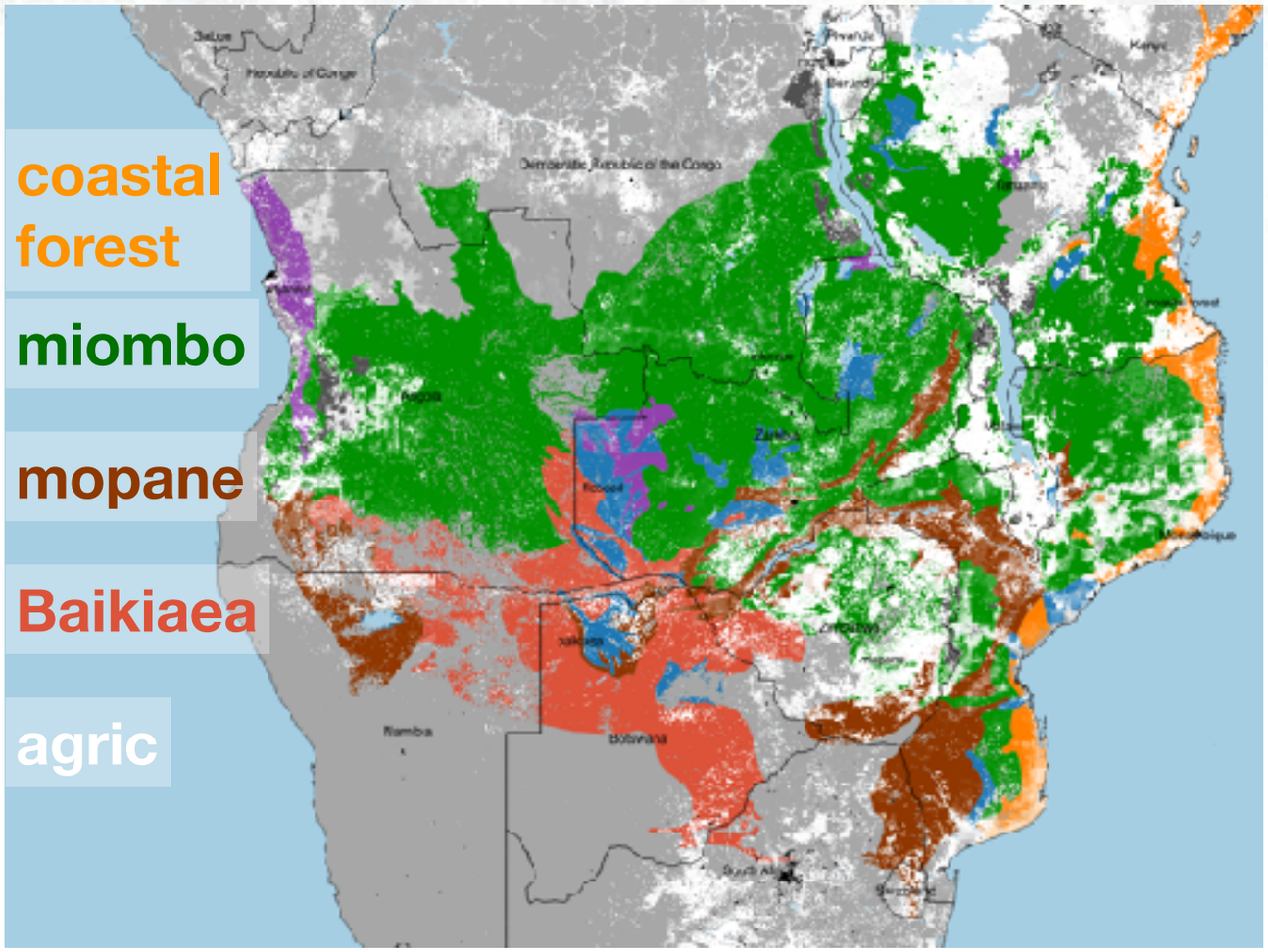
Plan for talk

1. Recent research results on land use change in the miombo ecoregion
2. Application of new remote sensing tools for forest management and monitoring
3. A regional network to understand global change impacts in African woodlands



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NERC SCIENCE OF THE ENVIRONMENT

JAXA

espa ecosystem services for poverty alleviation

esa

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Carbon losses from deforestation & widespread degradation offset by extensive regrowth in African woodlands. McNicol et al (2018) *Nature Communications*

Deforestation

Degradation

Regrowth

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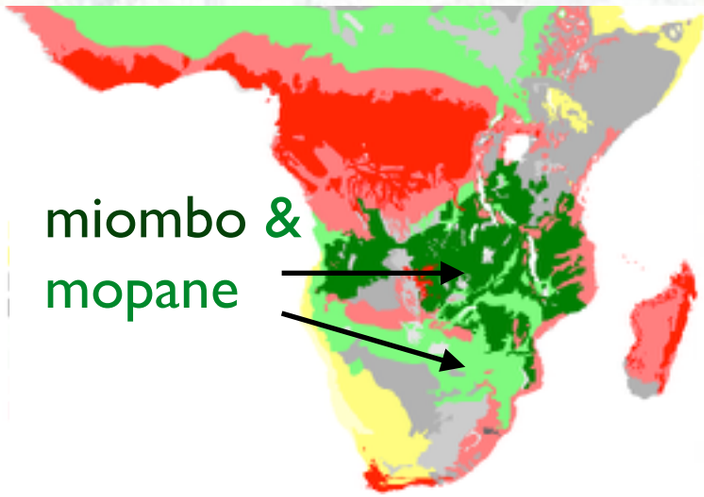
+ many others in Edinburgh tropical land use team and beyond

