



Territorial Land Use

Course: Environmental Science

Graduate Program in Environmental Science and
Technology

Federal University of ABC – UFABC

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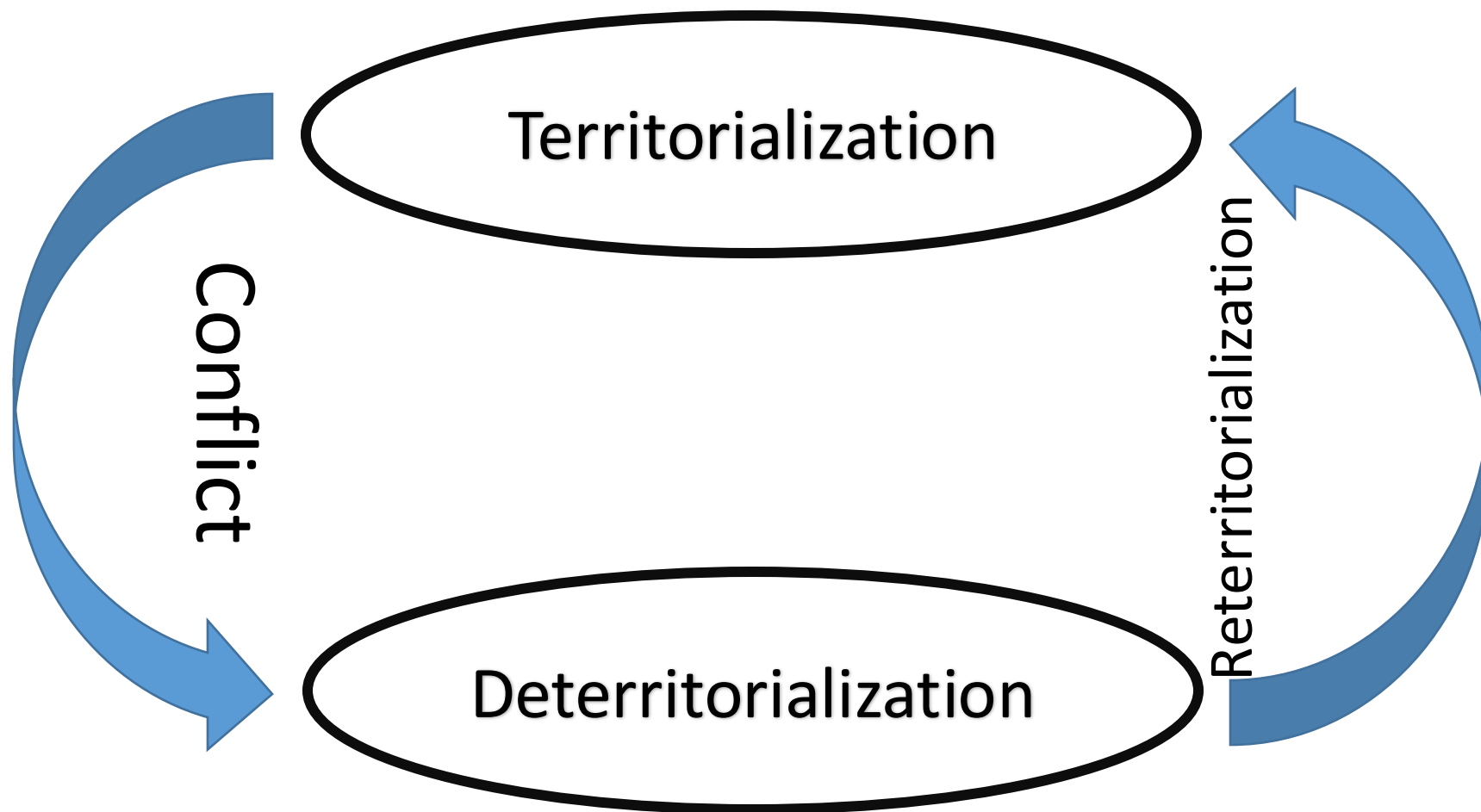
June, 2026

Outline

- Concepts
- Brazil in the global history of territorial occupation
- Occupation of Brazilian territory

Concepts

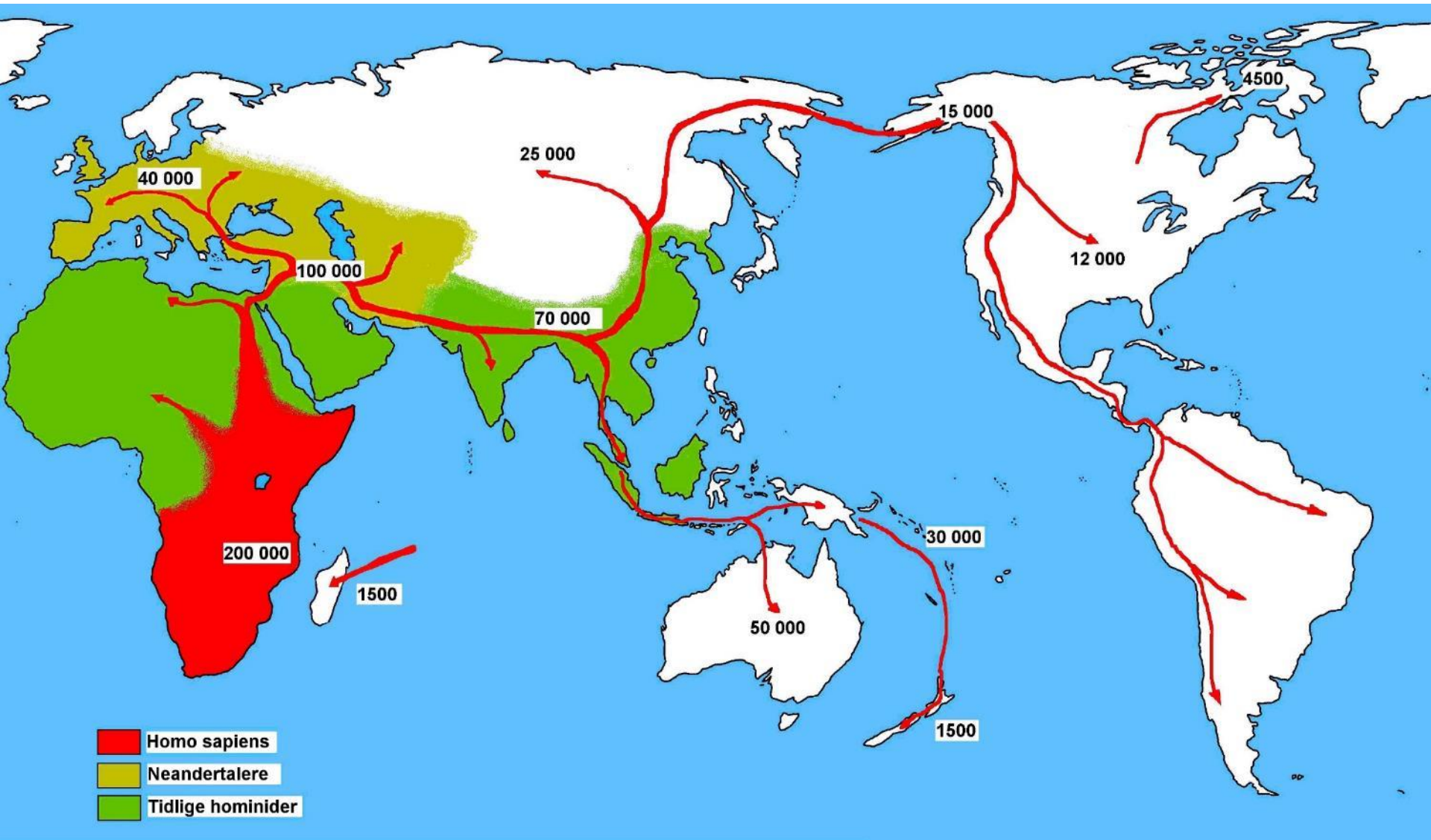
- **Territory:** A space constituted and delimited by power relations
 - Includes power over:
 - Fixed elements: infrastructure and built forms in space
 - Flows: networks (transport, information, capital)
- **Territoriality:**
 - Practices and behaviors aimed at controlling, defending, or asserting claims over territory
 - It is shaped by values attached to the territory:
 - Political-economic
 - Identity
 - Affective ties



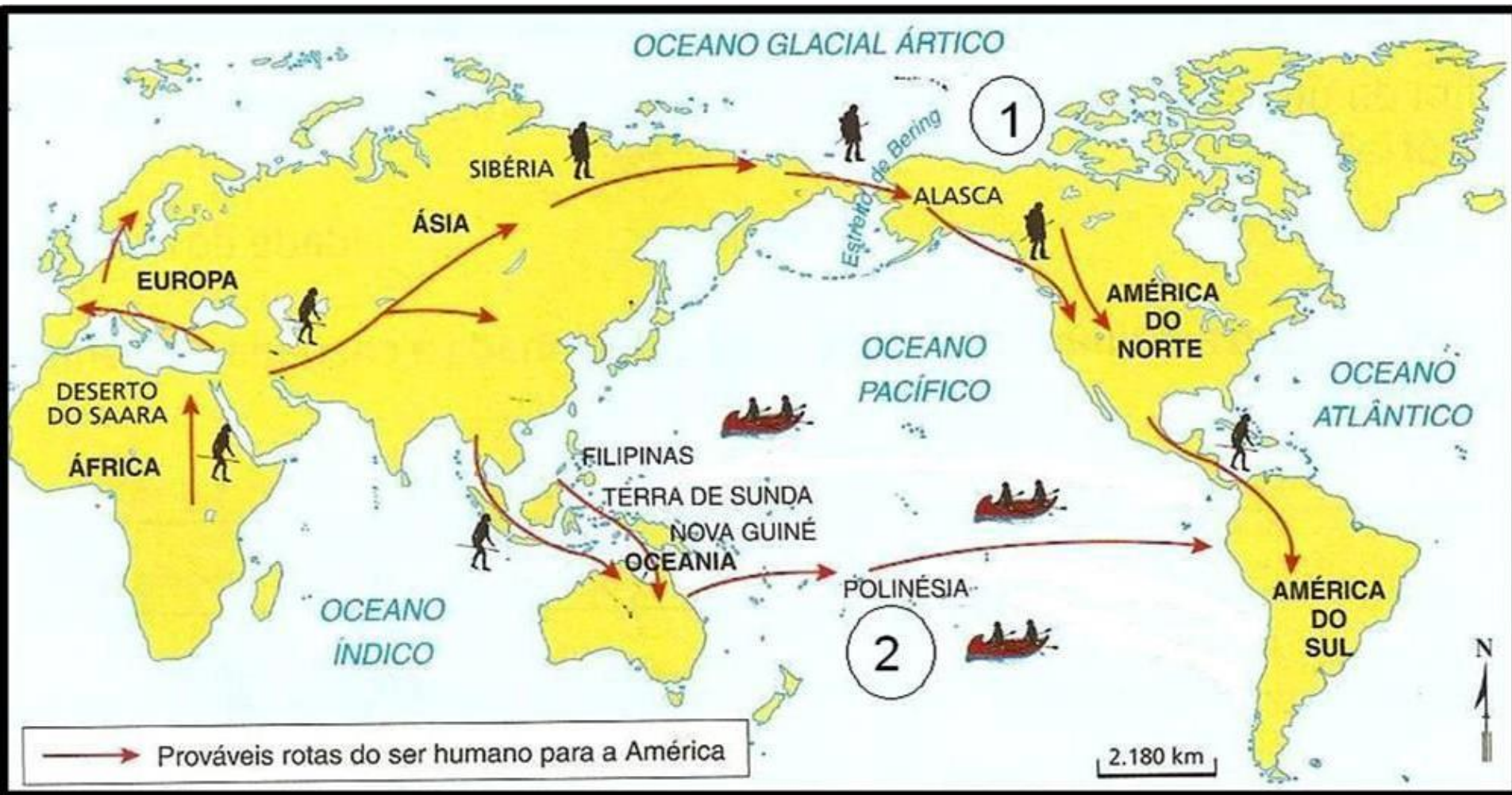
Waves of Spatial Diffusion

- Territorial occupation often occurs through waves of spatial diffusion:
 - Migration
 - Technological, cultural, or power transformation
- The domination of territory by newly arrived groups creates conflicts with the groups that occupied it in previous waves
- Shifting territorial borders creates zones of conflict

Expansion of *Homo sapiens*

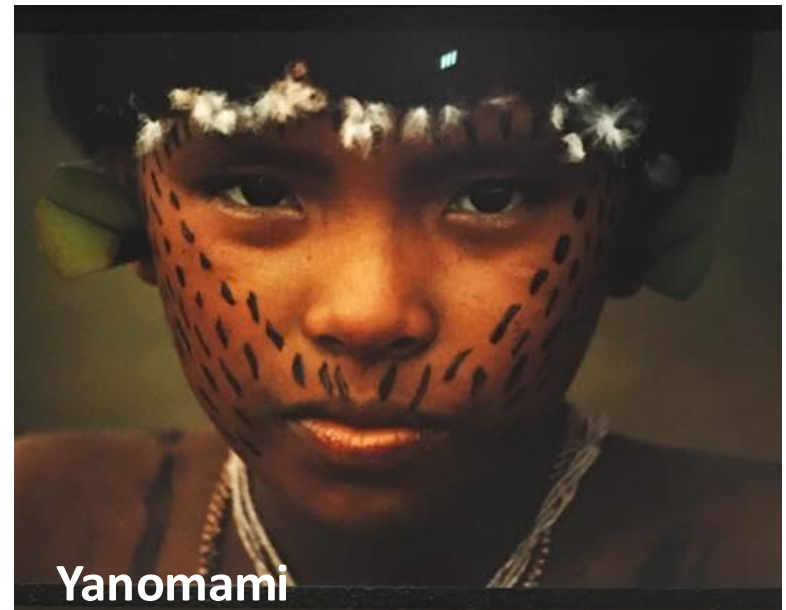


Expansion of *Homo sapiens*





Jê



Yanomami



**Australasian
Aboriginal**



Thailand

Castro e Silva, M. A., Ferraz, T., Bortolini, M. C., Comas, D., & Hünemeier, T. (2021). Deep genetic affinity between coastal Pacific and Amazonian natives evidenced by Australasian ancestry. *Proceedings of the National Academy of Sciences (PNAS)*, 118(14), e2025739118.

Timeline



<20,000 BCE – Sites of Santa Elina (MT), Pedra Furada (PI)

11,000 BCE – Luzia (Lagoa Santa – MG)

9,000 BCE – Frequent records of hunter-gatherer peoples in South America

6,000 BCE – Complex ceramic-producing societies along the Amazon river

3,000 BCE – Expansion of the Tupi ethnic group
– First geoglyphs in Acre

2,000 BCE – Sambaquis
– Domestication of agricultural plants (cassava, pepper, pumpkin, corn)

500 BCE– Tribes become increasingly sedentary→ population growth

0 – Widespread agriculture in the Tupi tribes
– Complex Tupi pottery civilizations on the Amazon River
– Tupi occupy the Brazilian coast
– Intensification of geoglyphs in Acre (up to 1,000 AD)

600 AD – Widespread agriculture in the Jê tribes

1,000 AD – Calçoene Megalith (Amapá)

DA SILVA, Aracy Lopes; GRUPIONI, Luís Donisete Benzi; DA SILVA MACEDO, Ana Vera Lopes. **A temática indígena na escola: novos subsídios para professores de 1o. e 2o. graus.** Mec, 1995.

UNIVERSIDADE DE SÃO PAULO. MUSEU DE ARQUEOLOGIA E ETNOLOGIA. **Brasil 50 mil anos: uma viagem ao passado pré-colonial, guia temático para professores.** Museu de Arqueologia e Etnologia, Universidade de São Paulo, 2001.

Indigenous peoples in Brazil
during the early colonial
period





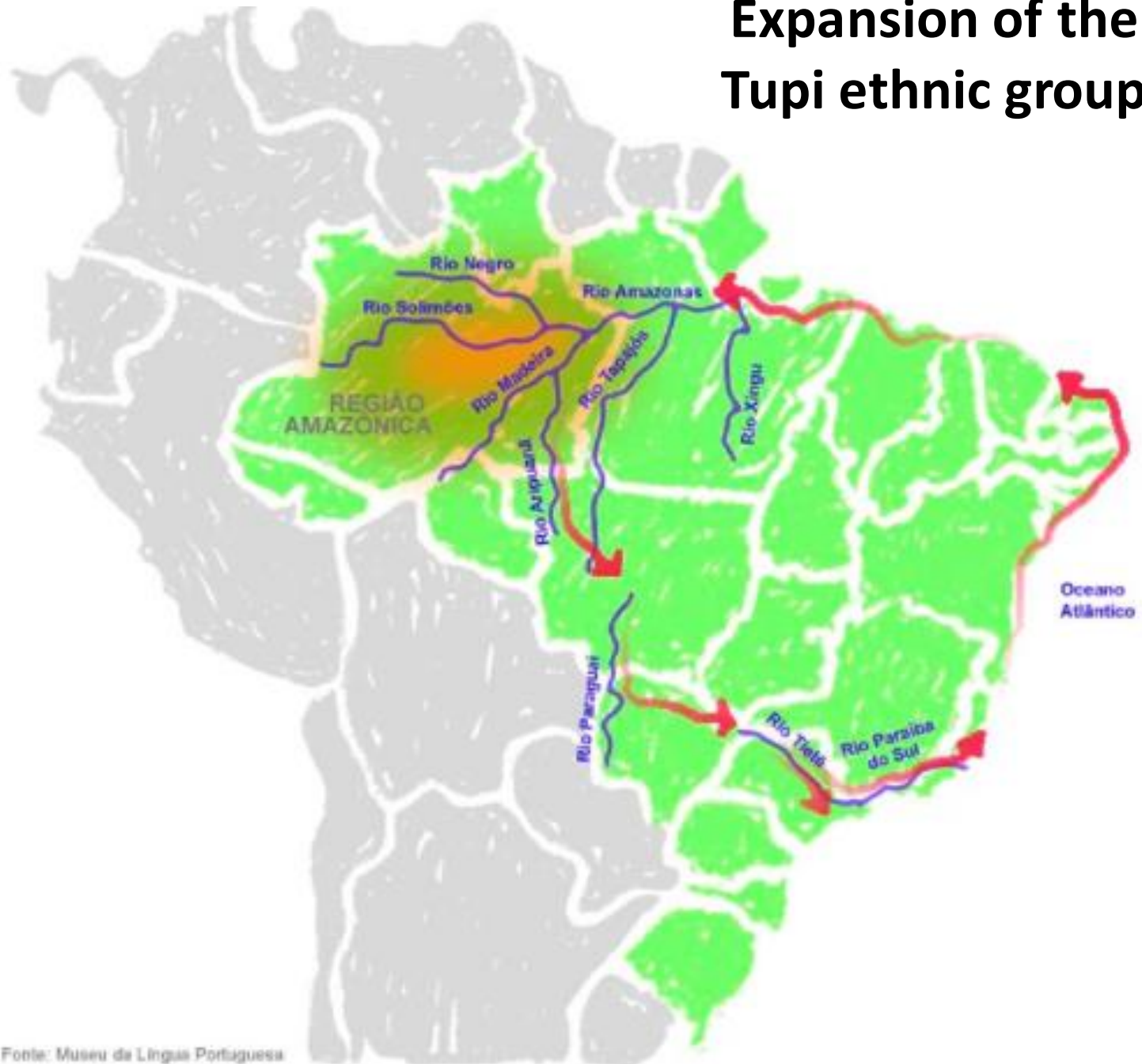
Sambaqui sites in Brazil



Nova Escola. Localização Geográficas de Sambaquis pelo Brasil. 2014.

<https://novaescola.org.br/conteudo/3105/localizacao-geografica-de-sambaquis-pelo-brasil>

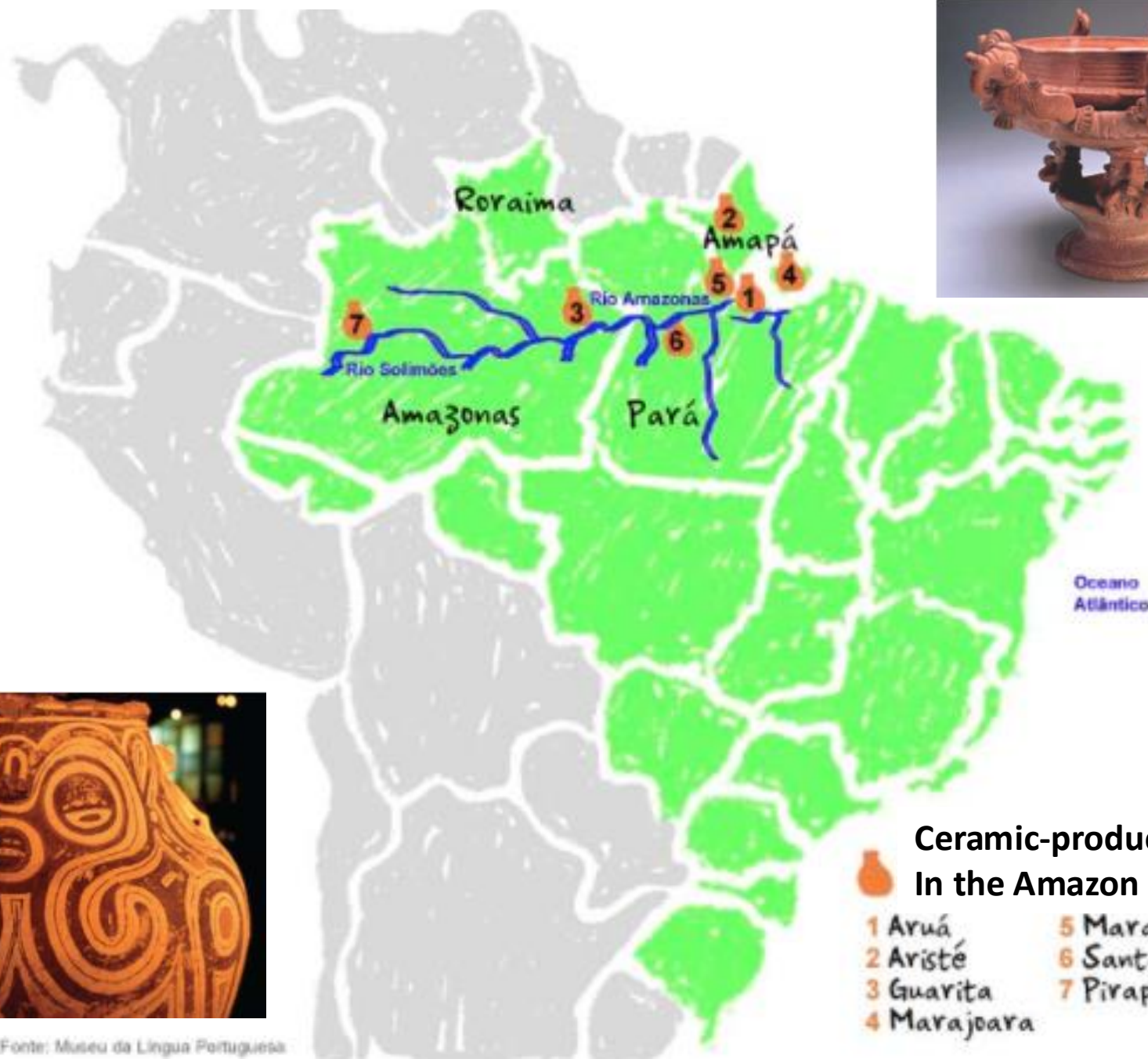
Expansion of the Tupi ethnic group



Sites of ceramic-producing societies in the Amazon



Fonte: Museu da Língua Portuguesa



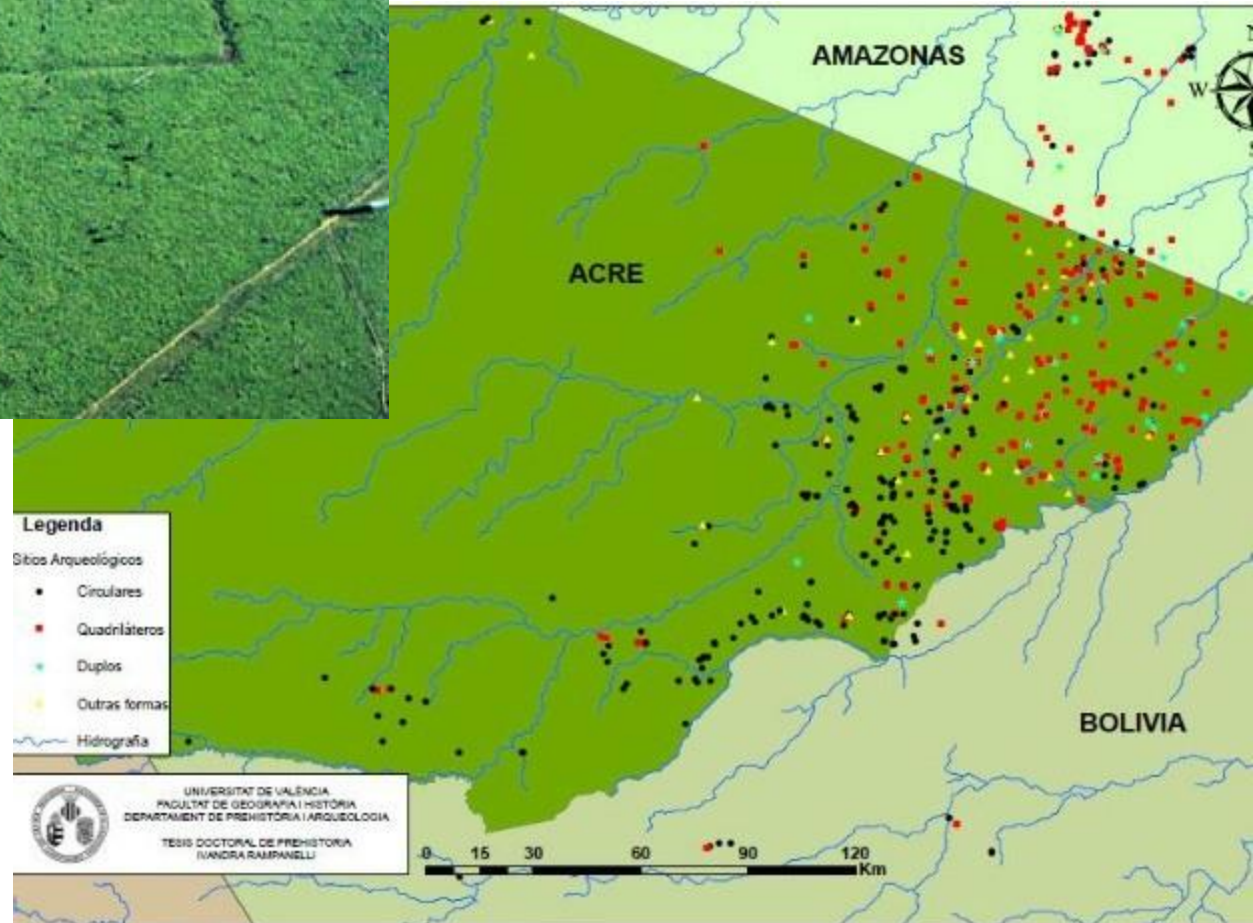
Ceramic-producing groups In the Amazon

- | | |
|-------------|---------------|
| 1 Aruá | 5 Maracá |
| 2 Aristé | 6 Santarém |
| 3 Guarita | 7 Pirapitinga |
| 4 Marajoara | |

