University of Exeter
Cornwall

CELEBRATING
20
YEARS
Penryn Campus
2004-2024

Shaping a Sustainable Future: Pioneering Research and Empowering Action

Tuesday, 10 September 2024

SUSTAINABLE
DEVELOPMENT
GOALS

Welcome

Professor Camille Bonneaud
Director, Environment & Sustainability Institute

Professor Brendan Godley
Director, Graduate School of Environment & Sustainability

University of Exeter Cornwall

Professor Martin Siegert

Vice President and Deputy Vice-Chancellor - Cornwall, University of Exeter

University of Exeter Cornwall

Critical Minerals and Climate Action:

Paving the way to net-zero

Dr Eva Marquis,
Research Fellow,
Camborne School of Mines

Critical Minerals and Climate Action: Paving the way to net-zero

Eva Marquis [1,2]

[1]Camborne School of Mines; [2]Environment and Sustainability Institute

What is Critical?

Released to Public: Earth, Image by Reto Stöckli (NASA)

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Released to Public: Earth, Image by Reto Stöckli (NASA)

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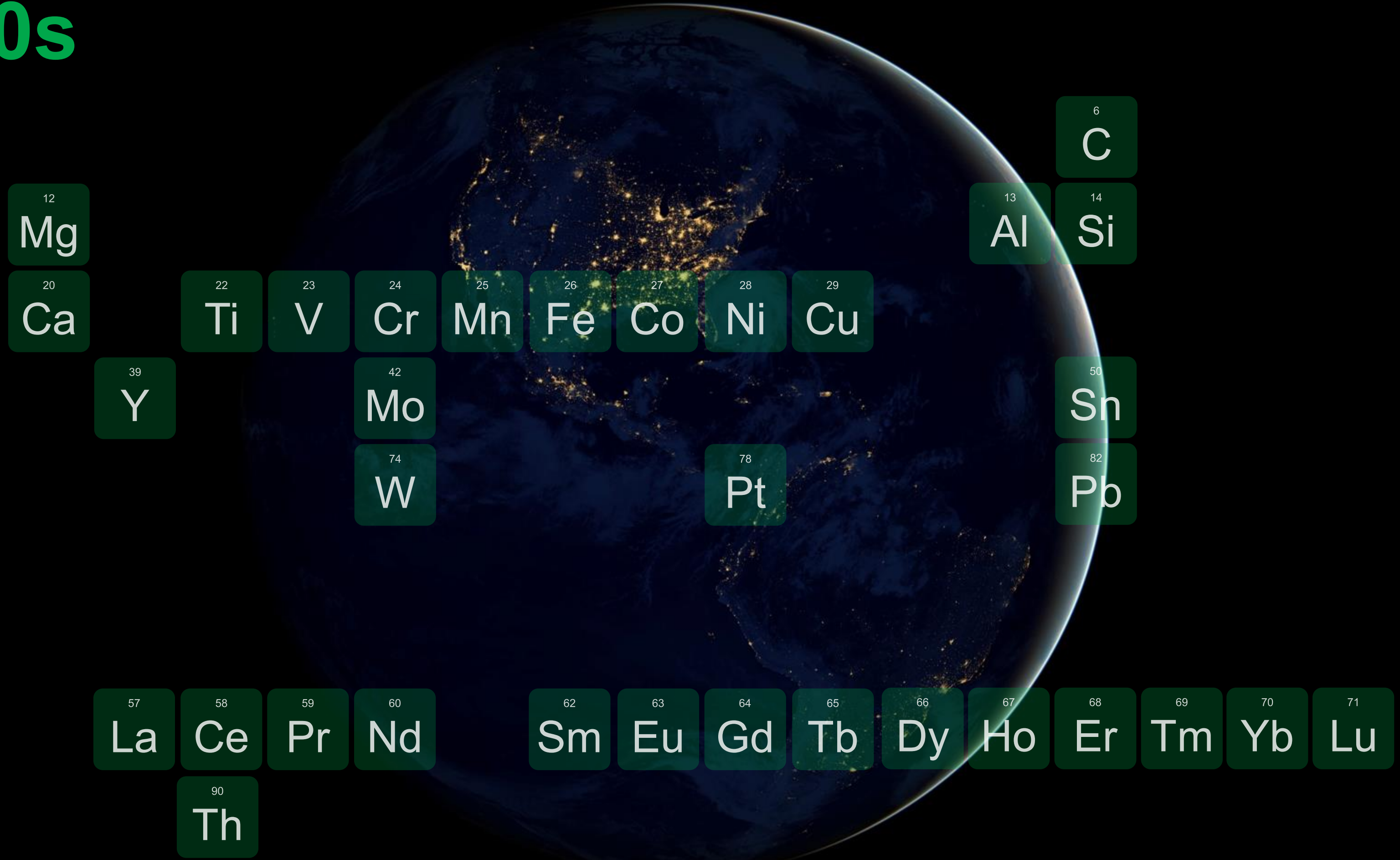
1700s

20
Ca

6
C

1800s

1900s



6
C
12
Mg
13
Al
14
Si
20
Ca
22
Ti
23
V
24
Cr
25
Mn
26
Fe
27
Co
28
Ni
29
Cu
39
Y
42
Mo
50
Sn
74
W
78
Pt
82
Pb
57
La
58
Ce
59
Pr
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Nd
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Sm
63
Eu
64
Gd
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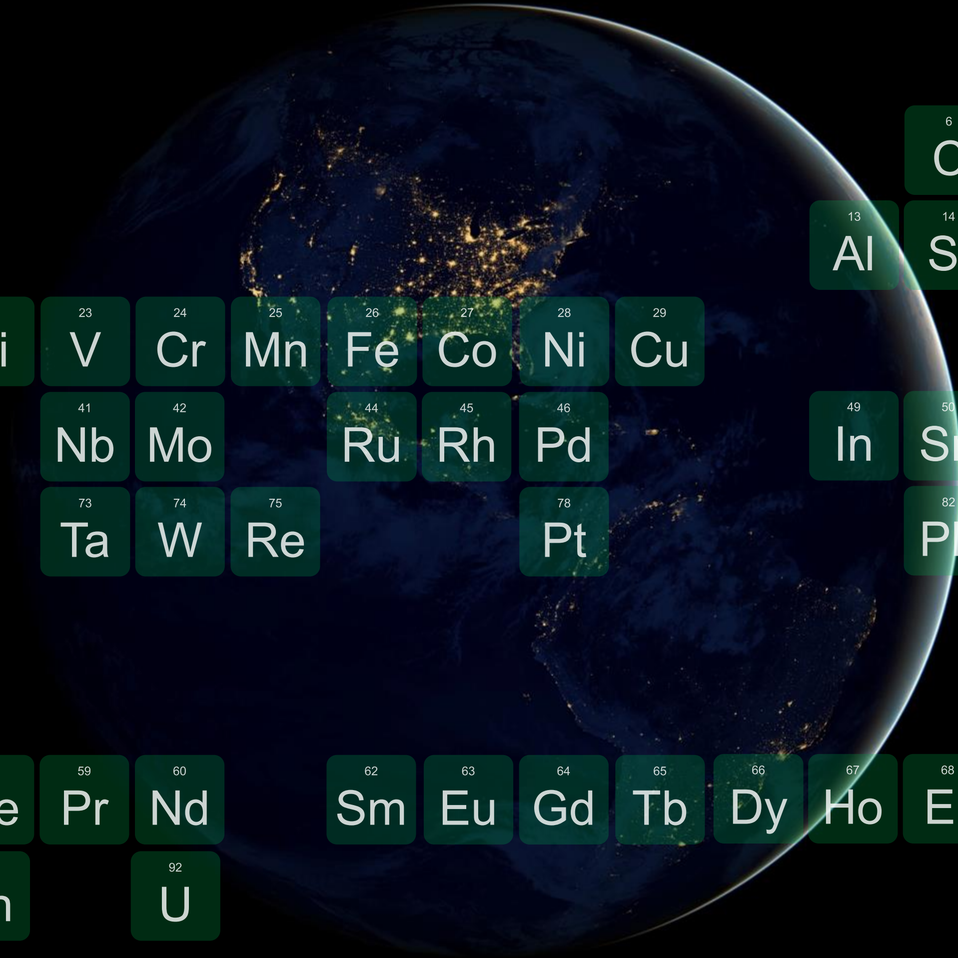
66
Dy
67
Ho
68
Er
69
Tm
70
Yb
71
Lu
90
Th