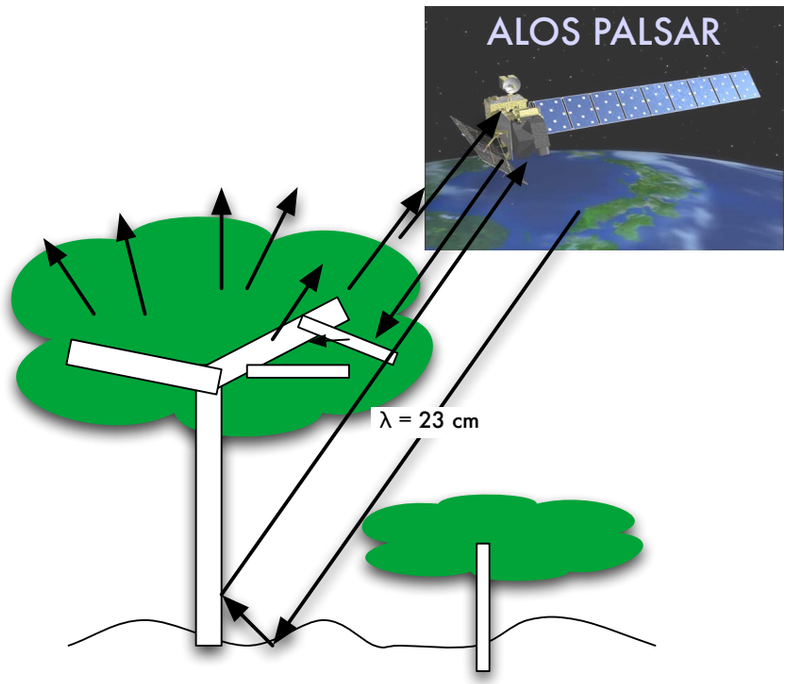
Current situation

- Knowledge around deforestation limited by poor data, and diverse definitions.
- Main global satellite data set (Hansen 2013; Landsat), primarily designed for wet tropics - validity at low biomass, and in seasonal ecosystems?
- $\Longrightarrow$ uncertainty on **deforestation**, particularly in savannas and woodlands (where rates are thought to be high)
- No large scale estimates of **degradation** or its role in C emissions - current best estimates rely on FAO harvest data. Case studies only in hotspots (Ahrends, 2010; Ryan 2014).
- Suggestions of widespread **increases** in woody biomass (satellite based, no ground data (Lui 2015 vs Stevens 2016)

Methods

- Focus on the woodlands of southern Africa (5M km^2)
- Produce annual biomass maps from long wavelength radar images (Thanks JAXA!) and ground plots (SEOSAW network).
- Probabilistic estimate that deforestation, degradation or regrowth has occurred in each 25 m pixel.
- Methods validated at smaller scales (Mitchard, 2009; 2012; Ryan 2012; 2014): good detection rates for regrowth and def+deg.
- Advantages of radar: simple, linear relationship with woody biomass in woodlands, not affected by clouds, or variations in grass or leaf biomass (major problem for e.g. Landsat, MODIS).
- Issues: doesn't work in flooded areas, sensitive to soil moisture at low woody biomass, limited data availability
- Full details: McNicol et al. *Nature Comm*. (2018). Open access





