Training of experts to assess soils damaged due to hostilities

Sumy National Agrarian University

Royal Agricultural University

Sustainable management of resources

Dr Nicky Cannon

Natural Capital

What is Natural Capital?

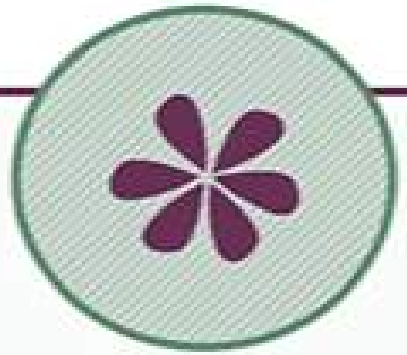
- ‘The world’s stocks of natural assets which include geology, soil, air, water and all living things’ (Definition from the World international forum on Natural Capital 2021)
- It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible.
- Services include the food we eat, the water we drink and the plant materials we use for fuel, building materials and medicines. There are also many less visible ecosystem services such as the climate regulation and natural flood defenses provided by forests, the billions of tonnes of carbon stored by peatlands, or the pollination of crops by insects.

How does agriculture influence Natural Capital?

What is Natural Capital?

Stocks

- Species
- Communities
- Landscapes
- Ecosystems
- Soils
- Air
- Water



Services

- Pollination
- Biomass
- Nutrient cycling
- Water purification

Benefits

- Timber
- Energy
- Clean water
- Clean air
- Recreation
- Hazard protection
  (flooding, climate change mitigation)
- Wildlife conservation

The Natural Capital Framework (Defra 2023)

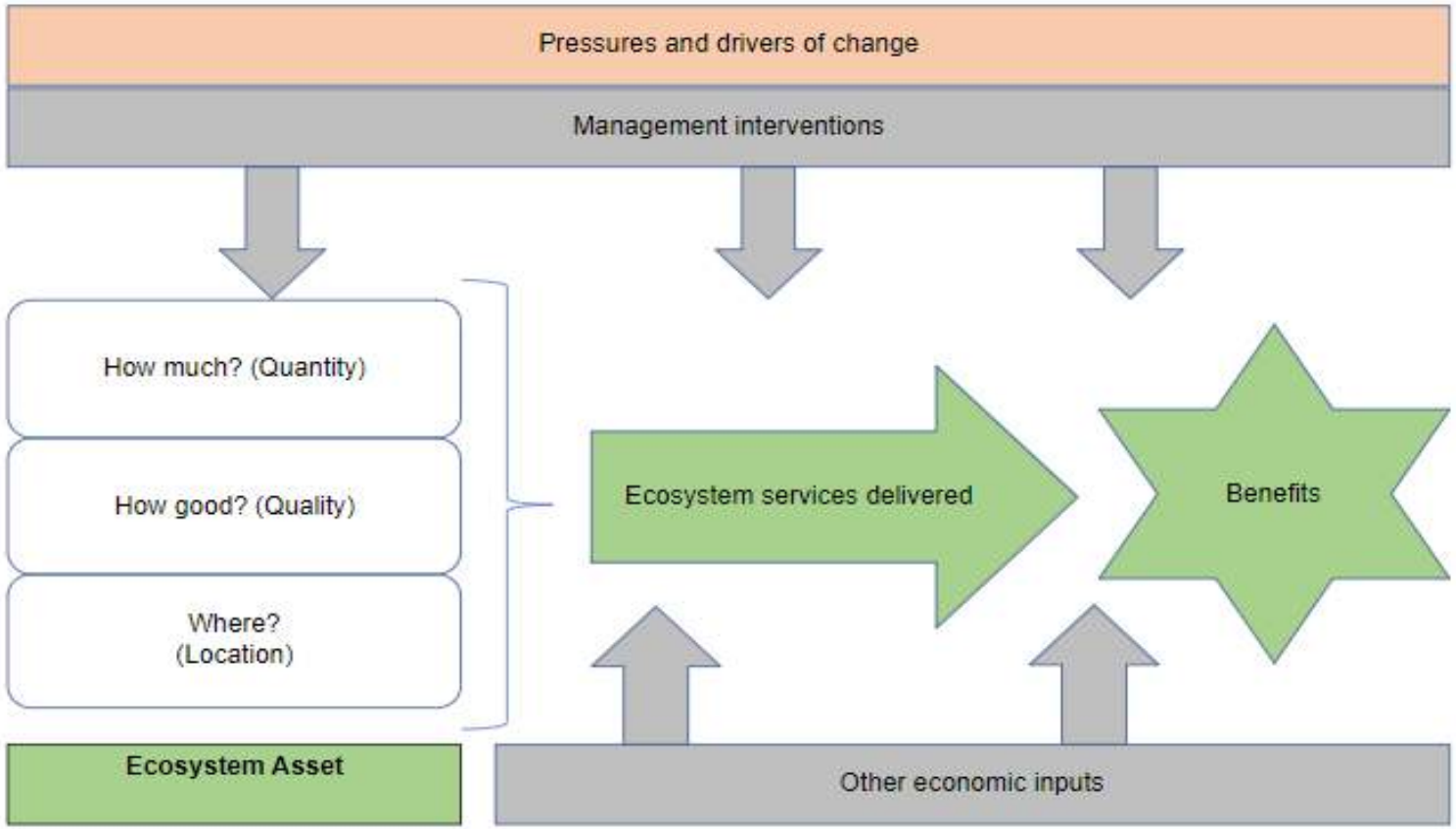
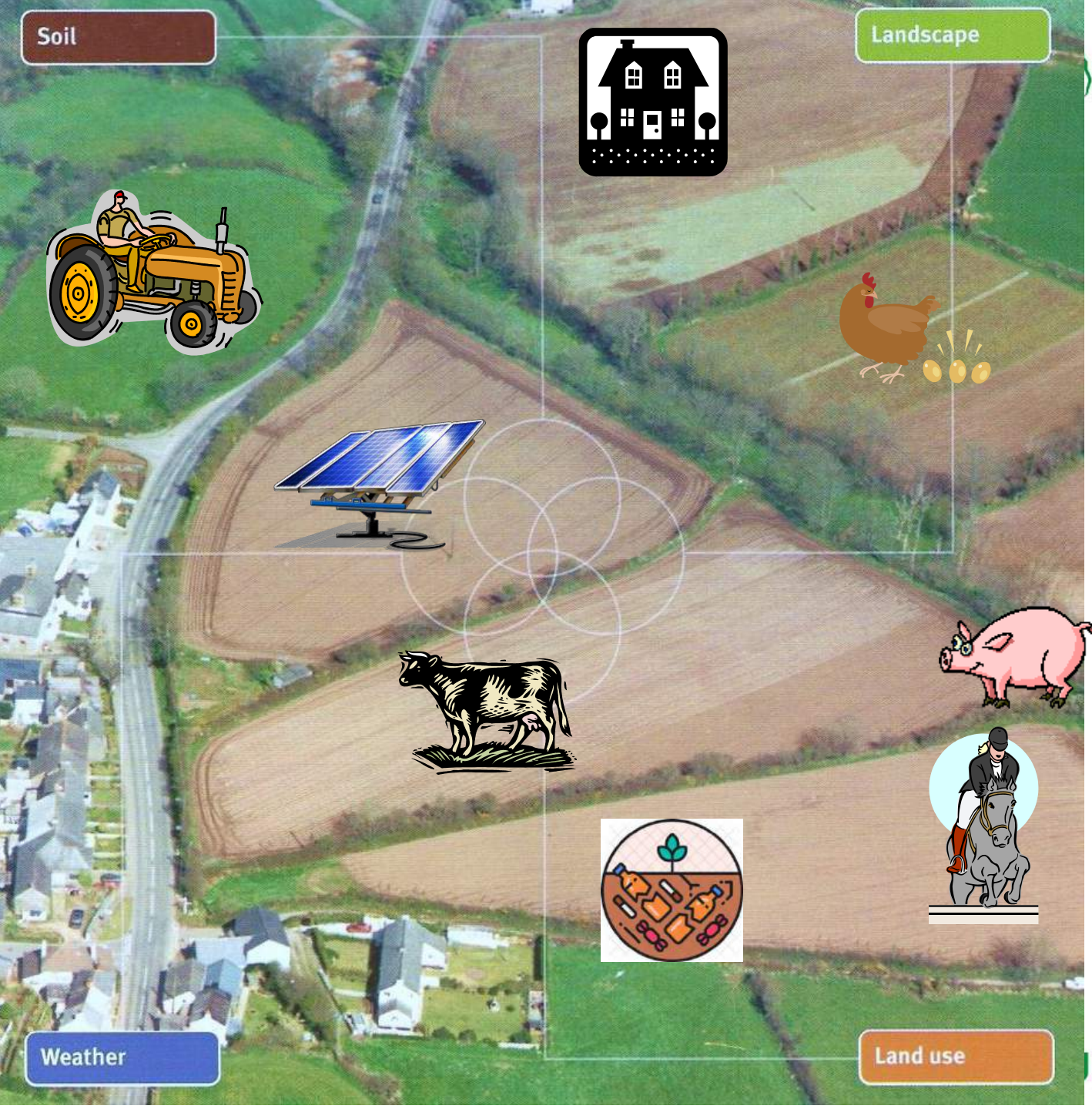


Figure 1: The Natural Capital Framework



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Factors influencing natural capital

And agriculture is part of the problem and the solution……..

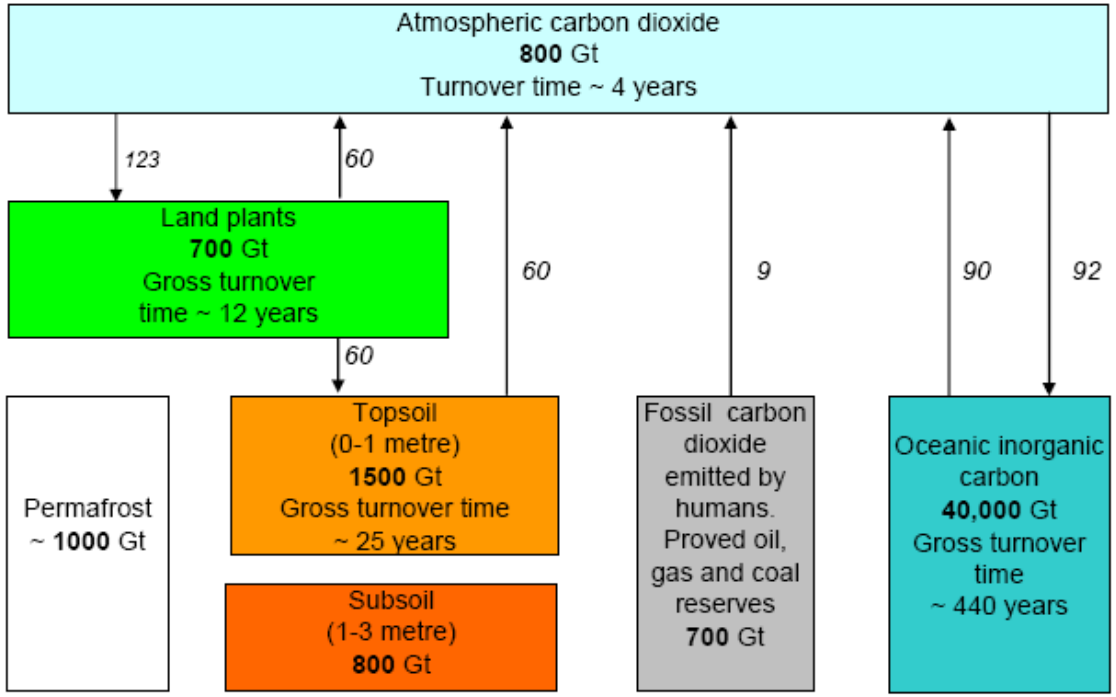


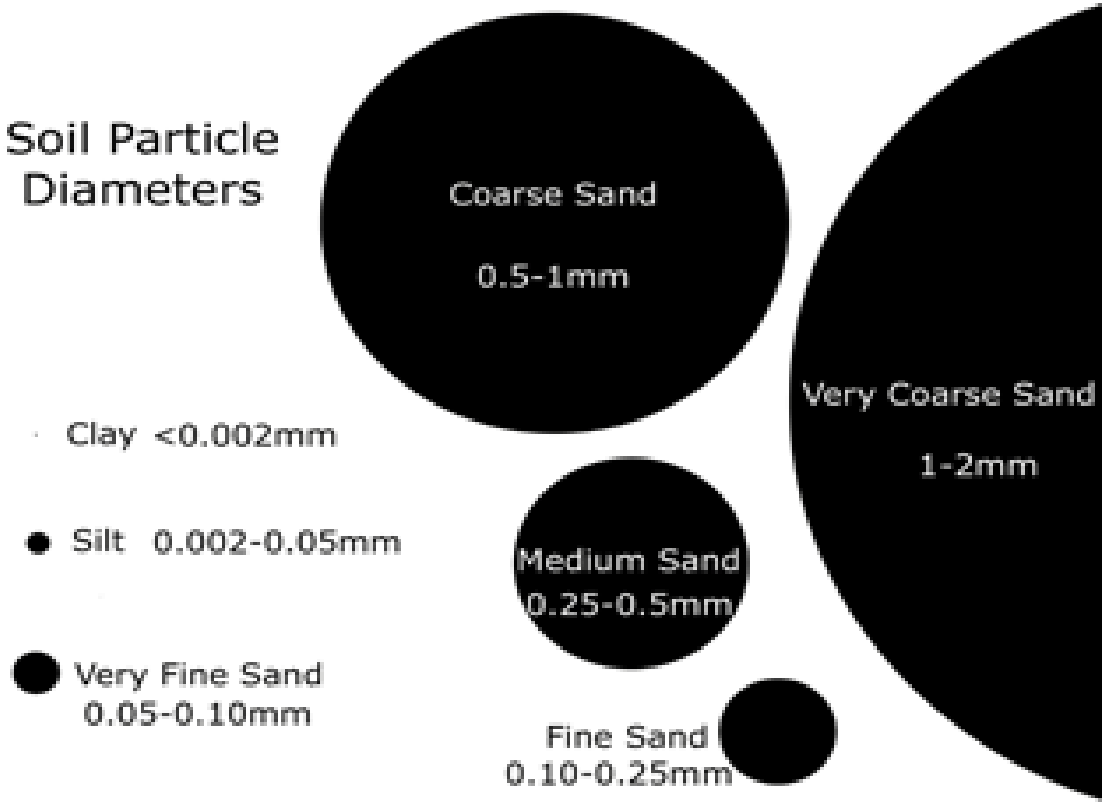
Figure 2.2 An outline of the natural terrestrial and oceanic carbon cycles.

