apesb
associação portuguesa de engenharia sanitária e ambiental

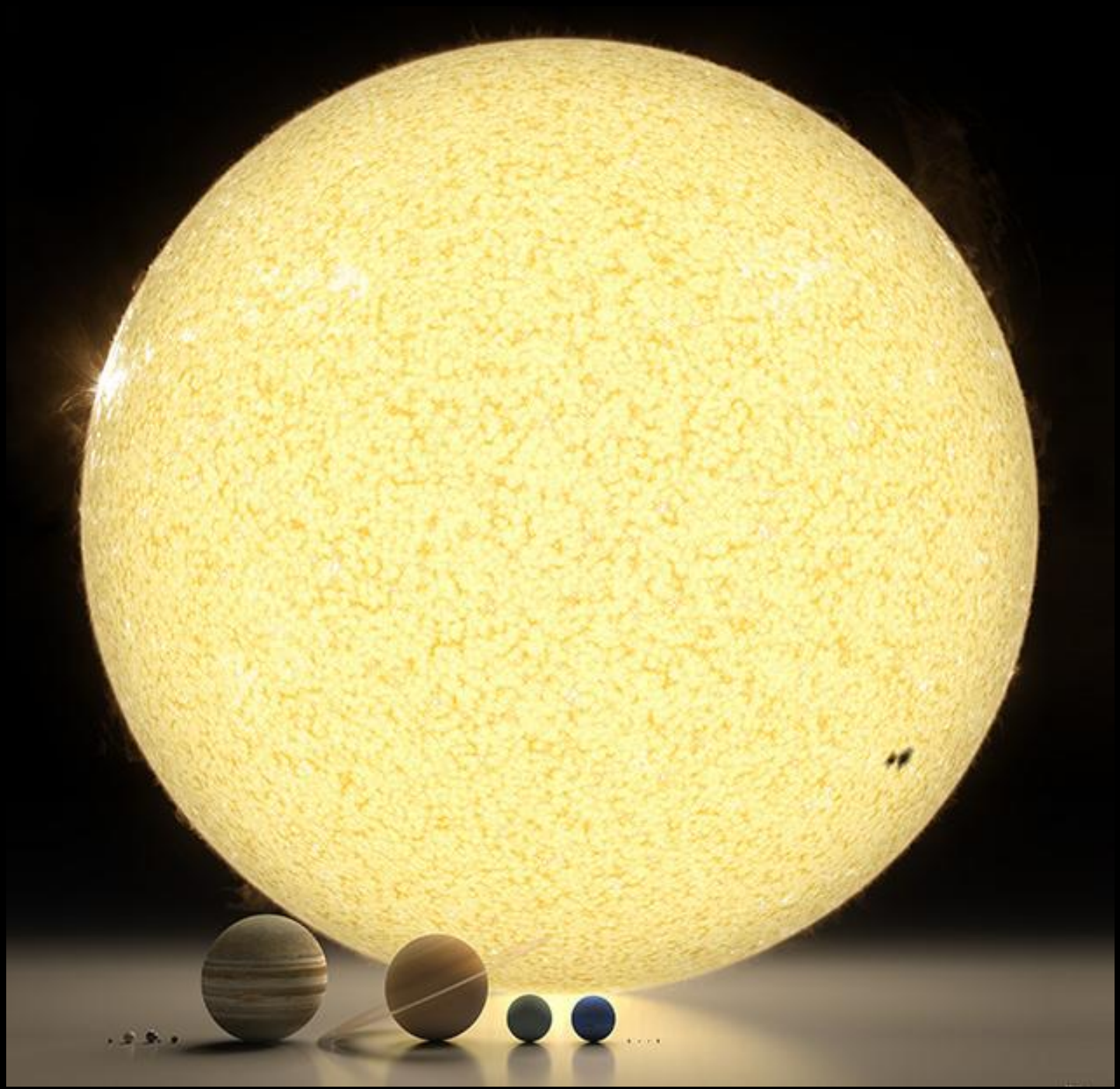
"Cidades e Territórios: Oportunidades e Benefícios da Economia Circular"

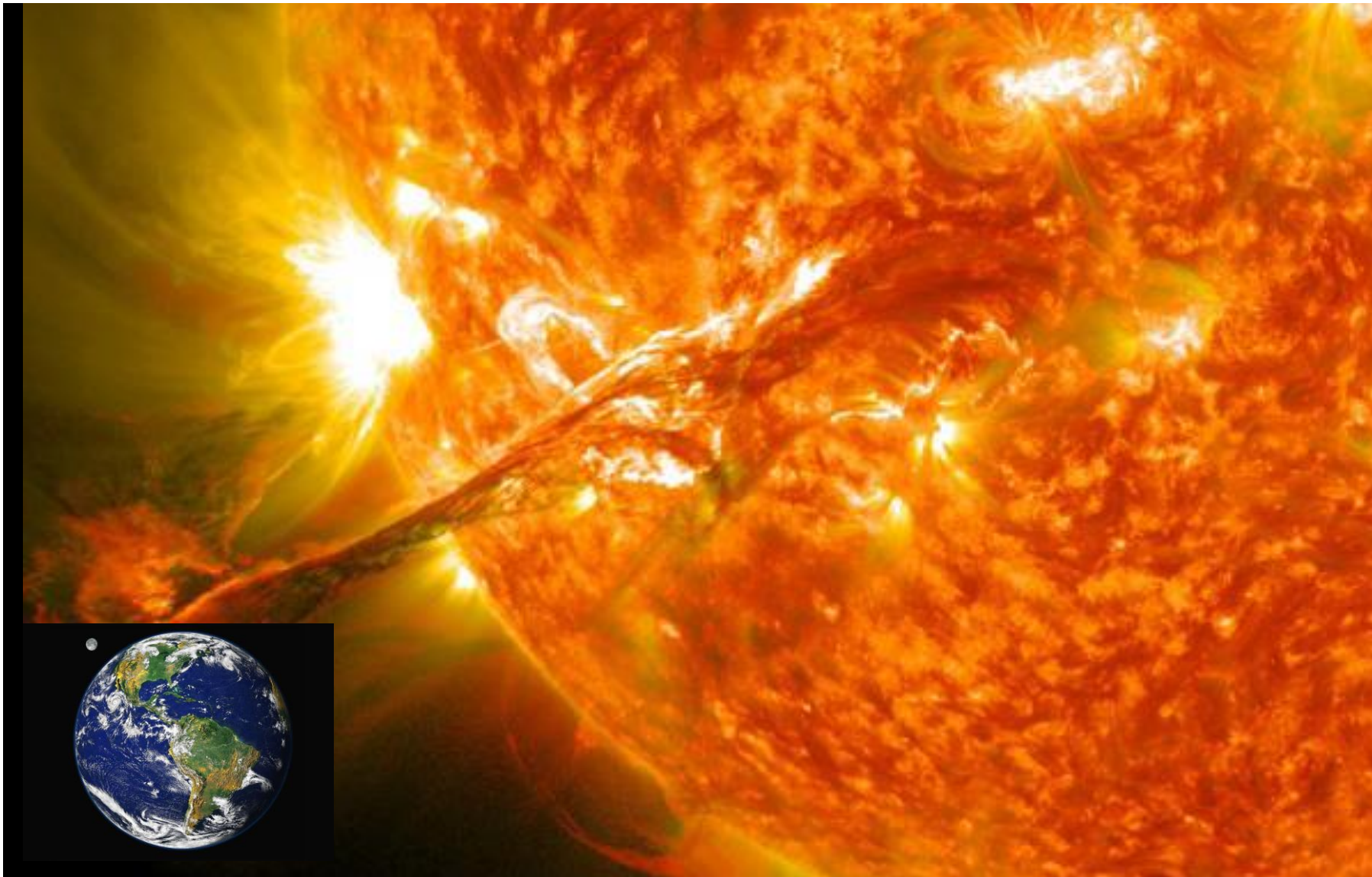
A Água e a Cidade

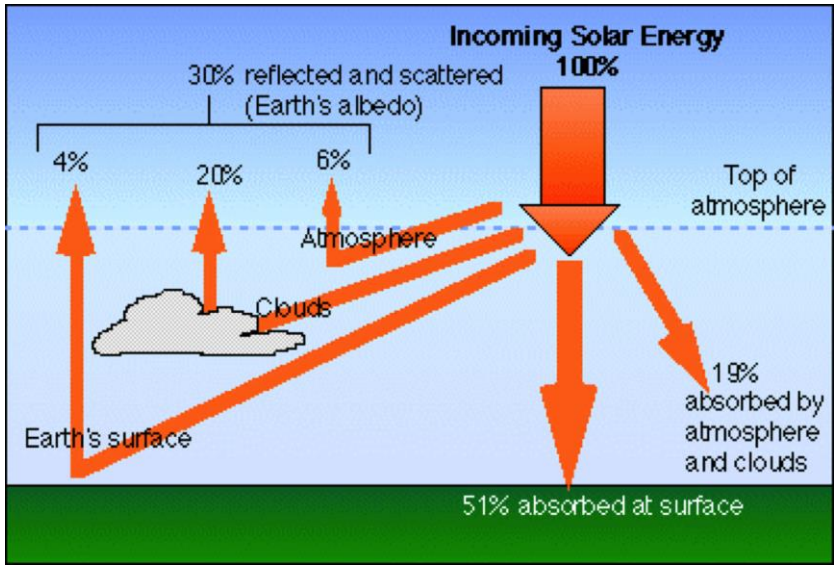
Paulo J. Ramísio

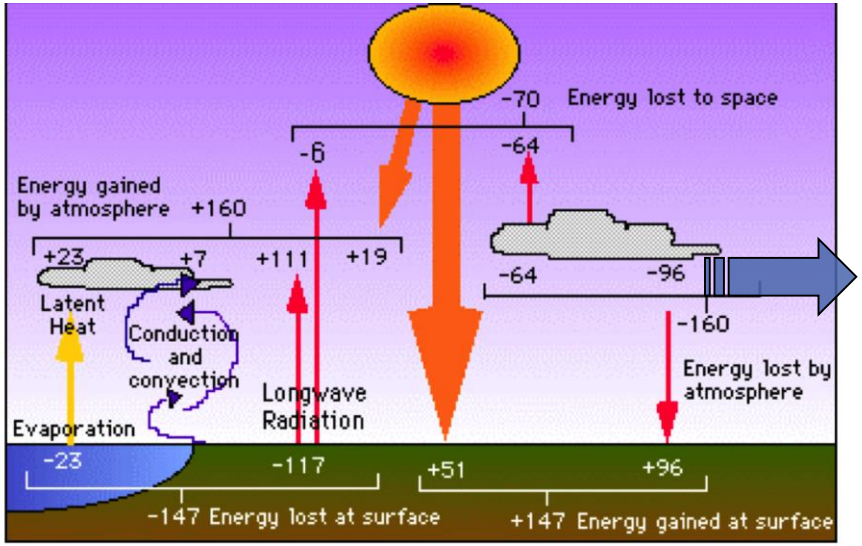
CCDRN – Economia Circular – S. Tirso, 14 maio 2019

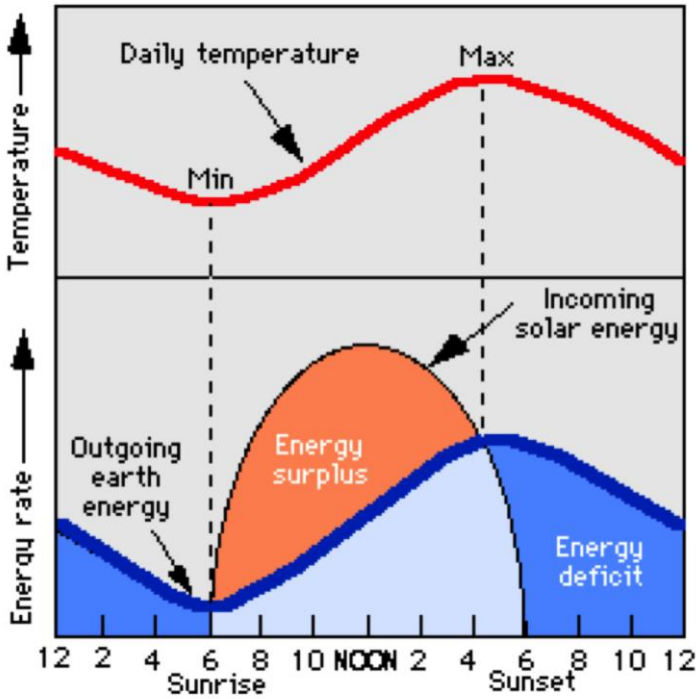
THE EARTH







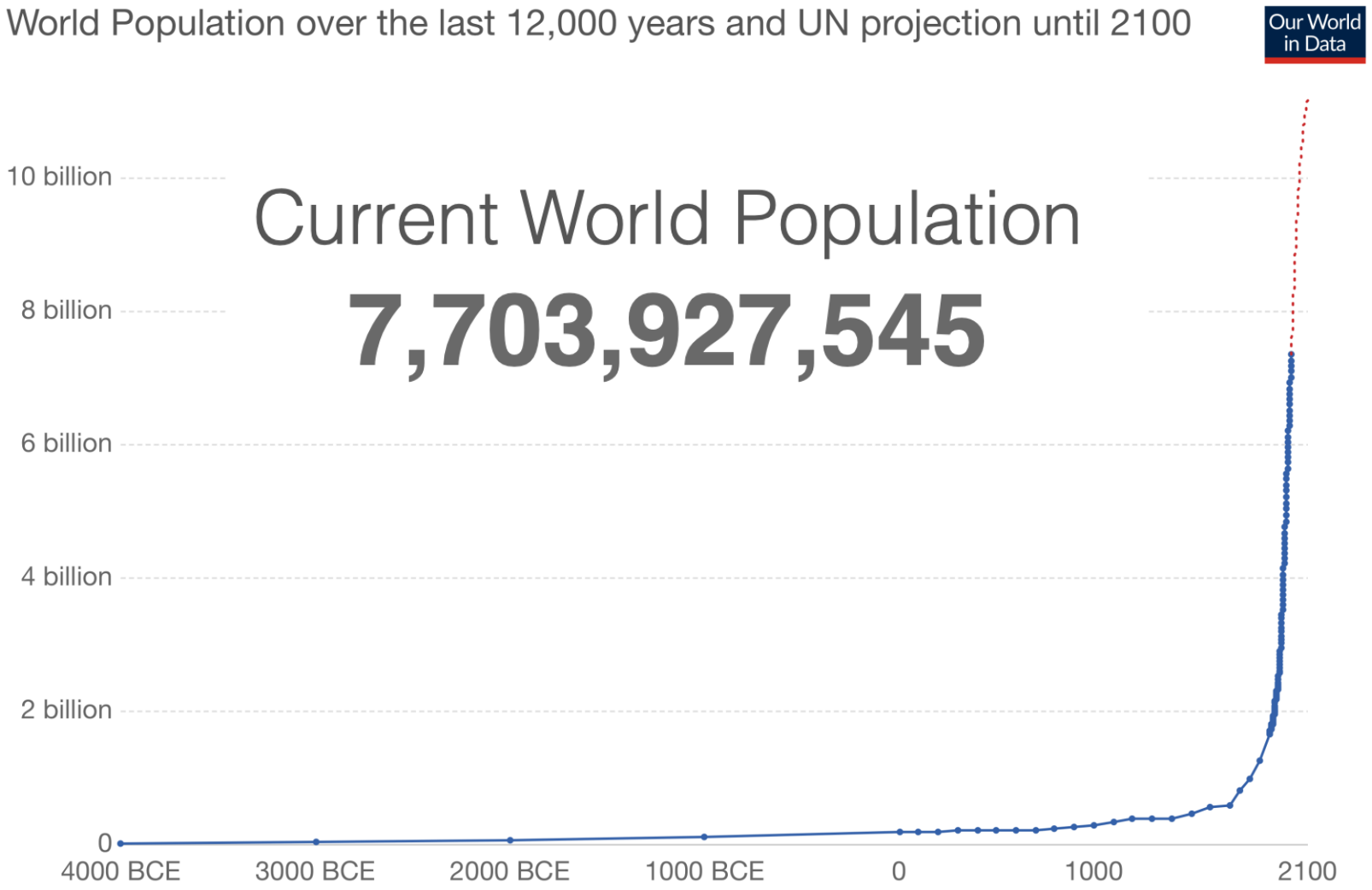




o, 14 maio 2019

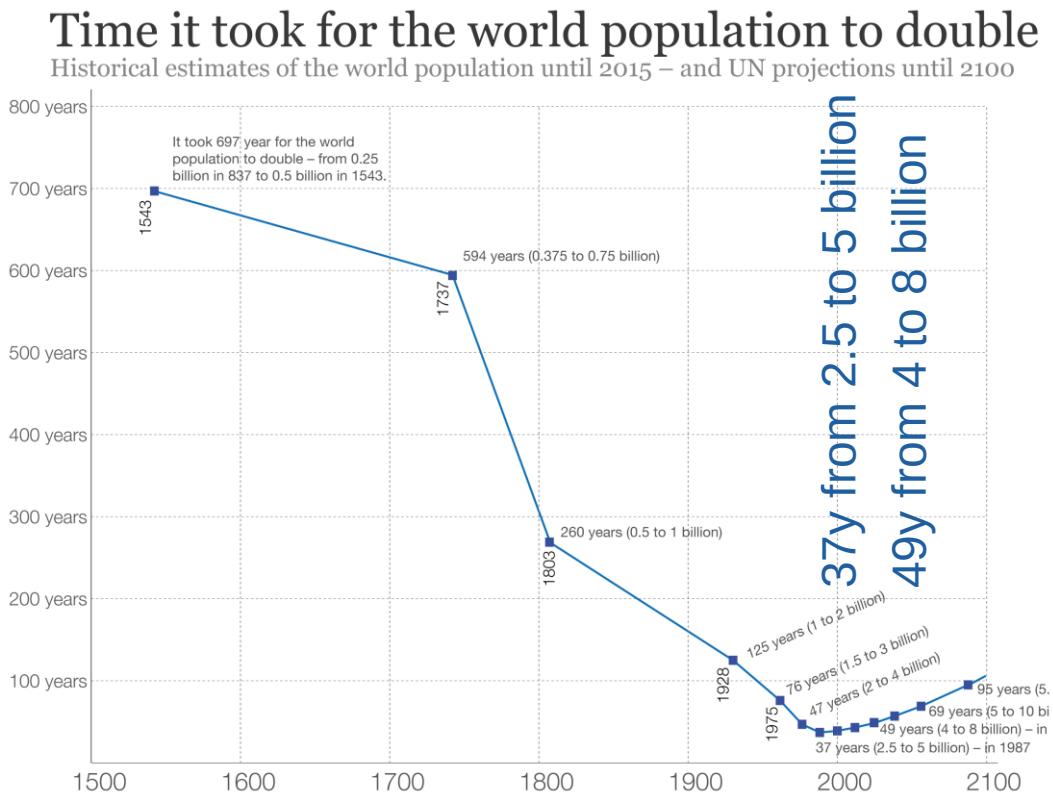
WORLD POPULATION

WORLD POPULATION GROWTH

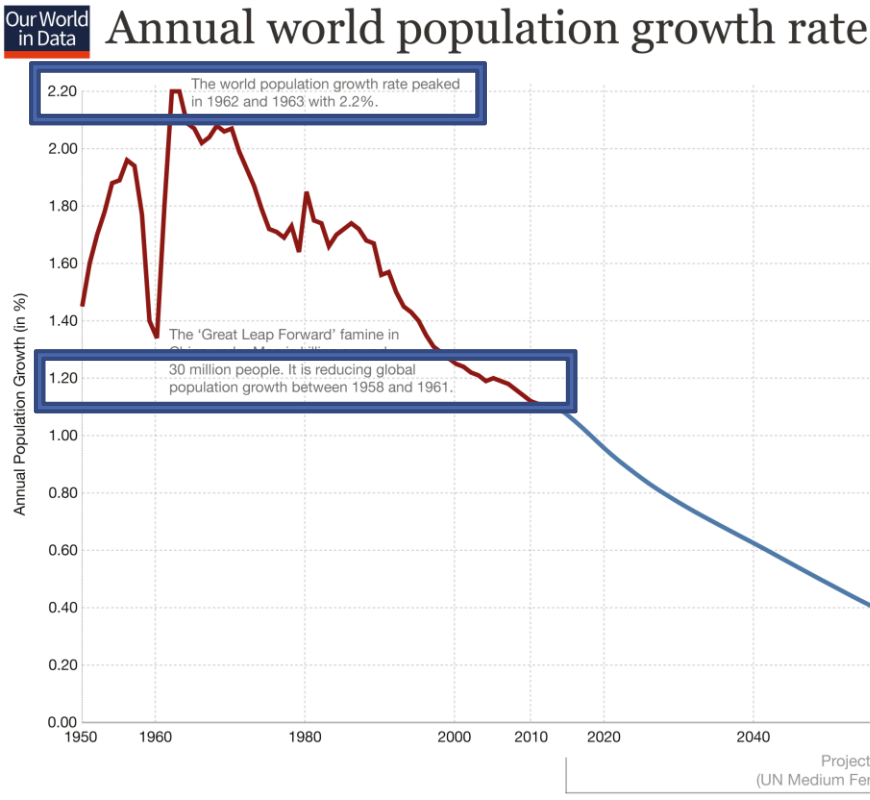


Source: World Population over 12000 years - various sources (2016), Medium Projection – UN Population Division (2015 revision)
OurWorldInData.org/world-population-growth/ • CC BY

WORLD POPULATION GROWTH



Data source: OurWorldInData annual world population series (Based on HYDE and UN until 2015. And projections from the UN after 2015 ('Medium Variant' 2015 Revisio
The data visualization is available at OurWorldinData.org. There you find the raw data, more visualizations, and research on this topic. Licensed under CC-BY-SA

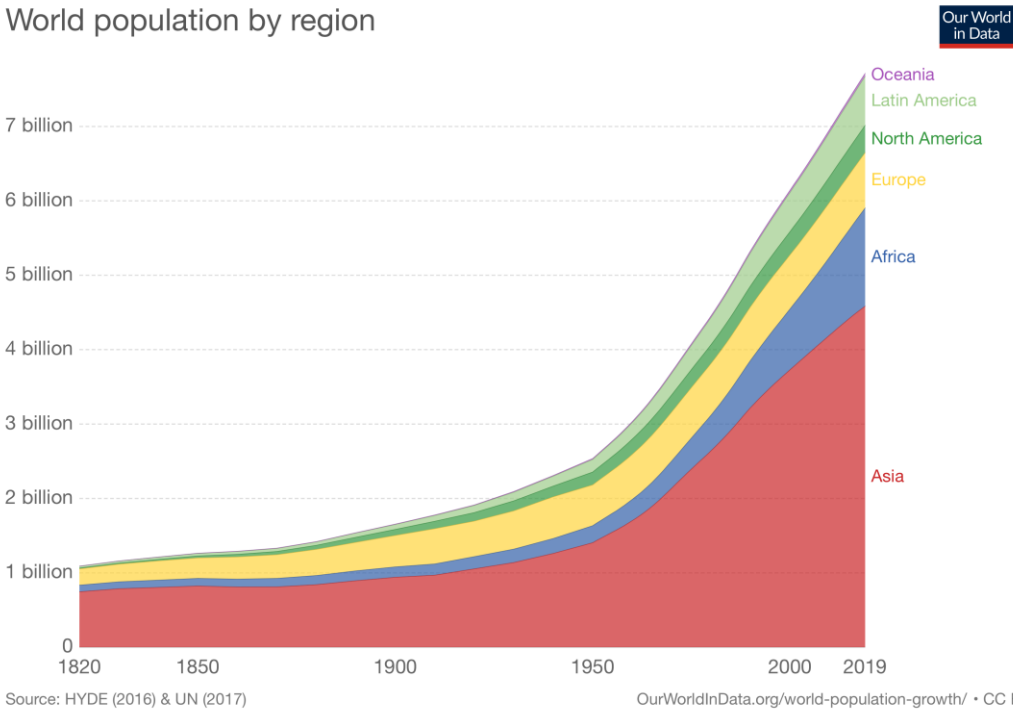


Data sources: Observations: US Census Bureau & Projections: United Nations Population Division (Medium Variant (2015 revision).
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.