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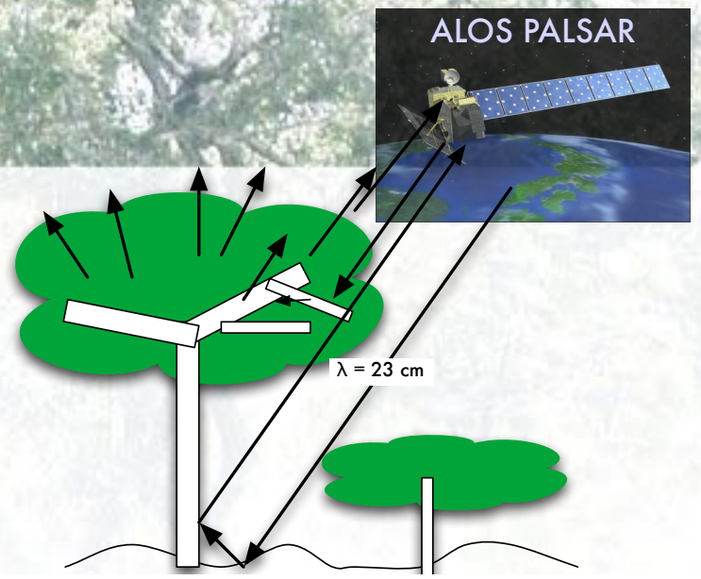