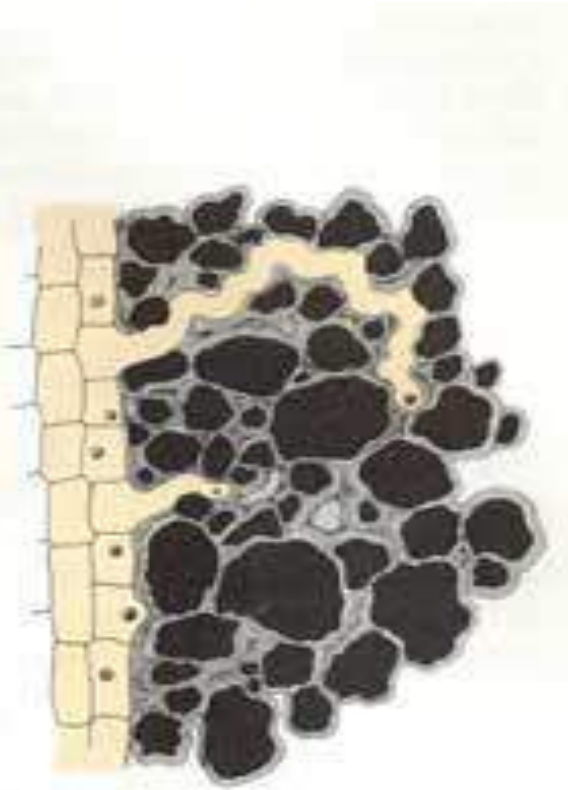
The units in bold are gigatones C: those in italics are gigatones C year^{-1}. This is an updated and simplified version of Figure 7.3 in IPCC, 2007: *Climate Change*. I, with the additional assumption that gross primary production (GPP) is twice net primary production (NPP). Soil excludes peatlands. Soil data from Jobbagy & Jackson. 2000. *Ecological Applications*, **10**, 423-436). At the beginning of 2009 the atmosphere contained 820 Gt CO2-C. Proved oil, gas and coal reserves are for 2008 – see **Table 3.2**.

The Ideal Soil

Contains

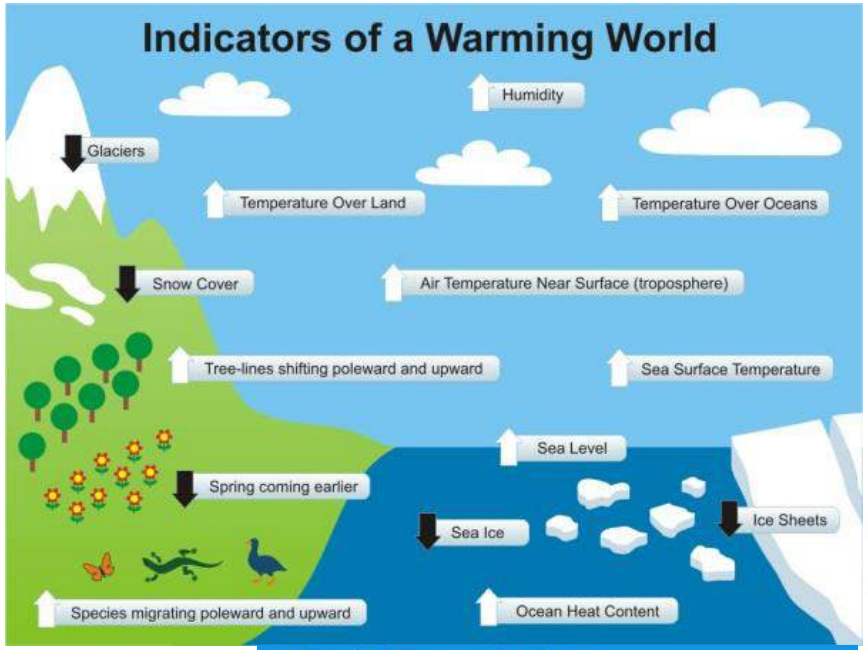
- 25% air
- 25% water
- 45% minerals such as sand, silt & clay
- 5% organic matter

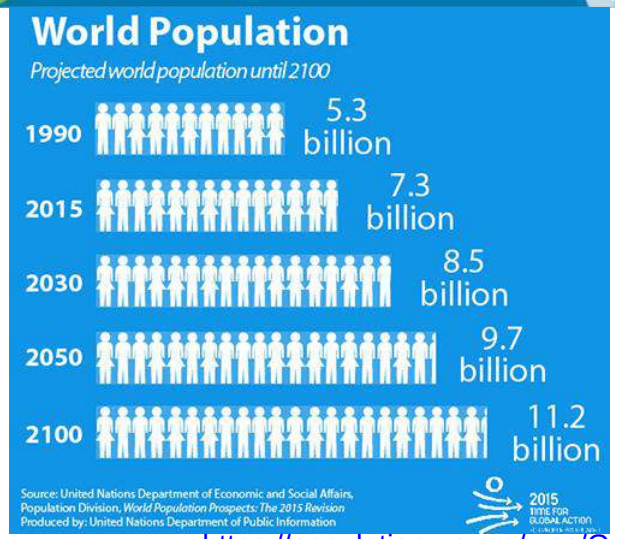




The Challenges Ahead……

- The bi-products of war
- Increased demand for food partially due to population growth
- Environmental degradation
- Climate change
- Global warming
- Water shortages

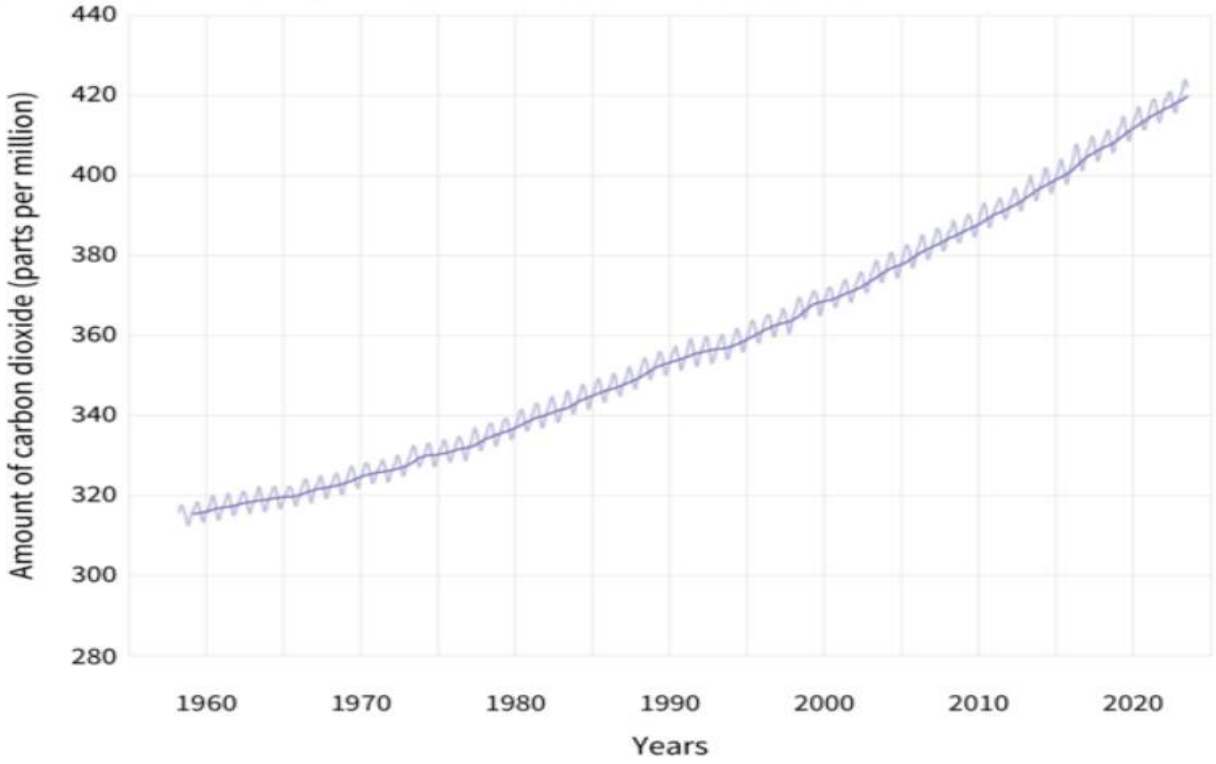




Try: https://www.worldometers.info/world-population/

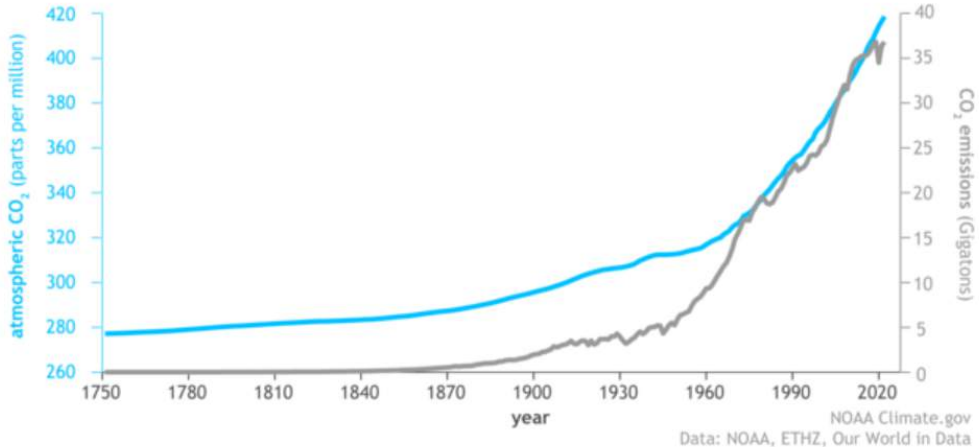
https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/900

