

Tipping points and deadline-aware climate emergency investments

Julian Caldecott

www.creatura.com

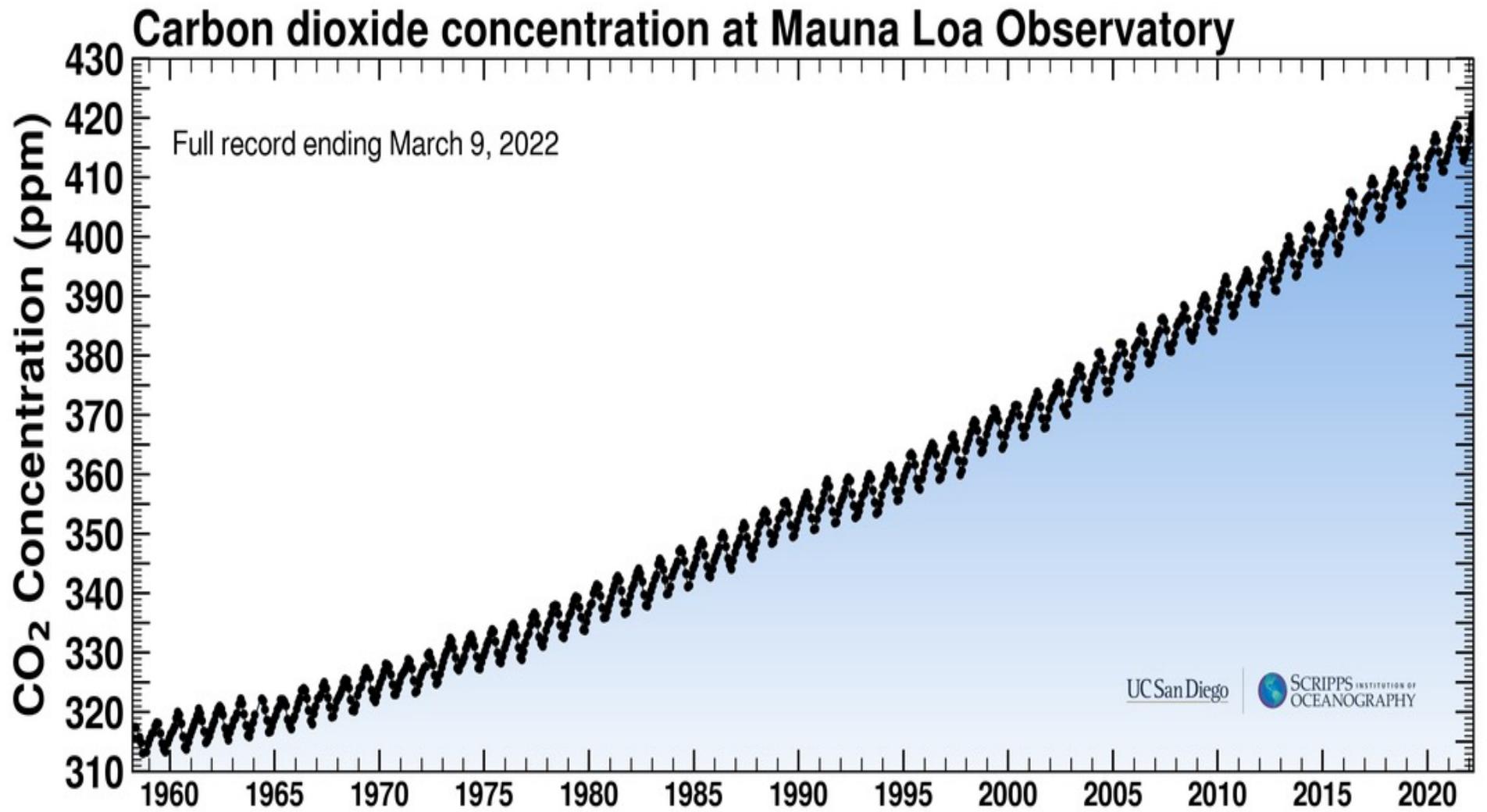
www.mostimportantthings.org

www.peacewithnature.scot

Edinburgh Environment and Development Network,
Edinburgh Climate Change Centre, 7 April 2022