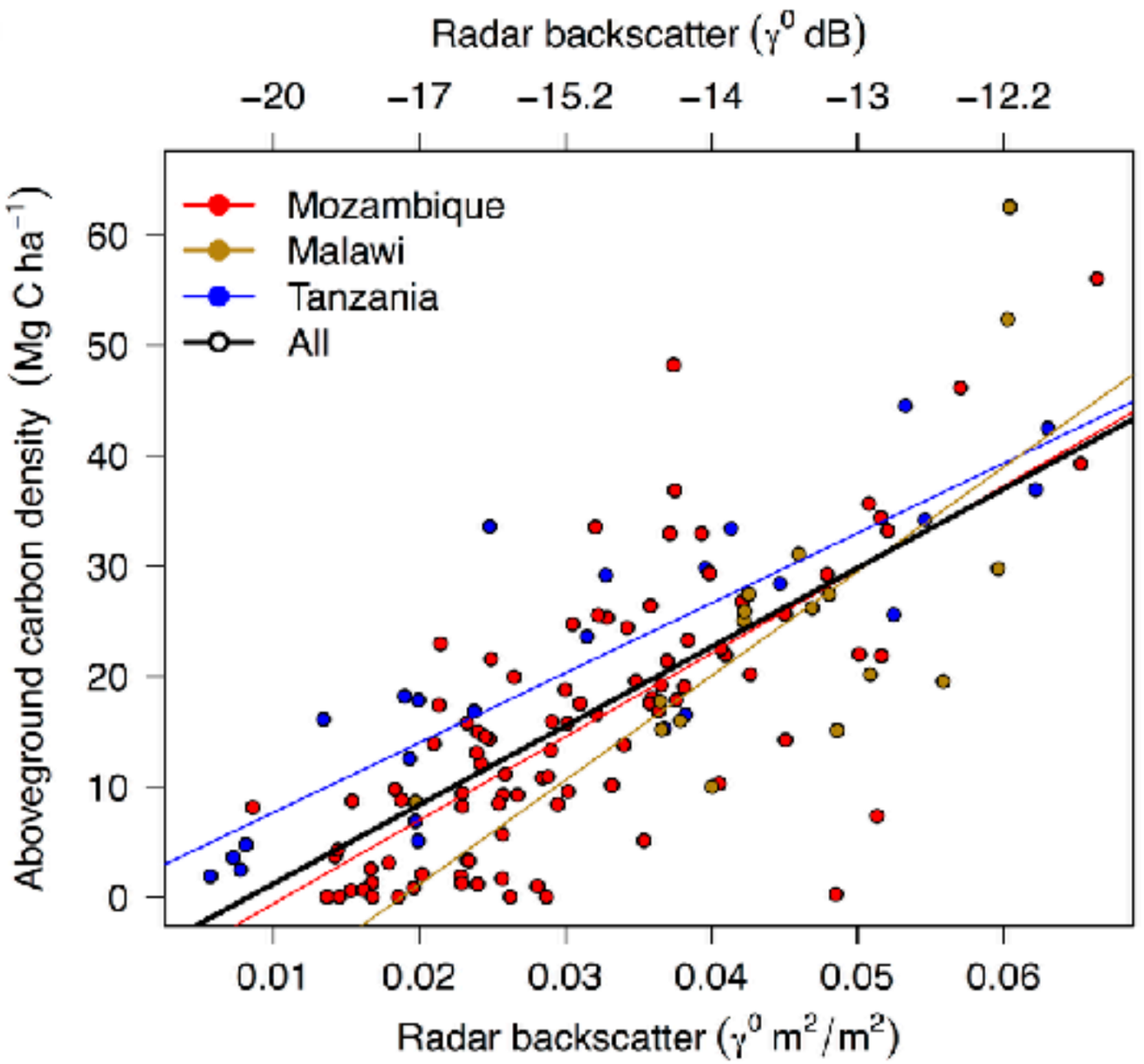
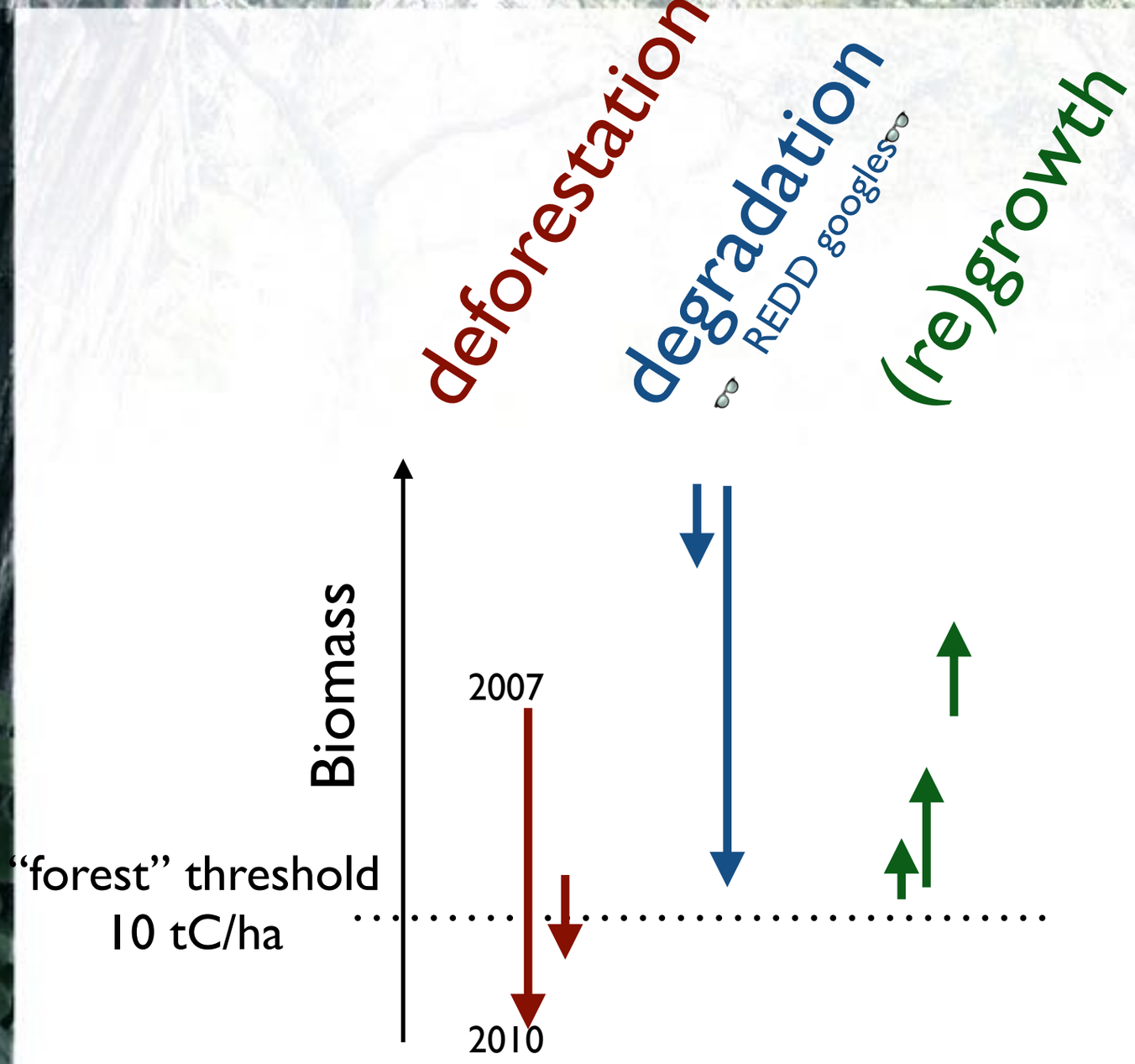
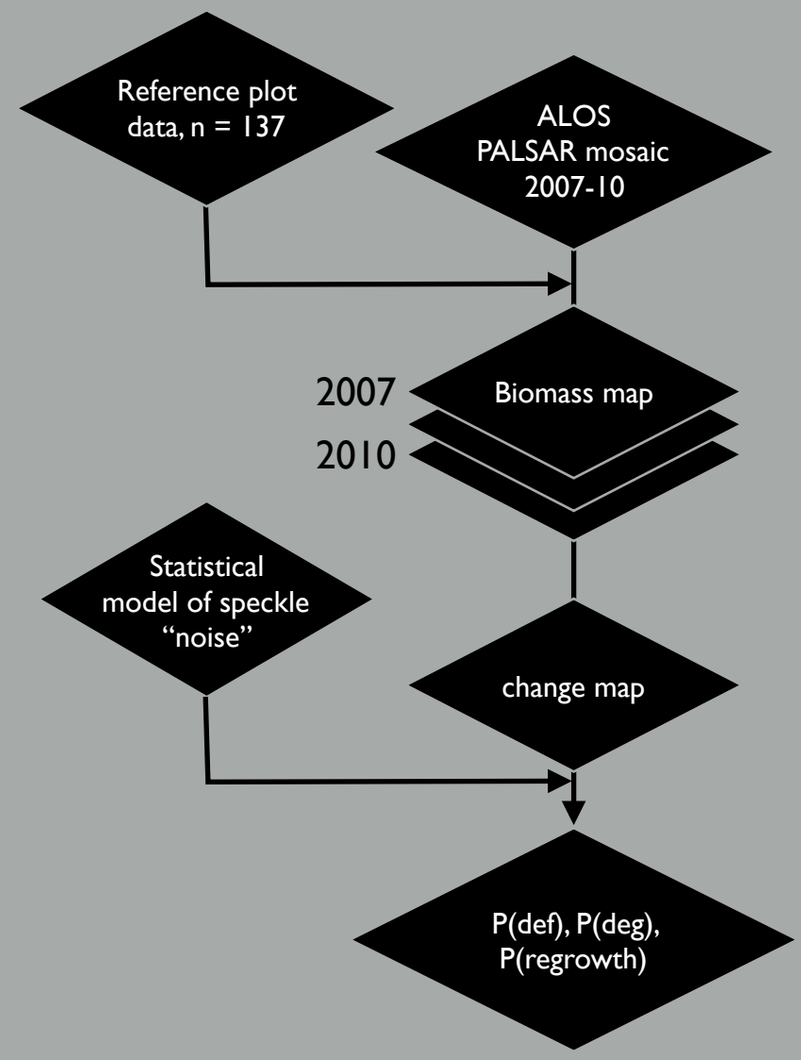




