CGIAR | INITIATIVE ON NEXUS Gains

Carbon Footprint of Water: How it Relates to the Water, Energy, Food and Environment Nexus and Why it is Important

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Overview

- The WEFE Nexus and climate change
- Carbon footprint of water: a wasted opportunity?
- On why carbon footprint of water is important for WEFE Nexus
- Conclusions

Source: https://balkangreenenergynews.com/exploring-opportunities-to-achieving-water-food-energy-ecosystems-nexus-in-western-balkans/

The WEFE Nexus and climate change

Origin:

- WEF Nexus - *Understanding the Nexus. Background paper for the Bonn2011 Nexus conference: The Water, Energy and Food Security Nexus (Hoff, 2011)*

- WEF (2011) report on “Water-Security: The Water-Food-Energy Climate Nexus”.

Rationale:

Water, energy, food are scarce resources and “*an integrative approach to water, energy and food may enhance resource security, efficiency, poverty reduction and better resource governance across sectors*” (Wiegleb and Bruns, 2018)

Messages:

- WEF Nexus approach leads to additional benefits.
- Climate was central to the Nexus discourse from the beginning

The WEFE Nexus and climate change

Progression:

- WEF Nexus picked up because it is logical
- Fits well with the systems thinking

11 years later:

- We are still struggling to move from theory to practice on the WEFE Nexus
- Narratives are still along sectoral lines:

Water for adaptation;
Energy for mitigation;
Food for security

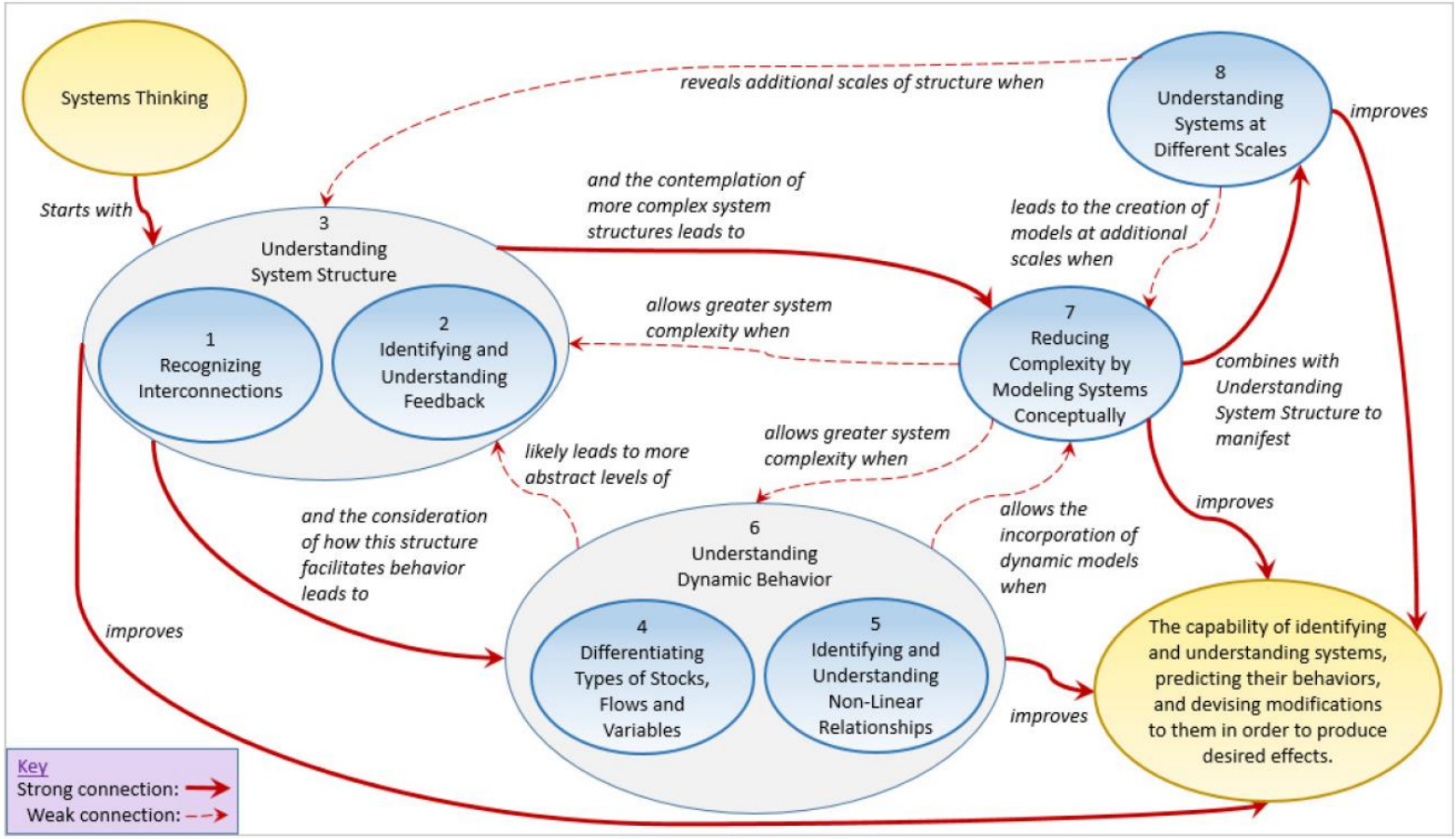

Fig 3: Systems Thinking Systemigram

Arnold and Wade (2015)

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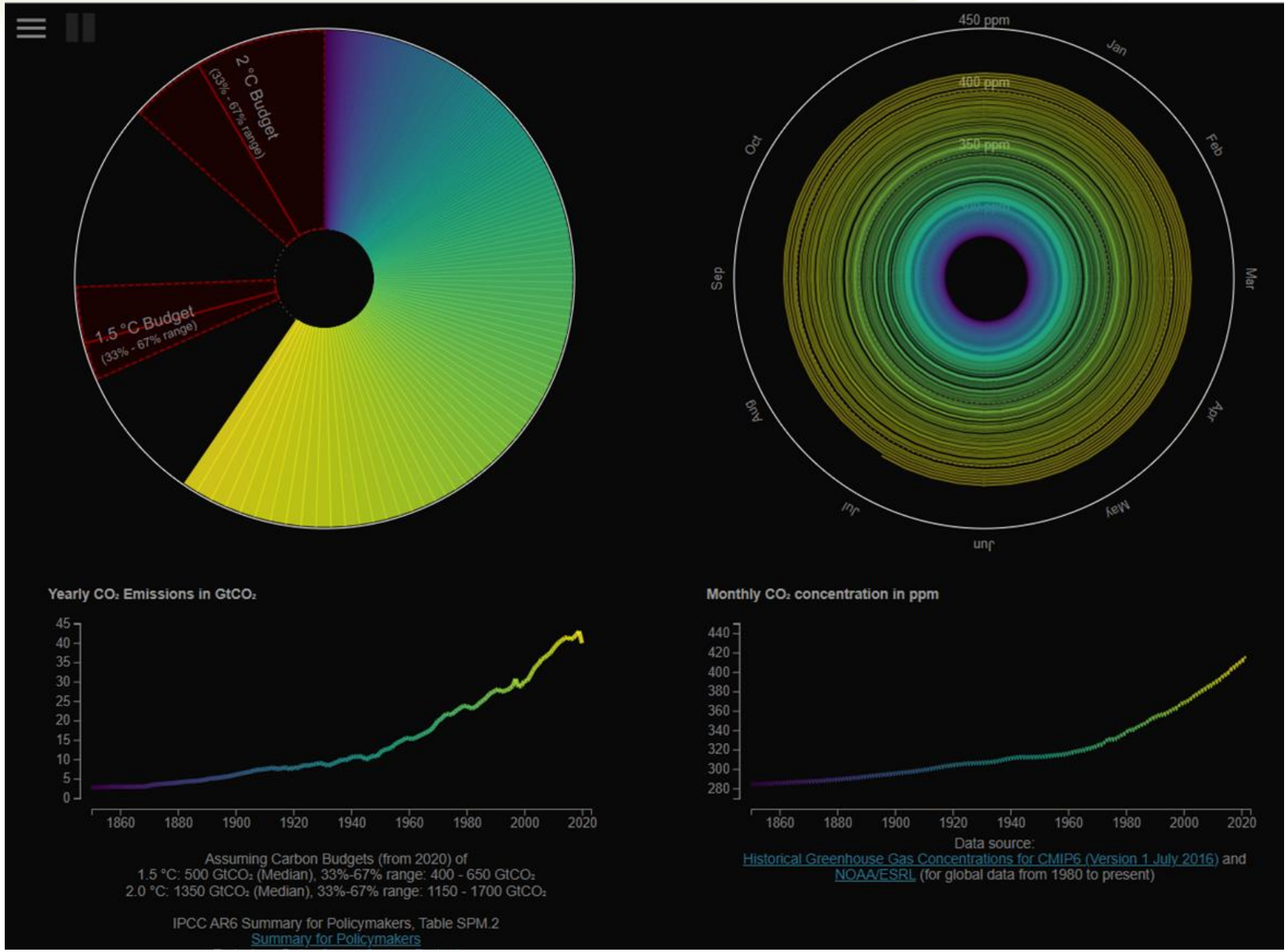
WEF sectors are drivers of climate change & are at risk from its impacts

