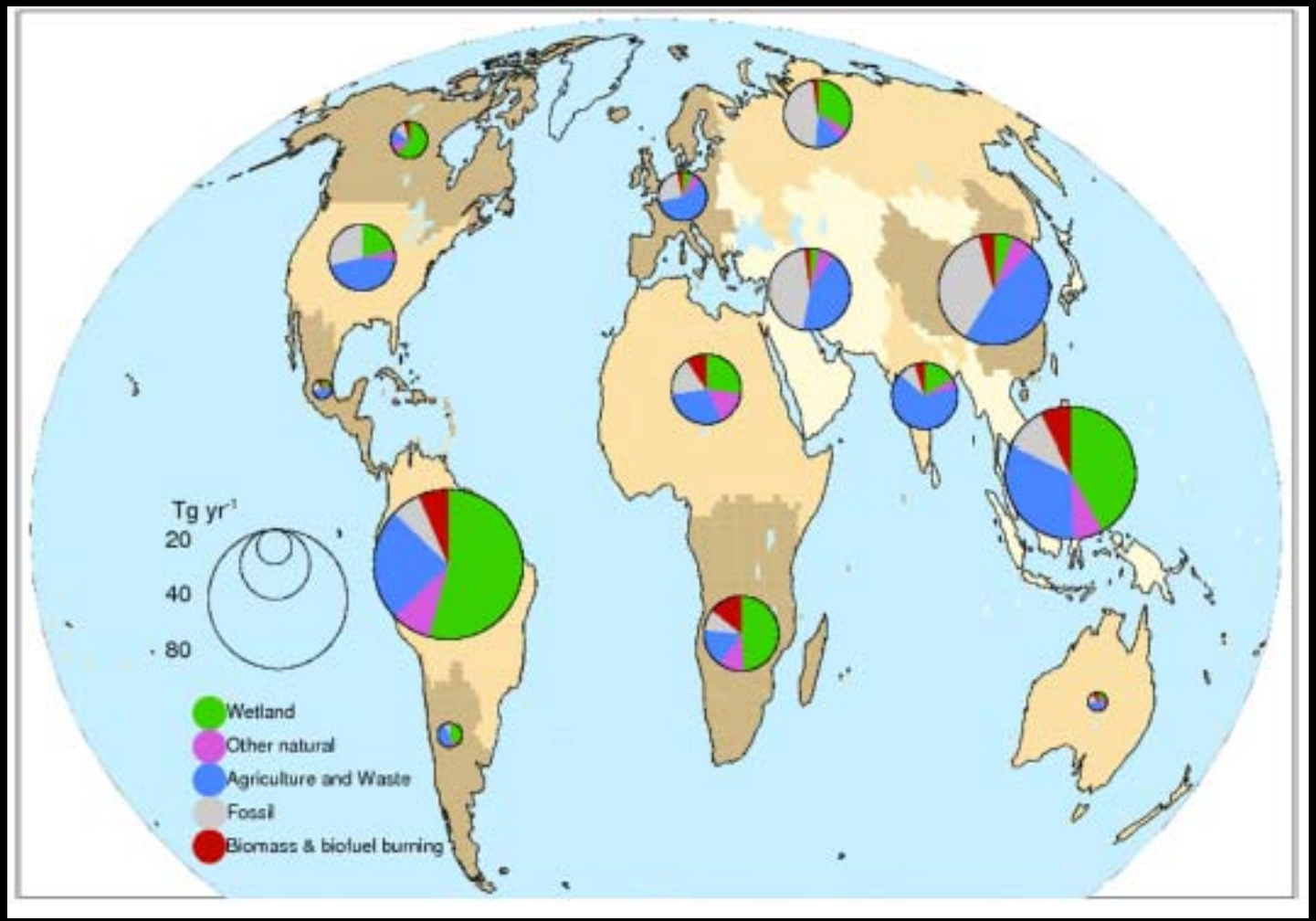
Agricultural Methane Sources

The growing role of methane in anthropogenic climate change

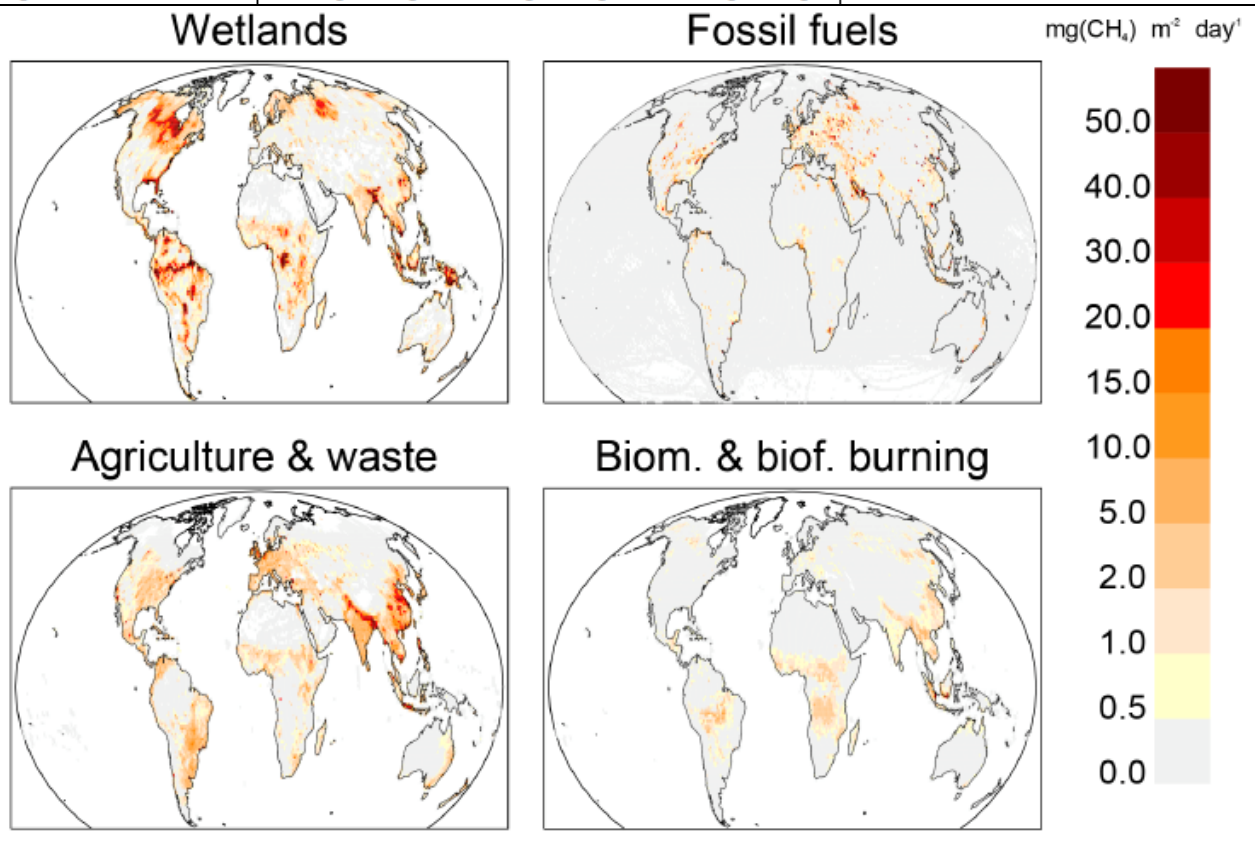
methane budget. New analysis suggests that the recent rapid rise in global methane concentrations is predominantly biogenic-most likely from agriculture-with smaller contributions from fossil fuel use and possibly wetlands. Additional attention is urgently needed to quantify and reduce methane



Agriculture emissions

	Kirschke et al. (2013) bottom-up	Kirschke et al. (2013) top-down	Bottom-up			Top-down		
Period of time	2000–2009	2000–2009	2000–2009	2003–2012	2012	2000–2009	2003–2012	2012
Agriculture and waste	200 [187–224]	209 [180–241]	190 [174–201]	195 [178–206]	197 [183–211]	183 [112–241]	188 [115–243]	200 [122–213]
Enteric fermentation & manure	101 [98–105][a]		103 [95–109][b]	106 [97–111][b]	107 [100–112][b]			
Landfills & waste	63 [56–79][a]		57 [51–61][b]	59 [52–63][b]	60 [54–66][b]			
Rice cultivation	36 [33–40]		29 [23–35][b]	30 [24–36][b]	29 [25–39][b]			