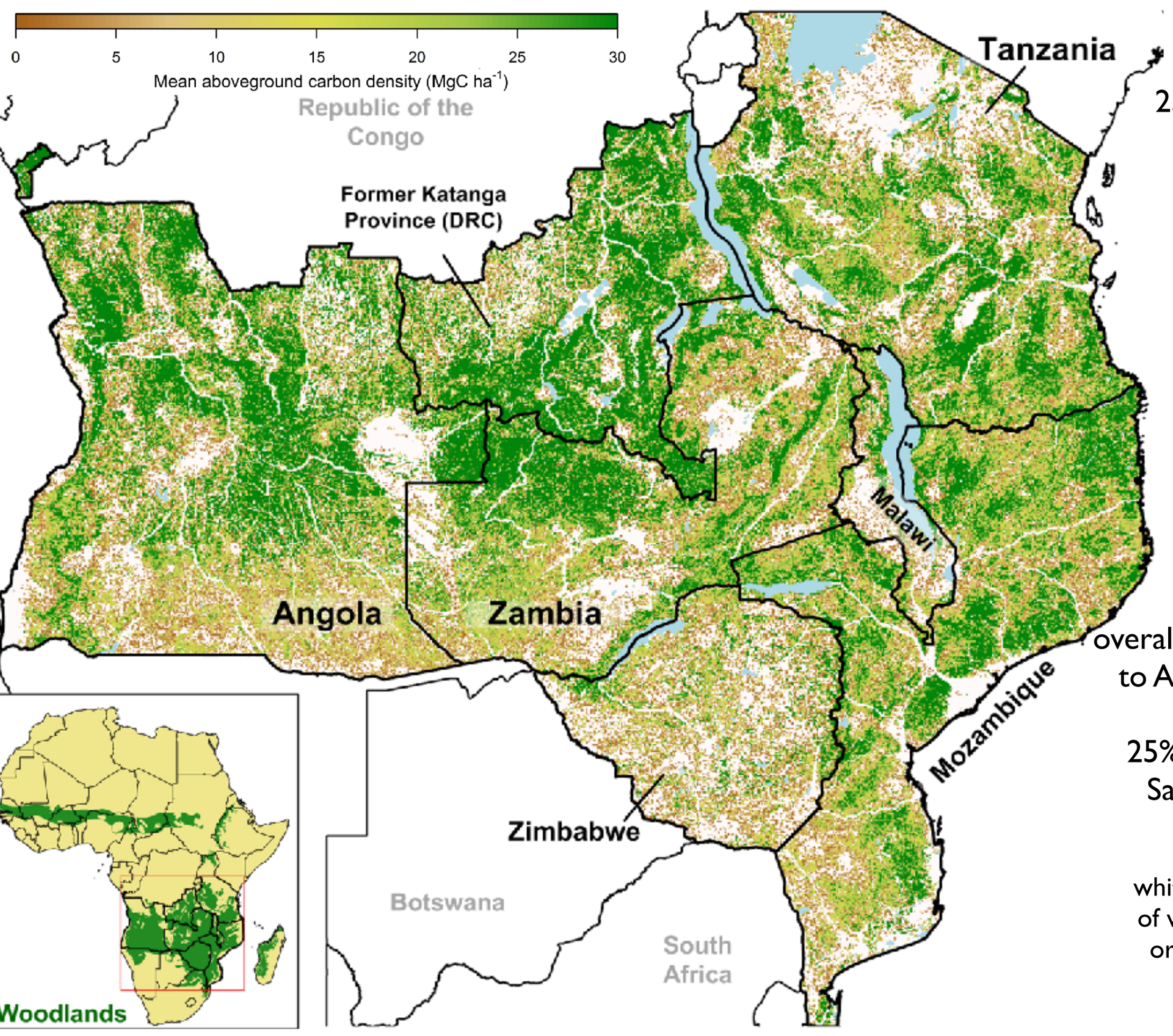
Novel estimates of the rates and locations of biomass change