WORLD POPULATION GROWTH

Current World Population

7,703,927,545



1	China	1,419,407,621	18,4%
2	India	1,366,815,573	36,2%
3	U.S.A.	328,789,141	40,4%
4	Indonesia	269,177,783	43,9%
5	Brazil	212,193,478	46,7%
6	Pakistan	204,099,709	49,3%
7	Nigeria	200,292,347	51,9%
8	Bangladesh	167,843,790	54,1%
9	Russia	143,904,558	56,0%
10	Mexico	132,122,600	57,7%

Country Overshoot Days 2018

When would Earth Overshoot Day land if the world's population lived like...

EARTH OVERSHOOT DAY

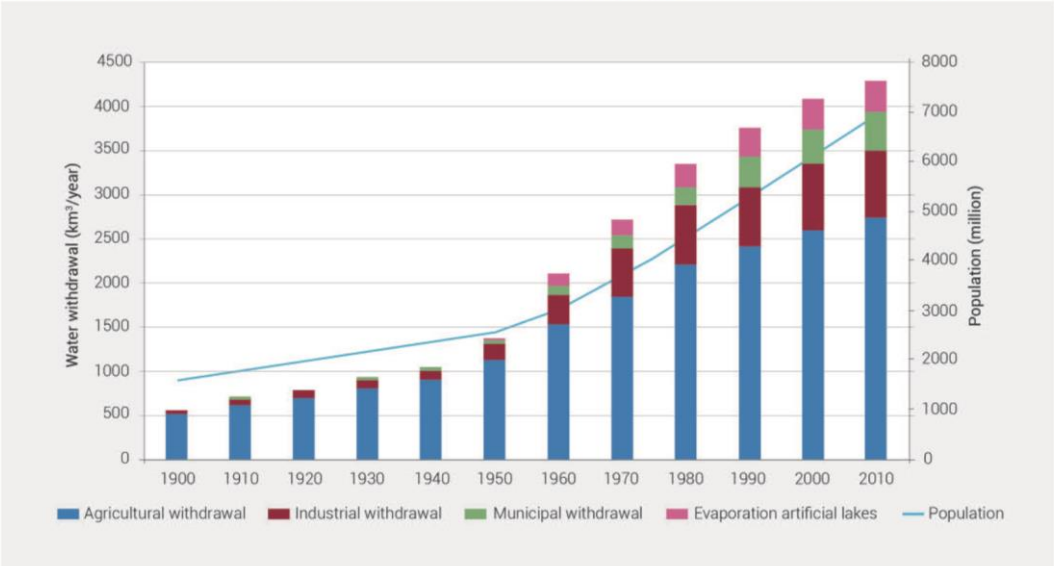
Source: Global Footprint Network National Footprint Accounts 2018

Global Footprint Network
Advancing the Science of Sustainability

WATER AVAILABILITY AND QUALITY

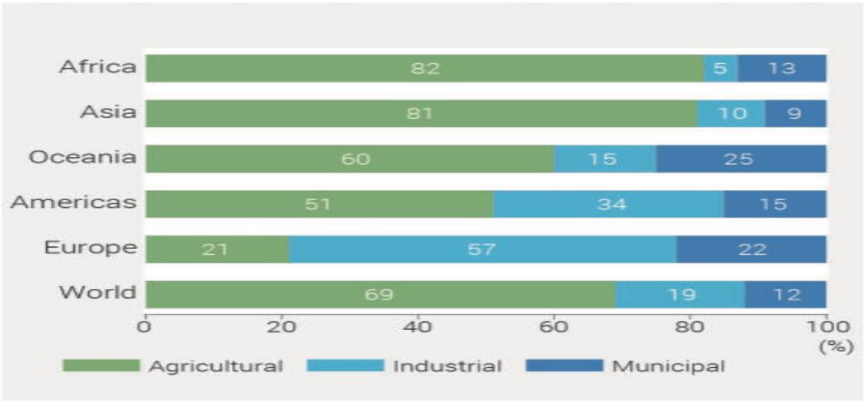
WATER WITHDRAW AND USES GROWTH

Figure 31. Water withdrawal and global population over time in agriculture, industry and municipalities, 1900–2010



Source: FAO (2

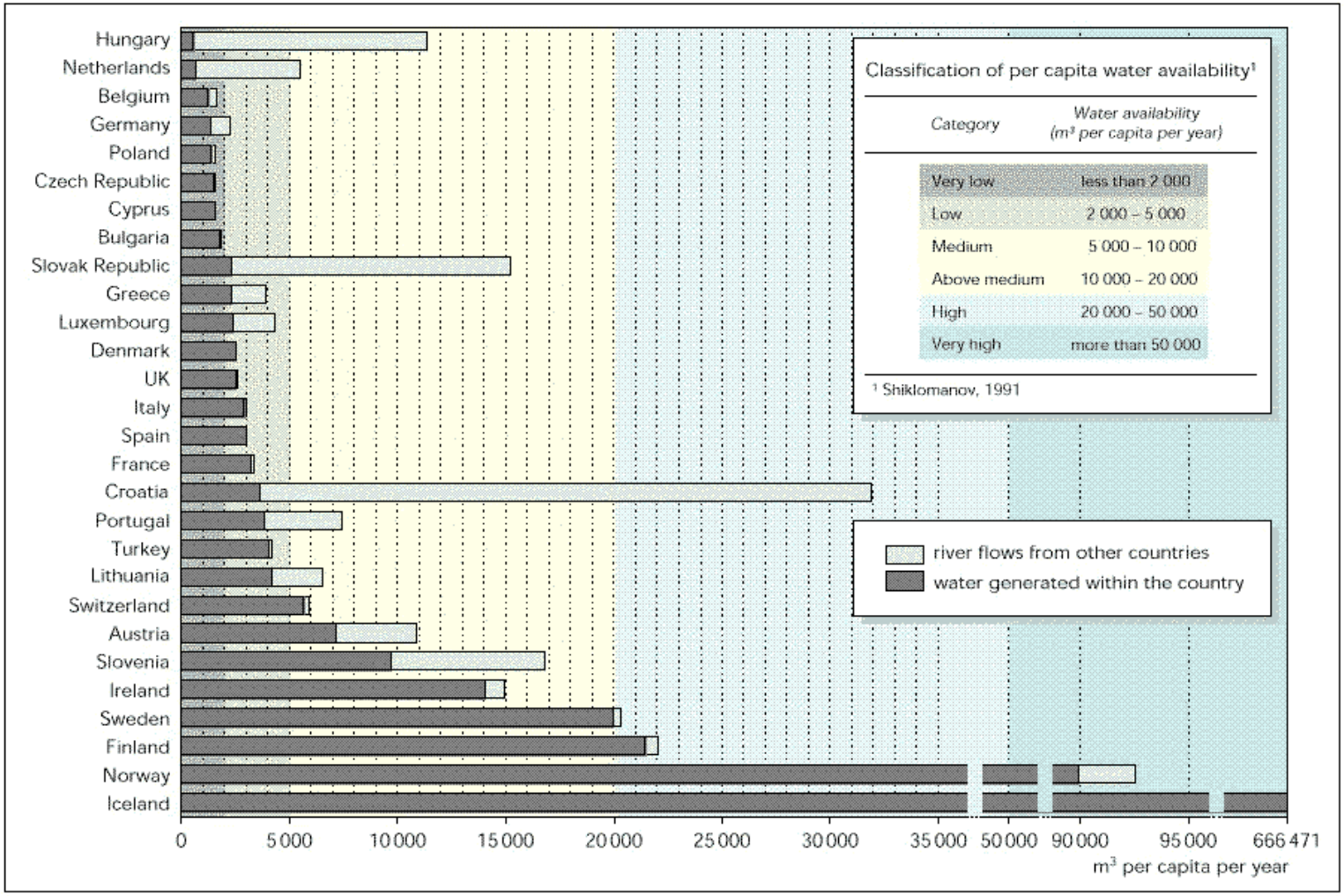
Figure 34. Water withdrawal ratios by continent



Source: FAO (2016a).

United Nations (2018). Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation. New York.

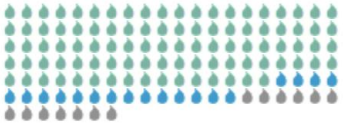
WATER AVAIABILITY IN EUROPE (m3/capita/year)



Global Average Water Footprint

1259 litre per pizza

76% green, 14% blue, 10% grey



255 litre for a glass of 250 ml

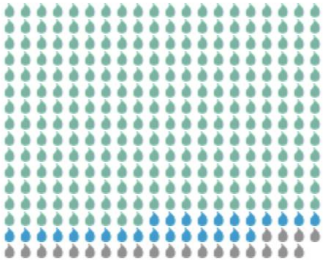
85% green, 8% blue, 7% grey

132 litre per cup of 125 ml

)6% green, 1% blue, 3% grey

3178 litre/kg

85% green, 8% blue, 7% grey



109 litre for a 125ml glass of wine

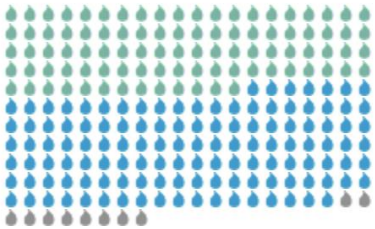
70% green, 16% blue, 14% grey

74 litre for a glass of 250 ml

85% green, 6% blue, 9% grey

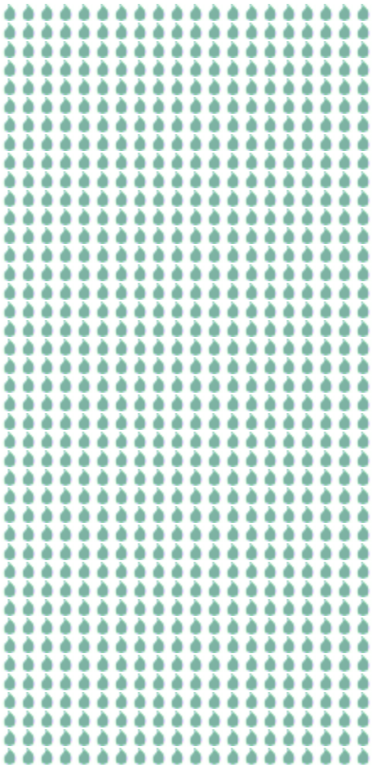
2277 litre/kg

41% green, 55% blue, 4% grey



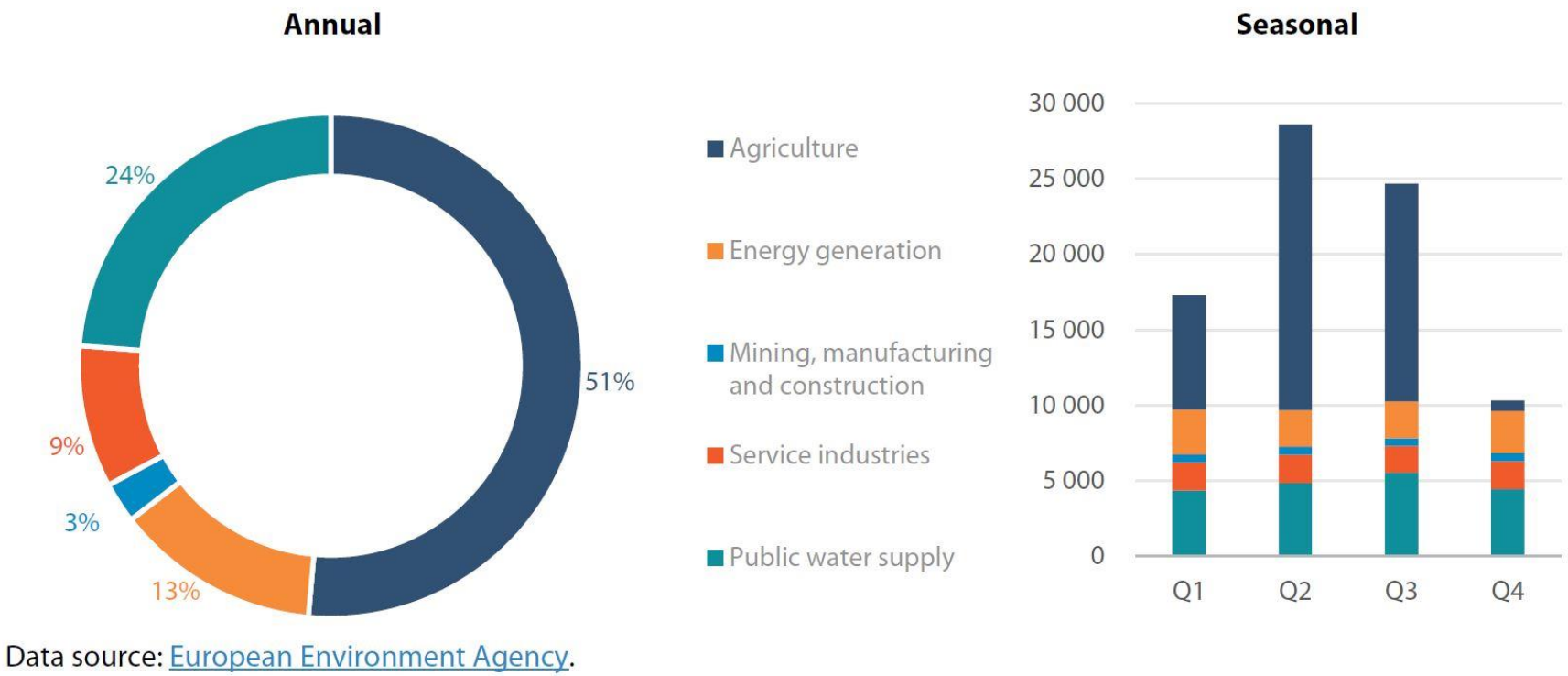
17196 litre/kg

98% green, 1% blue, 1% grey



Water use by economic sectors in Europe

Water use by sector in the EU (2014, hm^3)



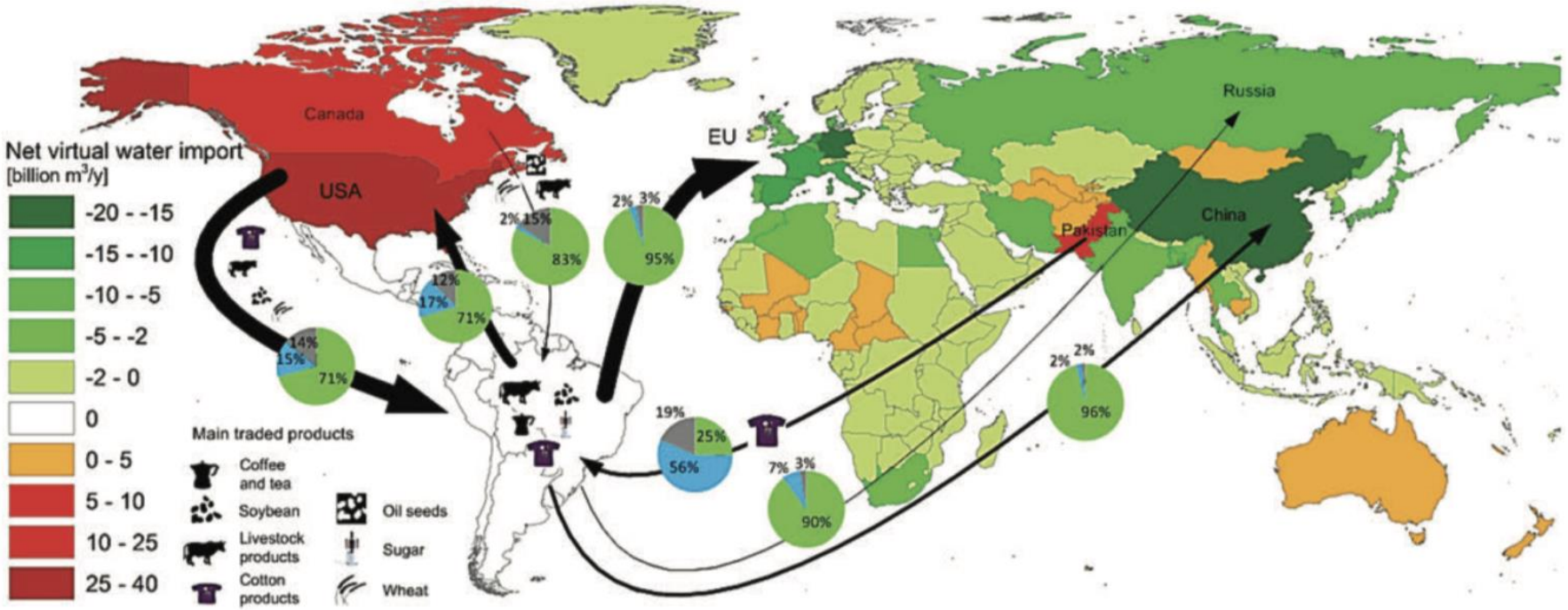
Data source: European Environment Agency.

Source: European Environmental Agency

Data coverage: EEA Member countries: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom

Cooperating countries: Albania, Montenegro, Serbia, the Former Yugoslav Republic of Macedonia

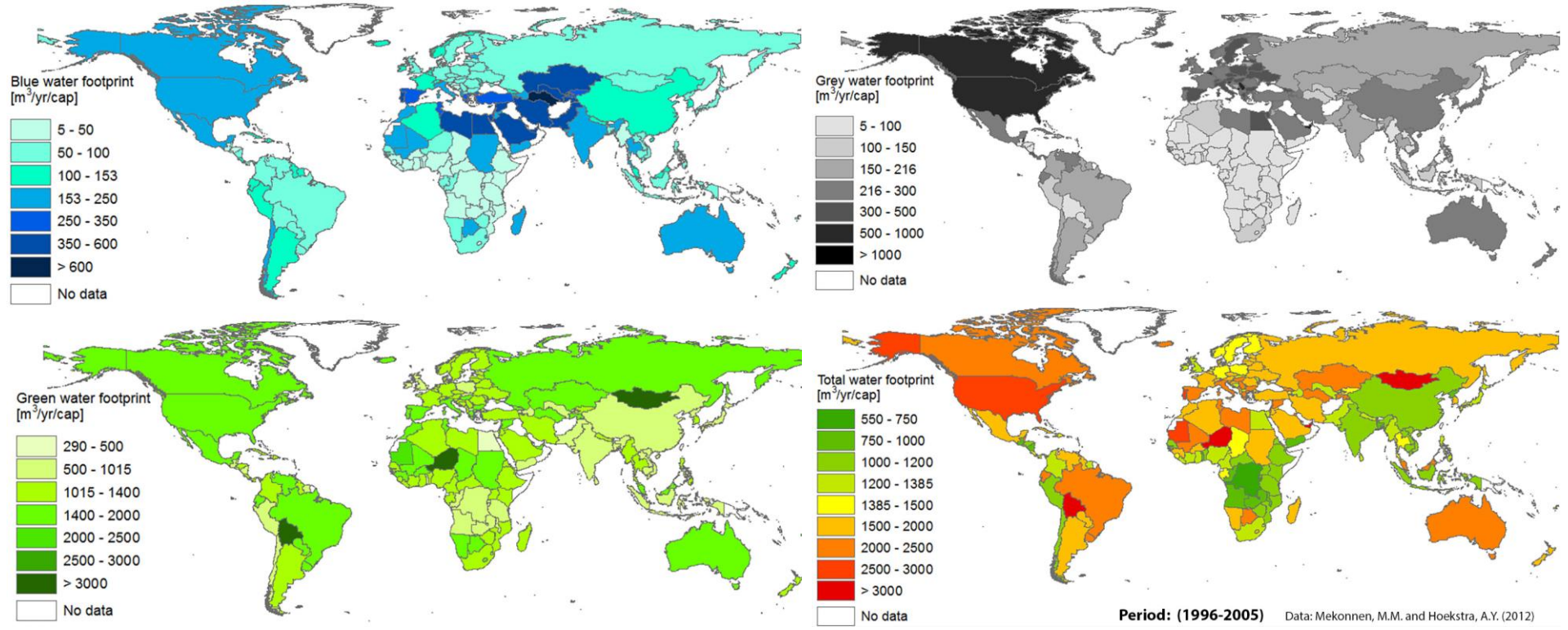
Net virtual water import and export related to imports of agricultural and industrial products from (green) and to (red) Latin America and the Caribbean



Period of 1996-2005 (only the largest gross virtual water flows (> 10 billion m3/y)
Source: Mekonnen et al. (2015)

United Nations (2018). Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation. New York.