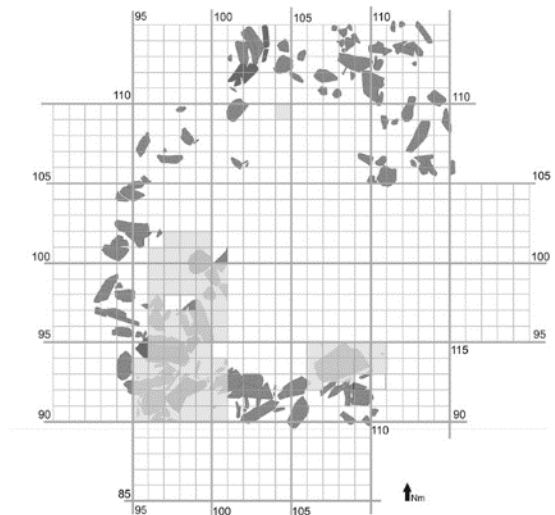
Geoglyphs



FERNANDES, I.R. G. **Las estructuras de tierra delimitadas por zanjas en la amazonía occidental.** 2016. Tese de Doutorado. Universitat de València.



Calçoene Megalith



CABRAL, Mariana Petry; DE MOURA SALDANHA, João Darcy. Paisagens megalíticas na costa norte do Amapá. **Revista de Arqueologia**, v. 21, n. 1, 2009.

Indigenous Peoples' Relations with the Landscape

- Extinction of large mammals
 - Interaction with climate change
- Fire management in the Cerrado and Pampas
 - Anthropogenic grasslands?
- Cultural forests (extractivism, management, slash-and-burn, archaeological black earths)

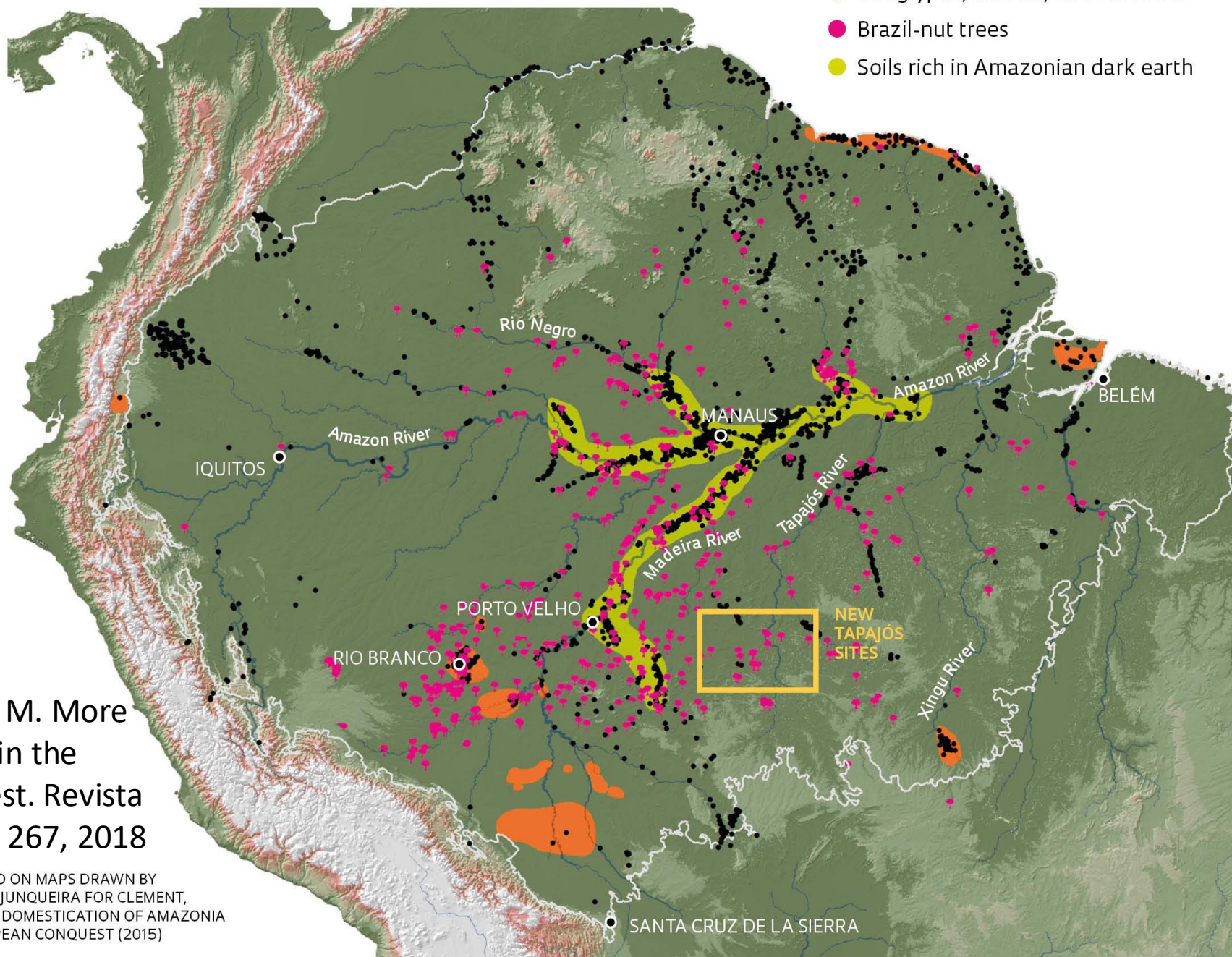


BARNOSKY, A. D.; LINDSEY, E. L. Timing of Quaternary megafaunal extinction in South America in relation to human arrival and climate change. **Quaternary International**, v. 217, n. 1, p. 10-29, 2010.

PIVELLO, V. R. The use of fire in the Cerrado and Amazonian rainforests of Brazil: past and present. **Fire ecology**, v. 7, n. 1, p. 24-39, 2011.

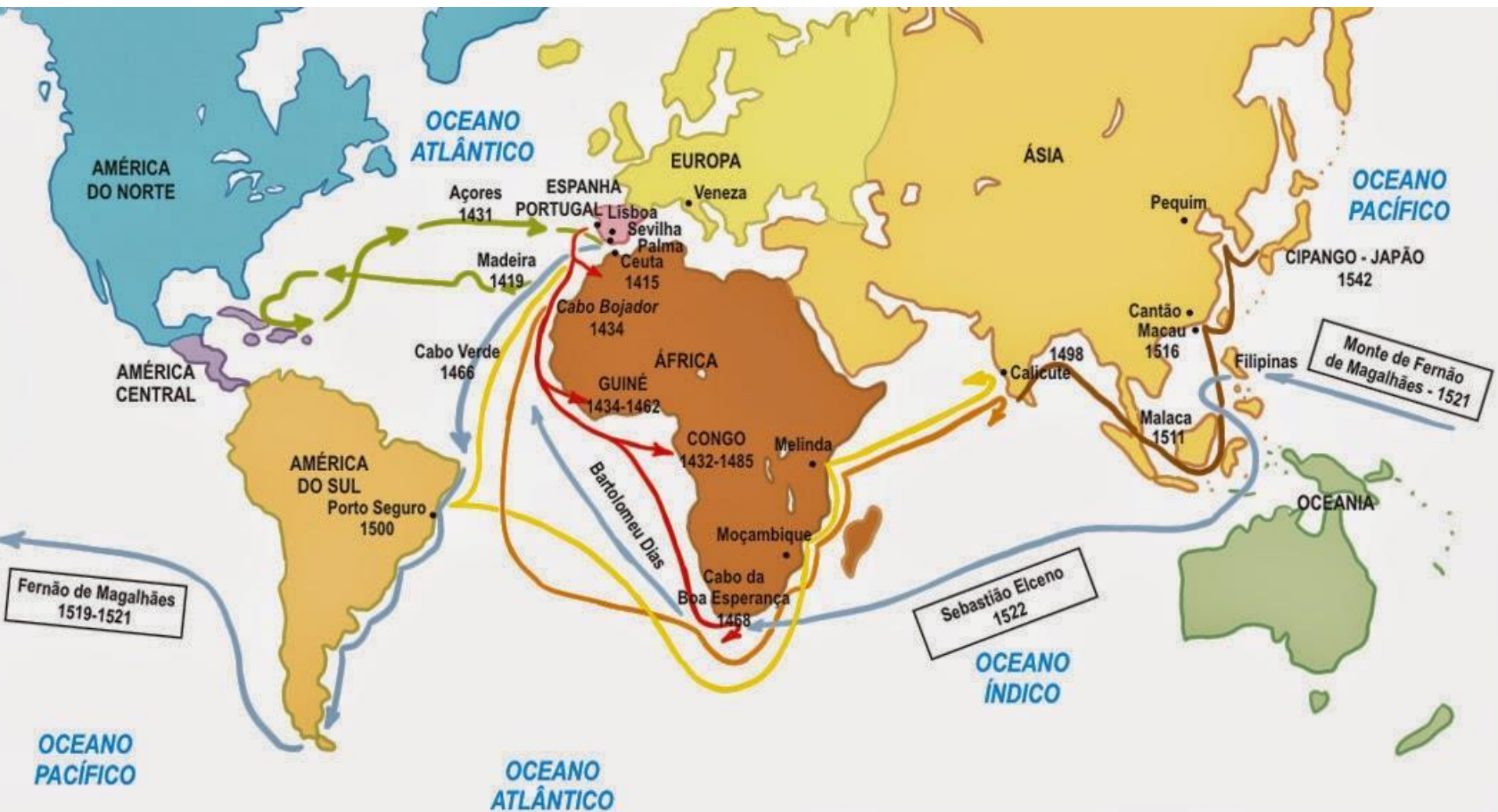
BALÉE, W.; **Cultural forests of the Amazon: a historical ecology of people and their landscapes**. University of Alabama Press, 2013.

- Archaeological sites
- Geoglyphs, ditches, and old roads
- Brazil-nut trees
- Soils rich in Amazonian dark earth



Pivetta, M. More people in the rainforest. *Revista Fapesp*, 267, 2018

SOURCE BASED ON MAPS DRAWN BY ANDRÉ BRAGA JUNQUEIRA FOR CLEMENT, C. R ET AL. THE DOMESTICATION OF AMAZONIA BEFORE EUROPEAN CONQUEST (2015)



Routes of Portuguese navigators



Early voyages

Vasco da Gama

Pedro Álvares Cabral

First voyage to Japan

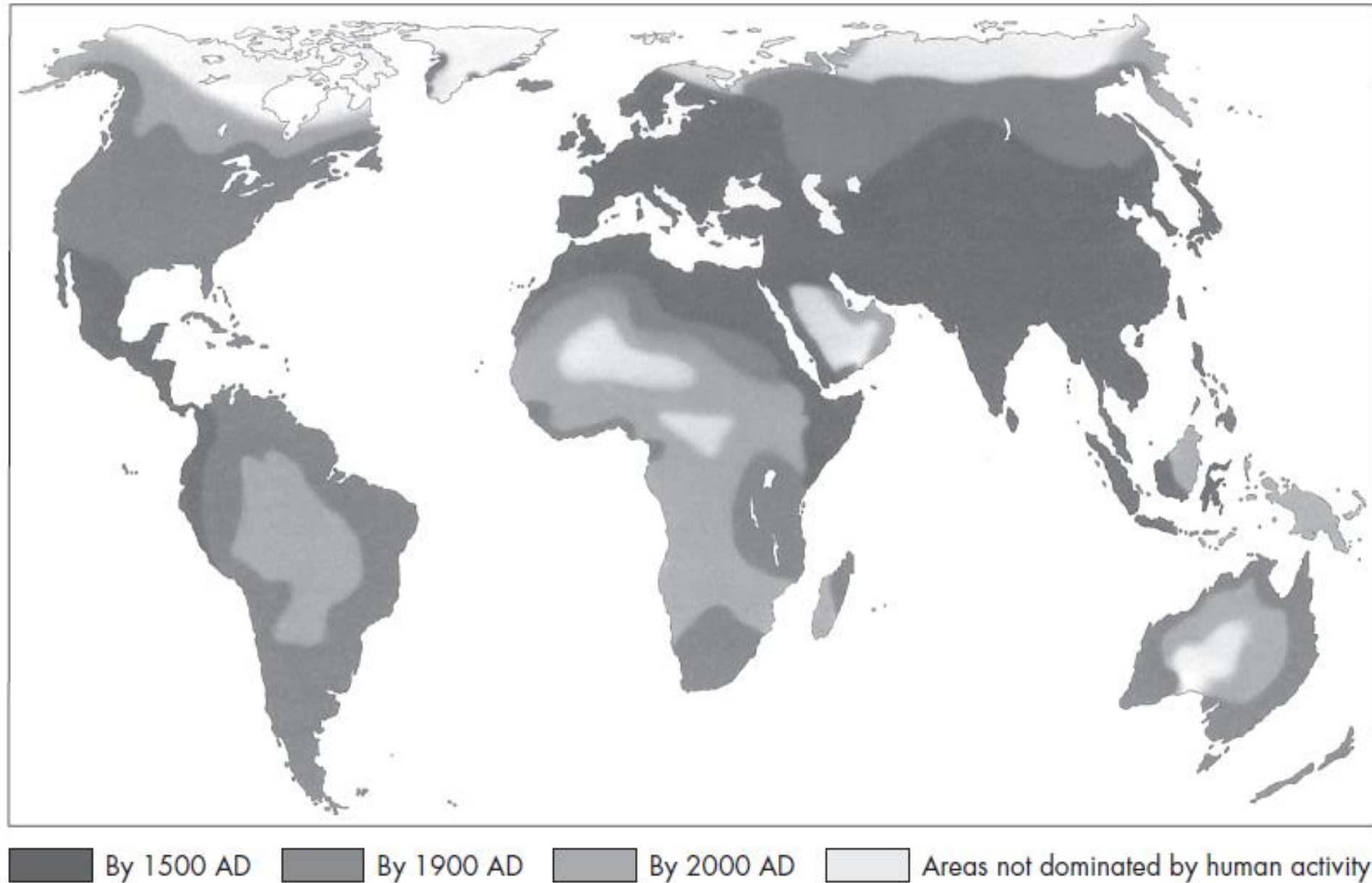
Routes of Spanish navigators



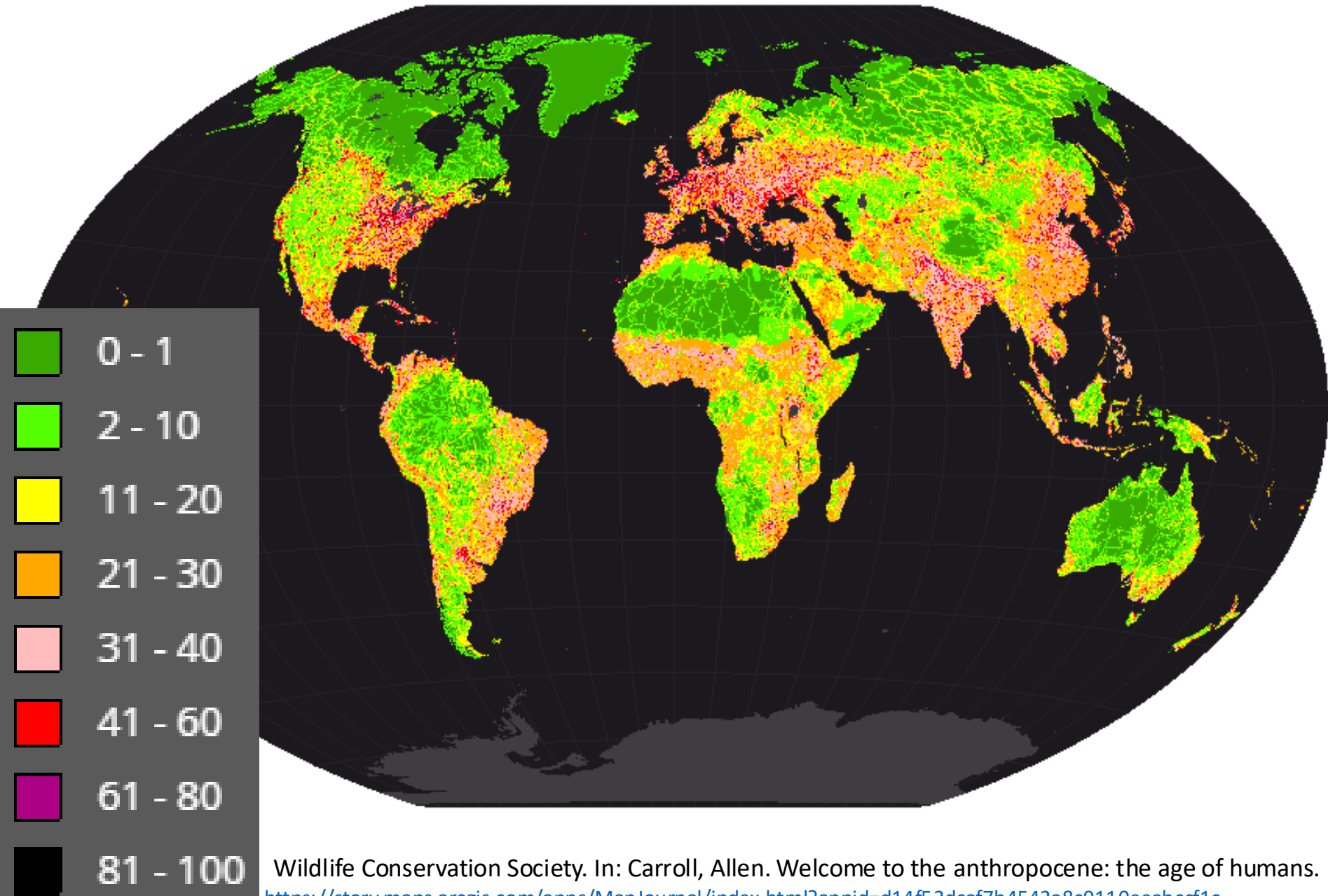
Cristóvão Colombo

Fernão de Magalhães and
Sebastião Elceno (first
circumnavigation voyage)

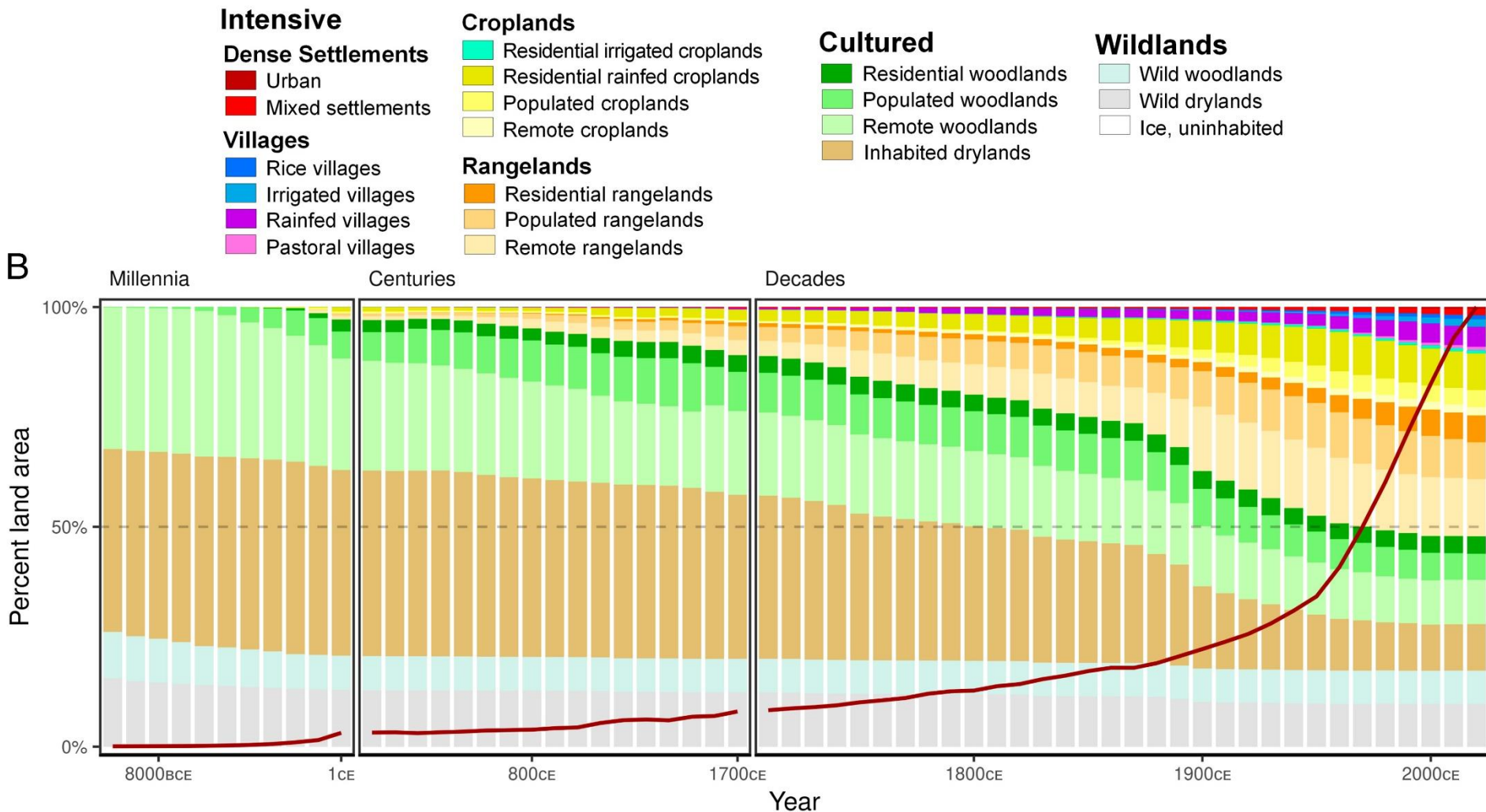
Human domination of the environment



Modification of the landscape by humans (%)