We don't have many more years of inaction.

The carbon budget will run out in about 8 years



Source: http://openclimatedata.net/climate-spirals/from-emissions-to-global-warming-line-chart/

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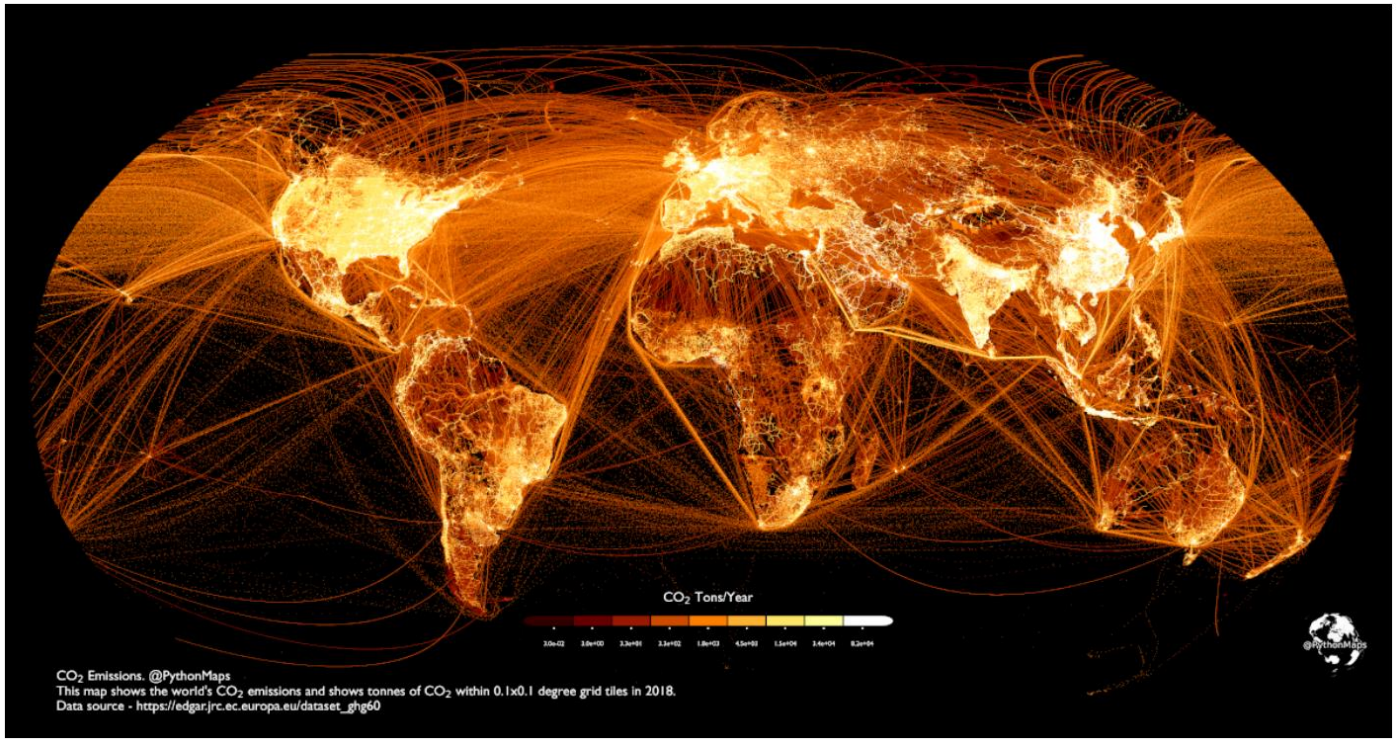
Global anthropogenic GHG emissions (2019): 59±6,6 $GtCO_{2\text{-eq}}$ Source IPCC AR6 WGIII

