

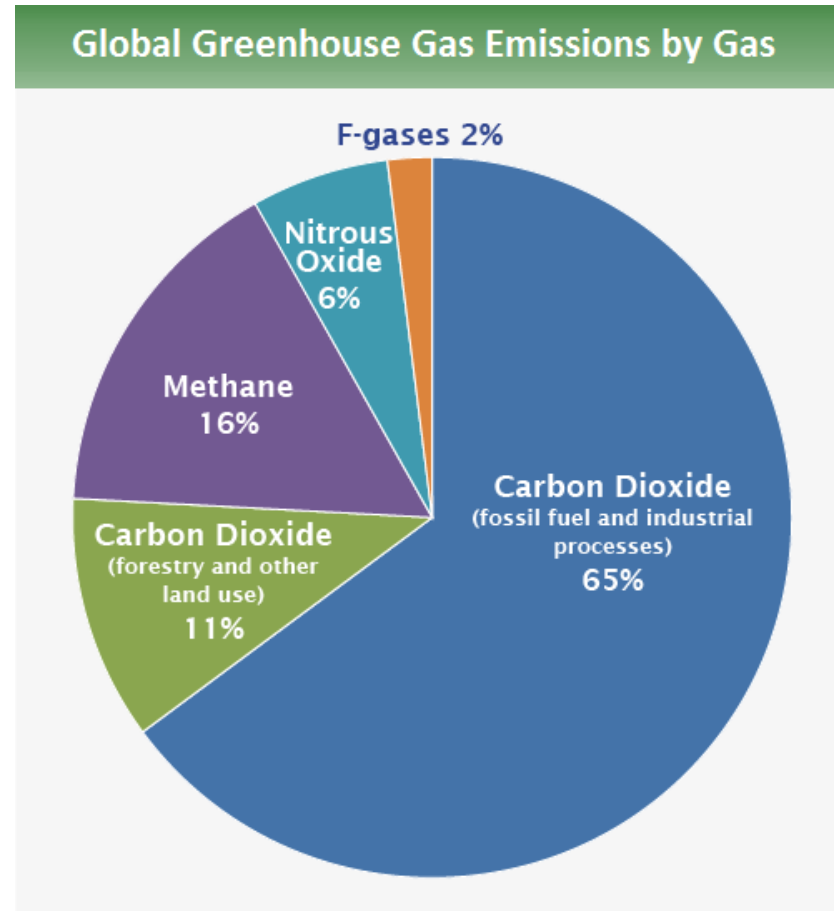
Methane's influence on climate change and how it affects our global water resources

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Globally: After CO₂, Methane is 2nd Largest GHG Emitted from Human Activities



Bottom Line Up Front

- Methane is a major contributor to global warming, which leads to climate change.
- Methane emissions can be decreased through assistance by the oil and gas industry.
- Reducing methane along with CO₂ emissions will help reduce global warming, which causes more extreme weather events that lead to decreased recharge in most latitudes (IPCC 2022).
- Less recharge means less available groundwater, which is problematic because groundwater is already being increasingly used by both third world countries as well as more established countries.

Important Facts About Methane (CH₄)

Methane is responsible for almost ½ (~45%) of global warming

Methane can trap 80 times as much heat as carbon dioxide in the first 20 years after its release into the atmosphere, before it is chemically broken down (IPCC).

Methane can trap 28 times as much heat as carbon dioxide in the first 100 years after its release (IPCC)

The methane released this year will cause as much warming over the next decade as all the CO₂ emissions from all fossil fuels burned this year, according to estimates based on peer-reviewed studies.

Reducing methane pollution is the most effective way to slow the rate of global warming in the short term, according to the United Nations Environment Program, among other sources.

More Facts About Methane (CH₄) & COP 28 Agreement

At COP 28 on December 2, 50 large hydrocarbon firms pledged to virtually eliminate CH₄ emissions associated with the exploration and production of fossil fuels by 2030.

The adopted target: To cut methane emissions by an order of magnitude to a 0.2% of oil and gas production by the end of the decade.