ATMOSPHERIC CARBON DIOXIDE

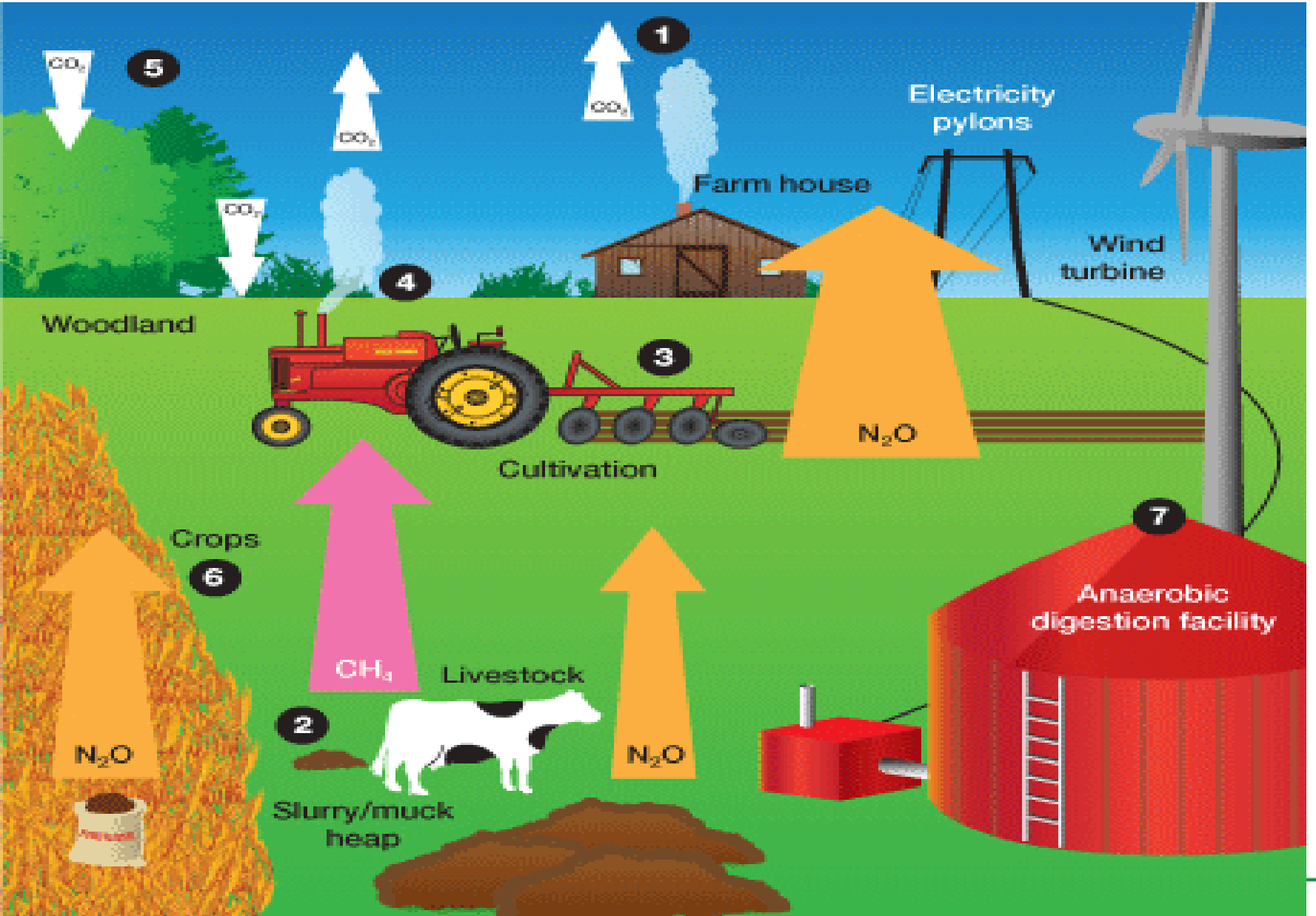


The modern record of atmospheric carbon dioxide levels began with observations recorded at Mauna Loa Observatory in Hawaii. This graph shows the station's monthly average carbon dioxide measurements since 1958 in parts per million (ppm). The seasonal cycle of highs and lows (small peaks and valleys) is driven by Northern Hemisphere summer vegetation growth, which reduces atmospheric carbon dioxide, and winter decay, which increases it. The long-term trend of rising carbon dioxide levels is driven by human activities. At Mauna Loa, the highest monthly value each year occurs in May. In May 2023, carbon dioxide hit 424 ppm—a new record. NOAA Climate.gov image, based on Mauna Loa monthly mean data from NOAA Global Monitoring Lab.

Global atmospheric carbon dioxide compared to annual emissions (1751-2022)

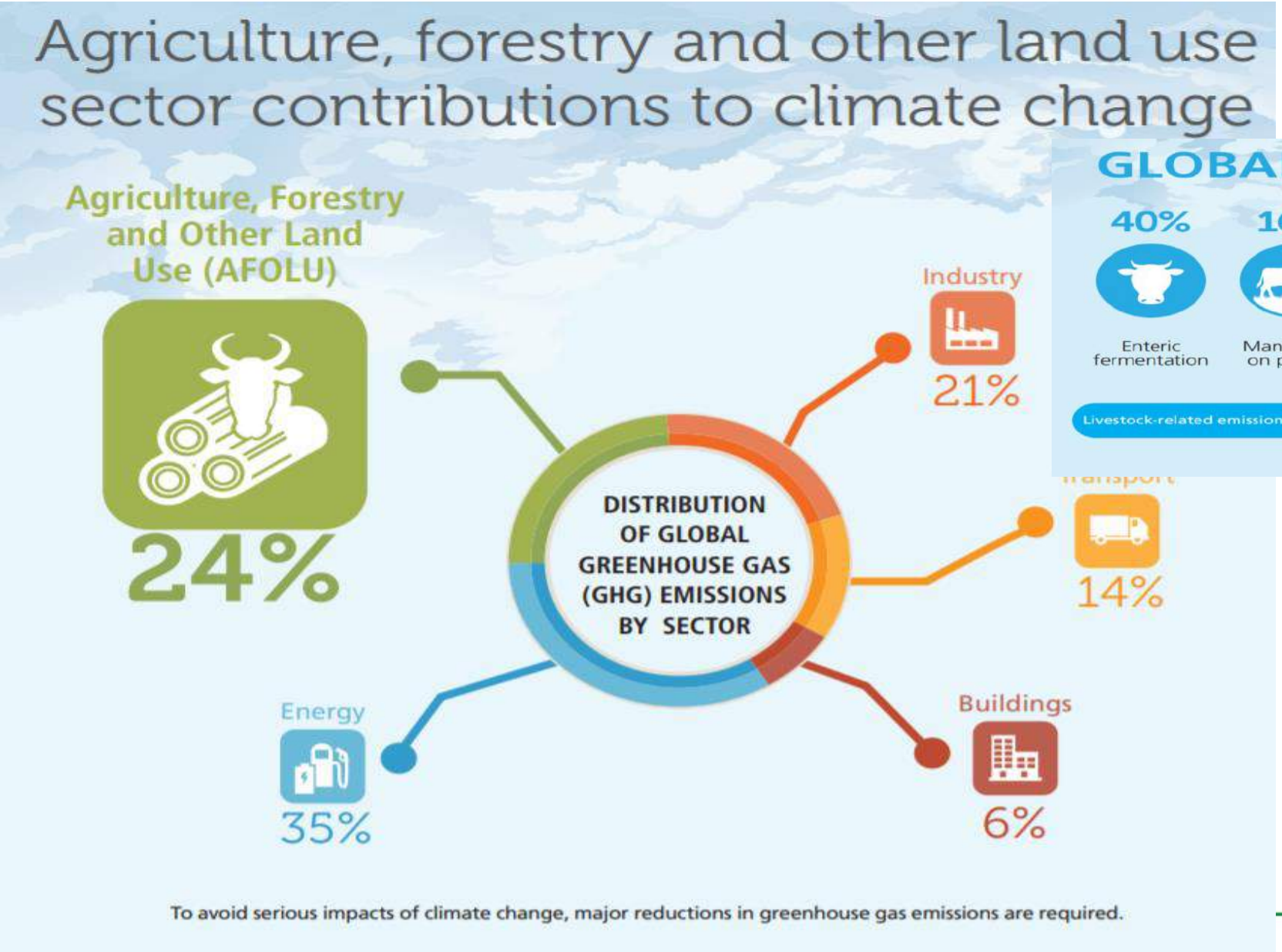


The amount of carbon dioxide in the atmosphere (blue line) has increased along with human emissions (gray line) since the start of the Industrial Revolution in 1750. Emissions rose slowly to about 5 gigatons—one gigaton is a billion metric tons—per year in the mid-20th century before skyrocketing to more than 35 billion tons per year by the end of the century. NOAA Climate.gov graph, adapted from original by Dr. Howard Diamond (NOAA ARL). Atmospheric CO_2 data from NOAA and ETHZ. CO_2 emissions data from Our World in Data and the Global Carbon Project.



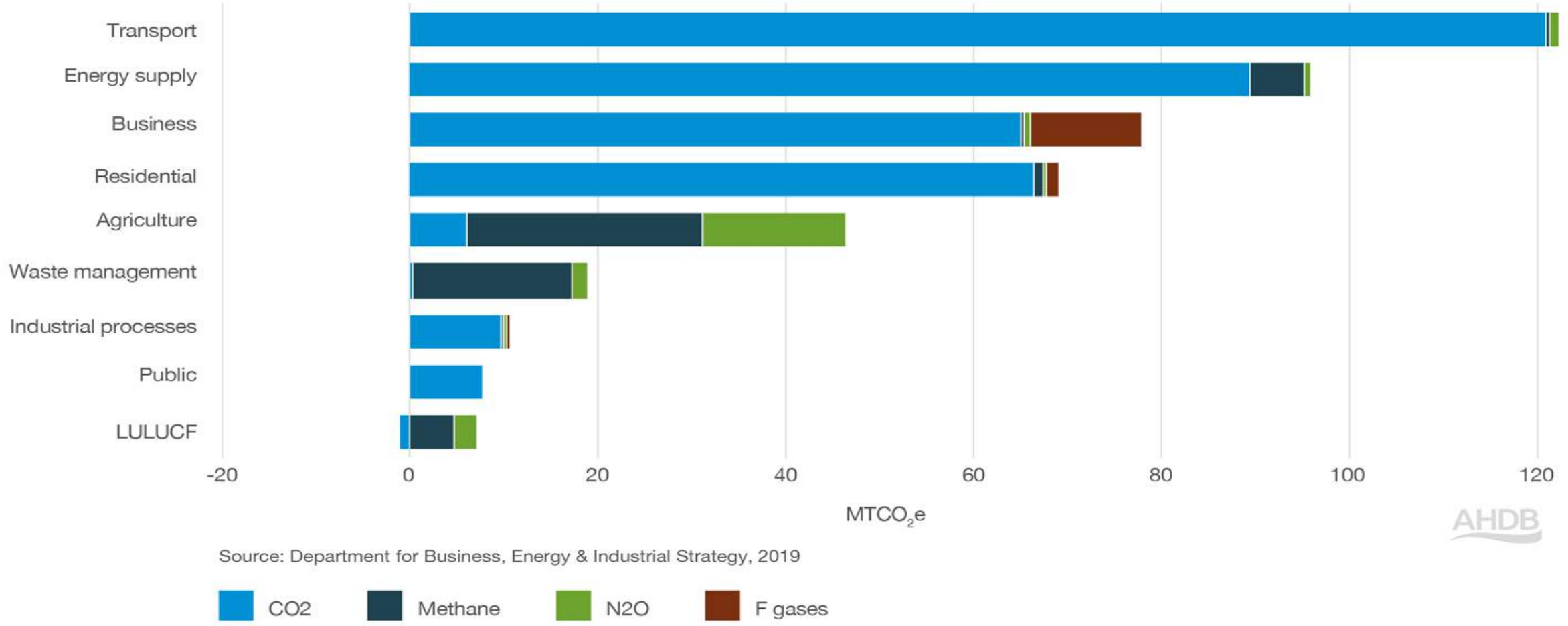
Green-house gases on farms

Agriculture, forestry and other land use sector contributions to climate change



To avoid serious impacts of climate change, major reductions in greenhouse gas emissions are required.

http://www.fao.org/3/a-i6340e.pdf

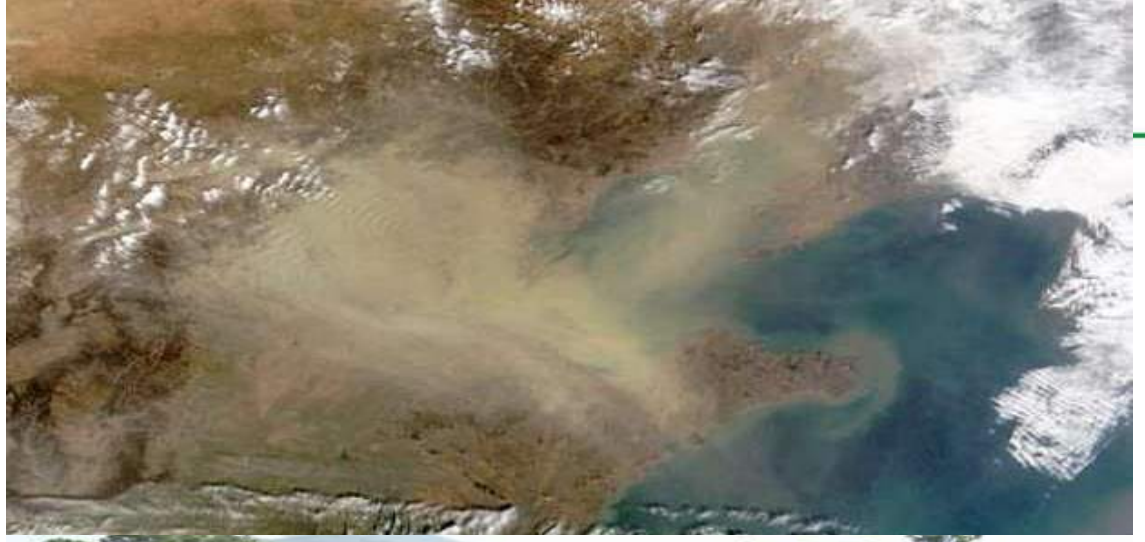


Notes: LULUCF = Land Use, Land Use Change and Forestry. Total estimated UK territorial greenhouse gas emissions in 2019 were 454.8 MT CO2e

Source: Department for Business, Energy & Industrial Strategy, 2019

Threats to soils

- Erosion
- Compaction
- Loss of soil organic matter
- Desertification
- Sealing
- Acidification
- Nutrient depletion
- Contamination/pollution



Key soil risks from climate change

- Milder, wetter winters
  - ↑ risk of soil erosion
  - ↑ risk of nutrient leaching
  - Saturated soils making spring establishment more difficult
    - ↑risk of soil compaction
- Hotter, drier summers
  - ↑ risk of drought
  - Potential Autumn crop establishment problems
  - ↑ risk of shrinkage of peat soils and wind erosion on light land
- More extreme weather incidents

