Agricultural risk in a changing world: Threats vs sustainability

Scoping meeting, Boulder 2017

Dr Pascal Peduzzi

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A new Global GAR Exposure Model for 2017-2020

Dr Andrea de Bono UNEP/GRID-Geneva

(already discussed in 2012!)

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Critical facilities: crops

provisioning services: production value per crops (GAEZ 2012)

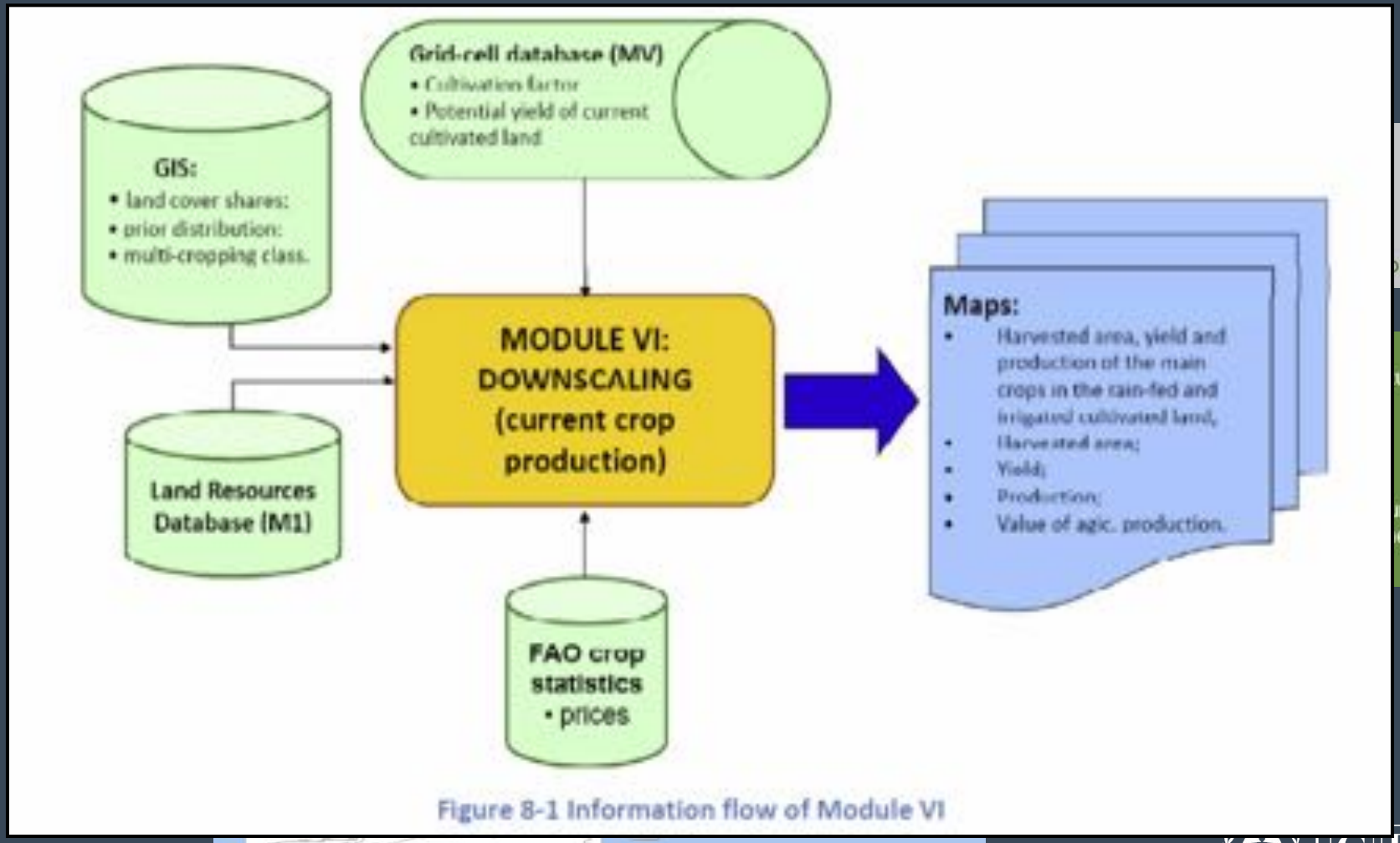

Figure 8-1 Information flow of Module VI

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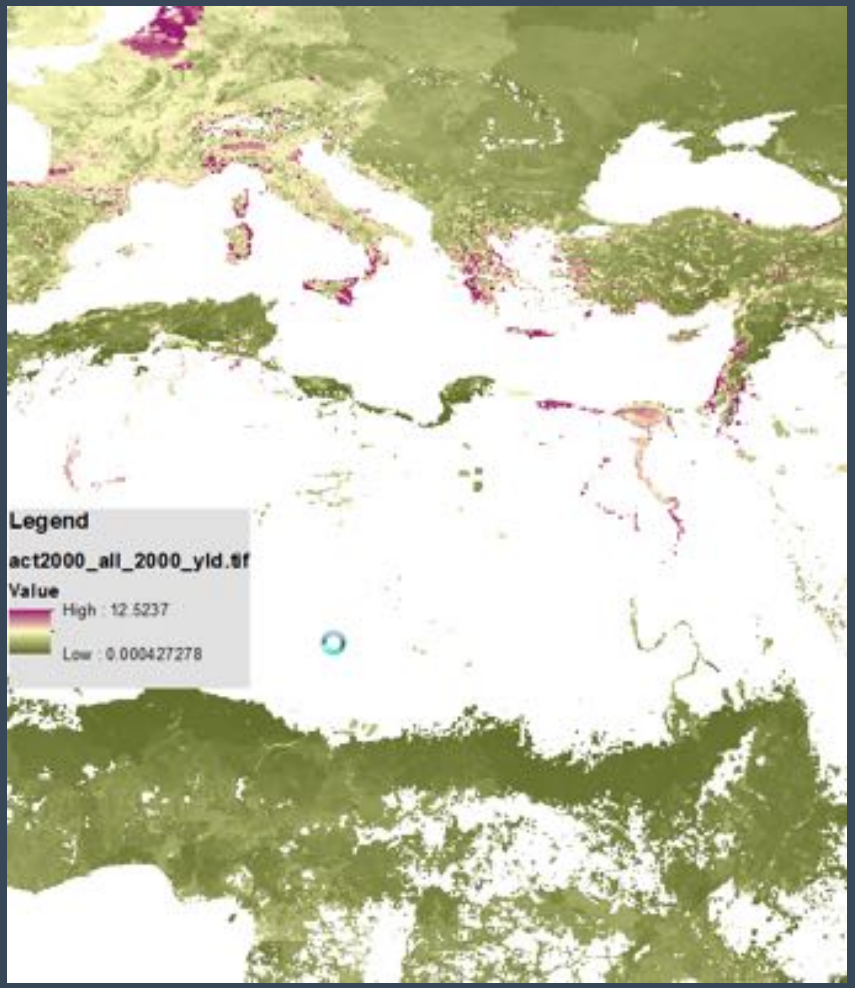
Critical facilities: crops

Provisioning services: production value per crops (GAEZ 2012)

Crop production value is expressed in Geary Kharmis dollars (GK$)* i.e., an international price weight (year 2000), used by UN, to compare different commodities in value terms.

* The Geary-Khamis approach that has been chosen by the UN to define the international prices and exchange rates derived from the data through a system of interdependent equations. In the equation system international prices of commodities are weighted averages of national prices converted into a common currency and weighted by national outputs. Exchange rates are equal to the ratio of the value of production of a given country at international prices divided by the value of production of the same country in national currency. When one currency is chosen as the numeraire, the system can be solved and has a unique solution. Exchange rates of the other currencies and international prices can be expressed in terms of the currency chosen as the reference. The set of international prices and exchange rates thus obtained can enter directly the computation of price and quantity index numbers



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Changes in precipitations

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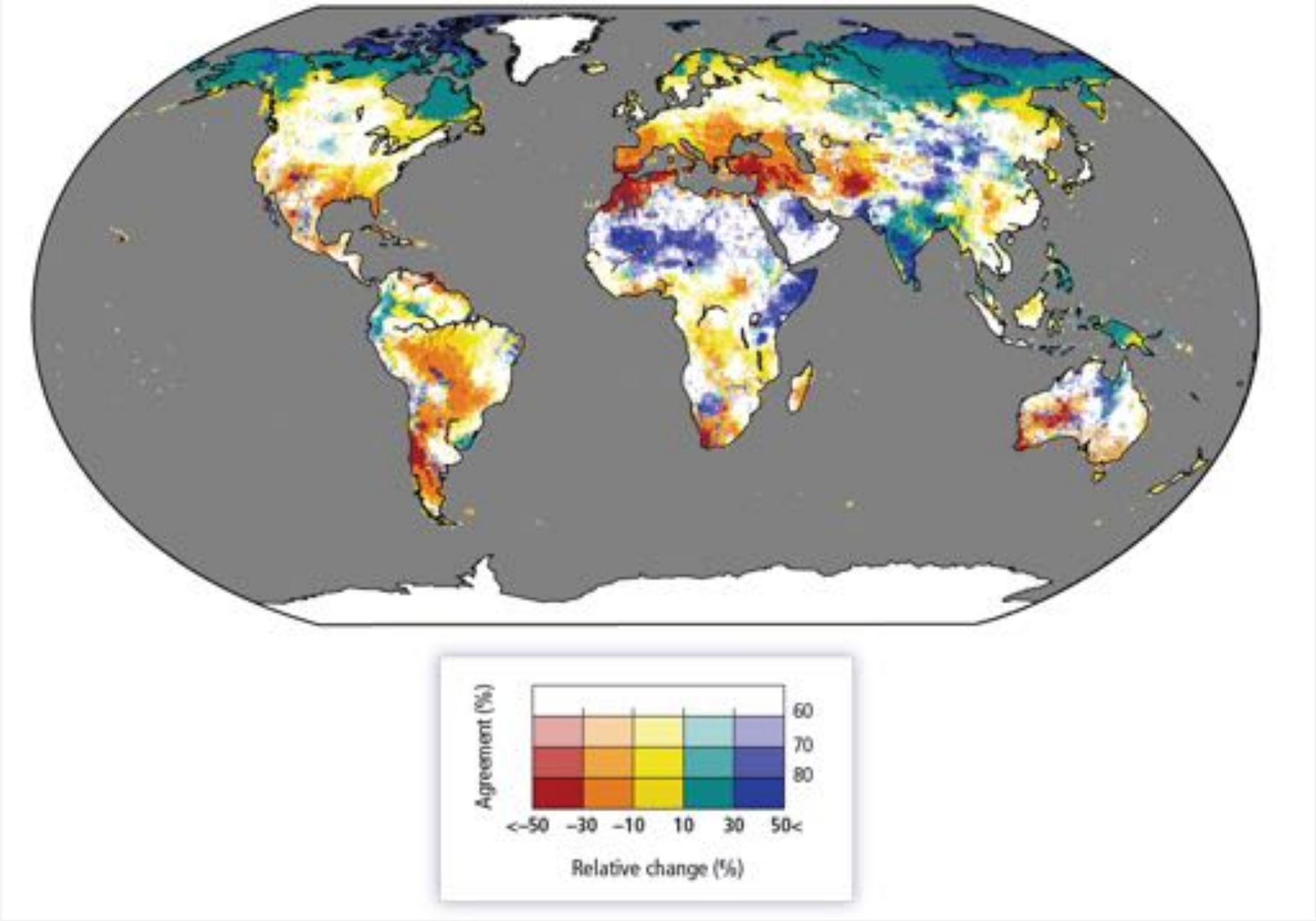
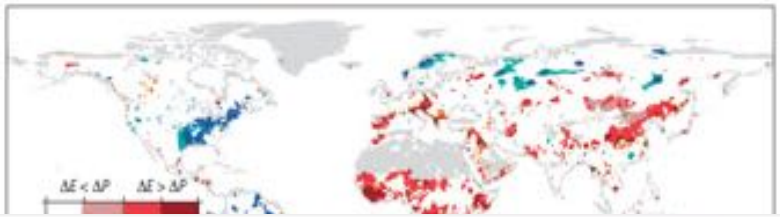
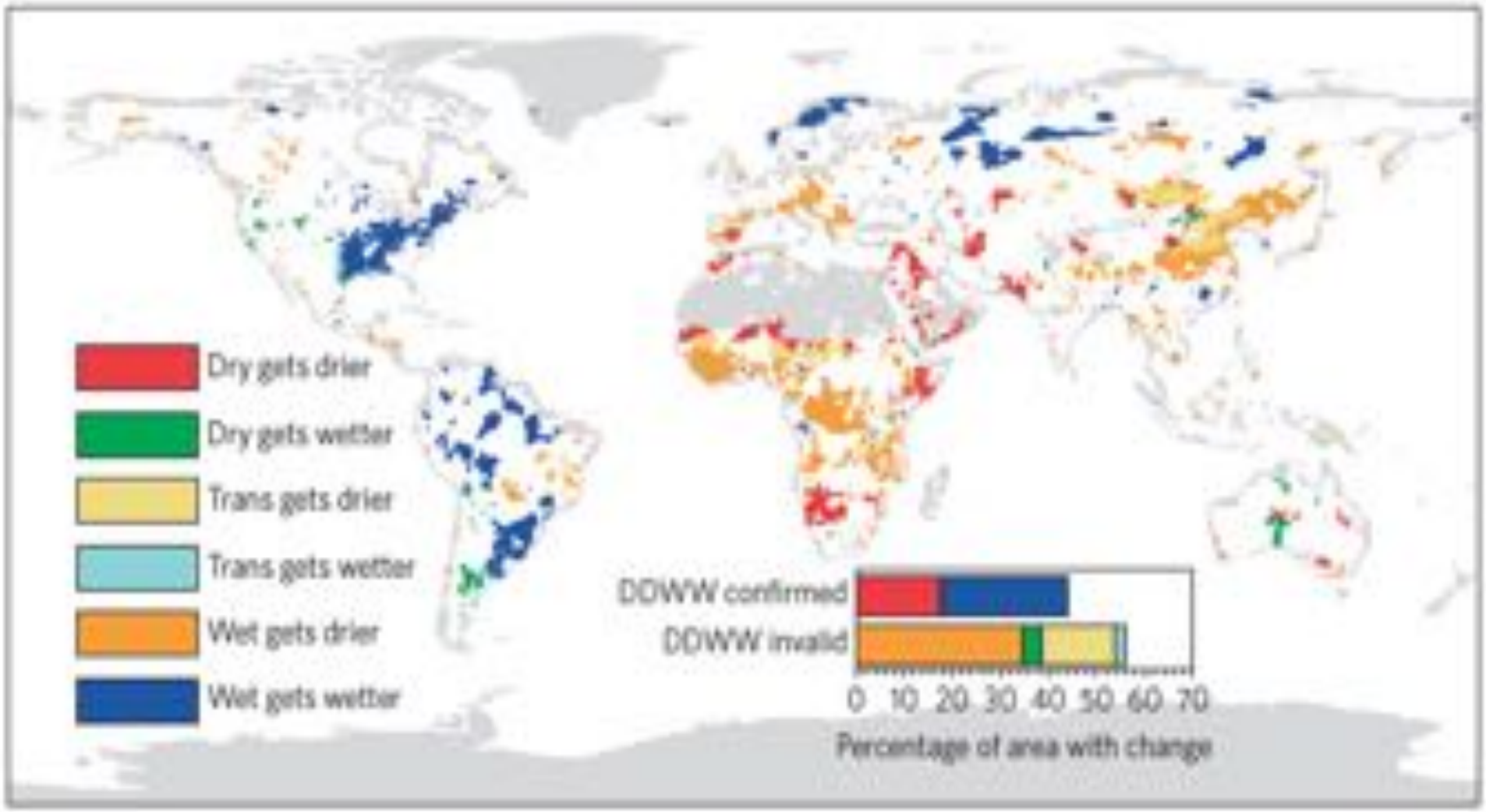


Percentage change of mean annual streamflow for a global mean temperature rise of 2°C above 1980–2010 (2.7°C above pre-industrial). Color hues show the multi-model mean change and saturation shows the agreement on the sign of change (Jiménez *et al*. 2014).