Firms also agreed to end routine flaring of CH₄; note that CH₄ comprises 70-90% of natural gas

Farming releases the most CH₄, largely via belching ruminants (cows mostly, from digestion) and upturned land

The energy sector is more concentrated and thus easier to regulate to curb CH₄ emissions

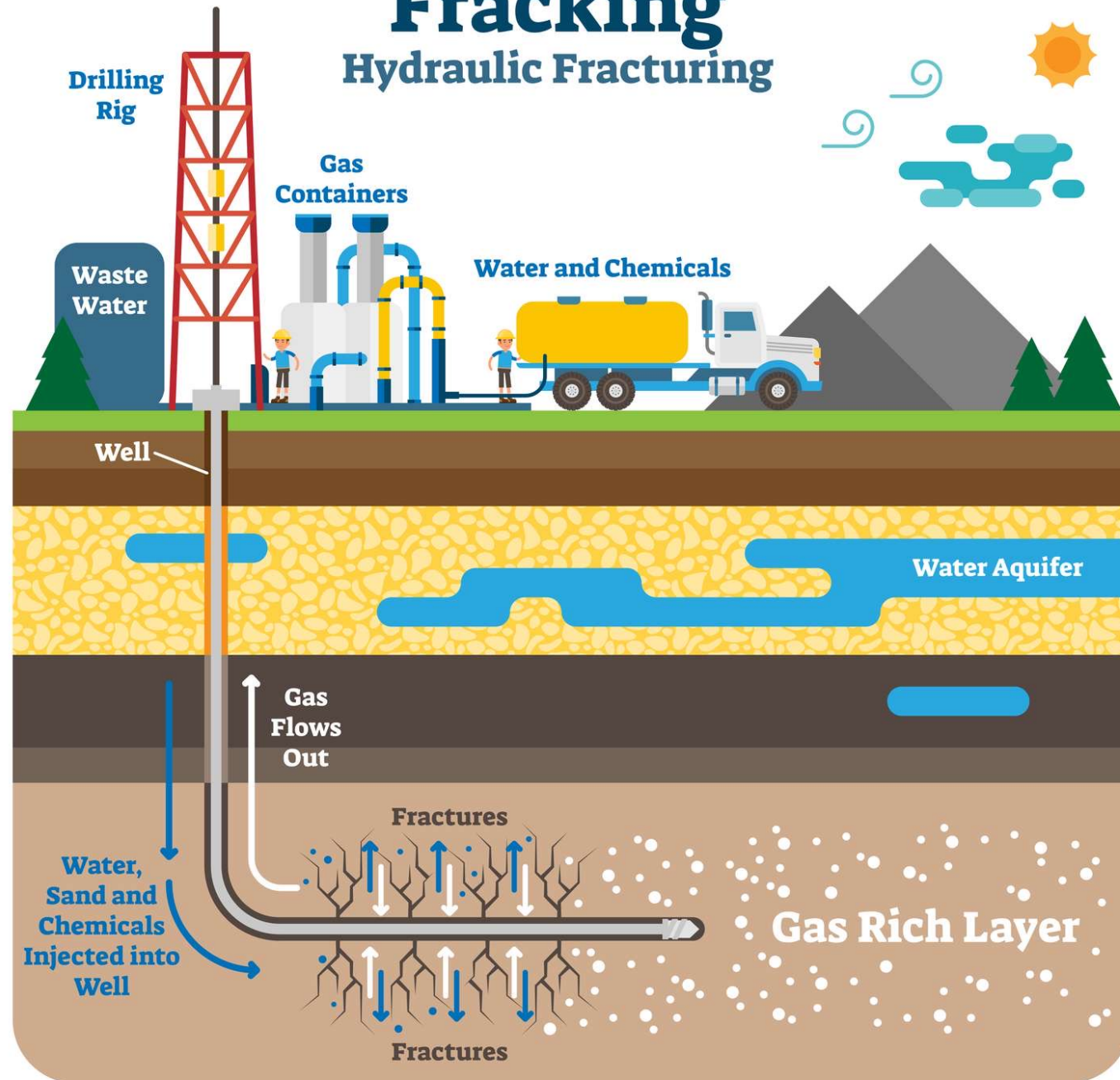


Global Sources of Methane (US EPA, October 10, 2023)