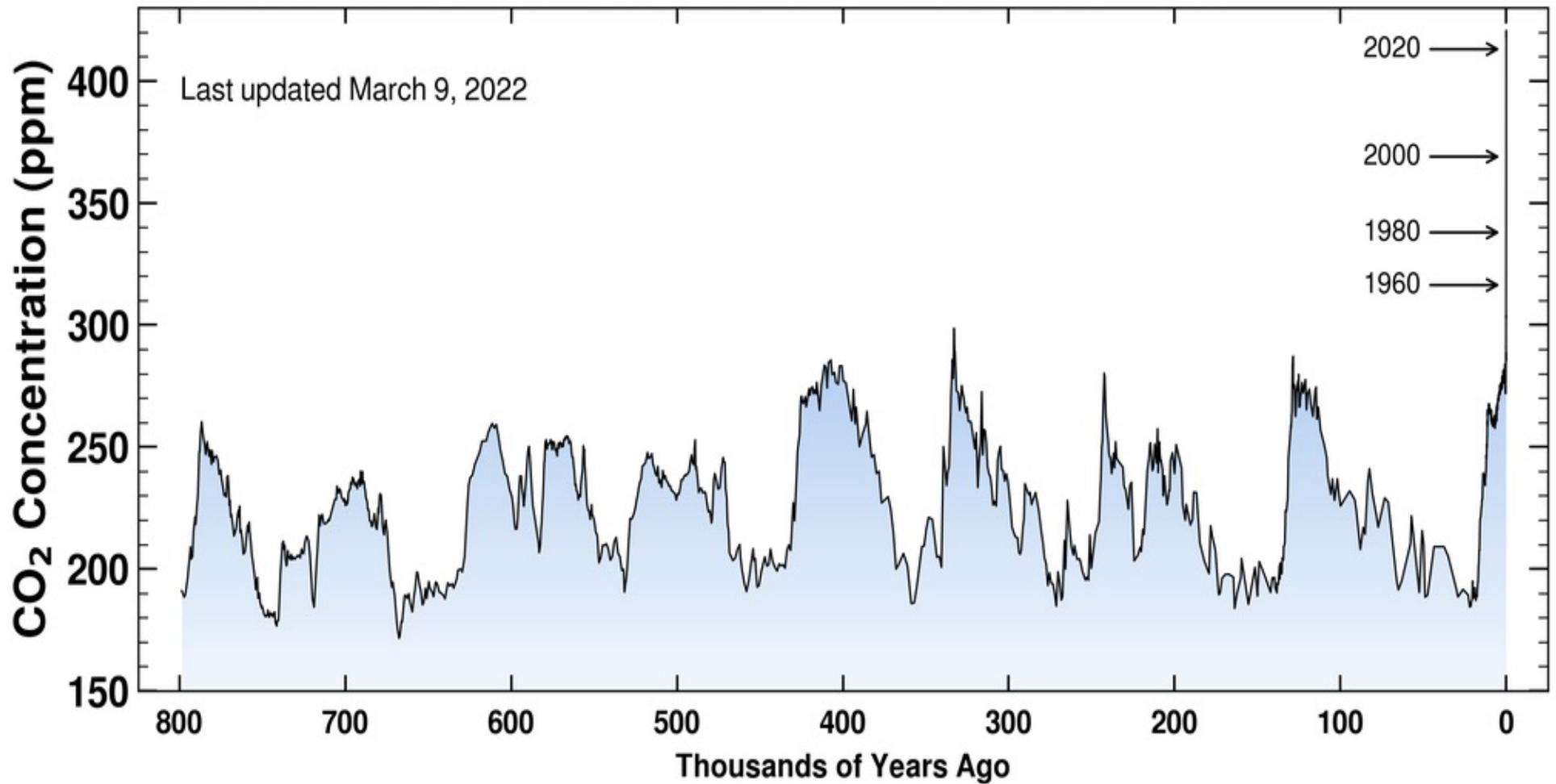
Julian's career key-words ...

- **1975-1991.** Ecology, rainforests, elephants, gibbons, monkeys, bearded pigs, rhinos, traditional ecological knowledge, national parks.
- **1992-2009.** Biodiversity and ecosystem management; bioprospecting; great apes; disaster assessment and prevention.
- **Since 2010.** Sustainable development; nature-based and community-based solutions (NCbS) for climate change mitigation and adaptation.
- **Since 2018:** XR; Schumacher Institute; SGP; SWT; books on mitigation, water and adaptation; an icy '*Titanic* moment'; Peace with Nature.



Source: <https://keelingcurve.ucsd.edu>

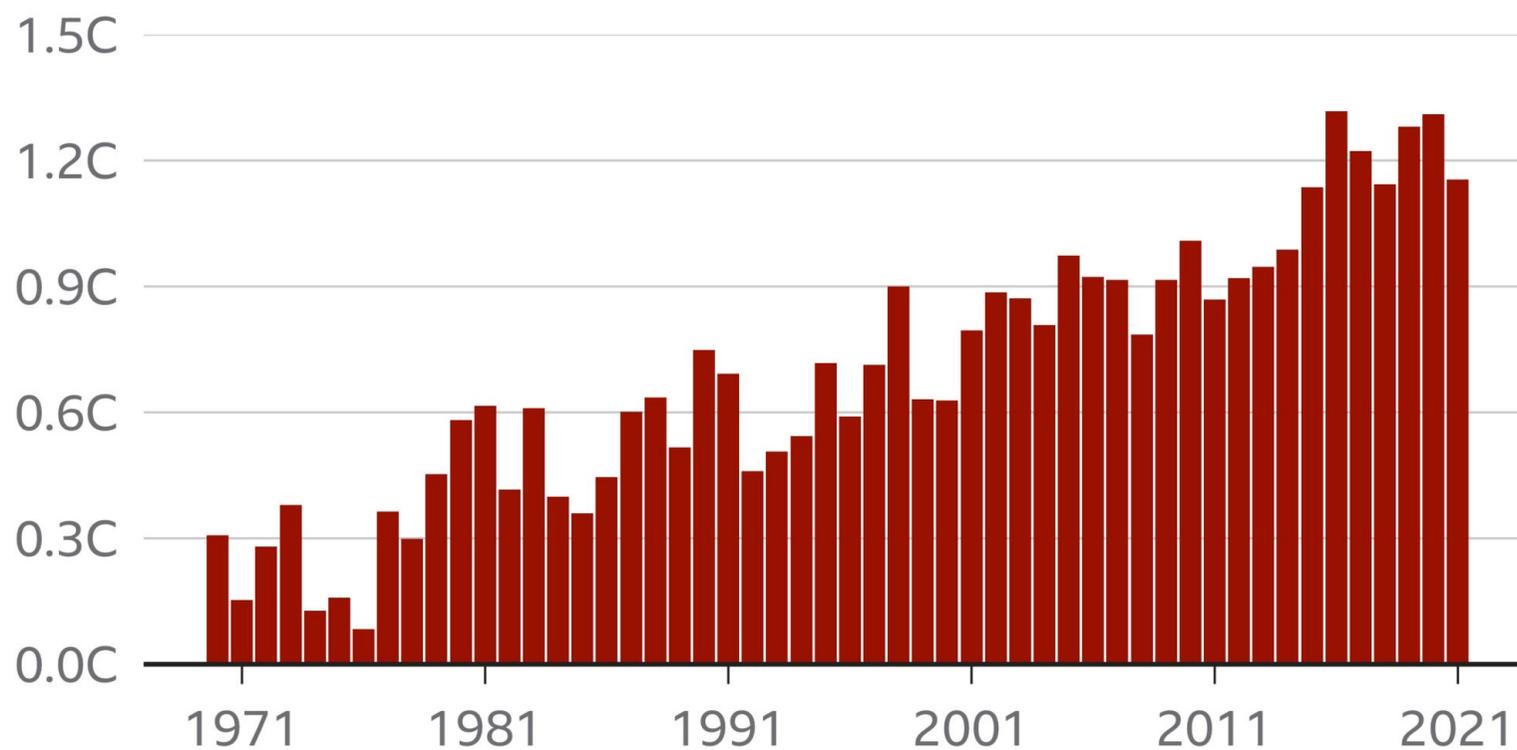
Ice-core data before 1958. Mauna Loa Data after 1958.