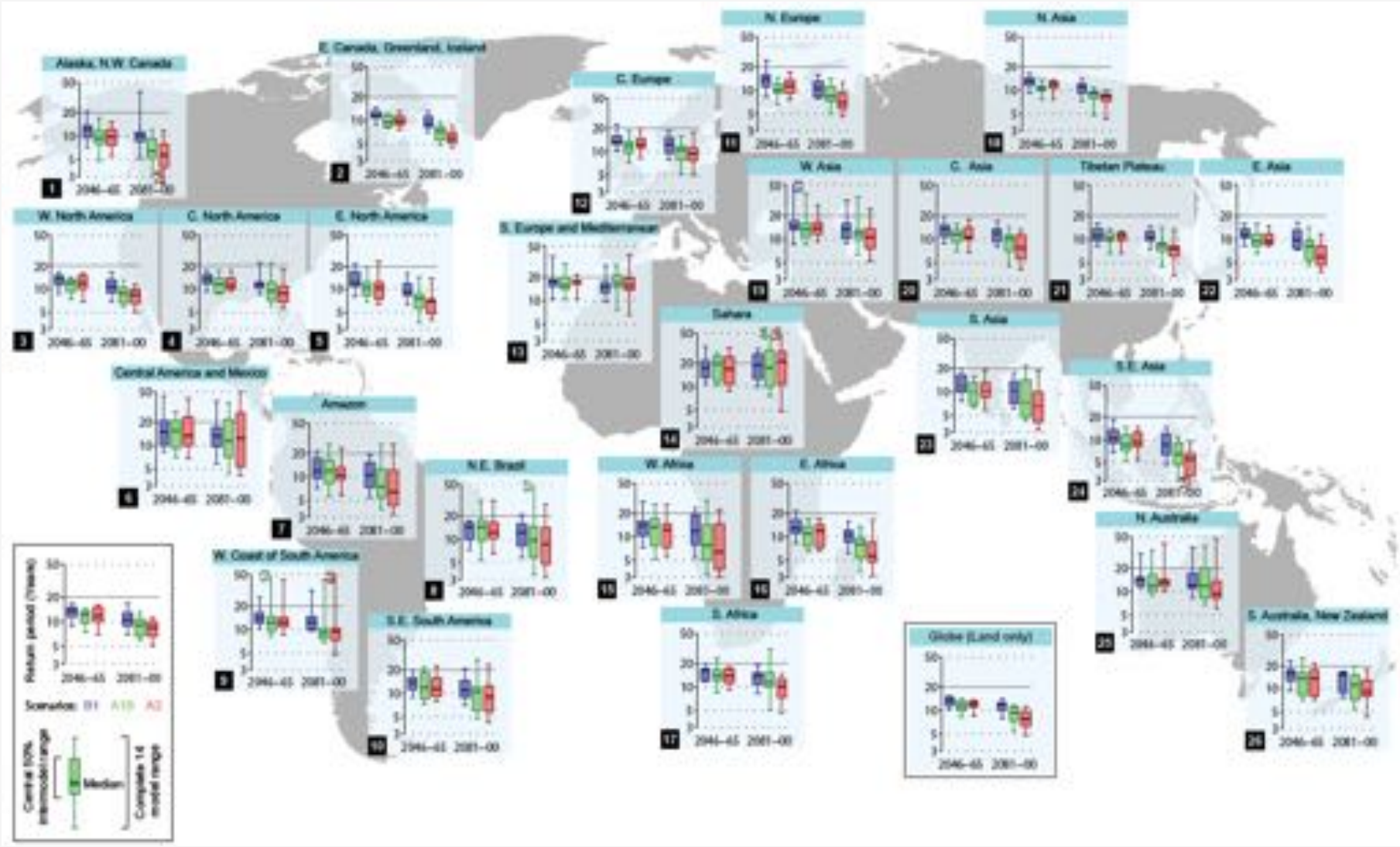
Detecting robust changes in drought: Summary



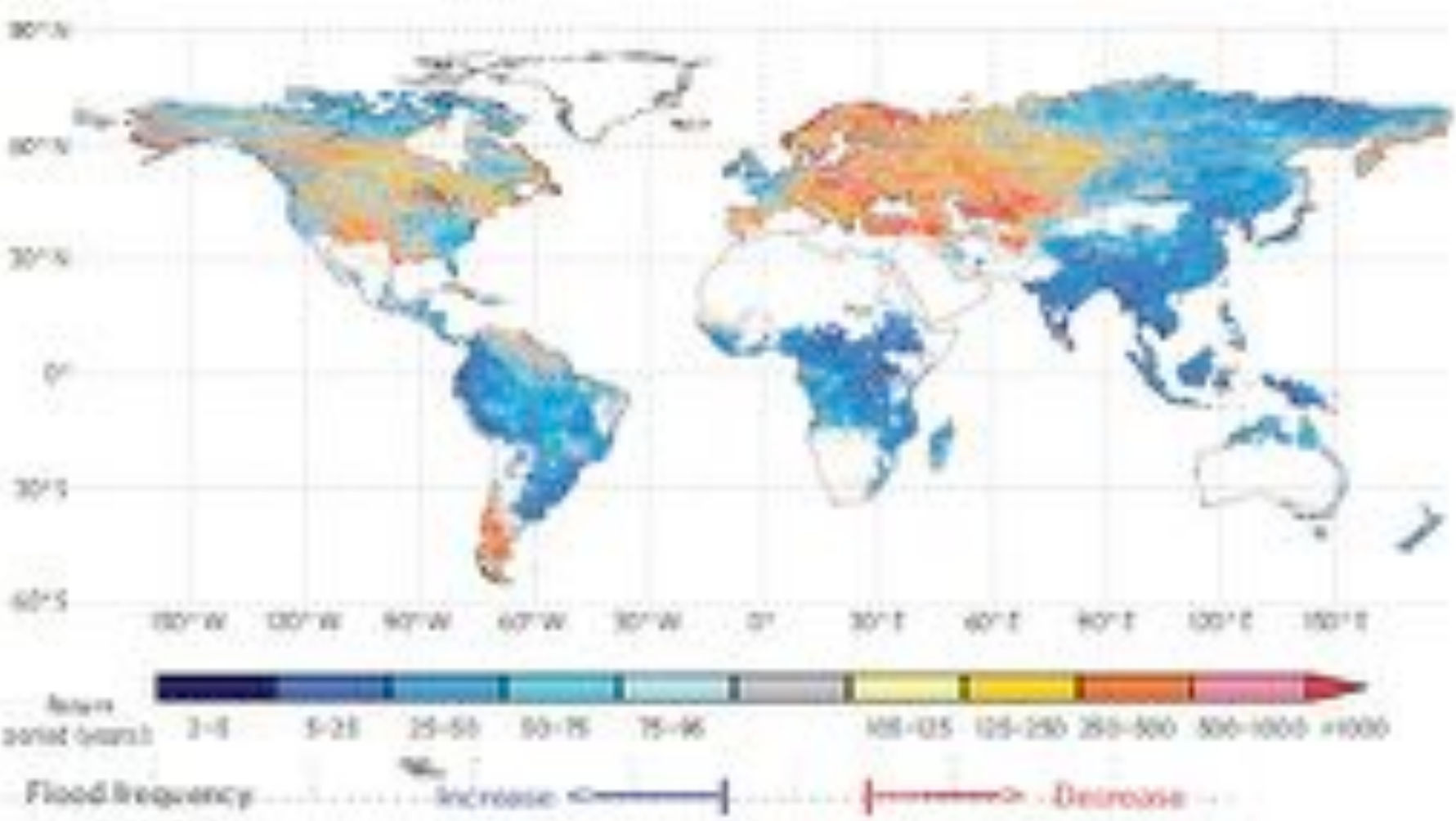
Robust assessment of changes in drought over land (comparison of 1948-1968 and



The frequency of heavy precipitation or the proportion of total rainfall from intense events will likely increase over many areas of the globe.

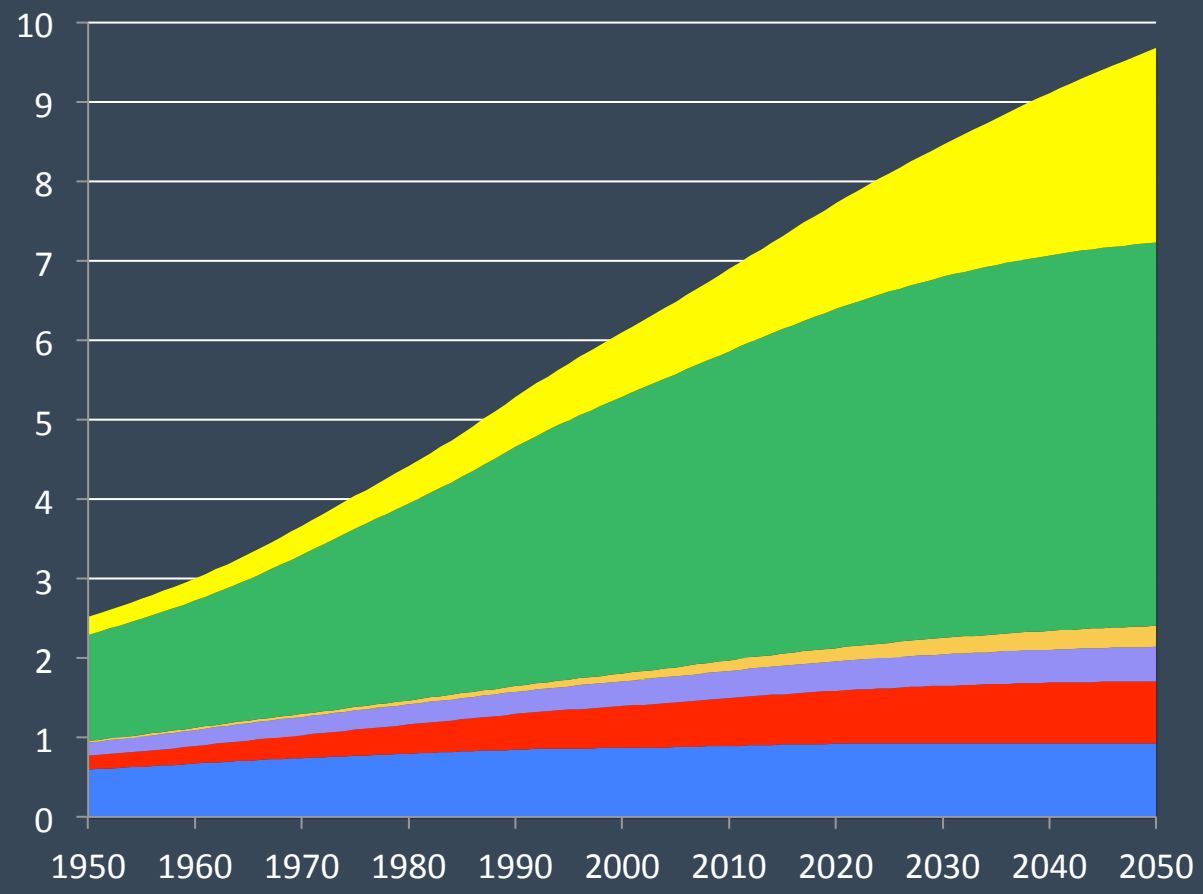


Projected return period (in years) of late 20th-century 20-year return values of annual maximum 24-hour precipitation rates. [Source: Seneviratne et al. (2012), based on Kharin et al. (2007).]



Changes in frequency of 100-year river discharge (Hirabayashi et al., 2014)

World population



9.7 billions in 2050

- Africa
- Asia + Pacific
- West Asia
- Polar
- North America
- Latin America + Caribbean
- Europe

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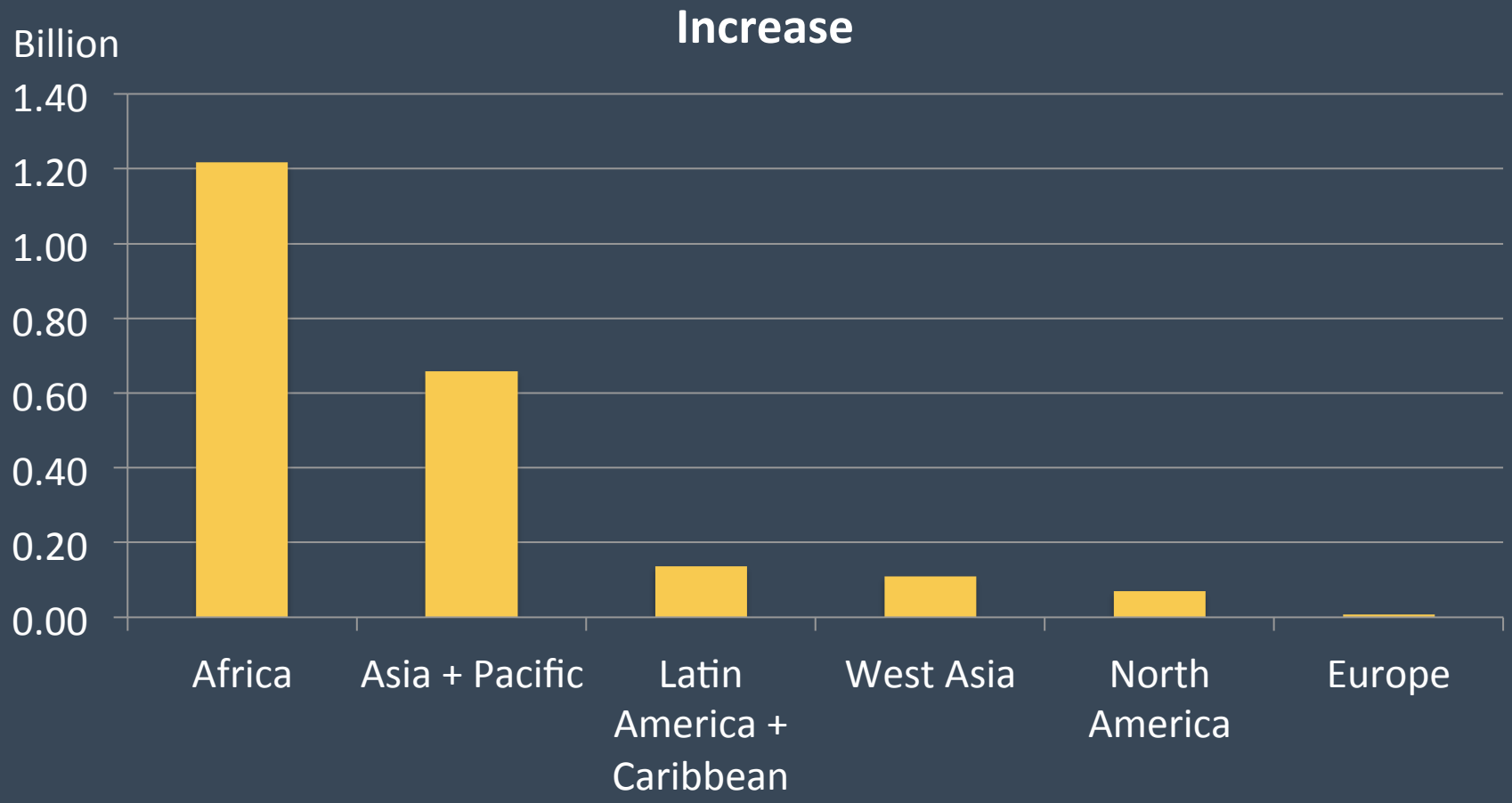
Population increase 2017-2050



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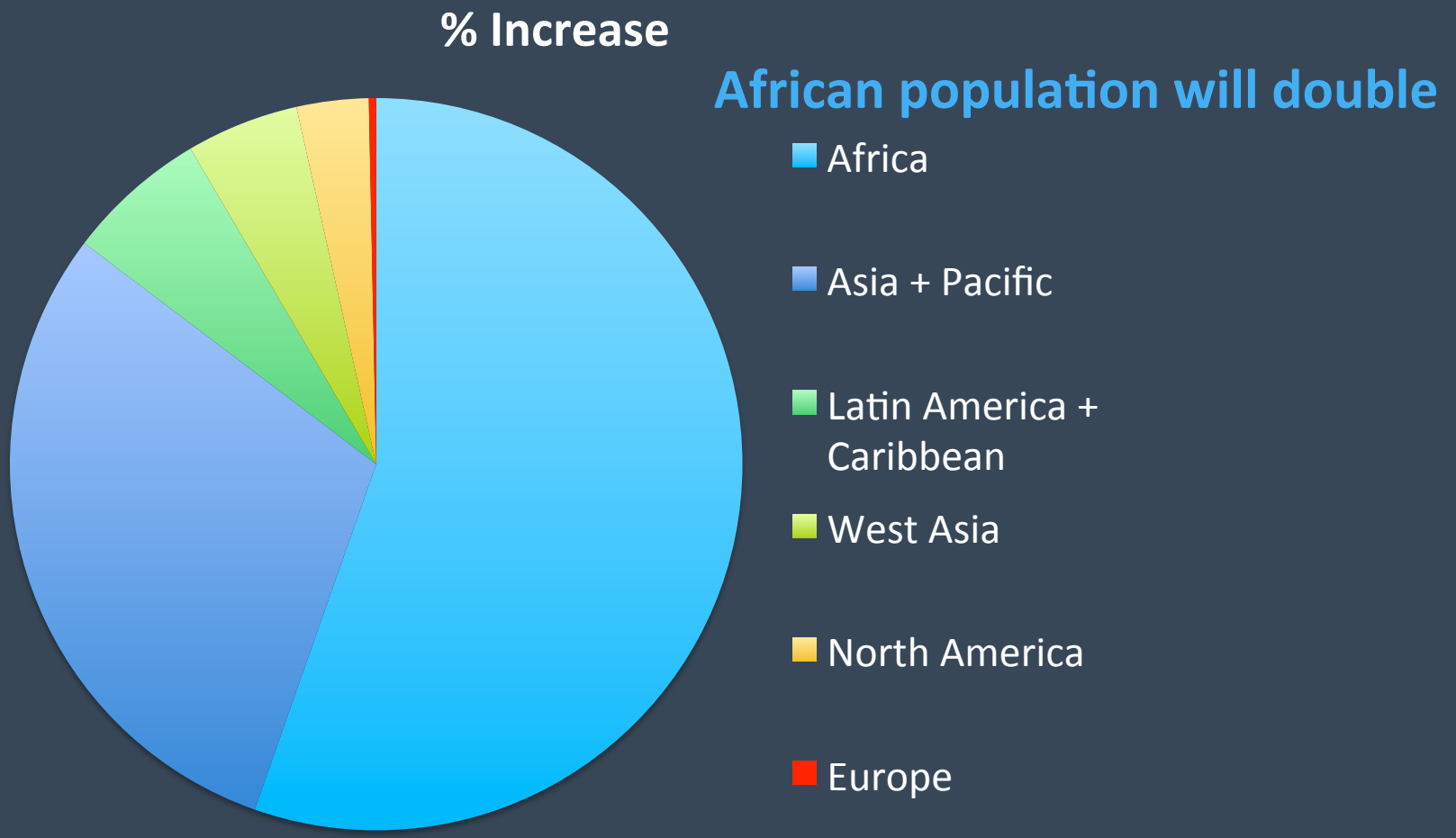
% Population increase 2017-2050



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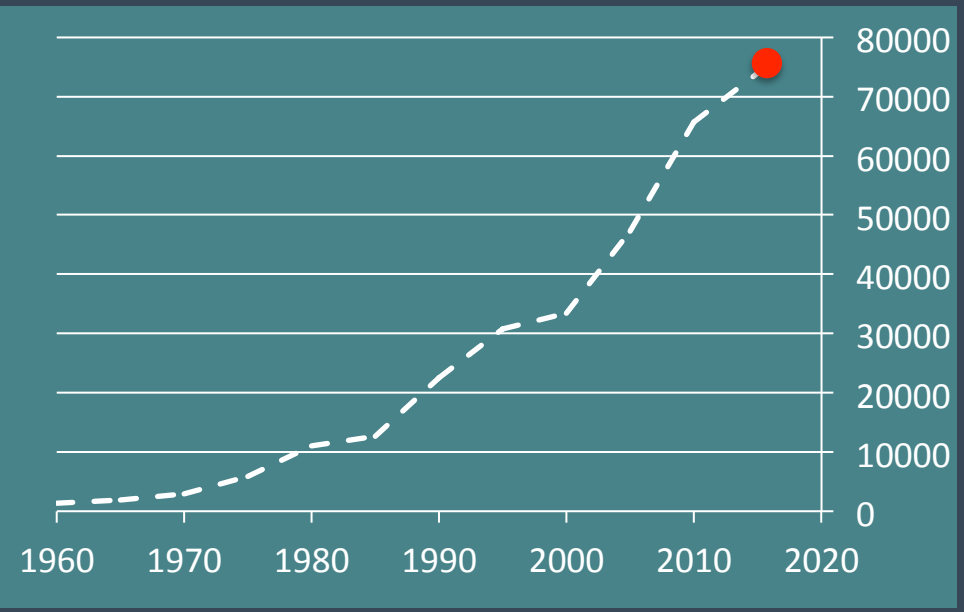
AFFLUENCE

If population was multiplied by two between 1970 et 2015, the GDP was multiplied by 25.



