Climate Change, Water Resources, Scarcity, and Pollution

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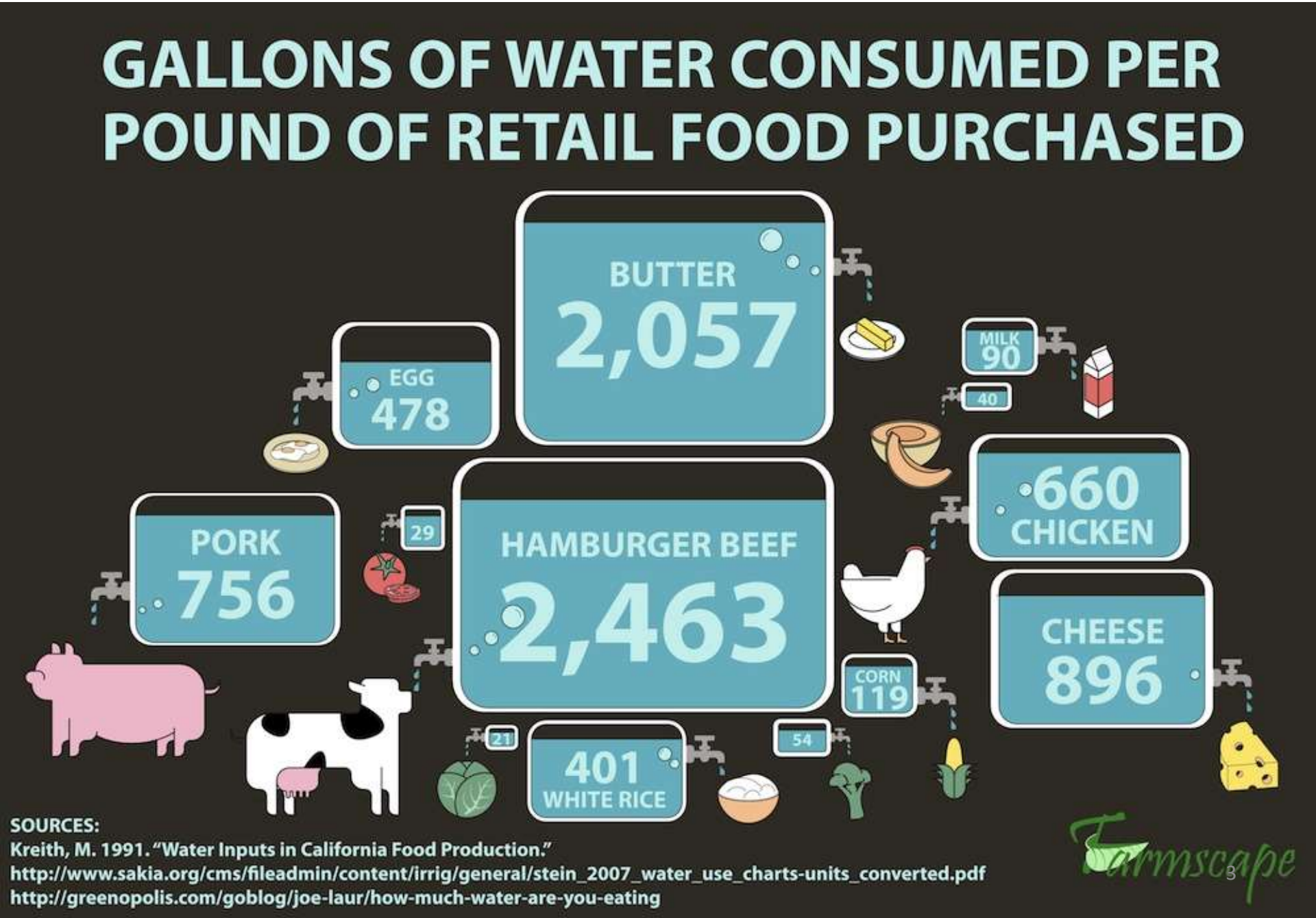
Kansas River at Manhattan, KS

Humans Must Have Water to Live…

- Must be in “just the right” amounts
  - Flooding = too much!
  - Drought = too little!
- Timing is really important too…
- Must be accessible…
  - Not too far away or locked in ice or underground…
- Must be clean enough to drink and abundant enough for producing food and other uses…

1 almond requires 1 gallon of water, 1 walnut requires 5 gallons, 1 avocado requires ~60 gallons



Population Concerns

- The U.S. Census Bureau estimates that by 2050, the number of people on Earth ≈ 9.5 billion, or about 40% greater than it was in 2010.