Source: <https://keelingcurve.ucsd.edu>

2021 was the fifth warmest year on record

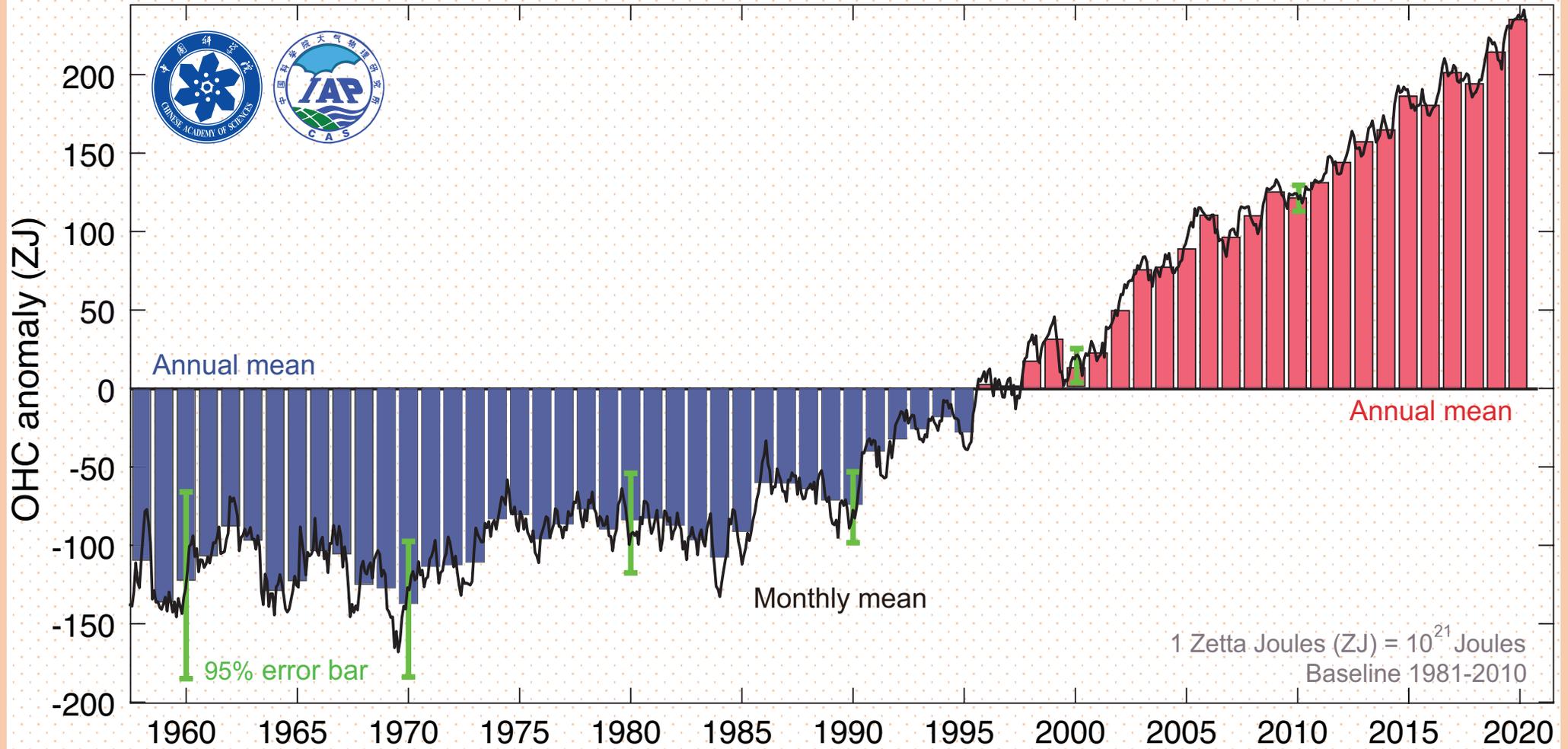
Annual global-average temperature increase (degrees C) above pre-industrial level