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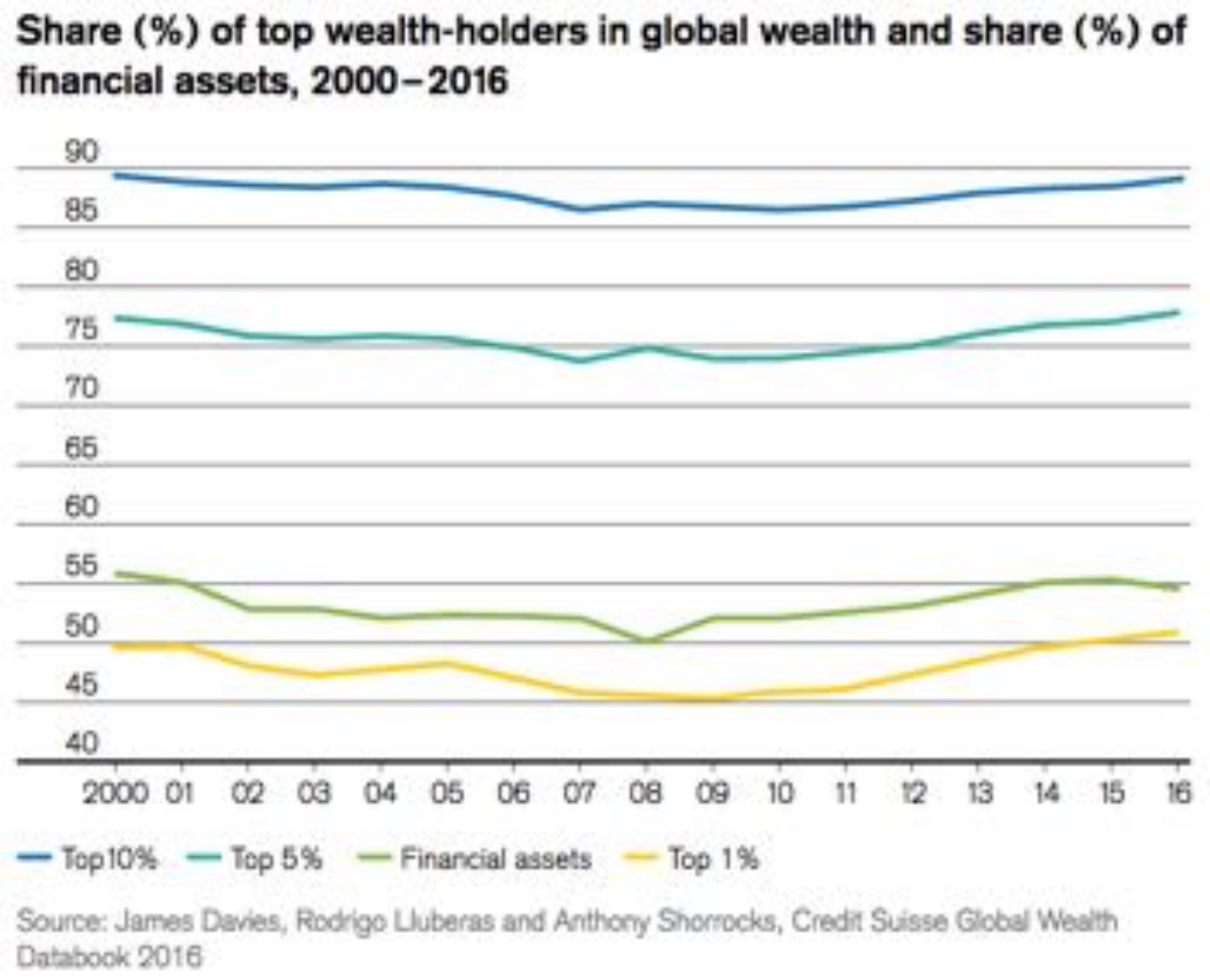
…but not equally distributed

The top 10% concentrates 90% of the wealth
The top 1% concentrates 50% of the wealth



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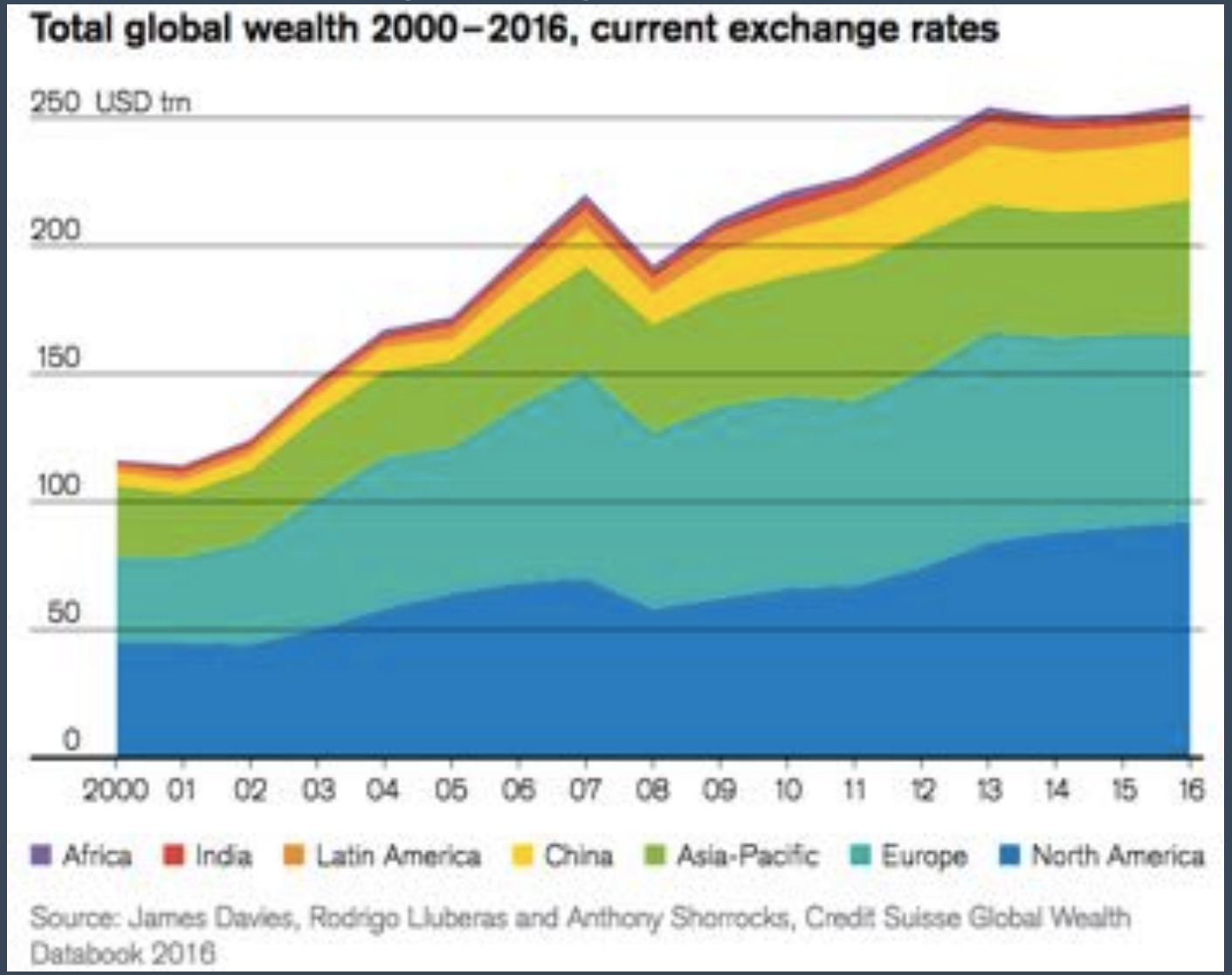
Europe and North America = 11% of world population (2017) and > 60% of wealth



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Malnutrition facts

- Today nearly 800 million people suffer from chronic hunger.
- Over two billion people suffer from health-affecting micronutrient deficiencies, and an estimated 150 million children under 5 years of age are stunted due to poor diets.
- 1.9 billion people are now overweight — 600 million of them are classified as obese.
- 5.9 million children under the age of 5 years died in 2015. About 45% of all child deaths are linked to malnutrition.
- Children in sub-Saharan Africa are more than 14 times more likely to die before the age of 5 than children in developed regions.

Source: WHO, 2016
http://www.who.int/mediacentre/factsheets/fs178/en/

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Food waste

- Every year, consumers in rich countries waste almost as much food (222 million tonnes) as the entire net food production of sub-Saharan Africa (230 million tonnes).
- 1/3 of the food produced in the world for human consumption every year (1.3 billion tonnes) gets lost or wasted.
- In the United States 30% of all food, worth US$48.3 billion, is thrown away each year. UK, 32% of food purchased in not eaten.
- In the USA, organic waste is the second highest component of landfills, which are the largest source of methane emissions.

Agricultural risk versus sustainability

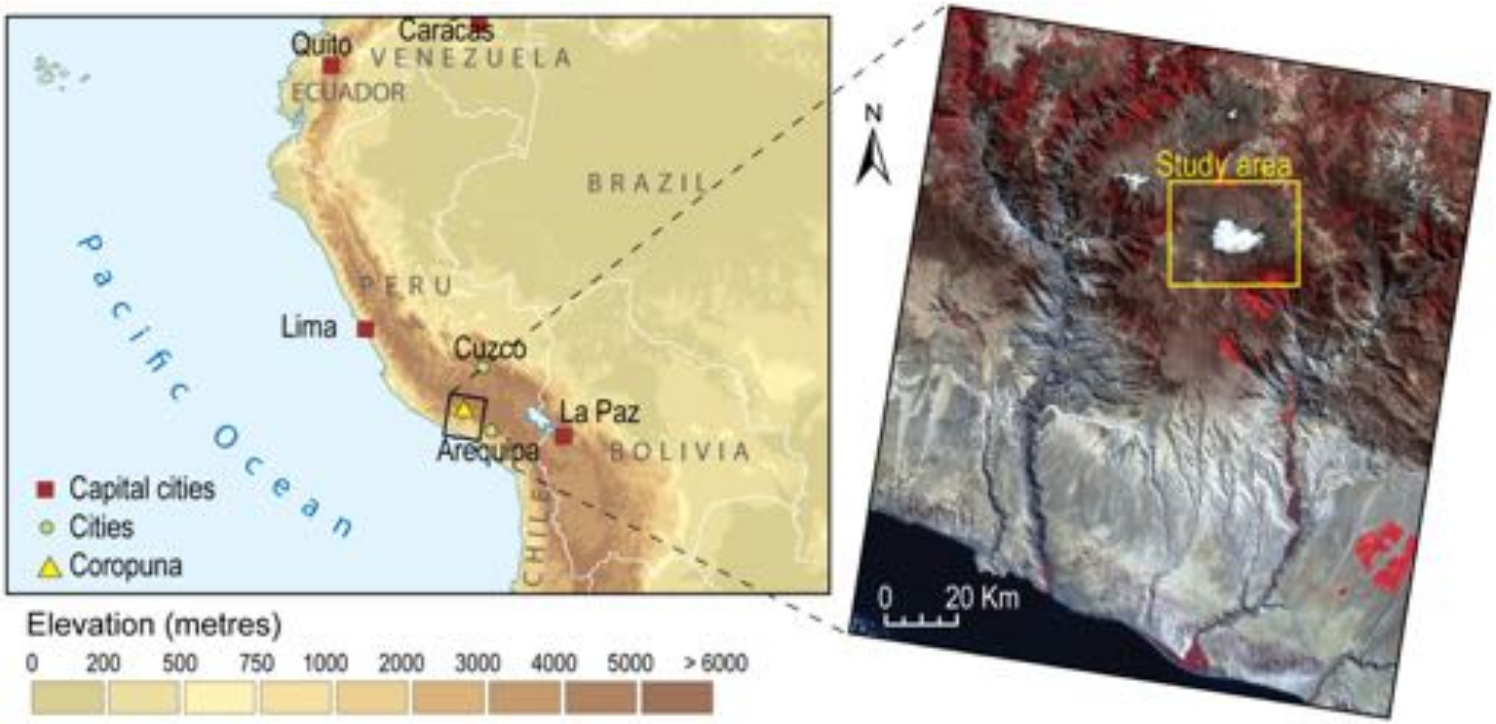
Provide governments with advices on threats to food security, taking into account population growth, socio-economic, Climate and environmental changes

- Climate change I: change in precipitations
- Climate change II: Glaciers retreats
- CC III: acquifers and SLR
- CC IV: Change in extremes
- Change in landcover
- Overexploitation → Subsidence
- Lower prob. Higher impacts

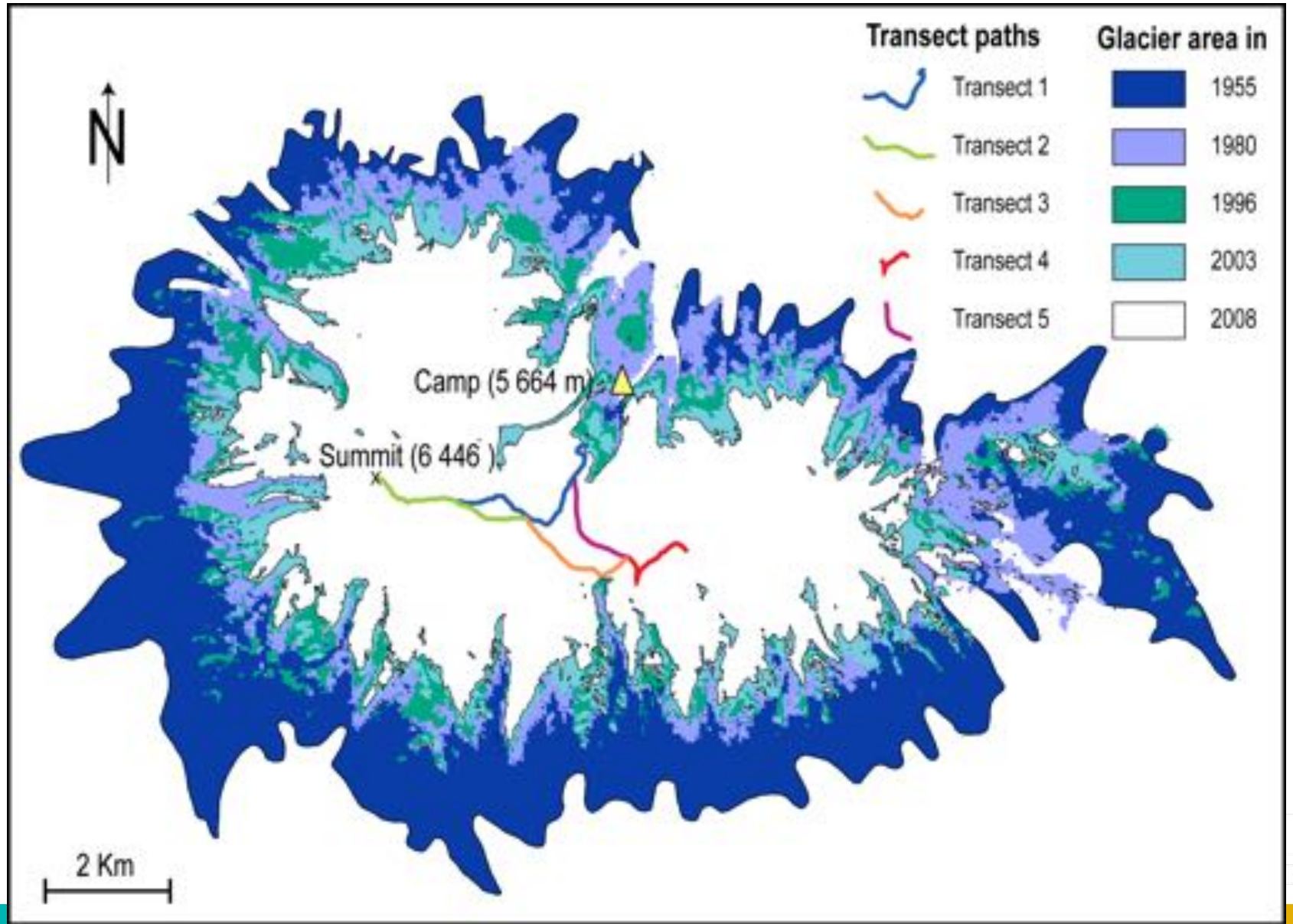
Glacier retreat

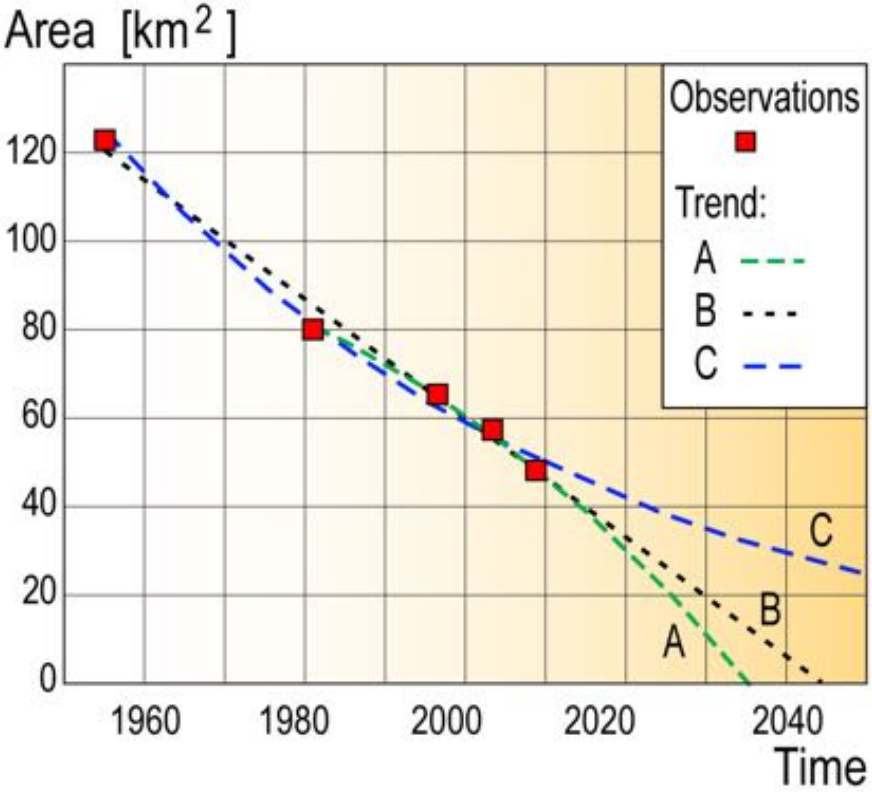
Glaciers

The Case of Coropuna (Peru)



Peduzzi, P., Herold, C., Silverio, W., Assessing high altitude glacier thickness, volume and area changes using field, GIS and remote sensing techniques: the case of Nevado Coropuna (Peru), *The Cryosphere*, **4**, 313-323, 2010
http://www.the-cryosphere.net/4/313/2010/tc-4-313-2010.html


Transect paths
Glacier area in
Transect 1
Transect 2
Transect 3
Transect 4
Transect 5
1955
1980
1996
2003
2008
N
Camp (5 664 m)
Summit (6 446)
2 Km