Franklin D. **Roosevelt (1882-1945) 32nd President of USA**

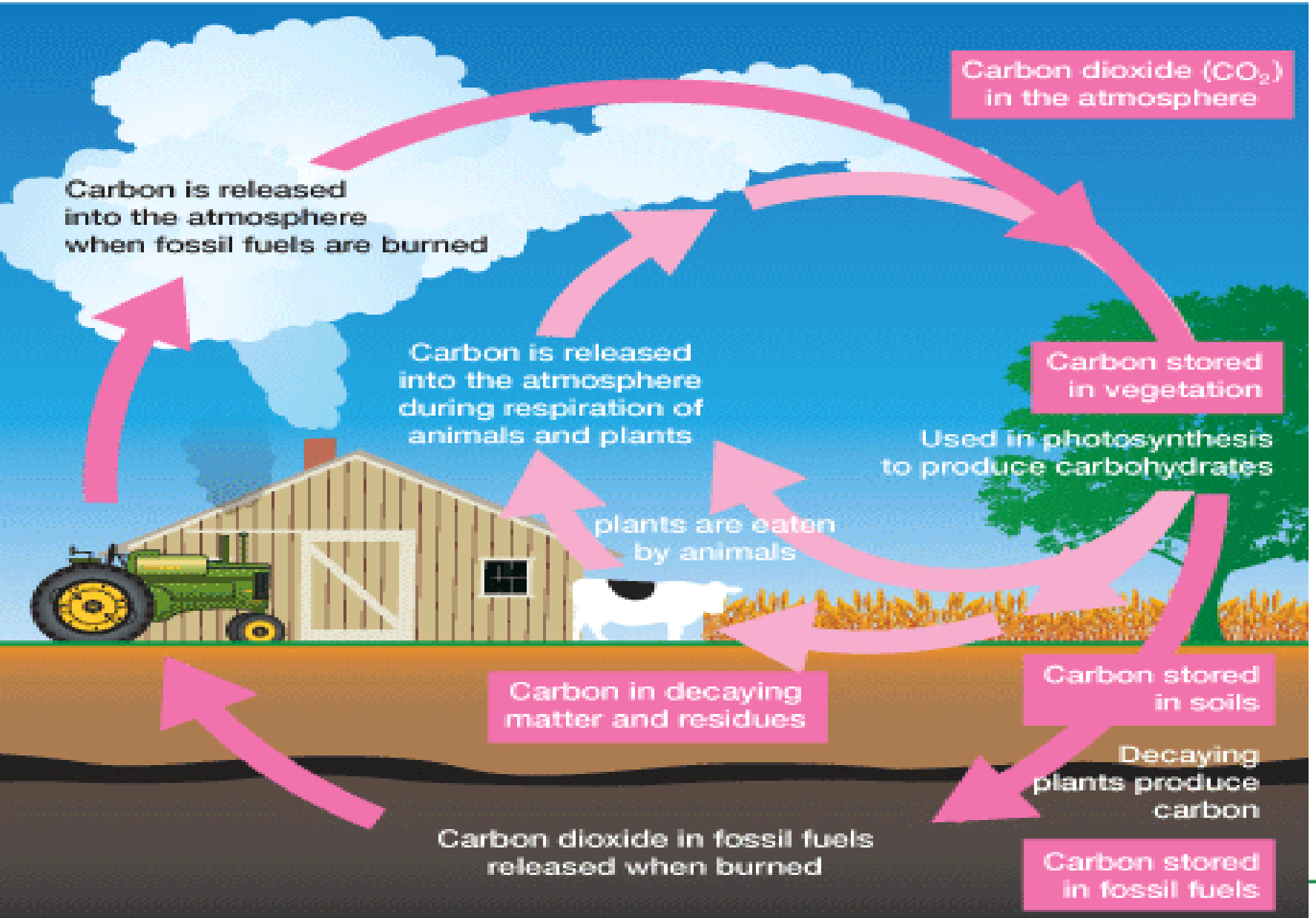
‘The nation that destroys its **soil** destroys itself.’

The importance of sustainable soil management

- Topsoil is the most productive component of any soil series
  - it can take more than 150 years for 1cm of topsoil to form.
- It costs Local Authorities
  - up to £30m/year to deal with the effects of soil erosion on roads and footpaths
  - water companies £55m/year in decontaminating drinking water of soils and phosphates.

Measure	Potential soil carbon sequestration rate (tonnes C /ha/year)
Zero-tillage	0.4
Reduced tillage	<0.4
Perennial grasses and permanent crops	0.6
Animal manure	0.4
Crop residues	0.7
Sewage sludge	0.3
Convert arable to grassland	1.2 to 1.7
Convert arable to woodland	0.3 to 0.6
Convert grassland to arable	–1.0 to –1.7
Convert woodland to arable	–0.6
Protection and restoration of farmed organic soils	Up to 4.6
Avoid deep ploughing of farmed organic soils	1.4 to 4.1
Sheep grazing on undrained peatland	>2.2

Table 2. Potential soil carbon sequestration rates of various management measures



Carbon Cycle on Farm

Measures to reduce soil and water damage on farms

Cultivate along contours where it is safe and practical to do so.

Research suggests that tramlines can be responsible for as much as 60 per cent of runoff on some soils. Consider loosening tramlines on high-risk land, as this can be effective if done at right angles to the slope. Avoid loosening tramlines running up and down slopes, as this can lead to channelling of runoff and gulley erosion.

Establish coarse seedbeds on unstable soils.

Incorporate more organic matter into your soil where needed.

Keep cattle away from watercourses during the winter.

Establish cross-slope beetle banks.

Cultivate as soon as possible after late harvest to loosen the soil. This will help to reduce runoff.

A well-managed watercourse ensures good drainage but has enough vegetation to filter out sediment.

Training of experts to assess soils damaged due to hostilities

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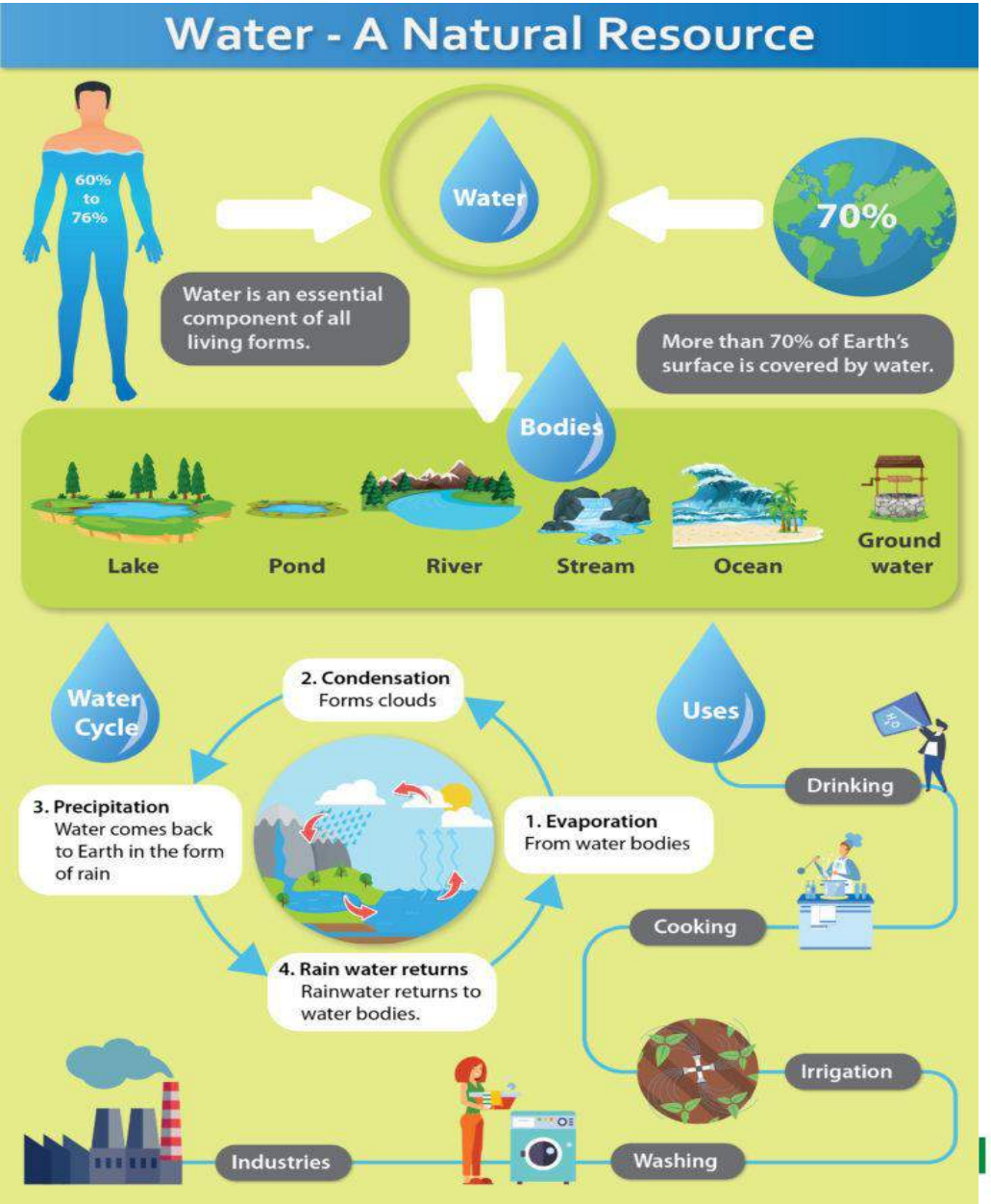
Water in agriculture

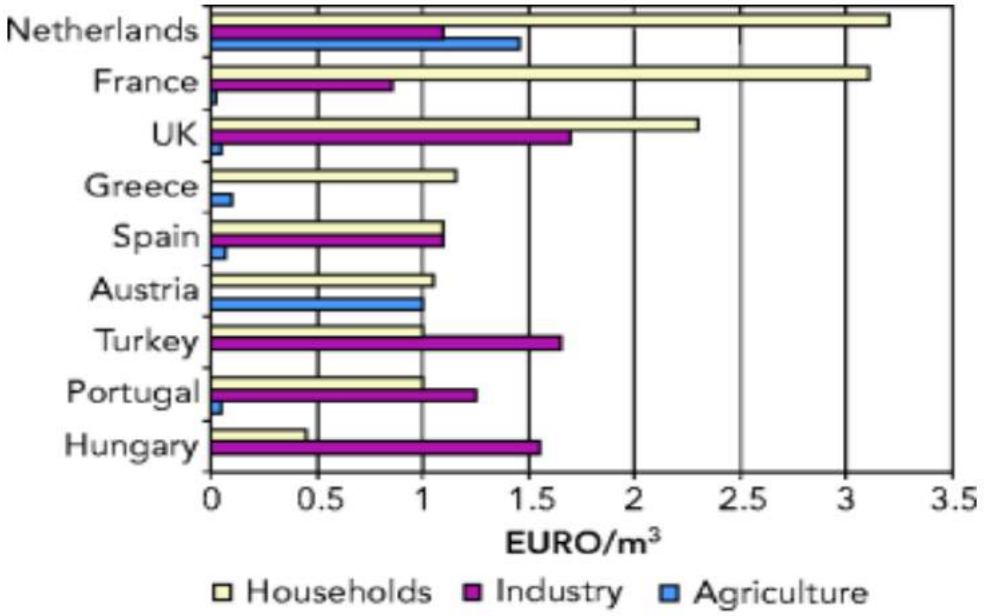


https://www.worldbank.org/en/news/infographic/2023/07/26/water-in-agriculture

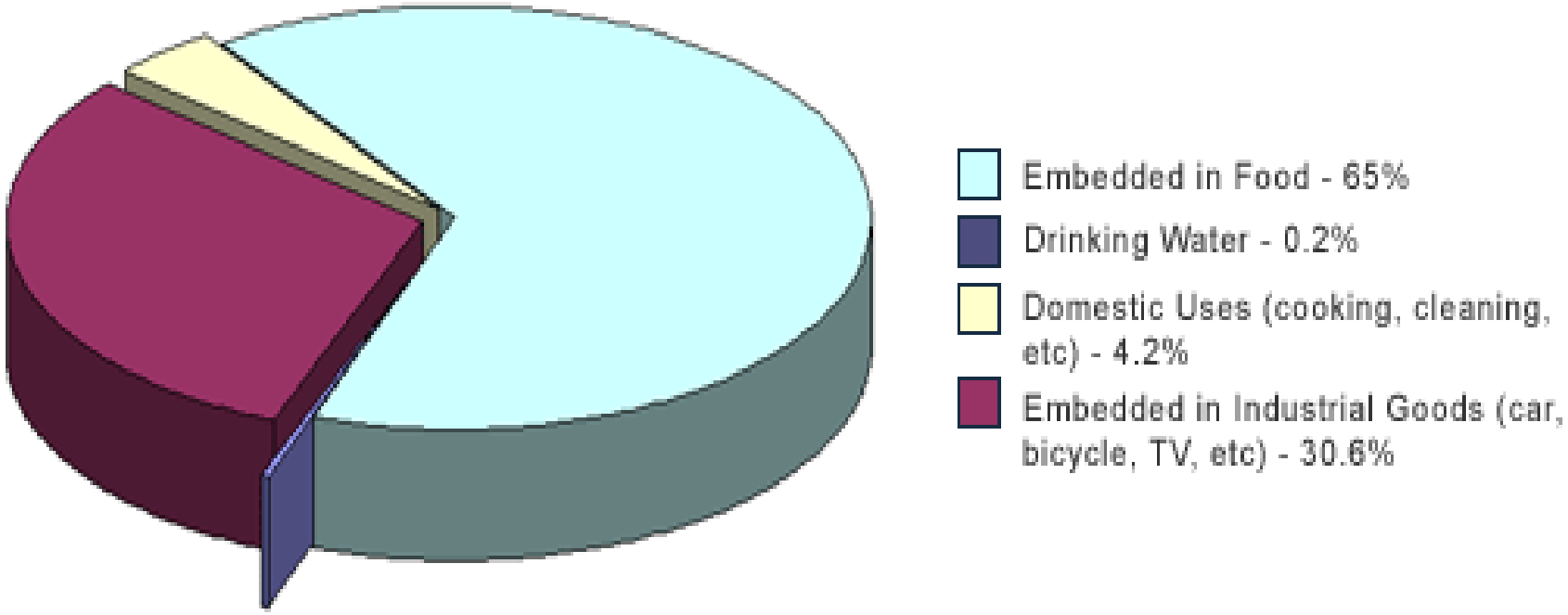
Water Use on farms

- Nearly 70 percent of global freshwater withdrawals are directed toward agriculture, mainly for irrigation
- Demand for water will rise due to climate change and increases in world population
- Important as agriculture can
  - Use water inefficiently on farms
  - Cause pollution to water courses

