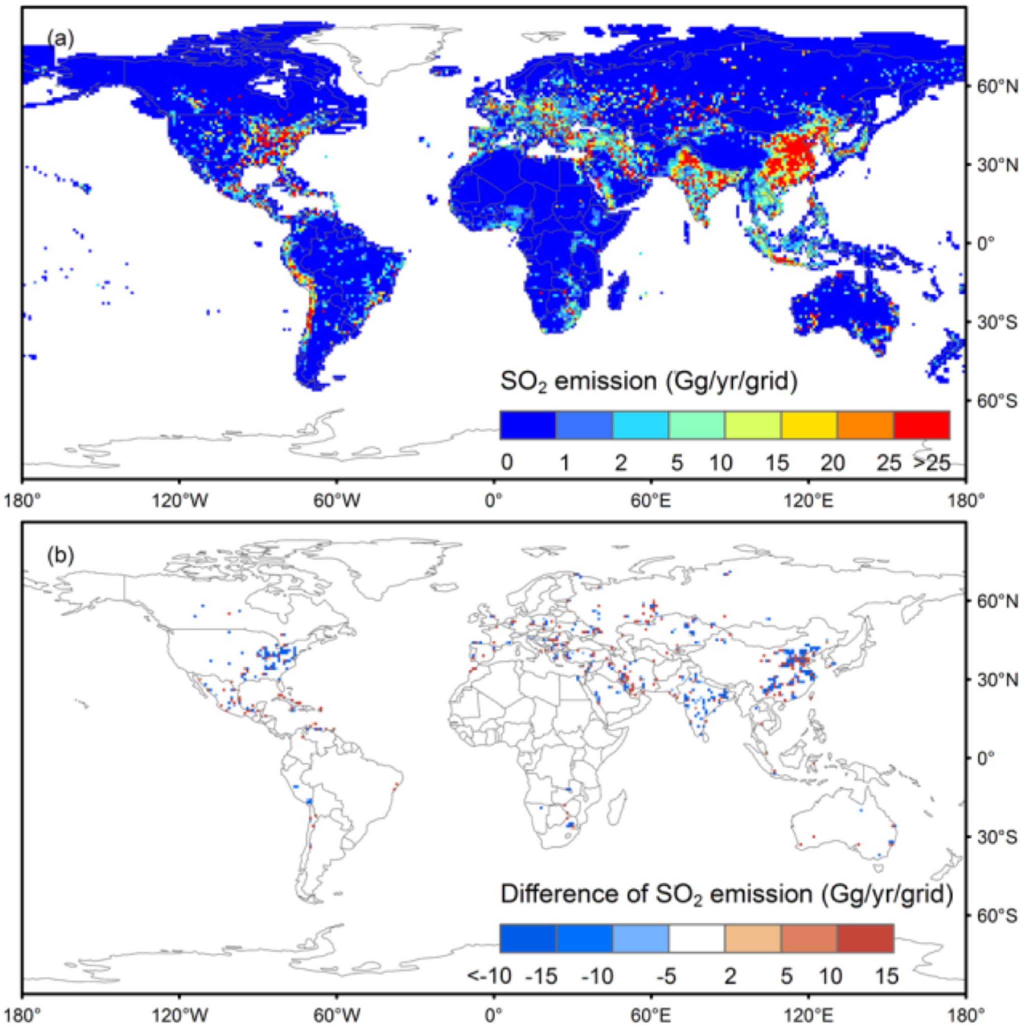
OMI data enhancing the SO2 inventory



Geographic distribution of SO2 sources in the OMI-based emission catalogue (Fioletov et al., 2011). SO2 sources identified that were found to be missing from bottom-up inventories are color coded by blue. The background is the global mean SO2 distribution (in DU) map for 2005–2014.