- 3.6 billion domestic ruminants
- * Wild animals ~15 Tg



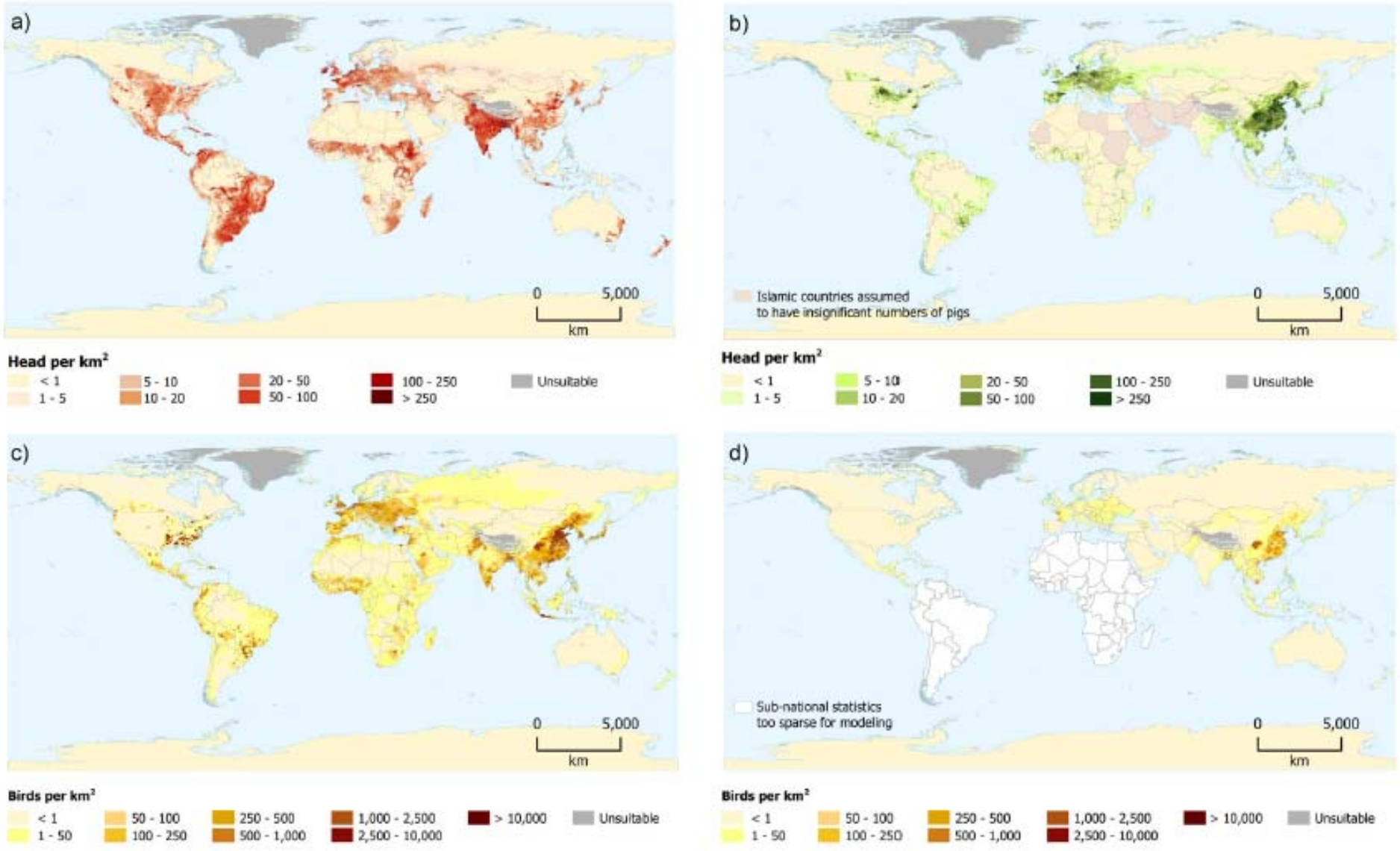
Change in agriculture emissions

	Average 2002-2006 *	Average 2008-2012 *	Difference **
Agriculture (all activities)			
EDGARv4.2FT2010***	141.9	151.4	9.5
EDGARv4.2EXT	140.6	150.6	10.0
FAOSTAT	126.4	134.4	8.0
GAINS	123.2	126.9	3.7
USEPA	123.5	127.9	4.4
Enteric fermentation & Manure management			
EDGARv4.2FT2010***	108.2	113.8	5.6
EDGARv4.2EXT	106.8	112.7	5.9
FAOSTAT	103.4	109.9	6.5
USEPA	99.7	103.3	3.6
Rice cultivation			
EDGARv4.2FT2010***	33.7	37.6	3.9
EDGARv4.2EXT	33.8	37.9	5.9
FAOSTAT	23.0	24.5	1.6
USEPA	23.8	24.6	0.8

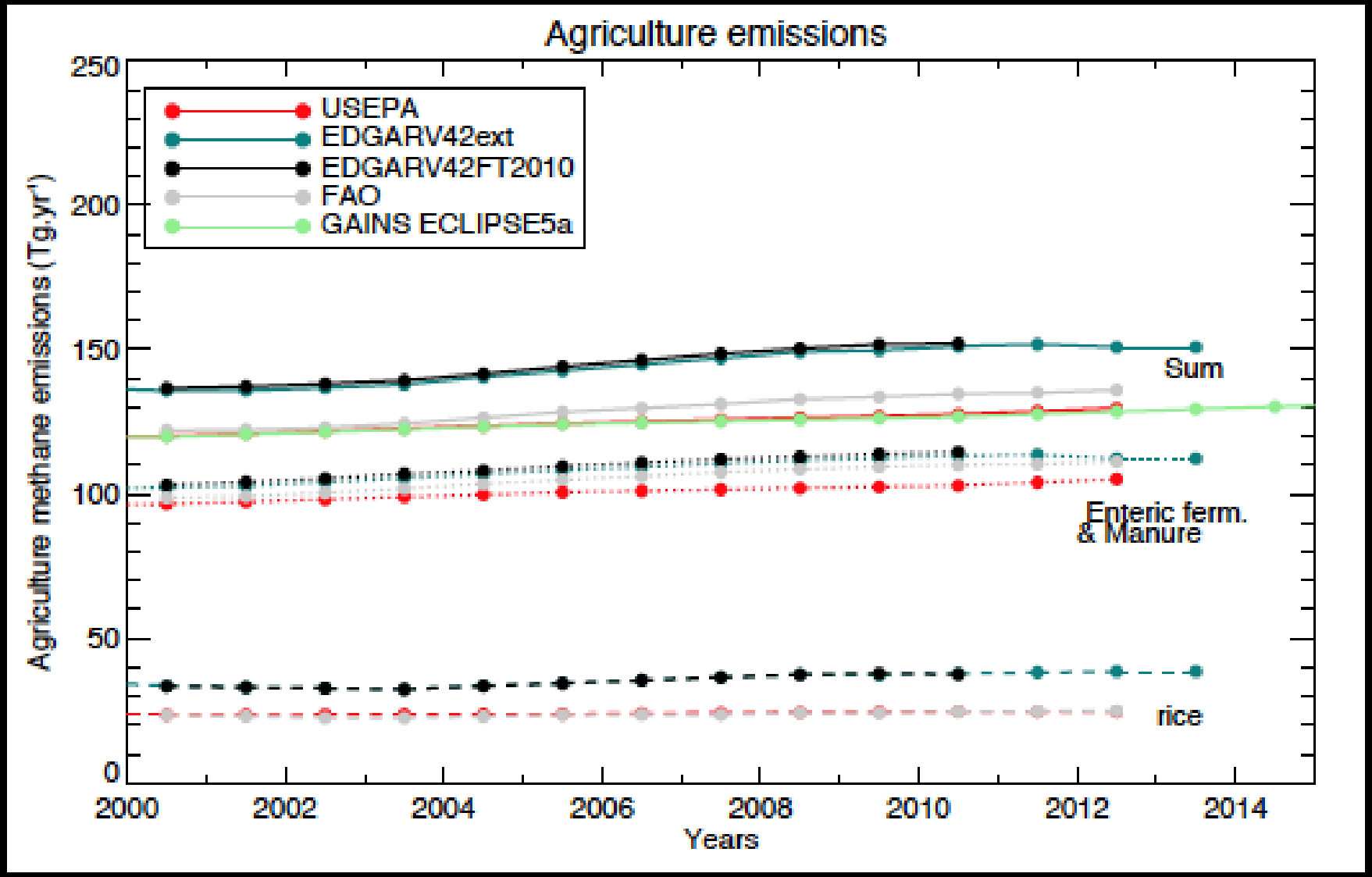
Data sources

- Tier 1 IPCC methodology
  - Country modifiers for manure
- FAOSTAT (EPA, EDGAR, GAINS)
  - Croplands
    - Rice agriculture
  - Livestock
    - Enteric fermentation
    - Manure management