https://www.eea.europa.eu/data-and-maps/figures/agricultural-industrial-and-household-water-prices-in-late-1990s



Areas of water consumption in the UK



Embedded Water Definition

Embedded water is the amount of water used in the entire process of producing, retailing and consuming (cooking for example) a product. It is also referred to as virtual water, embodied water or shadow water. The concept is very similar to embedded carbon

Source: Waterwise

The Pearl River Estuary, Guangdong Province, South China

See Quingdao on: https://www.beforetheflood.com/explore/the-crisis/sea-level-rise/

THE SHRINKING ARAL SEA
1960–2014

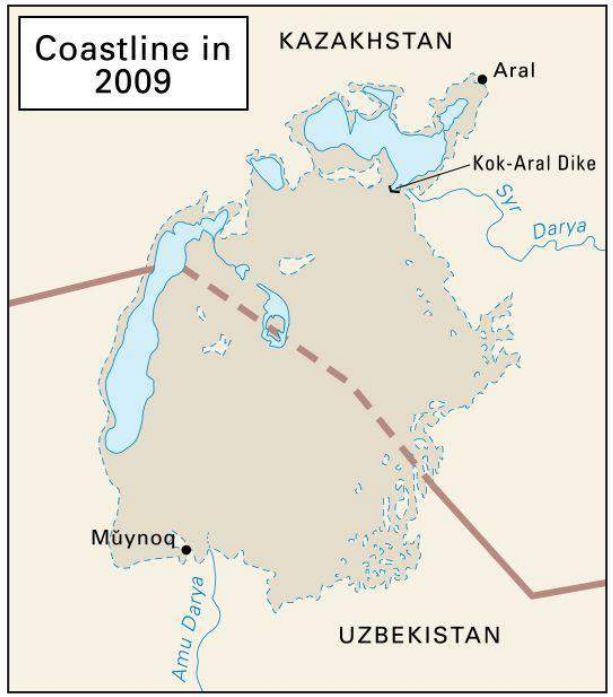
It was once the world's fourth largest body of inland water but has shrunk to a fraction of its former size because of the diversion of its inflowing rivers for agricultural irrigation.

Land submerged in 1960

1960 coastline

International boundary on former seabed

0 30 60 mi
0 30 60 90 km



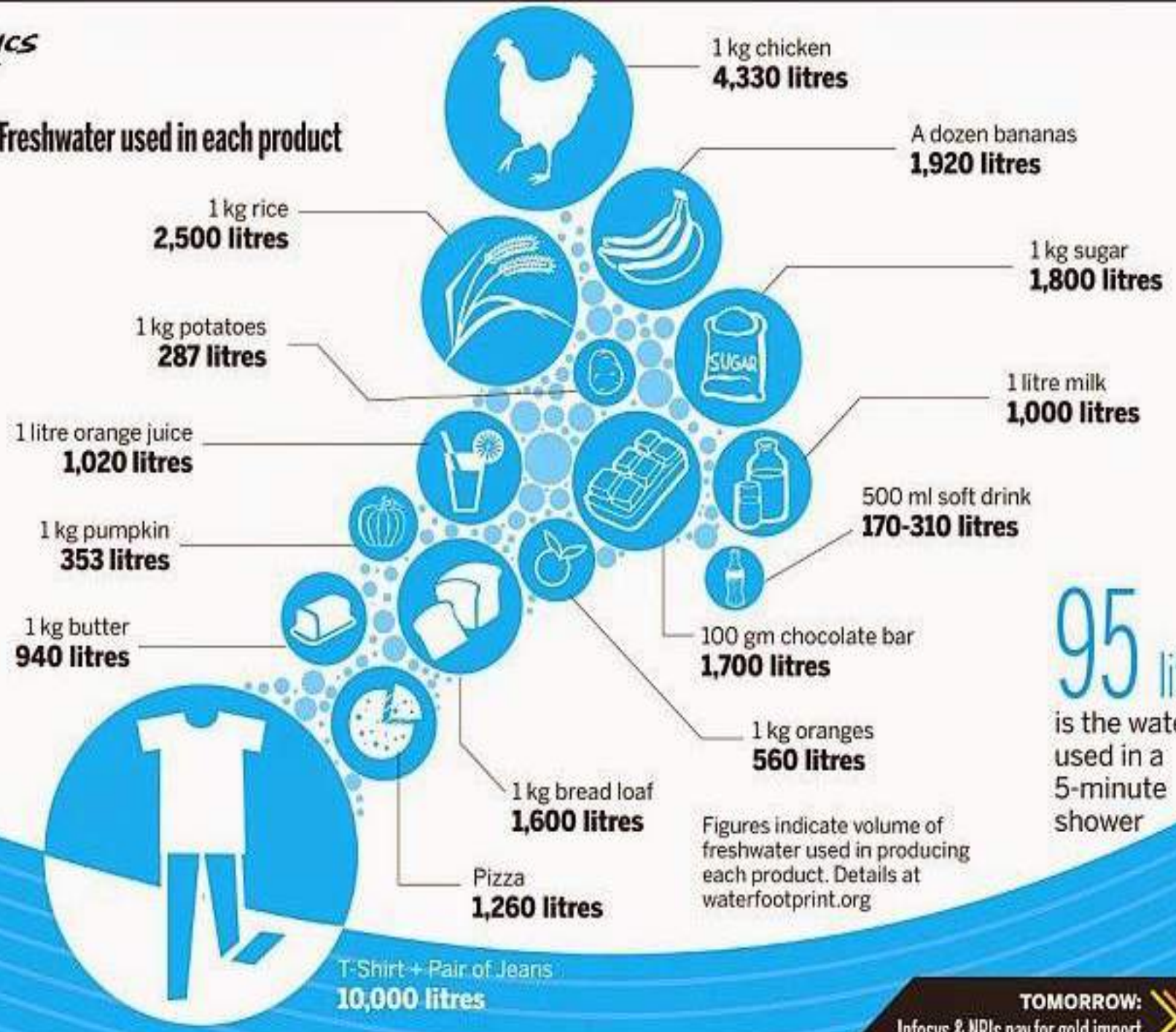
Why did the Aral sea shrink?

visual EDIT BY funALYTICS

YOUR WATER FOOTPRINT...

...is much larger than you think. The amount of water you consume depends not just on the duration of your daily shower or the number of clothes you wash but also on what you eat, the clothes you wear & the fuel you use. Take a look, calculate your water footprint & reduce it to earn a few extra minutes in the shower

Freshwater used in each product



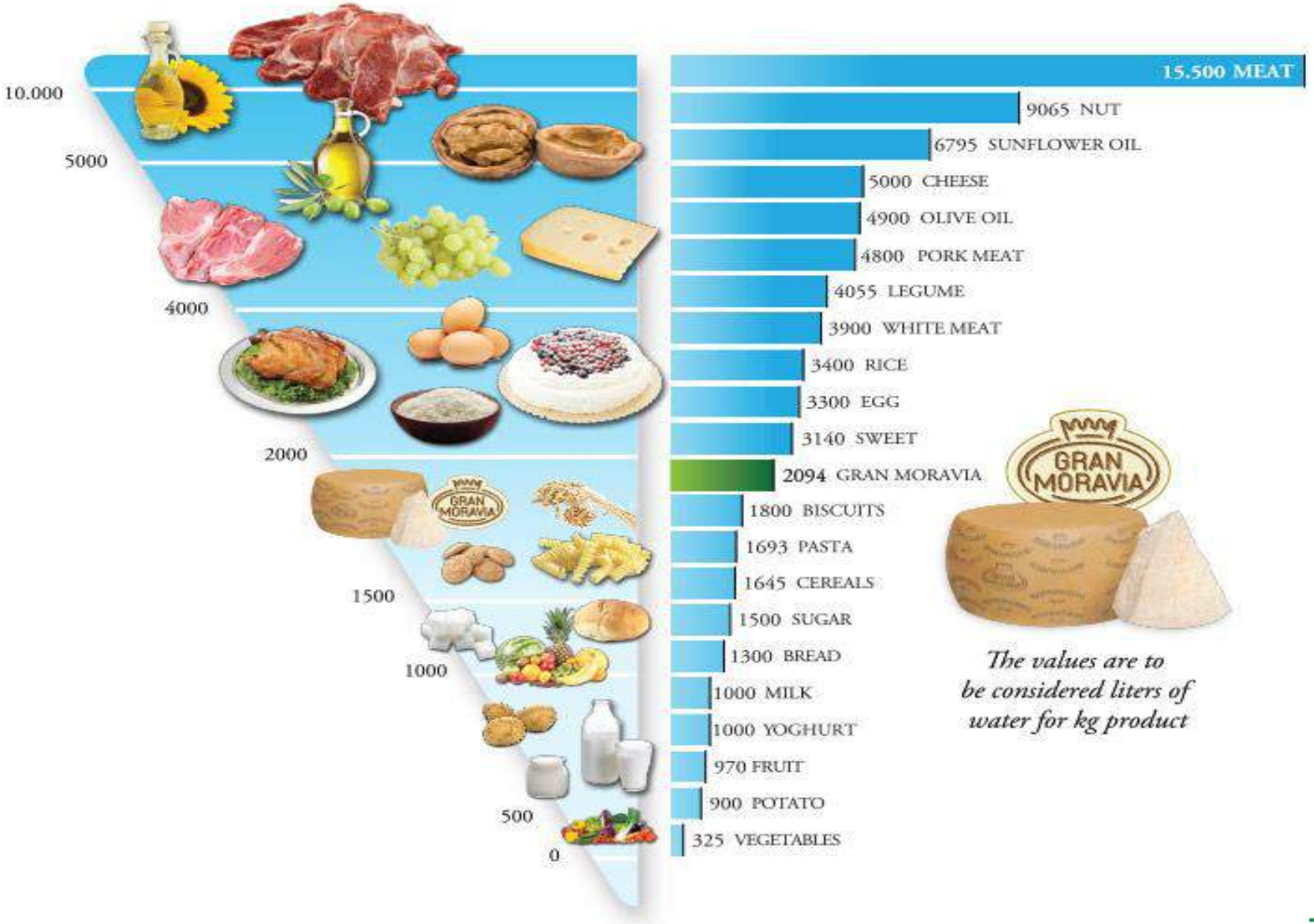
Figures indicate volume of freshwater used in producing each product. Details at waterfootprint.org