Wildlife Conservation Society. In: Carroll, Allen. Welcome to the anthropocene: the age of humans.
<https://story.maps.arcgis.com/apps/MapJournal/index.html?appid=d14f53dc7b4542a8c9110eeabccf1c>

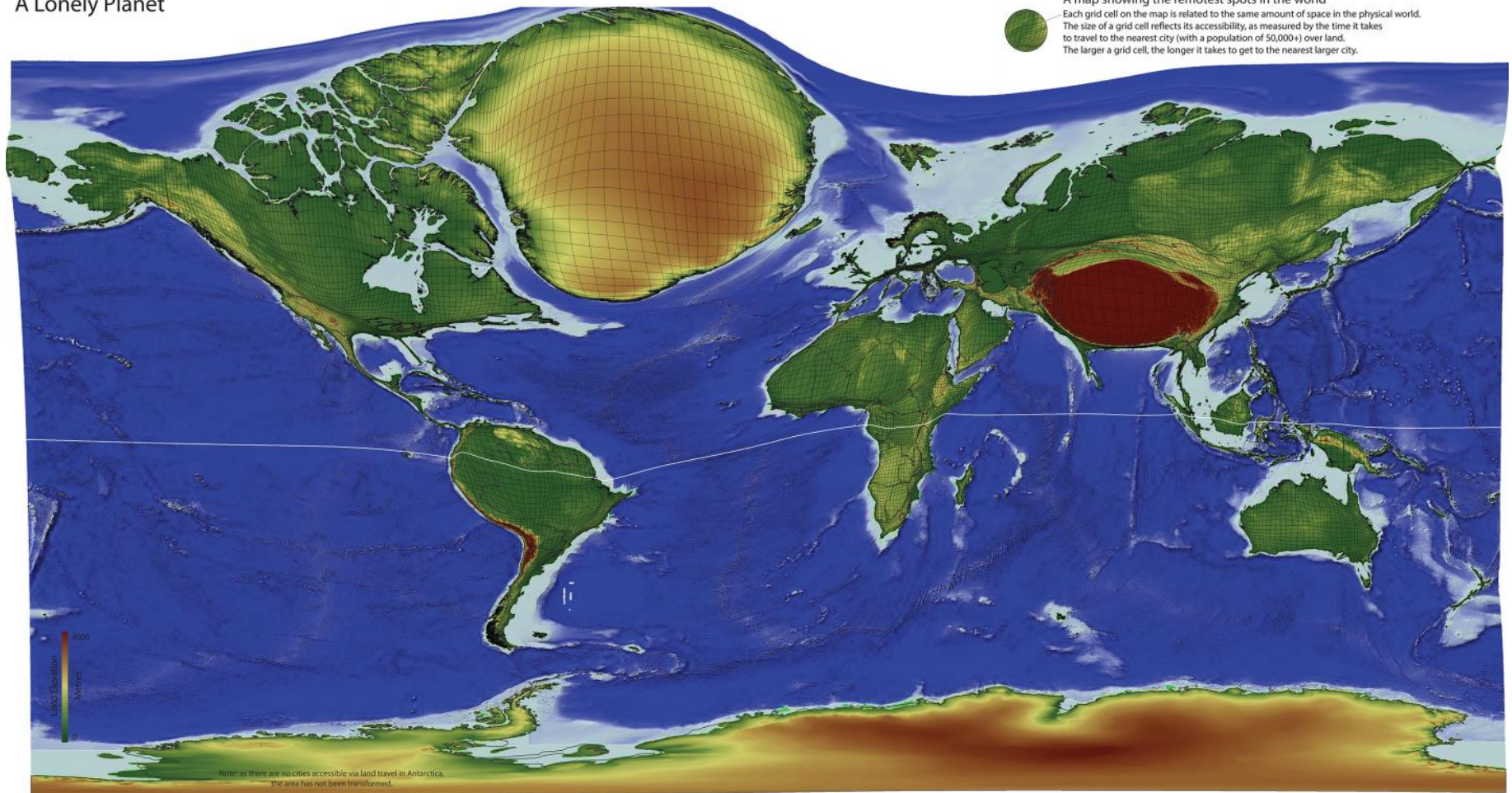


Ellis, E. C., Gauthier, N., Klein Goldewijk, K., Bliege Bird, R., Boivin, N., Díaz, S., ... & Watson, J. E. (2021). People have shaped most of terrestrial nature for at least 12,000 years. *Proceedings of the National Academy of Sciences*, 118(17), e2023483118.

Shrinking World

Cartogram of travel time to the nearest city of more than 50,000 inhabitants

A Lonely Planet



Hennig, B.D. (2016). Visualising spaces of global inaccessibility. In, S. Carver and Fritz, S. (ed.) Mapping wilderness: concepts, techniques and applications of GIS. Heidelberg / New York / Dordrecht / London (Springer). pp. 103-116.

Anthropocene

- Proposed geological epoch, in which humans have become major agents of change in the
 - Climate
 - Landforms (geomorphology)
 - Biogeochemical cycles
 - Vegetation cover and primary productivity
 - Species extinction rate

STEFFEN, W. et al. The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, v. 369, n. 1938, p. 842-867, 2011.

Ruddiman, WF. (2013). "The Anthropocene". *Annual Review of Earth and Planetary Sciences*. **41**: 45–68

Anthropocene

- Proposed starting points
 - 6000 BC – Agriculture and sedentary lifestyle
 - 1800 AD – Industrial Revolution
 - 1952 AD – Great acceleration of human impacts and global plutonium fallout from nuclear weapons testing

Waters, C. N., Turner, S. D., Zalasiewicz, J., & Head, M. J. (2023). Candidate sites and other reference sections for the Global boundary Stratotype Section and Point of the Anthropocene series. *The Anthropocene Review*, 10(1), 3-24.

STEFFEN, W. et al. The Anthropocene: conceptual and historical perspectives. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, v. 369, n. 1938, p. 842-867, 2011.

Ruddiman, WF. (2013). "The Anthropocene". *Annual Review of Earth and Planetary Sciences*. 41: 45–68

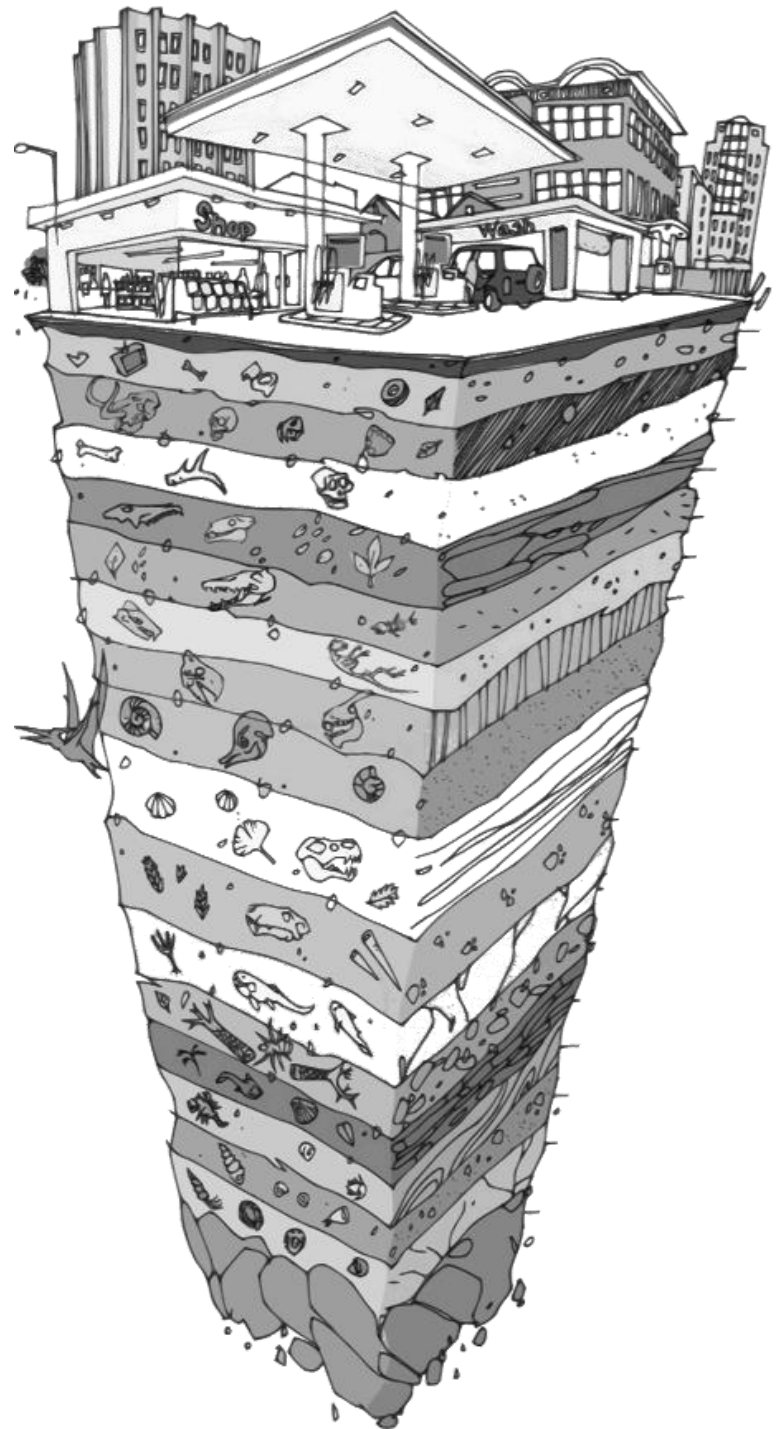
Anthropocene



Edward Burtynsky, “Clearcut #1, Palm Oil Plantation, Borneo, Malaysia” (2016)

<https://www.edwardburtynsky.com/projects/photographs/anthropocene>

Anthropocene

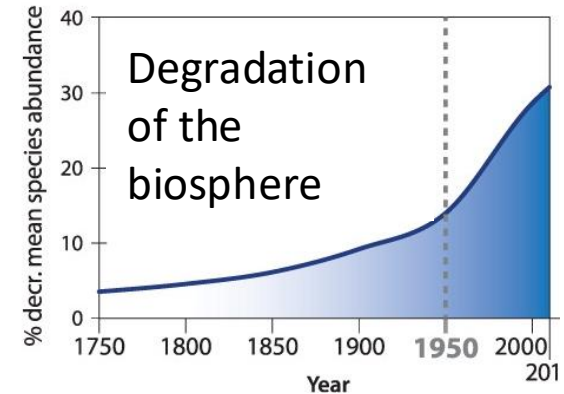
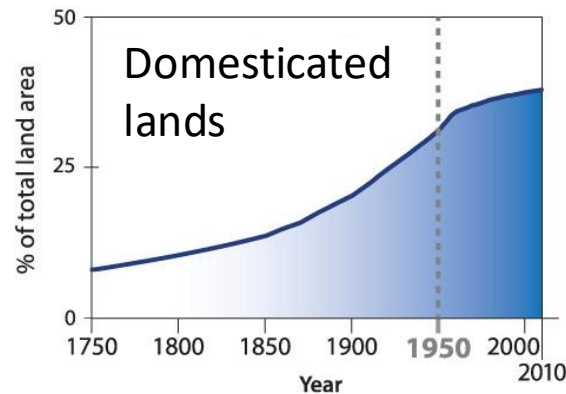
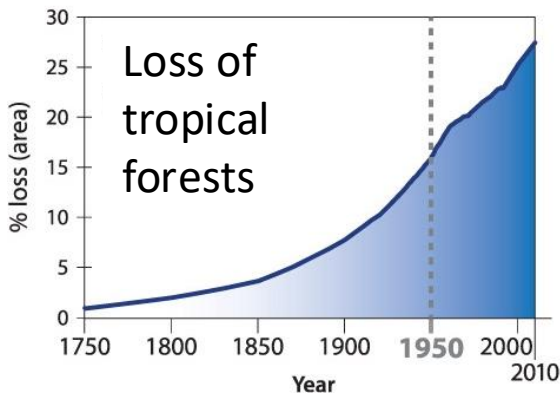
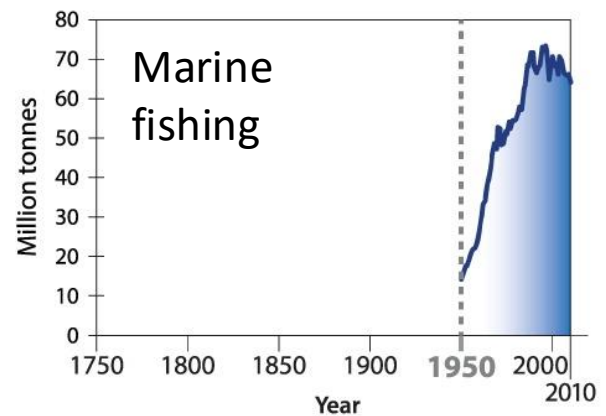
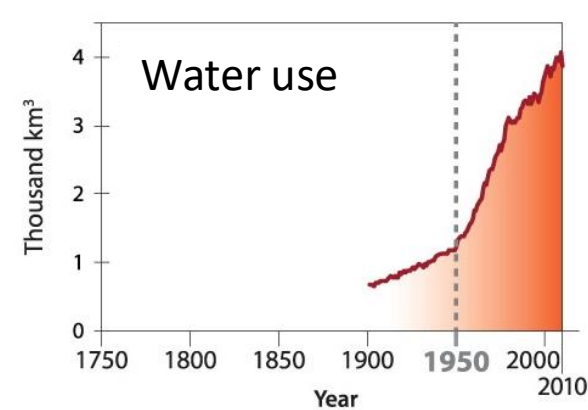
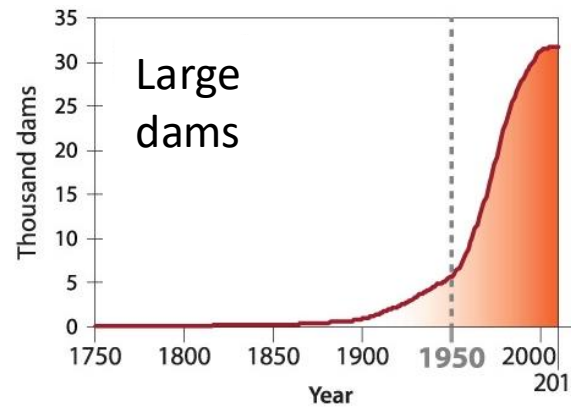
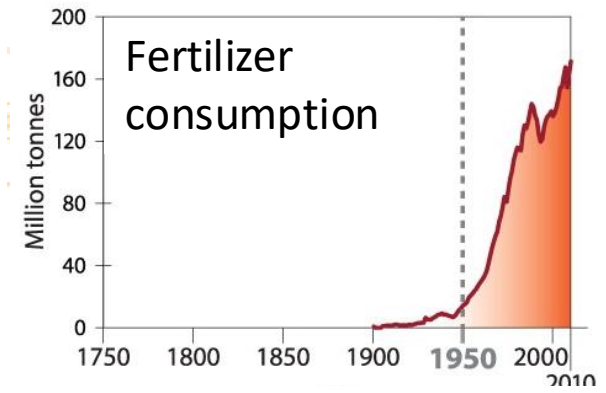
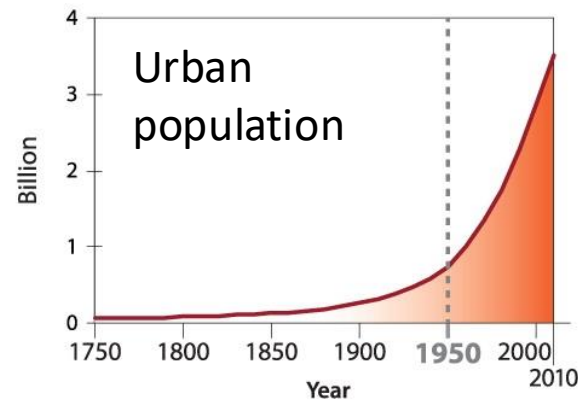
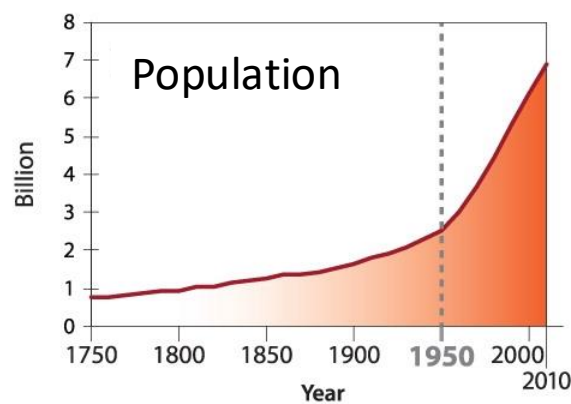


Anthropocene



Edward Burtynsky, “Dandora Landfill #1, Nairobi, Kenya” (2016)

<https://www.edwardburtynsky.com/projects/photographs/anthropocene>



Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review*, 2(1), 81-98.

Alternative conceptions of the Anthropocene

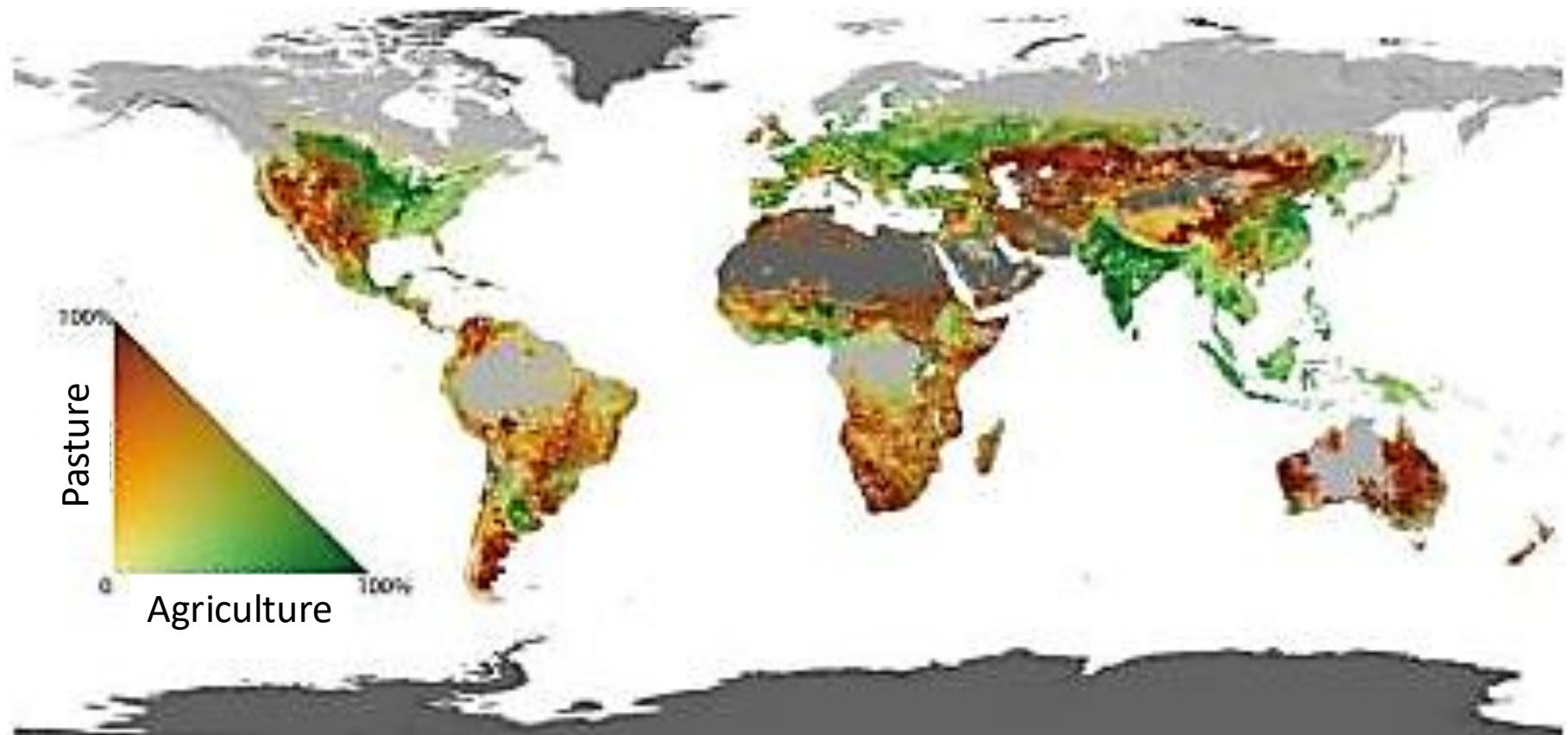
- Concepts:
 - Capitalocene: the cause would be capitalism
 - Phallocene, Hombrocene: gender perspective
 - Emphasizes the gendered dimensions of responsibility for environmental change
 - The Anthropocene literature has been criticized for male-dominated authorship and perspectives
 - Chthulucene: human history is entangled with many other species (livestock, agriculture, diseases, fungi, etc.)
- Anthropocene would be an unfolding event, not a geological epoch (IUGS, 2024)
- Should we assume we are in the Anthropocene, or should we try to return to the Holocene to avoid destabilization of the Earth system?

Veiga, J. E. (2019). *O antropoceno ea ciência do sistema terra*. Editora 34.