Exclude minor losses (<20% reductions), as small losses at 25 m are often 'natural' (Ryan et al 2014).



Final output: estimate of the probability that each land cover change has occurred in each 25 m pixel



2007

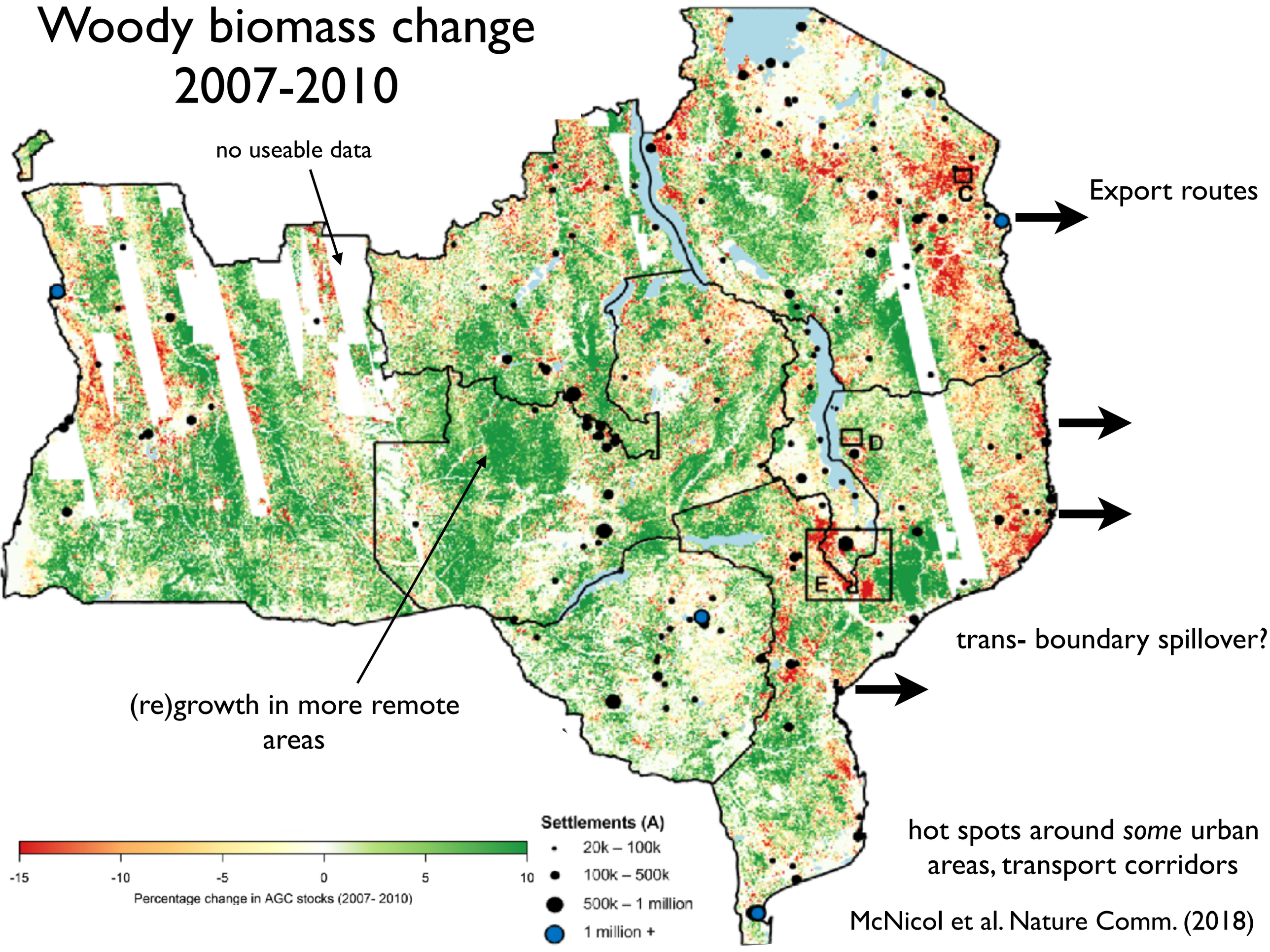
25 m resolution

overall stocks similar to Avitabile 2016

25% lower than Saatchi 2011

white indicates areas of very low biomass or masked due to soil moisture

Woody biomass change 2007-2010



hot spots around *some* urban areas, transport corridors

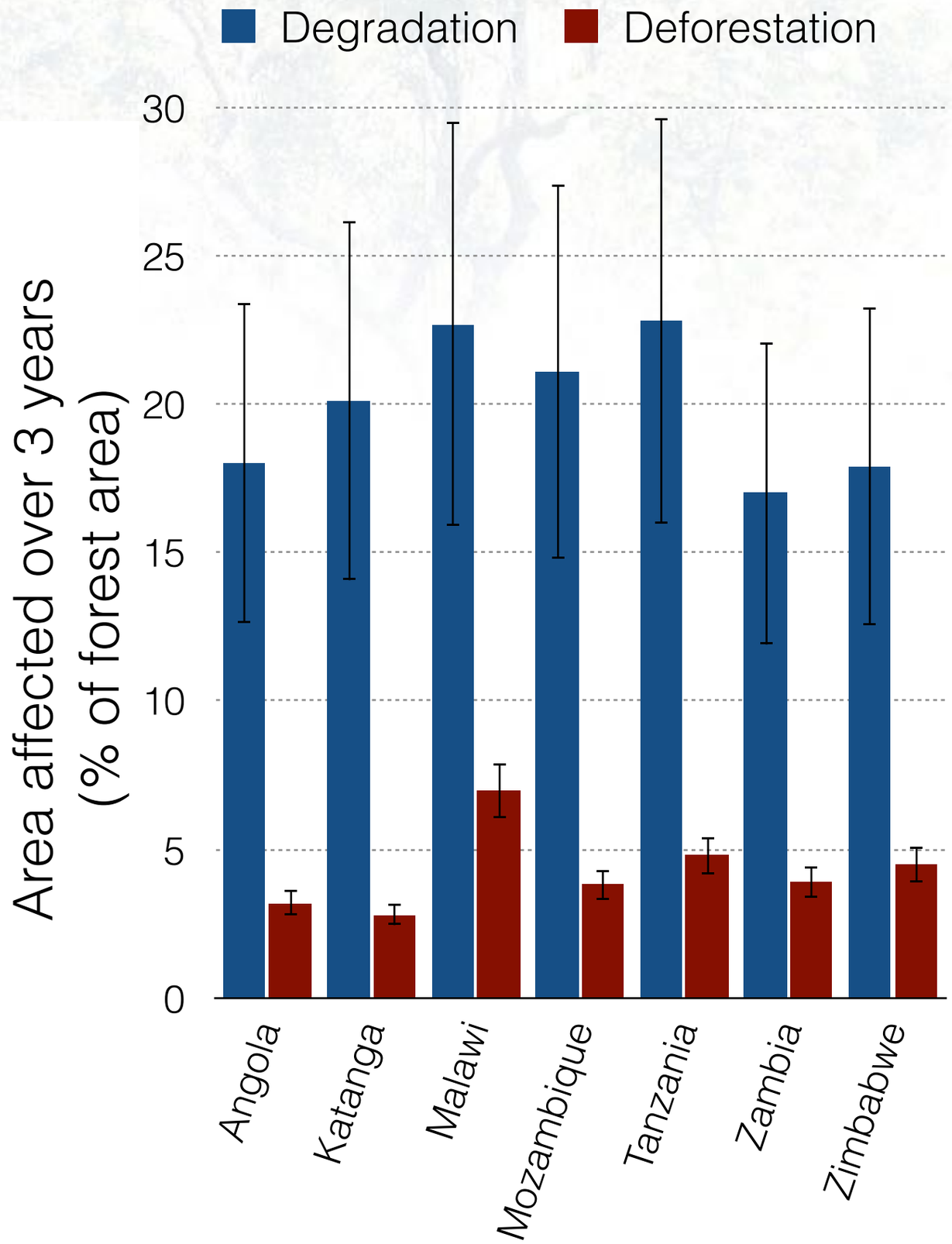
McNicol et al. Nature Comm. (2018)

Data summarised at admin level

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Country			AGC stocks (Gg C)				Carbon stock changes (Gg C)					Area changes (km²)			
2	> Region	Land area (km²)	Woodland area (km²)													
3	>> District			2007	2008	2009	2010	Gains	Losses	Deforestati	Degradatio	Minor losses	Gains	Deforestati	Degradatio	Minor losses
4																
5	Tanzania	897,602	435,589	1,030,188	1,033,267	962,644	980,280	55,714	105,468	28,987	53,971	22,510	187,342	42,492	87,753	117,808
6																
7	...															
8																
9	Morogoro	69,262	31,606	83,172	89,268	75,454	80,444	6,001	8,719	2,016	5,055	1,648	13,900	3,033	6,729	7,929
10	Kilombero	13,340	5,668	14,347	14,846	13,182	14,151	1,277	1,471	381	838	252	2,643	587	1,101	1,334
11	Kilosa	12,609	6,869	17,862	19,598	15,581	16,743	1,013	2,130	547	1,176	407	2,759	774	1,584	1,749
12	Morogoro rural	13,429	7,683	18,466	19,579	16,123	16,396	645	2,711	563	1,578	570	2,601	945	2,091	2,042
13	Morogoro urban	551	136	294	327	251	260	15	48	15	23	10	45	28	31	32
14	Mvomero	6,450	2,877	7,169	7,756	5,756	5,766	182	1,583	457	895	231	786	530	894	666
15	Ulanga	22,883	8,373	25,033	27,161	24,562	27,127	2,869	776	52	545	178	5,066	169	1,029	2,106