Source: F. Liu et al. (2018) submitted to ACP

OMI-HTAP enhanced SO2 inventory



(a) SO2 emissions in the OMI-HTAP inventory 2010

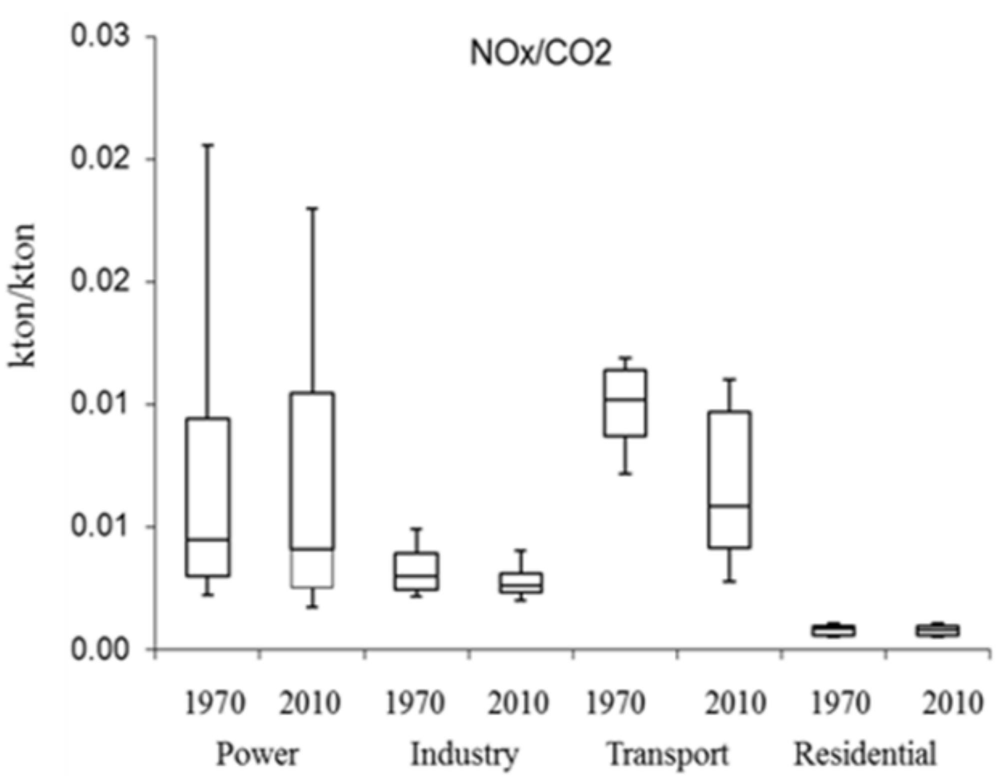
(b) the differences between the OMI-HTAP and the HTAP inventory for 2010. SO2 emissions in the HTAP inventory are subtracted from those in the OMI-HTAP inventory to derive the differences.

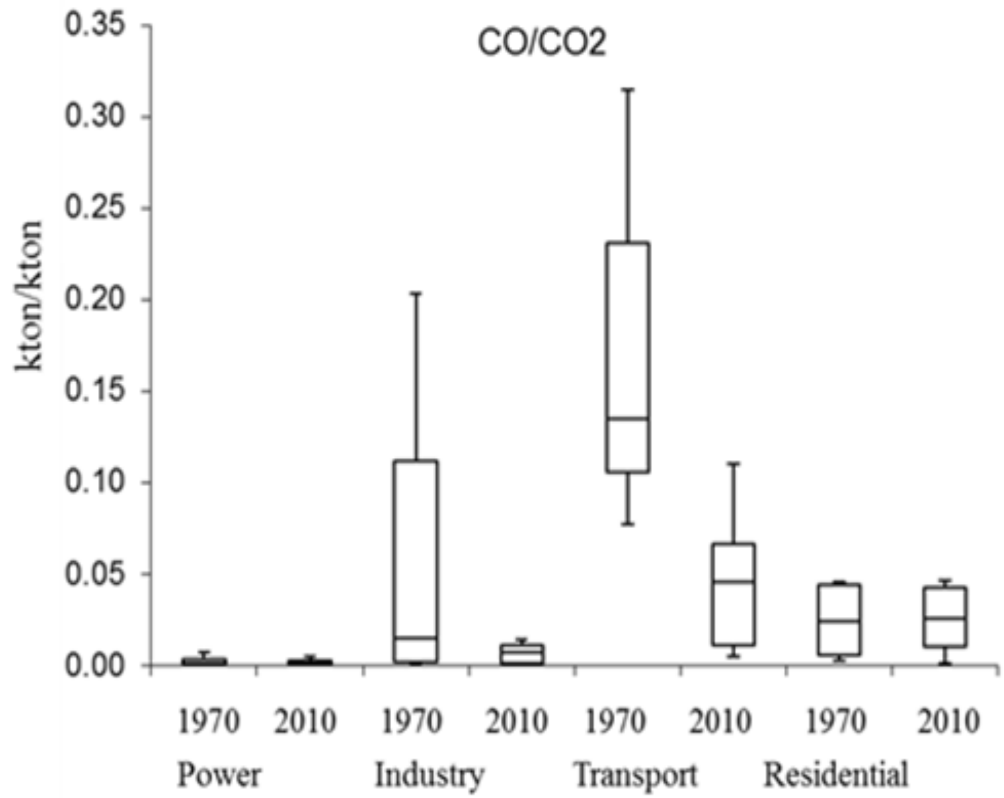
Emissions are regridded at the resolution of 1◦× 1◦ for illustration. The unit is Gg-SO2 per grid cell.