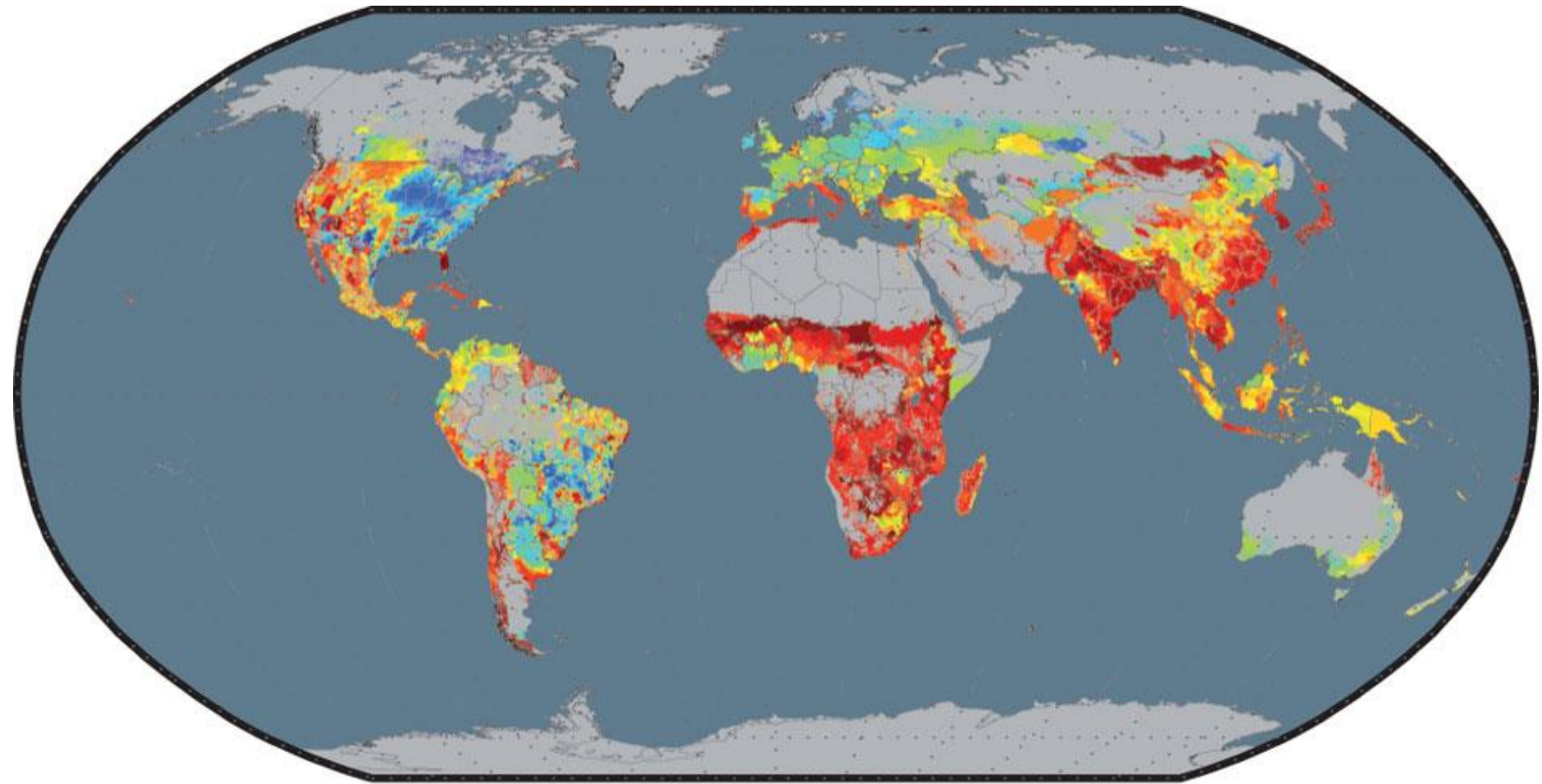
Haraway, D. J. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.

Gibbard, P., Walker, M., Bauer, A., Edgeworth, M., Edwards, L., Ellis, E., ... & Ruddiman, W. (2022). The Anthropocene as an event, not an epoch. *Journal of Quaternary Science*, 37(3), 395-399.

Agricultural land use in the world



- In 2014, 37% of the world's land area was agricultural land
[FAO <https://data.worldbank.org/indicator/AG.LND.AGRI.ZS>]



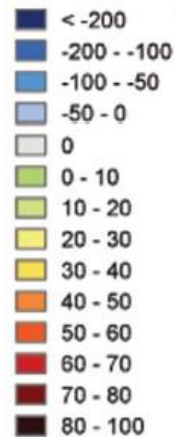
Food production as a fraction of the total cultivated area



FOLEY, Jonathan A. et al. Solutions for a cultivated planet. **Nature**, v. 478, n. 7369, p. 337-342, 2011.

a

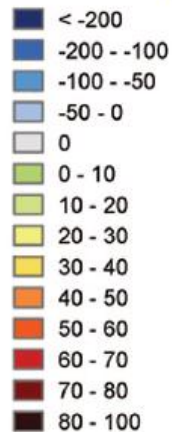
$\Delta\text{NPP}_{\text{LC}}$
[% of NPP_0]



Human Alteration of Primary Productivity

b

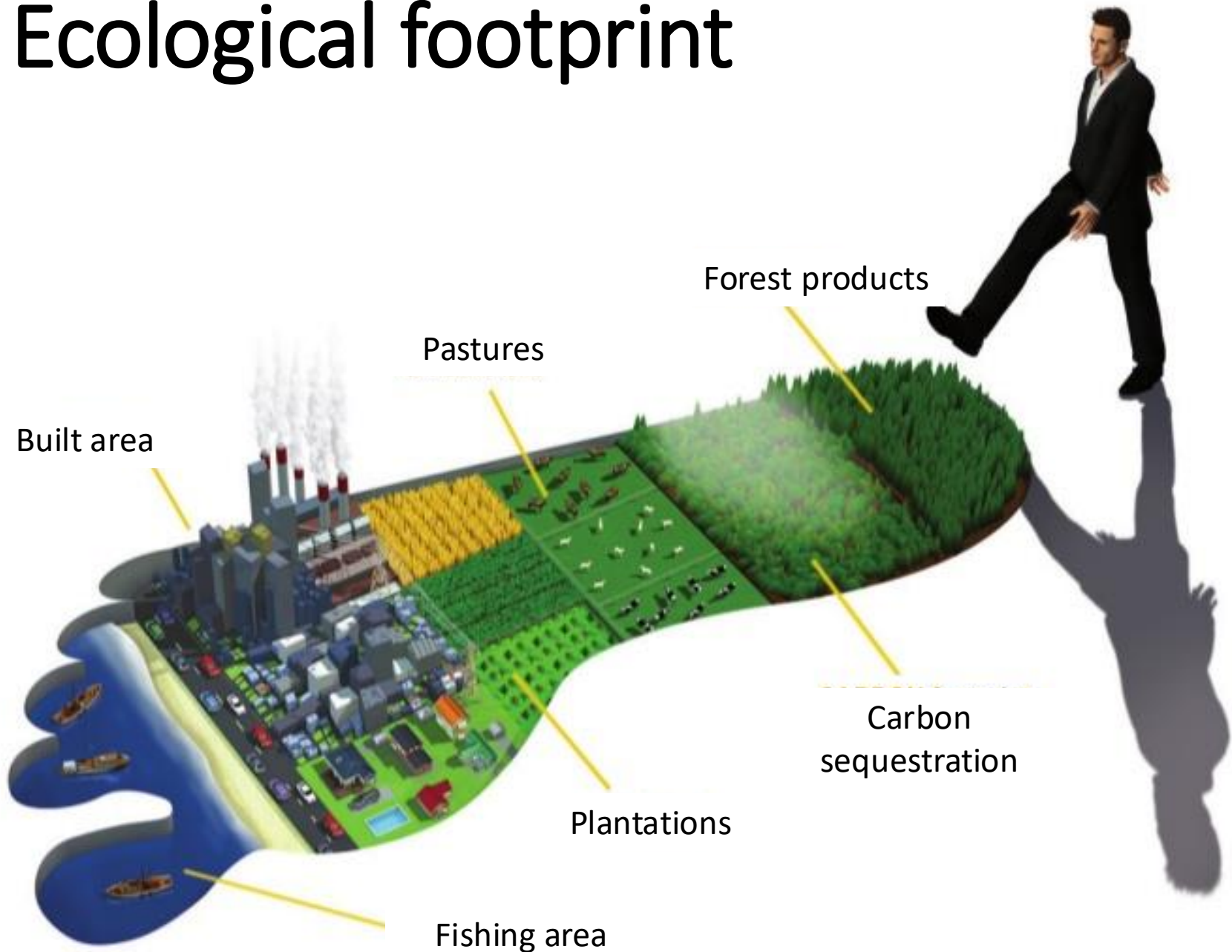
HANPP
[% of NPP_0]



Human Appropriation of Primary Productivity

23.8% of the NPP
- 53% harvest
- 40% induction of
pastures and forests
- 7% Burning

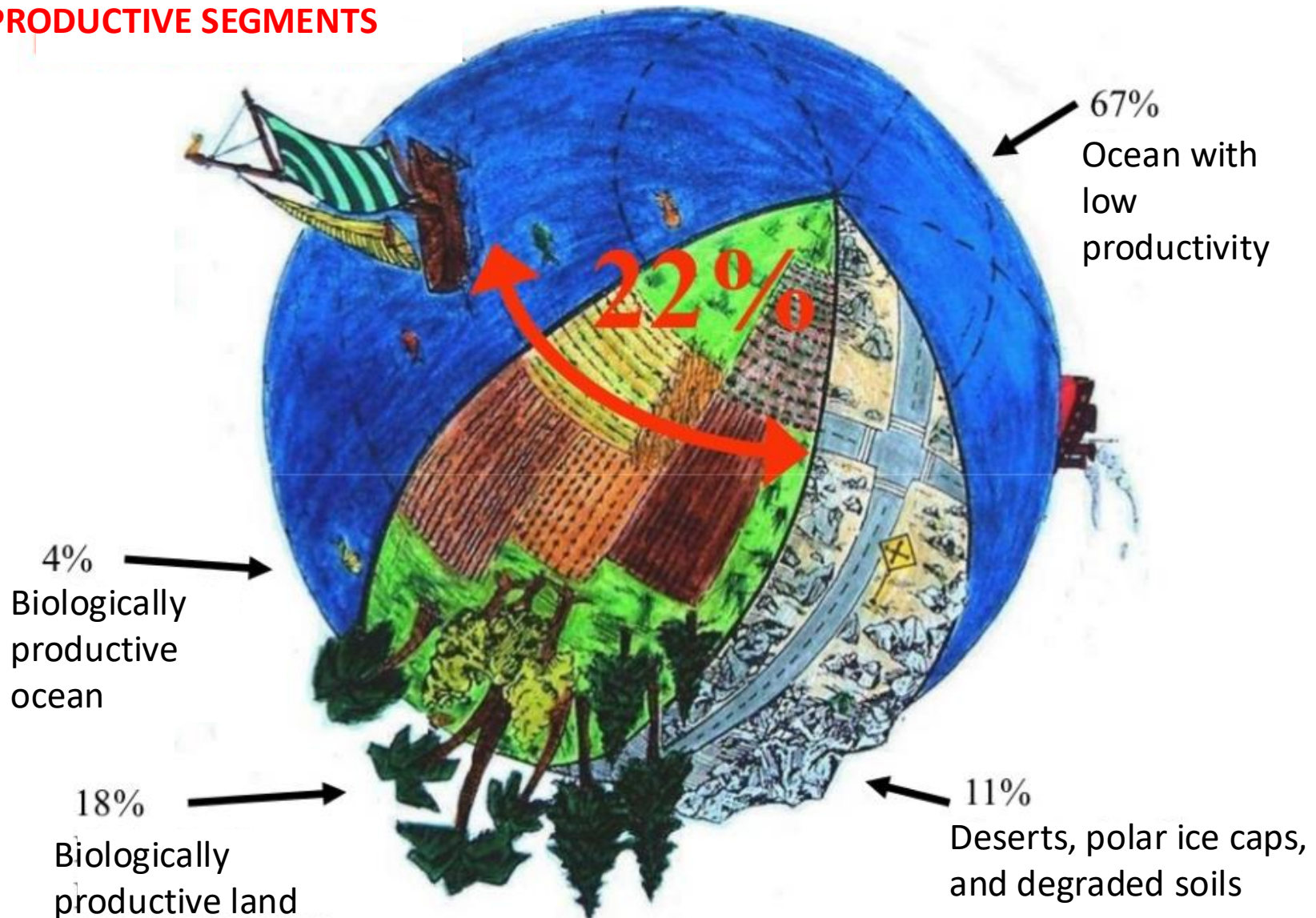
Ecological footprint



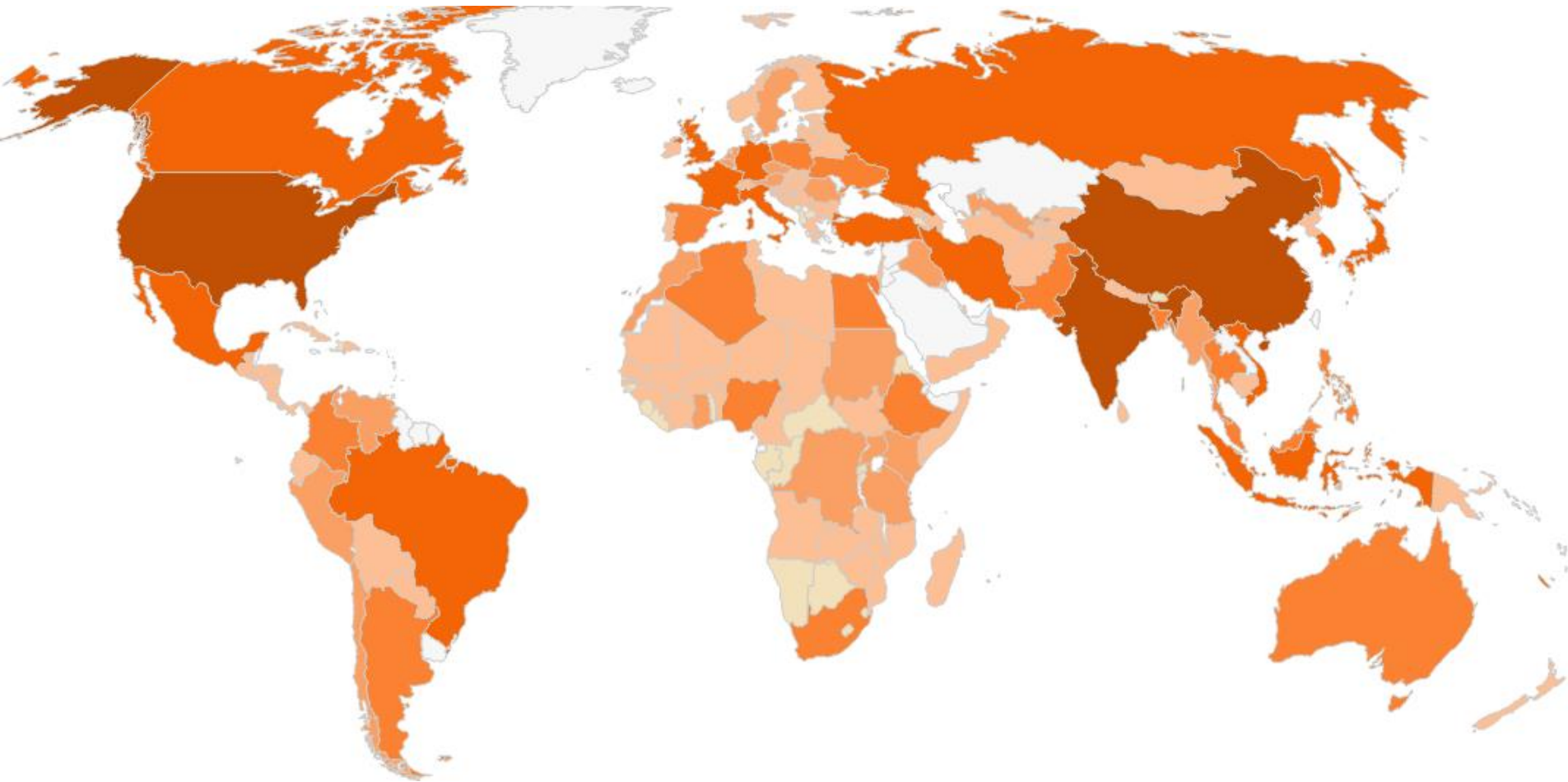
Biocapacity

1.5 ha per person is the limit for planet Earth

BIOPRODUCTIVE SEGMENTS



Ecological Footprint - 2025



Ecological footprint by country (measured in global hectares - gha)



> 1B



250M - 1B



100M - 250M



50M - 100M



25M - 50M

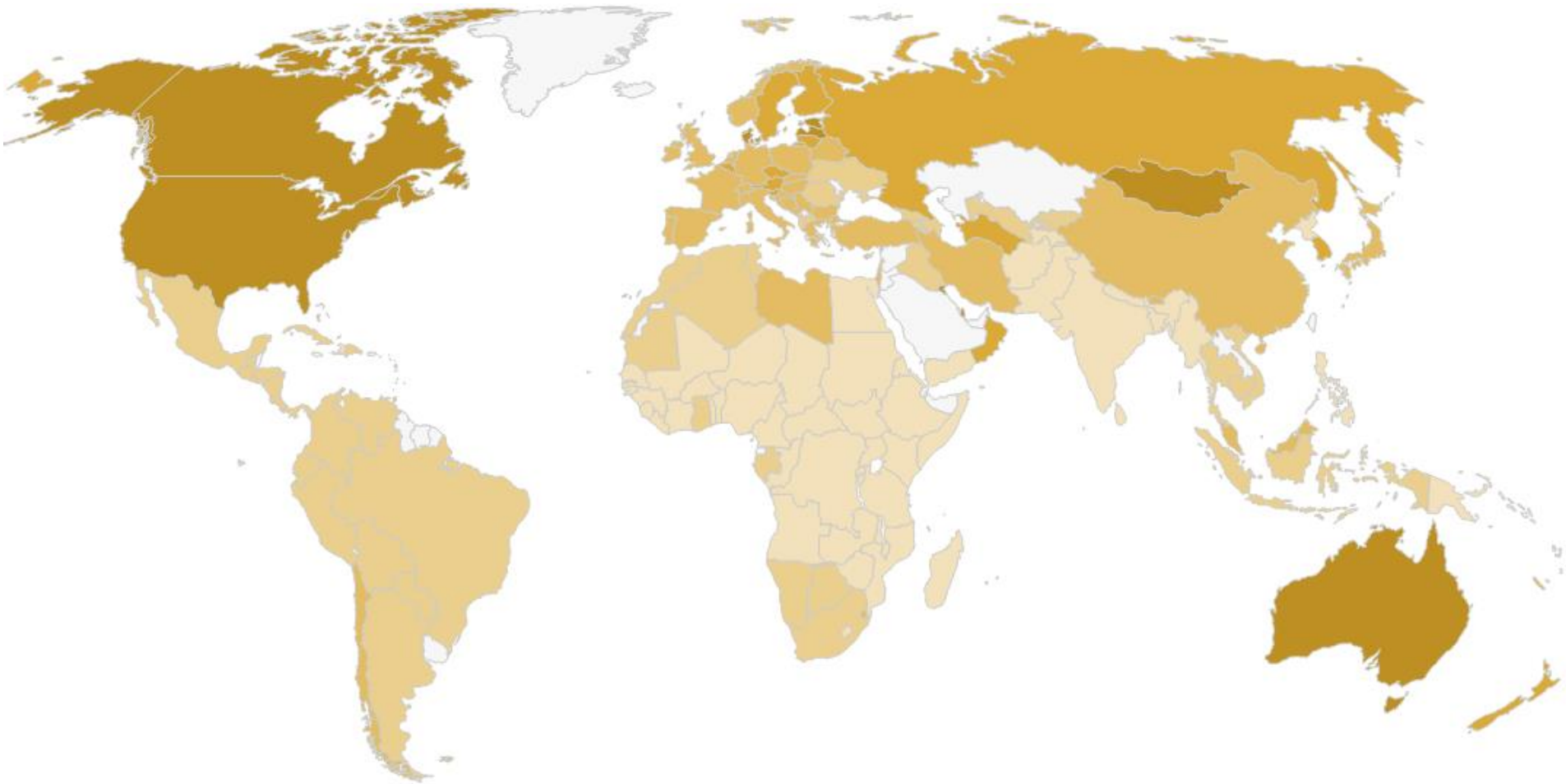


10M - 25M



< 10M

Ecological Footprint per capita - 2025



Ecological footprint per capita by national population (in global hectares)



> 6.7



5.1 - 6.7



3.4 - 5.1



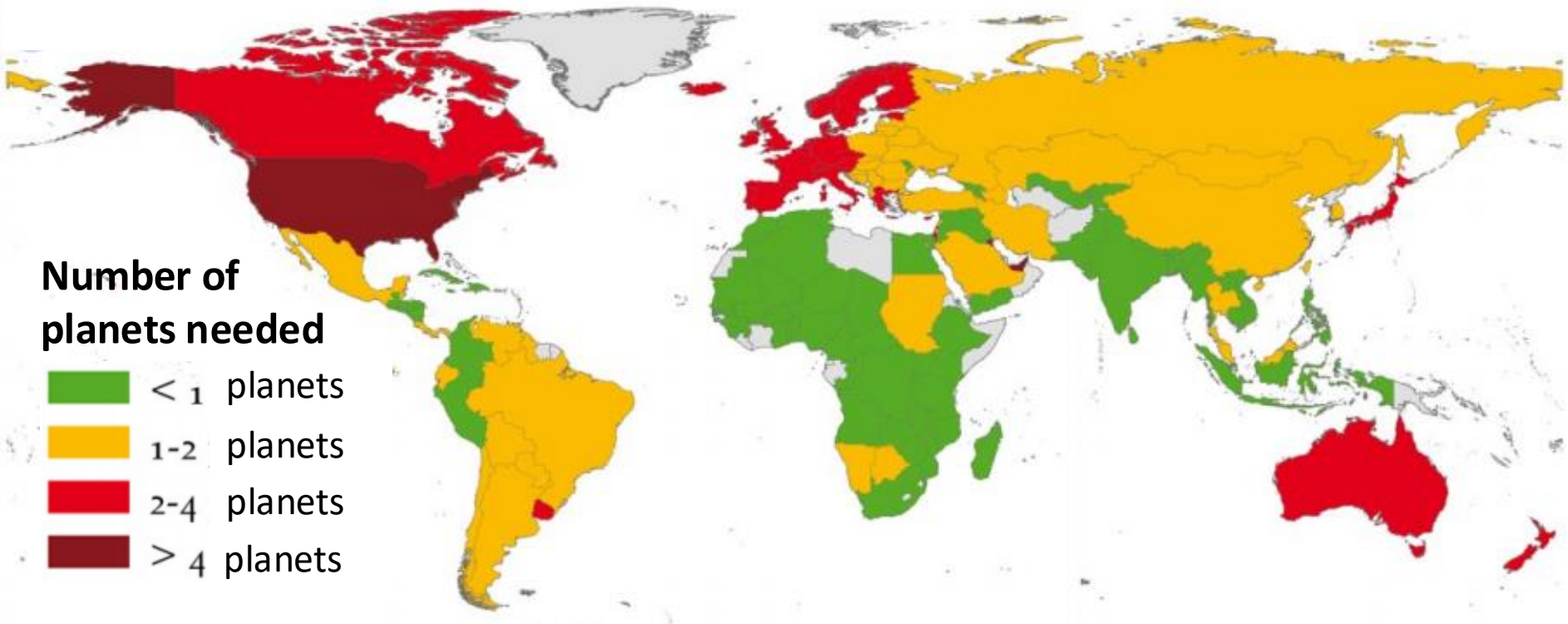
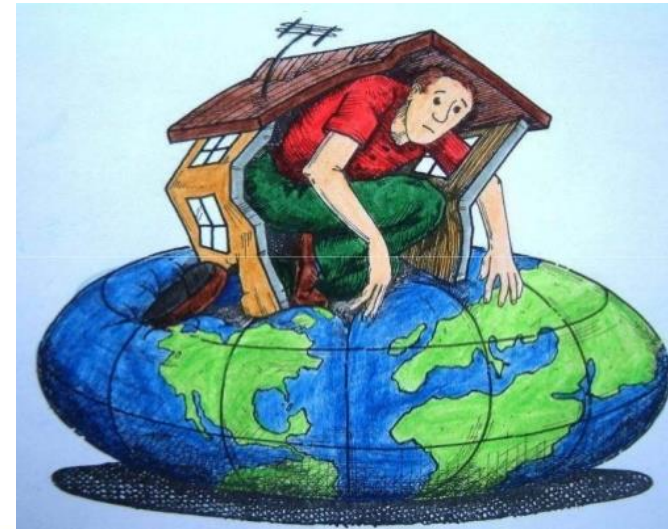
1.7 - 3.4