Source: ERA5, Copernicus Climate Change Service



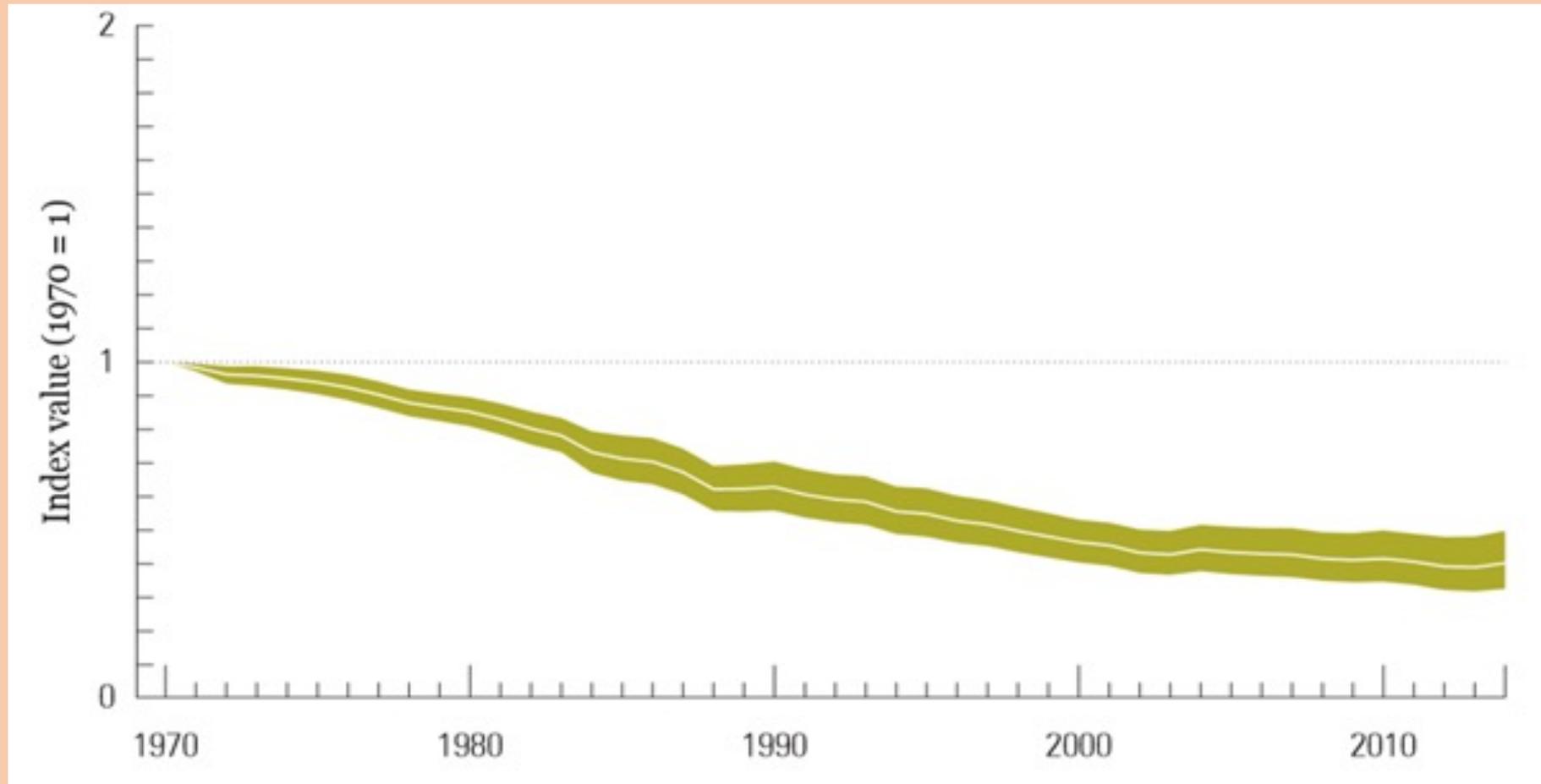
Global ocean heat content change in the upper 2000 m



Source: Cheng *et al.* Upper Ocean Temperatures Hit Record High in 2020. *Adv. Atmos. Sci.* **38**, 523–530 (2021).

<https://doi.org/10.1007/s00376-021-0447-x>

The 'Dying Planet Index' - global wildlife abundance



Source: WWF (2020) *Living Planet Report 2020: Bending the curve of biodiversity loss.*

- **Severe dangers (on-going threats):**
 - **Climate chaos** at all scales.
 - **Ecosystem collapse** at all scales.
 - **Mass extinction** of millions of wild species.
- **High probabilities (evidence of risk):**
 - **Climate systems** - system behaviour, physical chemistry.
 - **Ecological systems** - evolutionary history, ecological rules.
 - **Extinction processes** - past extinctions, habitats, changes.
- **Imminent timings (emergencies):**
 - **Worsening trends** - cryosphere melting; drying and burning.
 - **Recent changes** - equatorial deforestation; desertification.
 - **Tipping points** - sudden chaotic system change.