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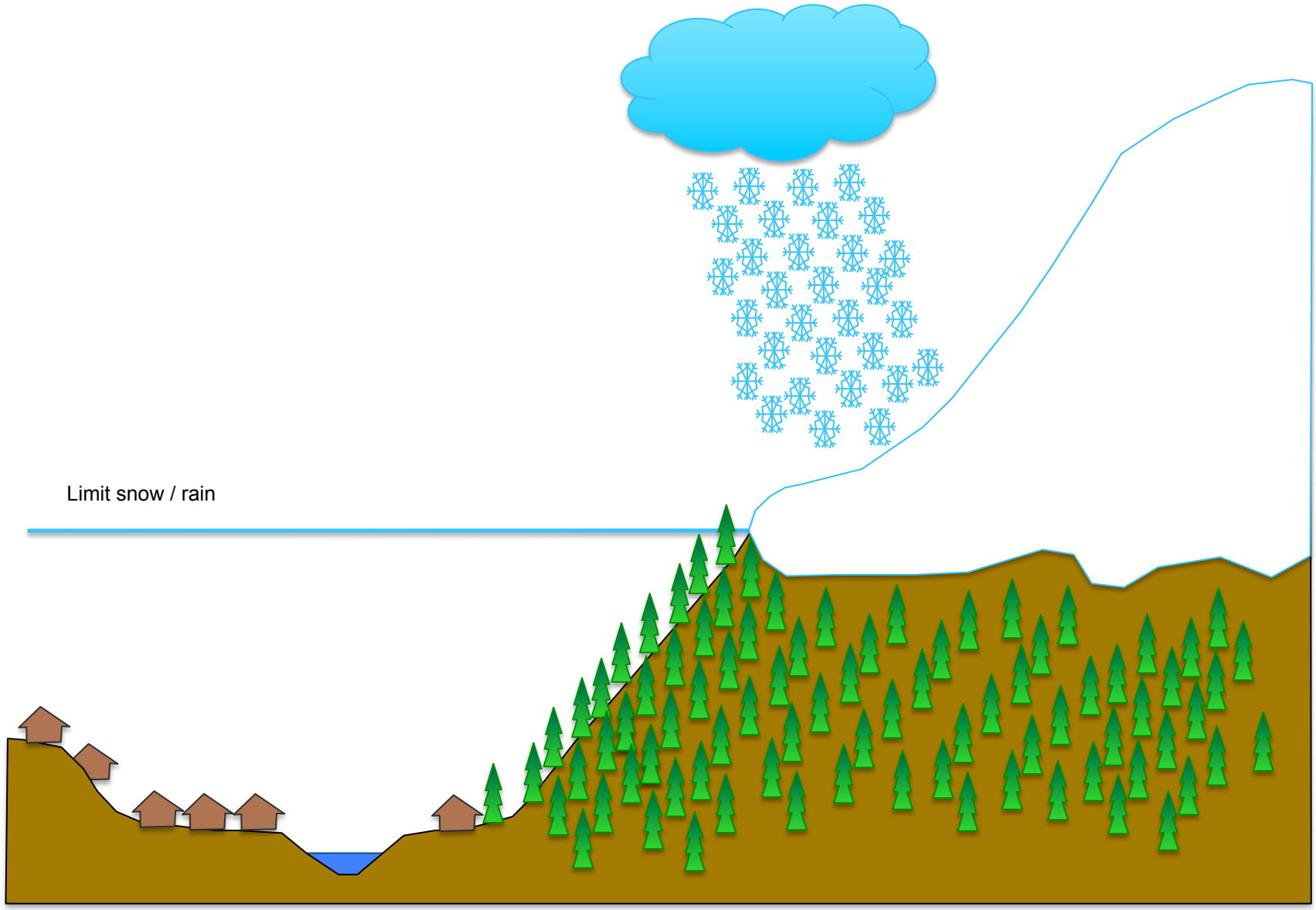
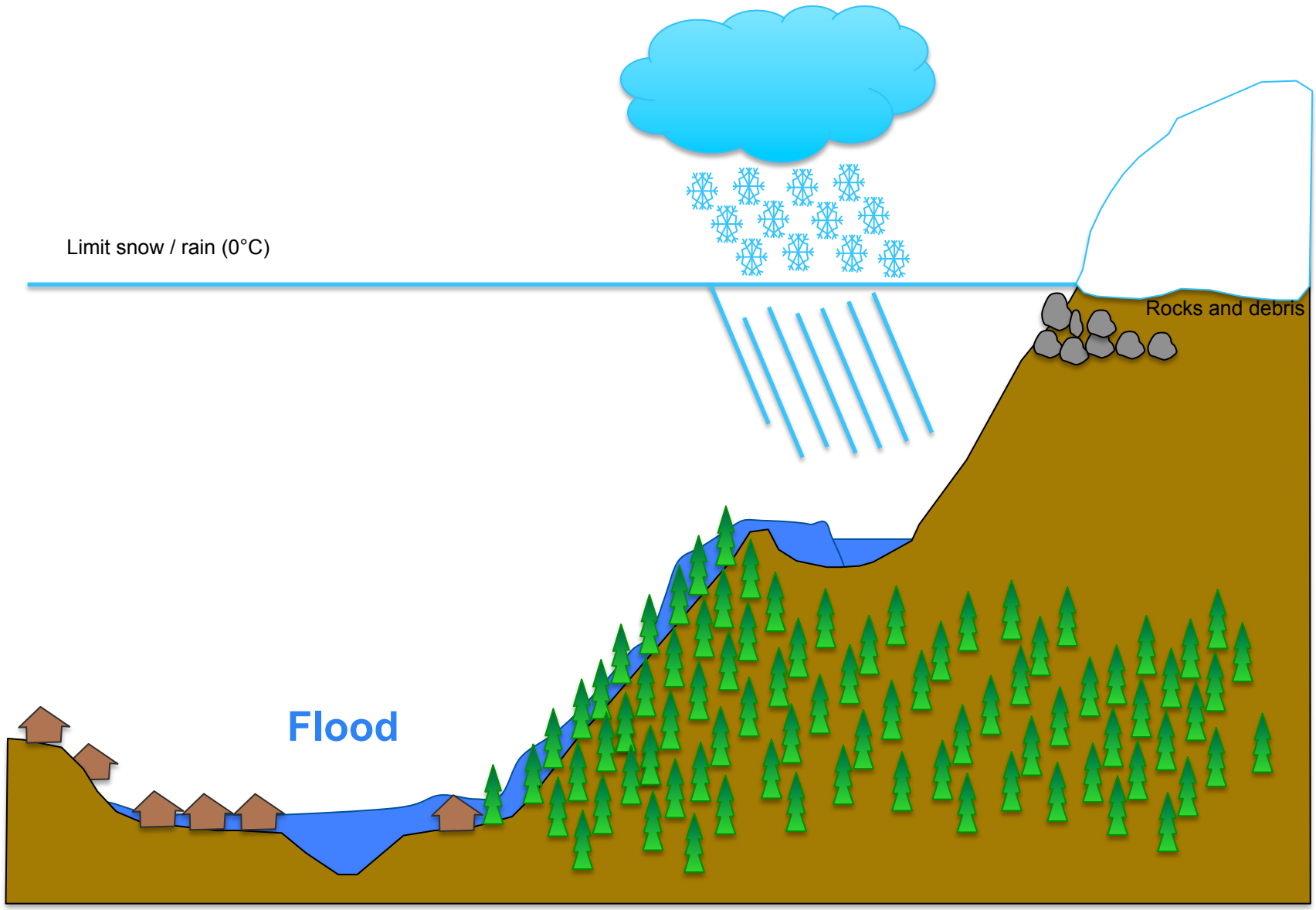
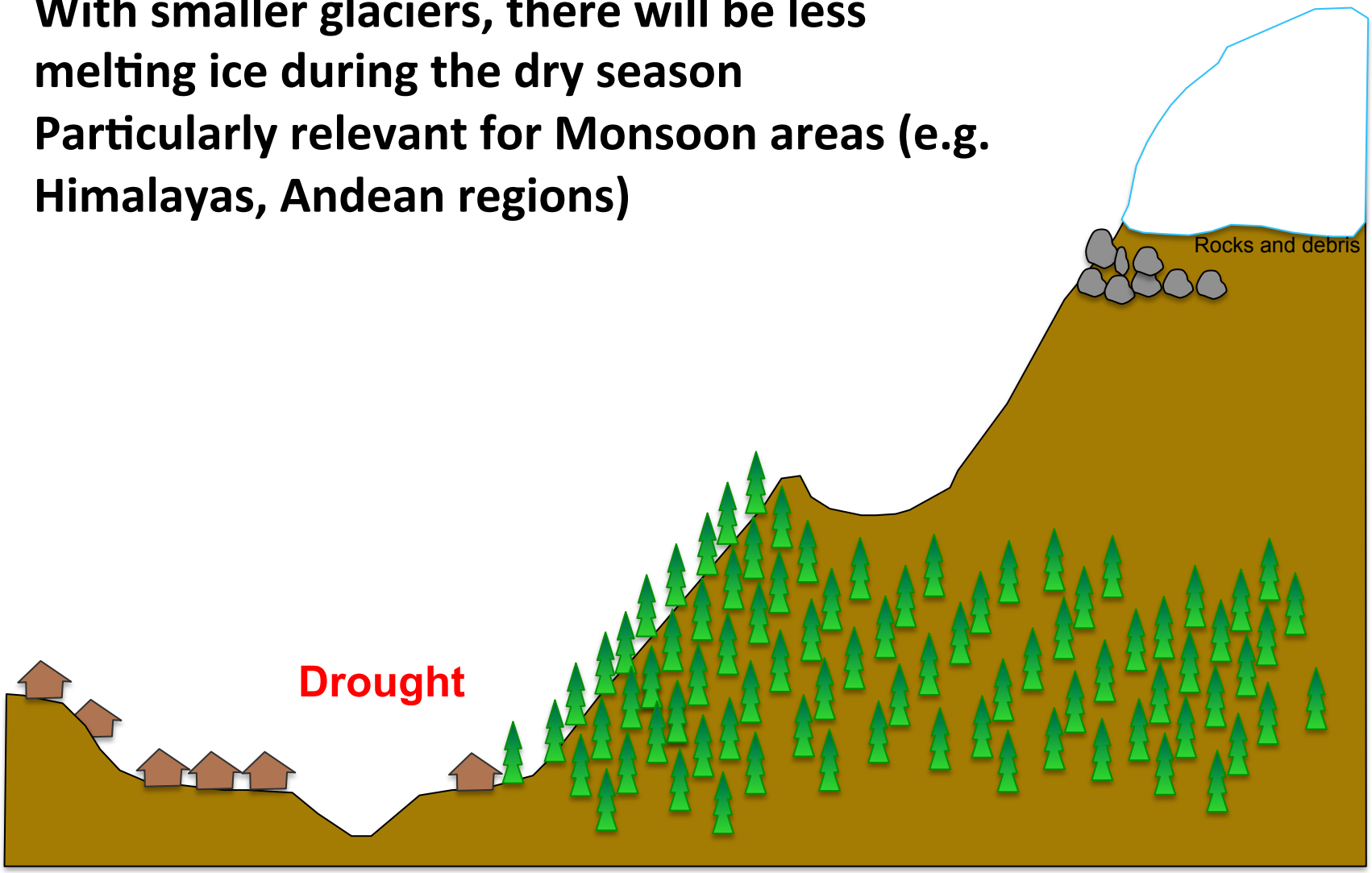
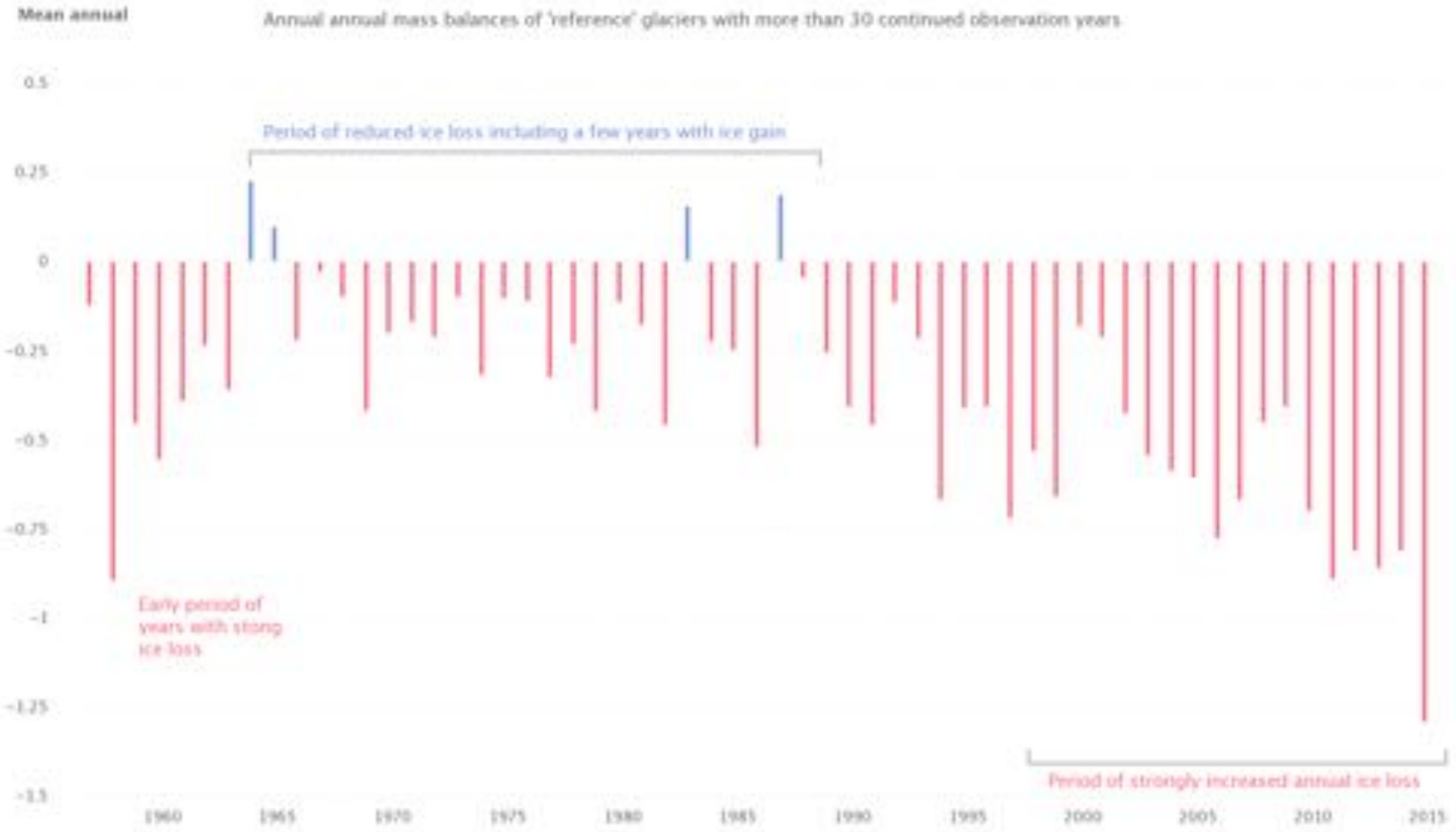

Limit snow / rain


Limit snow / rain (0°C)
Rocks and debris
Flood

With smaller glaciers, there will be less melting ice during the dry season
Particularly relevant for Monsoon areas (e.g. Himalayas, Andean regions)



Change in Glacier Mass



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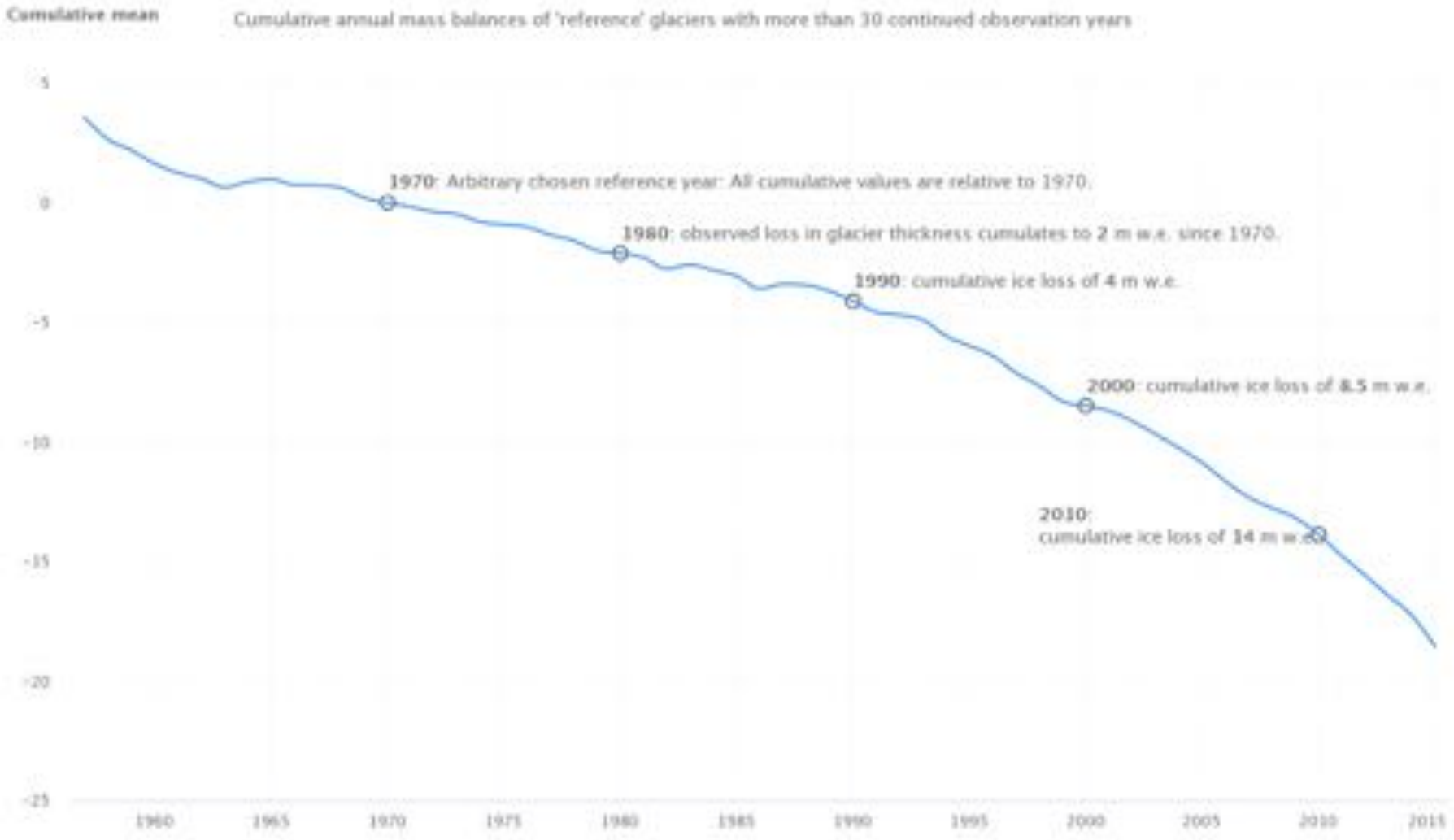
Change in Glacier Mass