Blue, Green, Grey and Total Water Footprint (m3/year/capita)



Source: Mekonnen, M.M. and Hoekstra, A.Y. (2012)

blue water footprint - volume of surface and groundwater consumed (evaporated) as a result of the production of a good;

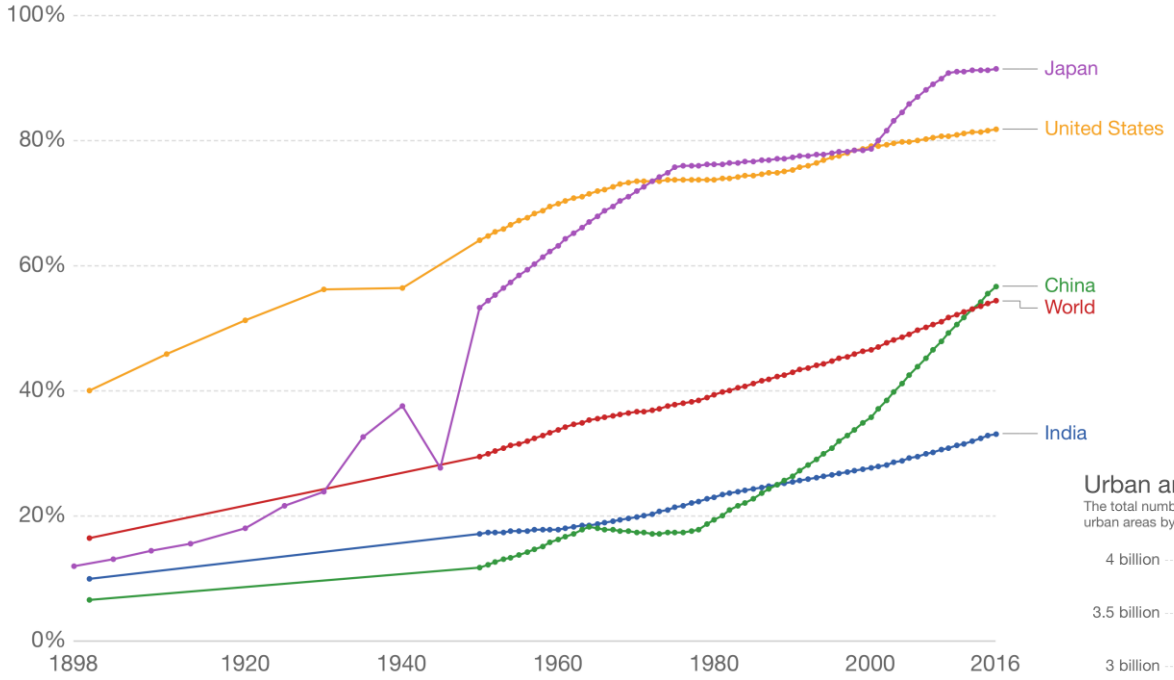
green water footprint - rainwater consumed.

grey water footprint - volume of freshwater required to assimilate the load of pollutants based on existing ambient water quality standards.

NATURAL AND URBAN ENVIRONMENT

Urbanization over the past 500 years

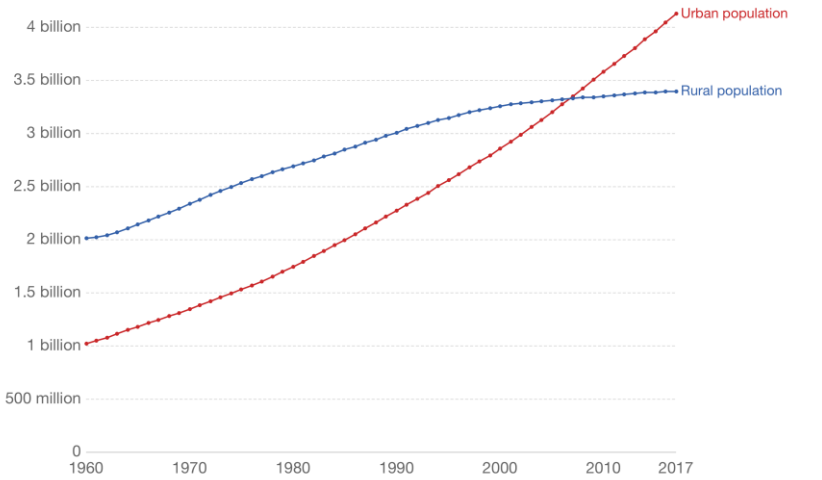
Share of the total population living in urban areas. Urban areas are based on national definitions and may vary by country.



Source: OWID based on UN World Urbanization Prospects 2018 and historical sources (see Sources)

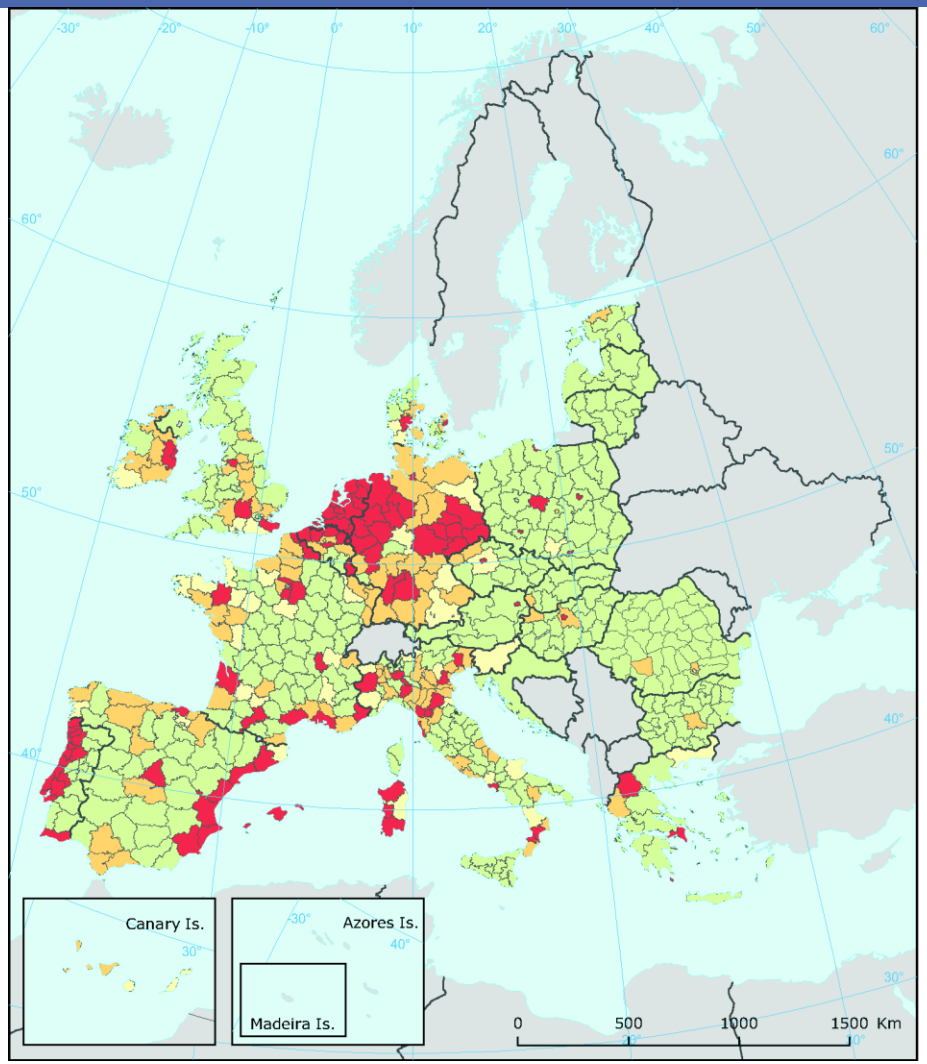
Urban and rural population, World

The total number of people living in urban or rural areas. Urban populations are defined based on the definition of urban areas by national statistical offices.



Source: World Bank, based on UN estimates

Deviation from average of the Urban sprawl (1990-2000)



Agriculture to artificial land

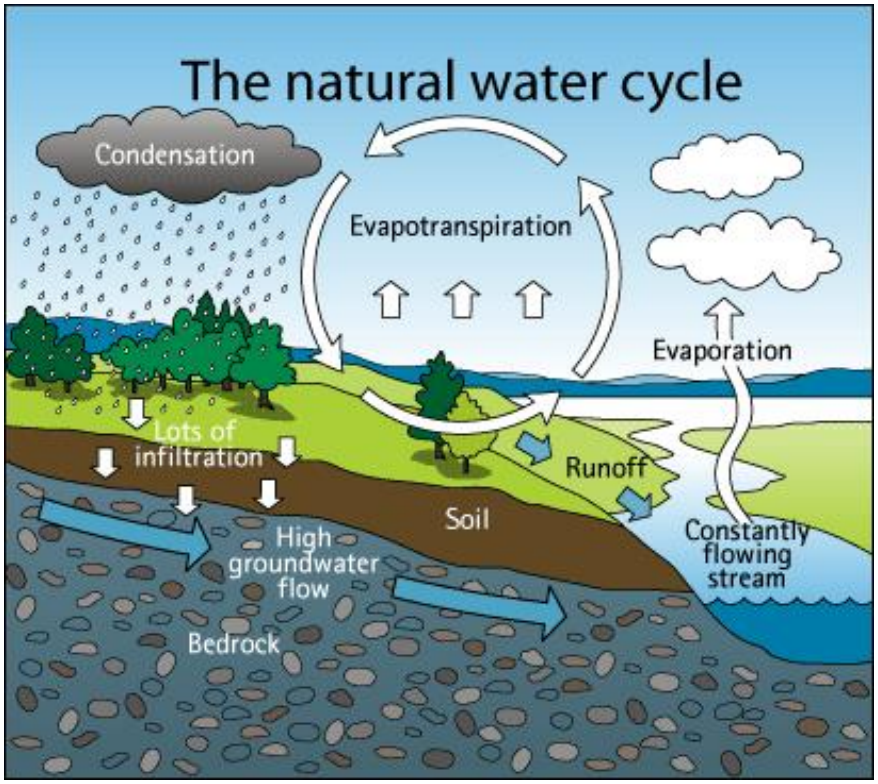
% difference to European mean value

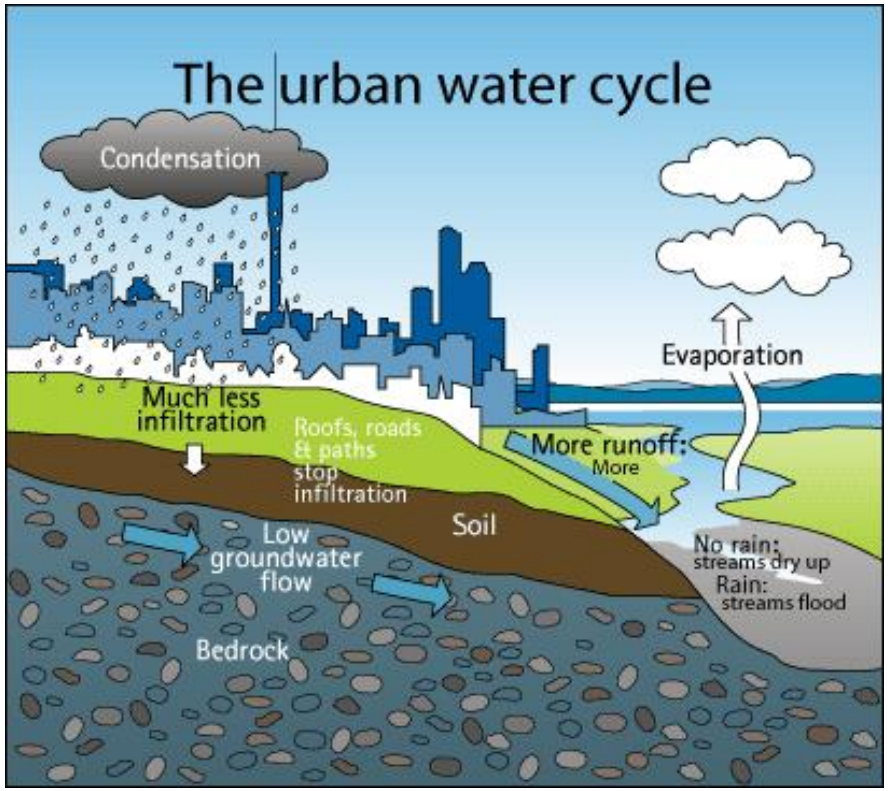
- < – 10
- – 10–10
- 10–100
- > 100
- NUTS region (*)
- Outside data coverage

(*) NUTS 2: Austria, Belgium, Germany, Greece, the Netherlands and the United Kingdom
NUTS 3: Bulgaria, Czech Republic, Denmark, Estonia, France, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia and Spain
NUTS 0: Croatia, Luxembourg and Slovenia

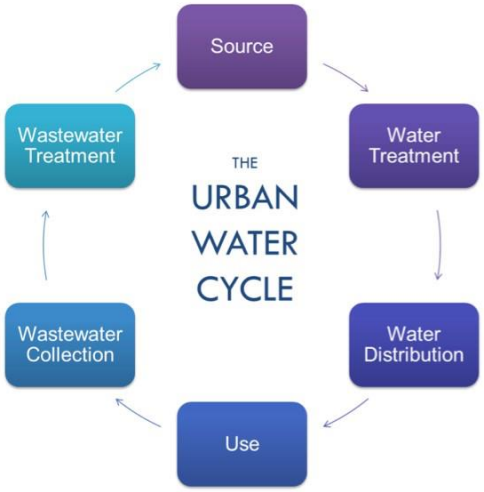
represented by NUTSX (NUTS3, NUTS2 mainly, NUTS0 in a few cases)

Source: European Environment Agency





(Source: Auckland Council)



Water Distribution: "Closed system" Controled by downstream

Wastewater Drainage: "Open System" Controled by upstream

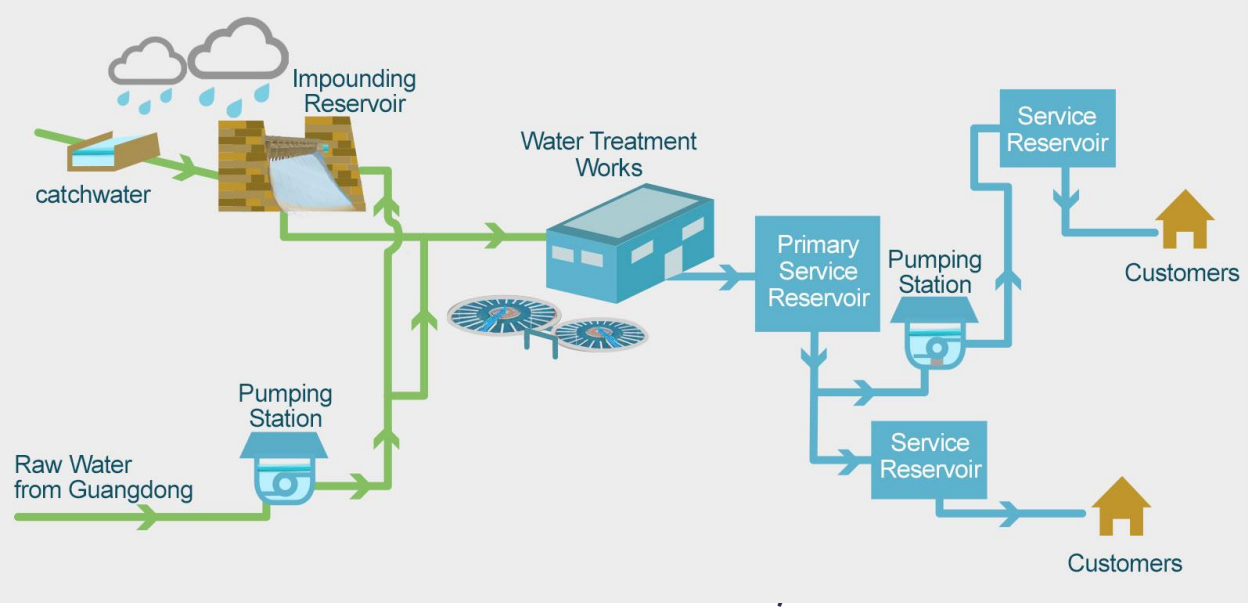


Figure 4.12 Current and projected levels of wastewater treatment in Europe

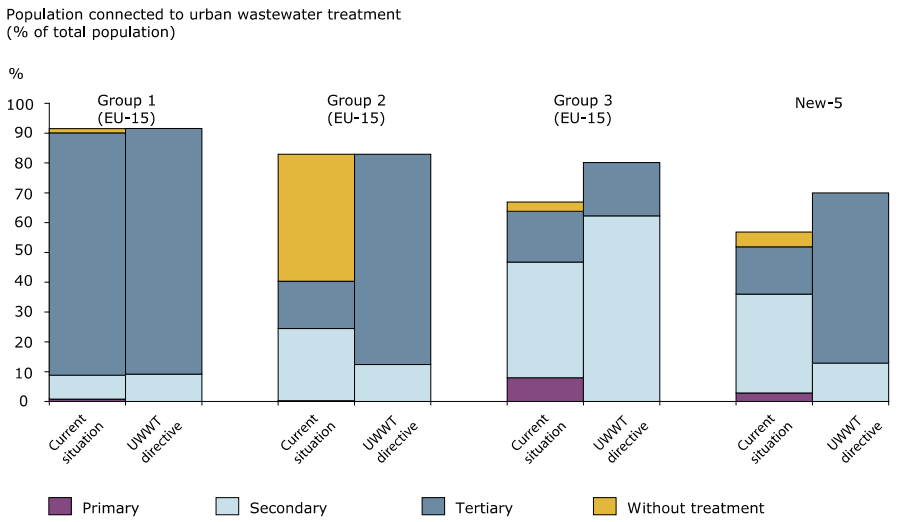
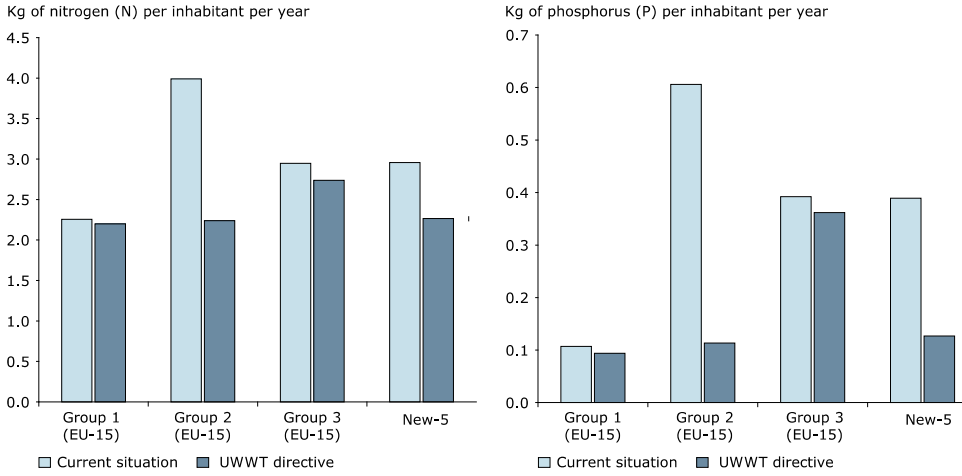


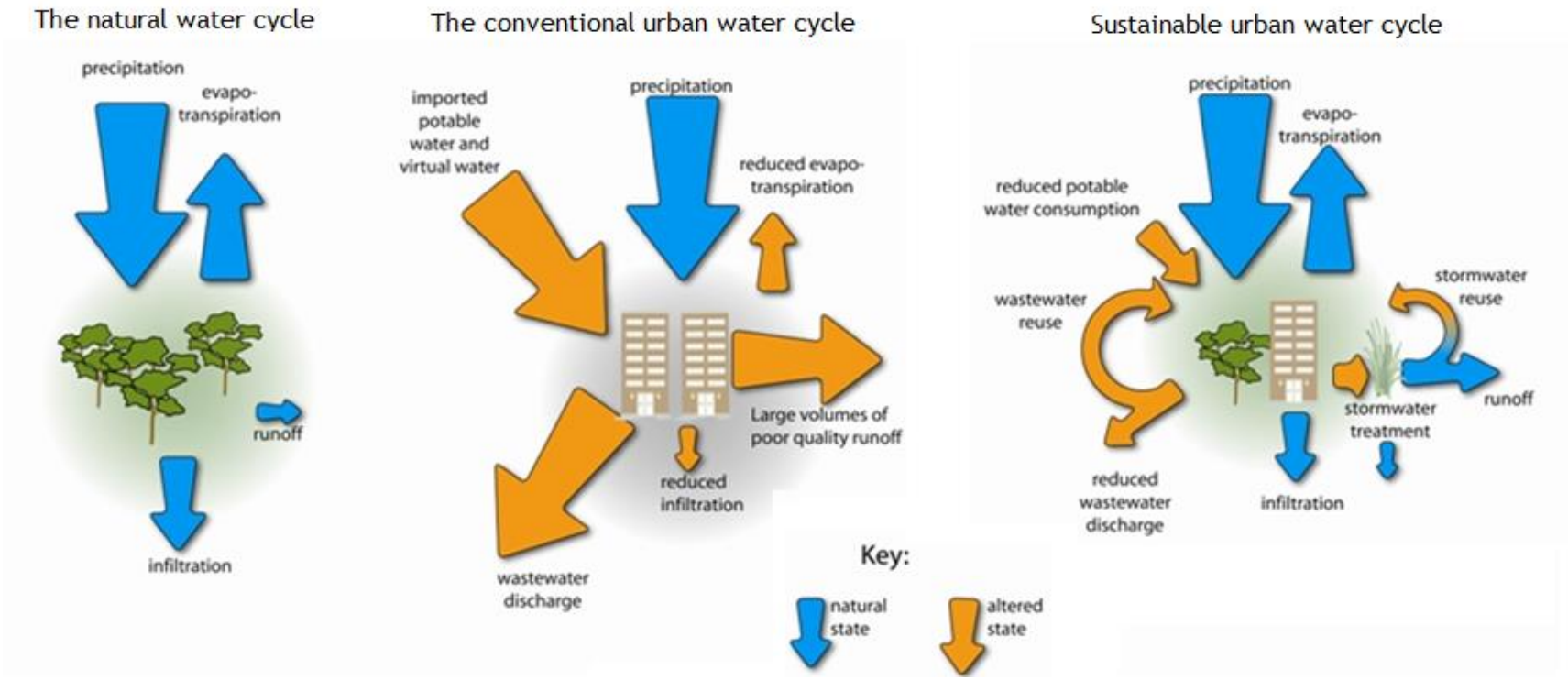
Figure 4.13 Discharges of nitrogen and phosphorous from wastewater treatment plants



Group 1 (EU-15) countries: the Netherlands, Germany, Austria, Denmark, Sweden, Finland.
Group 2 (EU-15) countries: Belgium and Luxembourg.
Group 3 (EU-15) countries: France, Ireland, Italy, Greece, Portugal, Spain.
New-5 countries: Estonia, Czech Republic, Poland, Hungary and Slovenia.