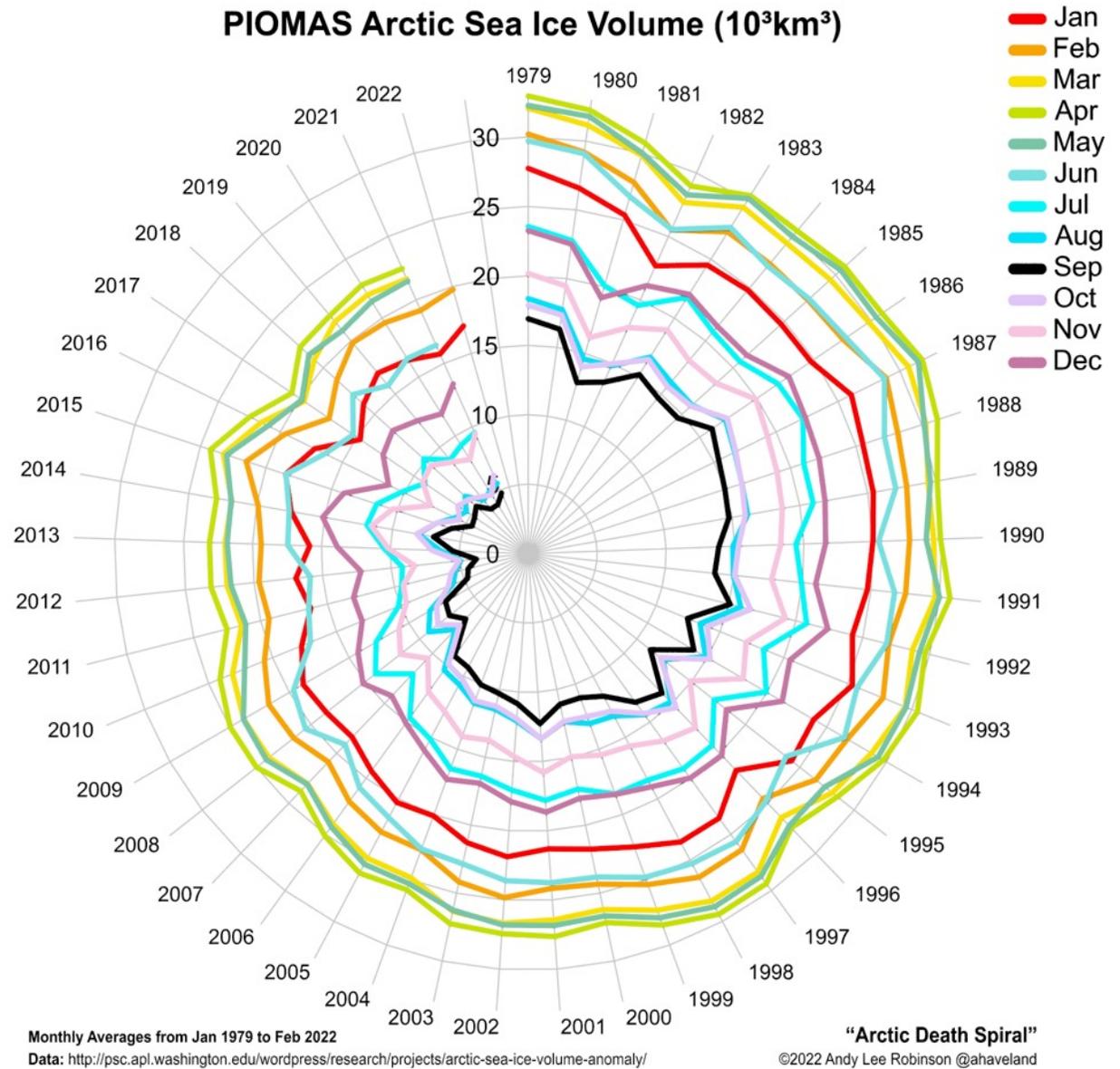
Sources of dangerous non-linearities

- **Oceanic systems:** heating, acidification, oxygen depletion, heatwaves; weakening major currents and on-shore effects.
- **Tropical forest systems:** *Rain forests make their own rain*; lost resilience in > 75% of Amazon rainforest since 2000 “**consistent with the approach to a critical transition**”. *Potential fate of all tropical rainforests: fire-maintained grassland.*
- **Polar systems:** the March 2022 bipolar heatwave; glacier flows unblocked by disintegrating ice shelves (Wilkins, Larsen, Conger); and disappearing Arctic sea ice ...

Source of Amazon quotation: Boulton, C.A., Lenton, T.M. & Boers, N. Pronounced loss of Amazon rainforest resilience since the early 2000s. *Nat. Clim. Chang.* **12**, 271–278 (2022). <https://doi.org/10.1038/s41558-022-01287-8>

The Arctic 'death spiral' (1979-2022)

Note expected 'game over' zero
sea ice in September 2035 \pm 5.



The 2030s look like big trouble

- **Directional global stresses, mounting chaos, tipping points.**
- **Ice heat sink.** It takes **334 J** to turn 1 g of ice at -1 C to liquid water, but only **4.2 J** to warm 1 g liquid water by 1 C.
- ***Titanic moment.*** The effect of biosphere heating in the Arctic has so far been to melt ice, not to warm sea water, sea beds or permafrosts.
- **Zero ice** → inevitable **sudden heating** → inevitable **rapid methane surge** ($\geq 100 \text{ GtCH}_4 \times 85 = \geq 8,500 \text{ GtCO}_2\text{e}$).
- **'Game over'**, unless we can recapture methane fast enough, and/or postpone the tipping point long enough to reverse the whole process.

Some prevailing attitudes

Impressions from 2020-2022 evaluations (DK & CH climate aid):

- “We have the technology to decouple energy from GHGs.”
- “It’s good mitigation if it saves **any GHGs at all, ever.**”
- “We used to do NCbS, but it’s slow and difficult.”
- “Norway can do NCbS and we’ll sell RE systems instead.”
- “RE is the best thing to do, and we’re the best in the world.”
- “What’s good for our economy is good for the world.”

Thinking like this is common, especially in industrialised countries.

Some pervasive biases

- Against **full accounting for LULUCF/AFOLU** emissions.
- Against **biodiversity/ecosystems/ecosystem** goods and services.
- Against **nature- and community-based solutions (NCbS)**.
- Against **valuing the future** in conventional economics.
- Against **non-monetary values** in conservative policies.
- Against **considering tipping points, non-linearities and deadlines**.
- Biases → wrong assumptions → poor decisions.

But what if ...

- What if we took mid-century **climate breakdown** seriously?
- What if we took global **ecosystem breakdown** seriously?
- What if tipping points meant **real dated deadlines**?
- What if we valued investments by **tCO₂e saved**, not money?
- What if we valued each tCO₂e saved by **when** it would be saved?
- What if we used tCO₂e**dmv** to reflect mid-century deadlines?
- [dmv = 'dated mitigation value': 1 tCO₂edmv2022 > 1 tCO₂edmv2026 > 1 tCO₂edmv2030, etc.]

Why think about timing and deadlines?

- Stressing Earth systems is like walking towards a cliff edge.
- The 'edge' or deadline = systems committed to breaking down.
- Stepping off the edge = the end of human agency.
- Evidence and precaution suggest an edge at 2050 ± 10 .
- Massive net GHG savings can 'move the edge' and buy time.
- Time needed to decarbonise and find permanent solutions.
- True mitigation value = effectiveness in buying time = GHG savings relative to the edge (i.e. 2050 ± 10).
- This can be represented by an exponential decline in mitigation value between 'now' and the 'edge'.

Converting the units ...

Exponential decay of the biophysical mitigation value of each tCO₂e by year from 'now' (Year 0/1) to 'mid-century' (Year 30/31):

Correcting tCO ₂ e to tCO ₂ edmv at exp(0.1).																
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Exp.	1.00	0.90	0.82	0.74	0.67	0.61	0.55	0.50	0.45	0.41	0.37	0.33	0.30	0.27	0.25	0.22
Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Exp.	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.05	0.05

Source: Caldecott, J. (2021) *Surviving Climate Chaos by Strengthening Communities and Ecosystems*. Cambridge University Press (Cambridge).

How to make deadline-aware investment choices

- **Step 1:** estimate annual net tCO₂e emission savings & costs over 20 years.
- **Step 2:** convert to tCO₂edmv and add to Σ tCO₂edmv with Σ € over 20 years.
- **Step 3:** make a final choice after considering **all important co-benefits**.
- **Advantages:**
 - favours actions that deliver **powerful mitigation results early**;
 - offers a way to **compare mitigation portfolios realistically**; and
 - favours actions that yield **co-benefits for many sectors or interests**.