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Coastal aquifers and Sea level rise

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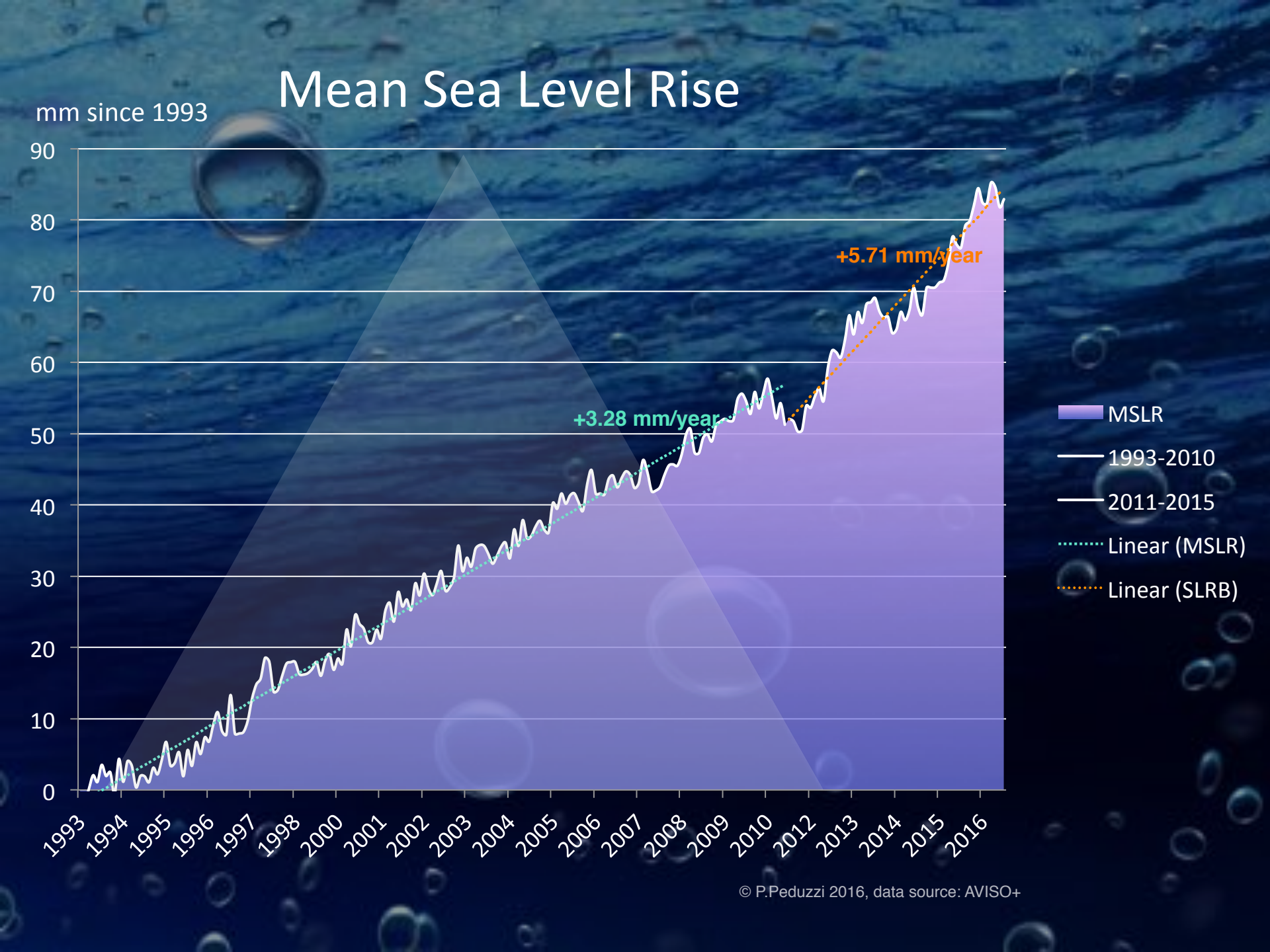
Mean Sea Level Rise



Sea Level Rise (0.26 – 0.82 m)

Table SPM.2 | Projected change in global mean surface air temperature and global mean sea level rise for the mid- and late 21st century relative to the reference period of 1986–2005. [12.4; Table 12.2, Table 13.5]

		2046–2065		2081–2100	
	Scenario	Mean	*Likely* range[c]	Mean	*Likely* range[c]
Global Mean Surface Temperature Change (°C)[a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
	Scenario	Mean	*Likely* range[d]	Mean	*Likely* range[d]
Global Mean Sea Level Rise (m)[b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

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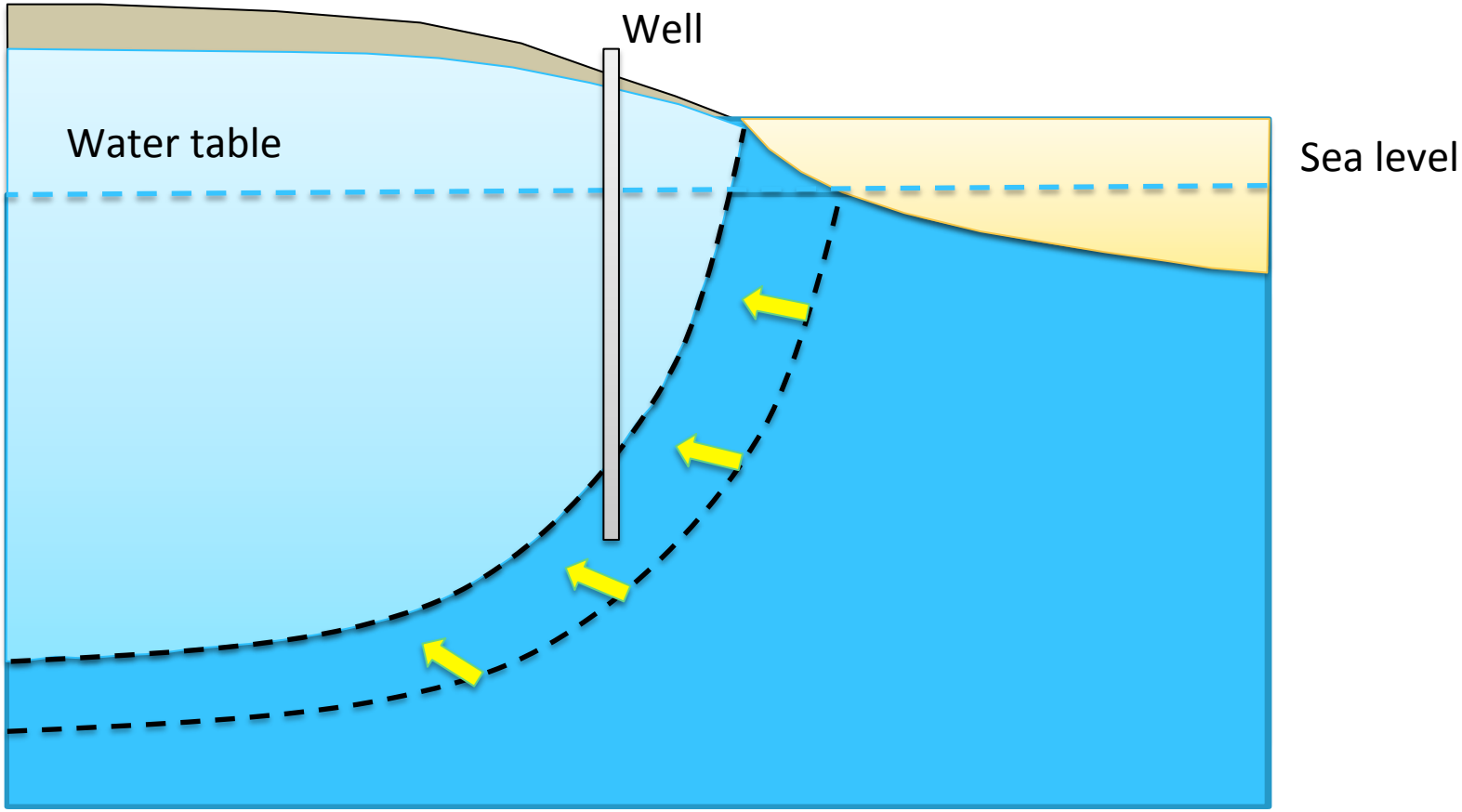
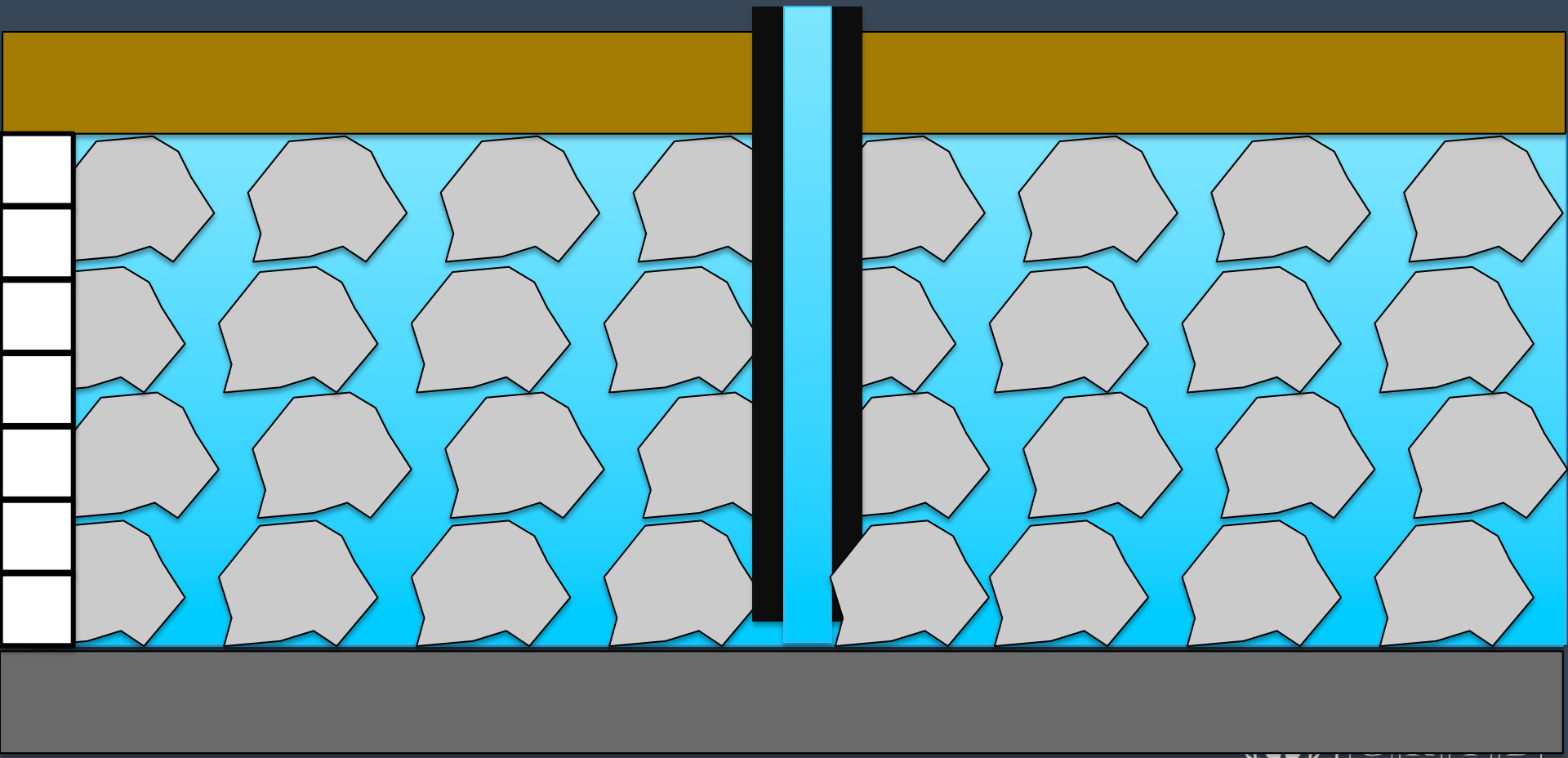
Sea leve rise and impacts on coastal aquifers



Subsidence

Water mining and subsidence



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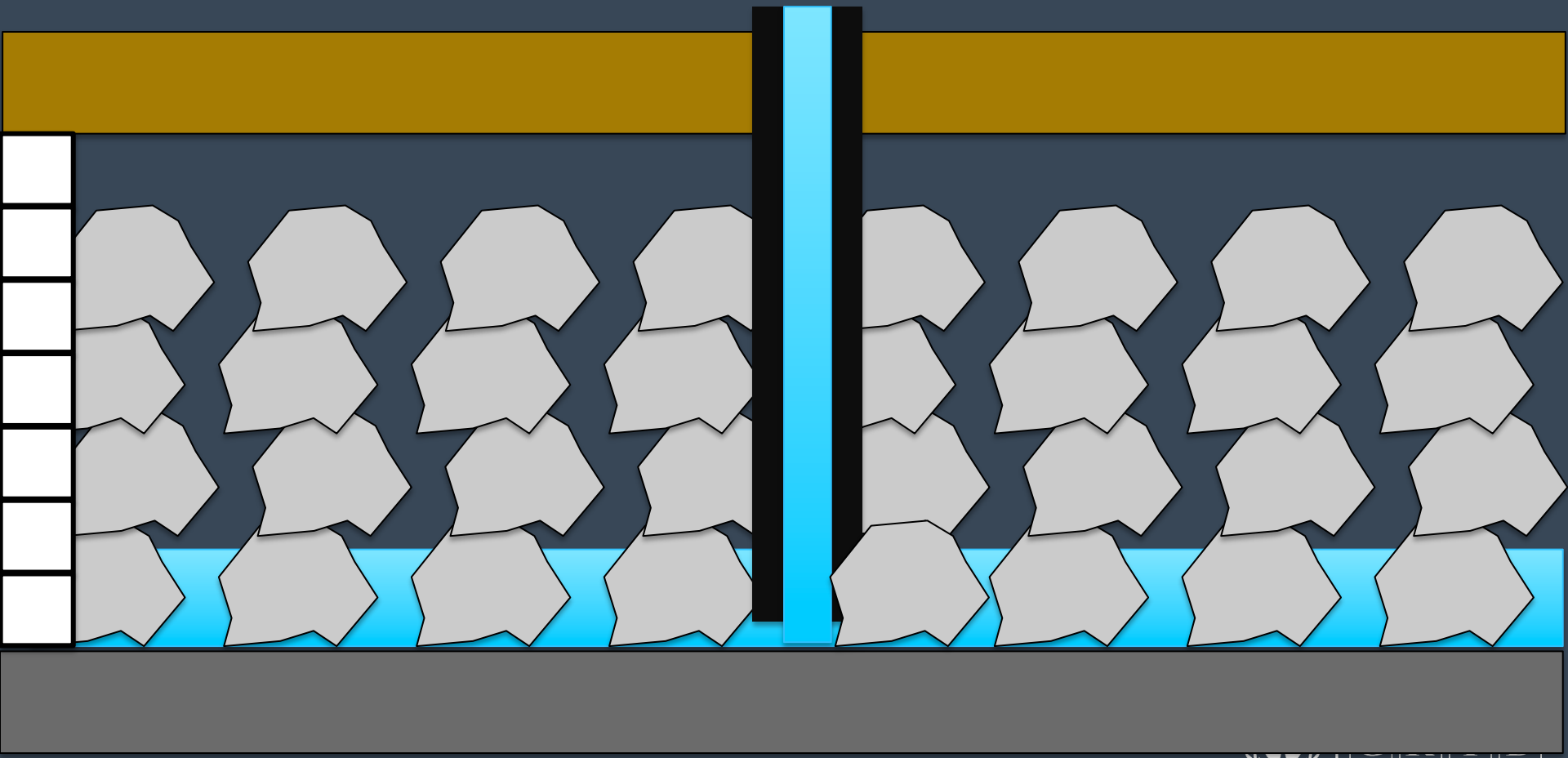
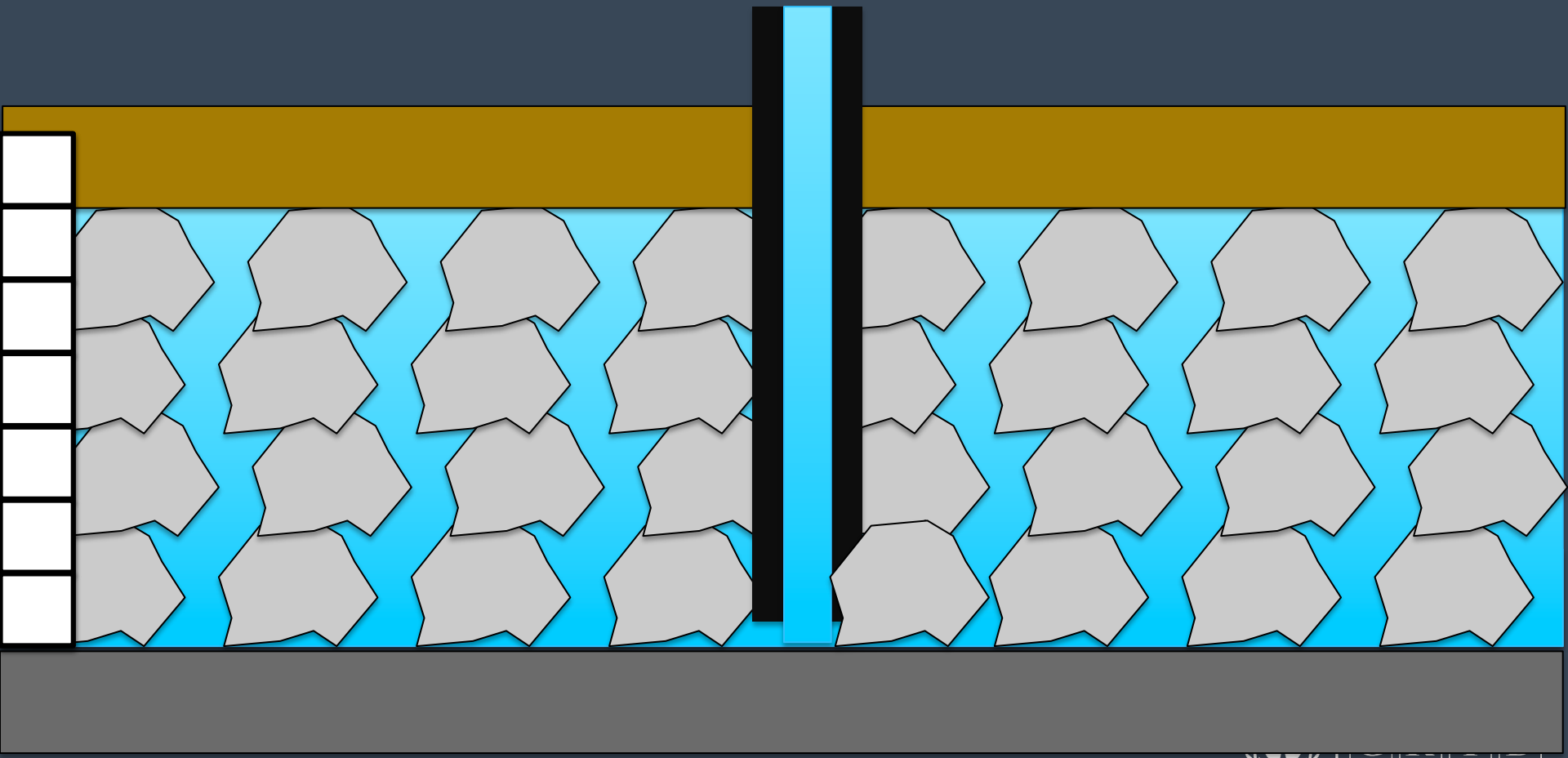
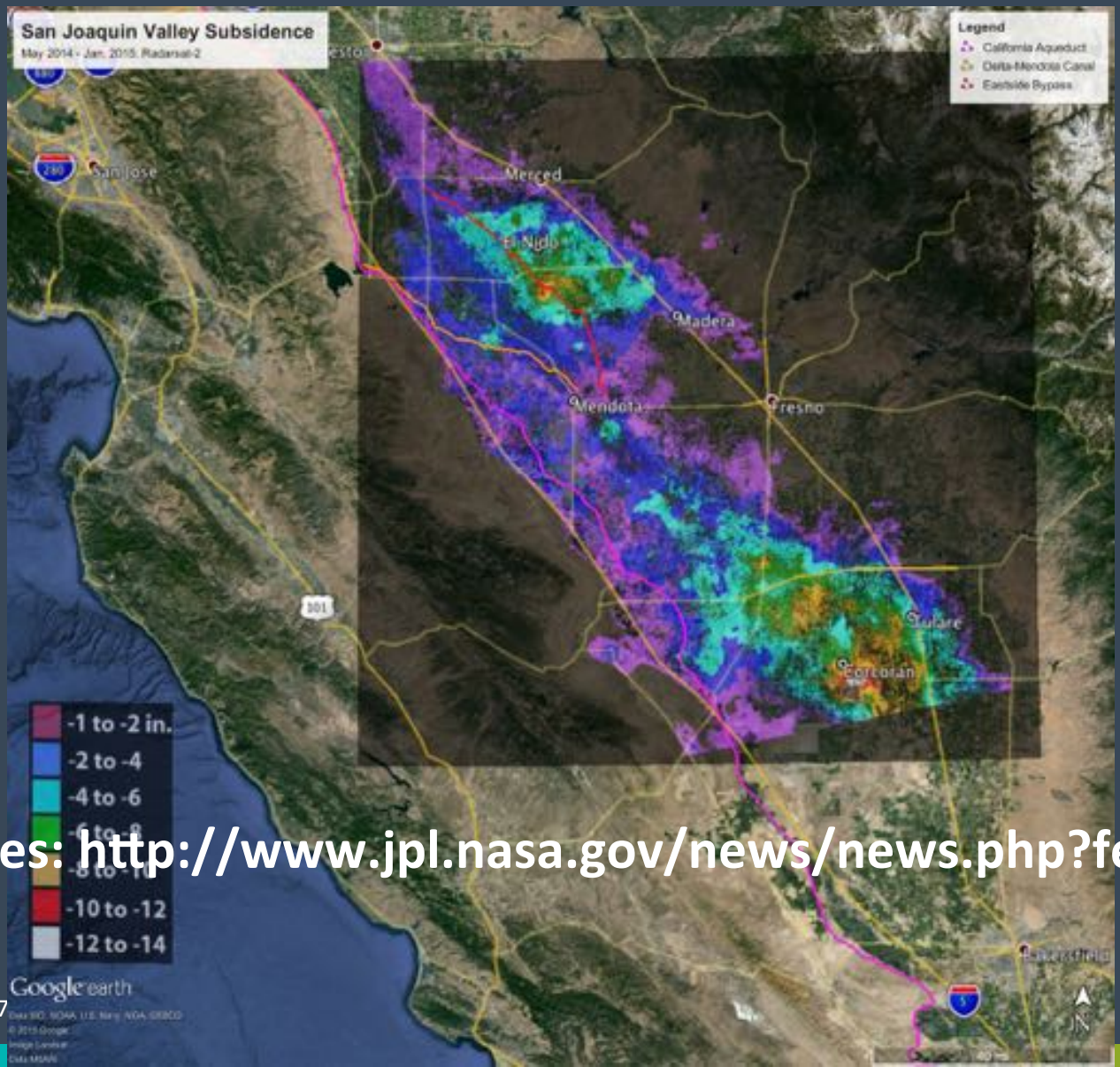