2000s



3 Li

12 Mg

19 K, 20 Ca, 22 Ti, 23 V, 24 Cr, 25 Mn, 26 Fe, 27 Co, 28 Ni, 29 Cu

39 Y, 41 Nb, 42 Mo, 44 Ru, 45 Rh, 46 Pd

73 Ta, 74 W, 75 Re, 78 Pt

6 C

13 Al, 14 Si, 15 P

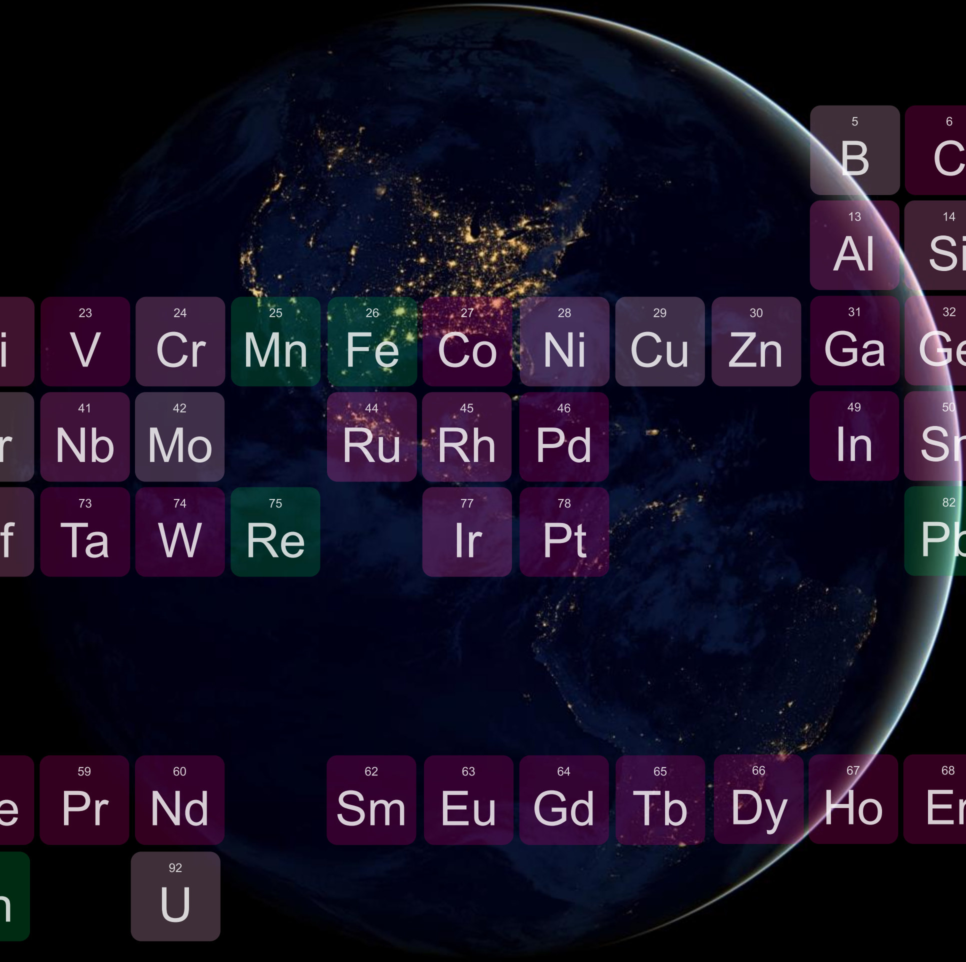
49 In, 50 Sn, 52 Te

82 Pb

57 La, 58 Ce, 59 Pr, 60 Nd, 62 Sm, 63 Eu, 64 Gd, 65 Tb, 66 Dy, 67 Ho, 68 Er, 69 Tm, 70 Yb, 71 Lu

90 Th, 92 U

2020s



2 He

3 Li, 4 Be, 5 B, 6 C, 9 F

12 Mg, 13 Al, 14 Si, 15 P

19 K, 20 Ca, 21 Sc, 22 Ti, 23 V, 24 Cr, 25 Mn, 26 Fe, 27 Co, 28 Ni, 29 Cu, 30 Zn, 31 Ga, 32 Ge, 33 As

37 Rb, 38 Sr, 39 Y, 40 Zr, 41 Nb, 42 Mo, 44 Ru, 45 Rh, 46 Pd, 49 In, 50 Sn, 51 Sb, 52 Te

55 Cs, 56 Ba, 72 Hf, 73 Ta, 74 W, 75 Re, 77 Ir, 78 Pt, 82 Pb, 83 Bi

57 La, 58 Ce, 59 Pr, 60 Nd, 62 Sm, 63 Eu, 64 Gd, 65 Tb, 66 Dy, 67 Ho, 68 Er, 69 Tm, 70 Yb, 71 Lu

90 Th, 92 U

2020s

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57-71 *	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 **	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Technology-Metal Match Maker