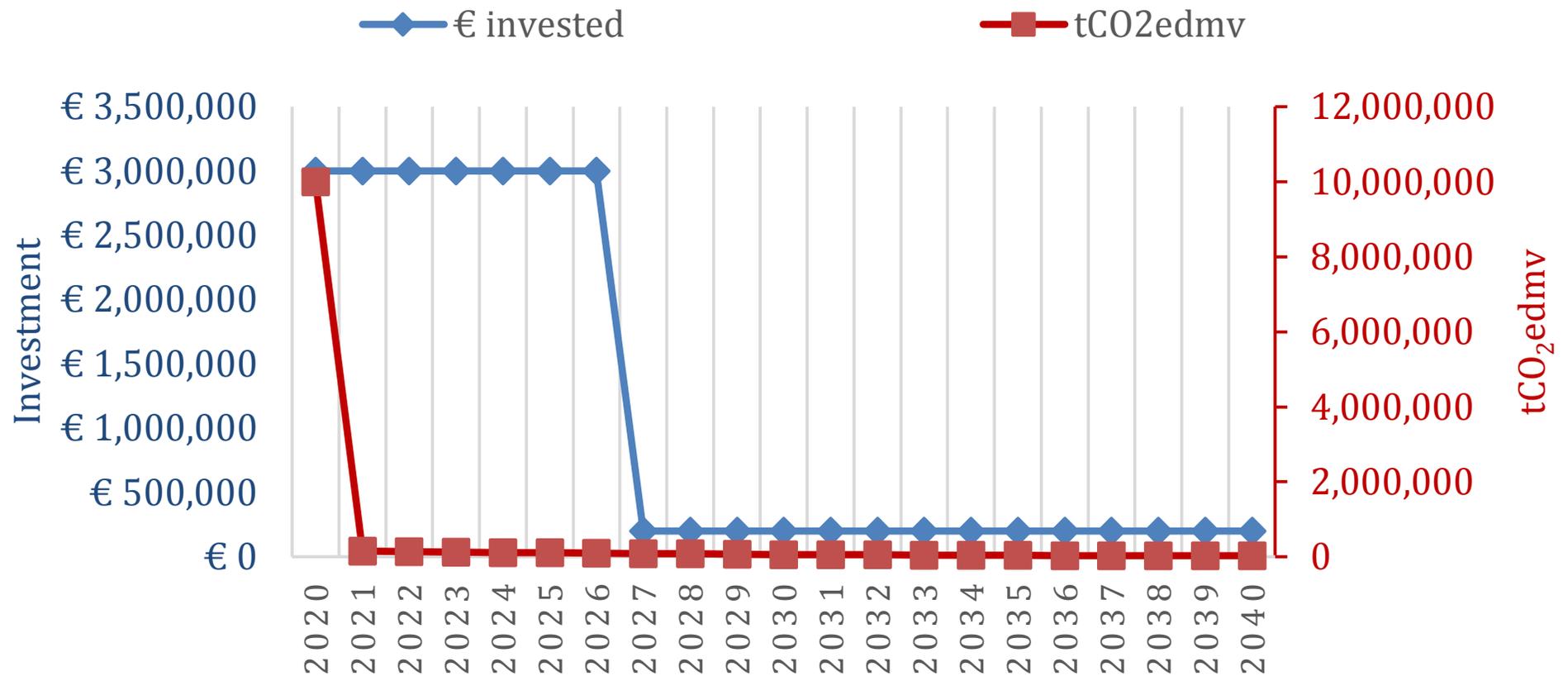
Source: Caldecott, J. (2021) *Surviving Climate Chaos by Strengthening Communities and Ecosystems*. Cambridge University Press (Cambridge).

Comparing three Danish mitigation investments.

- **Avoided deforestation**, based on real data from NCbS in and around the Harapan forest in Sumatra (2011-2018): very large, early, cumulative but uncertain gains at moderate cost.
- **Renewable energy**, based on real data from the Assela Wind Farm Project in Ethiopia (2021-2027): moderate, cumulative and certain gains at very high cost.
- **Capacity building**, based on the 2009-2020 South African energy partnership and SA emissions (500 MtCO₂e/year): potentially very large but slow and uncertain gains at low cost.

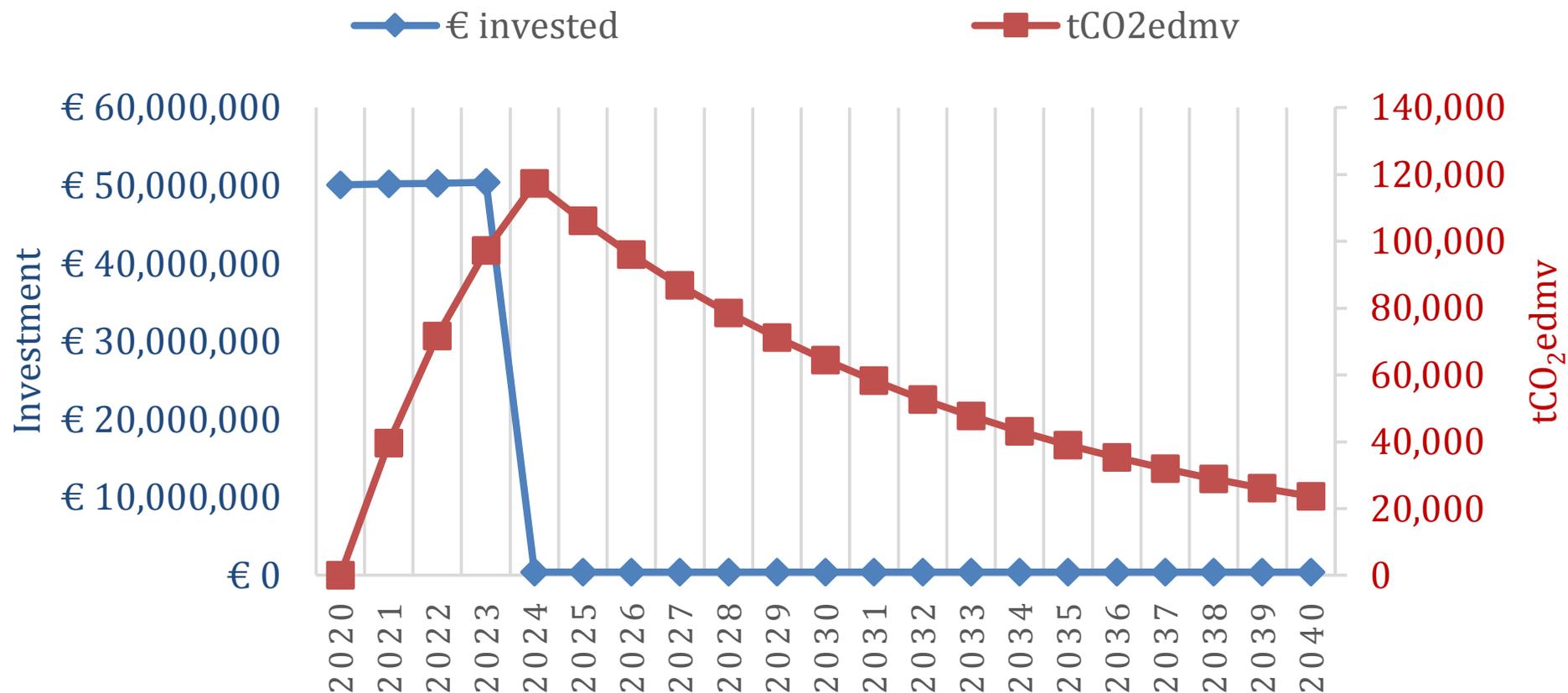
Source: Annex E: Comparing mitigation investments in a bounded future, by Julian Caldecott (in Caldecott, J., Bird, N.M. & Grøn, H.R., *Evaluation of Danish Funding for Climate Change Mitigation in Developing Countries*. Particip and MFA, Copenhagen, 2021).