1,400 litres
of water is what goes into a typical morning breakfast

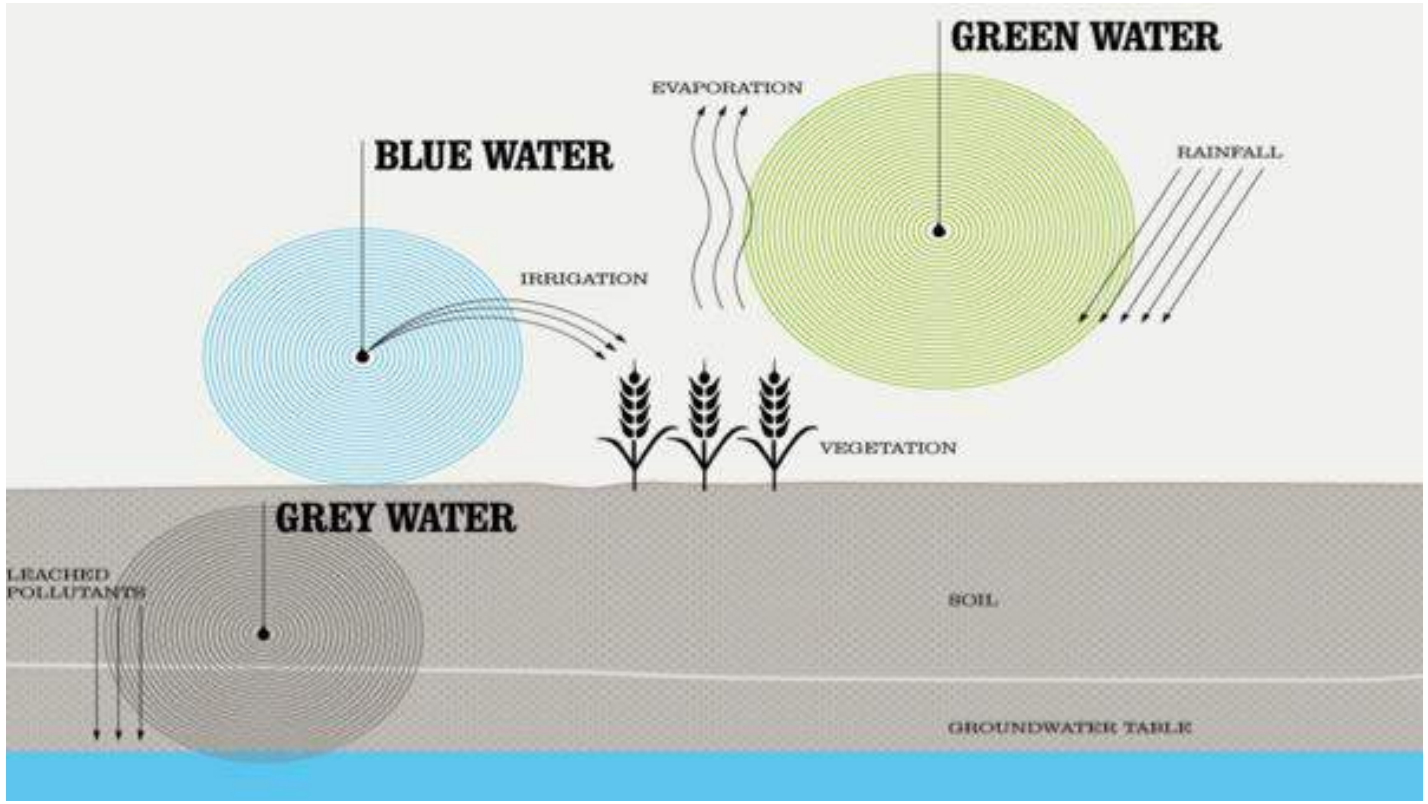
95 litres
is the water used in a 5-minute shower

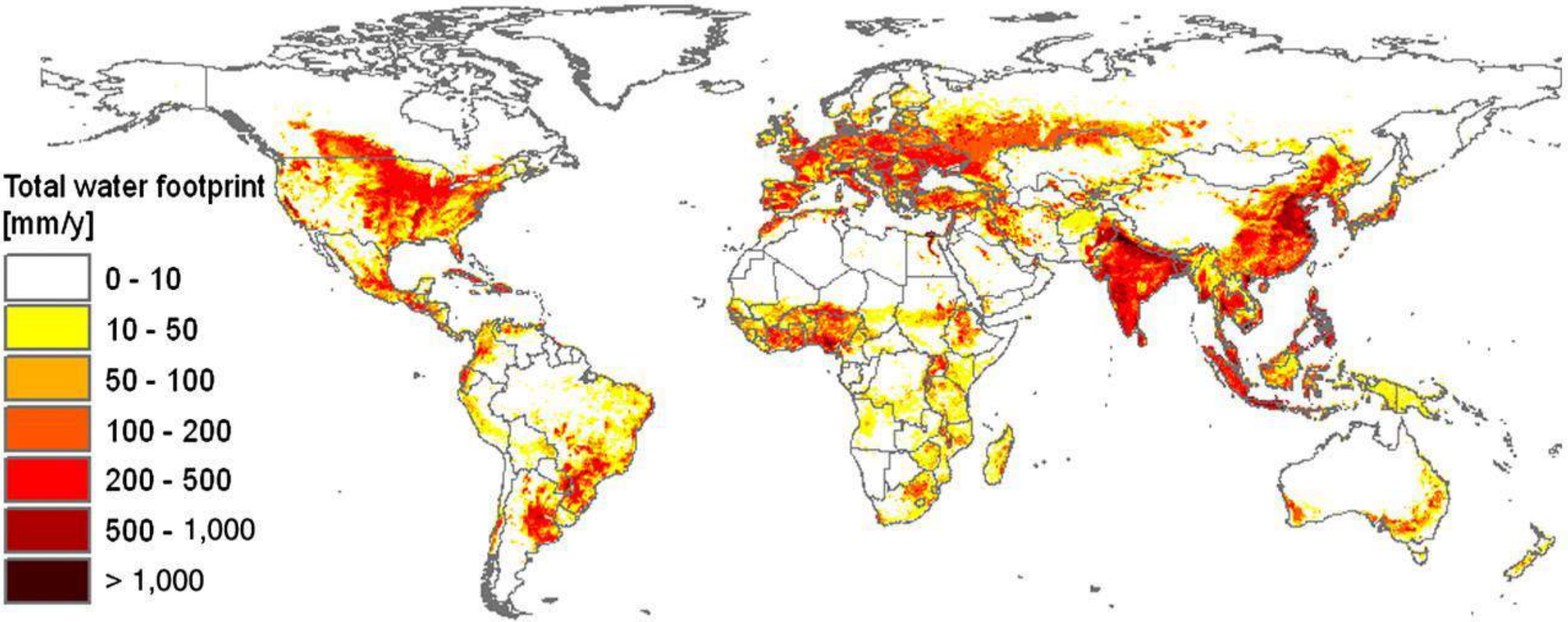
TOMORROW:
Infosys & NRIs pay for gold import

- Agricultural products



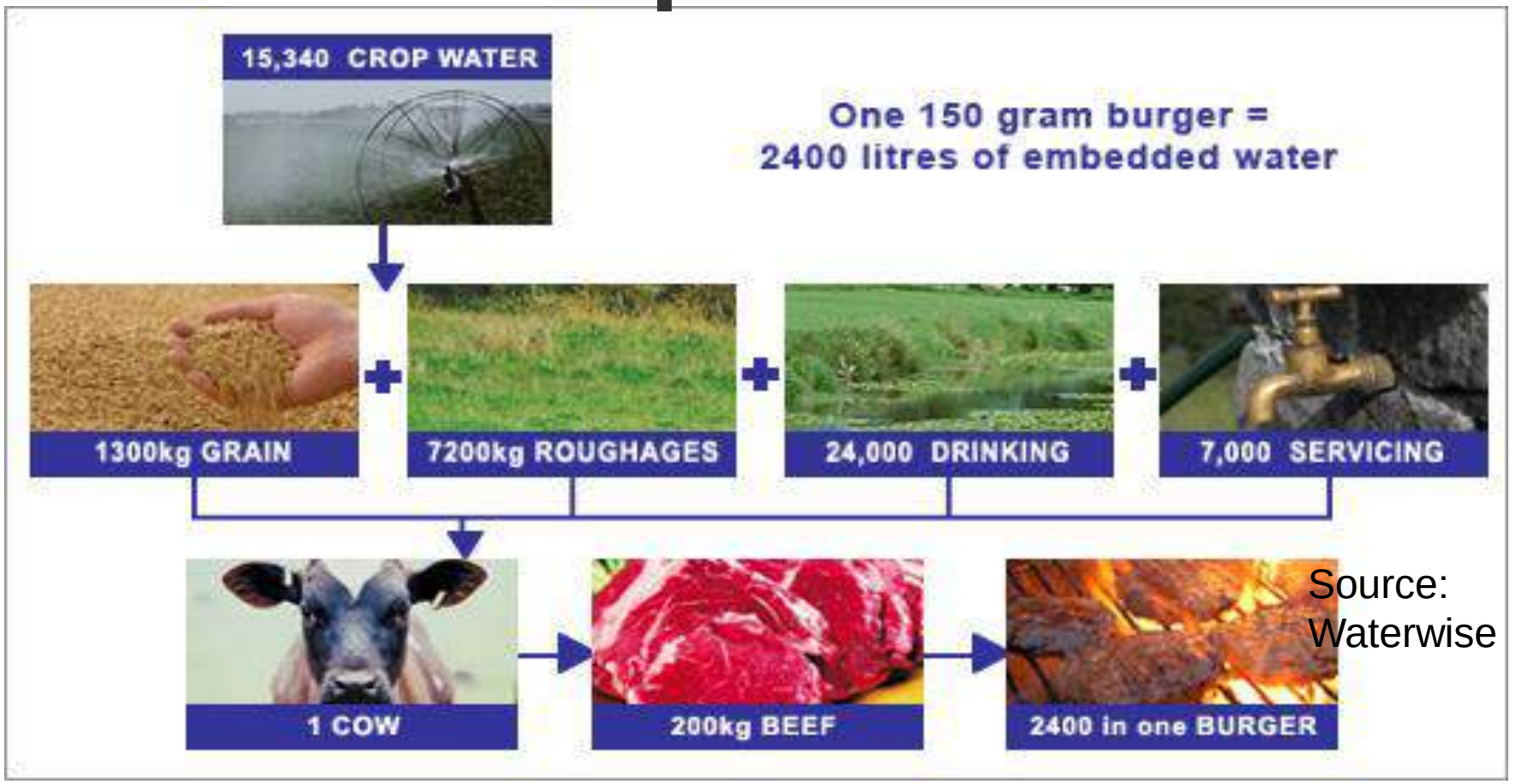

Water footprint
Green water
Blue water
Grey water
Rain water used
Water used from surface and groundwater
Freshwater used to dilllute pollution


GREEN WATER
EVAPORATION
BLUE WATER
RAINFALL
IRRIGATION
VEGETATION
GREY WATER
LEACHED POLLUTANTS
SOIL
GROUNDWATER TABLE



https://www.pnas.org/doi/full/10.1073/pnas.1109936109

Example of embedded water in beef production



Source: Waterwise

http://environment.nationalgeographic.com/environment/freshwater/embedded-water/

Improving water use on farm

Review water use quarterly. Look out for any increase in use that may indicate leaks.

Reuse water where possible.

Use a pressure wash instead of a low-pressure hose.

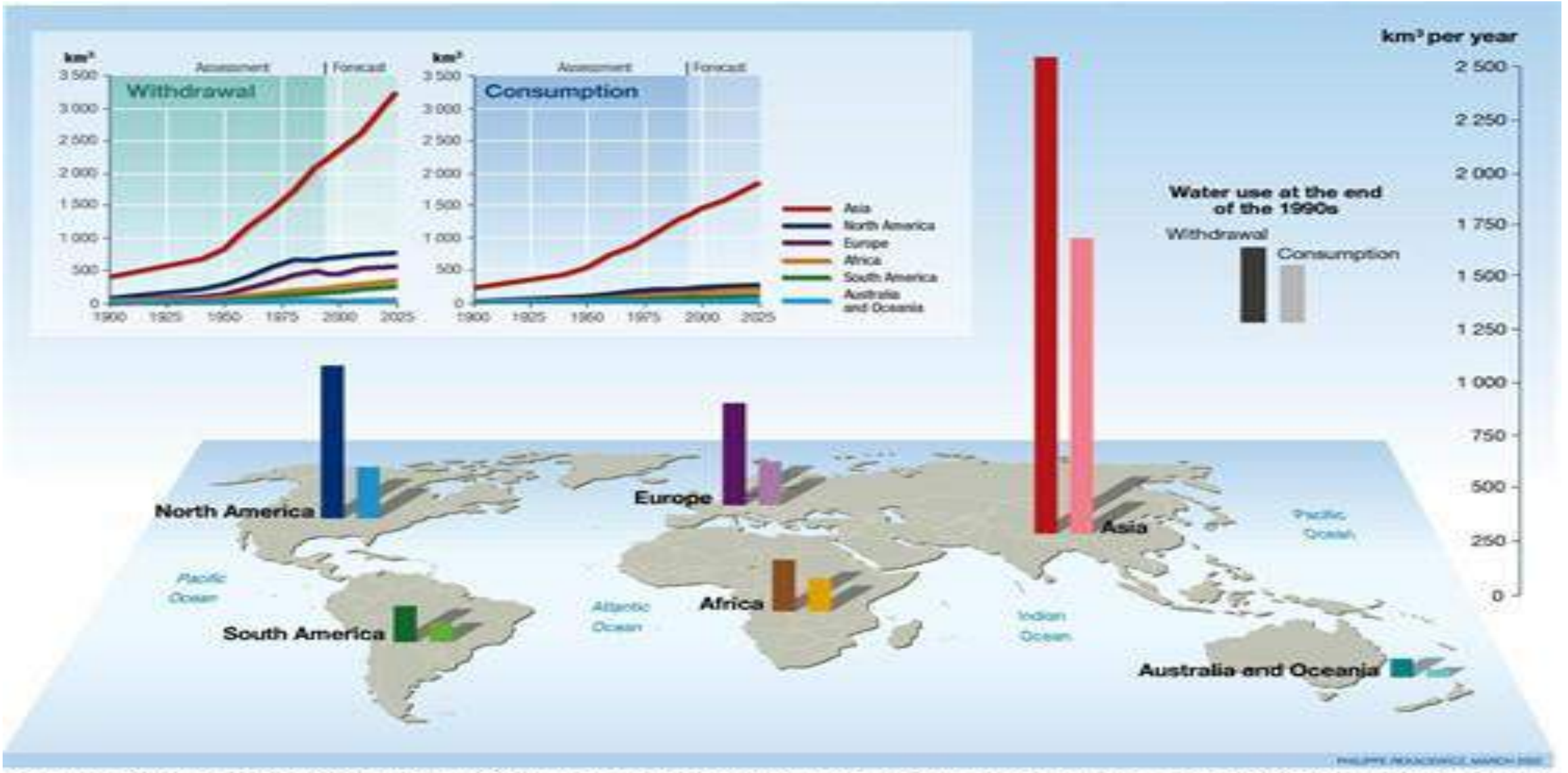
Install a high-pressure wash system for bulk tanks.