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27
Co

50
Sn

52
Te

74
W

78
Pt

60
Nd

Wind Turbine

Electric Vehicle

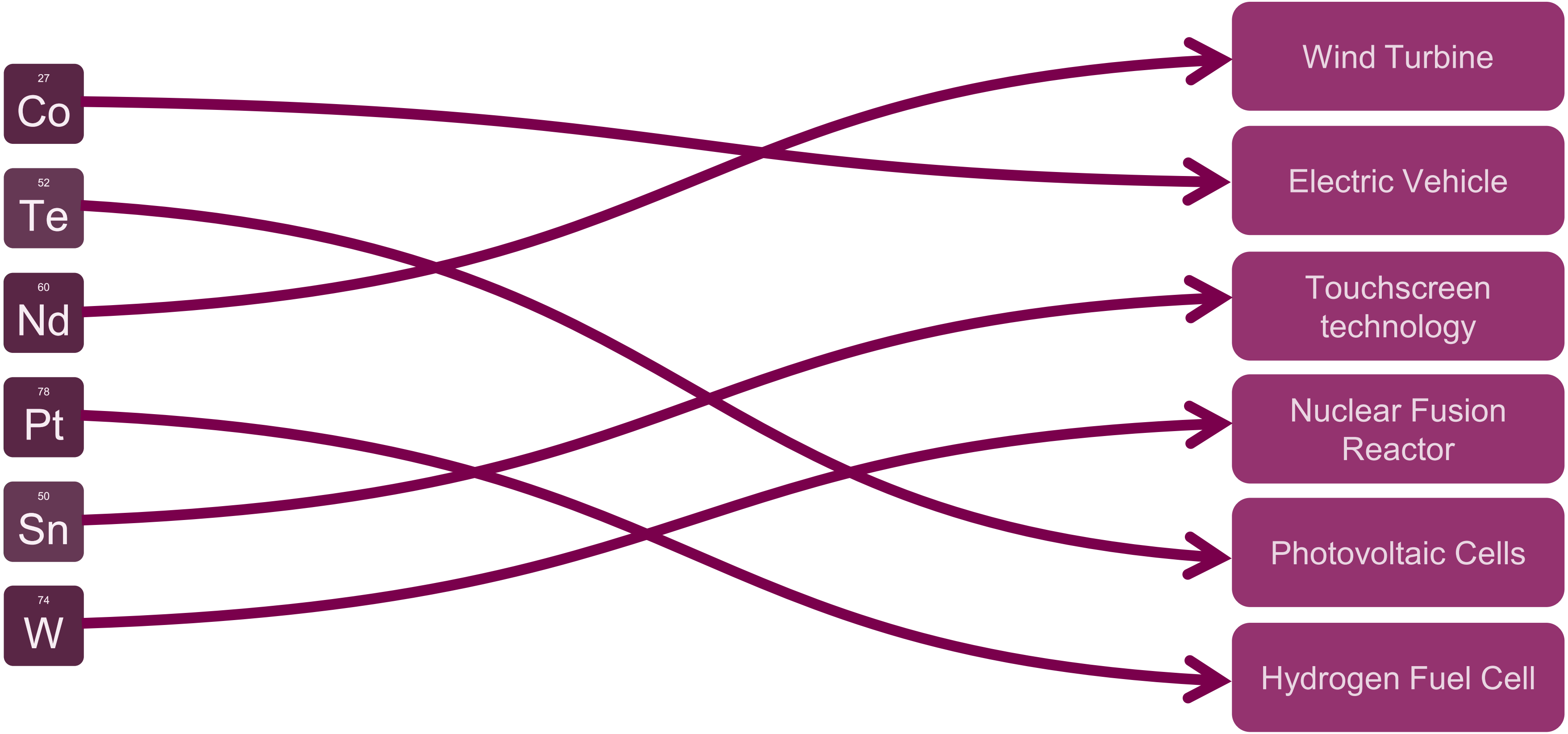
Touchscreen technology

Nuclear Fusion Reactor

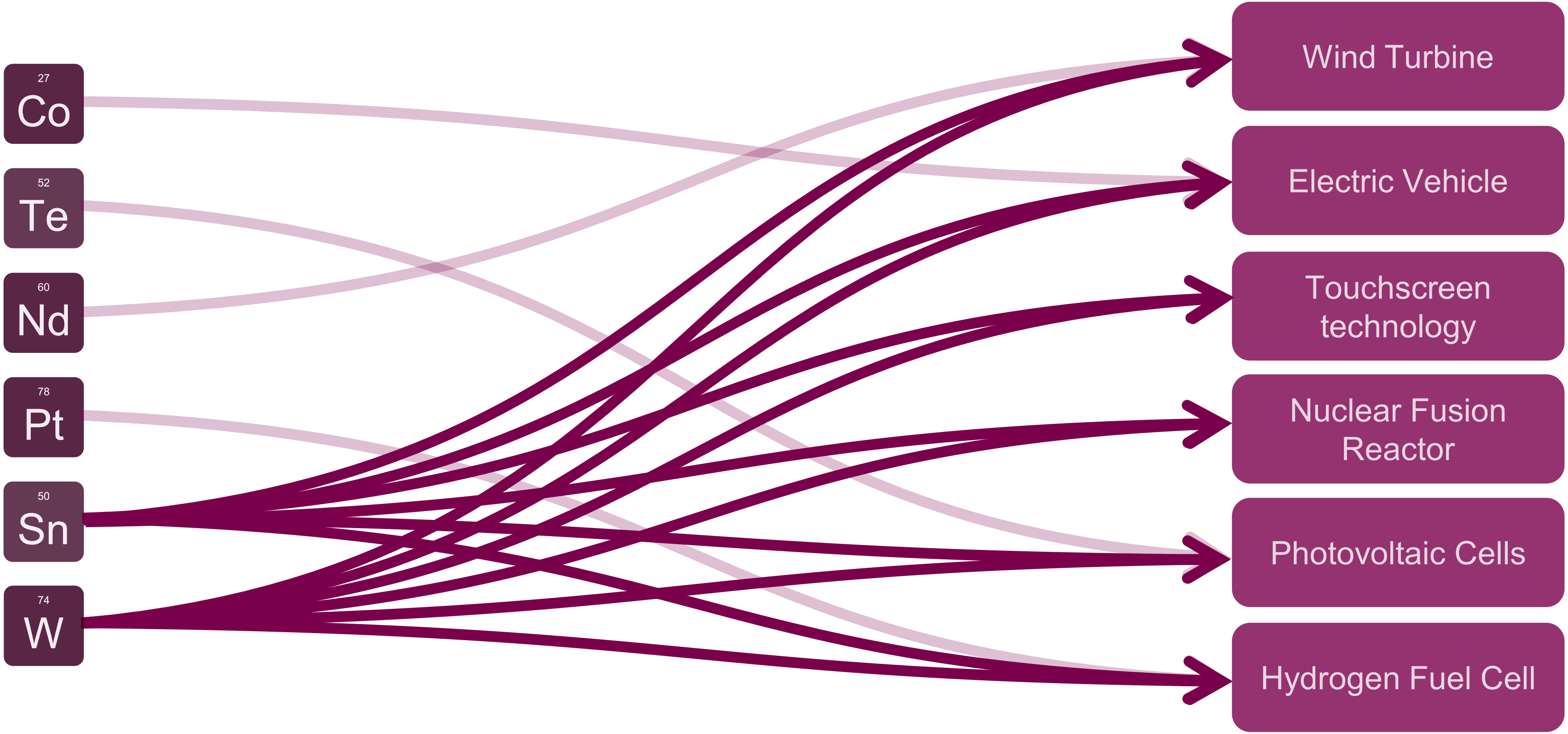
Photovoltaic Cells

Hydrogen Fuel Cell

Technology-Metal Match Maker



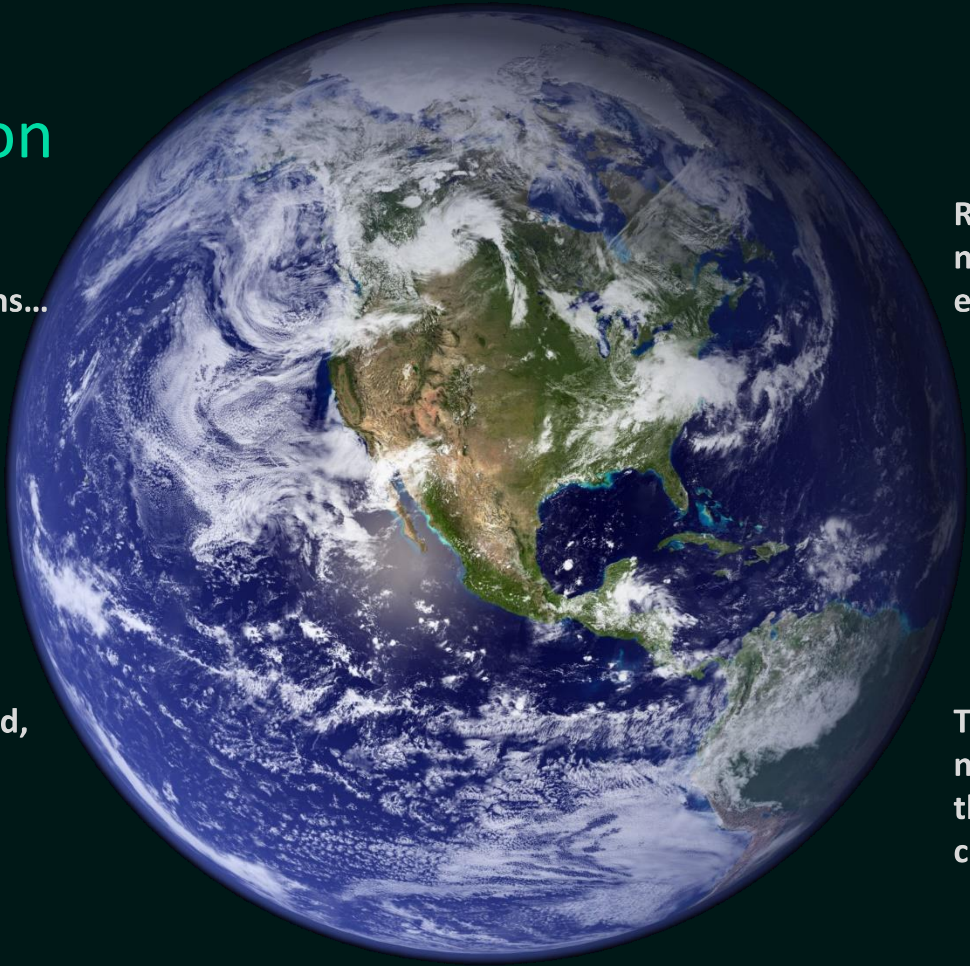
Technology-Metal Match Maker



Climate Action

Control, reduce and prevent anthropogenic greenhouse gas emissions…

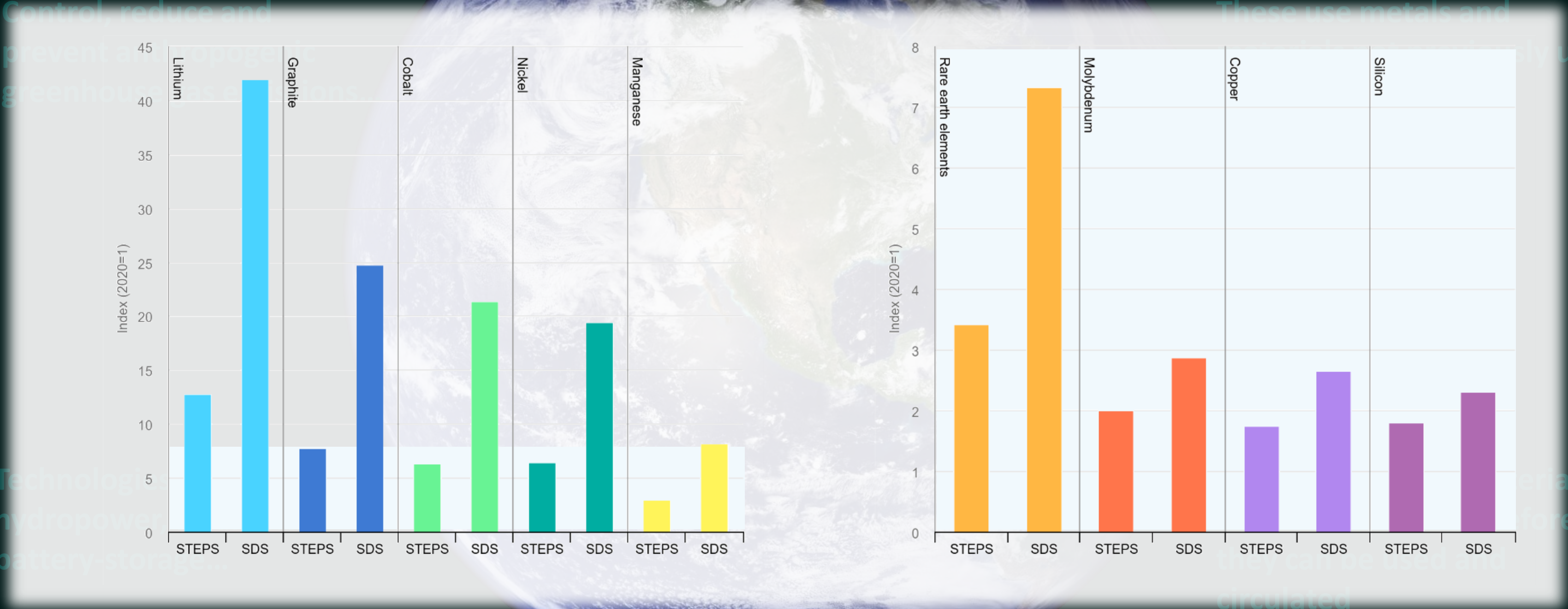
Requires metals and materials not previously used or extracted at scale…



Technologies include wind, hydropower, solar and battery-storage…