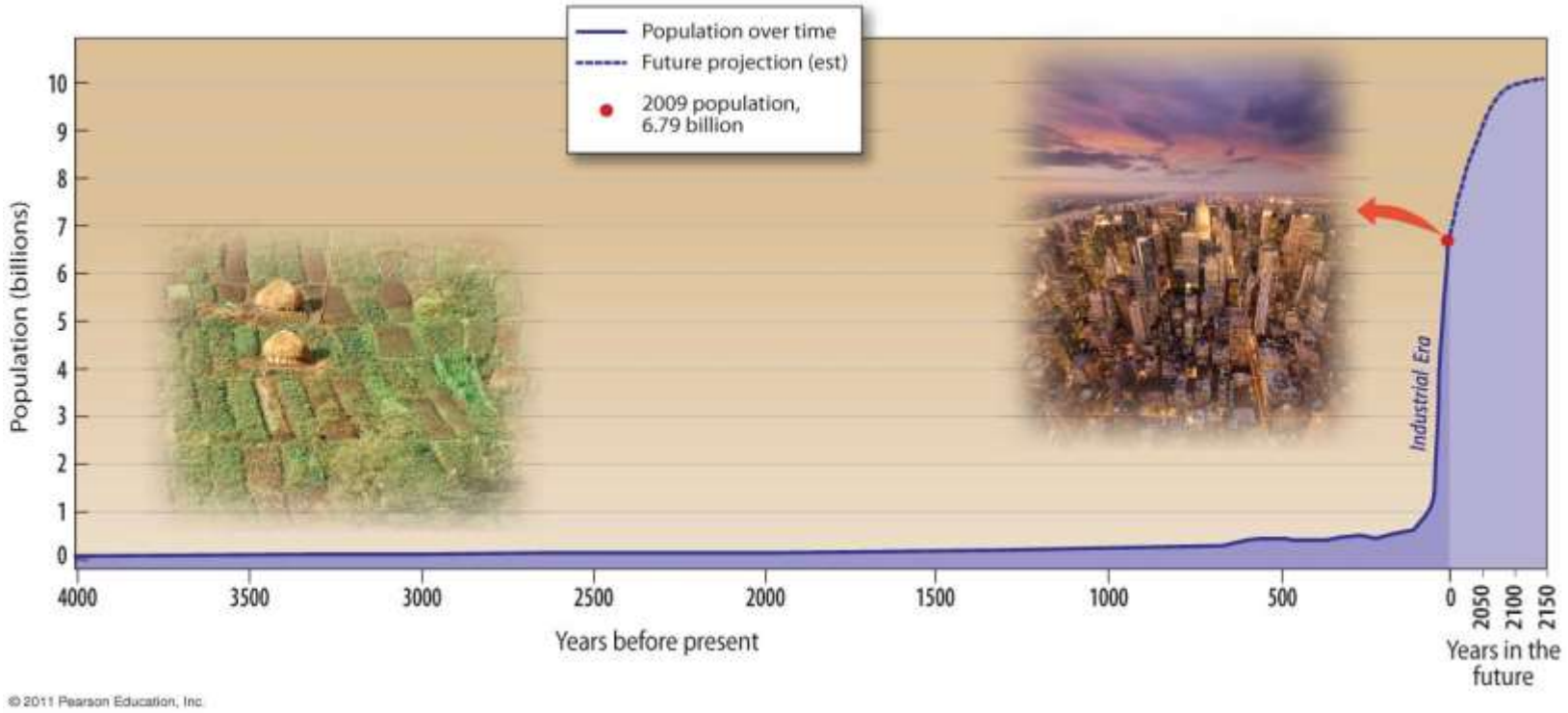


Figure 1-4 Human Population Blasts Off

http://www.npr.org/2011/10/31/141816460/visualizing-how-a-population-grows-to-7-billion

Earth is Like an Island in Space

- We are exceeding the carrying capacity of many resources on Earth:
  - Petroleum
  - Coal
  - Trees
  - Soil
  - **Water**
    - **Rivers**
    - **Groundwater**
  - Seafood
  - And 1000s of other resources
- Without technology, modern humans would suffer the same fate as Easter Islanders did.