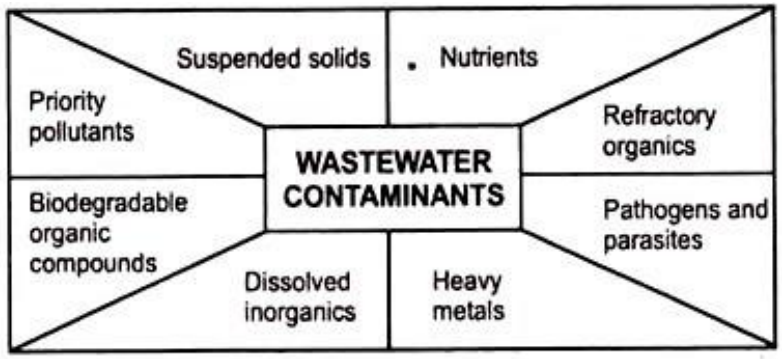
European Environment Agency (2005). European environment outlook. 87 pp. ISBN 92-9167-769-8

NATURAL AND URBAN ENVIRONMENT
SUSTAINABLE URBAN DRAINAGE SYSTEMS



Categories of contaminants in urban water

Urban Wastewater



Urban runoff

Pollutant		Urban runoff (1)	Highway runoff (2)	Roof runoff (3)	Atm. deposition, % (3)	Attached to SS, % (3, 4)	Drinking water std. (5)
SS	mg/ℓ	30-100	30-60	5-50			
COD		40-60	25-60	less	19	75	
Tot.N		2	1-2	less	70		11.3*
Tot.P		0.5	0.2-0.5	less	23	50	0.15
Pb	µg/ℓ	50-150	50-125	10-100	40	70-80	50
Zn		300-500	125-400	100-1000	30	30-40	100
Cd		0.5-3				70	5
Cu		5-40	5-25	10-100	7	30-40	100

(1) PH-Consult, 1990 (2) Hvitved-Jacobsen et al., 1992 (3) Malmquist, 1982 (4) Johansen, 1985
(5) DME, 1988

* Limit value specified as NO_3-N

Wastewater (continuos)

Microorganisms

Nutrients (N,P)

Metals

Inorganic substances

Biodegradable organic substances

Odor

Heat

Wastewater (intermittent)

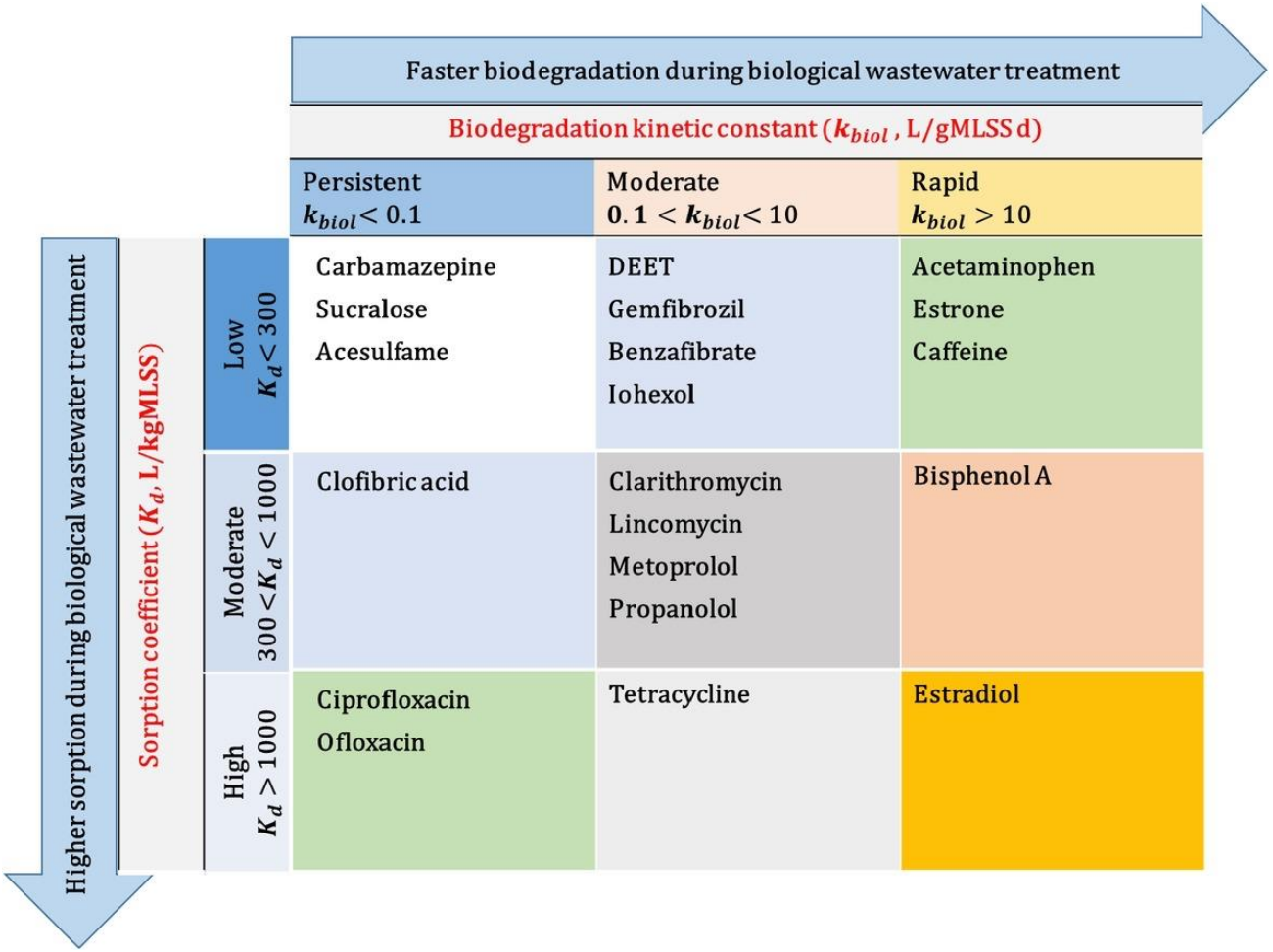
Nutrients (N,P)

Metals (Zn, Cu, Cr, Cd, Pb)

Inorganic substances

Heat

Occurrence and fate of emerging contaminants in municipal wastewater treatment plants



Ngoc Han Tran, Martin Reinhard, Karina Yew-Hoong Gin (2018) Occurrence and fate of emerging contaminants in municipal wastewater treatment plants from different geographical regions-a review, Water Research, Volume 133, Pages 182-207, ISSN 0043-1354, https://doi.org/10.1016/j.watres.2017.12.029.

Contaminants fate in environment

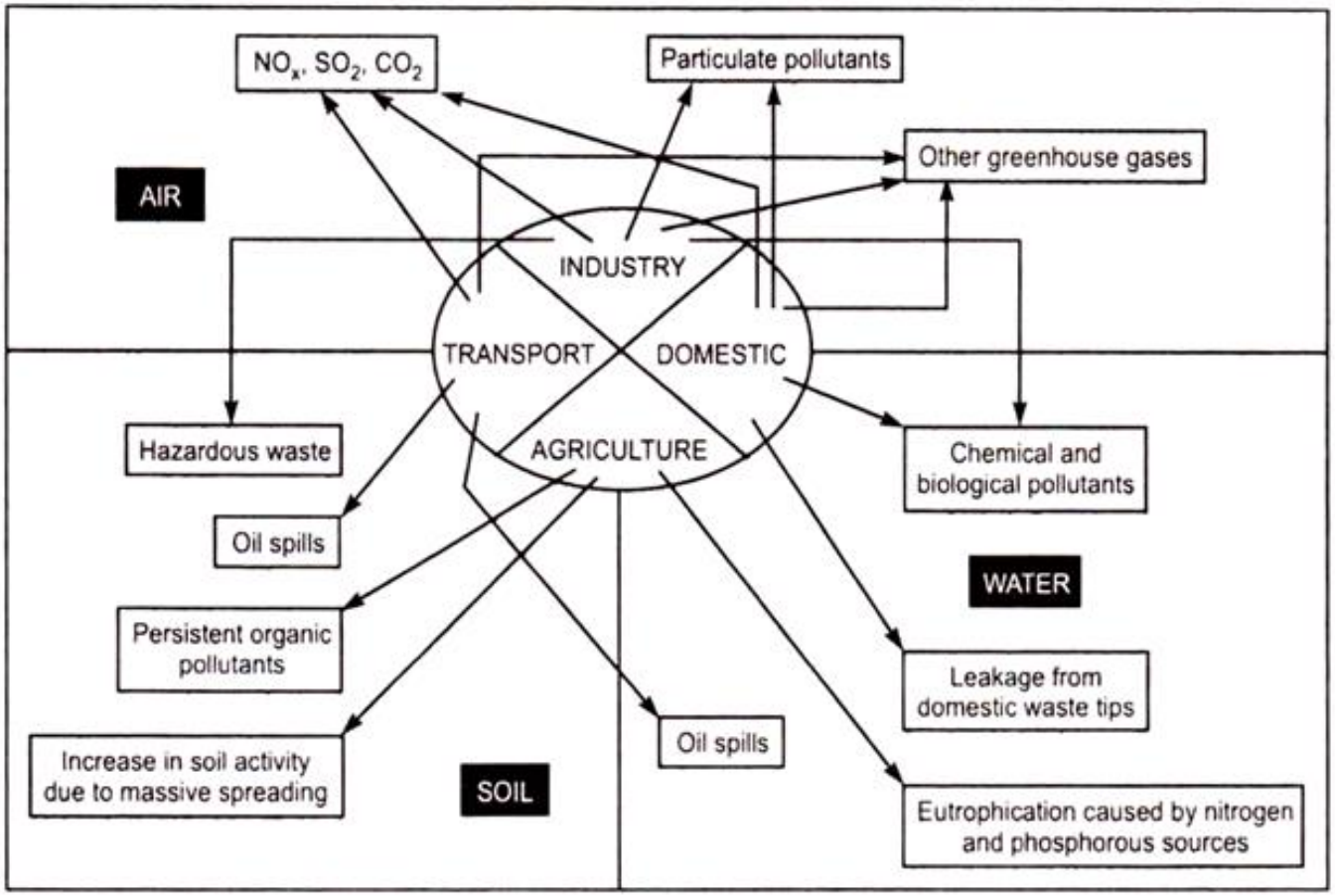
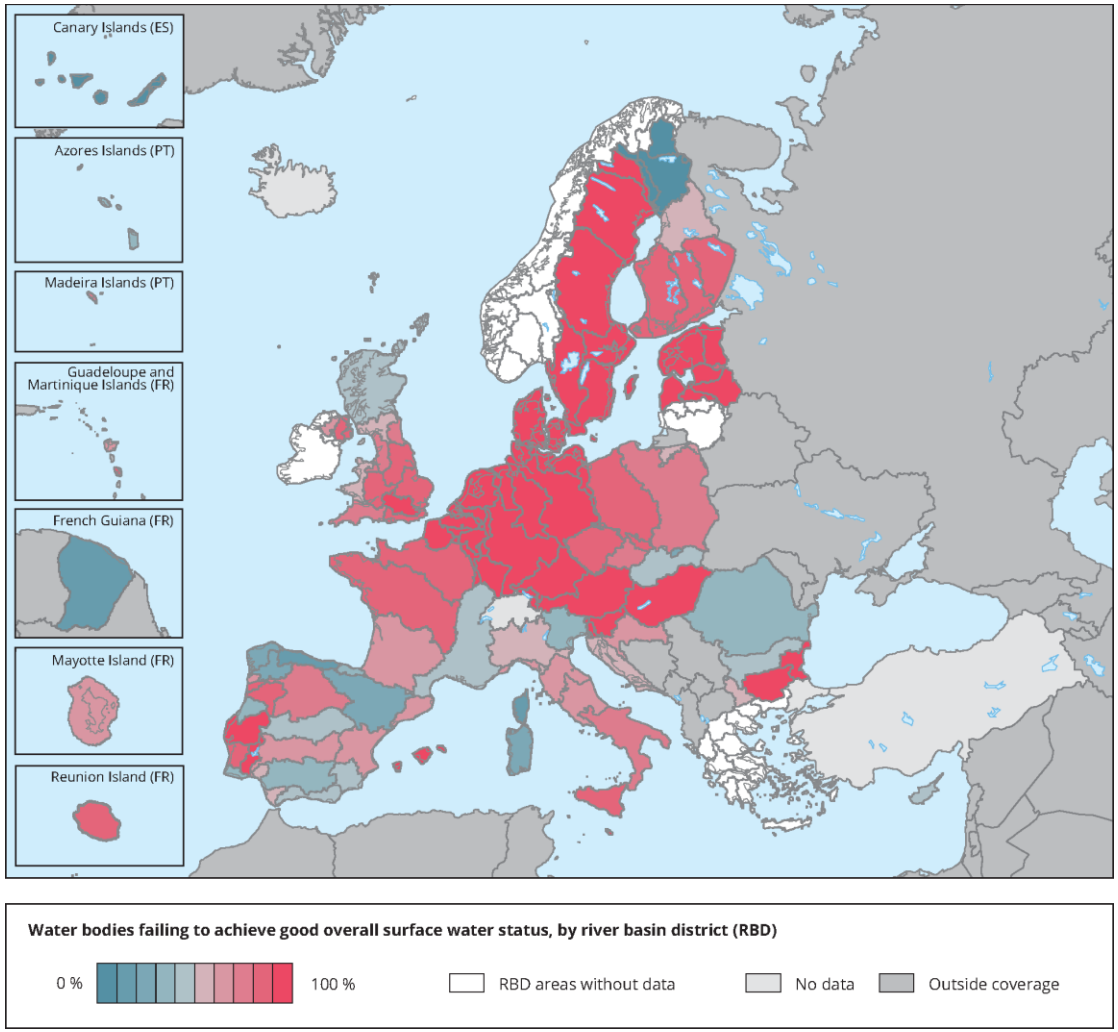
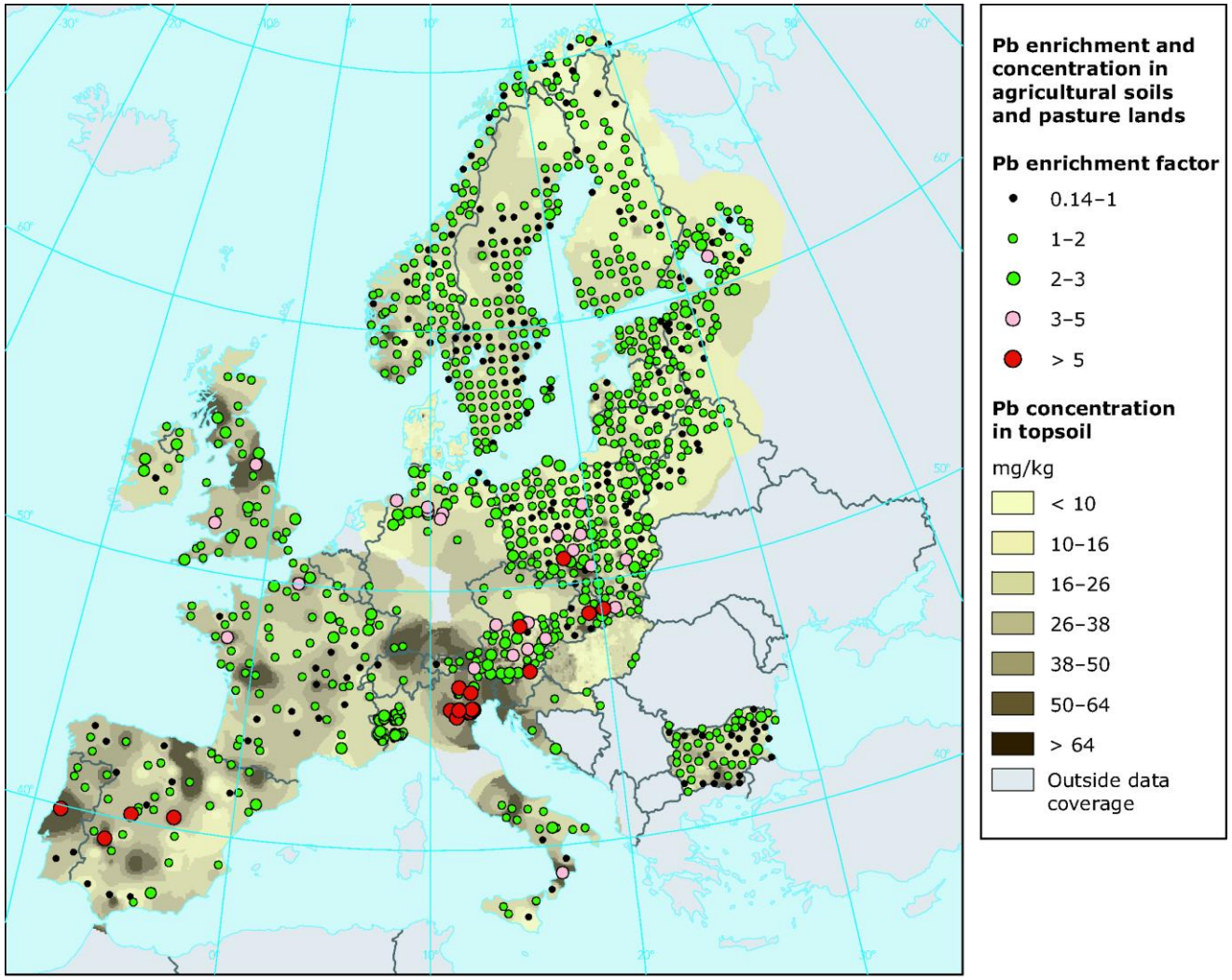


Fig. 16.1: The spider of environmental pollution due to anthropogenic activities. (Adapted from EIBE 2000)

Water bodies failing to achieve good status (%)



Source: European Environment Agency

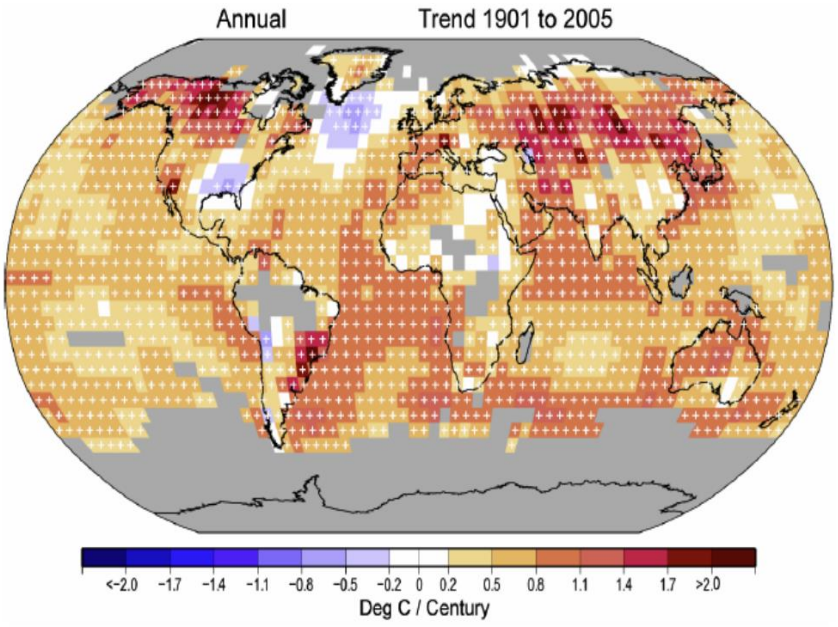


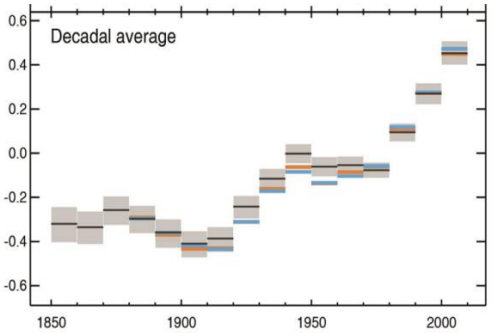
Source: European Environment Agency

FUTURE CHALLENGES

Observed change in the climate system:

Recent warming of the planet is unequivocal and unprecedented

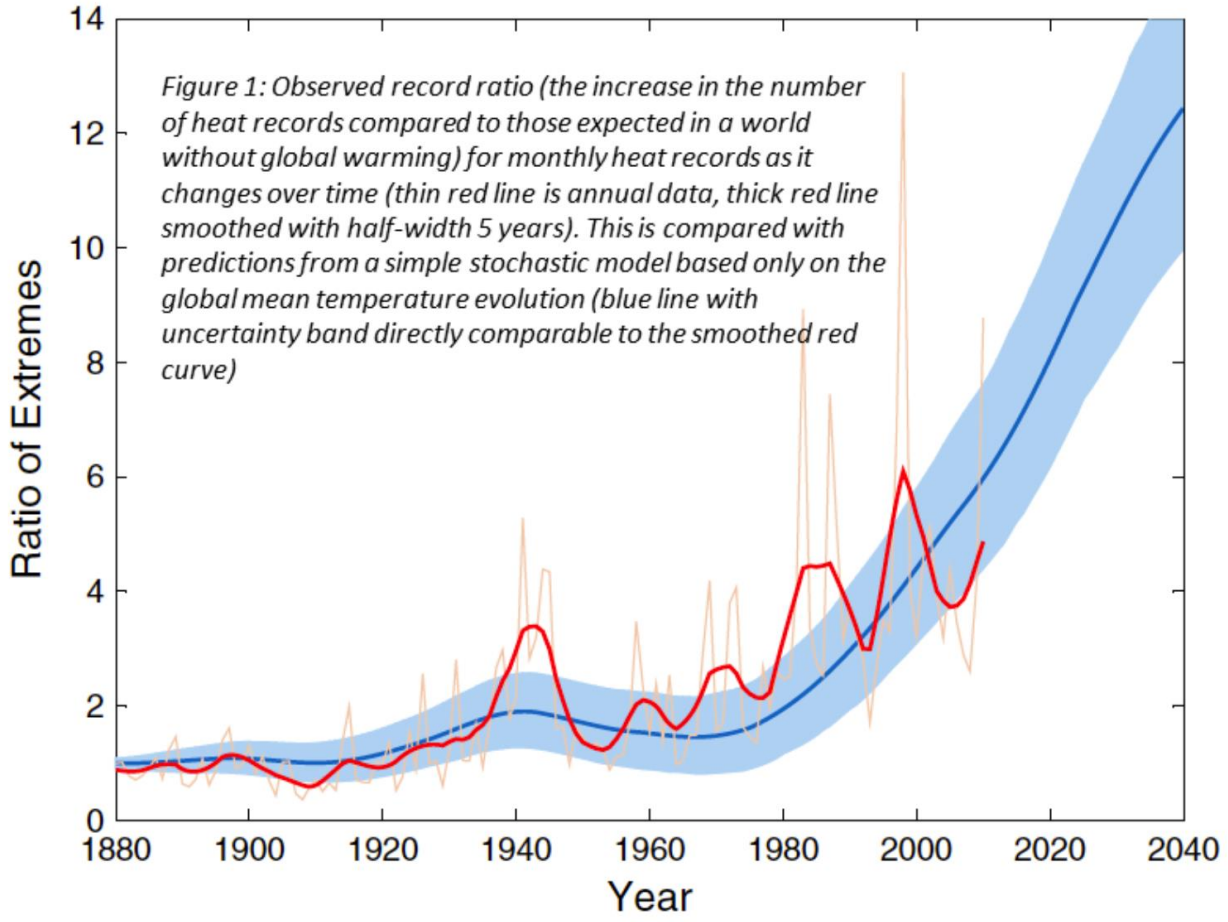




The Earth surface temperature has been successively warmer in the last three decades than in any previous decade since 1850

The planet is over 1°C warmer than it was in 1860, but there are substantial geographic differences in the rate of warming

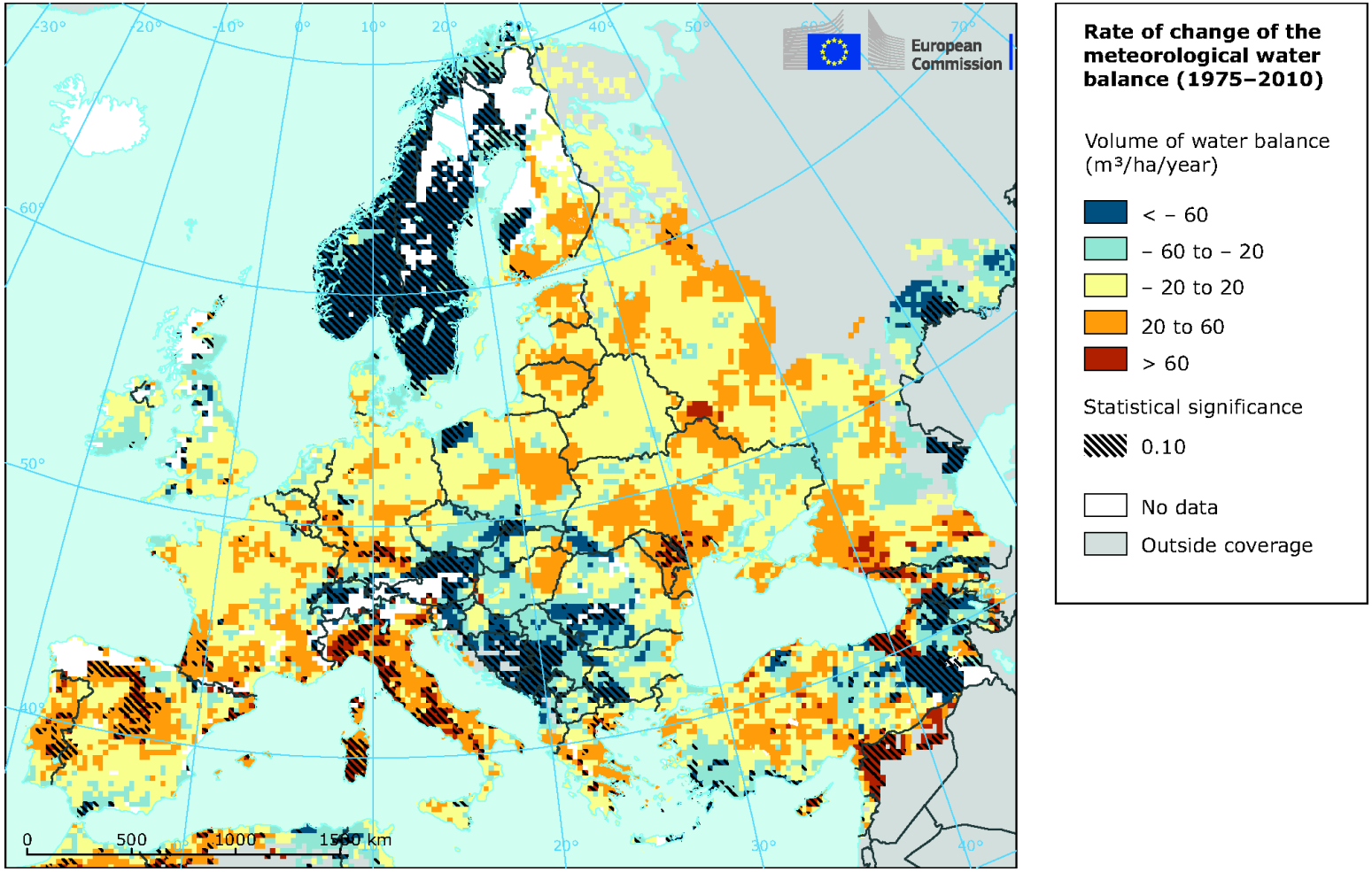
Global increase in monthly-mean temperature



Climatic Change January 2013 Global increase in record-breaking monthly-mean temperatures Dim Coumou, et al

- Fonte: Climate emergency institute

CLIMATE CHANGE – METEOROLOGICAL WATER BALANCE



Source: European Environment Agency

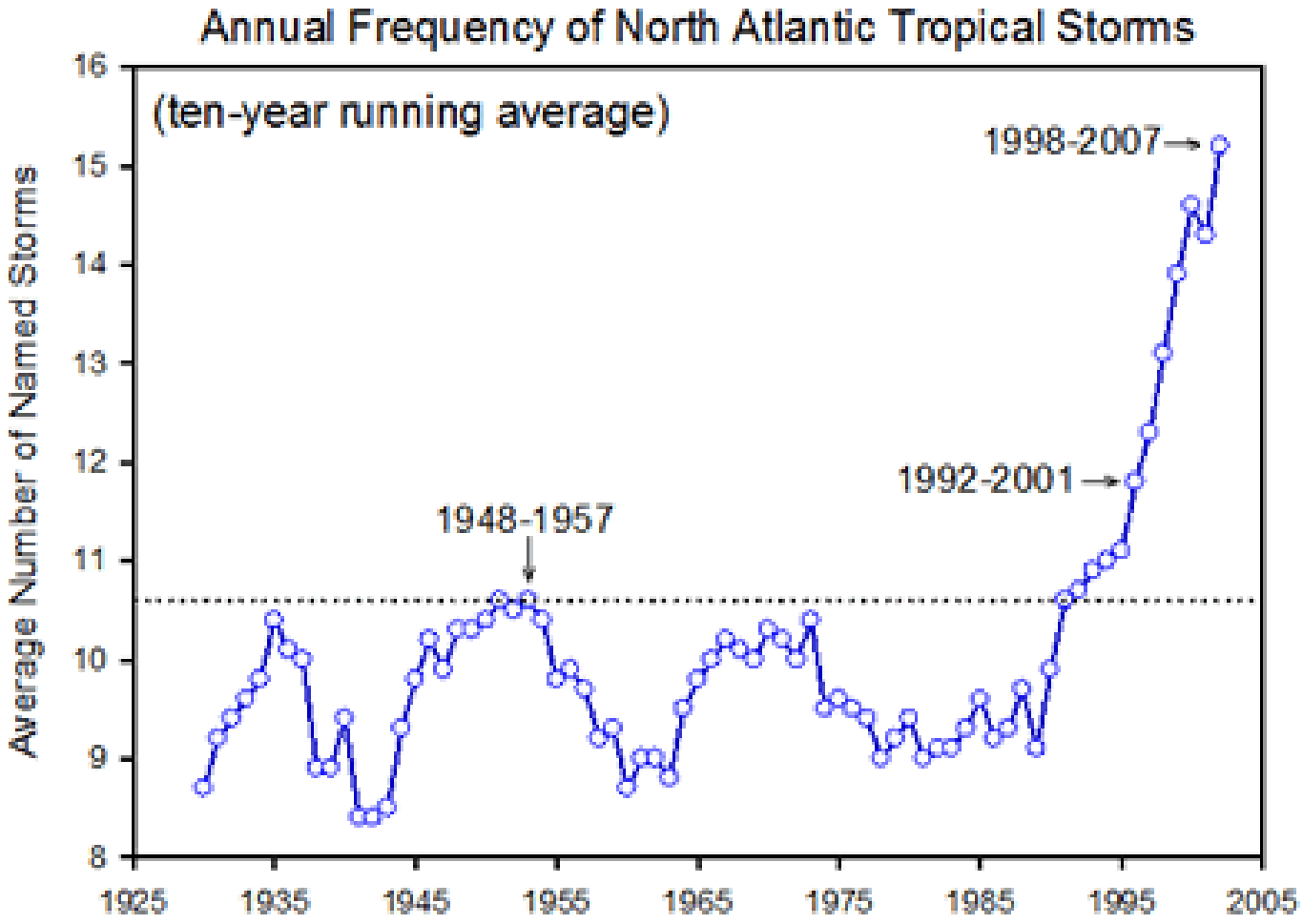
CLIMATE CHANGE

CLIMATE CHANGE

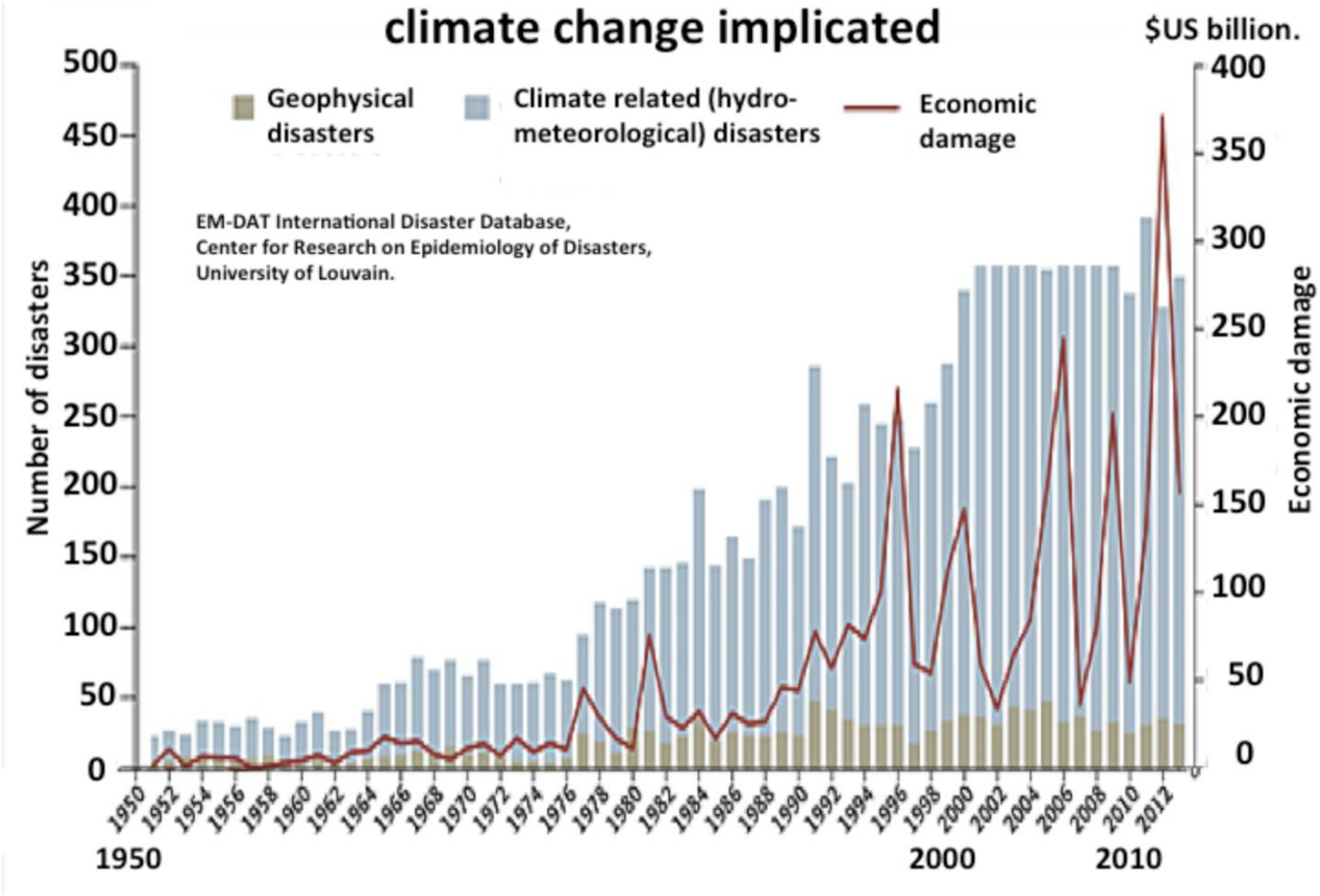
CLIMATE CHANGE

CLIMATE CHANGE

Annual Frequency of Storm events



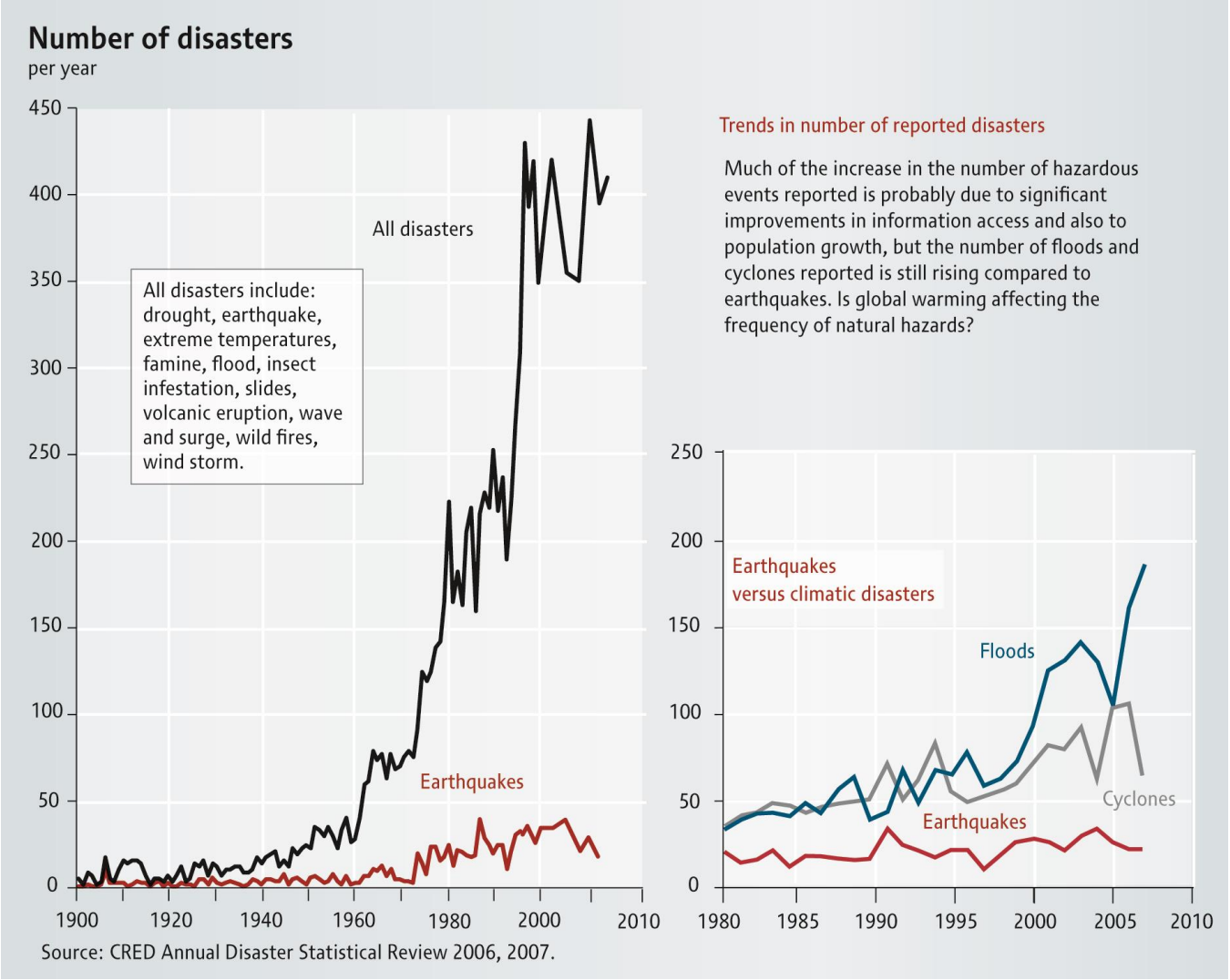
Disasters and Economic damage



Fonte: Climate emergency institute

CLIMATE CHANGE

Number of reported disasters



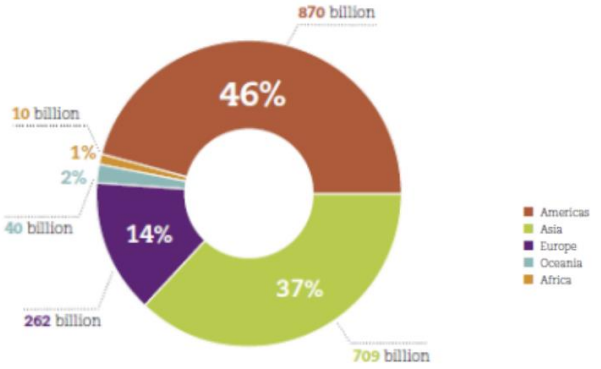
Climate-related Disasters (GAR,2015)

GREEN CLIMATE FUND

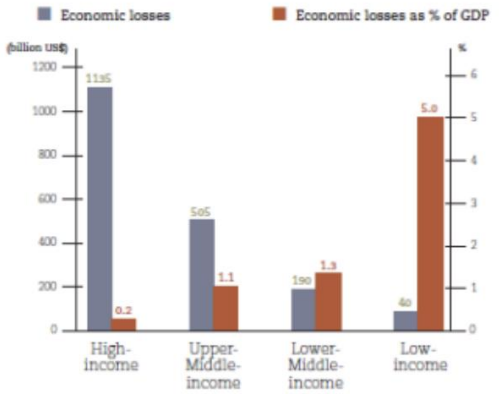
Climate related disasters are on the rise:

- **About 90% of natural disasters**
- **About 90% of casualties**
- **About 70% of economic losses**