These metals and materials need to be sourced before they can be used and circulated

Climate Action



STEPS: IEA Stated Policies Scenario
SDS: IEA Sustainable Development Scenario

IEA (2021), The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions, Licence: CC BY 4.0

What is Critical?

Released to Public: Earth, Image by Reto Stöckli (NASA)

What controls criticality?

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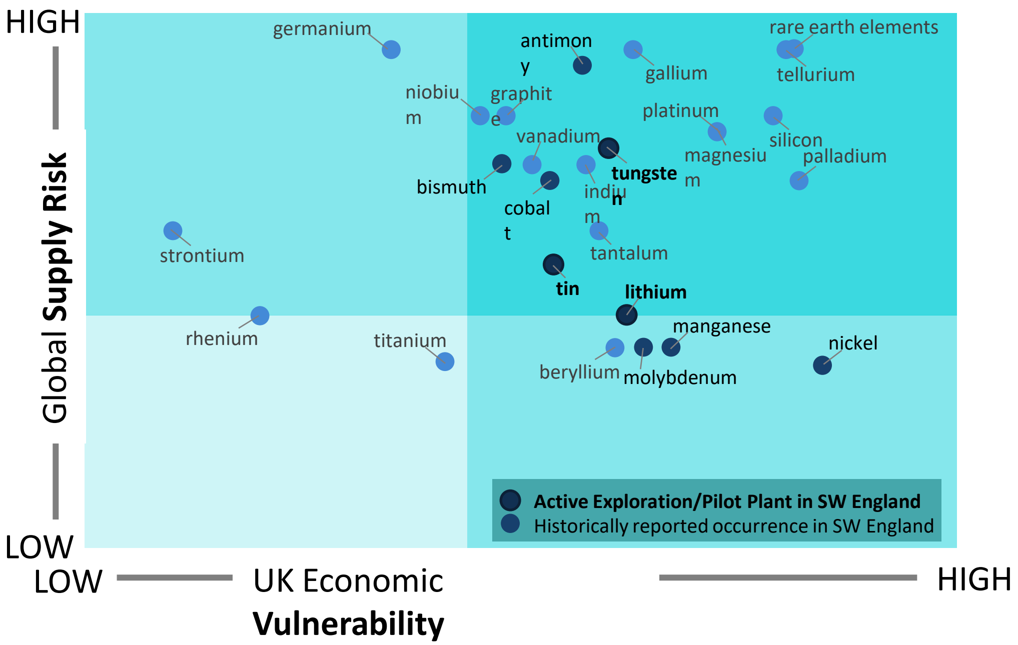
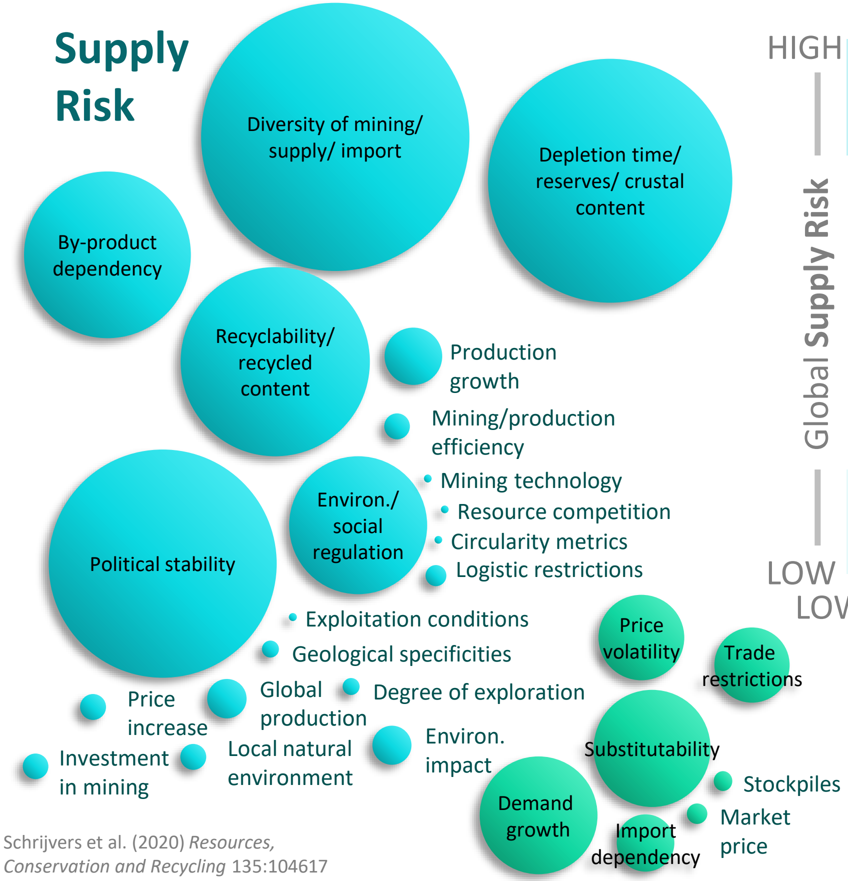
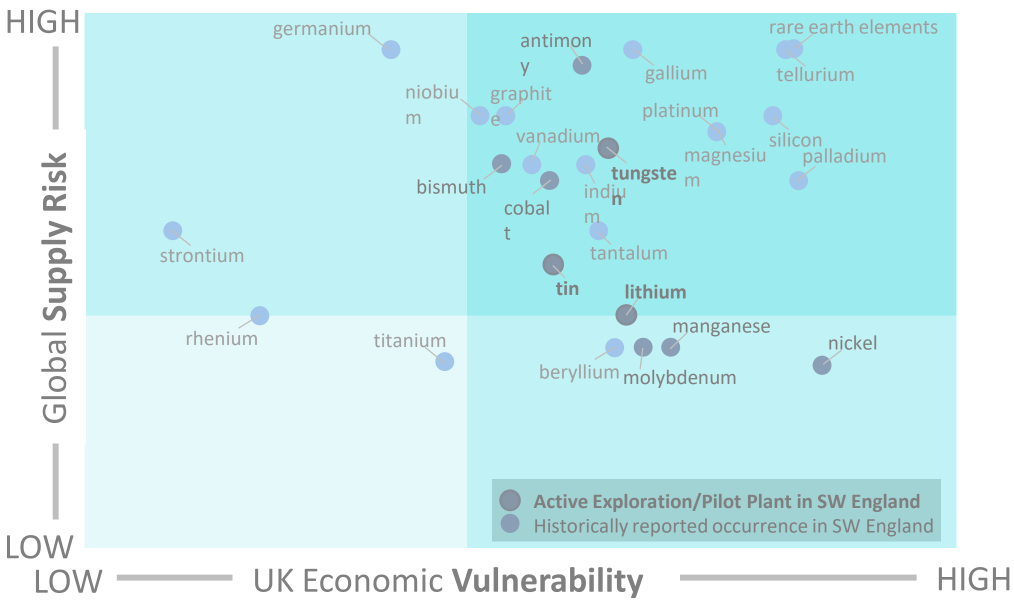
Critical Raw Materials are generally defined as being of **high economic importance** and **having high supply risk.**