Irrigate at night and consider using trickle irrigation.

Use a more accurate boom irrigator in place of a rain gun, so that you lose less water through evaporation.

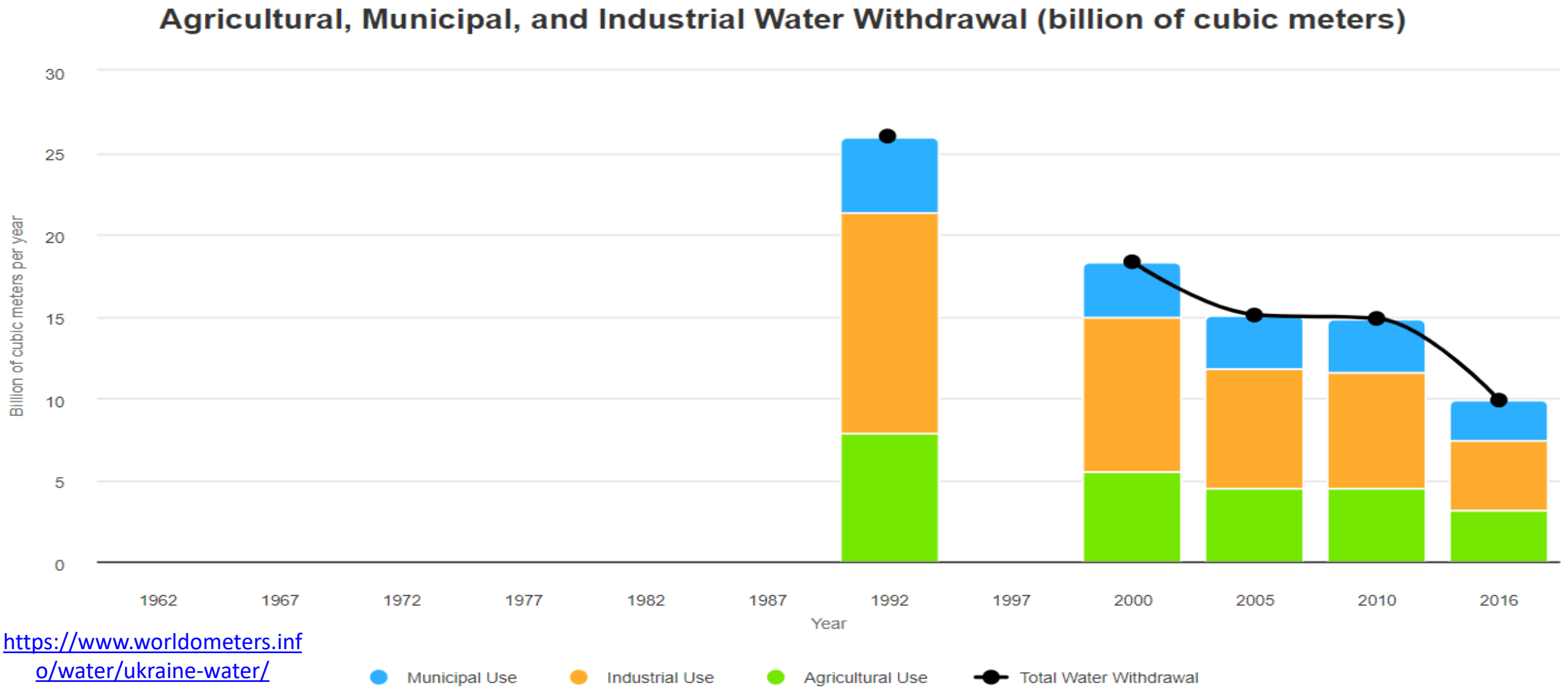
Use a tied ridger to create ridges between rows of crops, holding back water and preventing erosion.

Drip irrigation, delivered with the help of equipment that constantly monitors soil moisture, improves crop quality and yield while using less water.

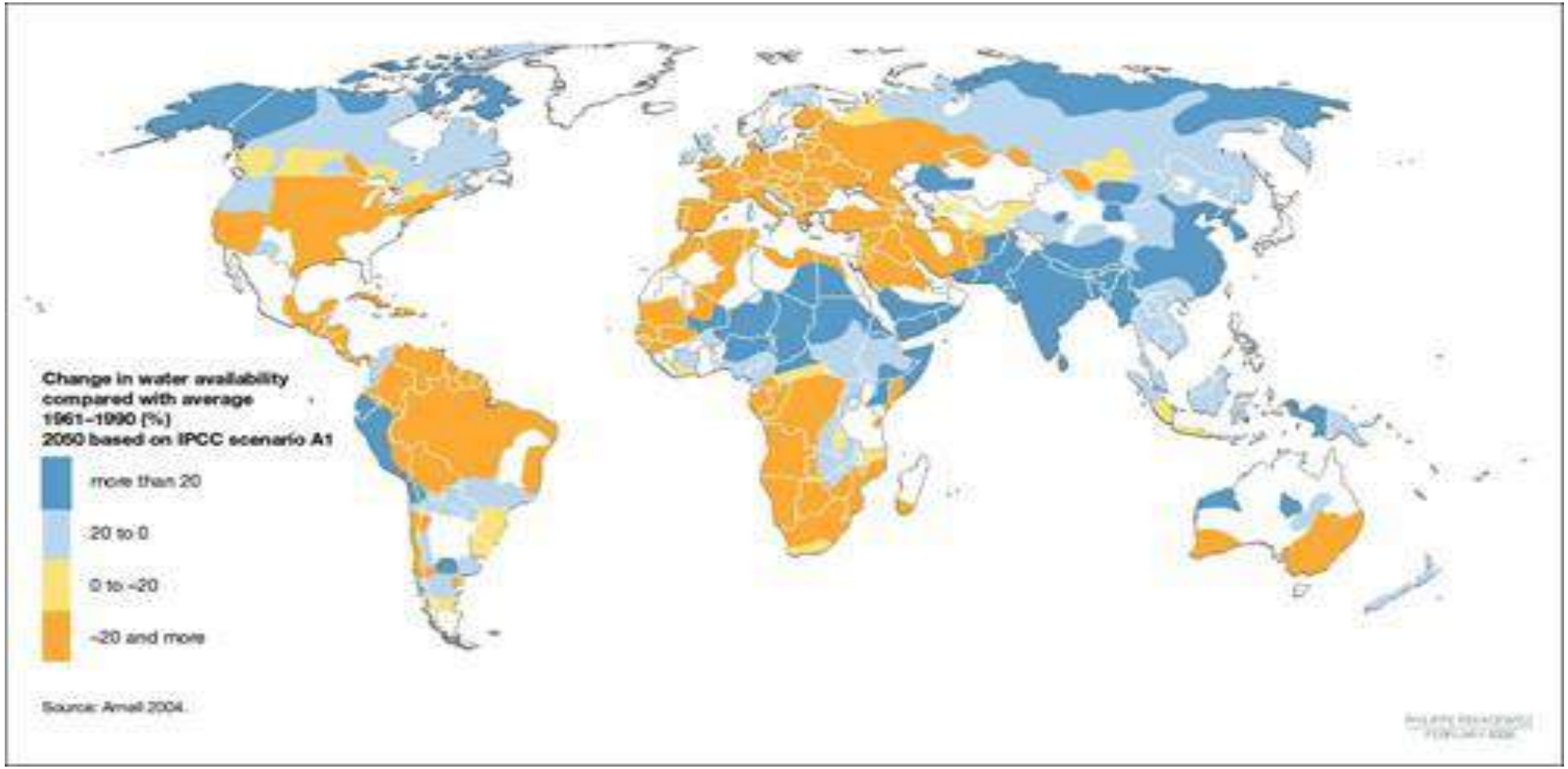


Source: Igor A. Shiklomanov; State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational,Scientific and Cultural Organization (UNESCO, Paris), 1999; *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000; Paul Harrison and Fred Pearce, *AAAS Atlas of Population 2001*, American Association for the Advancement of Science, University of California Press, Berkeley.

Ukraine's water withdrawals

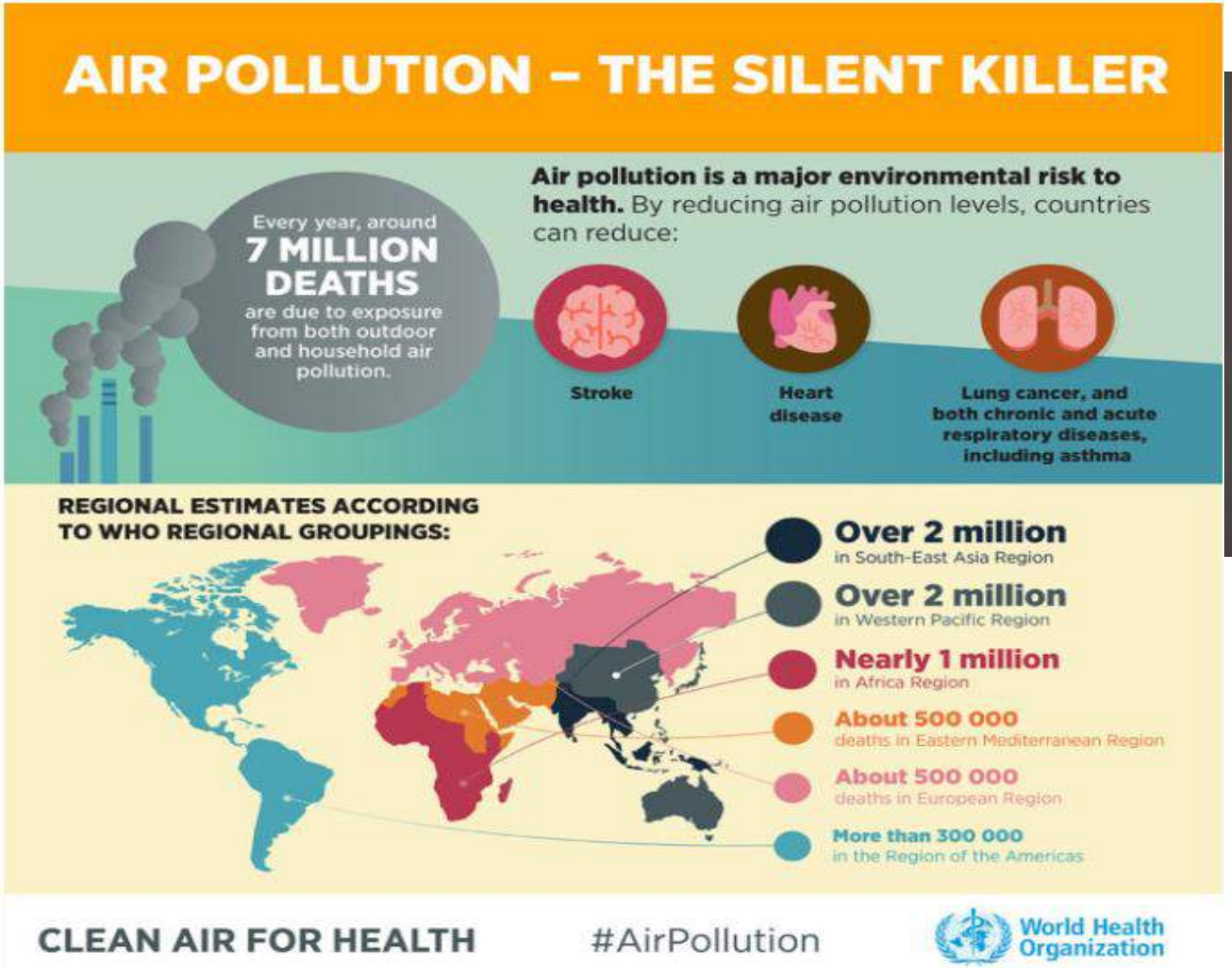


https://www.worldometers.info/water/ukraine-water/



This potentially makes Ukraine one of the most vulnerable zones to water shortages.