Water mining and subsidence



NASA: California Drought Causing Valley Land to Sink



Sources: http://www.jpl.nasa.gov/news/news.php?feature=4693

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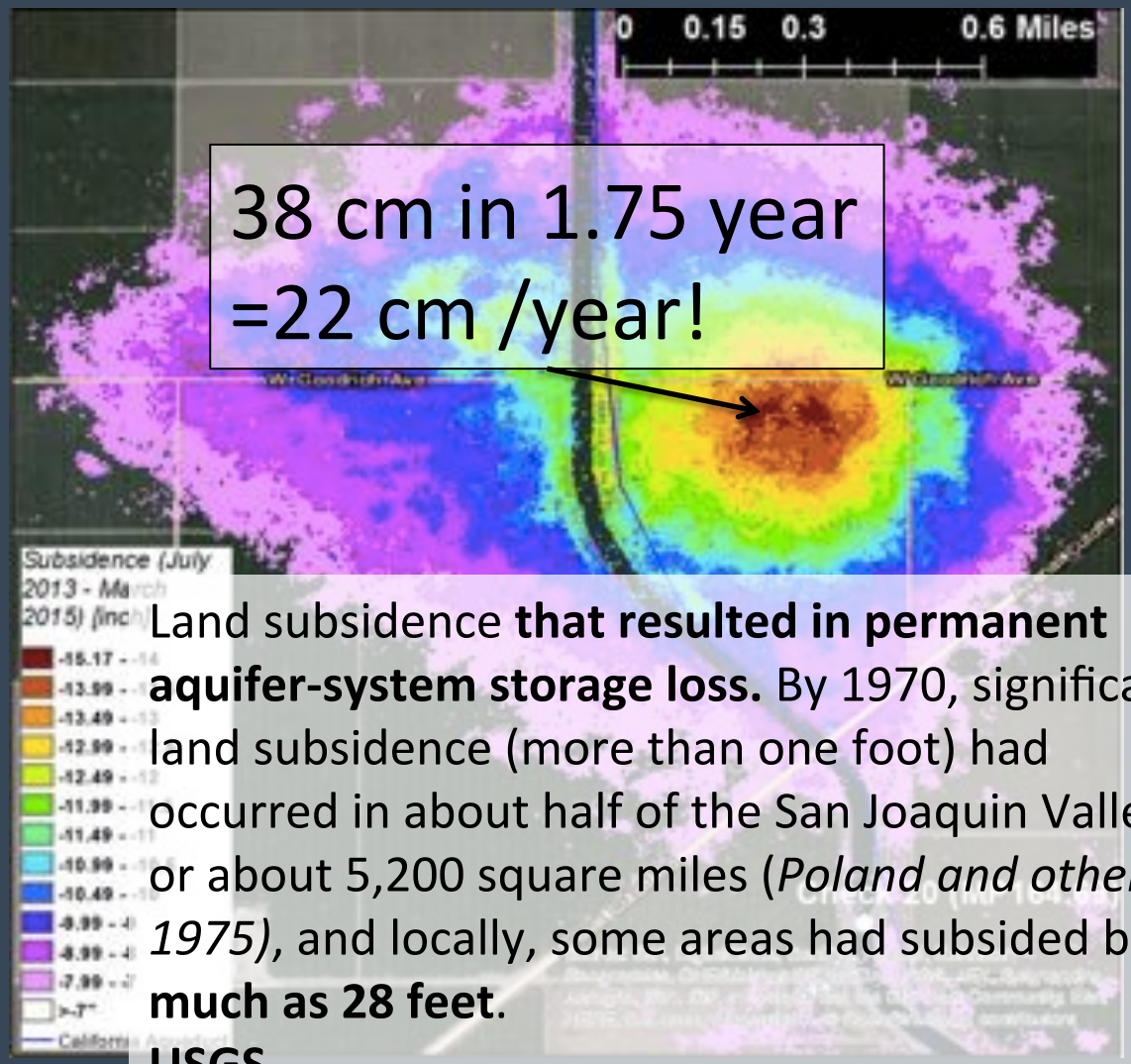
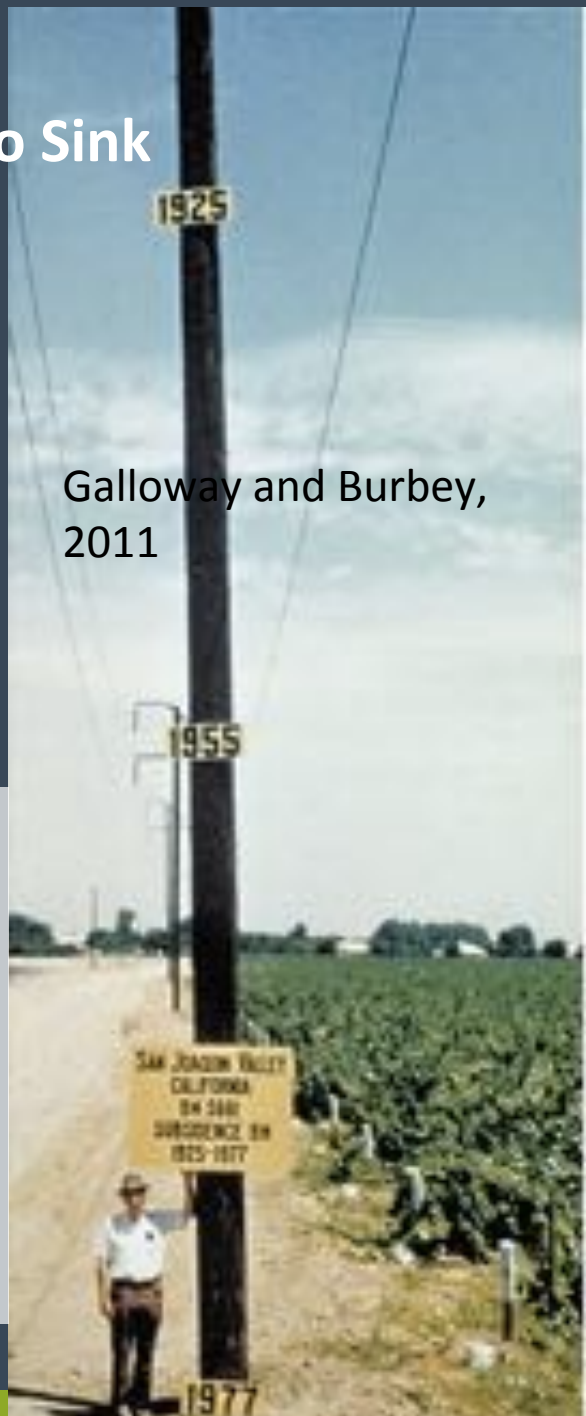


Land subsidence **that resulted in permanent aquifer-system storage loss.** By 1970, significant land subsidence (more than one foot) had occurred in about half of the San Joaquin Valley, or about 5,200 square miles (*Poland and others, 1975)*, and locally, some areas had subsided by **as much as 28 feet**.

USGS



Galloway and Burbey, 2011

A Glass Half Empty: Regions at Risk Due to Groundwater Depletion

Sources: UNEP, https://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=76

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Lower probability, Higher impacts

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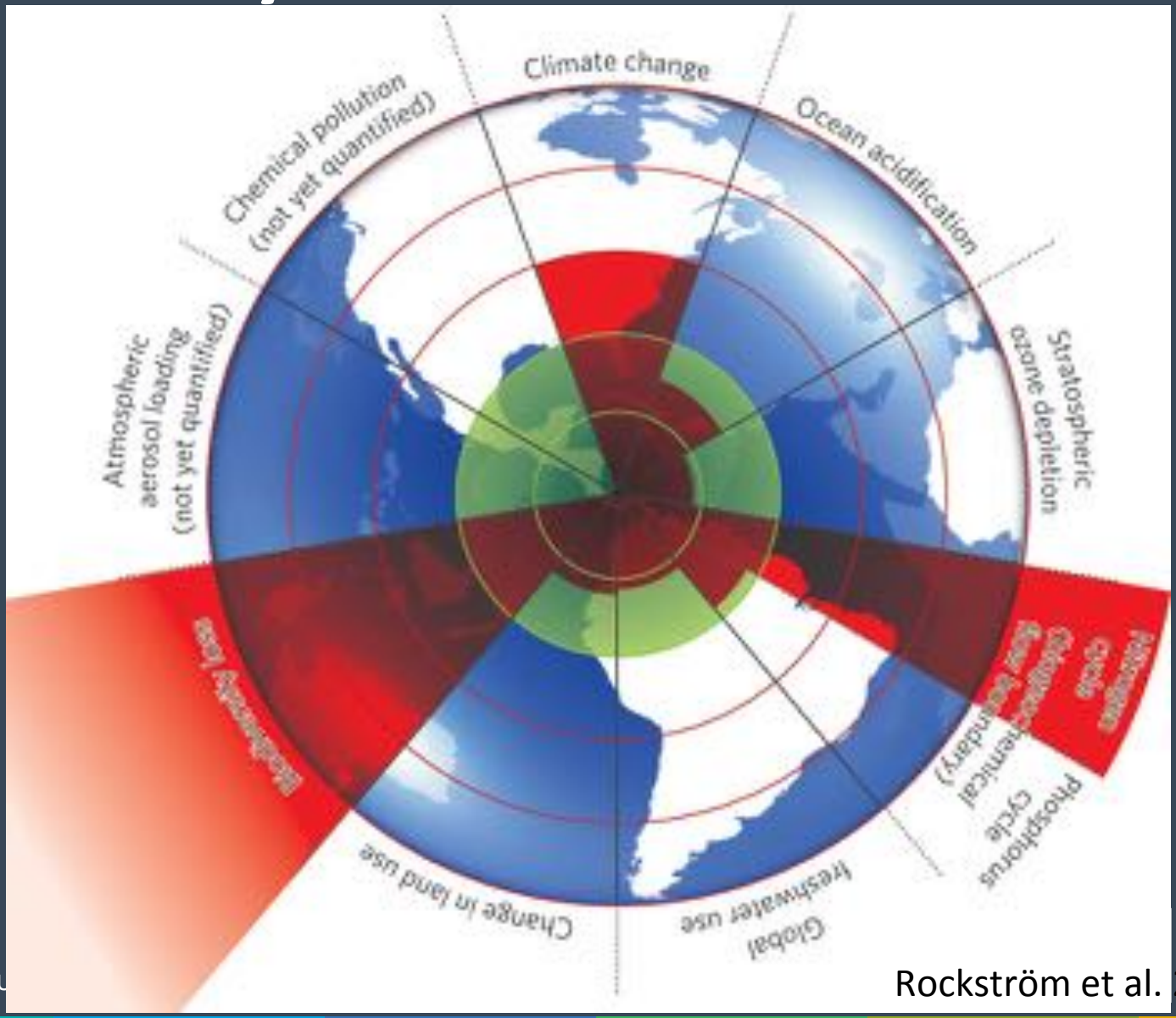
Planetary boundaries



Rockström et al. 2009

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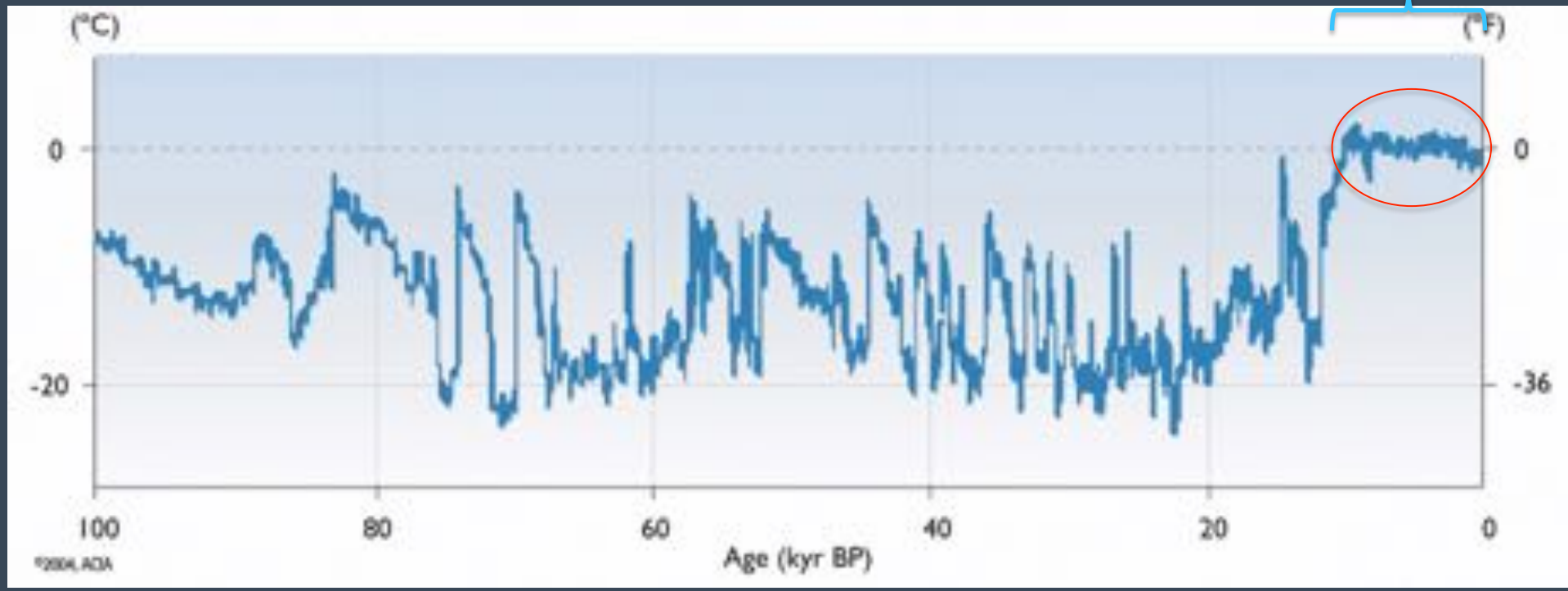
Holocene



The holocene is characterised by a very stable climate. This is allowing predictibility.
-11700 years (from now) corresponds as well to the start of agriculture.