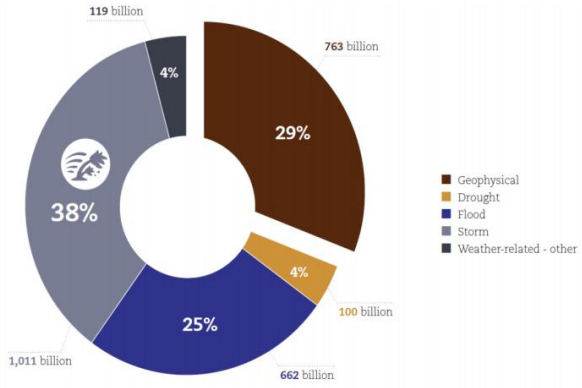
Climate related-disasters will continue to rise as climate change gathers pace



Economic damage (US$) per region (1995-2015)



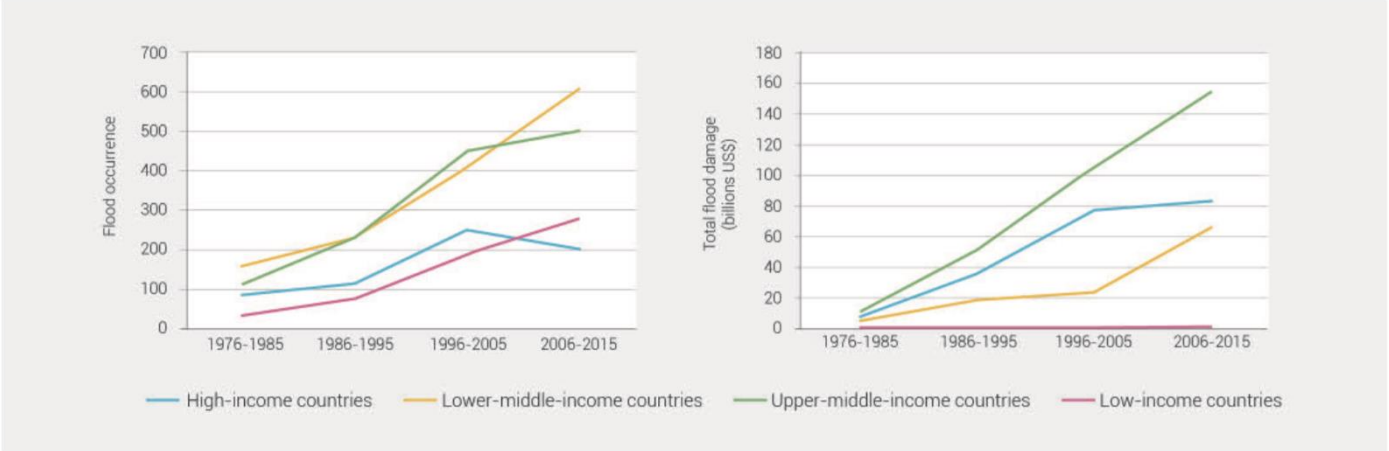
Economic losses (absolute and as % of GDP, 1995-2015)



Economic damage (US$) per disaster (1995-2015)

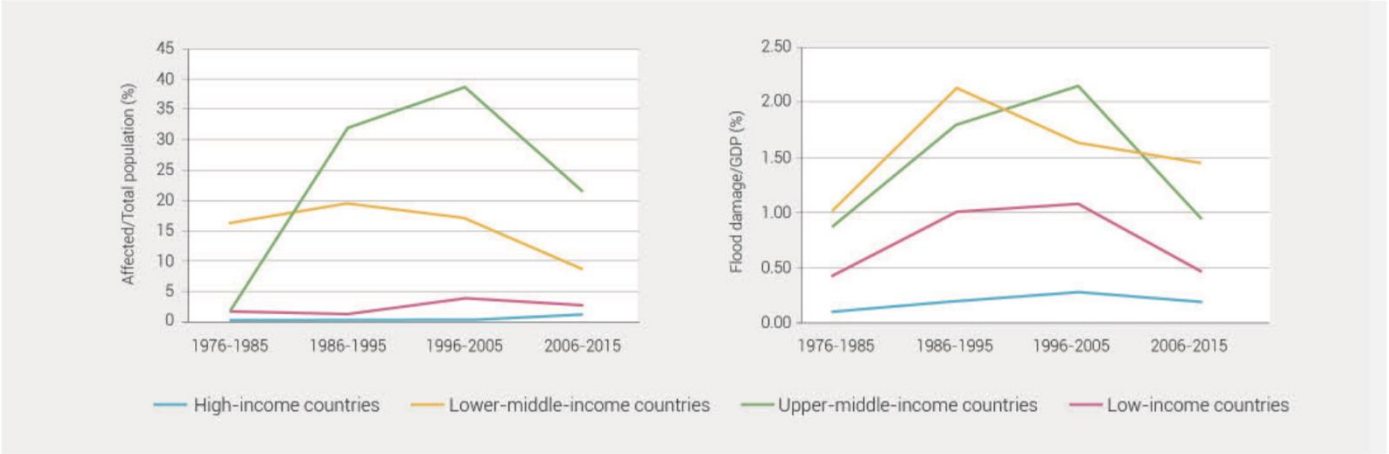
Flood occurrence and economic damage over time

Figure 37. Flood occurrence (left) and economic damage (right) increase over time



Data sources: CRED (n.d.); United Nations, Department of Economic and Social Affairs, Population Division (2017a); United Nations, Statistics Division (n.d.).

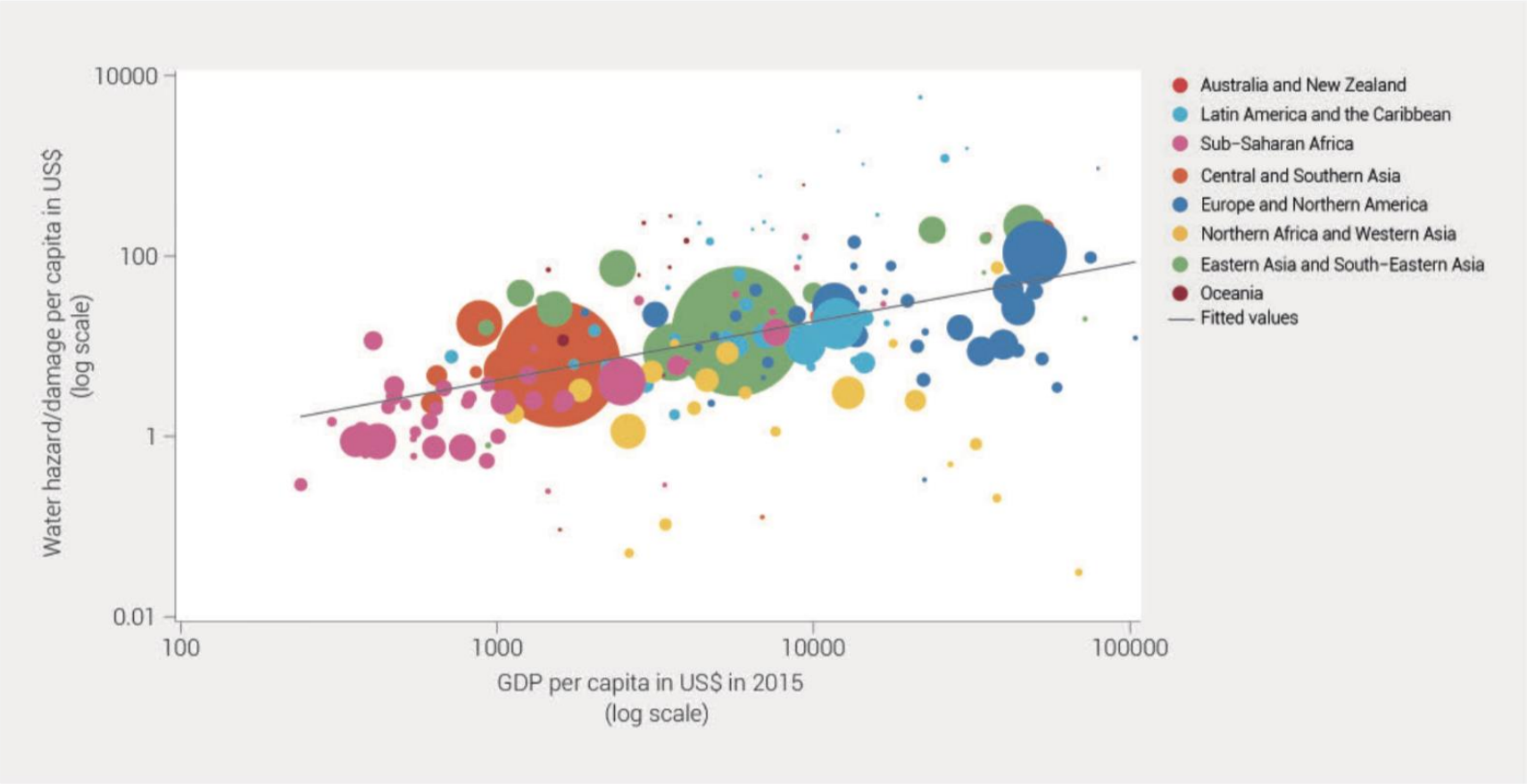
Figure 38. Percentage change in flood-affected population (left) and flood damage percentage of GDP (right) over time



Data sources: CRED (n.d.); United Nations, Department of Economic and Social Affairs, Population Division (2017a); United Nations, Statistics Division (n.d.).

Water Hazard damages

Figure 39. Relationship between water hazard damage per capita and GDP, 2015

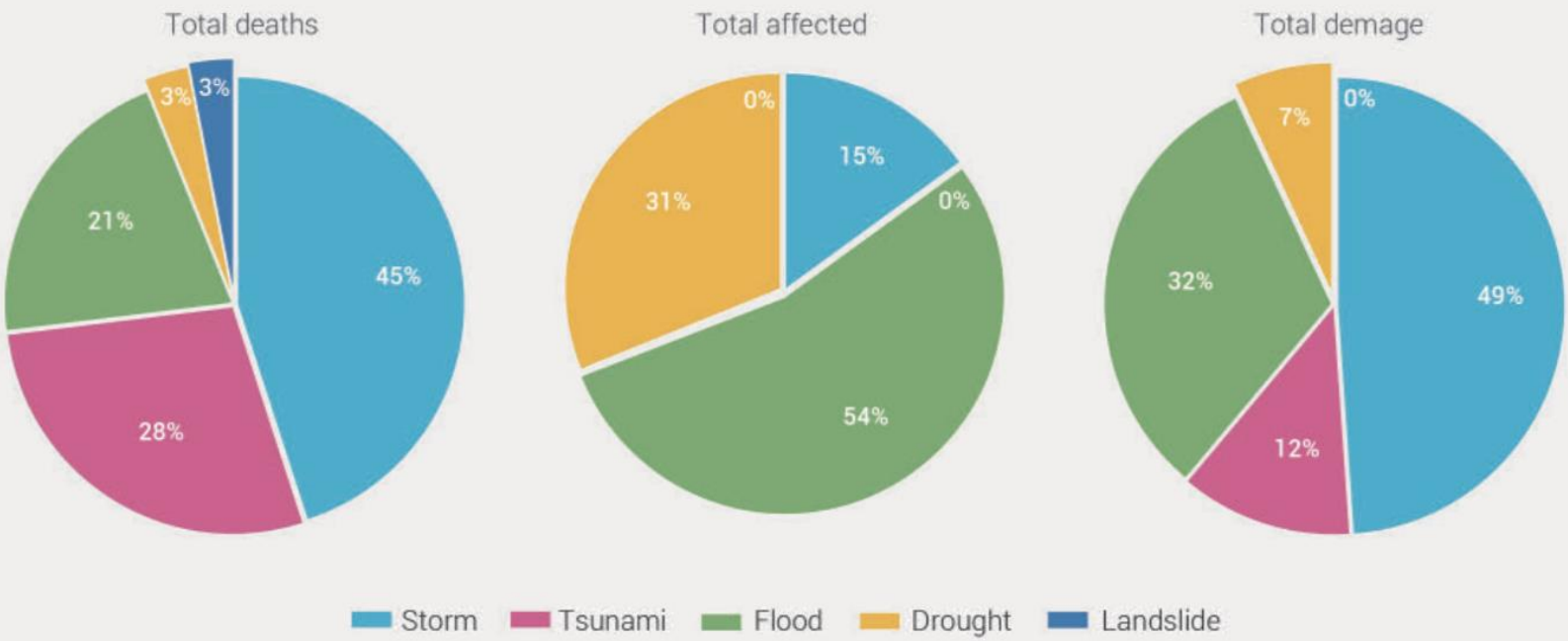


Data source: World Bank (2018).

CLIMATE CHANGE

Water Hazard damages

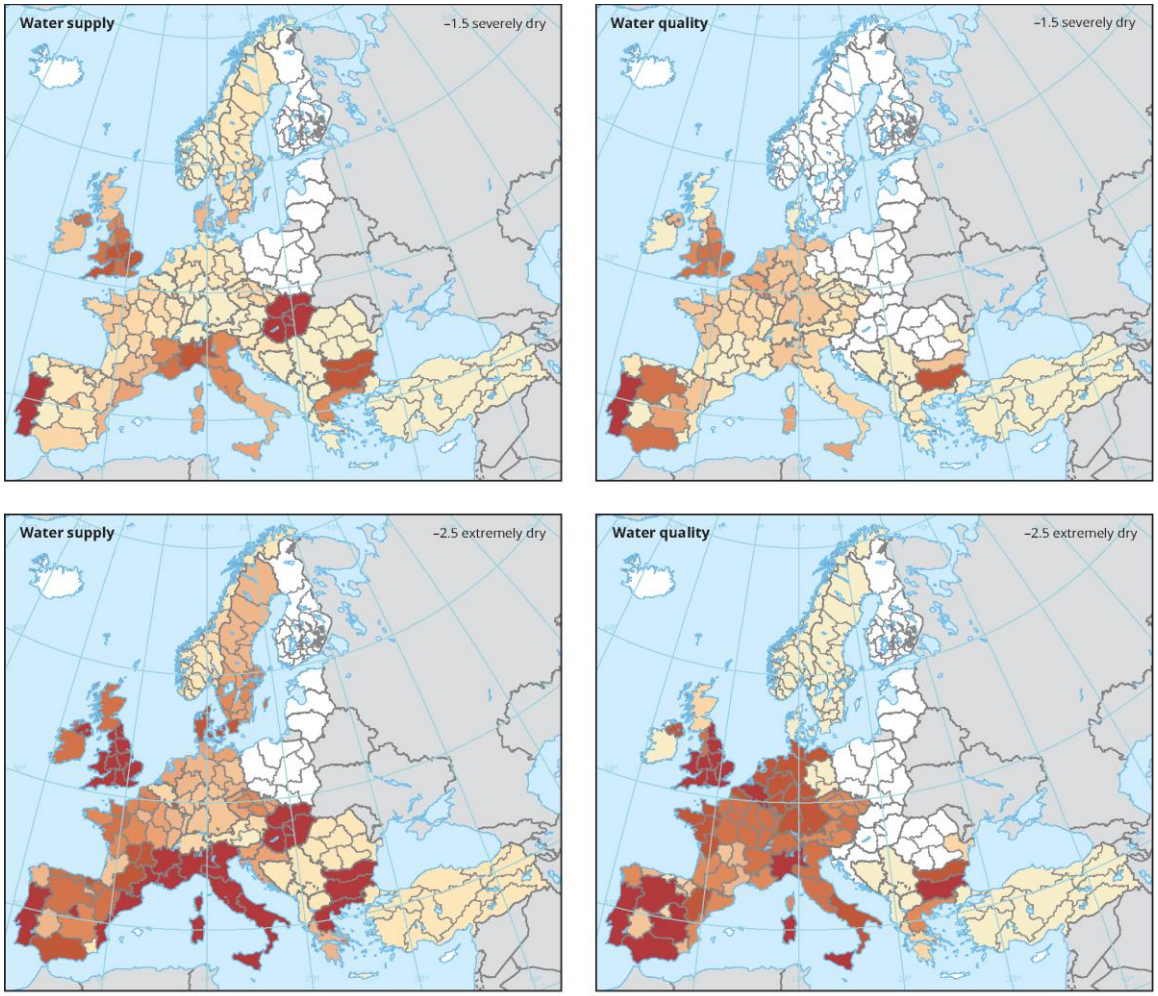
Figure 36. Disaster mortality (left), directly affected people (middle) and damage by water-related hazards (right), 1990–2015



Data source: CRED (n.d.).

CLIMATE CHANGE

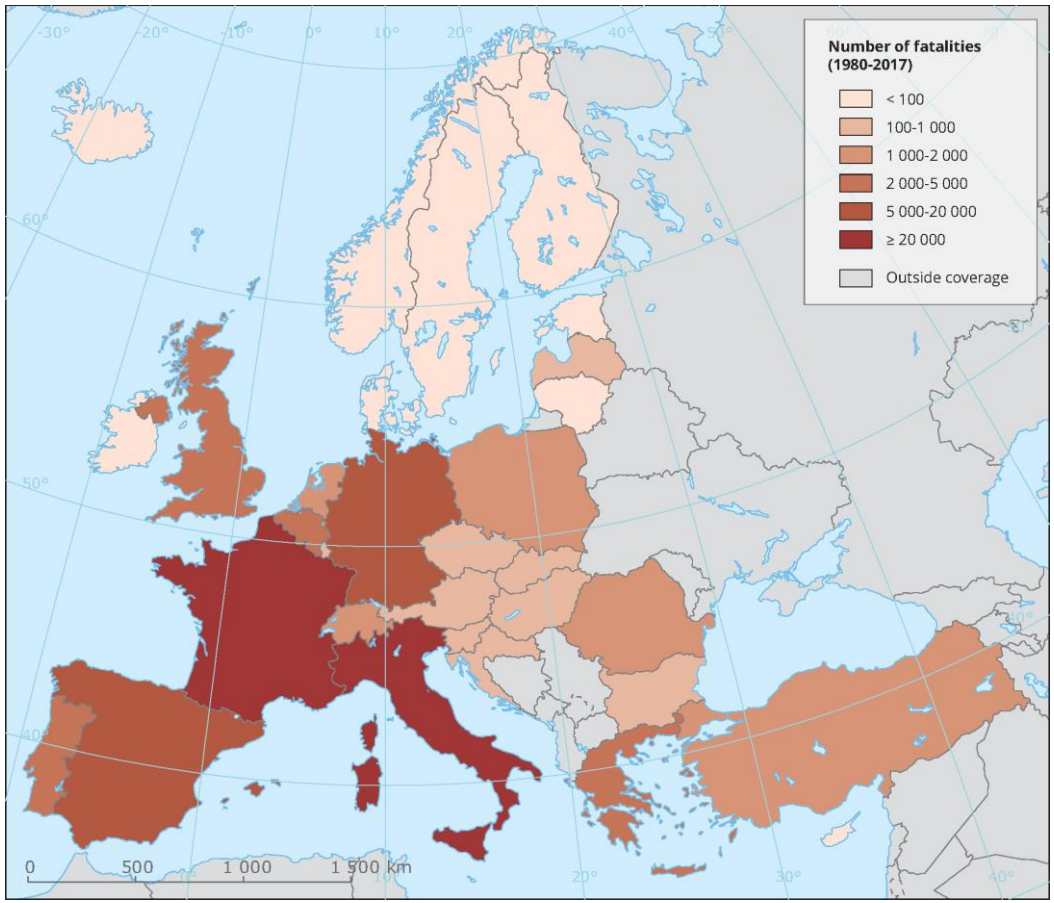
Drought risk maps with the likelihood of impact occurrence