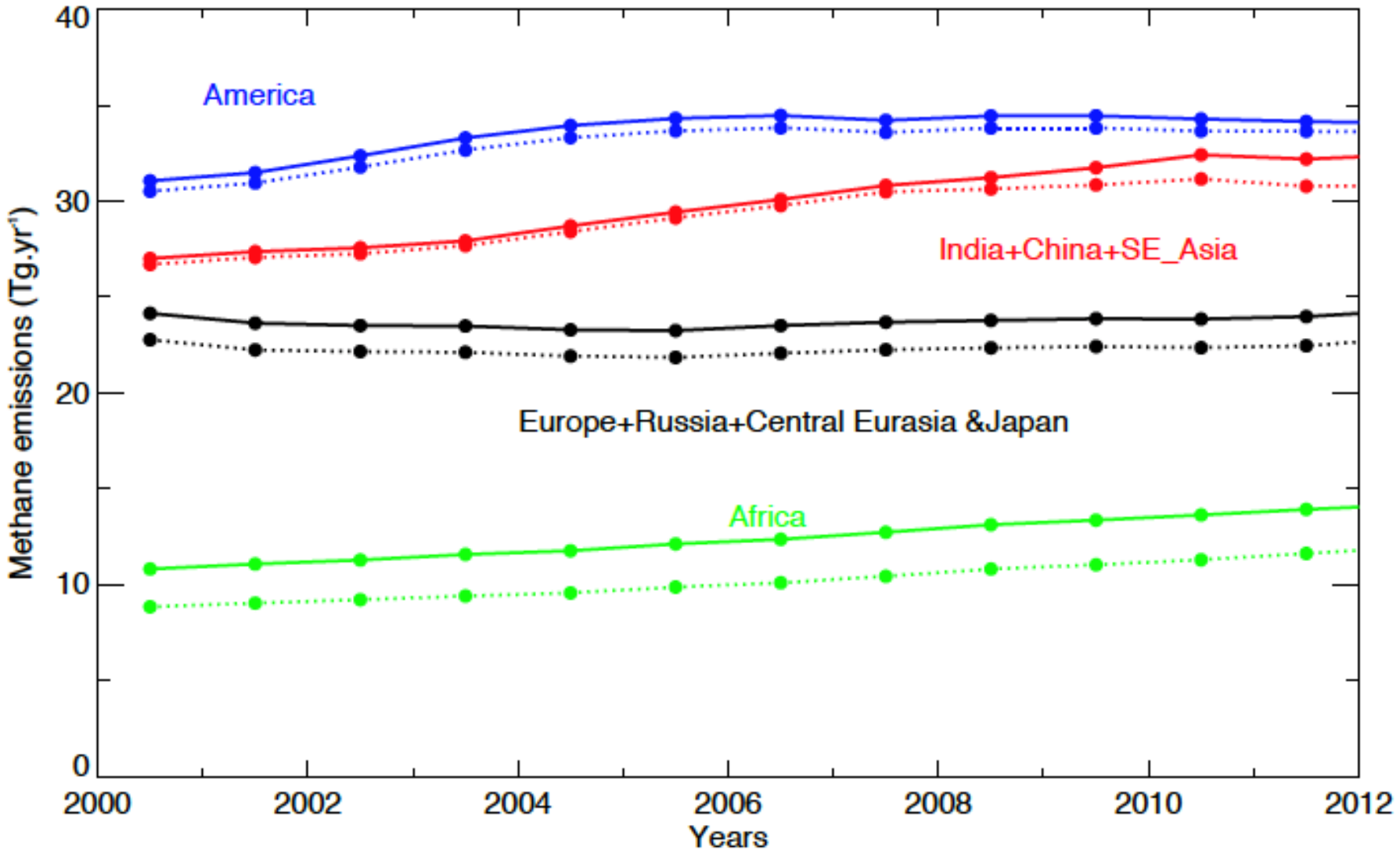
FAOSTAT downscaling



Change in agriculture emissions



Change in livestock emissions



Livestock emissions

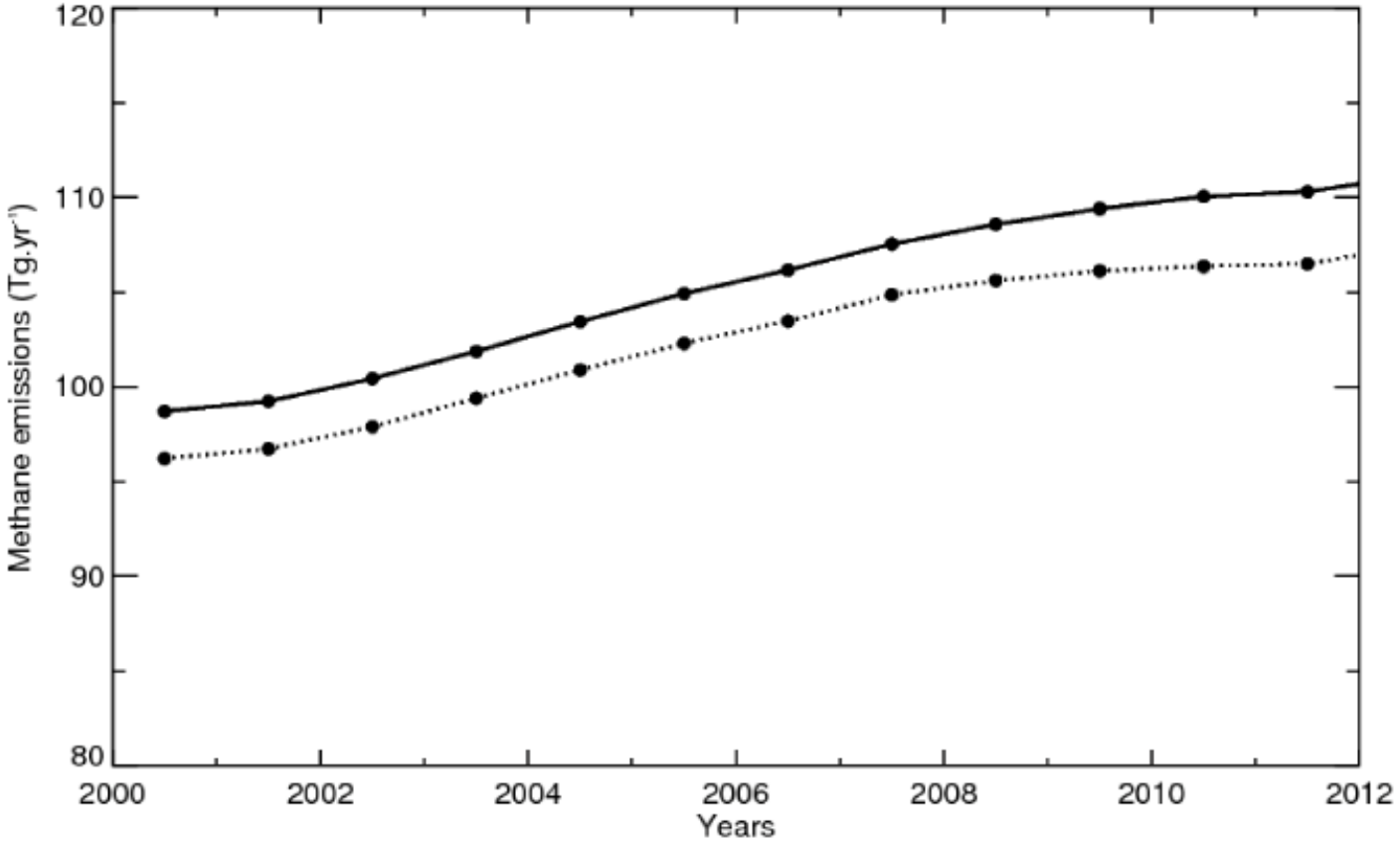
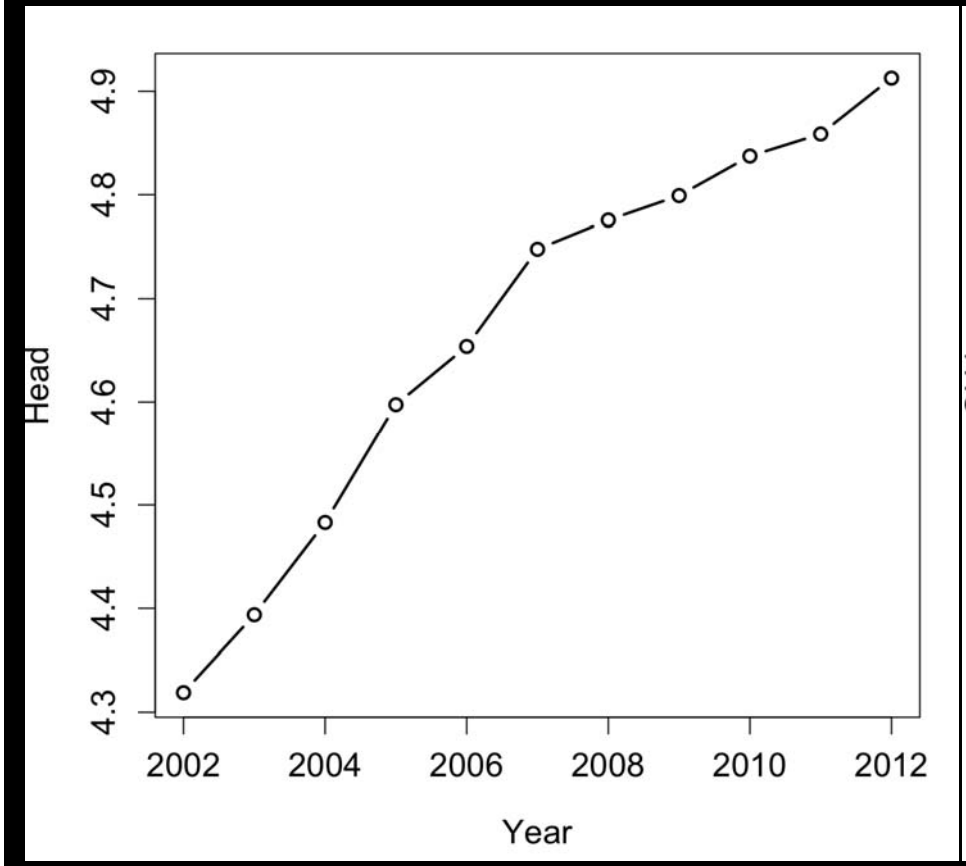
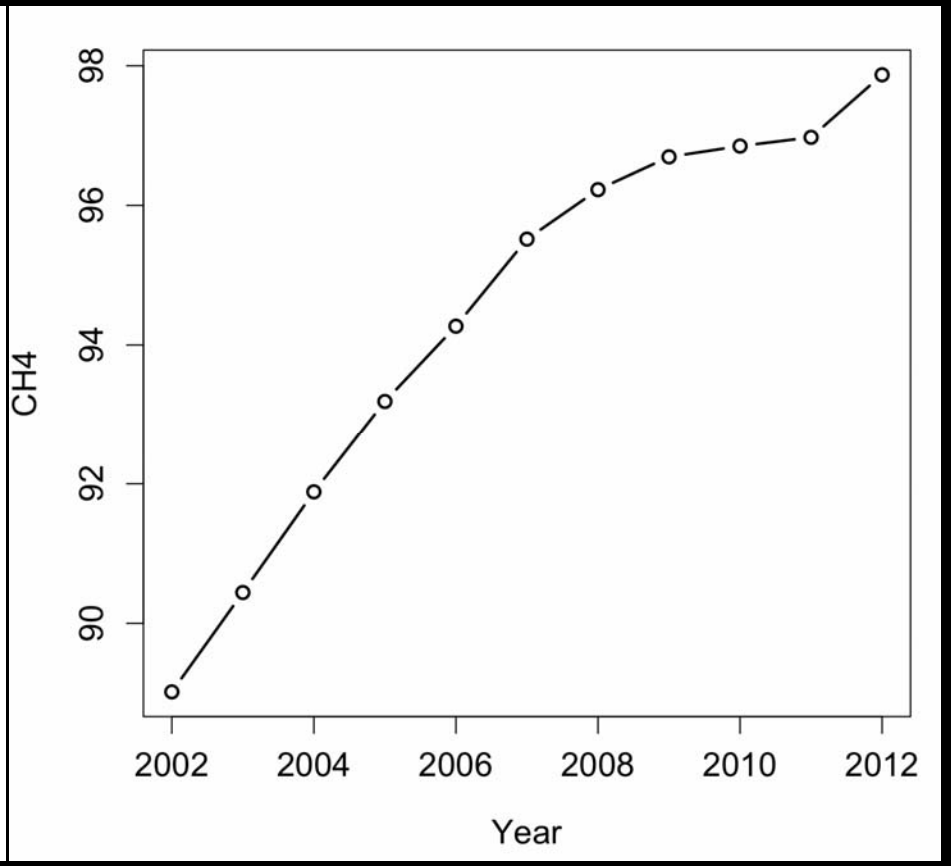


Figure S13: Global methane emissions from enteric fermentation and manure (in Tg CH_4 yr^{-1}). Solid lines: the former version of FAOSTAT used in Saunois et al., 2016 and in this study. Dotted line: the updated (version of Jan. 2017) version of FAOSTAT.