- Globally, 50-65% of total CH₄ emissions come from human activities.² Methane is emitted from energy, industry, agriculture (particularly thousands of cows generating CH₄ from digestion), land use, and organics decay in landfills.
- **The largest source of anthropogenic methane emissions is agriculture, responsible for around one quarter of emissions, closely followed by the energy sector, which includes emissions from coal, oil, natural gas and biofuels**
- Methane is also emitted from a number of natural sources. Natural wetlands that are not managed or changed by human activity are the largest source, emitting CH₄ from bacteria that decompose organic materials in the absence of oxygen.
- Reservoirs and ponds with high organic matter and low oxygen levels also produce methane through the microbial breakdown of organic matter. Smaller sources include termites, oceans, sediments, volcanoes, and wildfires.

Fracking

Hydraulic Fracturing



GHG emissions produced now will have the greatest impact on generations not yet born but still in the grip of time. **It's the accumulation that pushes temperatures upwards** and the more that have been emitted, the smaller the prospect of outlasting the ongoing rise (T. Nelson Thompson, Cleveland Plain Dealer, November, 2023).

Warmer Temperatures Cause Climate Change

- Climate change influences when, where & how much rain falls.
- Higher global temperatures cause water to evaporate in larger amounts, resulting in **more atmospheric water vapor**, which leads to more frequent & intense storms & flooding

How Global Groundwater (gw) is Affected by Climate Change

- Increased variability in precipitation and more extreme weather events caused by climate change can lead to longer periods of droughts and floods, which directly affects availability and dependency on groundwater
- **Extreme storms create more runoff & less recharge to aquifers**
- In long periods of droughts there is a higher risk of depletion of aquifers, especially in case of small and shallow aquifers.
- People in water-scarce areas will increasingly depend on groundwater, because of its buffer capacity as an alternative to lack of surface water.

Climate Change Alters How Fast/or Slow Recharge Occurs

- Recharge is the process of filling aquifers primarily via rainfall
- Groundwater will often flow back out into streams, lakes, rivers and oceans. This step of the hydrologic cycle is called gw “discharge”. Humans can artificially increase discharge by pumping from wells.
- Climate change is impacting the recharge process. Warming is expected to drive changes to [global rainfall patterns](#), affecting the amount of water available for recharge.

Climate Change Alters How Fast/or Slow Recharge Occurs

- **We are now only starting to understand how long it could take groundwater to react to the impacts of climate change in different parts of the world...in most latitudes, recharge will decrease****
- For example, the time it takes for decreases in recharge to translate into decreases in discharge – referred to as gw response time - or the amount of freshwater flowing into rivers and streams – is understudied
- ** Although comparatively minor, groundwater rise/groundwater flooding is occurring in areas such as the Midwest US where extreme storms have increased, resulting in inundation & degradation of building foundations, or causing flooding of landfills, releasing & transporting contaminants offsite that will eventually be deposited & potentially leached into groundwater supplies elsewhere. Inundation of residential septic systems/dispersal of waste is another concern, as are releases from large coal ash impoundments from burnt coal waste from power plants containing toxic metals such as arsenic & selenium at high concentrations.

Climate Change Alters How Fast/or Slow Recharge Occurs

- The regions most “sensitive” to changes in climate include humid and wet areas, such as the Amazon, Indonesia and parts of central Africa, the research shows. In some of these areas, it could take less than 10 years for climate change to fully impact groundwater flows.
- In dry, arid parts of the world, groundwater could take longer to react to climate change and other stresses, such as land-use change and pumping.

Climate Change Affects Consumption of Groundwater Resources

- Indirect climate change impacts such as the intensification of human activities and land use changes increase the demand for groundwater as surface water supplies decrease
- Large glacier or annual snowpack melt-off at accelerated rates results in less surface water for drinking & agriculture in lower elevations, & more runoff & less aquifer recharge.

Climate Change Will Cause Sea-Level Rise, Which Will Adversely Affect Coastal Aquifers

- A large percentage of the world's population lives in coastal areas
- In some cases, sea-level rise will cause seawater intrusion as saltwater inundates the natural freshwater barrier that otherwise blocks this landward movement of ocean water
- This will make some drinking water supply wells unusable as the water will become brackish, or salty

Summation

- Methane is a major contributor to global warming, which leads to climate change.
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