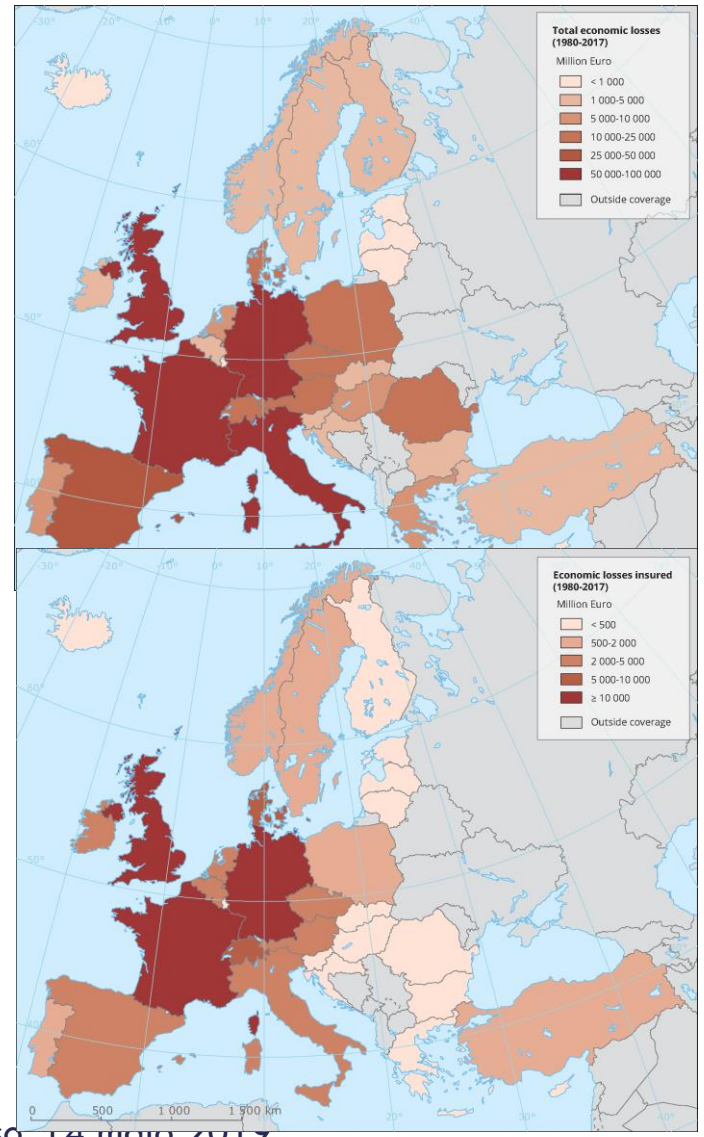
Source:
European Environment Agency

CLIMATE CHANGE

Impacts of extreme weather and climate related events in EU

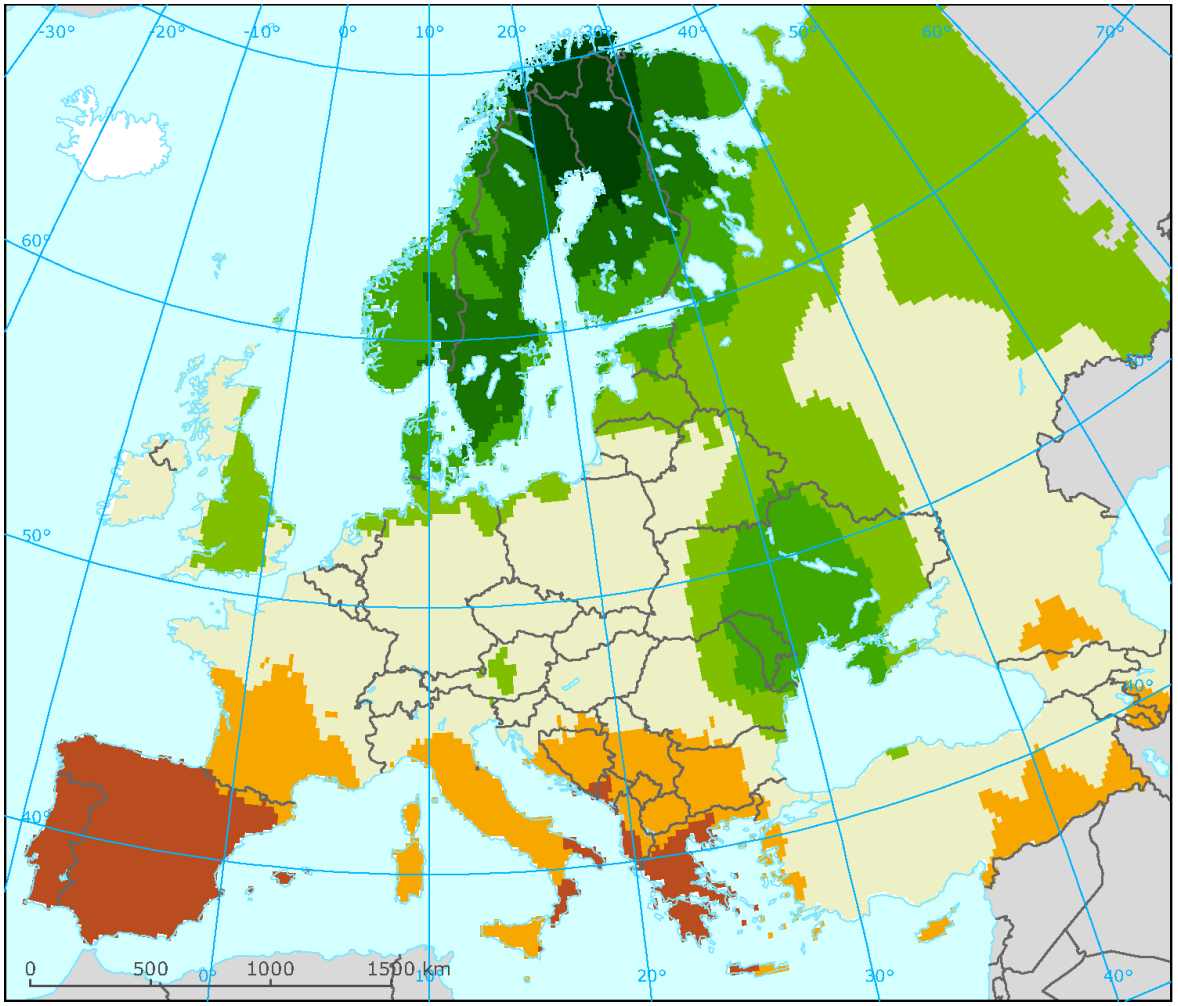


Source: European Environment Agency



CLIMATE CHANGE

Projected changes in water-limited crop yield in Europe (%)



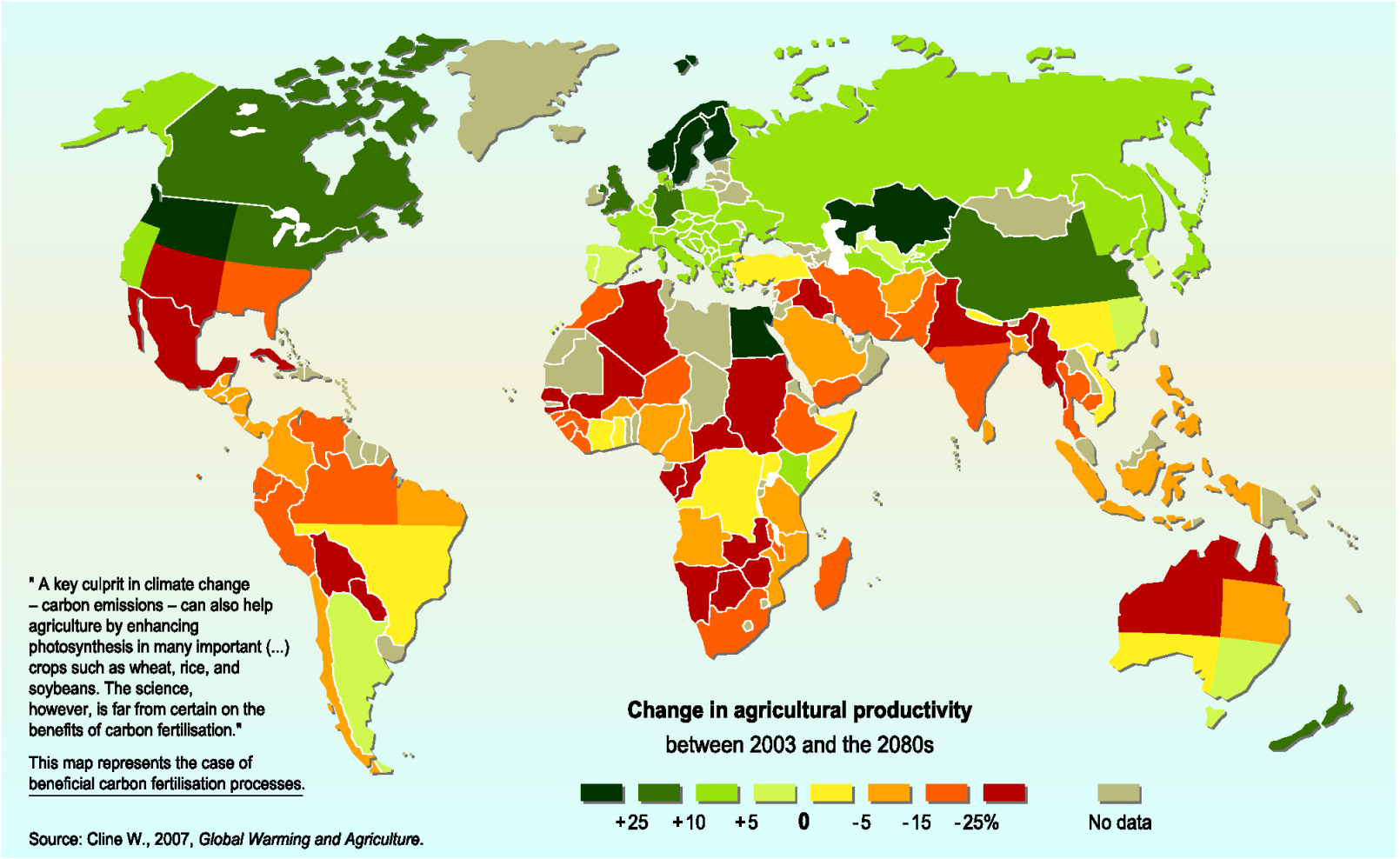
Projected changes in water-limited crop yield

(%)

- – 25 to – 15
- – 15 to – 5
- – 5 to 5
- 5 to 15
- 15 to 25
- 25 to 35
- > 35
- No data
- Outside coverage

Source:
European Environment Agency

Projected impact of climate change on agricultural yields



Global risks in terms of likelihood and impact (2008-2018)

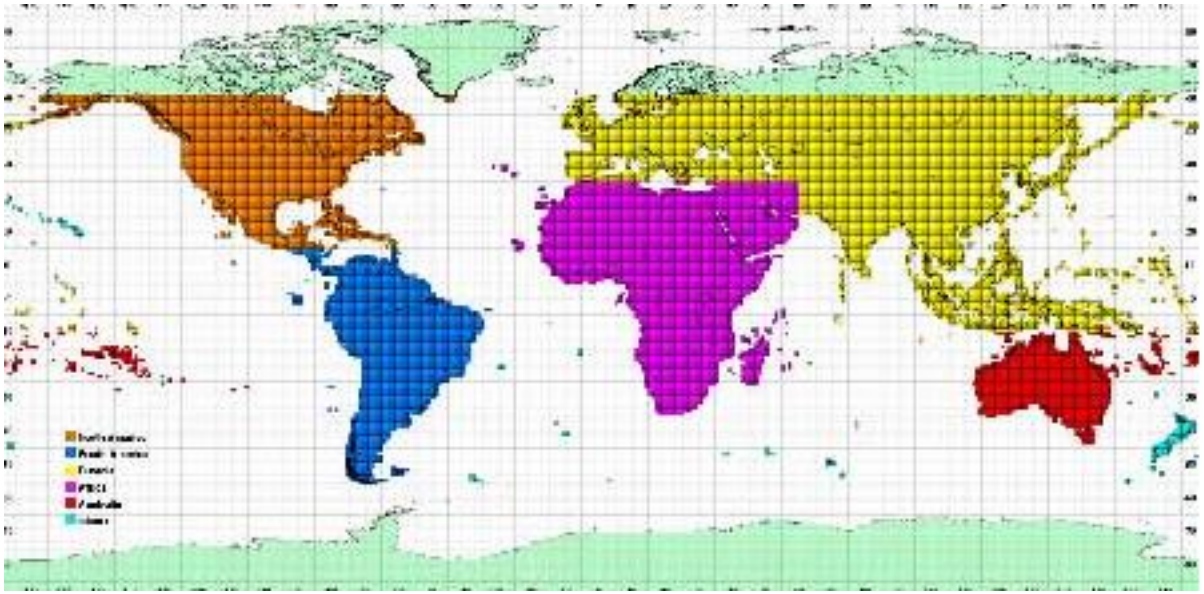
Figure IV: The Evolving Risks Landscapes, 2008–2018

Source: World Economic Forum 2008–2018, Global Risks Reports.
Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were re-categorized first as societal risks and then as a trend in the 2015 and 2016 Global Risks Reports, respectively.

ADRESSING THE CHALLENGES FOR A (SUSTAINABLE) FUTURE

Global Terrain data

Terrain Data
SRTM3 - Shuttle Radar Topography Mission Global Coverage (~90m)
Version 2
Resolution: ~90 m, 3 arc-sec - **Coverage:** Global **Projection:** Geographic ;

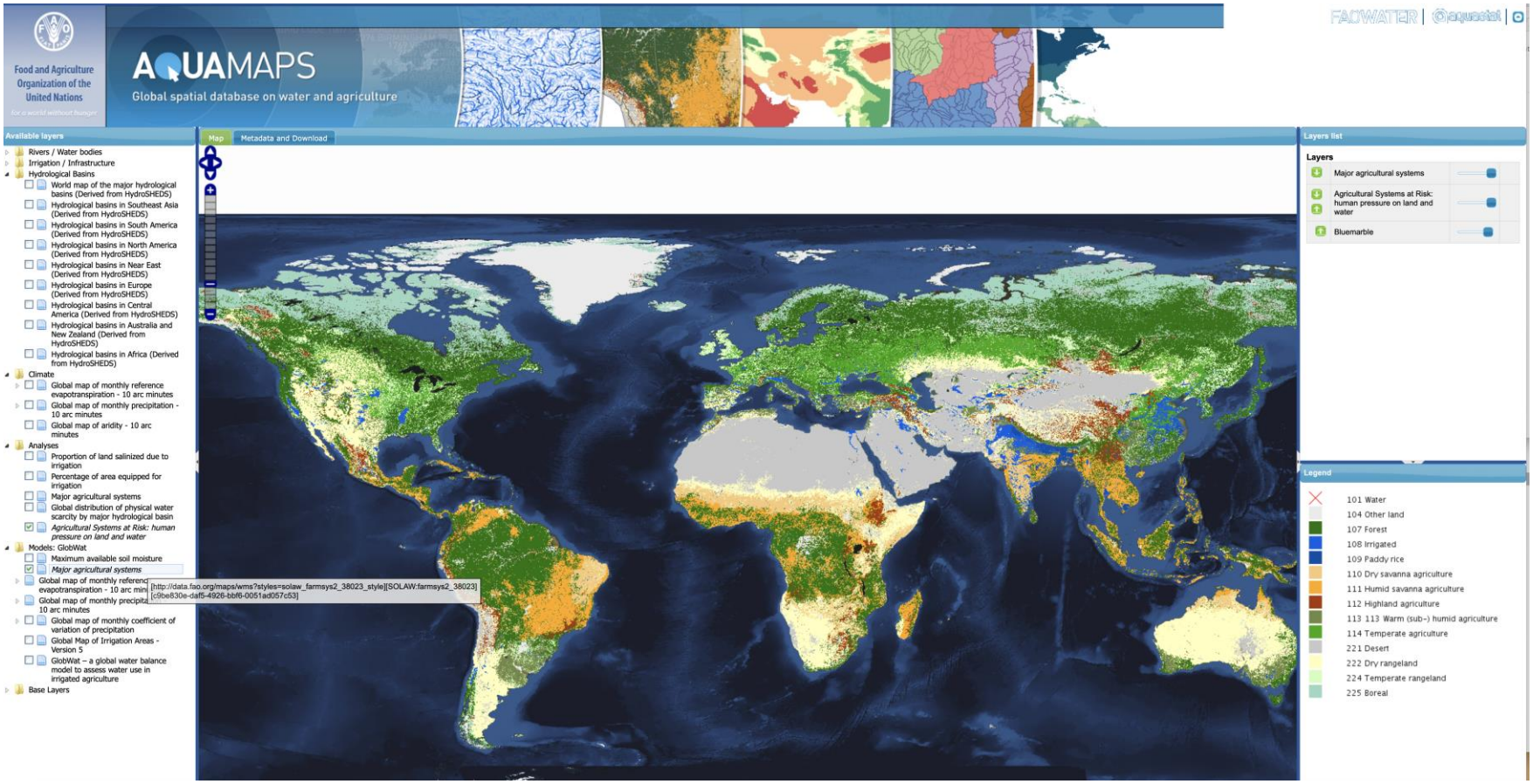


DATA AND TOOLS

CORINE – Land cover

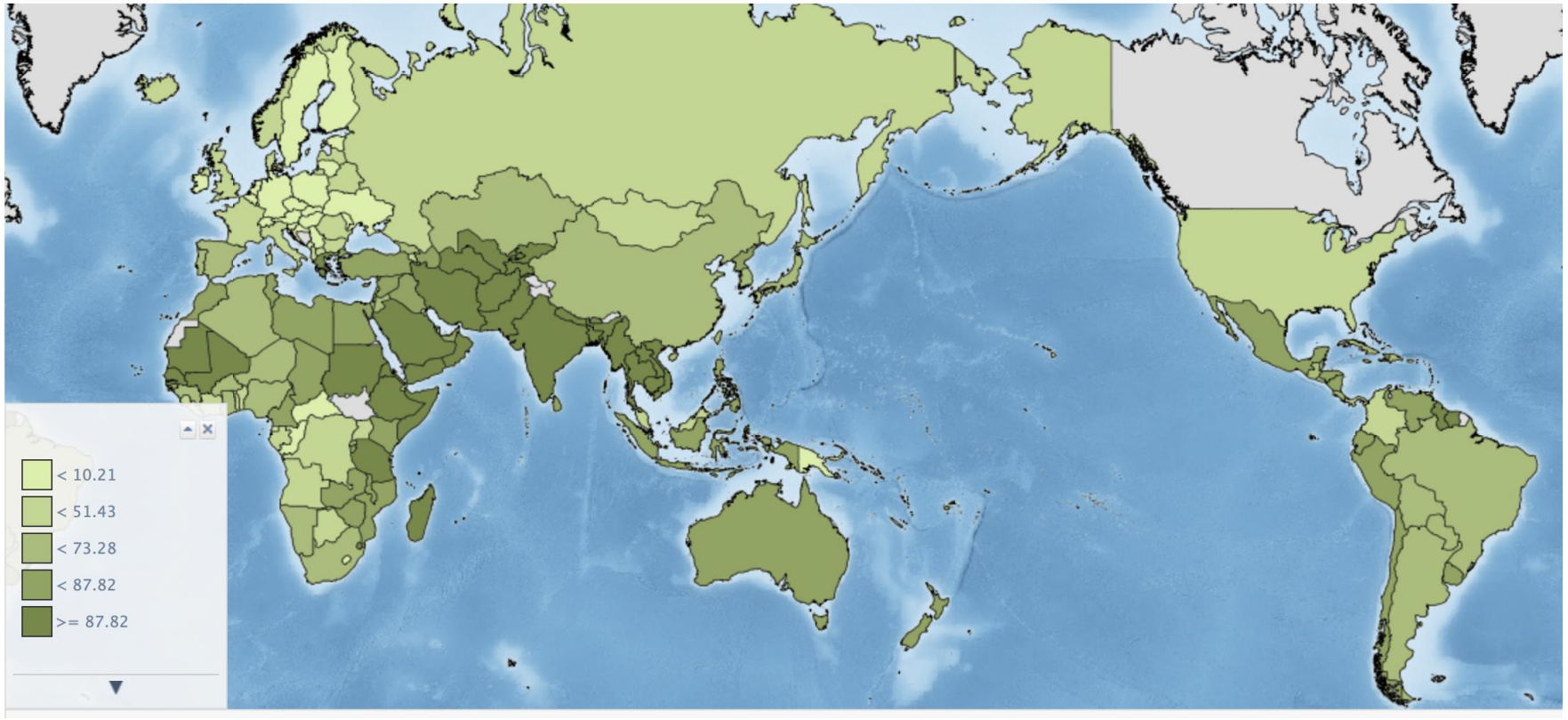
DATA AND TOOLS

AQUAMAPS – Global spacial database on water and agriculture



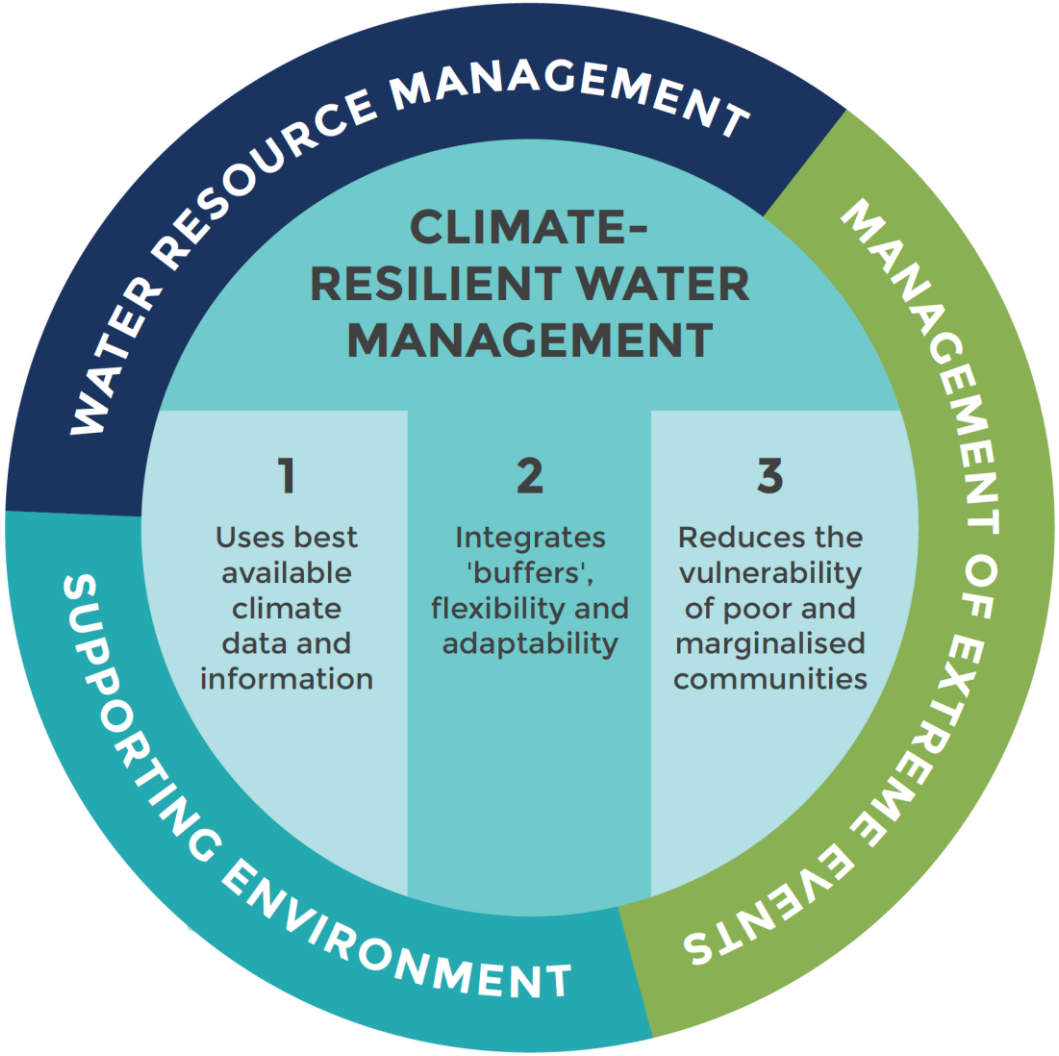
http://www.fao.org/nr/water/aquamaps/

Proportion of total water withdrawal for agriculture (%)