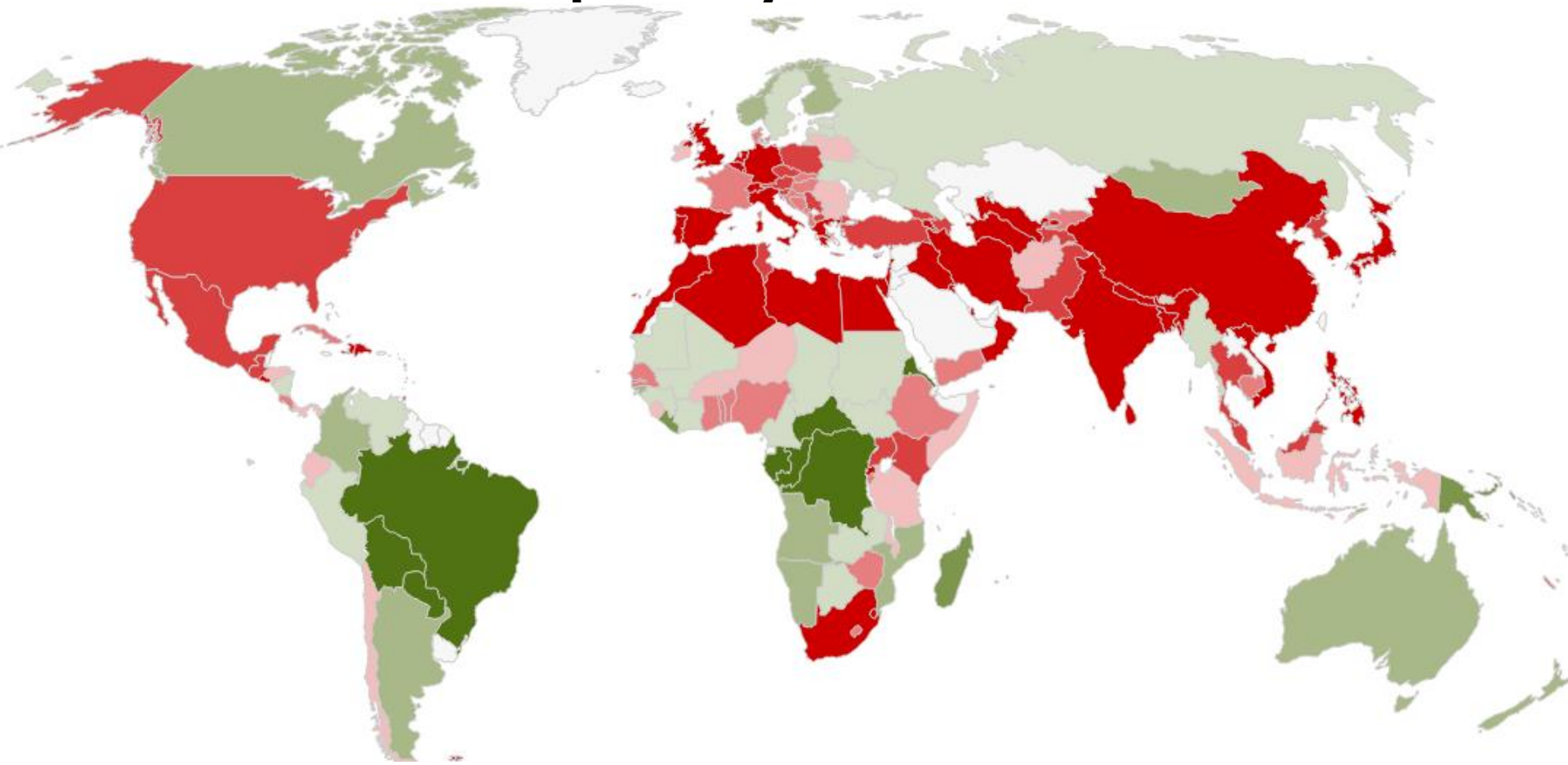
< 1.7



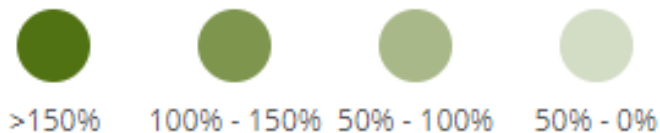
Ecological footprint



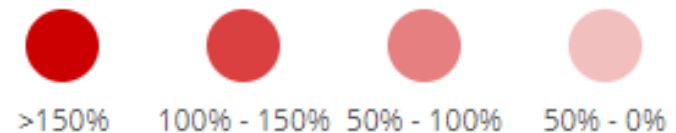
Biocapacity use - 2025



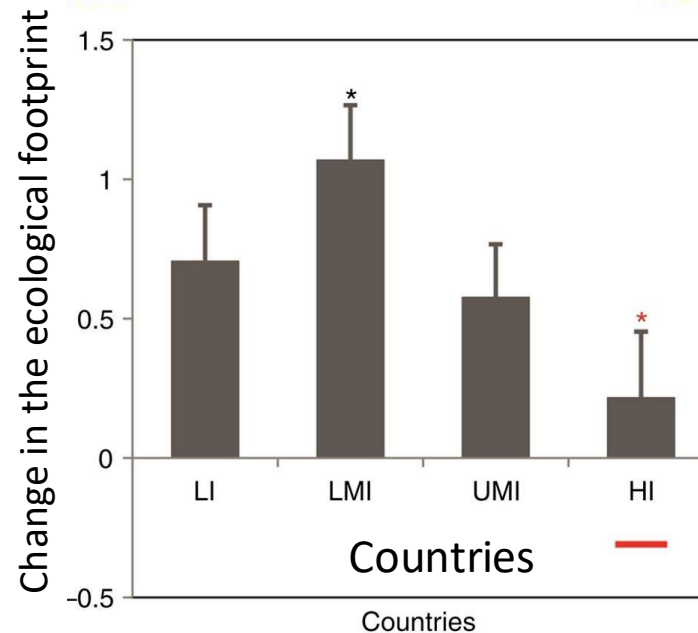
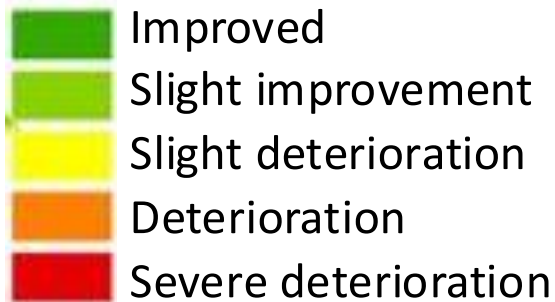
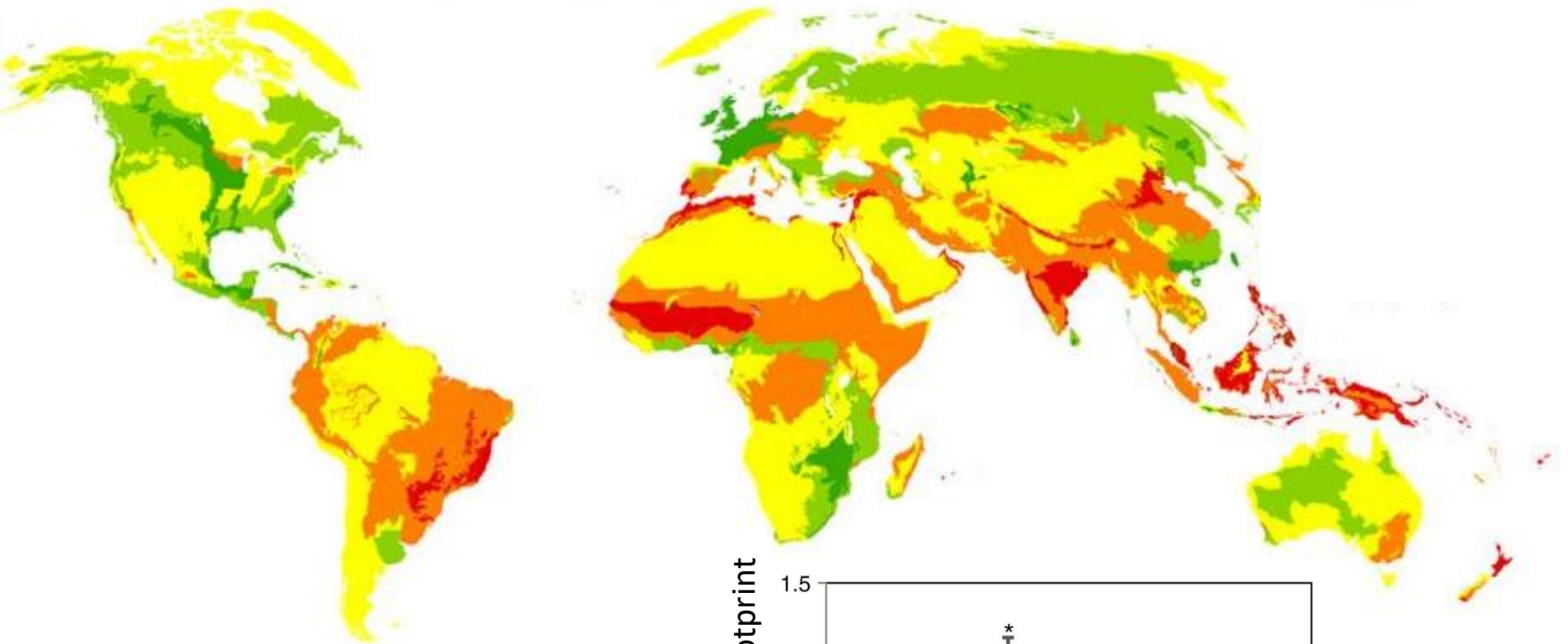
Biocapacity lenders
Biocapacity greater than footprint



Biocapacity debtors
Footprint greater than biocapacity



Change in Ecological Footprint 1993-2009

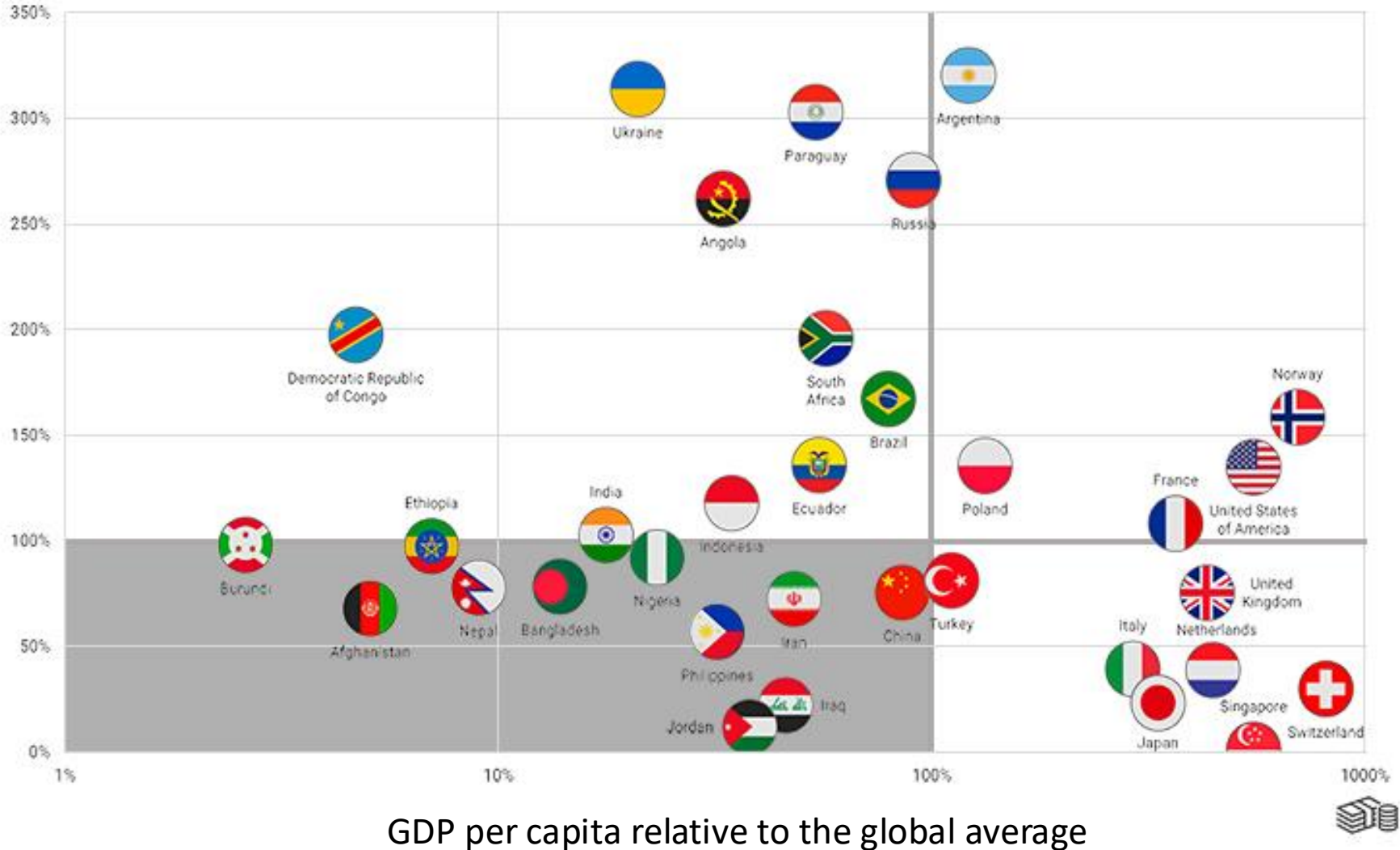


Venter, O. et al. 2016. Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation. *Nature Communications*, 7, p.12558.



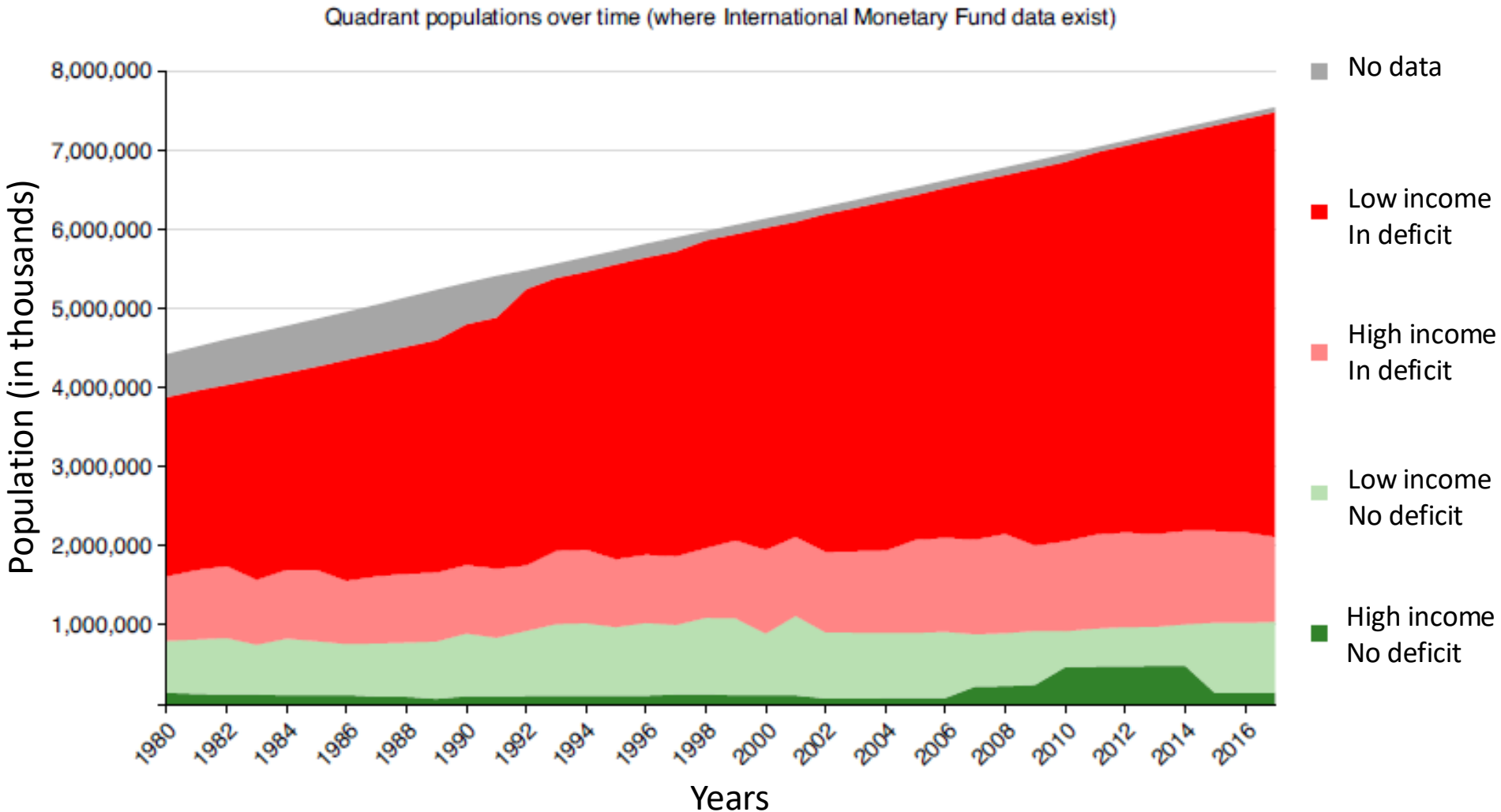
Food Security: Biocapacity vs Income (2022)

Food-production biocapacity as a %
of food consumption



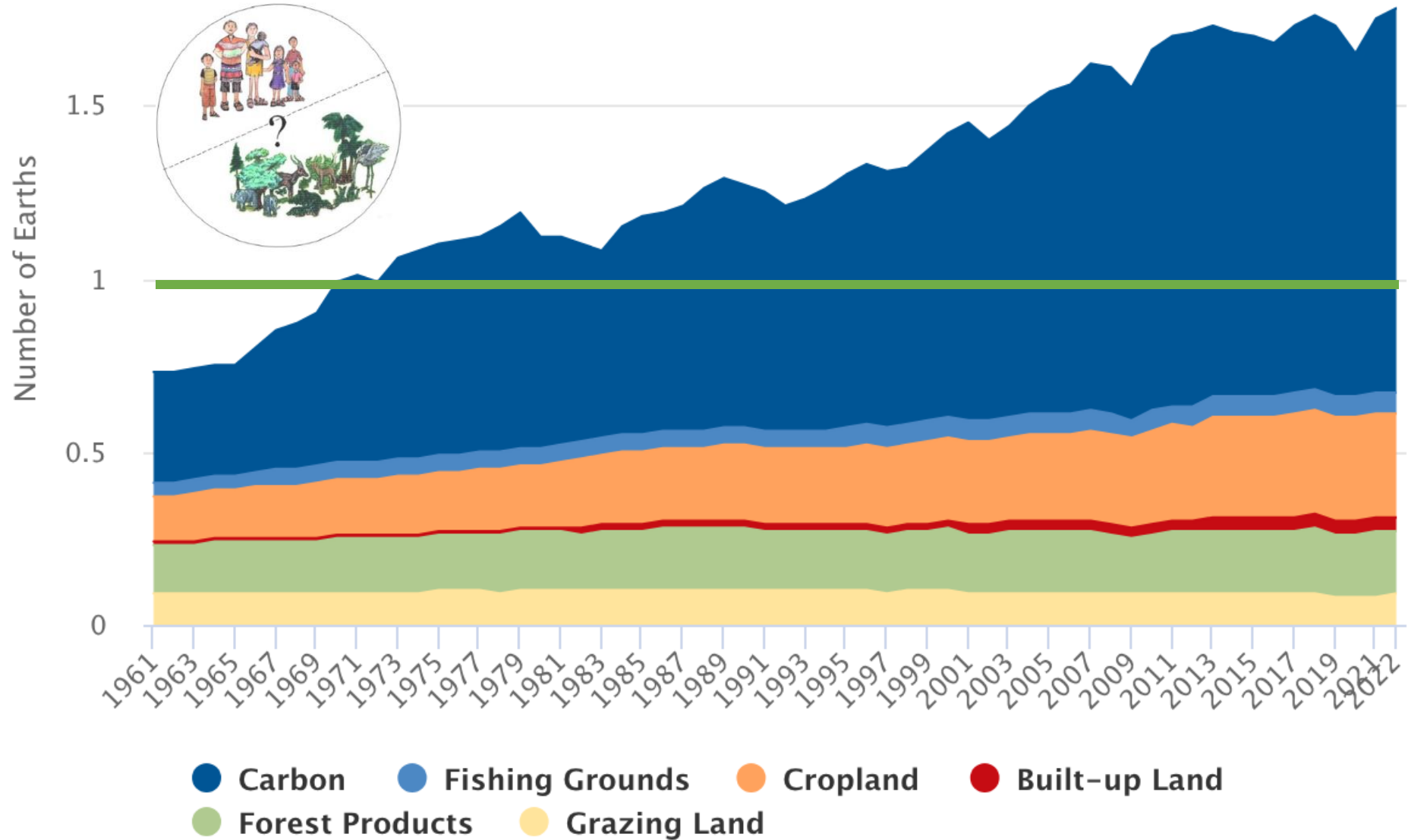
<https://www.footprintnetwork.org/2022/07/13/food-security-in-a-world-of-overshoot/>

Population in the world by income group vs. biocapacity deficit



Wackernagel, M., Hanscom, L., Jayasinghe, P., Lin, D., Murthy, A., Neill, E., & Raven, P. (2021). The importance of resource security for poverty eradication. *Nature Sustainability*, 4(8), 731-738.