What controls criticality?

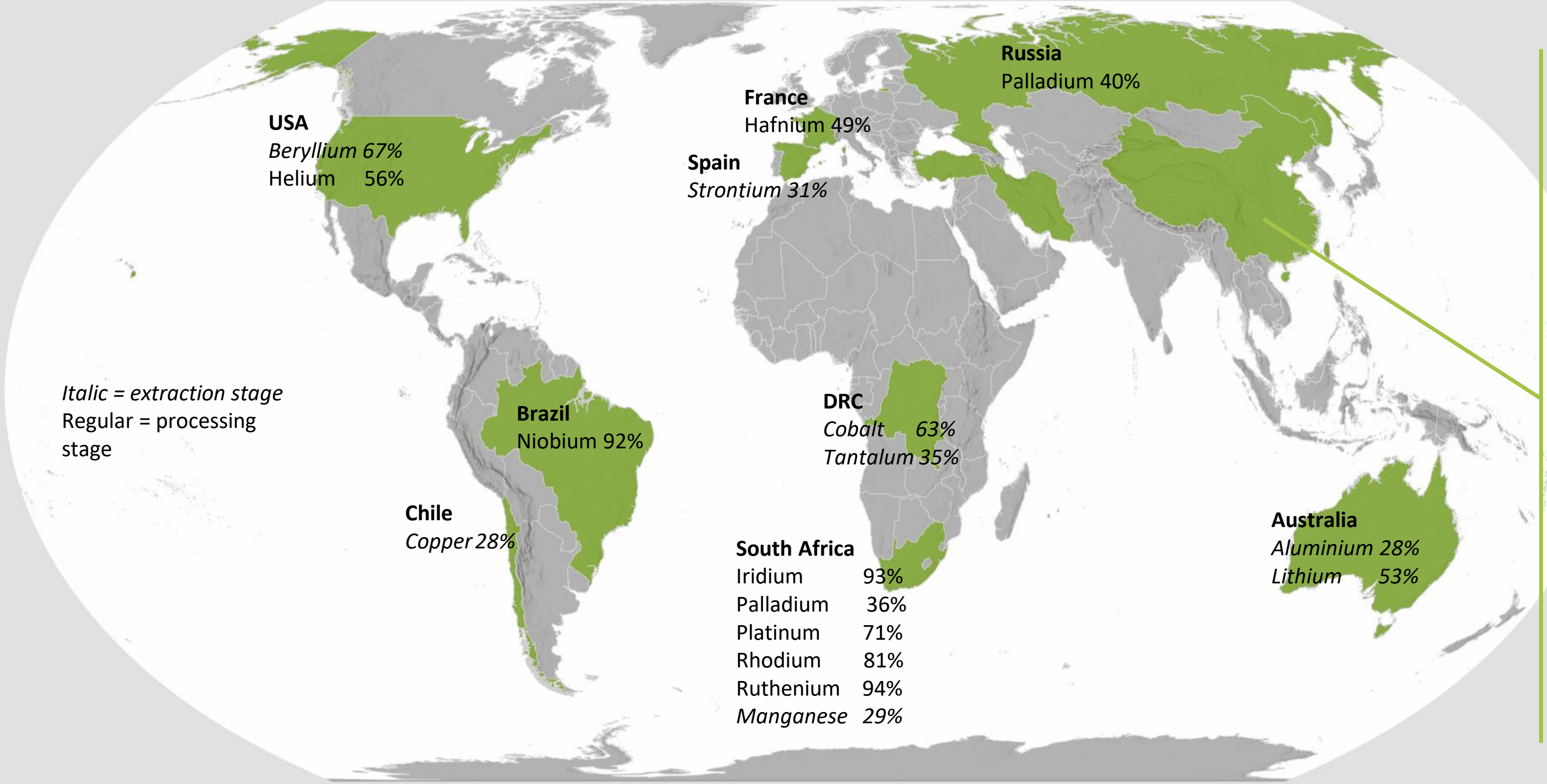




Schrijvers et al. (2020) *Resources, Conservation and Recycling* 135:104617

Vulnerability Indicators

What controls criticality?