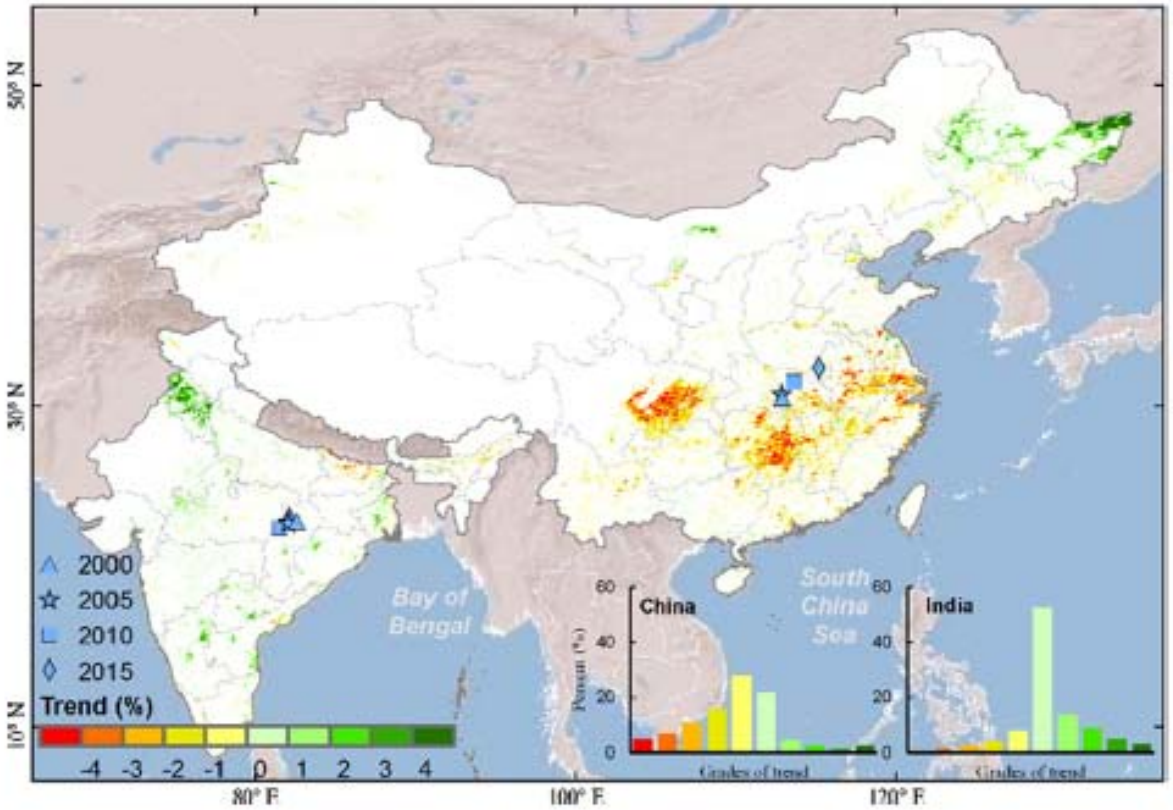
Relationship between change in number of domesticated animals vs emissions





FAOSTAT

Trends in rice cropland area



Paddy rice croplands underwent a significant decrease in South China and increase in Northeast China from 2000 to 2015, while paddy rice fields expansion is remarkable in northern India. The paddy rice fields centroid in China moved northward due to the substantial rice planting area shrink in Yangtze River Basin and rice area expansion in high latitude regions (e.g., Sanjiang Plain).