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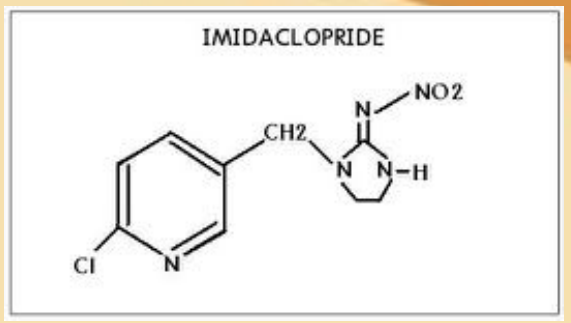
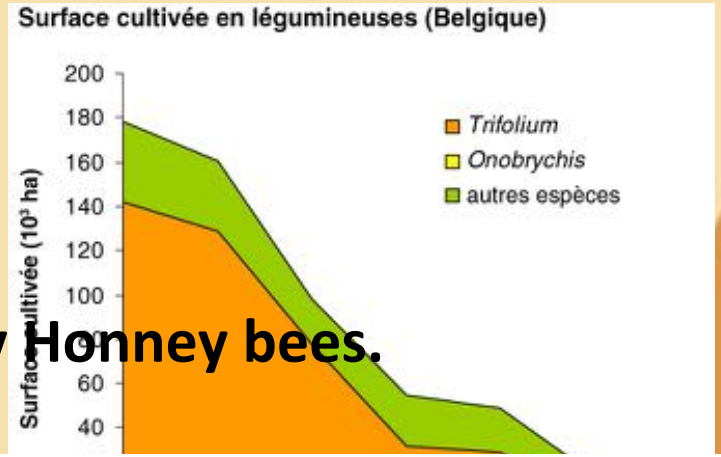




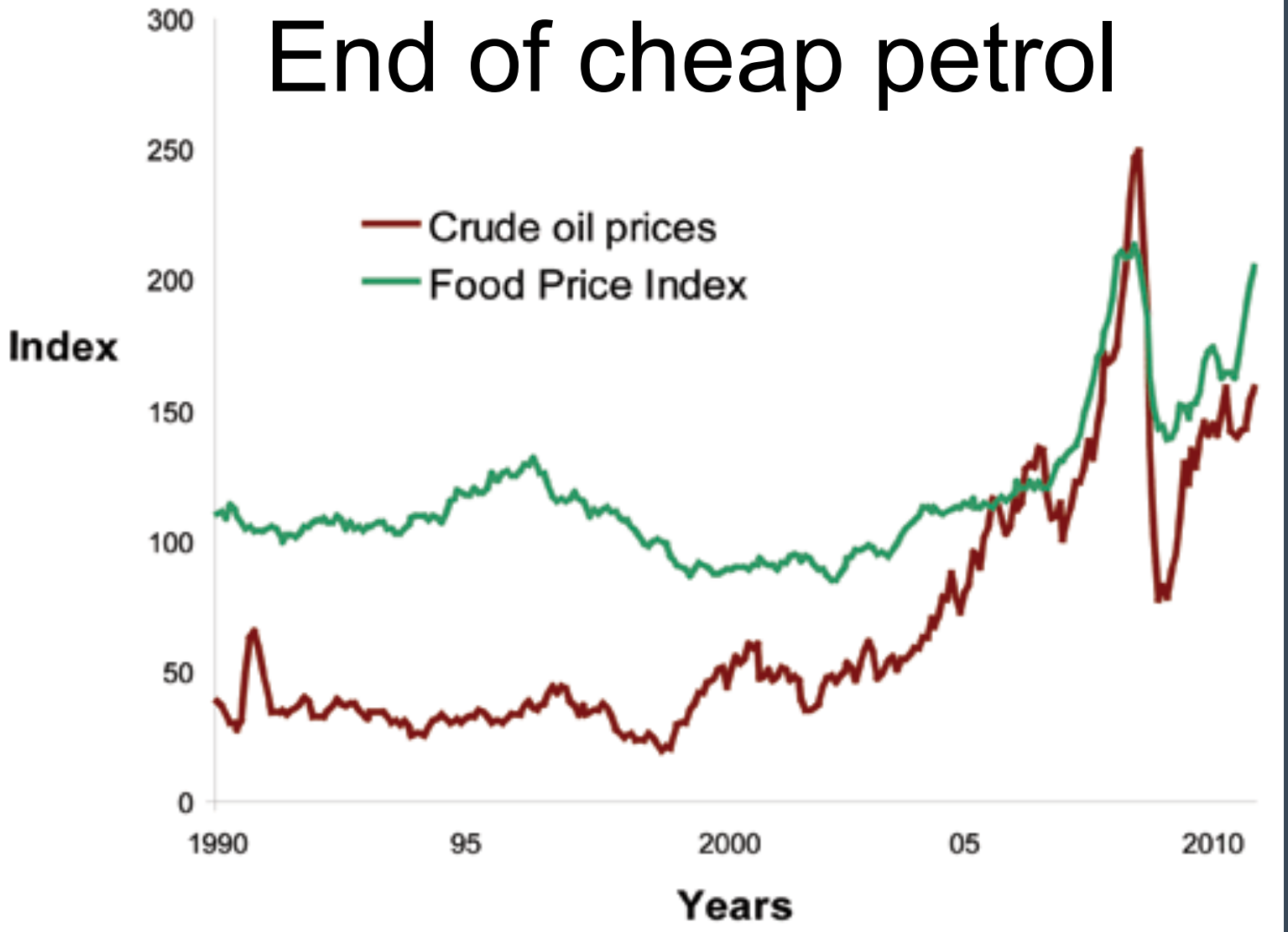
A majority of our crops are pollinated by Honney bees.

"Acute and sublethal effects of pesticides on honey bees have been increasingly documented, and are a primary concern."
Sources: USDA 2013
http://www.usda.gov/documents/ReportHoneyBeeHealth.pdf

GMO's; firm owning seeds, env' and socio-economical impacts

- Seeds are produced by a limited number of company (monopole + reduction of the varieties.
- GMO's mostly modified to tolerate Glyphosate, or to produce pesticides. Adapted for USA, but then doesn't fit as well in other geographical context (example Cotton BT) + reduction of varieties and development of resistances.
- Dependencies from farmers (copyright)

End of cheap petrol

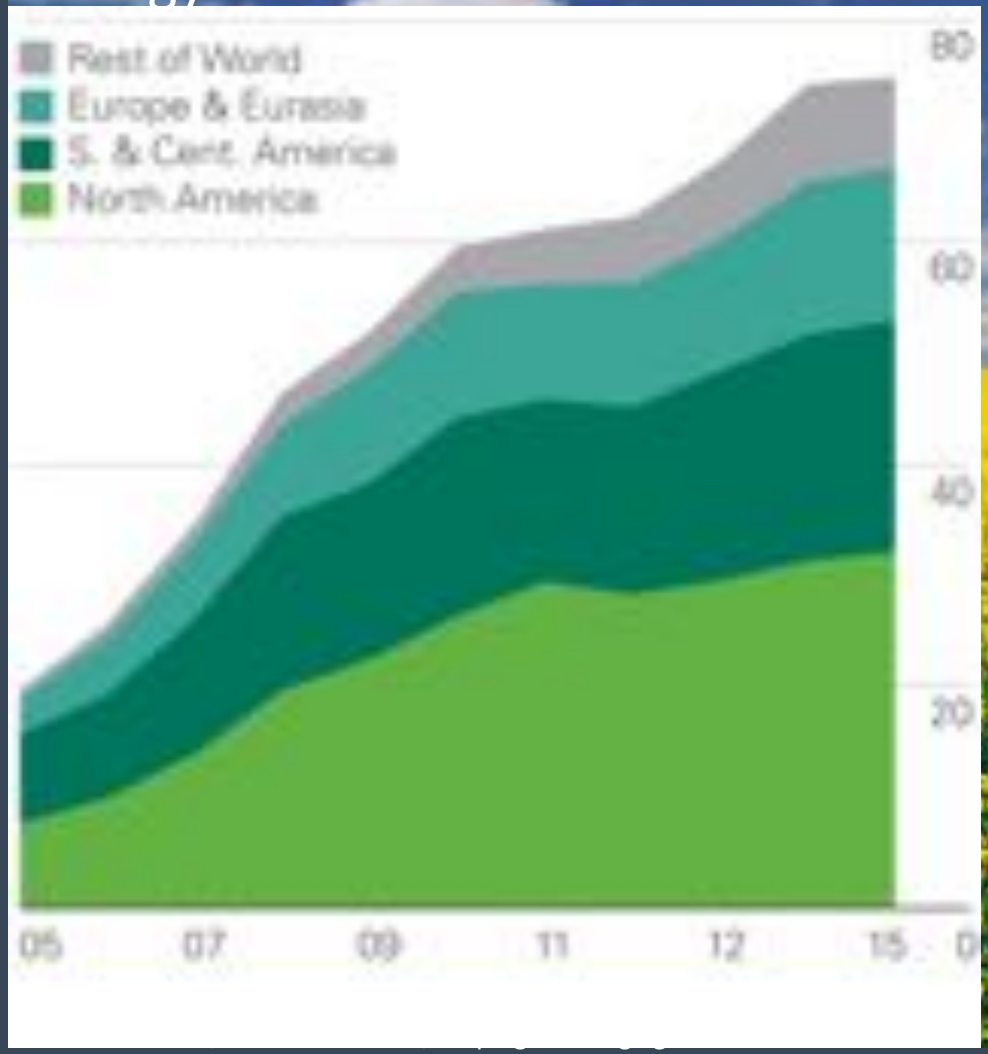


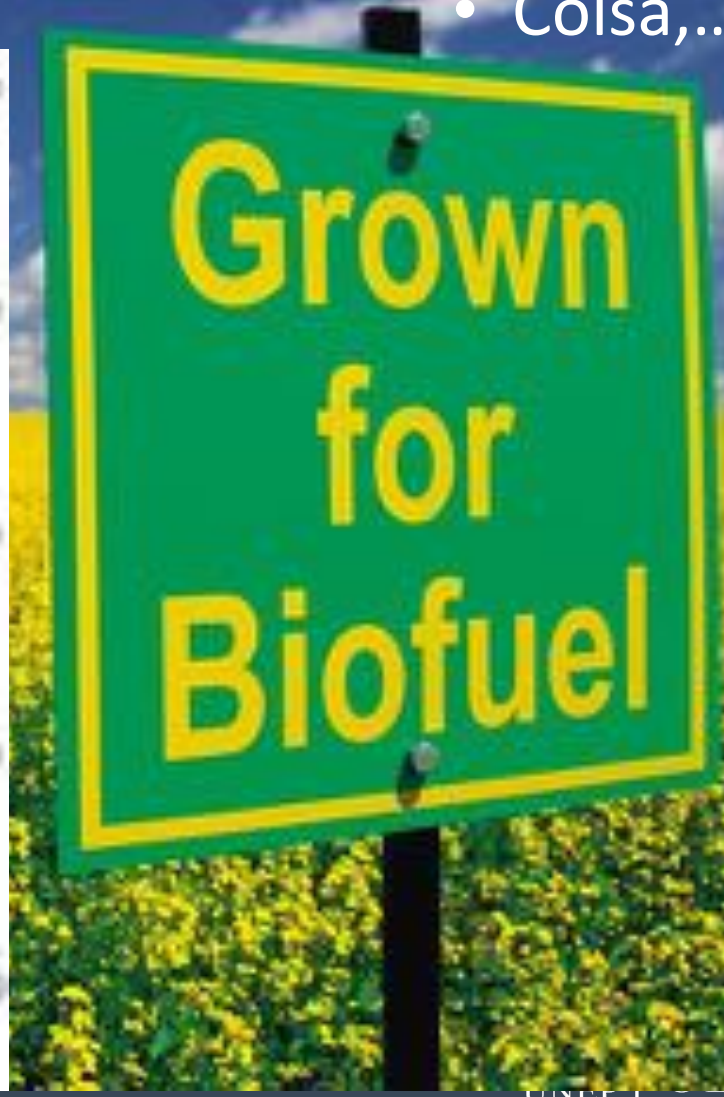
- In industrialized agriculture: 1 food calorie requires 7-10 cal. of fossil energy (Dahlberg 2000).

Energy vs food ? Crops for biofuel

About 80 million oil tons eq., i.e. 2.8% of global energy. Sources: BP

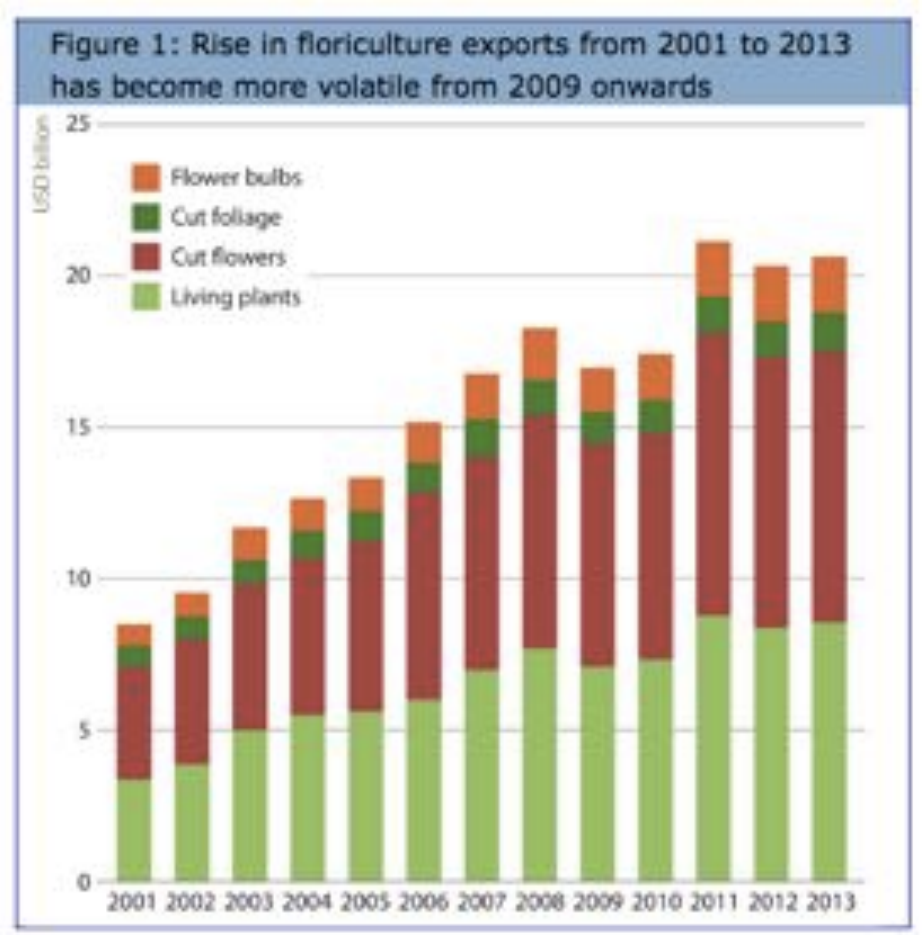
- Palm oil
- Corn
- Colsa,…

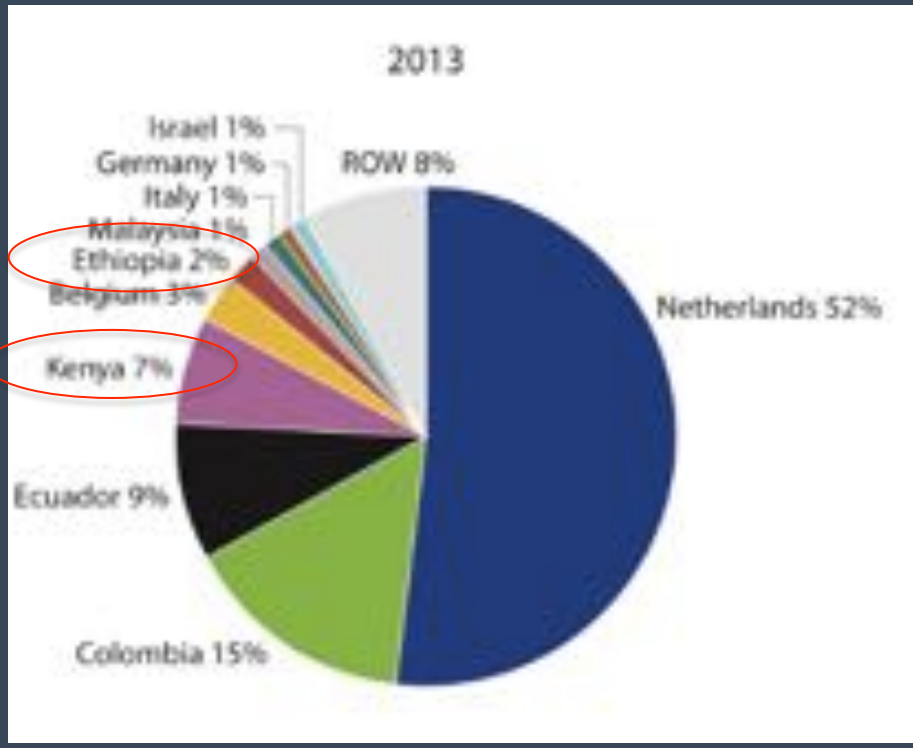




http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewable-energy.html

Flowers production





>20 billions USD in 2013

Source: UN Comtrade, 2014.

https://www.rabobank.com/en/images/World_Floriculture_Map_2015_vanRijswick_Jan2015.pdf

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Meat production

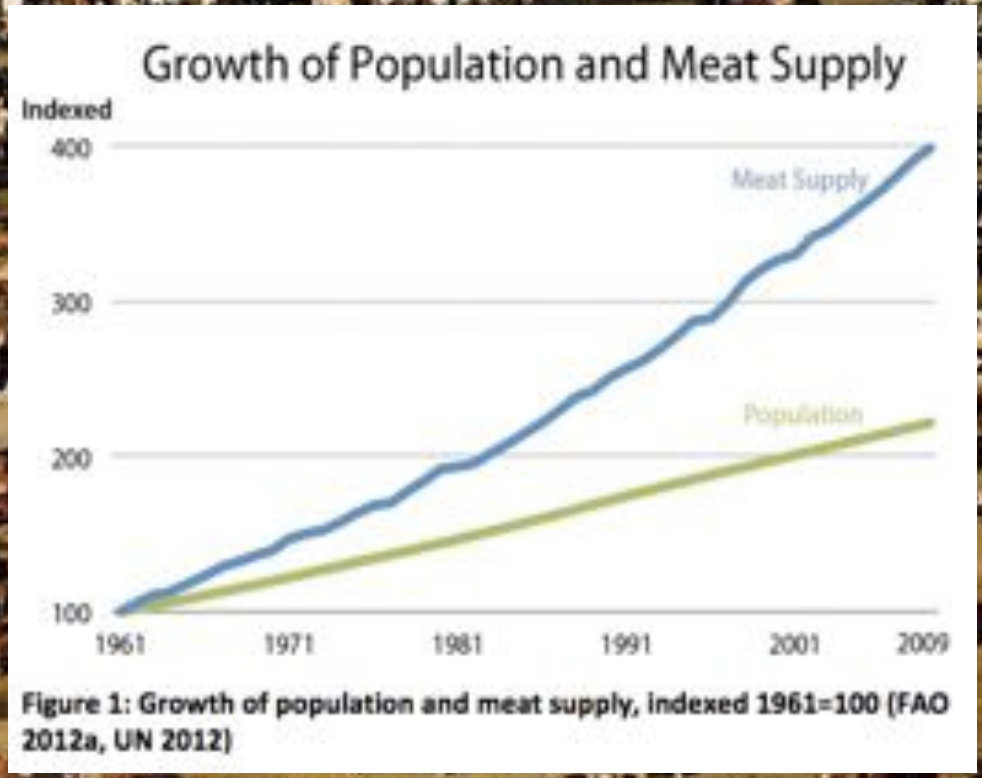

Figure 1: Growth of population and meat supply, indexed 1961=100 (FAO 2012a, UN 2012)

Photo: Yann Artus-Bertrand

Feedlot near Bakersfield, California, United States (36°19'N, 120°16'W).