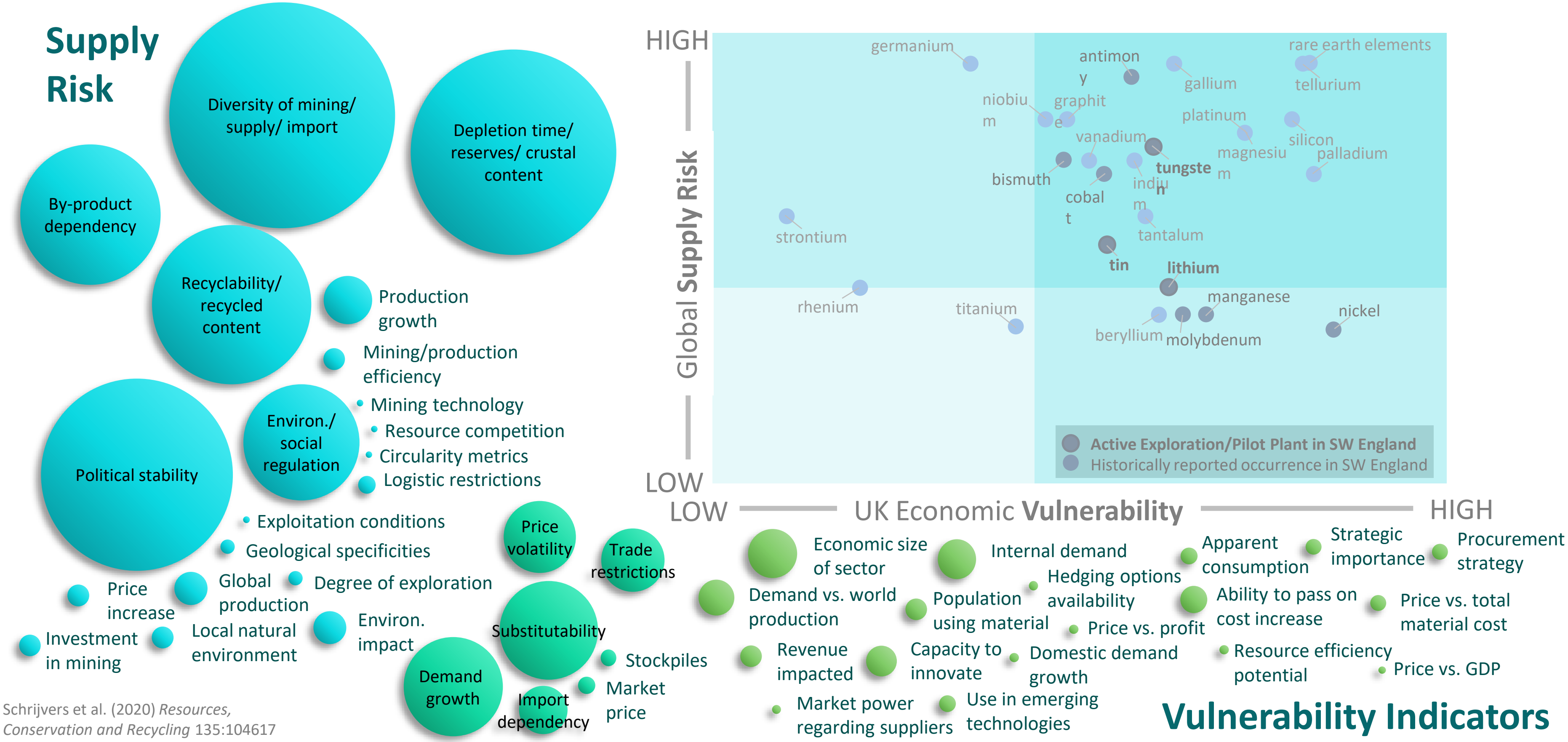
China

Aluminium	56%
Antimony	*56%*
Arsenic	44%
Baryte	*32%*
Bismuth	70%
Cobalt	60%
Coking Coal	*53%*
Copper	38%
Fluorspar	*56%*
Gallium	94%
Germanium	83%
Lithium	56%
Magnesium	91%
Manganese	58%
Natural Graphite	67%
Nickel	33%
Phosphate Rock	*44%*
Phosphorous	79%
Scandium	67%
Silicon Metal	76%
Titanium Metal	43%
Vanadium	*62%*
LREEs	85%
HREEs	100%

European Commission, (2023) Study on the critical raw materials for the EU 2023 – Final report, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2873/725585

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

What controls criticality?



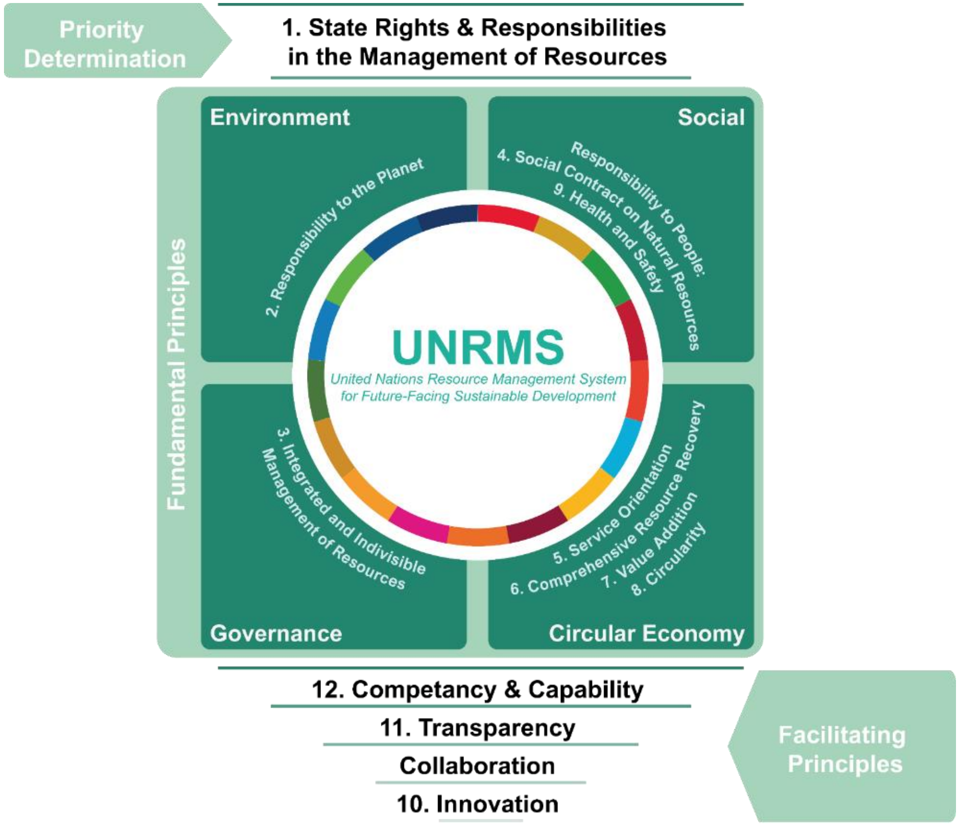
Schrijvers et al. (2020) *Resources, Conservation and Recycling* 135:104617

What can be done to alleviate Criticality?

Released to Public: Earth, Image by Reto Stöckli (NASA)

Sustainable Resource Management

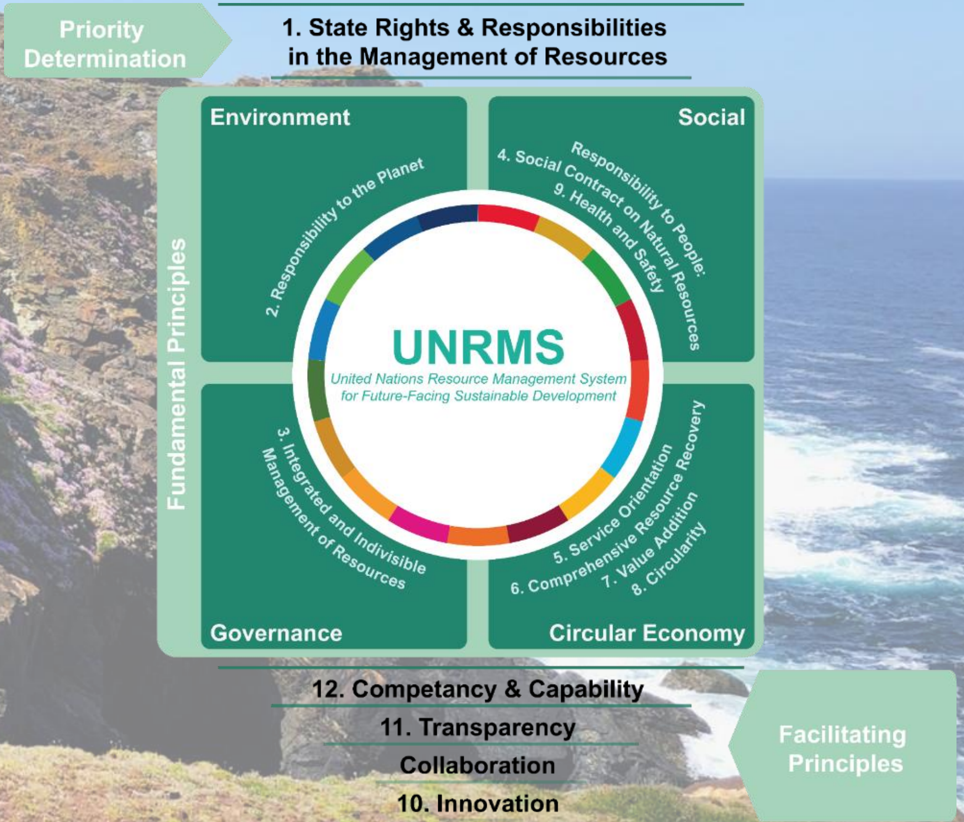
- **United Nations Resource Management System**
  - 12 fundamental principles and 54 underlying requirements