Trends in rice cropland area

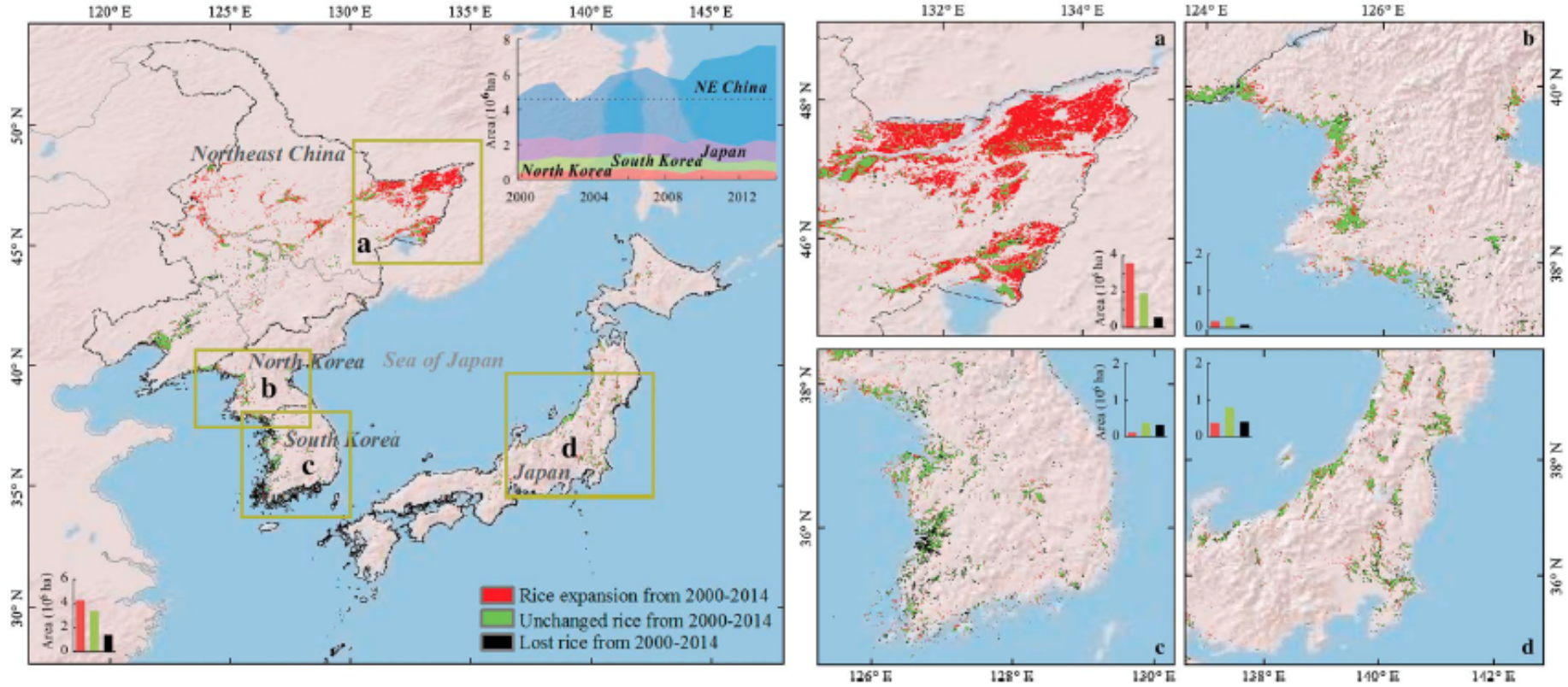


Figure 1. Spatial distribution of paddy rice area changes in northeastern (NE) Asia from 2000–2014. The zoom-in figures in the right side are for (a) NE China, (b) North Korea, (c) South Korea, and (d) Japan, corresponding to the box a–d in the main figure. The column graphs in the five figures show area distributions of three categories, including unchanged paddy rice, rice expansion, and lost paddy rice area from 2000 to 2014. The stacked area figure in the major map shows the interannual paddy rice area variations of the three countries and one region.