**a) Avoided deforestation: total GHG saved =
11.439 MtCO₂edmv (0.4/EUR)**



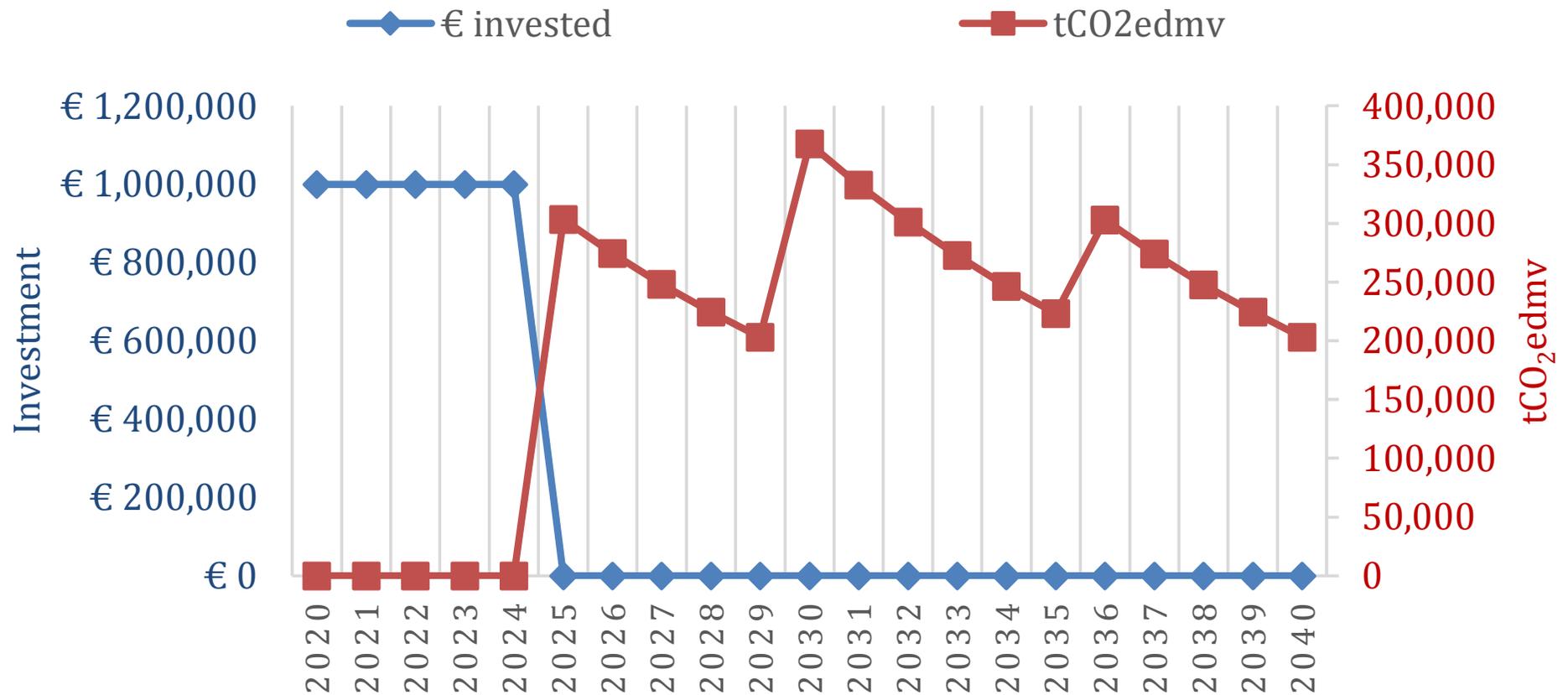
Source: Figure © Julian Caldecott 2022, based on data in Annex E: Comparing mitigation investments in a bounded future, by Julian Caldecott (in Caldecott, J., Bird, N.M. & Grøn, H.R., *Evaluation of Danish Funding for Climate Change Mitigation in Developing Countries*. Particip and MFA, Copenhagen, 2021).

b) Renewable energy: total GHG saved = 1.216 MtCO₂edmv (0.01/EUR)



Source: Figure © Julian Caldecott 2022, based on data in Annex E: Comparing mitigation investments in a bounded future, by Julian Caldecott (in Caldecott, J., Bird, N.M. & Grøn, H.R., *Evaluation of Danish Funding for Climate Change Mitigation in Developing Countries*. Particip and MFA, Copenhagen, 2021).

c) Capacity building: total GHG saved = 4.362 MtCO₂edmv (0.9/EUR)



Source: Figure © Julian Caldecott 2022, based on data in Annex E: Comparing mitigation investments in a bounded future, by Julian Caldecott (in Caldecott, J., Bird, N.M. & Grøn, H.R., *Evaluation of Danish Funding for Climate Change Mitigation in Developing Countries*. Particip and MFA, Copenhagen, 2021).