- *Meat is an inefficient source of calories. It accounts for 17% of global calorific intake, but uses twice that amount of land, water and feed.*
- *Livestock also damages the environment. It accounts for between 8% and 18% of greenhouse-gas emissions, depending on how you account for changes in land use (when the Amazon is cut down for pasture, carbon emissions rise).*
- *Roughly a fifth of all the world's pasture has been degraded by overgrazing.*
- *Livestock uses water inefficiently: you need about 15,000 litres of water to produce a kilo of beef but only 1,250 litres for a kilo of maize or wheat.*

The Economist, 31.12,2013

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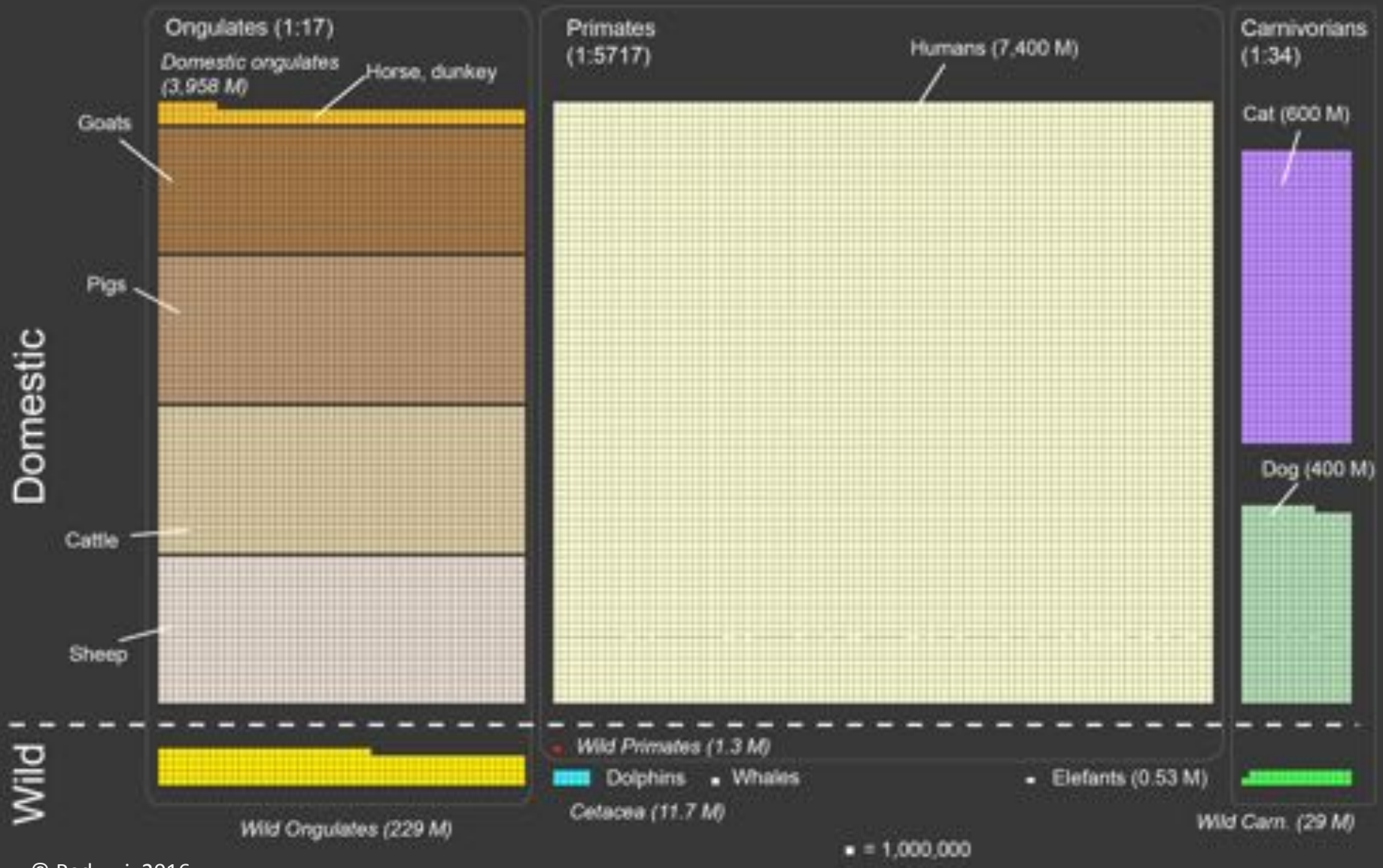
LARGE MAMMALS (Wild:Domestic)



Soil degradation

UNEP

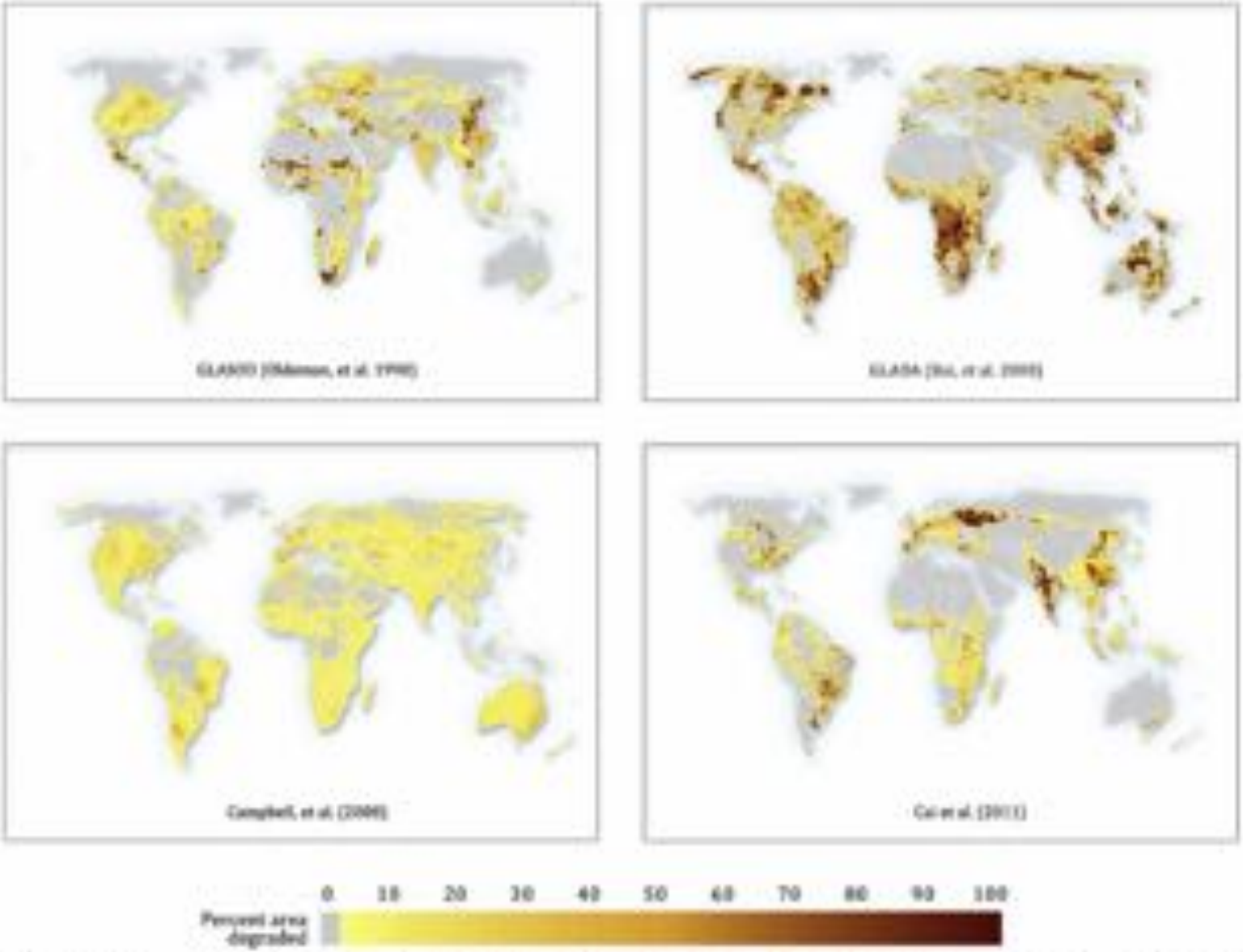
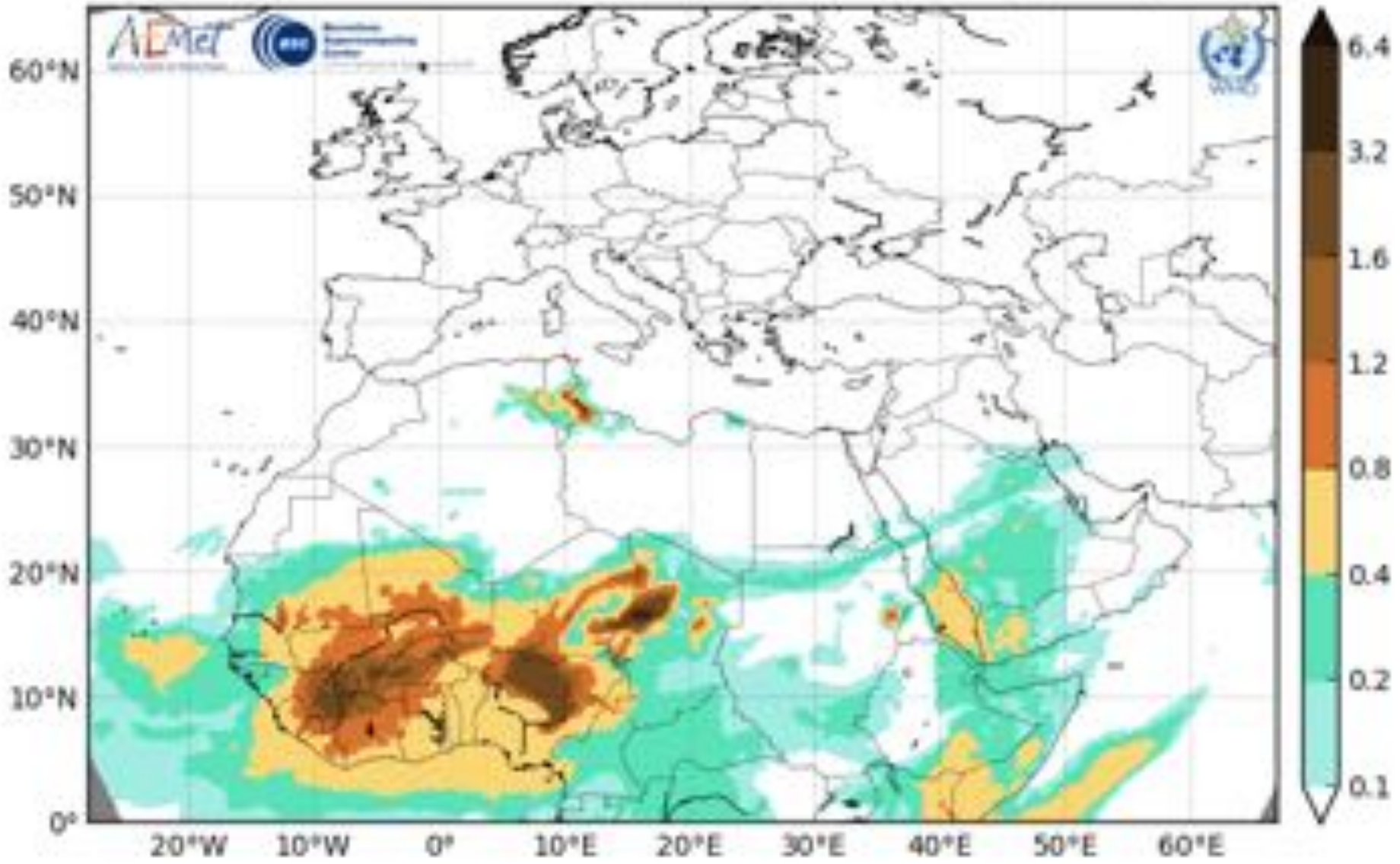


Fig. 1. Maps of land areas (percent of cell area) affected by degradation; each panel represents one of the methods described, all shown with common legend and 20 km grid.


Barcelona Dust Forecast Center - http://dust.aemet.es/
NMMB/BSC-Dust Res:0.1°x0.1° Dust AOD
Run: 12h 06 FEB 2017 Valid: 12h 06 FEB 2017 (H+00)
60°N
50°N
40°N
30°N
20°N
10°N
0°
20°W
10°W
0°
10°E
20°E
30°E
40°E
50°E
60°E
6.4
3.2
1.6
1.2
0.8
0.4
0.2
0.1

Dust storm analysis to support SDGs 15.3 and UNCCD

1. Provide a spatial distribution of dust storm increase frequency/intensity as a proxy for soil degradation.
2. Statistical trends on dust storm frequency and intensity (based on product 1) - can be done at global, regional, national, sub-national and raster level, according to needs.
3. Geospatial and statistical analysis on drivers. By crossing the trends in frequency and intensity with other processes (such as : deforestation, bush fires, climate: change in precipitations, winds, temperatures, change in agriculture patterns), it will be possible to identify and quantify the role of the different drivers.

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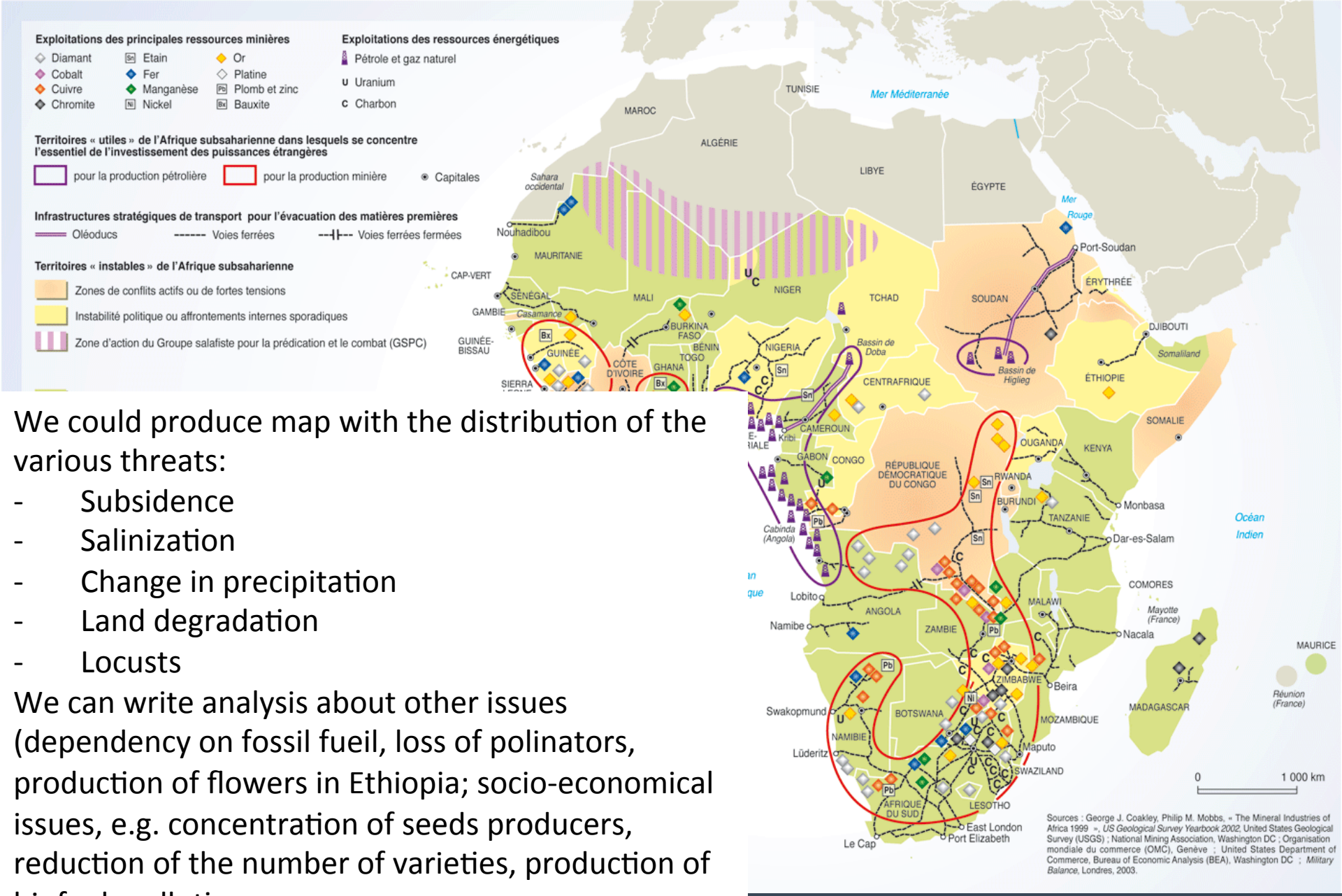

We could produce map with the distribution of the various threats:

- Subsidence
- Salinization
- Change in precipitation
- Land degradation
- Locusts

We can write analysis about other issues (dependency on fossil fueil, loss of polinators, production of flowers in Ethiopia; socio-economical issues, e.g. concentration of seeds producers, reduction of the number of varieties, production of biofuel, pollution,…

Credit: Philippe Rekacewicz

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We need to talk about solutions

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We ’re looking forward to work with you!