Energy supply	Industry	AFOLU	Transport	Buildings
20 (34%)	14 (24%)	13 (22%)	8,7 (15%)	3,3 (6%)

Food systems related emissions:
21-37% Rosenzweig et al. 2020
34% Crippa et al. 2021

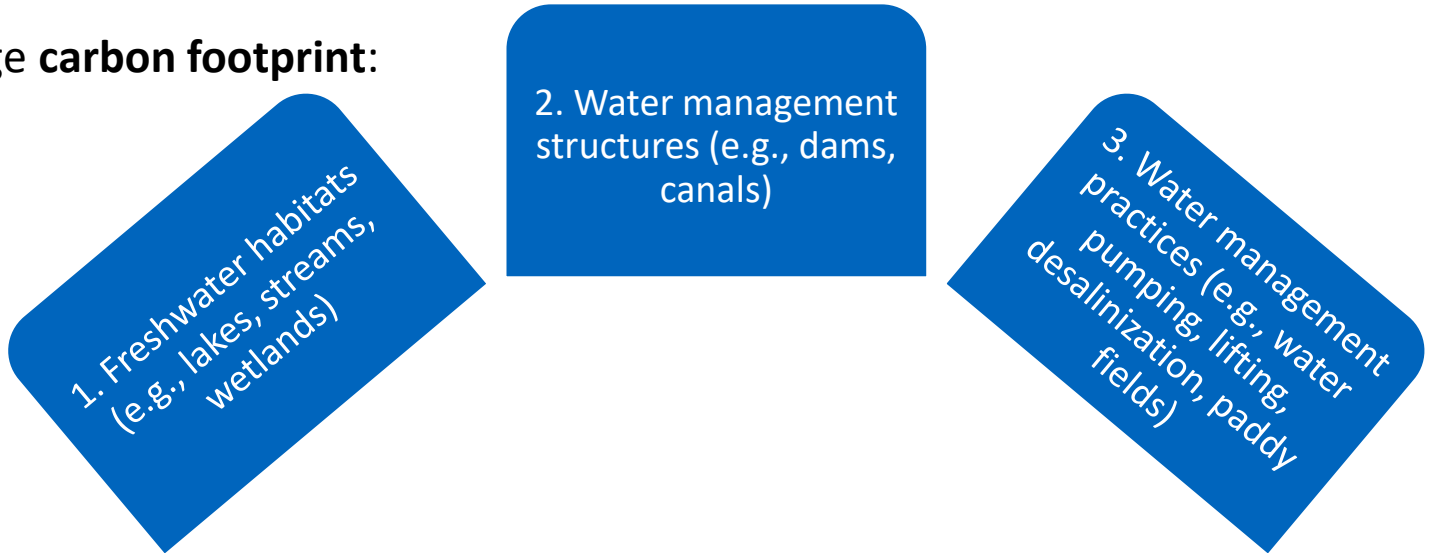
Water??? Does it have emissions?



Source: https://www.visualcapitalist.com/cp/mapped-carbon-dioxide-emissions-around-the-world/

Carbon footprint of water: a wasted opportunity?

Water has a large **carbon footprint**:



1. Freshwater habitats (mostly driven by the natural processes):

- CO2 transfer from inland waters to the atmosphere is about 1.8 Pg of C (~ 6,6 Gtons of CO_2 or more than two times emitted in the buildings category) Source: Raymond et al. 2013
- IPCC estimates that lakes & rivers emit 159 Tg (Mtons) of CH4 year IPCC AR6 WGI
- Wetlands 149 (bottom up) to 180 (top-down) Tg or Mtons of CH4 year IPCC AR6 WGI
- Some freshwater habitats can act as sources of some GHGs and sinks for others depending on various factors, e.g., peatlands can act as source of CH4 but sink of CO2 Abdalla et al. 2016