UNRMS: Cornwall Case Study

Met4Tech

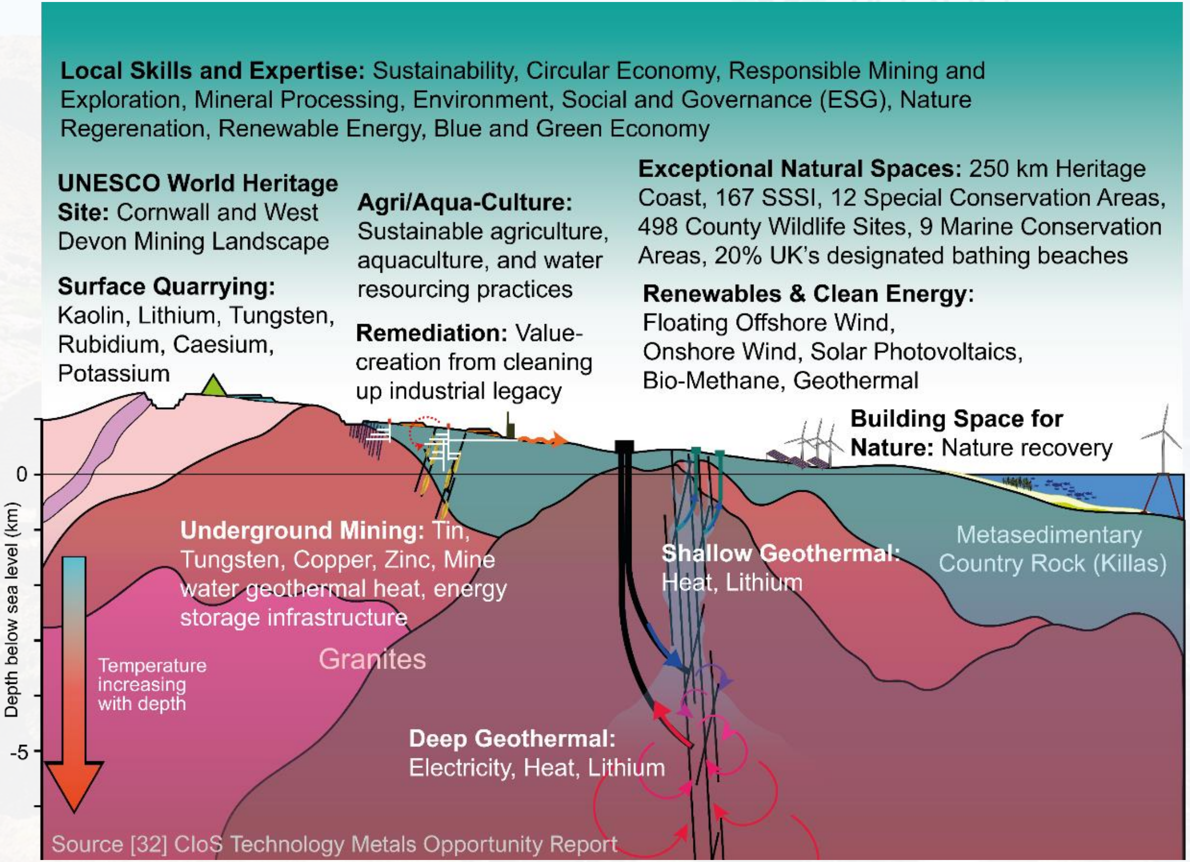
University of Exeter



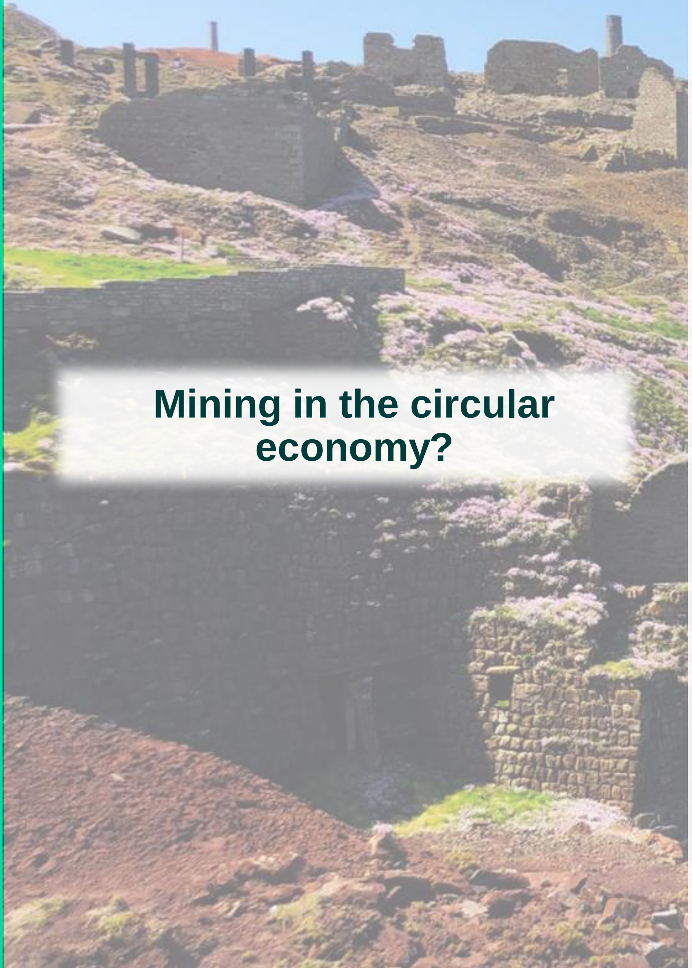
UNRMS: Cornwall Case Study

Diverse set of **“Geo-Resources”** spanning natural and social capital…

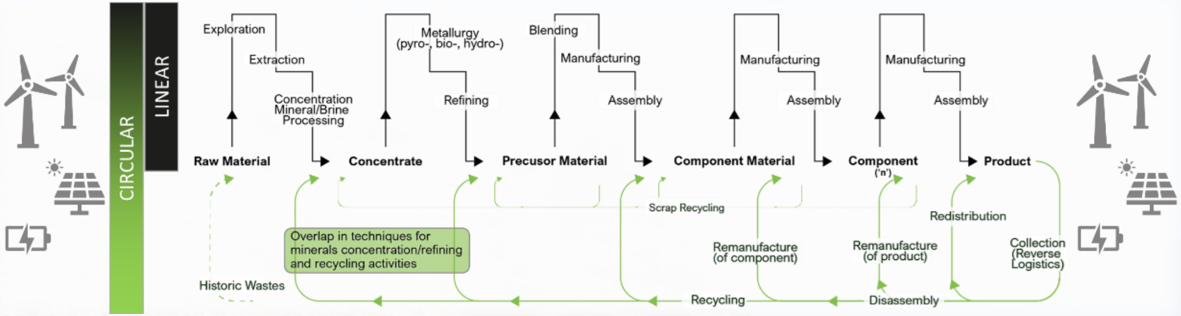
…how can these be balanced?

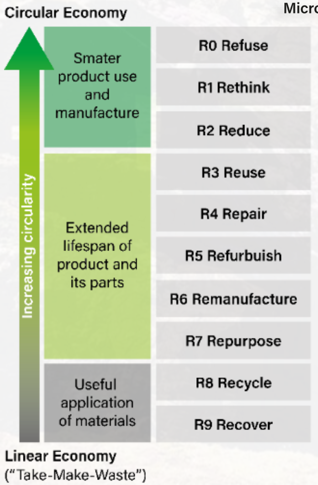


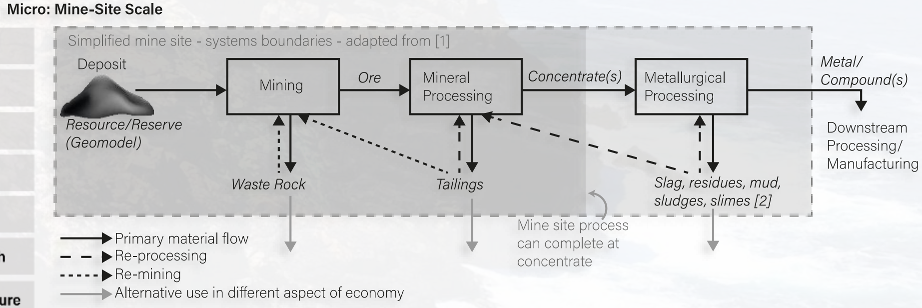
UNRMS: Cornwall Case Study



Mining in the circular economy?