Moai on Easter Island

Sustainability

- Sustainability is a critical concept in environmental studies and is one that we will use as a measure throughout *Living with Earth.*
- Being sustainable means the capability of continued existence in an environment with minimal long-term effect on it.
- Not exceeding the carrying capacity of the land/Earth!!!

Figure 1-3 Many Natural Resources Can Be Sustained On farms like this experimental agricultural station in Peru, methods are carefully chosen to help maintain soil quality.

Sustainability Examples:

- If you have an aquifer with 100 meters of water, but use 10 meters per year:
  - In 10 years, you would be out of water.
    - That's unsustainable!
    - Also, pumping the aquifer dry results in destroying pore space (aquifer capacity)…
  - If you allow enough recharge to keep pace with usage, its possible to extend the longevity of the aquifer.
    - That's sustainable (with conditions).
      - Recharge must keep pace with your demand for water…
      - Mining water shouldn't destroy aquifer capacity…

- If you owned a forest with 1000 trees in it, but cut down 100 trees per year to heat your home:
  - In 10 years, you would be out of trees.
    - That's unsustainable!
  - If you replace the trees you cut by replanting, its possible to extend the longevity of the forest.
    - That's sustainable (with conditions).
      - Replanting and growth must keep pace with your demand for trees…
      - Harvesting trees shouldn't destroy habitat…


Las Vegas, Nevada is NOT Sustainable!!!
2009/03/27 1:42 pm

Non-functional vegetation ~ lawns and ornamental landscaping

- Accounts for ~50% of water use in some places like Las Vegas, L.A., etc…
  - Felicia Marcus
    - Attorney and Consultant;
    - DWFI Board Member
    - Water Policy Group

Sustainable – xeriscaped – butterfly bush

Not Sustainable – not xeriscaped

Lake Mead and Hoover Dam

- Much of the electricity generated at Hoover Dam goes to Las Vegas, NV and Los Angeles, CA.
- Millions of gallons of water are also taken from this reservoir for LA and Vegas as well.
  - They are extremely dry areas and don't have enough water to support themselves there without external inputs of water.
  - LA and Vegas are not sustainable in terms of water (or electricity) use/demand.
  - Why did Las Vegas become the place it is?
    - They wanted less regulated gambling, and that's where they could do it in the early 1930s.
    - The decision wasn't based on practical things like water, food, climate, or situation (like a river).
    - The population quickly outgrew the local resources
      - Exceeded the carrying capacity of the area
  - In 2021, Lake Mead is/was at a record low since filling in 1930s
    - Down 140 feet since 2000 when considered "full"…and its still falling…
    - https://www.wbur.org/hereandnow/2021/07/09/southwest-water-shortages
    - What will LA and Las Vegas do when there isn't any water or power coming from these dams?