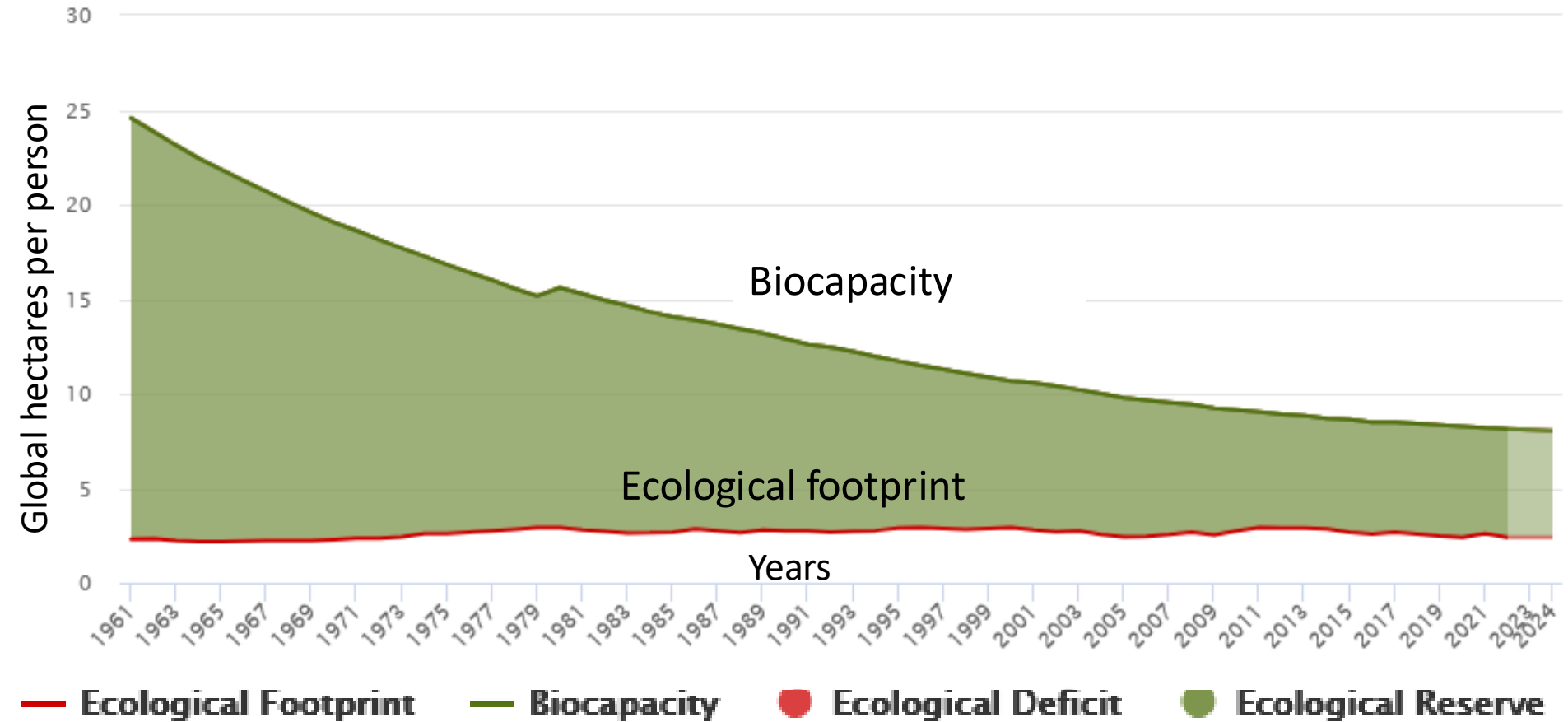
Global ecological footprint by land type



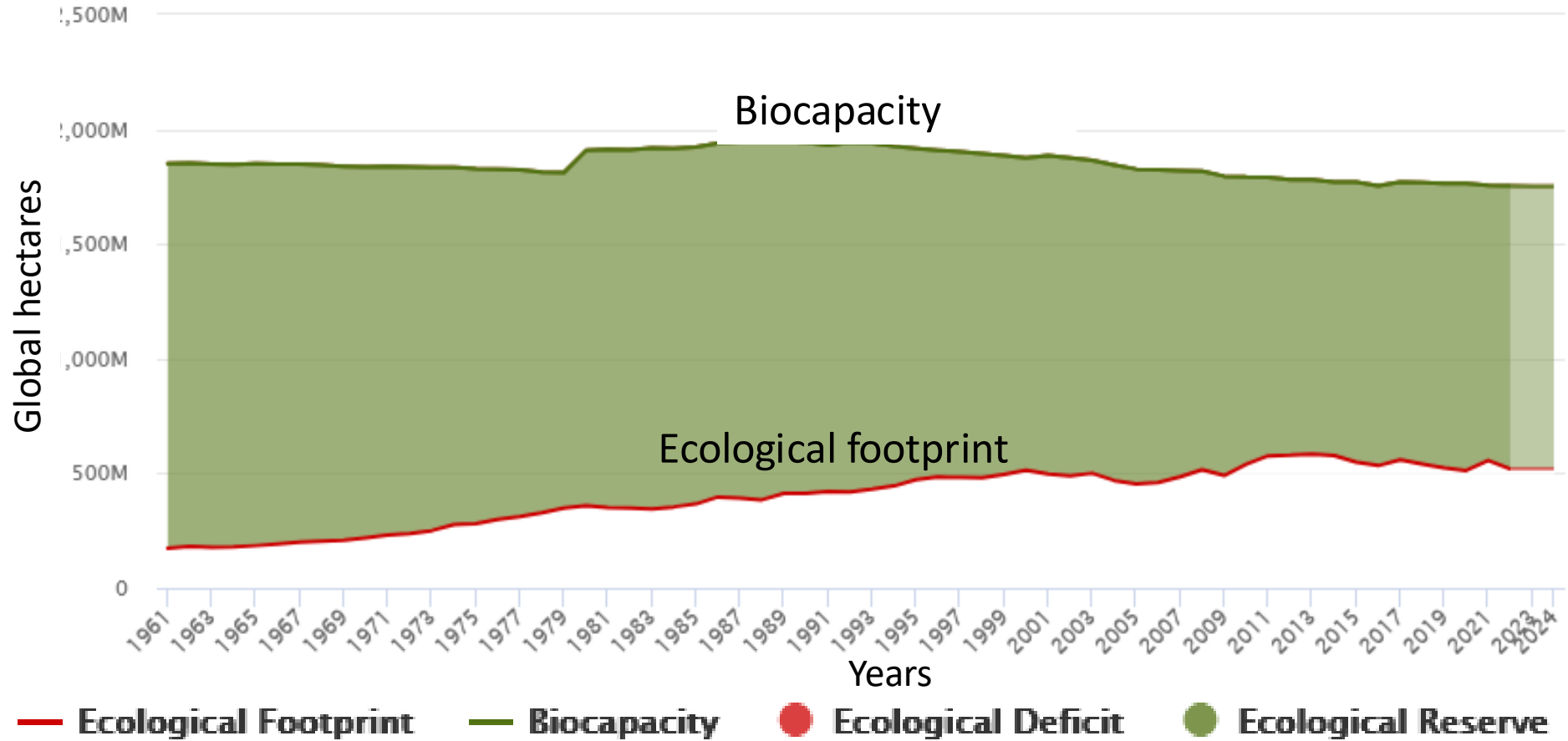
York University, FoDaFo, Global Footprint Network, 2025 National Footprint and Biocapacity Accounts

<https://data.footprintnetwork.org/>

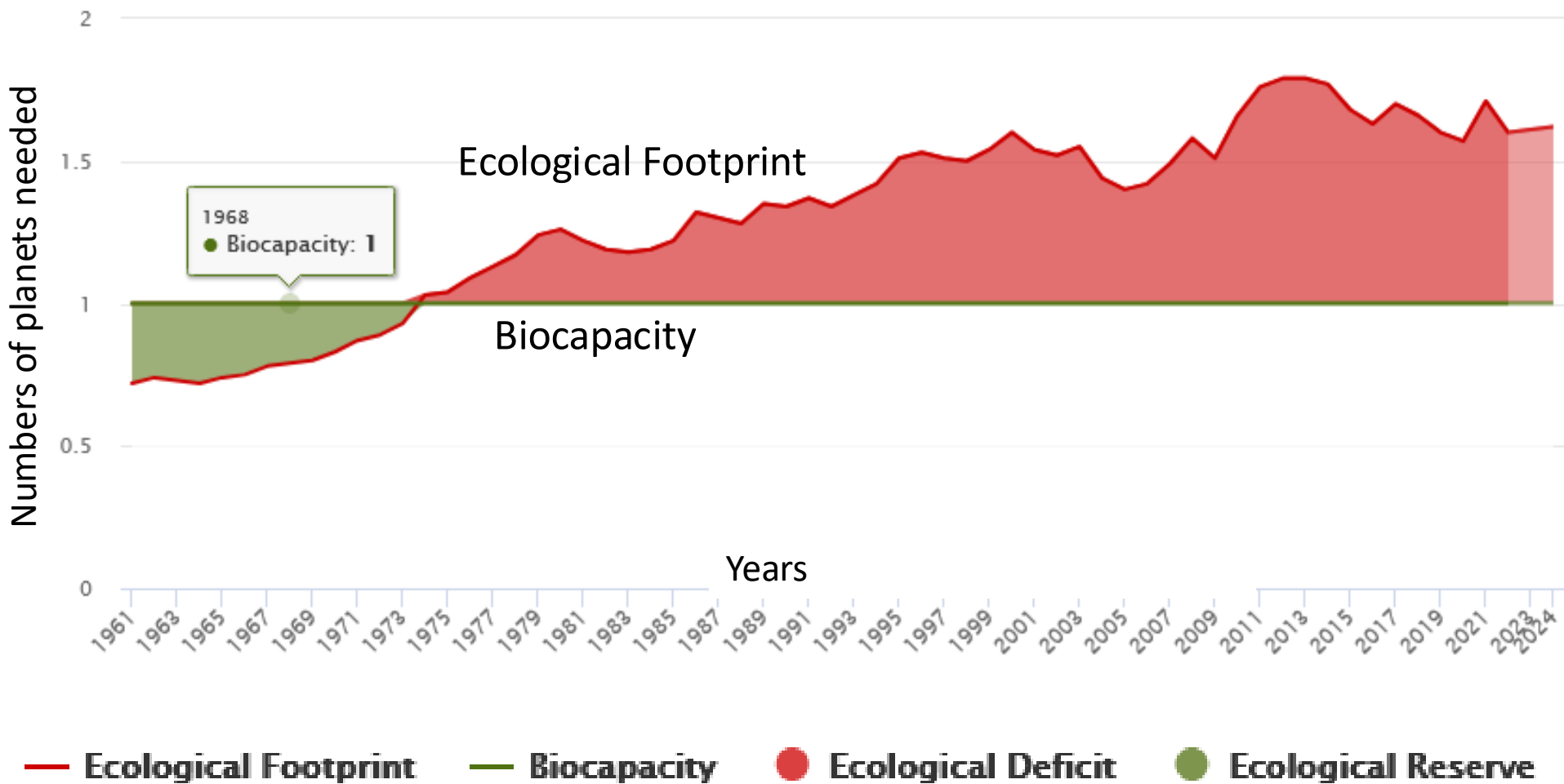
Brazil's Ecological Footprint per capita



Brazil's Ecological Footprint



Brazil's Ecological Footprint



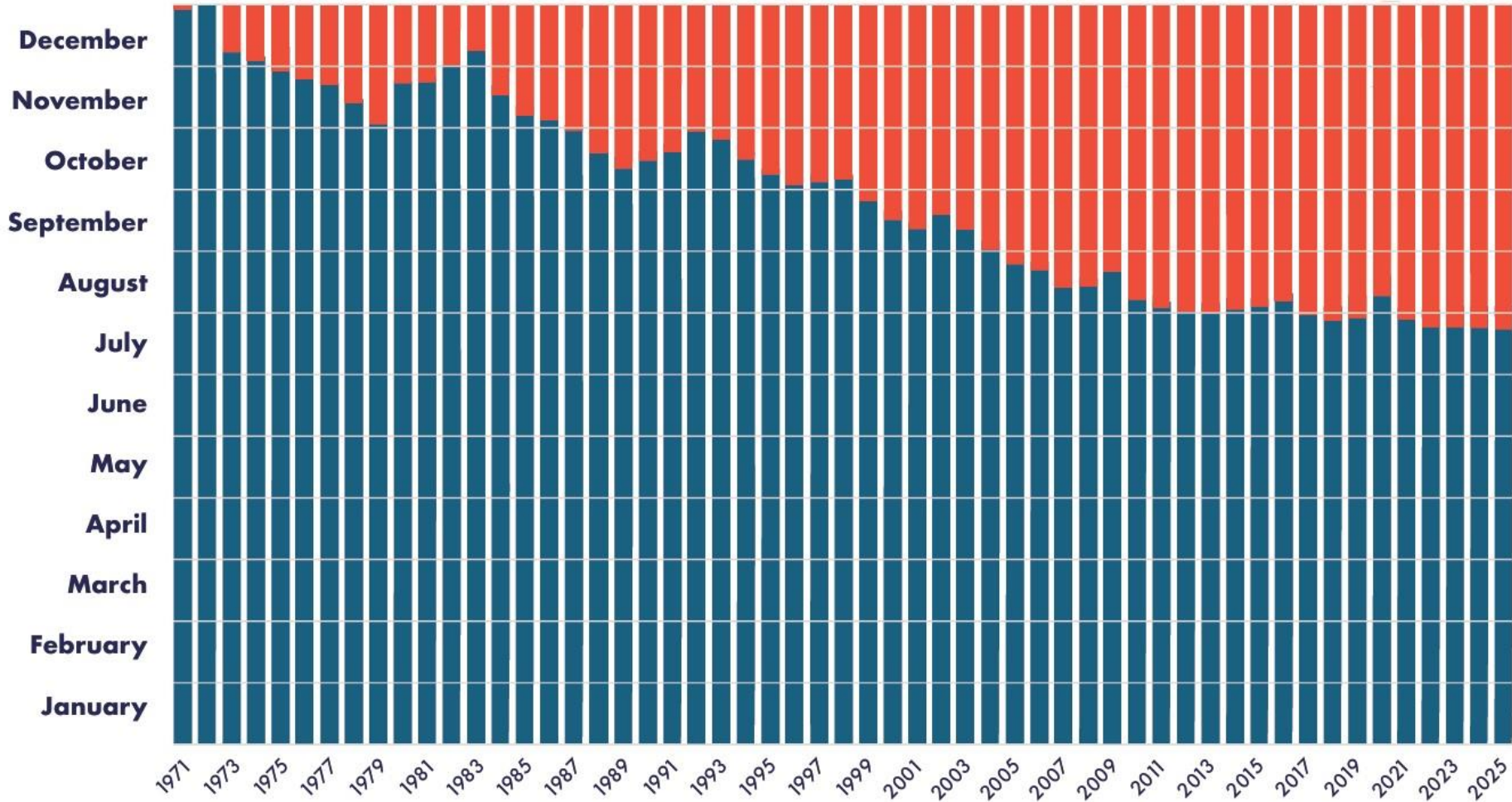
1 Earth



Earth Overshoot Day

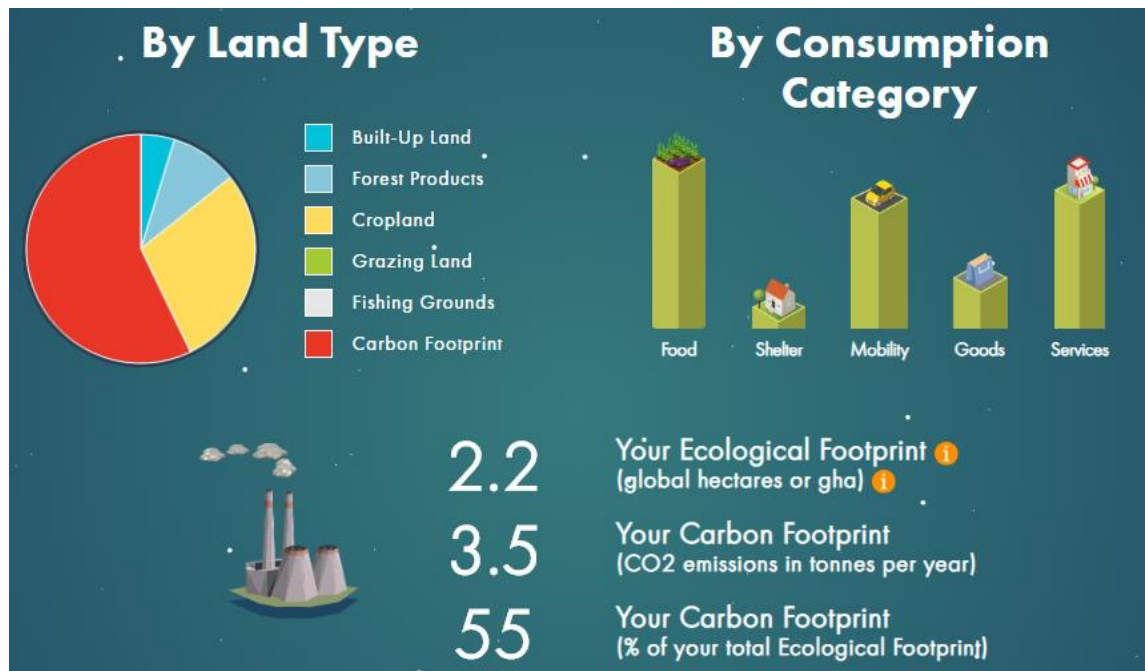
1971 - 2025

1.8 Earths

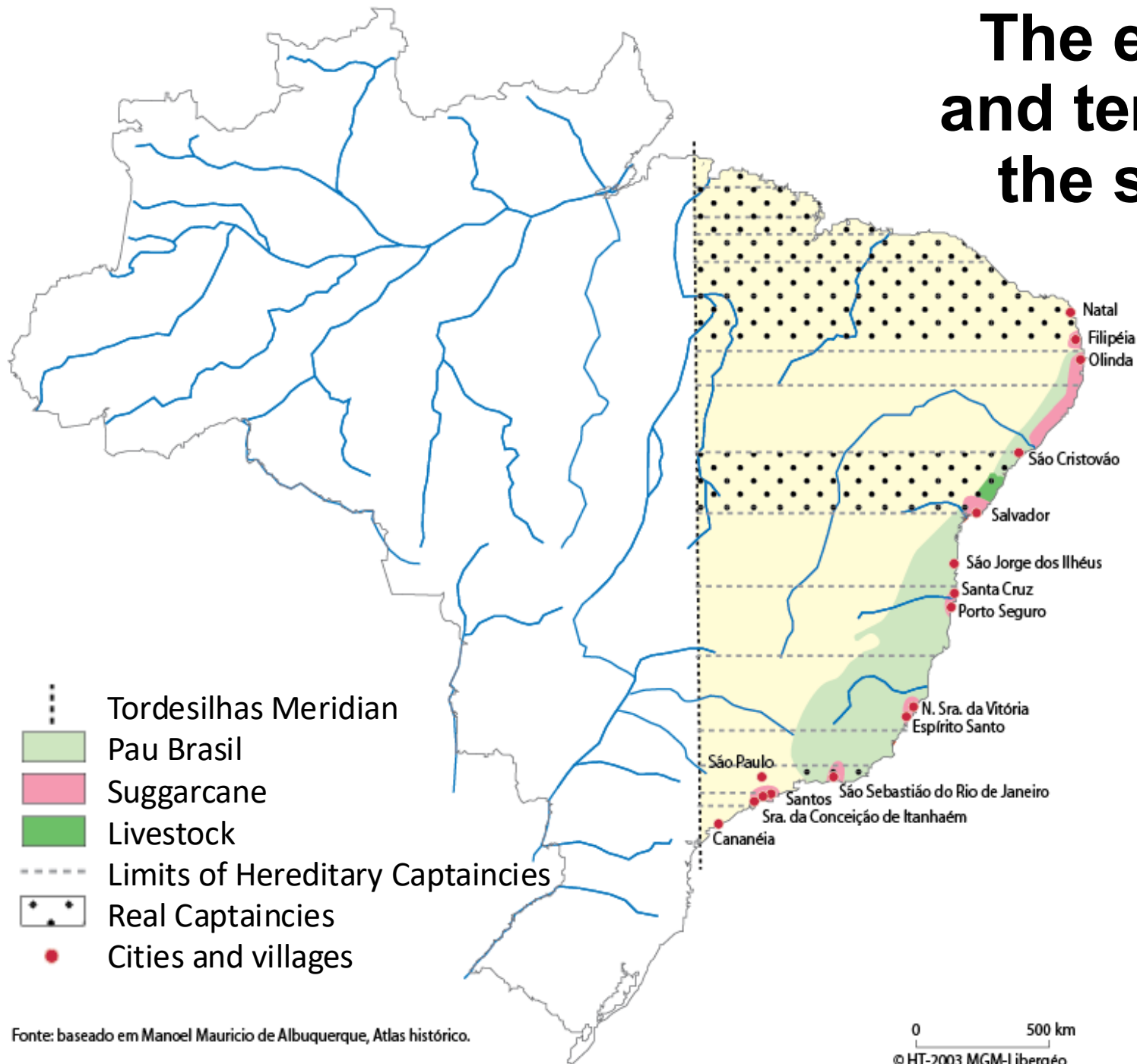


Exercise for the next class

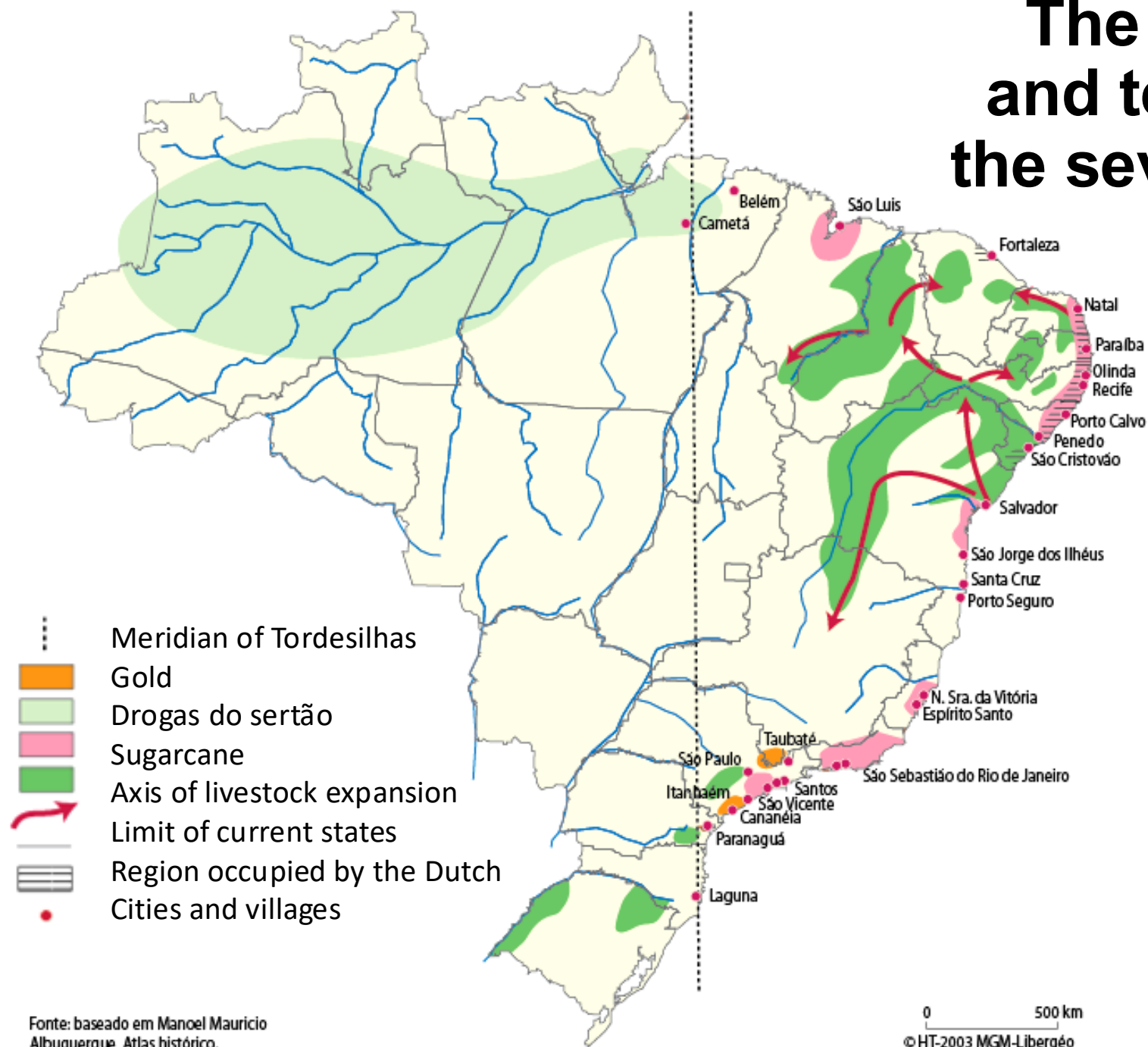
- Calculate your ecological footprint in:
<http://www.footprintcalculator.org>
- Use the detailed input options
- Take a screenshot and upload it to the Moodle activity