Source: AQUASTAT, FAO

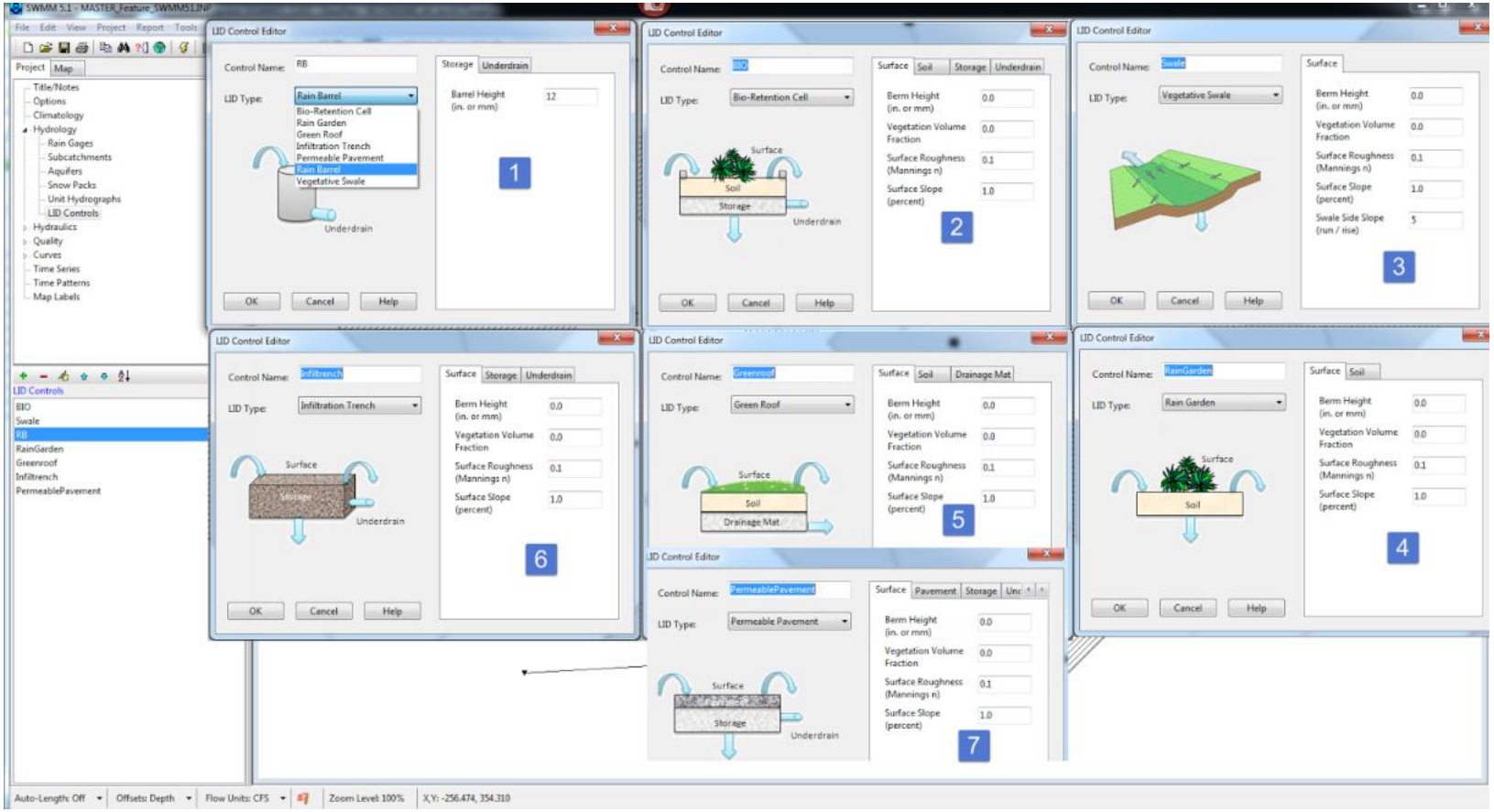
CHANGES FOR A SUSTAINABLE DEVELOPMENT
INTEGRATED WATER MANAGEMENT





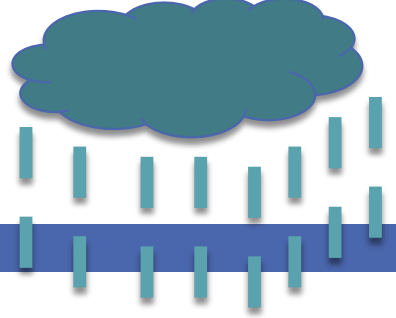

Sustainable Urban Drainage Systems



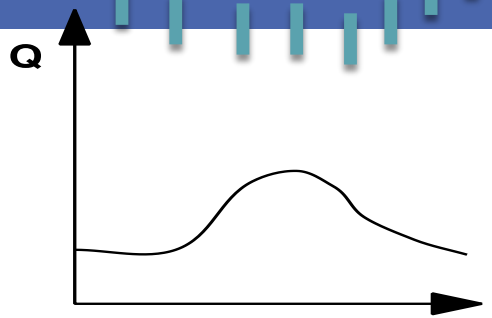
https://swmm5.org/2014/04/20/seven-types-of-lid-controls-in-swmm-5-1/

HYDROLOGICAL STUDIES
FLOOD CONTROL

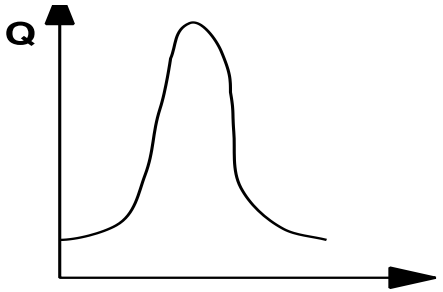


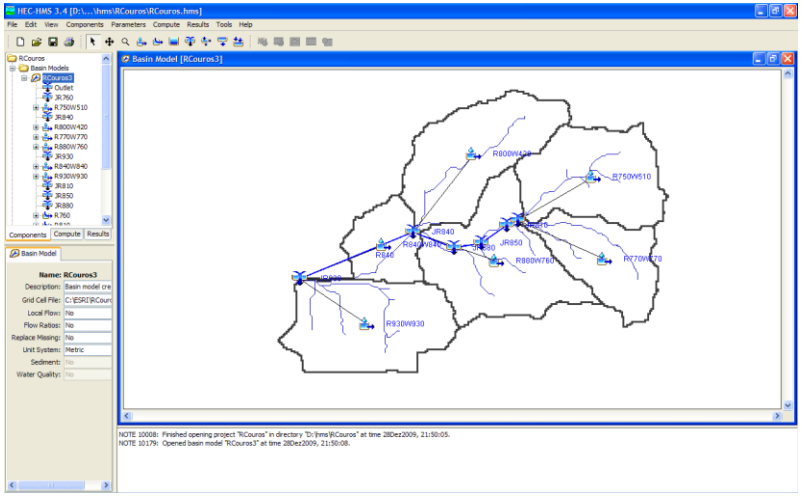
Precipitation → Vegetation → Surface runoff

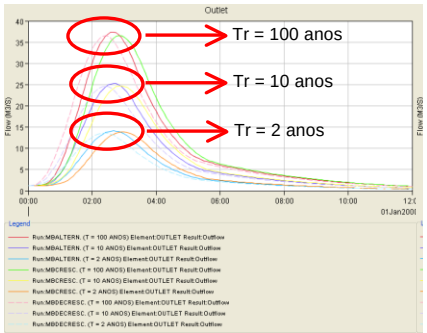
Precipitation → Infiltration → Subsurface runoff



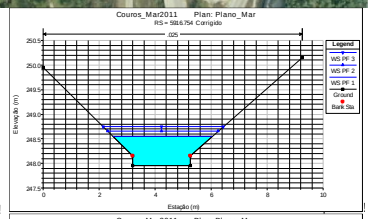
Precipitation → Surface runoff

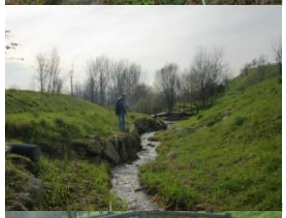


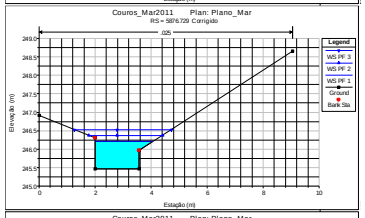


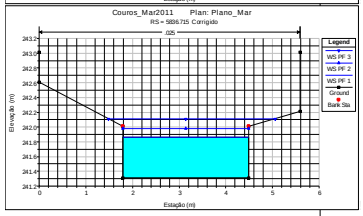


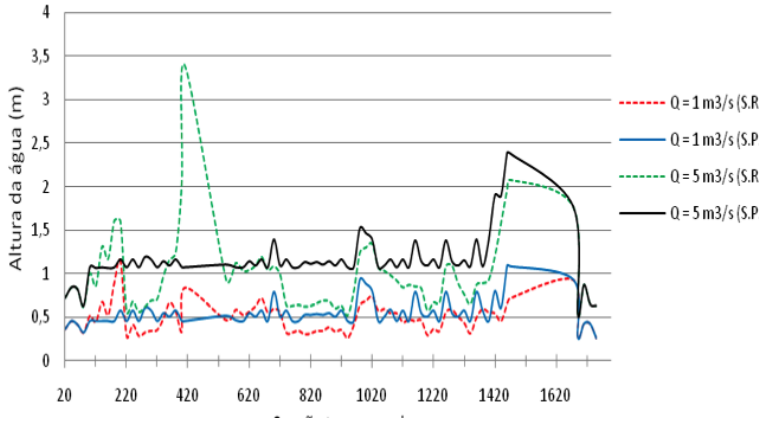
HYDRODYNAMIC MODELS
FLOOD CONTROL

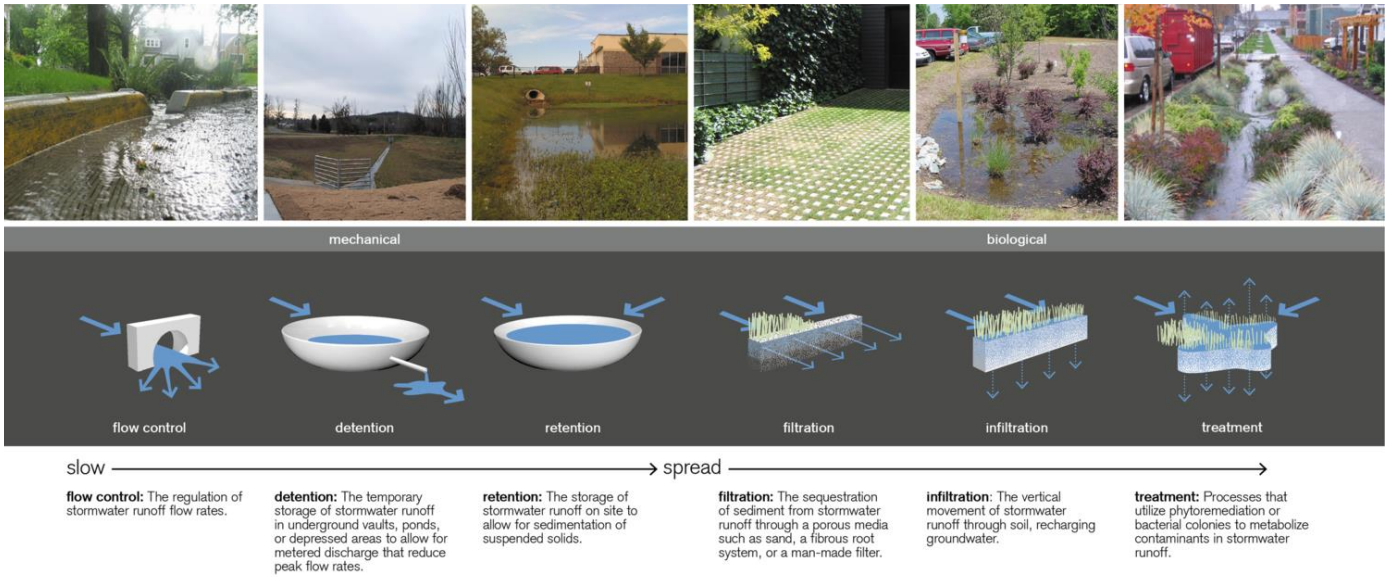








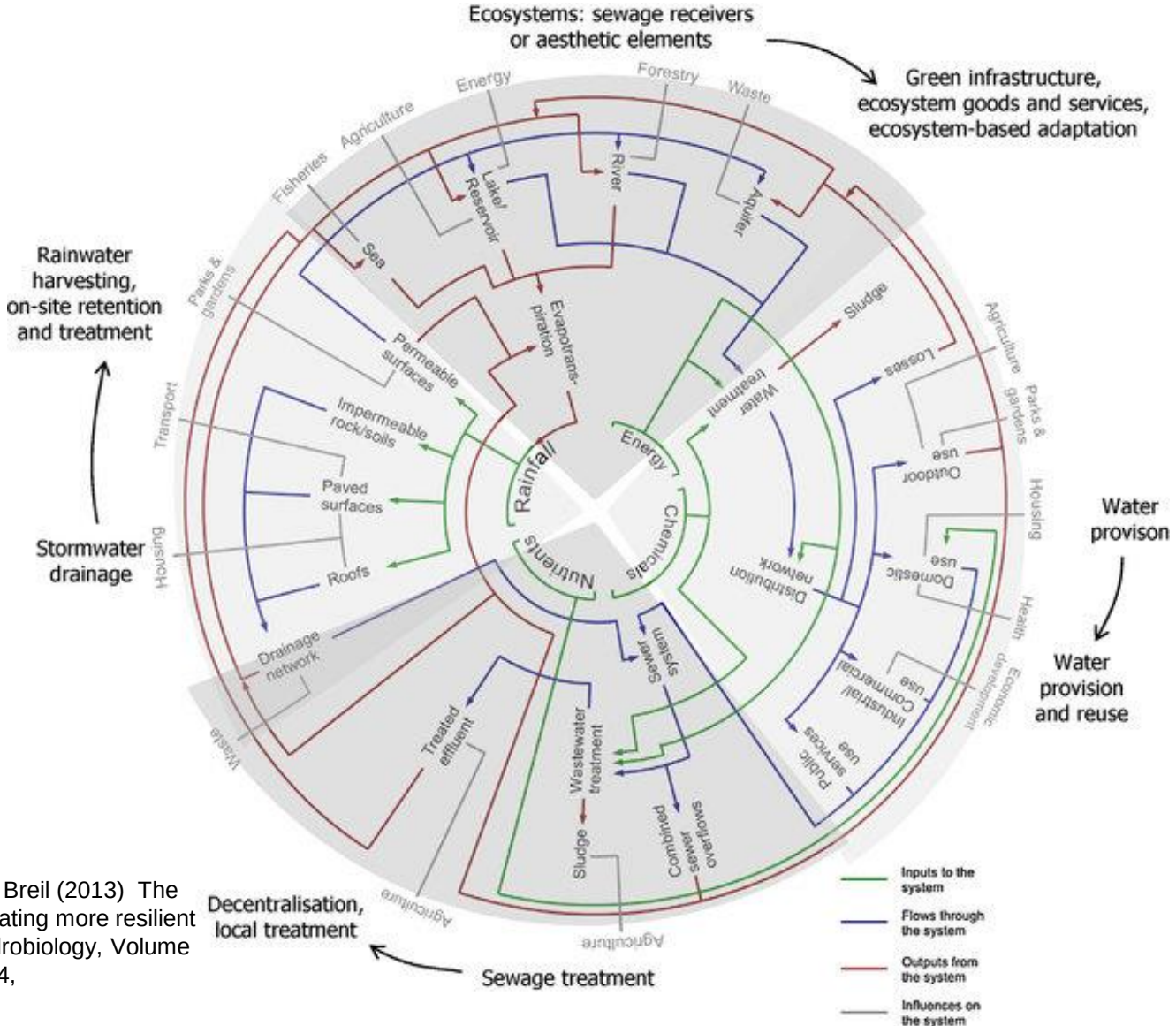




A generic characterization framework for exploring nature based built environment solutions.

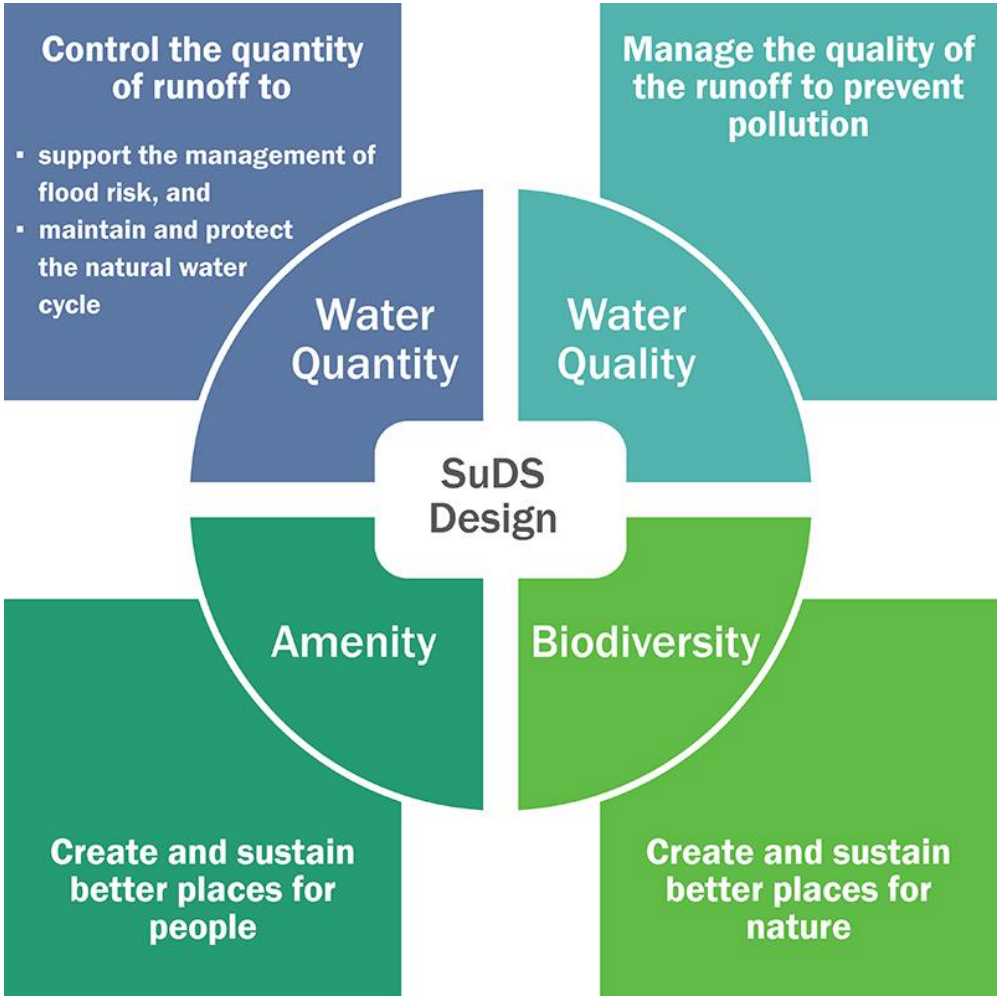
Adapted from: Yangang Xing,Phil Jones and Iain Donnison. Characterisation of Nature-Based Solutions for the Built Environment. Sustainability

NATURAL AND URBAN WATER CYCLE
SUSTAINABLE URBAN WATER SYSTEMS



Iwona Wagner and Pascal Breil (2013) The role of ecohydrology in creating more resilient cities, Ecohydrology & Hydrobiology, Volume 13, Issue 2, Pages 113-134,

NATURAL AND URBAN WATER CYCLE
SUSTAINABLE URBAN WATER SYSTEMS



INTEGRATED WATER RESOURCES MANAGEMENT

RESILIENT SYSTEMS

CIRCULAR ECONOMY - RESOURCE RECOVERY

CHANGES FOR A SUSTAINABLE DEVELOPMENT
SUSTAINABLE DEVELOPMENT GOALS

Figure 21. How SDG 6 can bring immense benefits for sustainable development

SDG 6 Global Indicators

INDICATORS	TIER	CUSTODIANS
6.1.1 Proportion of population using safely managed drinking water services	II	WHO, UNICEF
6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	II	WHO, UNICEF
6.3.1 Proportion of wastewater safely treated	II	WHO, UN-Habitat, UNSD
6.3.2 Proportion of bodies of water with good ambient water quality	II	UN Environment
6.4.1 Change in water-use efficiency over time	II	FAO
6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	I	FAO
6.5.1 Degree of integrated water resources management implementation (0-100)	I	UN Environment
6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation	I	UNESCO, UNECE
6.6.1 Change in the extent of water-related ecosystems over time	I	UN Environment, Ramsar
6.a.1 Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	I	WHO, UN Environment, OECD
6.b.1 Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	I	WHO, UN Environment, OECD

UN WATER

SUSTAINABLE DEVELOPMENT GOALS

Source: UNWater.org

United Nations (2018). Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation. New York.

apesb
associação portuguesa de engenharia sanitária e ambiental

"Cidades e Territórios: Oportunidades e Benefícios da Economia Circular"

A Água e a Cidade

Paulo J. Ramísio

CCDRN – Economia Circular – S. Tirso, 14 maio 2019