Lake Powell water level is down…

https://www.nps.gov/glca/learn/news/20210419.htm

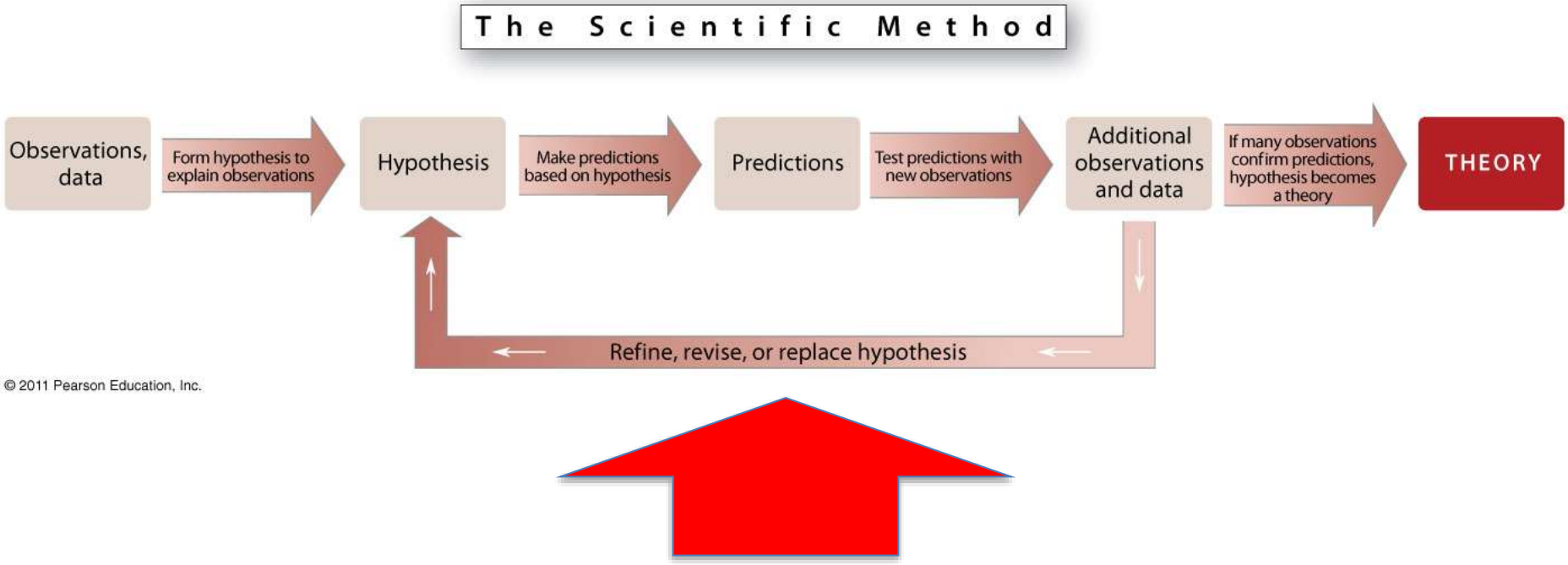
How Science Helps

- Science helps people to better understand and solve problems.
  - Science is one of many ways/methods to “know” something, or produce knowledge.
  - Its basically an order of operations that allows us to create knowledge or build upon pre-existing knowledge.

- Predicting volcanic eruptions, or where landslides will occur or other problems such as Climate changes related to water is possible with science, for example…

Doing Science—An Iterative Method

Figure 1-13 The Scientific Method



The best part about Science is right here, because being able to change the questions you ask is critical to understanding something. It's a huge shortcut to understanding something! When you have more questions, Science lets you ask them. Because of this quality, Science is self-correcting and iterative. Very few other knowledge production methods do this…

Iterative = repeating, or repetitious

SCIENCE IN YOUR FUTURE

Science can be used as a tool to address some important human-environment interaction issues such as:

- Availability of clean water
  - Will be the biggest problem in this century…
- Transition from oil to other energy sources…
- Global climate changes…

Figure 1-14 A Thirsty World
The demand for water is increasing for drinking, sanitation, industry and agriculture. Resources are being strained.

IPCC 2021 – A. The Current State of the Climate

A.1 It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

A.2 The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years.

A.3 Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. **Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones**, and, in particular, their attribution to human influence, has strengthened since the Fifth Assessment Report (AR5).

A.4 Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3°C, with a narrower range compared to AR5.

IPCC 2021 - B. Possible Climate Futures

B.1 Global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO2) and other greenhouse gas emissions occur in the coming decades.

B.2 **Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, and heavy precipitation, agricultural and ecological droughts in some regions, and proportion of intense tropical cyclones, as well as reductions in Arctic sea ice, snow cover and permafrost.**

B.3 **Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.**

B.4 Under scenarios with increasing CO2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO2 in the atmosphere.

B.5 Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level.

Climate Change, Water Pollution & Scarcity

- Water pollution and freshwater scarcity are already major (and growing) problems.

- Climate changes (warming) exacerbate other water problems:
  - Droughts decrease availability.
  - Changes in weather patterns decrease availability and or expected, regular water deliveries.
  - Sea level rise and salt water intrusion.
  - Increased withdrawals from aquifers = “use it and lose it” scenarios.
  - Increased pollution into depleting freshwater sources further degrades the water resources
    - Increased pollution into rivers and especially aquifers results in unusable water resources and increased sickness and diseases.
  - Catastrophic Outburst Floods and Mass Movements Caused by Climate Change Can Destroy otherwise “safe” Water Reservoirs…