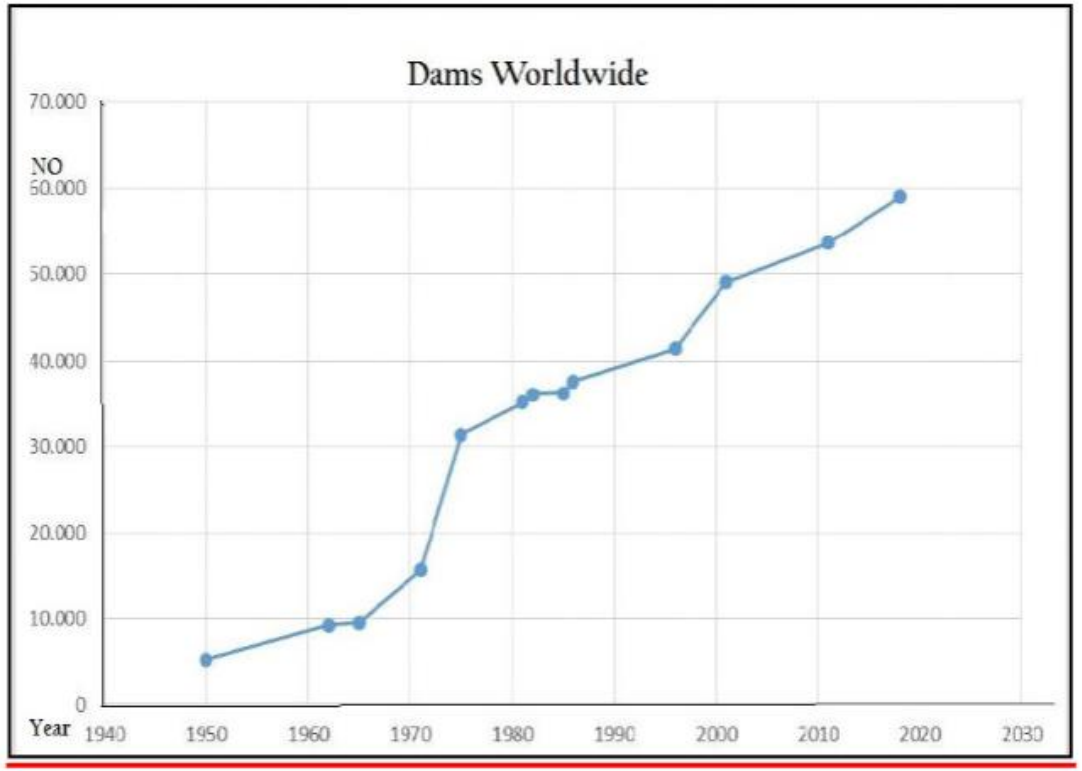
Relevant anthropogenic factors include: *vegetation changes* in the watershed (inland waters); *addition of N fertilizers* (wetlands); changes in *river morphology* (smaller rivers/streams emit more than large rivers)

Carbon footprint of water: a wasted opportunity?

2. Water management infrastructure (mostly anthropogenic)

Dams are ubiquitous – globally, there were 800,000 dams in 2007 (Adamo et al. 2020) & their number is increasing

- 91000 dams in the US alone (NID, 2020)
- Most of water reservoirs are built for irrigation (e.g., 75% serve for irrigation, flood control & urban water supply)



Growth of numbers of dams in the world. Source: Adamo et al. 2020

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Dams (structures) & water reservoirs emit carbon through different processes