Different strategies, different advantages

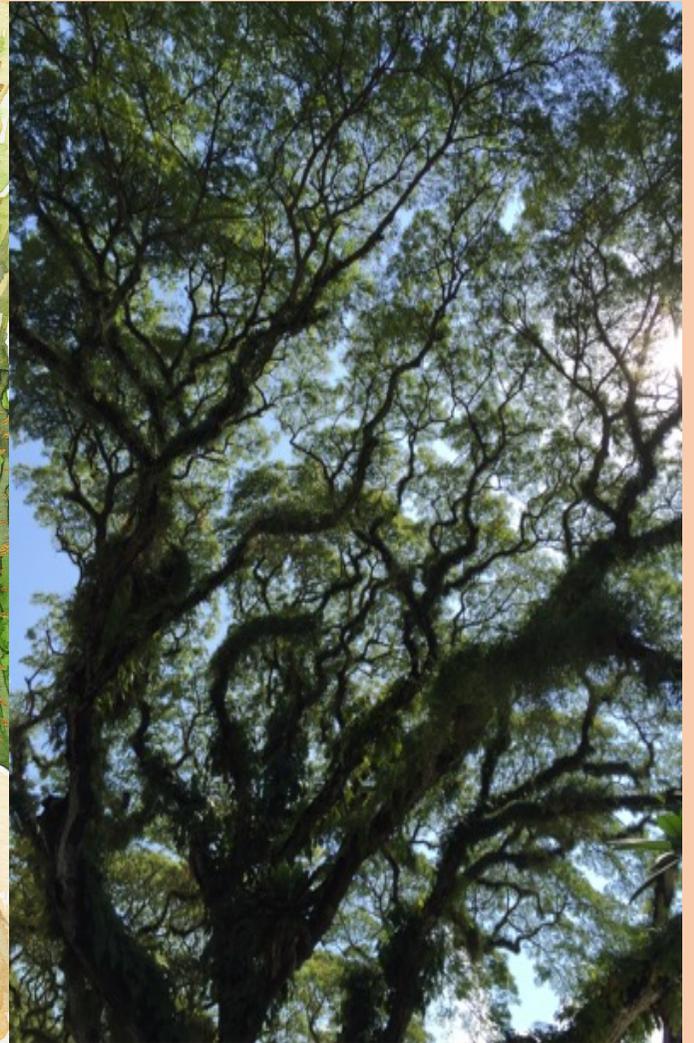
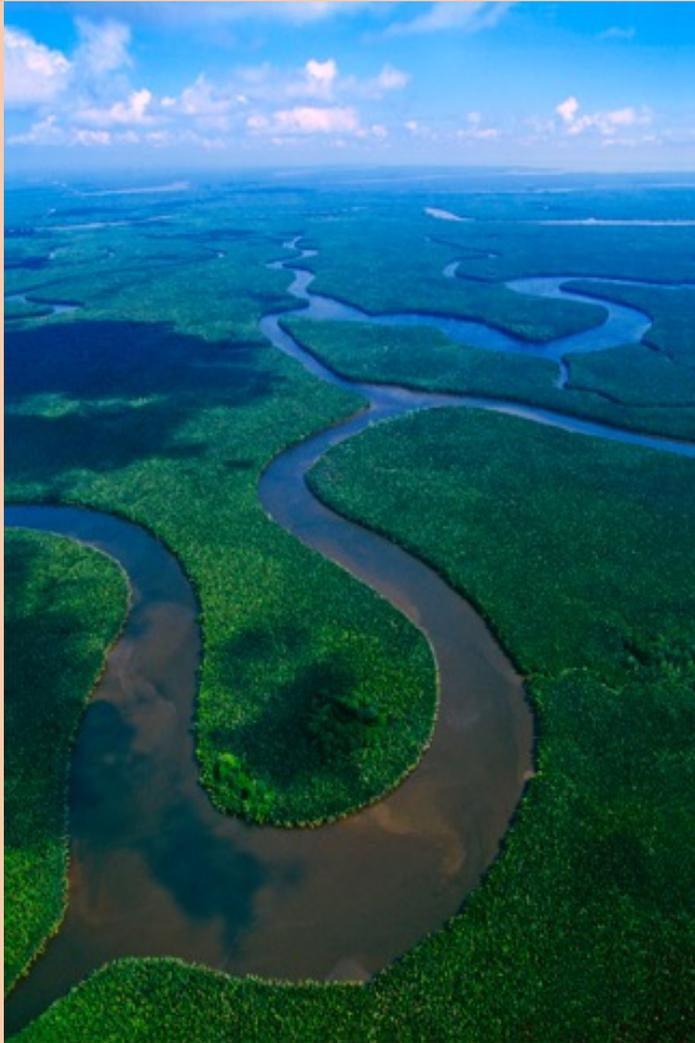
- Some offer quick solutions that buy time for transformative system change (decarbonisation, peace with nature).
- Some offer gains in employment, trade, energy supply, and facilitate diplomacy for policy dialogue.
- Some offer added value for adaptation, biodiversity and environmental security.
- **In an emergency, even temporary success is valuable:**
 - **to buy time** to make changes permanent (or to off-set/re-capture later if needed); and meanwhile
 - **every tCO₂e not released** subtracts from global heating.

To postpone mid-century breakdown...

- Choose only investments appropriate to NDCs and to local (and/or sub-national, national) conditions and opportunities.
- Choose only investments that are proven to save lots of tCO₂edmv quickly, cheaply, with many co-benefits.
- Urgently target conservation and NCbS efforts in high carbon-density ecosystems, with co-benefits for biodiversity, ecosystems, security, livelihoods, etc.
- Traditions of NCbS success (e.g. DK in Nepal & Bolivia, CH in Mongolia, Bolivia & Laos) should be validated and replicated!

The last decade of human agency: no more 'blah, blah, blah'





Painting of Greta Thunberg by Florence Thornton (<https://www.florencethornton.com>).