Living Near Water is Inherently Dangerous - Fatalities and Flooding

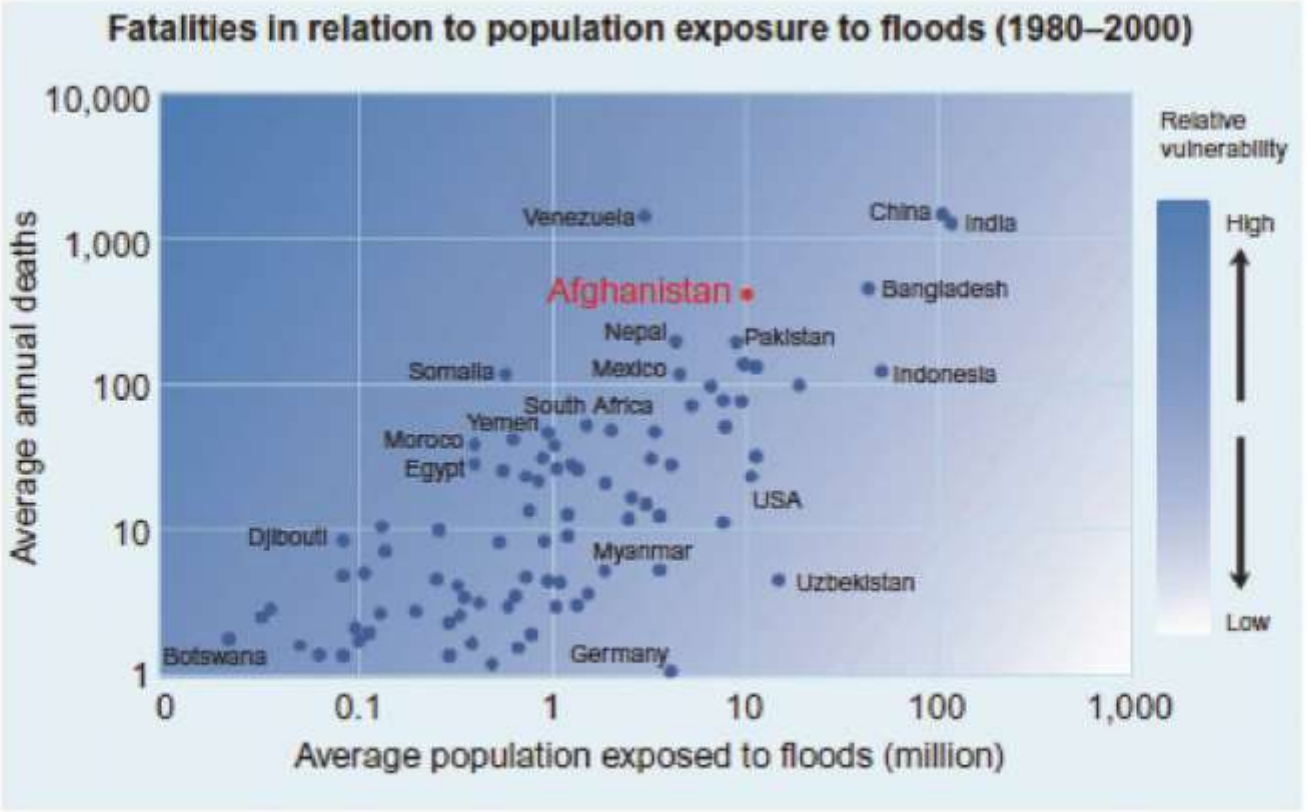


FIG. 5.7 Afghanistan is among the most vulnerable to floods in the world (Thomas and Eqrar, 2011). *Adapted from UNEP/GRID Geneva as quoted in ICIMOD presentation—Kabul (May 2008).*

Rishiganga Hydroelectric Project and dam

Photo from Ajay Bhatt / AFP: www.scroll.in/

Damaged Dhauliganga hydropower project after a glacier broke off in Joshimath causing a massive flood in the Dhauli Ganga river, in Chamoli district of Uttarakhand, Sunday, Feb. 7, 2021. Photo: PTI; www.thewire.in

Nanda Devi Glacier Outburst Flood, Uttarakhand, India

- Ice and debris flow from large piece of glacier that broke away.
- Rishiganga Hydroelectric Project was building a dam and infrastructure at Reni, India (~300 km NE of New Dehli).
  - Construction began in 2006 (15 years ago).
  - Debris/ice flow destroyed the dam on 2-11-21.
- Nearly 200 people missing.
- Video