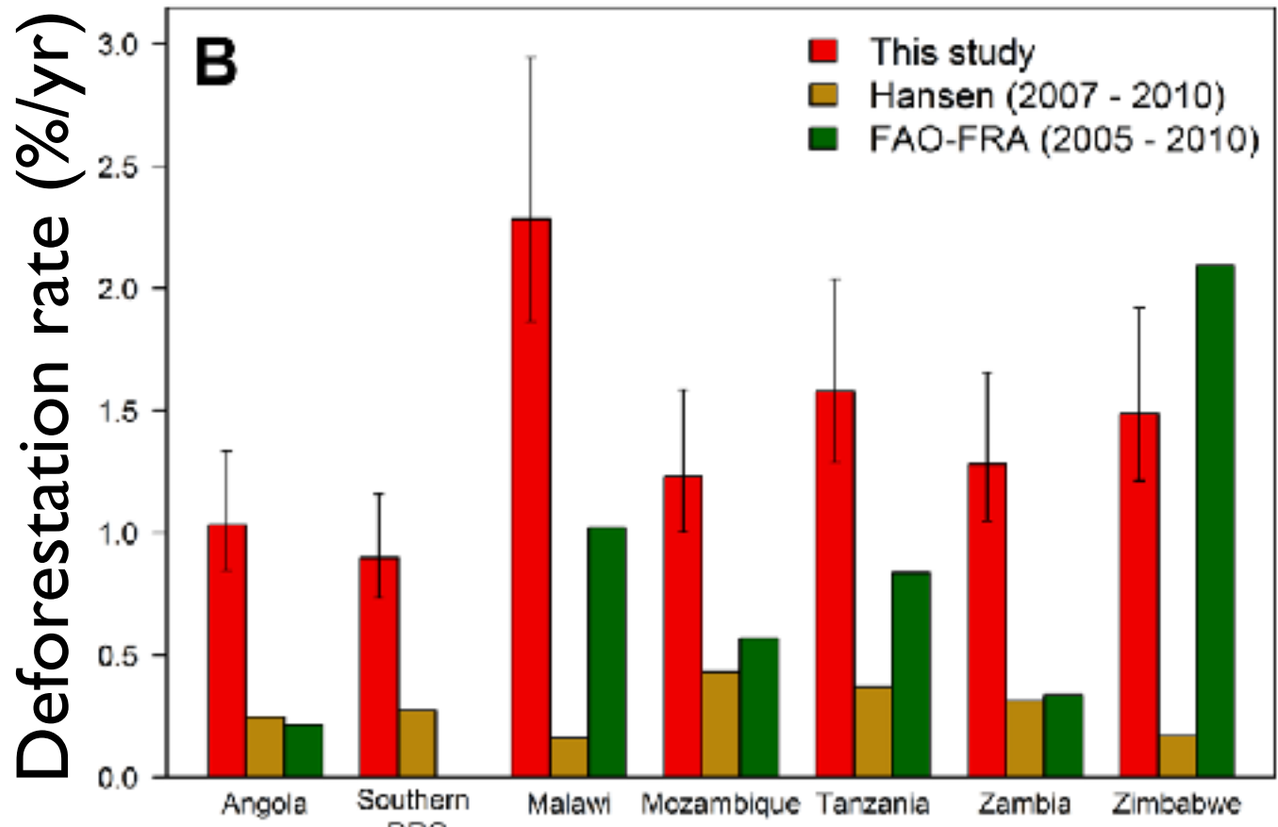
Main findings: Degradation

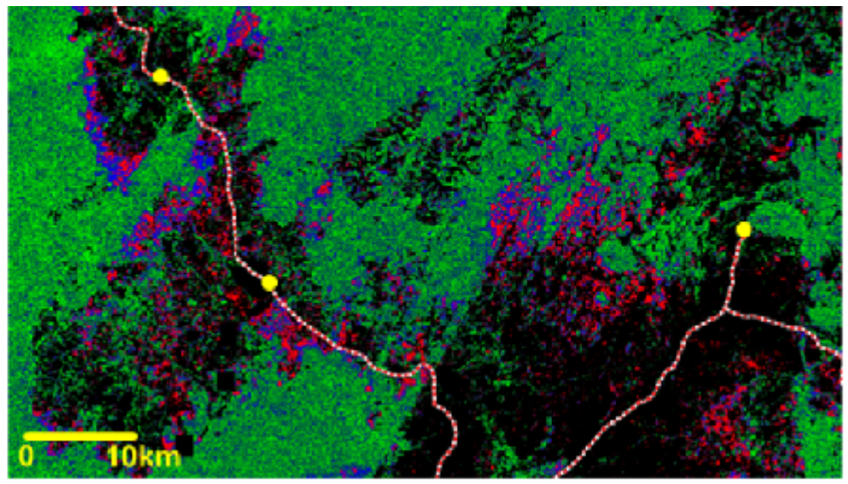
- widespread - affects 20% of study area over three years
  95%CI = [17 – 22%]
- Mostly in higher biomass woodlands
- Particularly high along eastern seaboard, near urban areas
- Accounts for 65% of carbon losses
  [57-72%]



Deforestation

- 2.2 x Hansen and FAO FRA deforested area estimates
- "mopping up" is common, more so than "frontier" deforestation
- Most deforestation at low biomass (90% <20 tC/ha) - *coup de grace*, not first cut