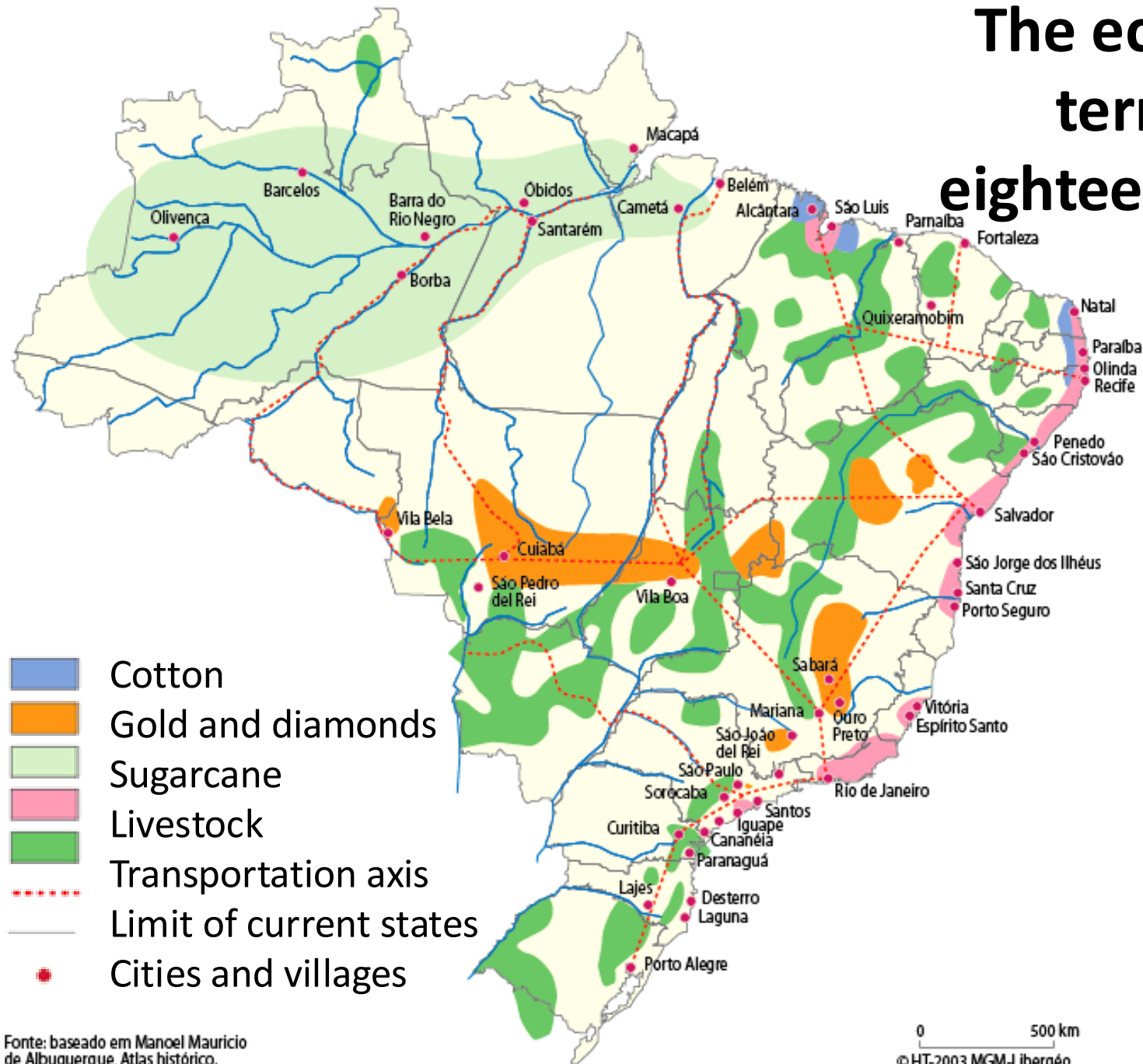
The economy and territory in the sixteenth century



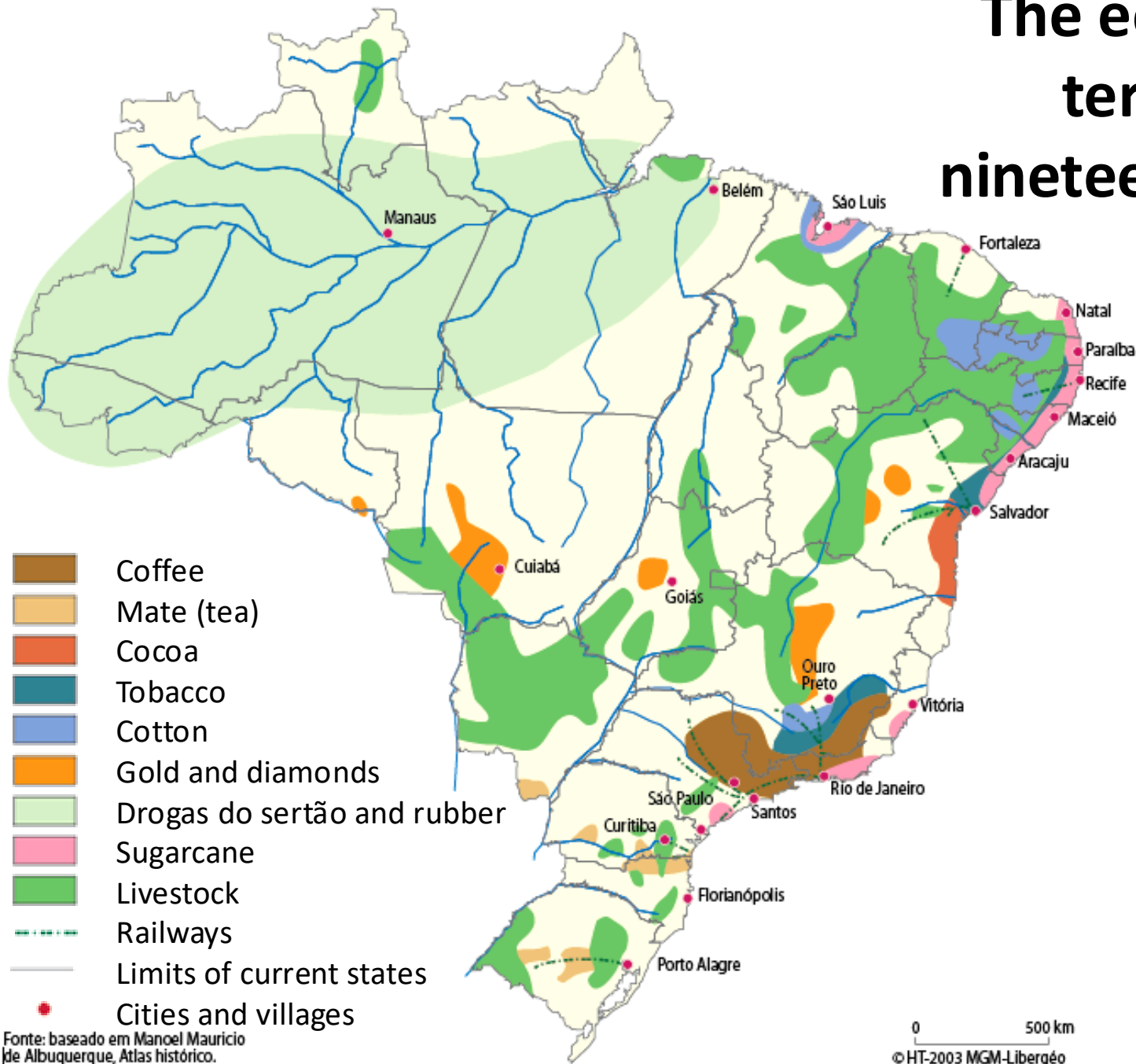
The economy and territory in the seventeenth century



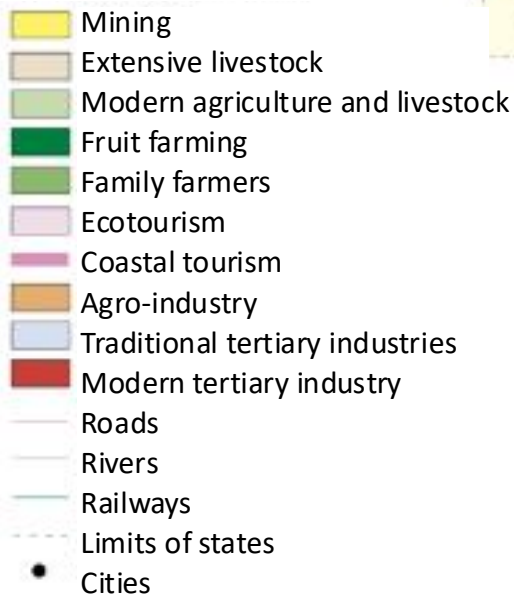
The economy and territory in the eighteenth century



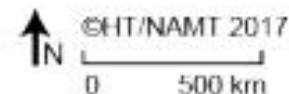
The economy and territory in the nineteenth century



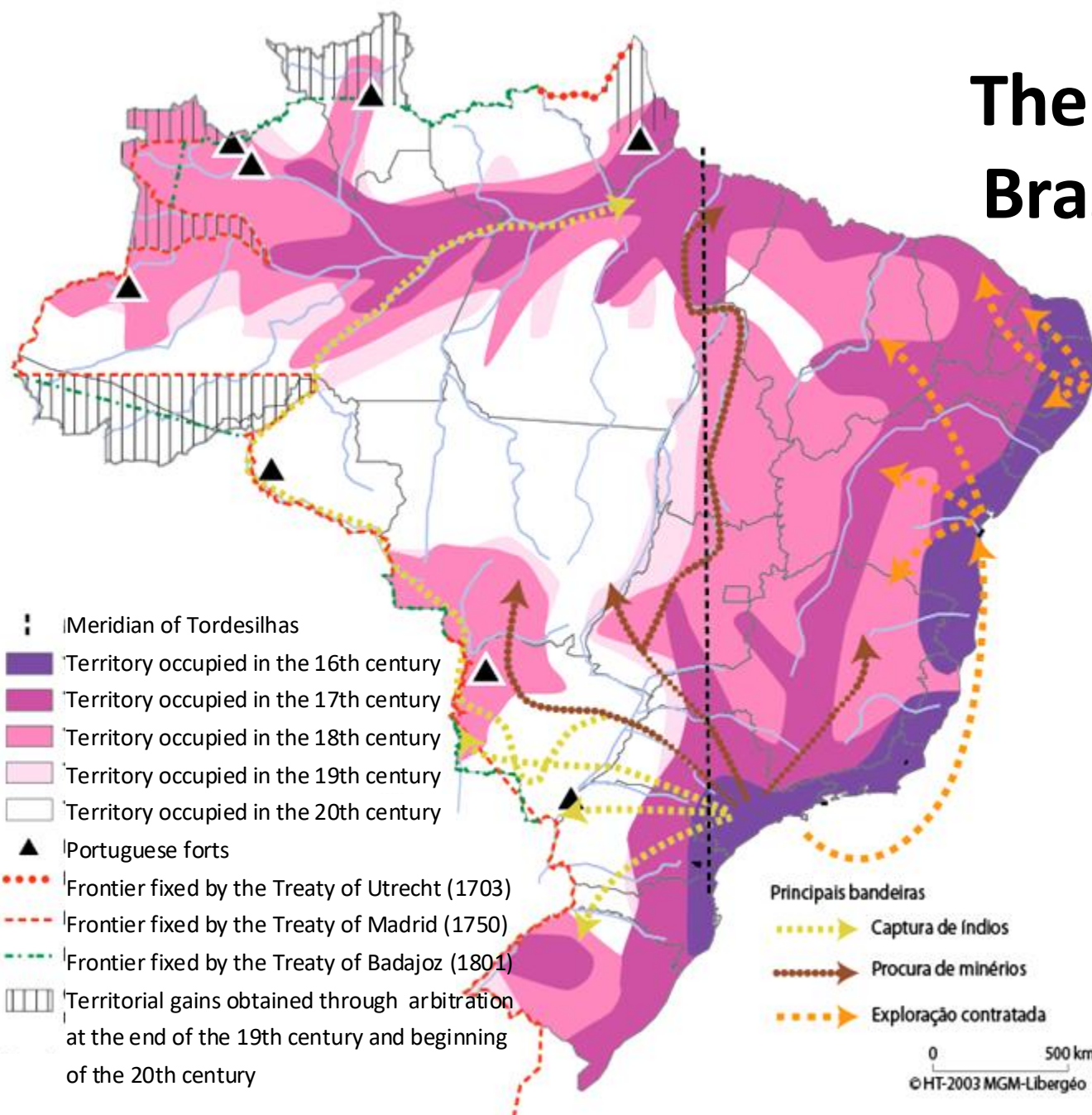
The economy and territory in the twentieth century



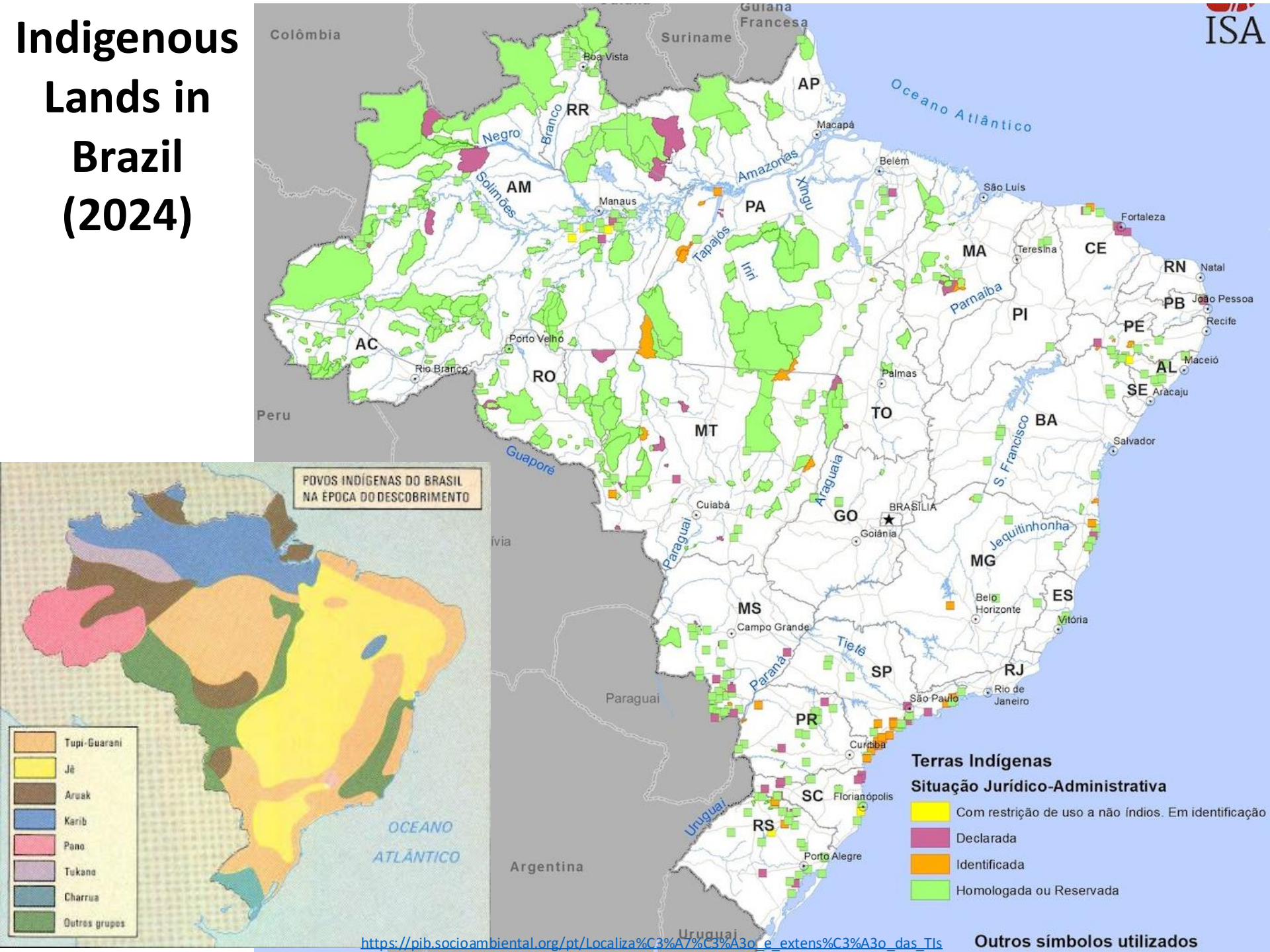
Nonato Júnior, R. and Théry, H., 2017. O Rio Grande do Norte no Brasil: uma contextualização em onze imagens. *Confins* (32).



The occupation of Brazilian territory



Indigenous Lands in Brazil (2024)



Demographic Density (inhabitants/km²) - 2022



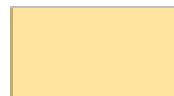
More than 100



26 to 100



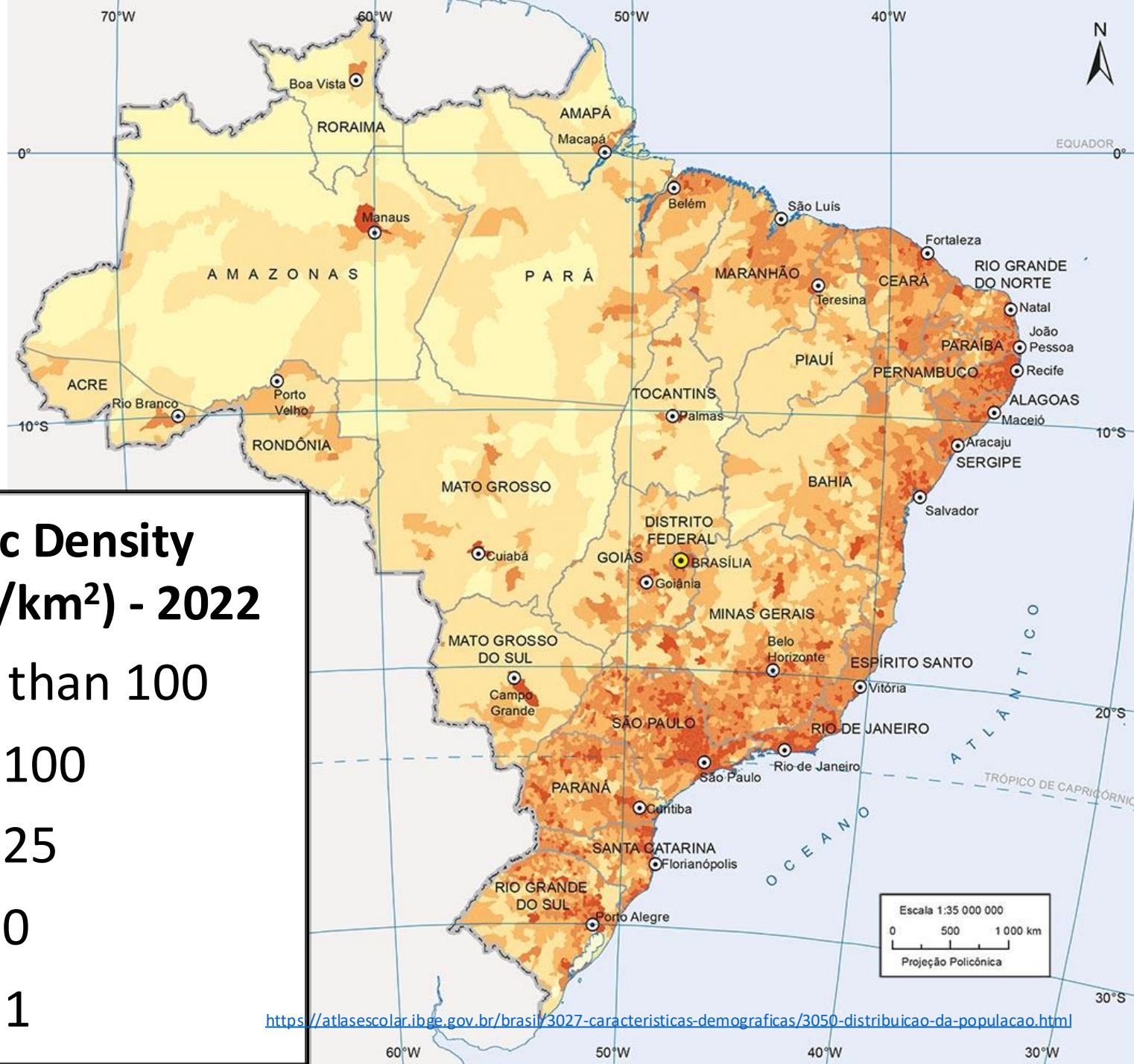
11 to 25



2 to 10

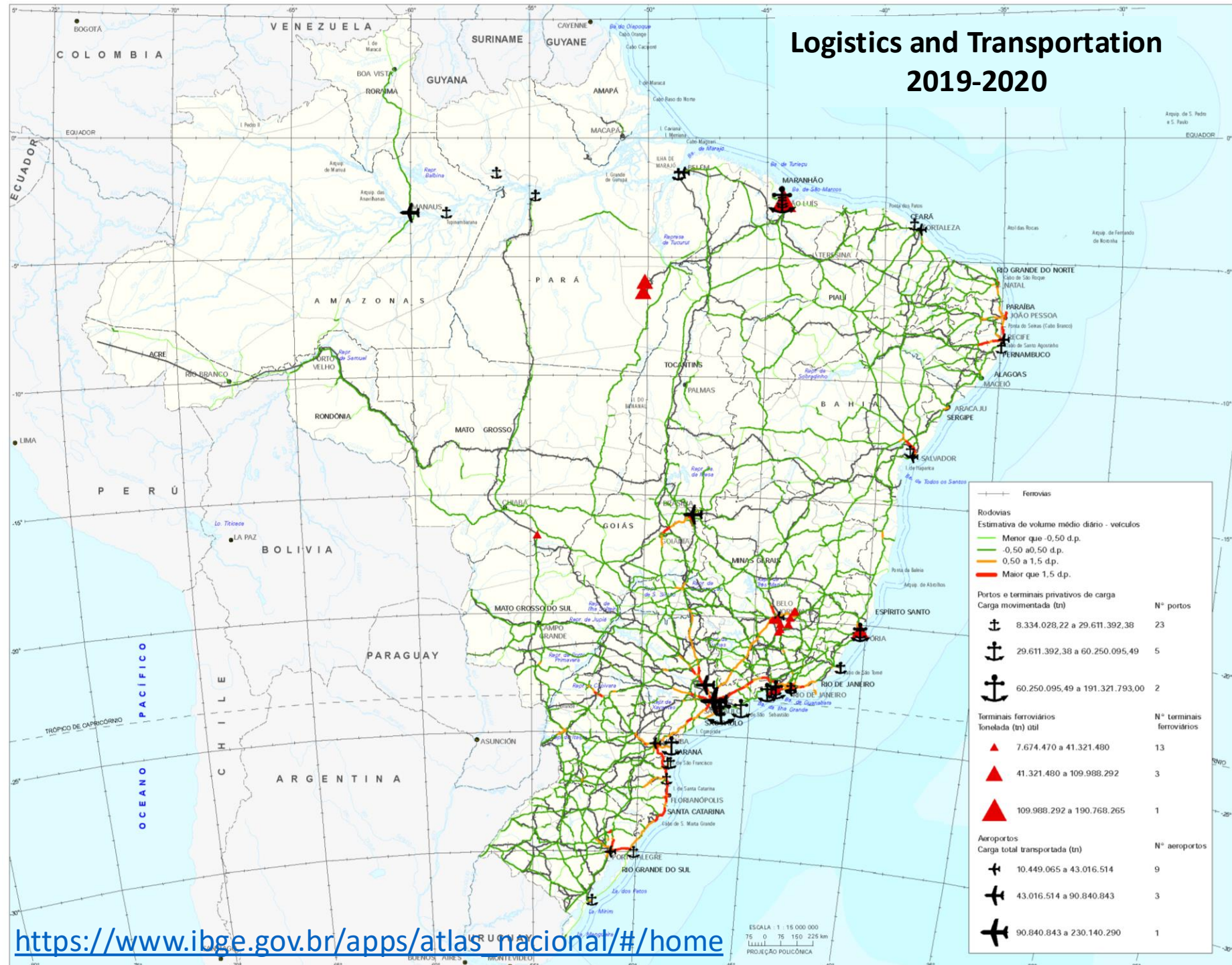


up to 1



<https://atlascolar.ibge.gov.br/brasil/3027-caracteristicas-demograficas/3050-distribuicao-da-populacao.html>