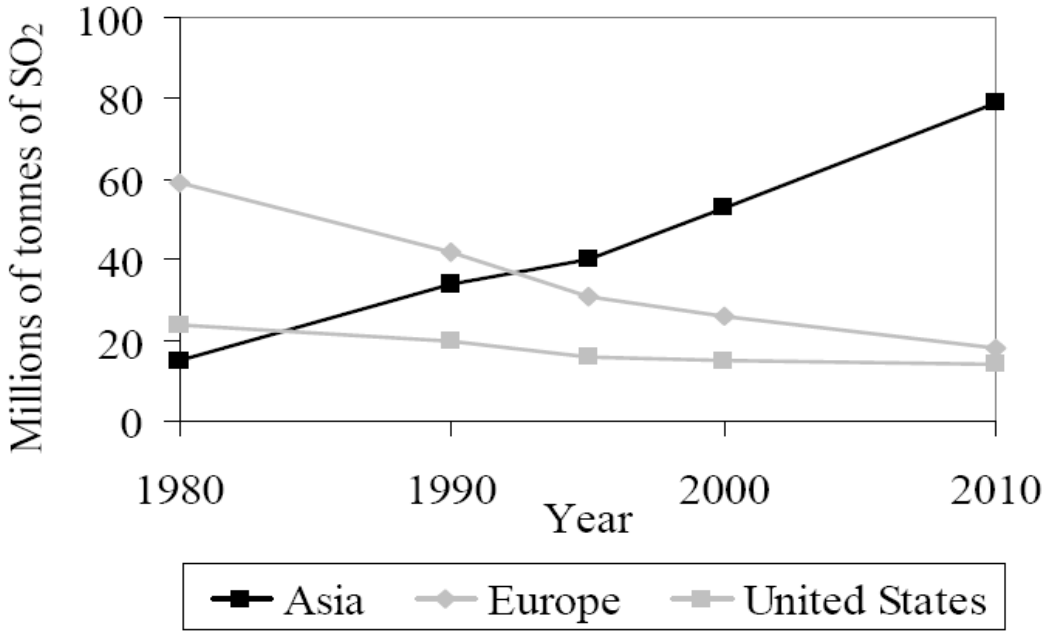
Agriculture will need to adapt both in cropping and water efficiency



https://www.who.int/news/item/02-05-2018-9-out-of-10-people-worldwide-breathe-polluted-air-but-more-countries-are-taking-action

Air and agriculture

- Air can be polluted by agriculture in the following ways:
  - Nitrogen Compounds (nitrous oxide and ammonia)
  - Dust
  - Odour
  - Smoke (Farm Waste Management controls have reduced this substantially)



Regional SO_2 emissions from fossil fuel burning (UNEP, 2000)

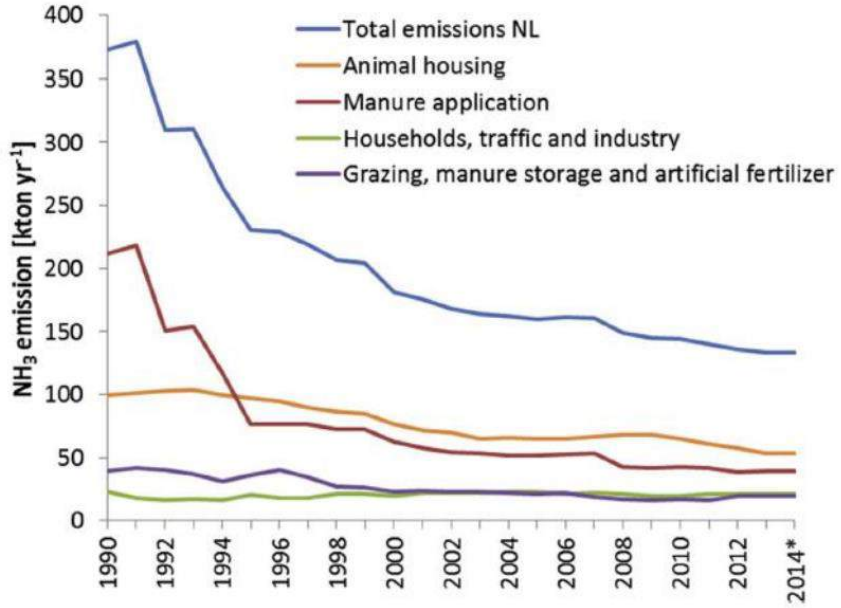


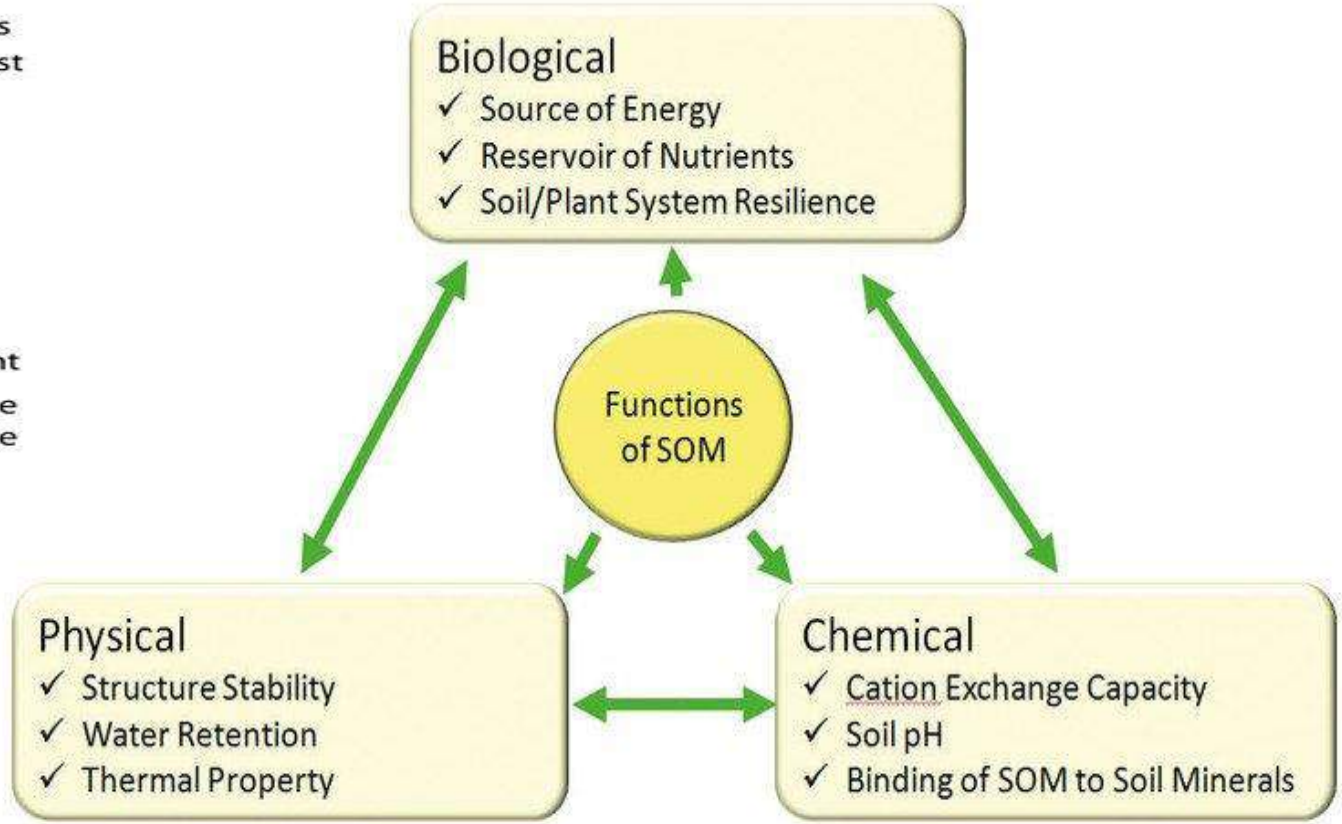
Figure 7: Estimated contributions to the changes in NH_3 emission from agriculture in the Netherlands 1990 to 2014 (Wichink-Kruit et al., 2017).

Effect of air pollutants on plant growth

Pollutant	Major sources	Major impacts	Major scale of effects
Sulphur dioxide (SO_2)	Power generation; industry; commercial and domestic heating	Visible foliar injury; altered plant growth; elimination of lichens and bryophytes; forest decline	Local
Nitrogen oxides (NO_x)	Power generation; transport	Altered plant growth; enhanced sensitivity to secondary stresses; eutrophication	Local
Ozone (O_3)	Secondary pollutant formed from NO_x and hydrocarbons	Visible foliar injury; reduced growth; forest decline	Regional
Suspended particulate matter (SPM)	Transport; power generation; industry; domestic heating	Altered plant growth; enhanced sensitivity to secondary stresses	Local
Fluorides	Manufacturing and smelting industries	Reduced plant growth; fluorosis in grazing animals	Local

Emberson 2003

Soil, air and water are closely linked



1% organic matter in top 15cm rootzone weighs about 20,000Kg per hectare

Table 1. Two versions of sustainable agriculture and their key assumptions: a summary

Version 1	Version 2
'Sustainable' intensification and land sparing to meet an inevitably increasing global demand for food.	Agroecological approaches with land sharing and sparing, enabled by demand reduction through the adoption of healthy, sustainable, low-waste food consumption.
Key assumptions	**Key assumptions**
Demand is exogenous, and will increase as population size and wealth increase.	Demand can be changed, and should be shaped by social needs.
Growing market demand requires productivity growth to raise supply.	The current unsustainability of farming is a form of market failure that can be corrected to reduce demand.
Dietary change is difficult, and is not the preserve of policy.	A healthy diet is also a (more) sustainable one.
The potential for technologically led sustainable intensification is substantial.	Agroecological approaches can supply sufficient nutrients to 'feed the world', if consumption patterns change.
Land sparing is enabled by sustainable intensification.	Agroecological approaches are more sustainable than sustainable intensification.

Source: Chatham House research.

https://www.chathamhouse.org/sites/default/files/2022-05/2022-05-24-sustainable-agriculture-benton-harwatt_4.pdf

A model for improving Ukraine's natural capital after the war

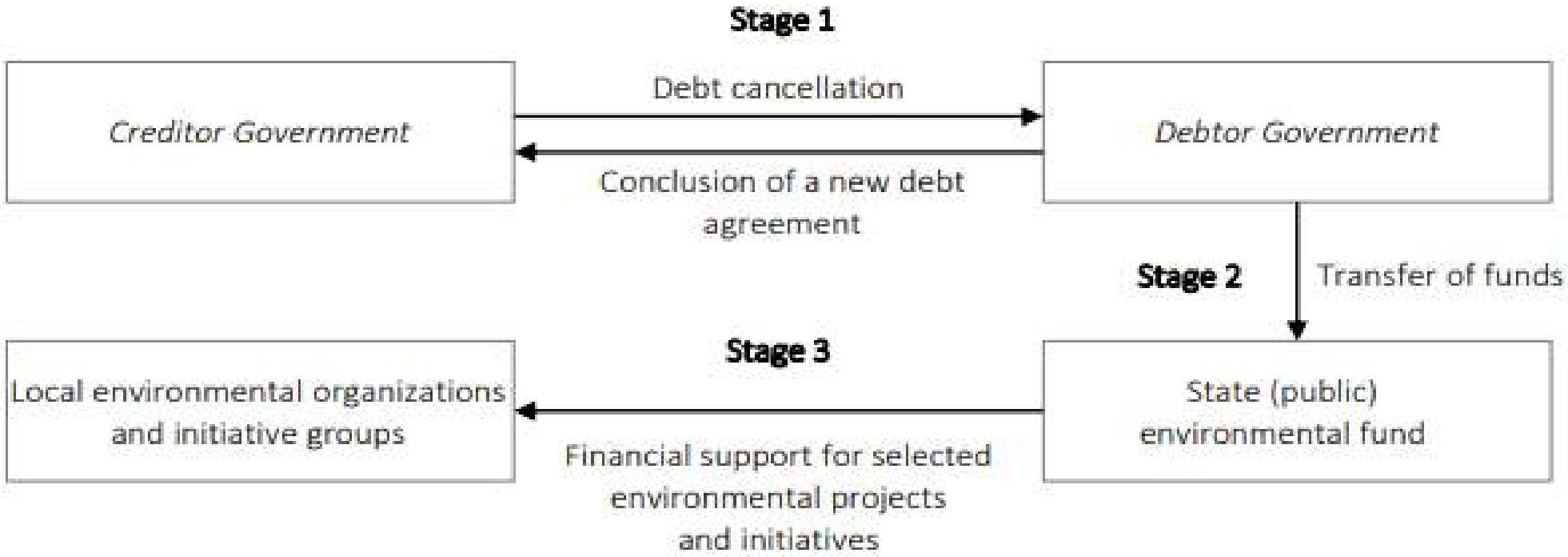


Figure 4. Illustrative example of bilateral debt-for-nature initiatives

Naumenkova et al (2023). Debt-for-nature or climate swaps in public finance management. Problems and Perspectives in Management

Challenges for Agriculture

- These are many both to cope with and also mitigate climate change
- Every farm has a part to play
- Important to understand the implications of all systems and operations

- Lots of challenges but loads of opportunities

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