Trends in rice CH4 emissions

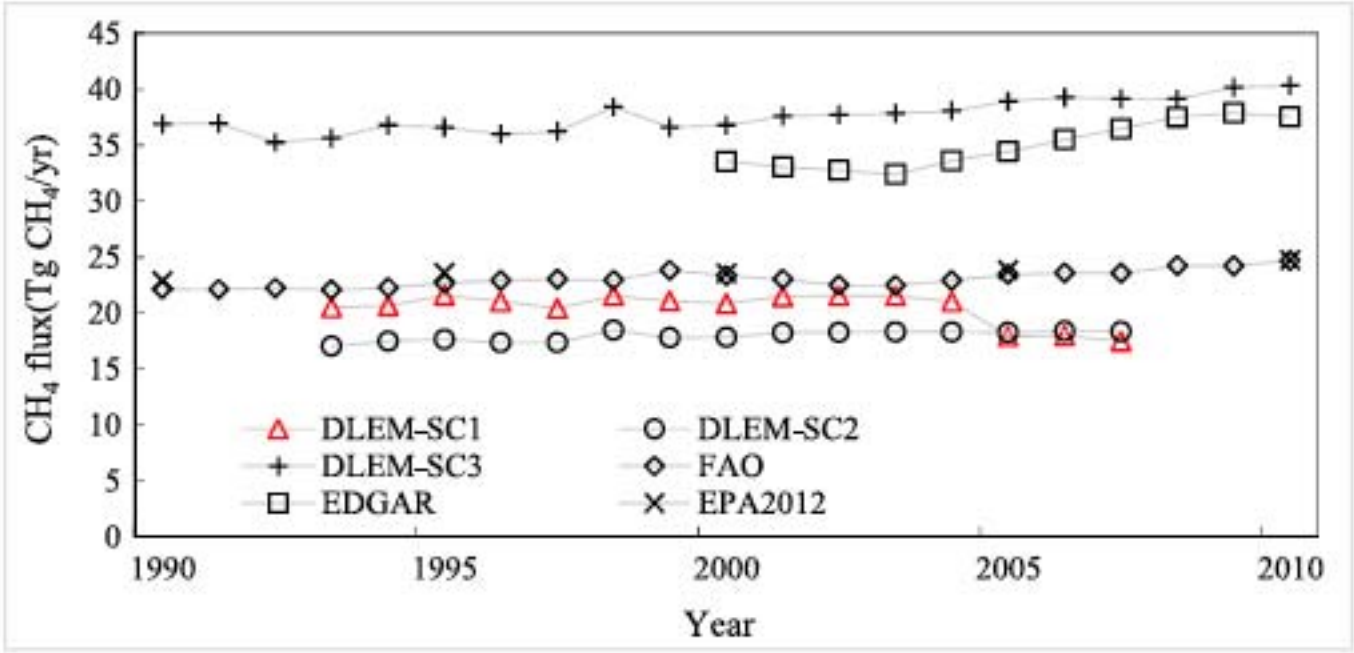
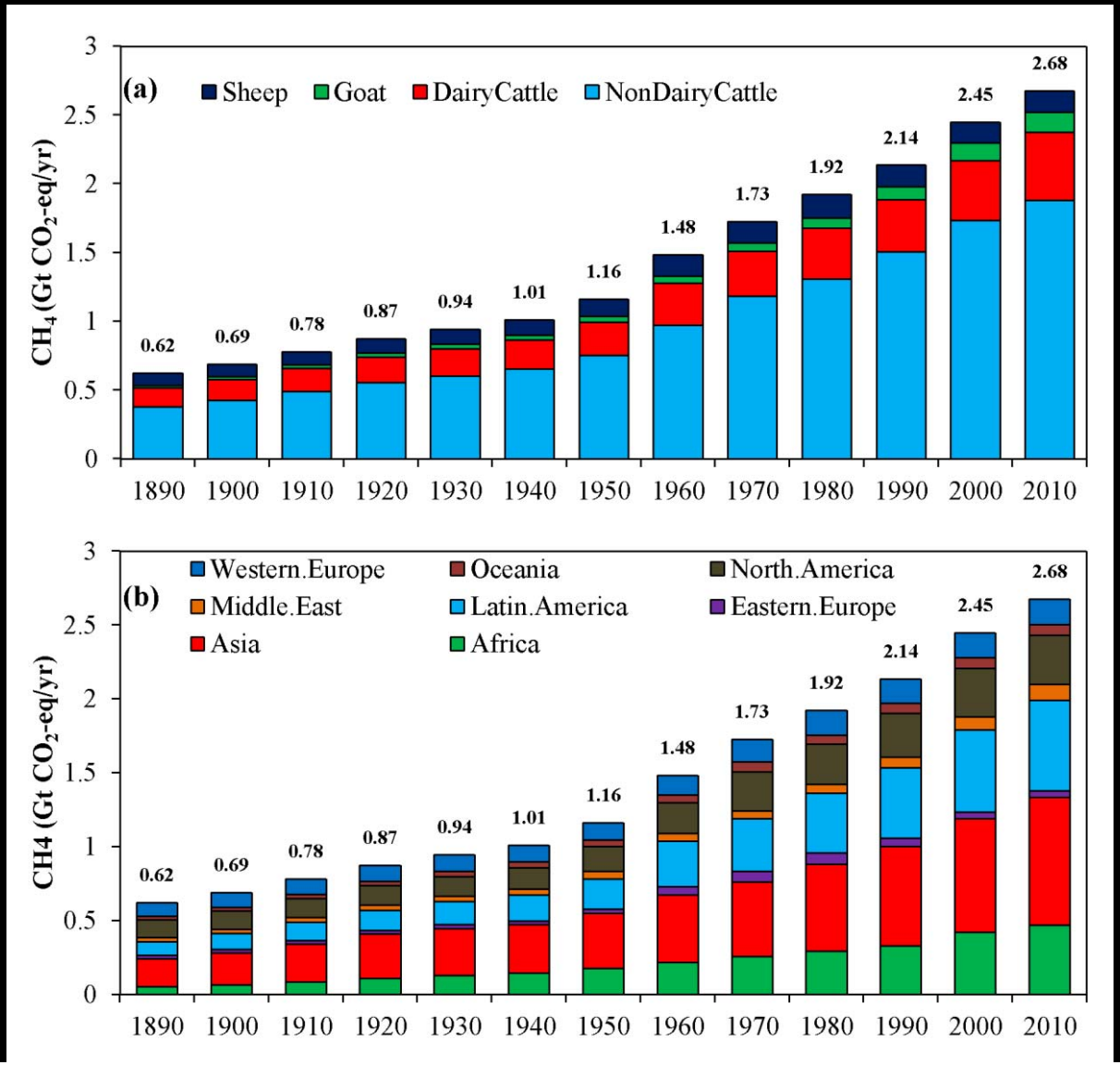


Figure 9. Comparison of temporal variation in estimated CH_4 emissions from global rice fields among three scenarios of water regime scheme (DLEM-SC1, DLEM-SC2, and DLEM-SC3) and three previous estimates (FAO, EDGAR, and EPA2012).

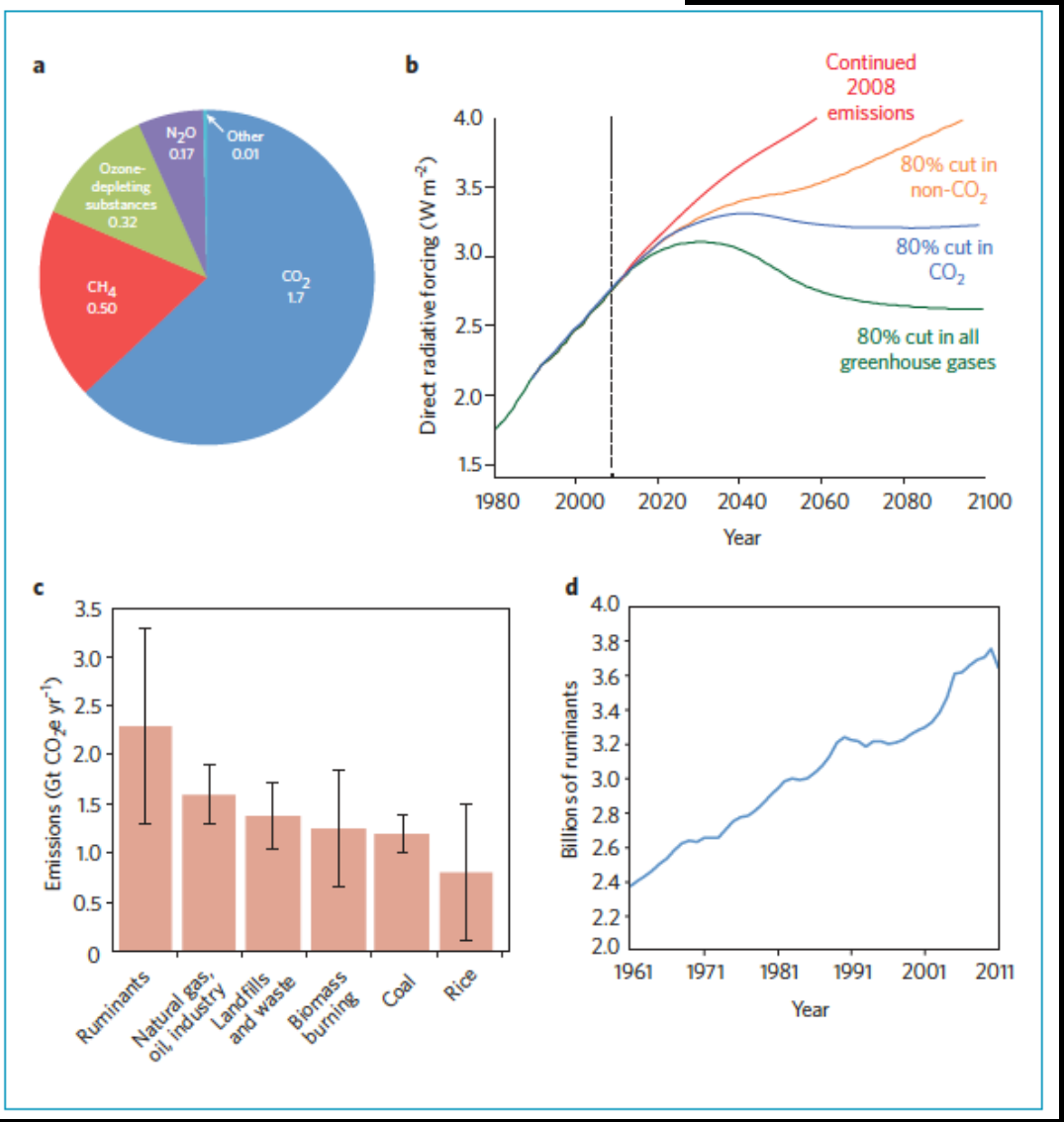
Trends in livestock CH4 emissions

Tier 2



Ruminants, climate change and climate policy

William J. Ripple, Pete Smith, Helmut Haberl, Stephen A. Montzka, Clive McAlpine and Douglas H. Boucher



Exploring the influence of ancient and historic megaherbivore extirpations on the global methane budget