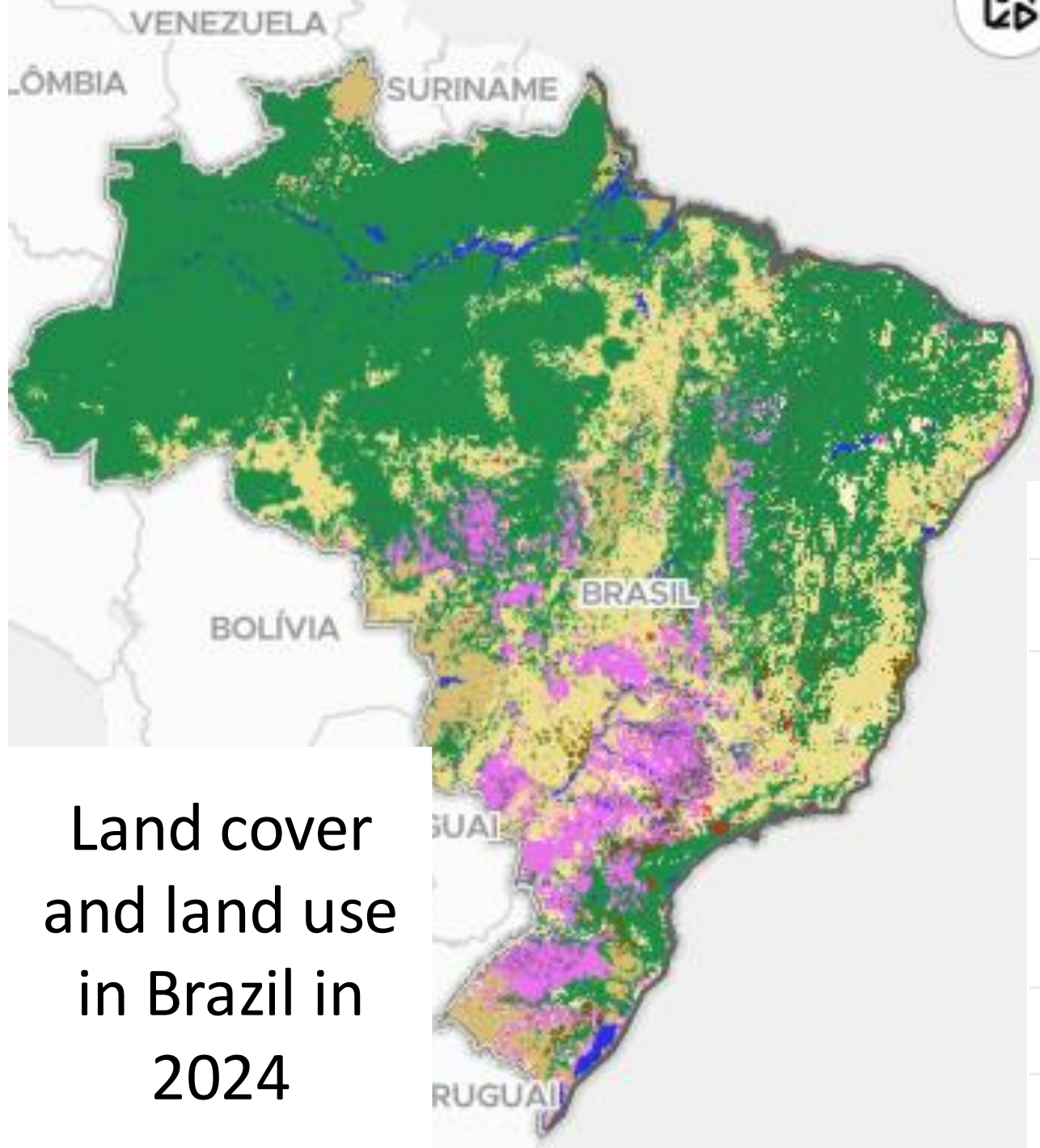
Logistics and Transportation 2019-2020





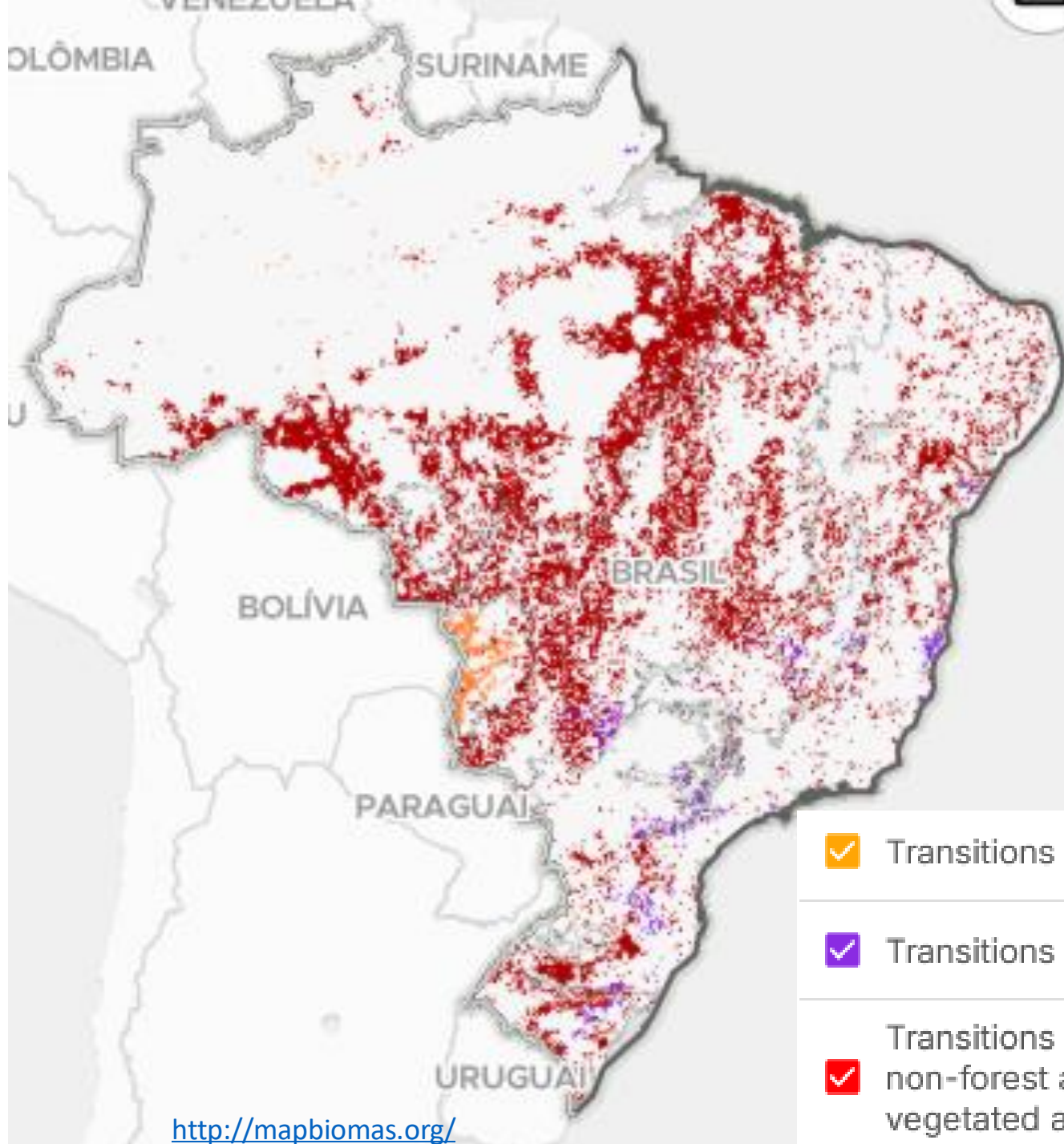
Land cover and Land use in Brazil in 1985

- ✓ 1. Forest
- ✓ 2. Herbaceous and Shrubby Vegetation
- ✓ 3. Farming
 - ✓ 3.1. Pasture
 - ✓ 3.2. Agriculture
 - ✓ 3.3. Forest Plantation
 - ✓ 3.4. Mosaic of Uses
- ✓ 4. Non vegetated area
- ✓ 5. Water



Land cover and land use in Brazil in 2024

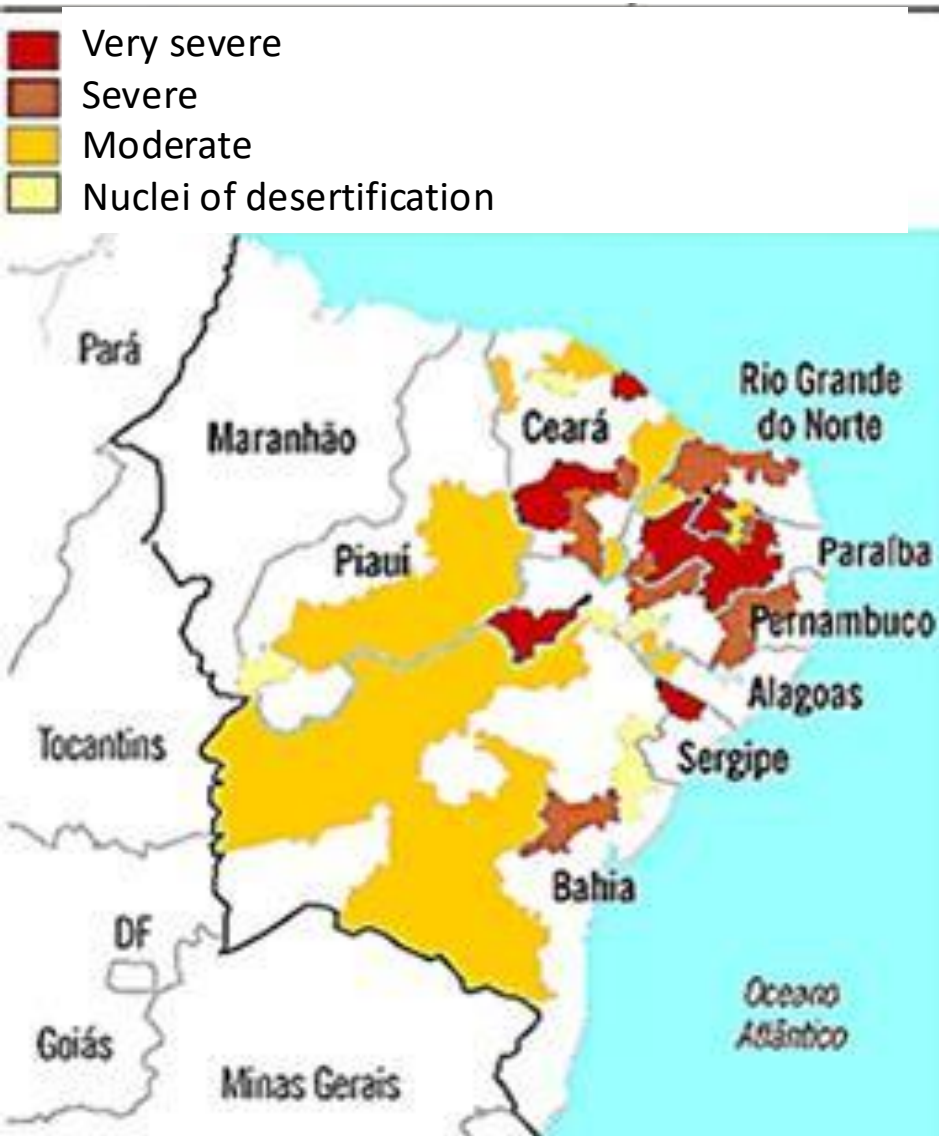
- ✓ 1. Forest
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 - ✓ 3.1. Pasture
 - ✓ 3.2. Agriculture
 - ✓ 3.3. Forest Plantation
 - ✓ 3.4. Mosaic of Uses
- ✓ 4. Non vegetated area
- ✓ 5. Water



Land use and land cover transitions 1985-2024 MapBiomas

- ✓ Transitions that reduce water surface.
- ✓ Transitions with gain in forestry areas.
- ✓ Transitions from forest cover or natural non-forest areas to agriculture or non-vegetated areas.

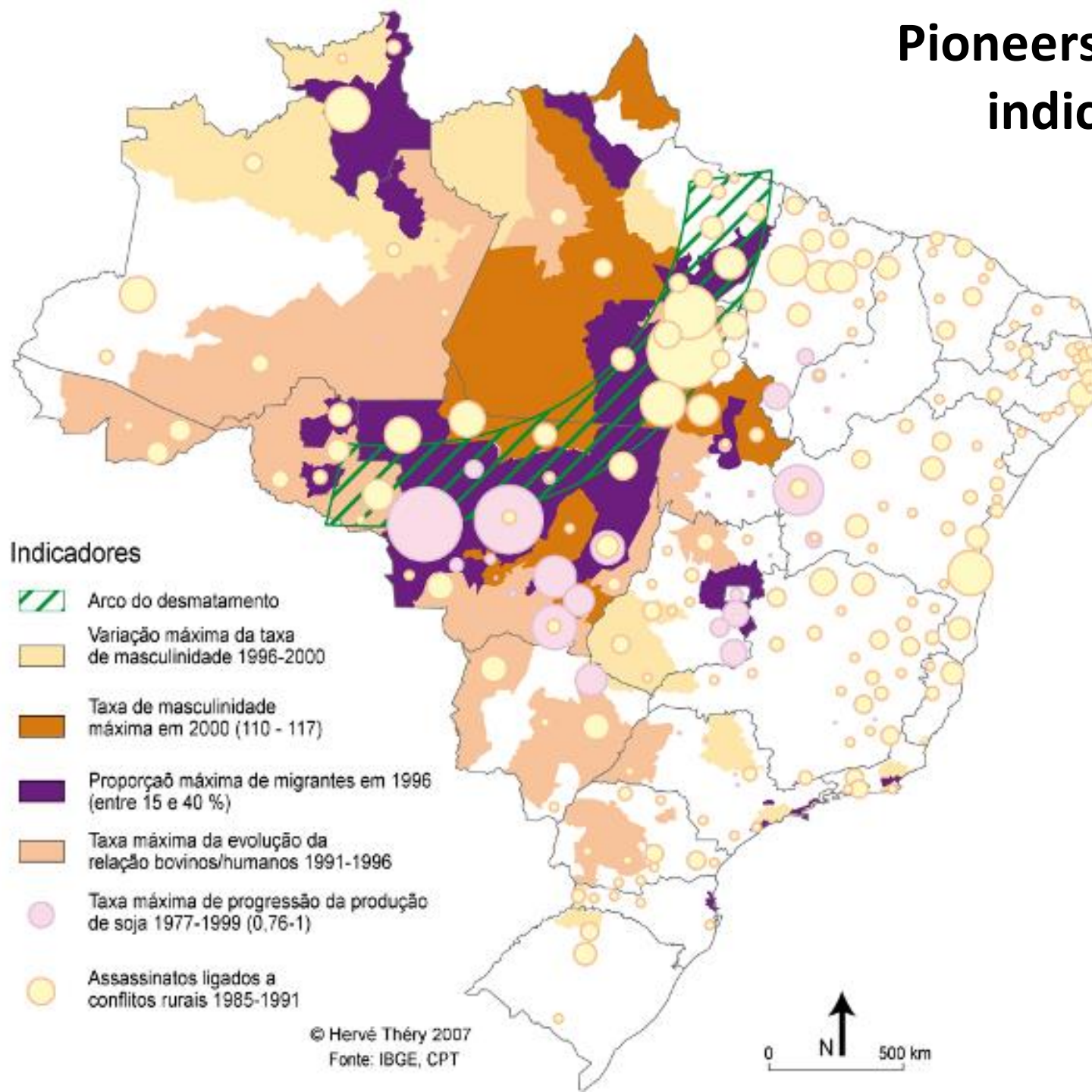
Areas vulnerable to desertification in the Northeast of Brazil



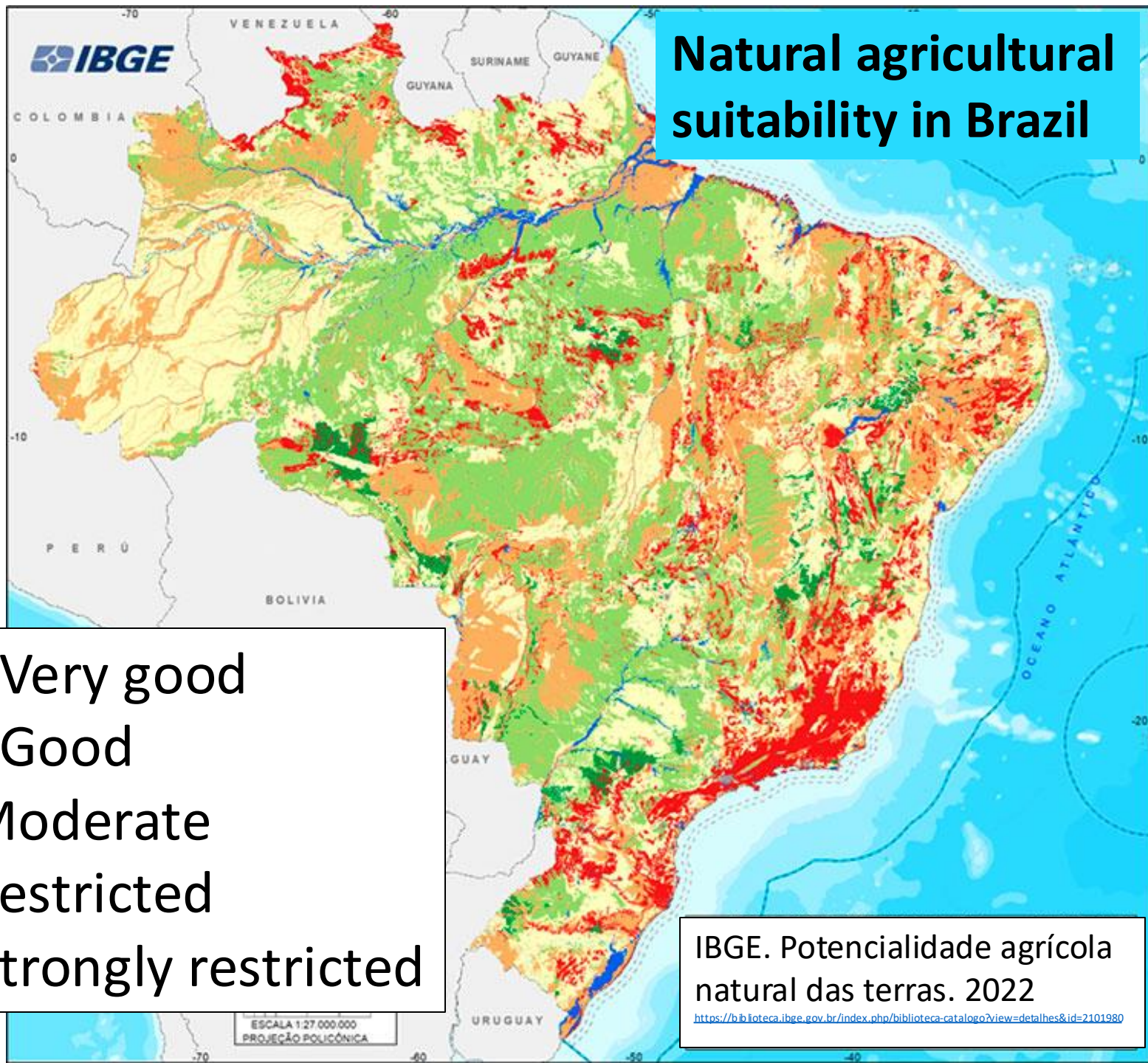
Sandy soil degradation in Rio Grande do Sul State



Pioneers' frontier indicators



Natural agricultural suitability in Brazil



A1 – Very good

A2 – Good

B – Moderate

C – Restricted

D – Strongly restricted

IBGE. Potencialidade agrícola natural das terras. 2022

<https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2101980>

Discourses on Territorial Occupation

Simplified discourse

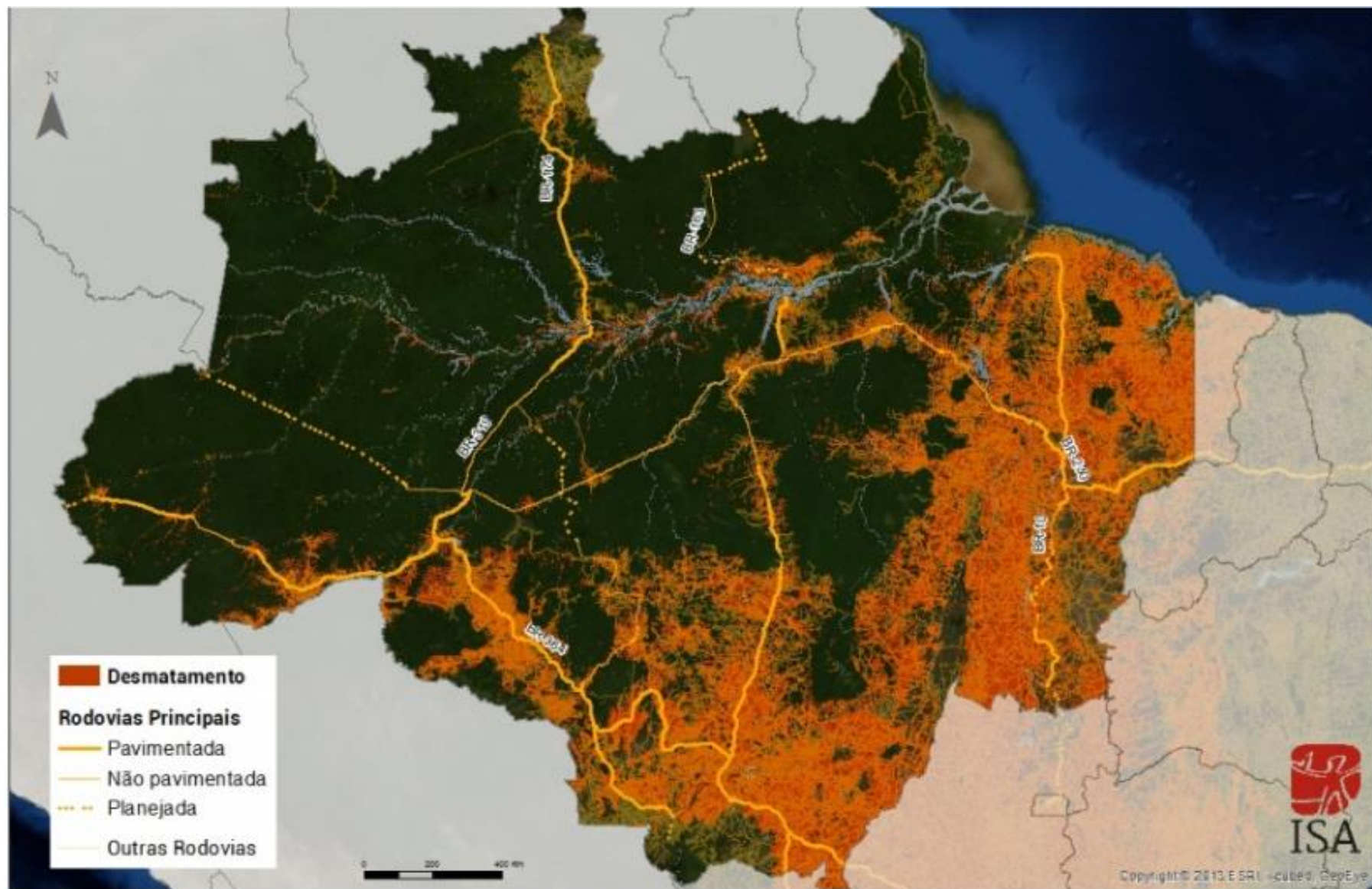
- Poverty causes environmental degradation
 - Poor households often lack access to alternative, more sustainable income sources

More complex analysis

- Many case studies have shown that degradation increased as formerly poor populations became more economically integrated
- Need to focus on economic opportunities and the direction of public policies

Question

What criteria would be at stake for the Brazilian government when deciding whether to open a new highway corridor in the Amazon?



<https://www.socioambiental.org/pt-br/noticias-socioambientais/amazonia-esquartejada>

Discourses on Territorial Occupation

Simplified discourse

- Traditional communities have developed sustainable ways of managing the environment

More complex analysis

- Many traditional communities today have a higher population density than in the past
- Consumption aspirations of the inhabitants of traditional communities have changed
- Production increasingly extends beyond subsistence

Discourses on Territorial Occupation

Simplified discourse

- Cities occupy less than 2% of the territory, so they are not the main cause of environmental degradation

More complex analysis

- Urban ecological footprint drives expansion of agriculture, mining, etc.
- Pollution spreads beyond the city boundaries