Source: F. Liu et al. (2018) submitted to ACP

3. Evaluation of emission ratios of multipollutant bottom-up inventory

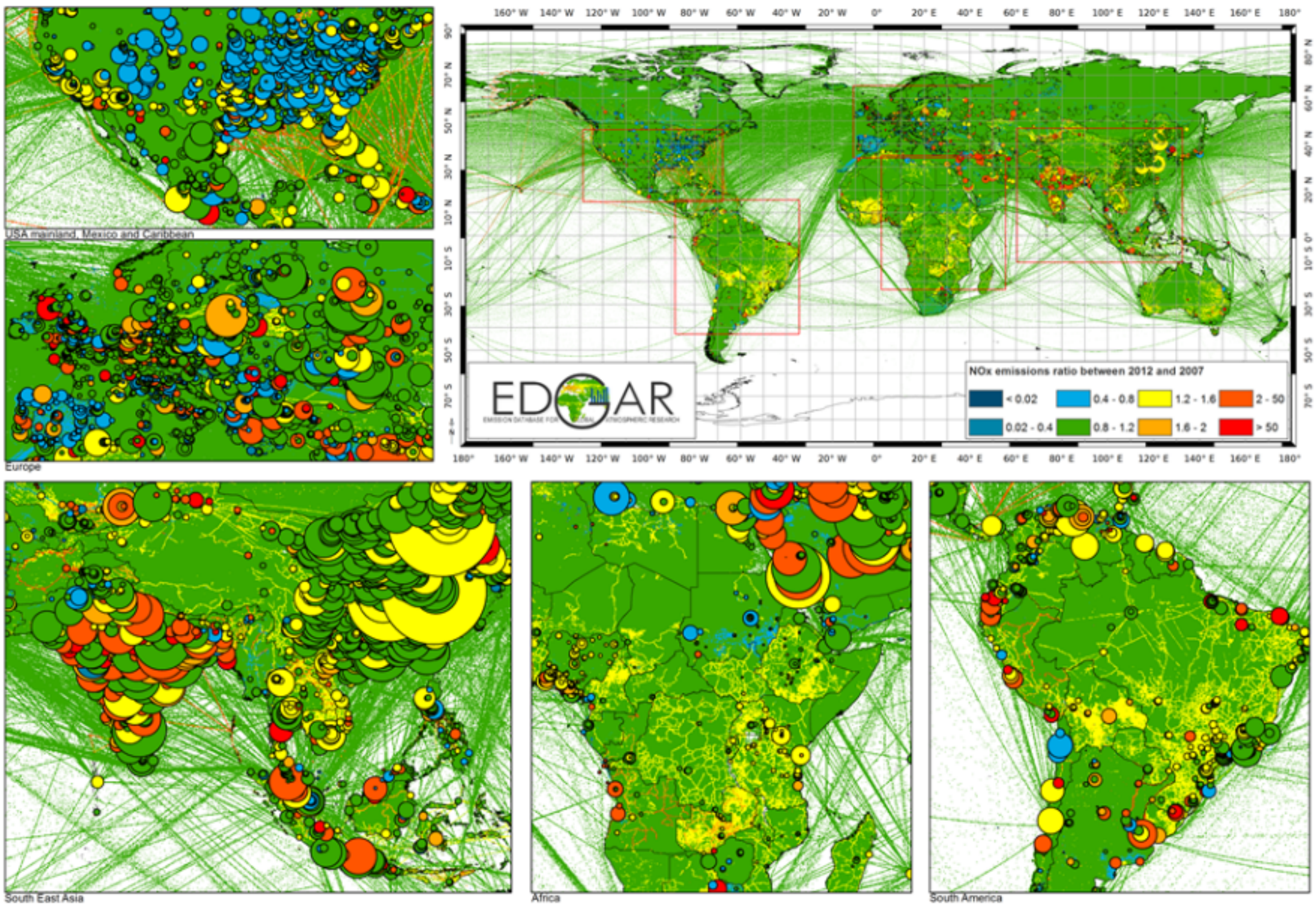
EDGARv4.3.2 inventory for greenhouse gases and particulate air pollutants





Source: Crippa et al. (2018) submitted to ESSDD

Bottom-up change in strength of NOx point sources



Relative change over 5 years (2012 versus 2007) in NOx emission of point sources in EDGARv4.3.2

circle size= point source strength

colour = relative change
Green stable within 20%
Yellow increase 20% - 60%
Blue decrease -20% - -60%

These changes are not present in the CO_2 data with these strengths!

Source: Crippa et al. (2018) submitted to ESSDD

Conclusion

Moving towards a dynamic update of static inventories

① Different info sources are sometimes our best defence

② Combining data into knowledge needs to flow to the right people at the right time

③ With Copernicus and Galileo the EU produces, collates and distributes data, information and knowledge on a free and open basis

④ We need to build capacity, especially in those parts of the world with less data infrastructure

Contact: greet.maenhout@ec.europa.eu

Top: Rondonia deforestation (04.08.84 to 04.08.13)
Centre: Nanchang urbanization (15.07.89 to 25.01.14)
Bottom: Al Jouf agricultural expansion (26.10.84 to 30.01.14)
all images Landsat courtesy USGS / NASA all tiles 300 km^2 and N - S orientation