Felisa A. Smith[a,1], John I. Hammond[a], Meghan A. Balk[a], Scott M. Elliott[b], S. Kathleen Lyons[c], Melissa I. Pardi[a], Catalina P. Tomé[a], Peter J. Wagner[c], and Marie L. Westover[a]

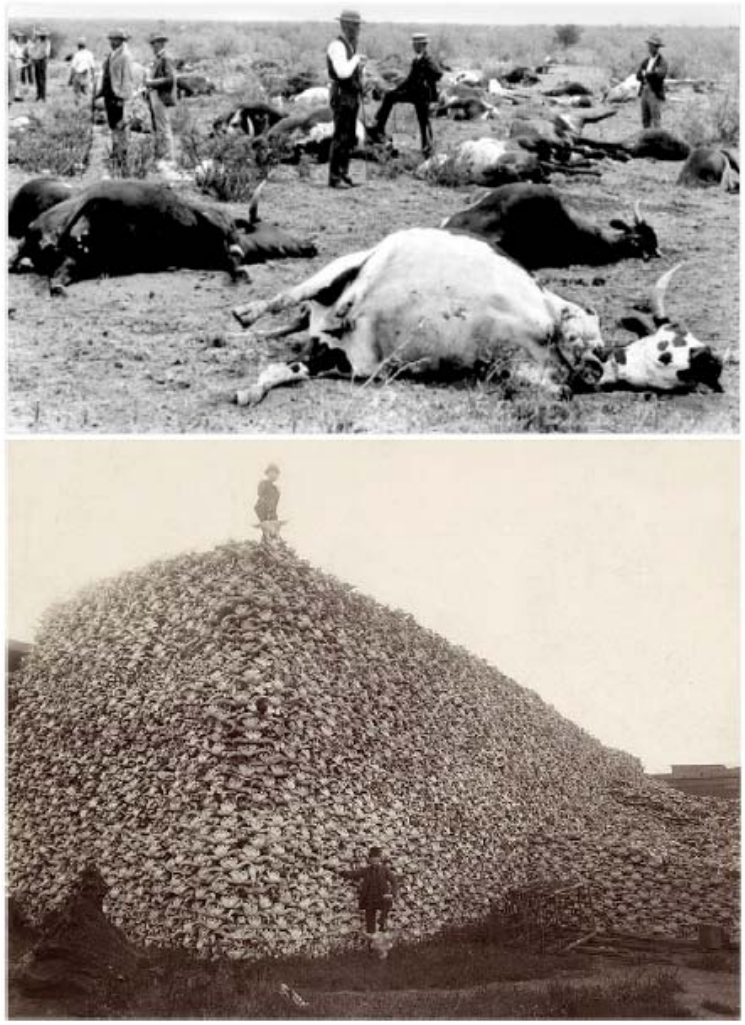
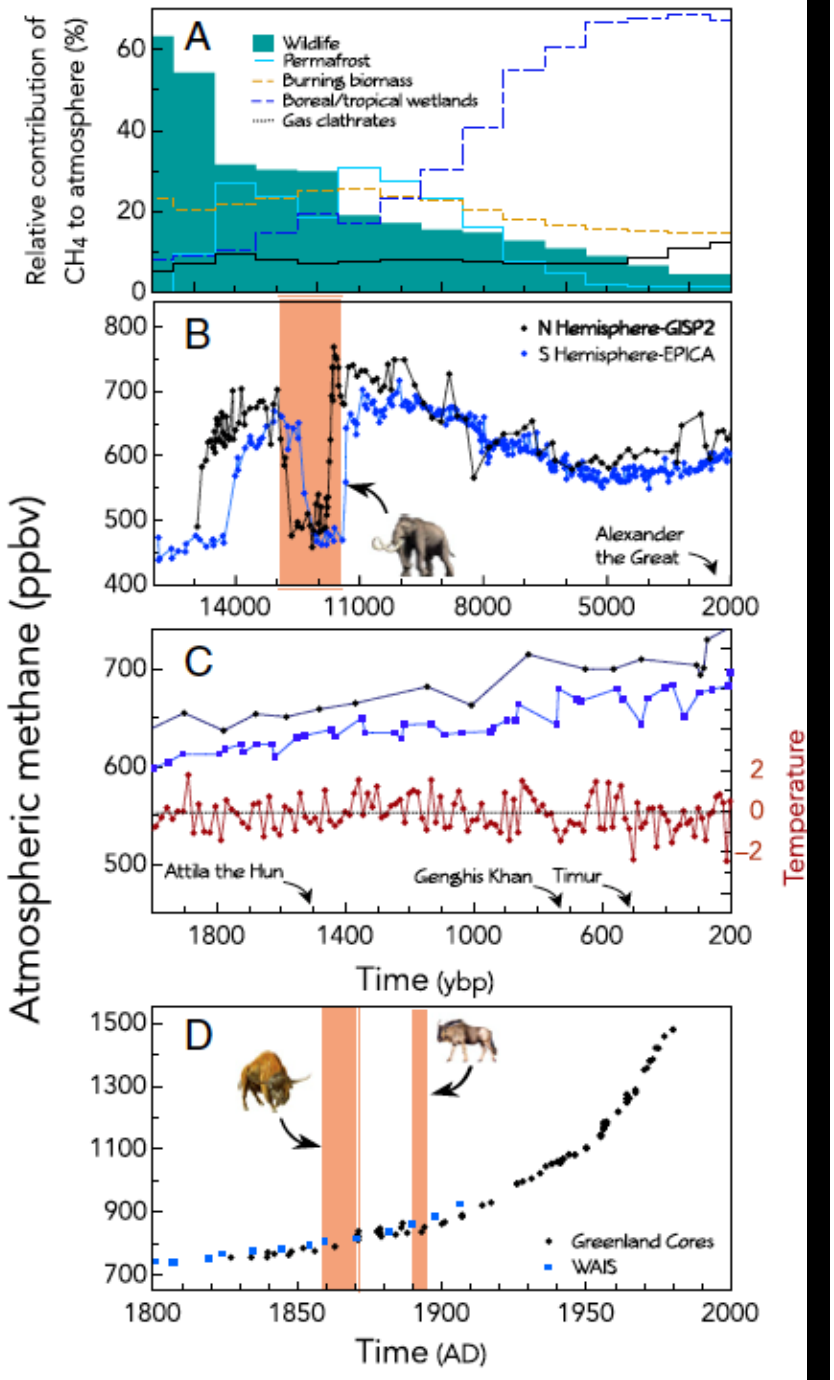
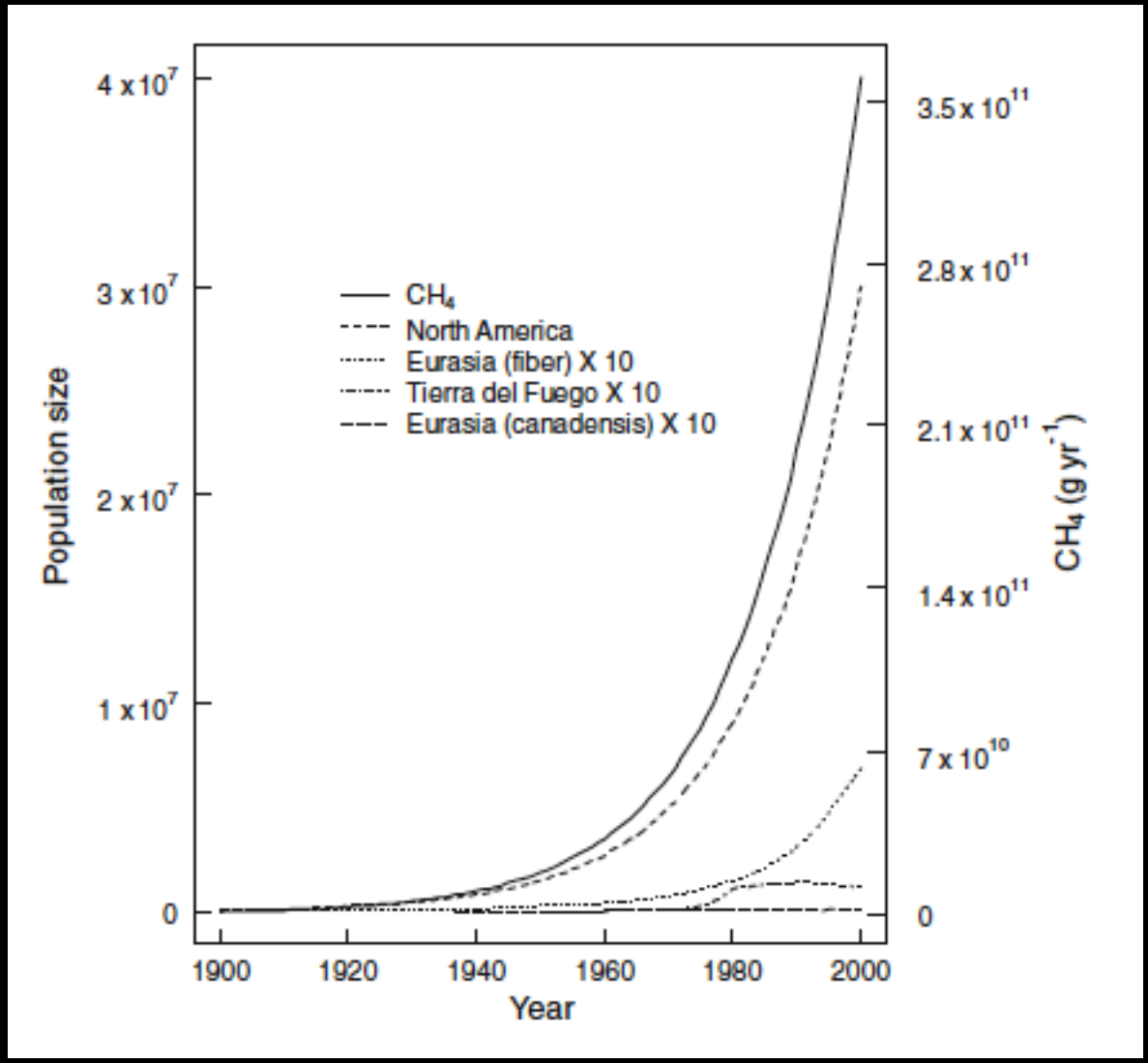