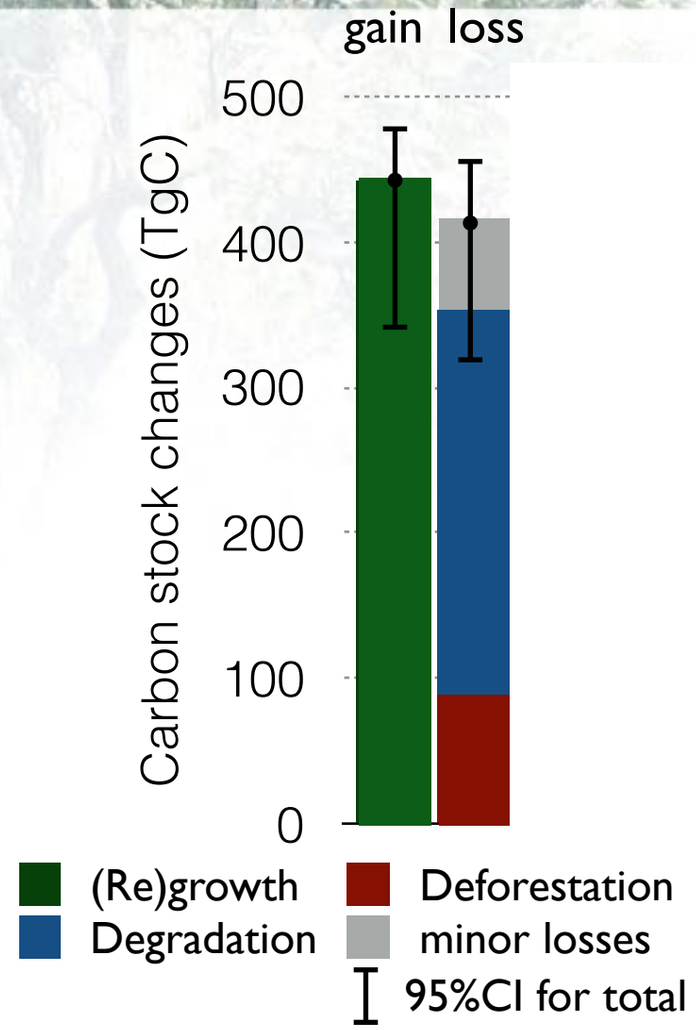




black = non-forest

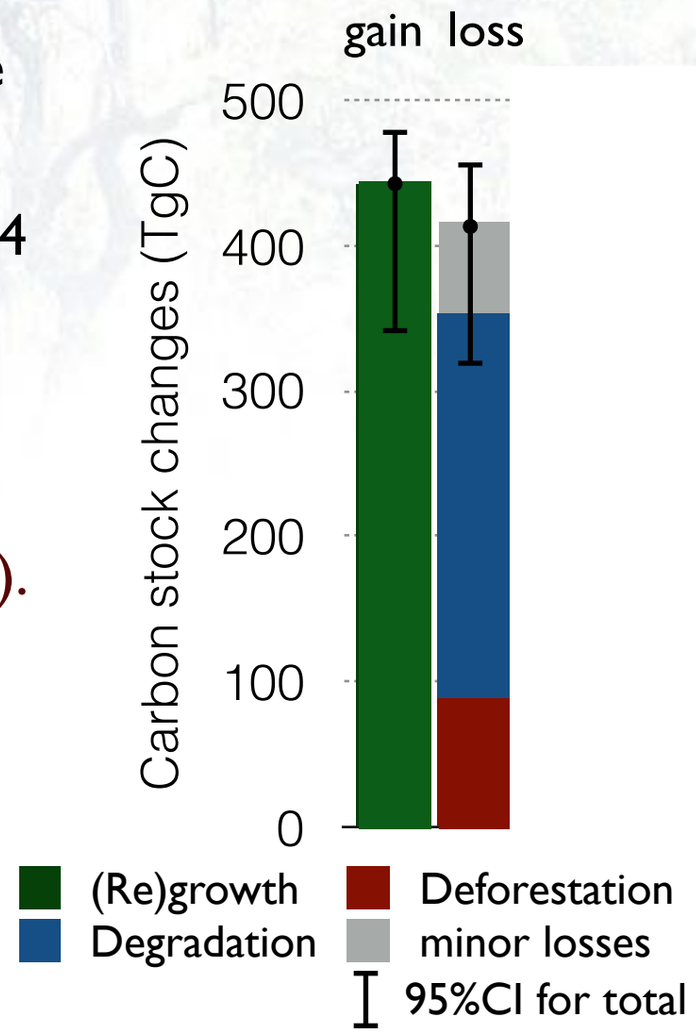
(Re)growth

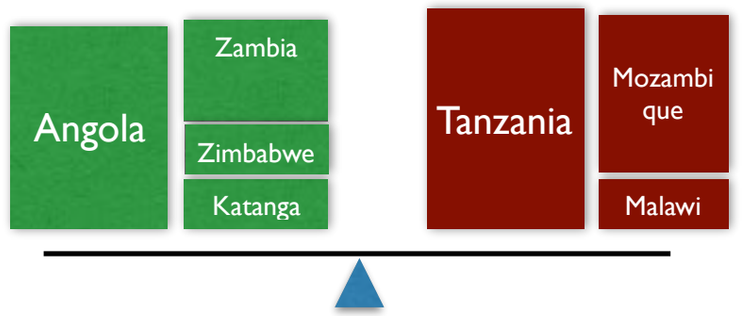
- Widespread esp in more remote areas (Angola and Zambia), mostly at lower biomass
- Observed growth rate (1.3 ± 0.9 MgC/ha/yr) similar to estimates from ground based studies
- Lots of regrowth is expected: recovery post disturbance in a highly resilient system.
- Region wide, no detectable change in woody carbon stocks: losses balanced by (re)growth?



Overall

- Bad news: Gross losses due to deforestation and degradation are higher than previously thought, mainly due to degradation.
  - Scaled up to all African woodlands, gross losses are 0.34 Pg/yr. vs 0.18 for Amazonia (Song et al, 2015).
- Degradation: 65% of biomass loss; affects 6 x area of deforestation.
- Deforested area 2.2 x FAO (2010) and Hansen et al (2013). Mostly in mosaic landscapes.
- Good news: Region-wide, woody biomass constant over 3 years: losses roughly balance regrowth, but national differences
- Implications for targeting REDD activities…
- Next steps
  - 2017 update now available!





McNicol et al. Nature Comm. (2018)

Putting it in to practice

- Moving these methods out of the University ….