FIGURE 2.1. Carbon Fluxes in Terrestrial and Aquatic Landscapes

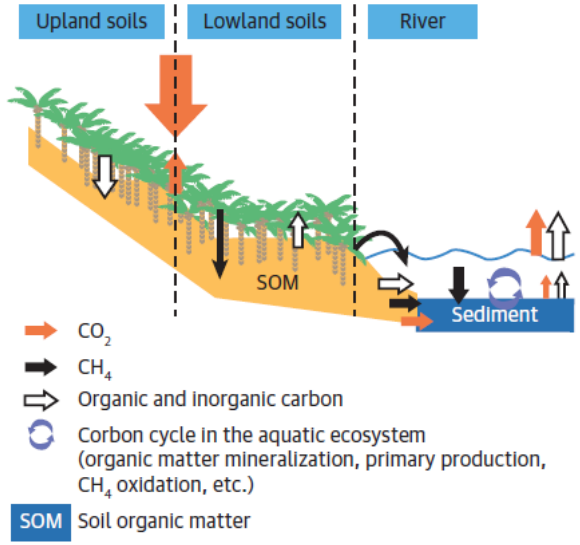
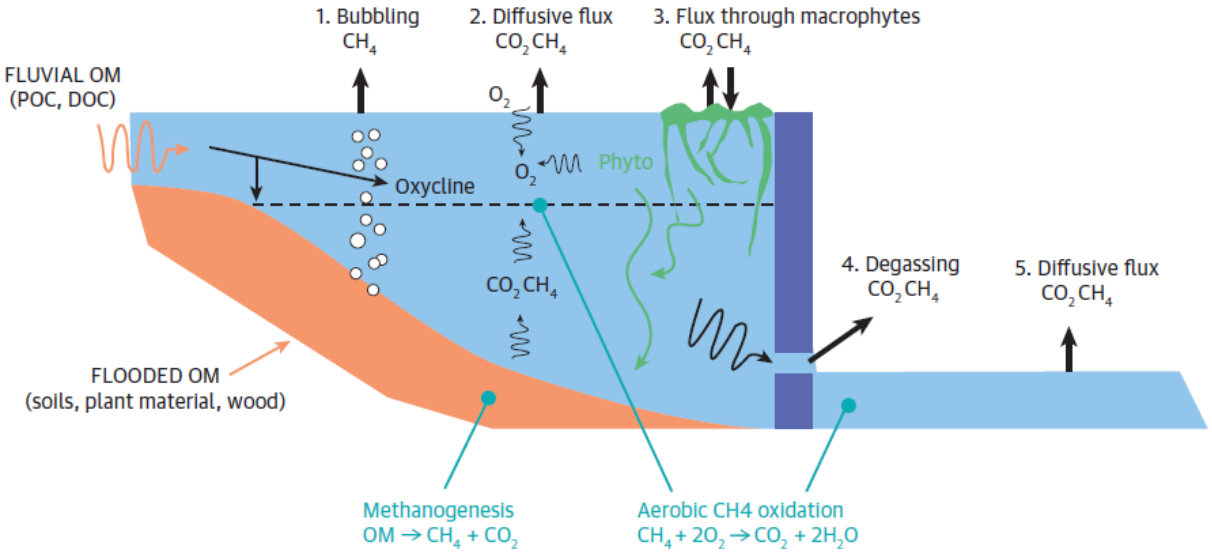


FIGURE 2.2. Main Fluxes of Carbon for a Reservoir



World Bank. 2017. *Greenhouse Gases from Reservoirs Caused by Biogeochemical Processes*. World Bank, Washington, DC.

More from my colleague - Nishadi

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3. Water management practices (mostly anthropogenic - water pumping/lifting/paddies)

- annual groundwater pumping emits 0,53 Tg/annum (0.2% of global methane emissions) (Kulongoski & McMahon, 2019
- emissions from energy use for water (e.g., 45,3-62,3 Mt CO2 in India alone, 8-11% of the total annual emissions) (Rajan et al., 2020)
- Water lifting in Uzbekistan consumes about 20% of electricity (Rakhmatullaev and Abdulla ev, 2014) and is responsible for the associated emissions

132.2 meters – elevation @175 m3/sec 7 pump stations

- Paddies are large sources of CH4 (e.g., rice emits ~ 31 Tg or 31 Mtons of CH4) and also CO2 (IPCC AR6 WGI)

So why is it important for WEFE Nexus?

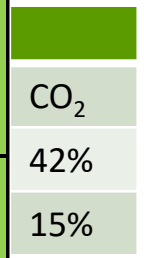
Carbon footprint of water clearly demonstrates the close interlinkages between WEFE sectors
Water is important for food
Water is important for energy
Energy is used to supply water to food systems

- Reducing emissions from freshwater habitats (to a lesser degree), infrastructure and management practices is important to meet climate targets

- WEFE studies can help identify key leverage points:

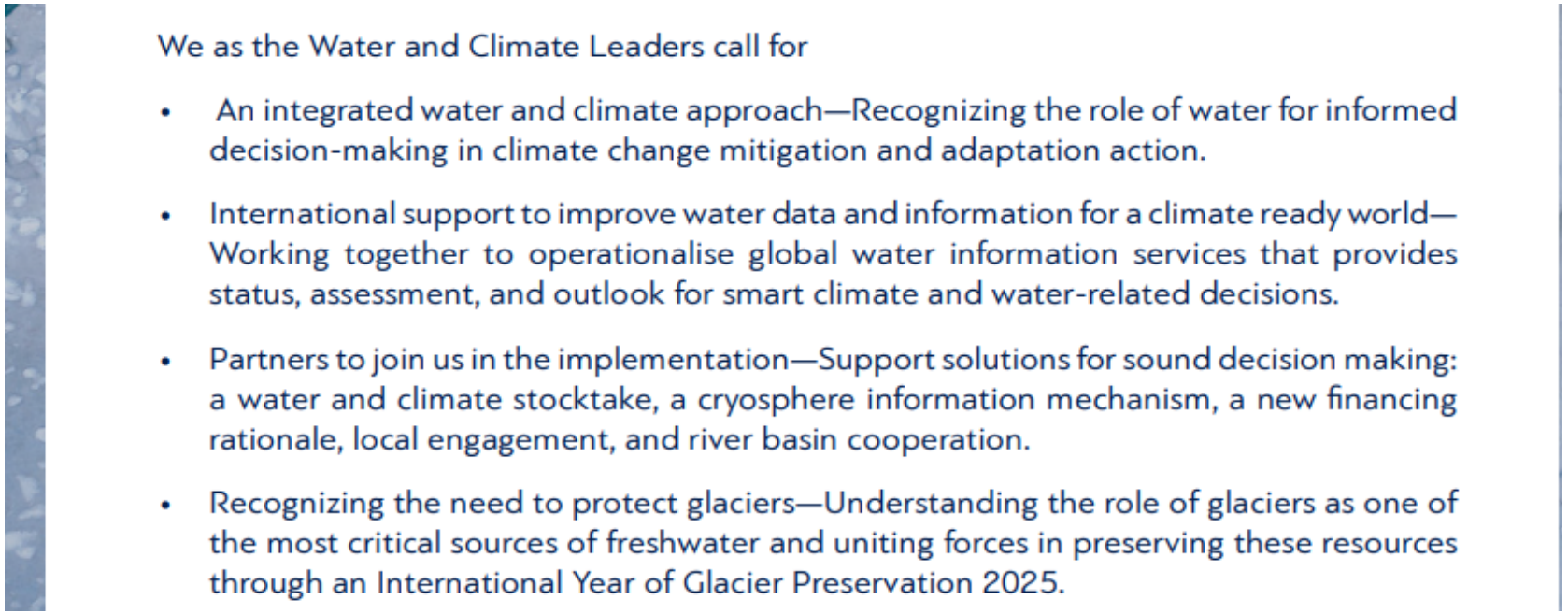
Djumaboev et al., 2019. Water and emission savings in a lift irrigated area of Uzbekistan

Crop	Total pumped area, ha	Irrigation application, mm		Total water use, MCM		**Total water saving, MCM**	Electricity consumption, GWh		**Total energy saving, GWh**	GHG emissions, Kton		**CO_2 reduction, Kton of GHGs**
		Current	Improved irrigation practices	Current	Improved irrigation practices		Current	Improved irrigation practices		Current	Improved irrigation practices	
Wheat	102600	1011	587	1037	602	**435**	468	272	**196**	219	127	**92**
Cotton	119681	765	648	916	776	**140**	413	350	**63**	194	164	**30**
Total	222281	N/A	N/A	1953	1378	**575**	880	621	**259**	413	291	**122**



So why is it important for WEFE Nexus?

- WEFE Nexus approach is data and information intensive
- We have good understanding of emissions from energy & increasingly food systems
- Emissions related to water are still under-studied
- Data on emissions from WEFE sectors is key to understand benefits, synergies and tradeoff when planning and managing interventions
- Climate change & Land special report of IPCC (2019) states that integrated water management has Moderate positive mitigation effect (0,3-3 $GtCO_2$ year)



We as the Water and Climate Leaders call for

- An integrated water and climate approach—Recognizing the role of water for informed decision-making in climate change mitigation and adaptation action.
- International support to improve water data and information for a climate ready world—Working together to operationalise global water information services that provides status, assessment, and outlook for smart climate and water-related decisions.
- Partners to join us in the implementation—Support solutions for sound decision making: a water and climate stocktake, a cryosphere information mechanism, a new financing rationale, local engagement, and river basin cooperation.
- Recognizing the need to protect glaciers—Understanding the role of glaciers as one of the most critical sources of freshwater and uniting forces in preserving these resources through an International Year of Glacier Preservation 2025.

Source: https://www.water-climate-coalition.org/wcc/wp-content/uploads/2022/06/Endorsed_Action_plan.pdf

Conclusions

- Inland water bodies produce GHG emissions
- Some habitats can be both source and sink
- Most of the freshwater habitats are sources of CH4
- Conversion of freshwater habitats or areas around them can increase emissions
- Emissions occur through various processes/pathways and can show spatial, diurnal and seasonal variation
- WEFE Nexus approach can contribute to climate mitigation goals

Thank You!

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