Fig. 1. Historic photographs illustrating scope of mammal extirpations. (*Upper*) Field of dead cattle during rinderpest outbreak in South Africa, 1896. (*Lower*) A massive pile of American bison (*Bison bison*) skulls ultimately ground for fertilizer, ~1870. Images courtesy of Wikimedia Commons.



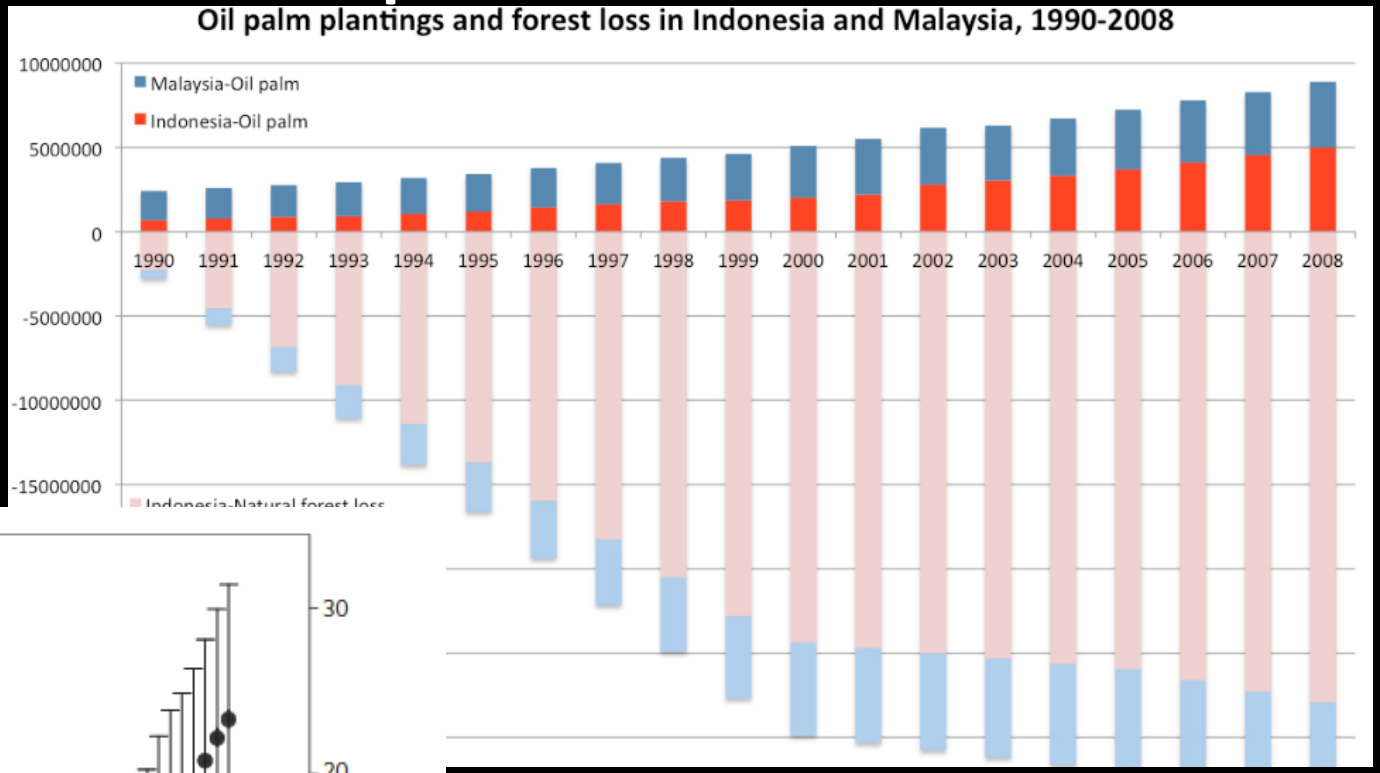
Beaver-mediated methane emission: The effects of population growth in Eurasia and the Americas

Colin J. Whitfield, Helen M. Baulch,
Kwok P. Chun, Cherie J. Westbrook

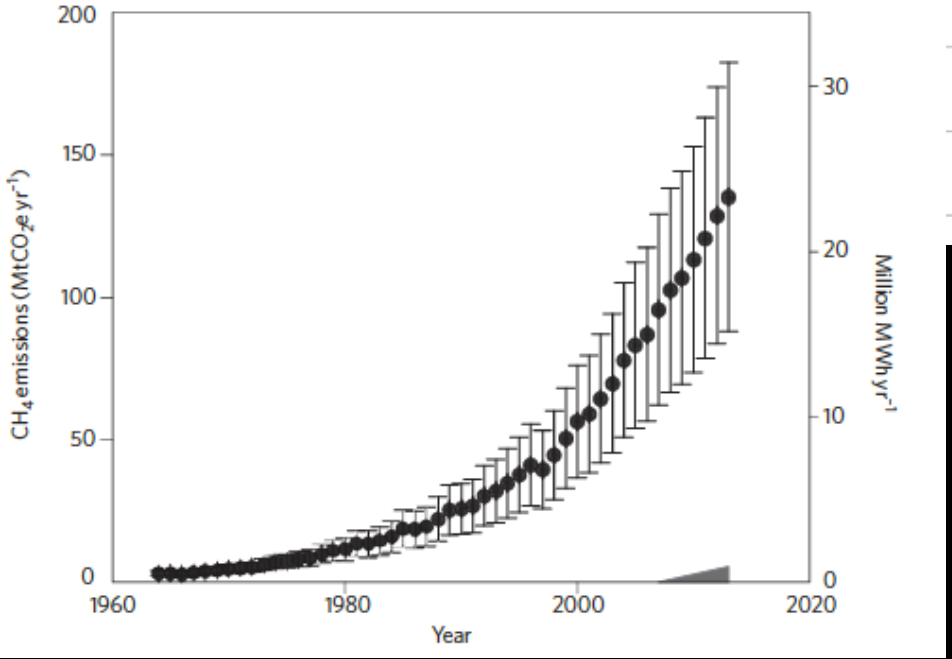


42,000 km^2 in new wetlands
0.18-0.8 Tg yr^{-1} (from just beavers)

Palm oil plantations



Wastewater effluent



Taylor et al. 2014