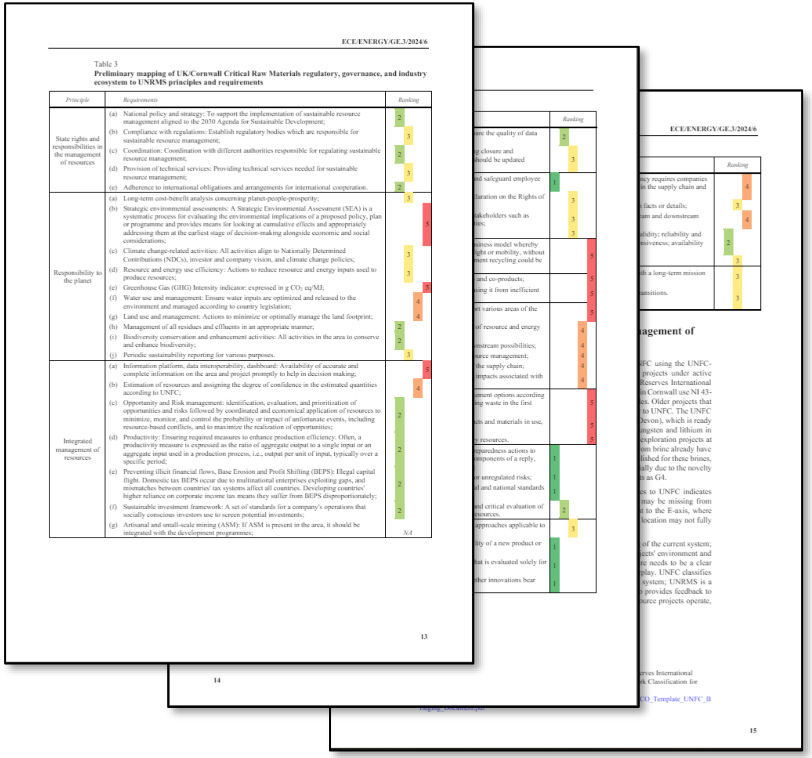




... resource efficiency, by/co-product recovery, waste valorisation, industrial symbiosis, dematerialisation, end-of-life extension, resources-as-a-service ...

UNRMS: Cornwall Case Study

Applicability Mapping



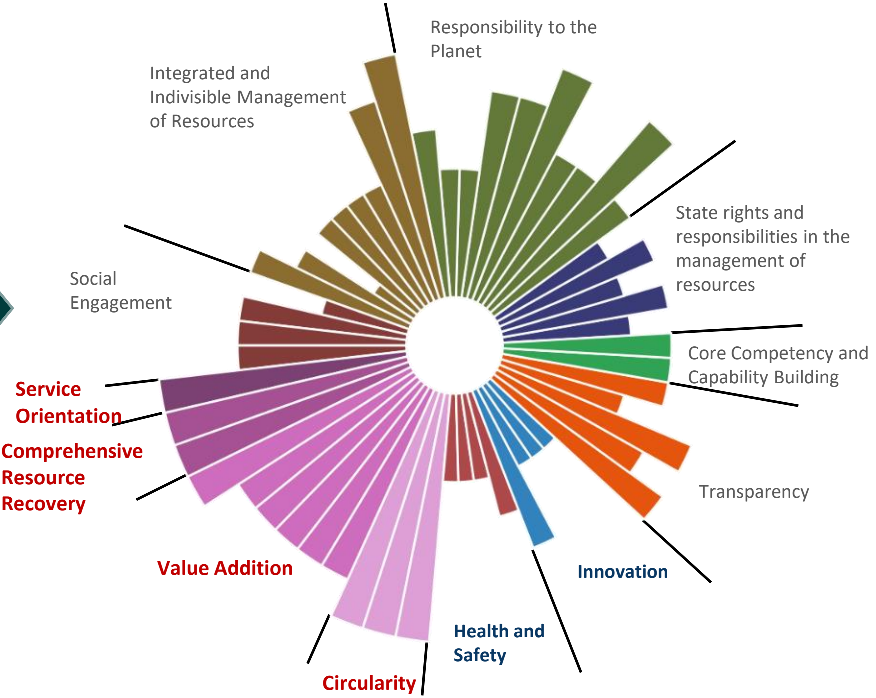
ECE/ENERGY/GE.3/2024/6

Table 3

Preliminary mapping of UK/Cornwall Critical Raw Materials regulatory, governance, and industry ecosystem to UNRMS principles and requirements

Principle	*Requirements*	*Ranking*
State rights and responsibilities in the management of resources	(a) National policy and strategy: To support the implementation of sustainable resource management aligned to the 2030 Agenda for Sustainable Development;	2
	(b) Compliance with regulations: Establish regulatory bodies which are responsible for sustainable resource management;	3
	(c) Coordination: Coordination with different authorities responsible for regulating sustainable resource management;	2
	(d) Provision of technical services: Providing technical services needed for sustainable resource management;	3
	(e) Adherence to international obligations and arrangements for international cooperation.	2
Responsibility to the planet	(a) Long-term cost-benefit analysis concerning planet-people-prosperity;	3
	(b) Strategic environmental assessments: A Strategic Environmental Assessment (SEA) is a systematic process for evaluating the environmental implications of a proposed policy, plan or programme and provides means for looking at cumulative effects and appropriately addressing them at the earliest stage of decision-making alongside economic and social considerations;	5
	(c) Climate change-related activities: All activities align to Nationally Determined Contributions (NDCs), investor and company vision, and climate change policies;	3
	(d) Resource and energy use efficiency: Actions to reduce resource and energy inputs used to produce resources;	3
	(e) Greenhouse Gas (GHG) Intensity indicator: expressed in g CO_2 eq/MJ;	5
	(f) Water use and management: Ensure water inputs are optimized and released to the environment and managed according to country legislation;	4
	(g) Land use and management: Actions to minimize or optimally manage the land footprint;	4
	(h) Management of all residues and effluents in an appropriate manner;	2
	(i) Biodiversity conservation and enhancement activities: All activities in the area to conserve and enhance biodiversity;	2
	(j) Periodic sustainability reporting for various purposes.	3
Integrated management of resources	(a) Information platform, data interoperability, dashboard: Availability of accurate and complete information on the area and project promptly to help in decision making;	5
	(b) Estimation of resources and assigning the degree of confidence in the estimated quantities according to UNFC;	4
	(c) Opportunity and Risk management: identification, evaluation, and prioritization of opportunities and risks followed by coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events, including resource-based conflicts, and to maximize the realization of opportunities;	2
	(d) Productivity: Ensuring required measures to enhance production efficiency. Often, a productivity measure is expressed as the ratio of aggregate output to a single input or an aggregate input used in a production process, i.e., output per unit of input, typically over a specific period;	2
	(e) Preventing illicit financial flows, Base Erosion and Profit Shifting (BEPS): Illegal capital flight. Domestic tax BEPS occur due to multinational enterprises exploiting gaps, and mismatches between countries' tax systems affect all countries. Developing countries' higher reliance on corporate income tax means they suffer from BEPS disproportionately;	2
	(f) Sustainable investment framework: A set of standards for a company's operations that socially conscious investors use to screen potential investments;	2
	(g) Artisanal and small-scale mining (ASM): If ASM is present in the area, it should be integrated with the development programmes;	*NA*

13



Thank you for Listening!

BREAK

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13 CLIMATE ACTION
7 AFFORDABLE AND CLEAN ENERGY
14 LIFE BELOW WATER
3 GOOD HEALTH AND WELL-BEING
17 PARTNERSHIPS FOR THE GOALS
16 PEACE, JUSTICE AND STRONG INSTITUTIONS

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Beyond the Horizon:
The transformative potential of offshore wind energy

Professor Philipp Thies, Professor of Renewable Energy & **Professor Peter Connor**, Associate Professor in Sustainable Energy Policy, University of Exeter Engineering

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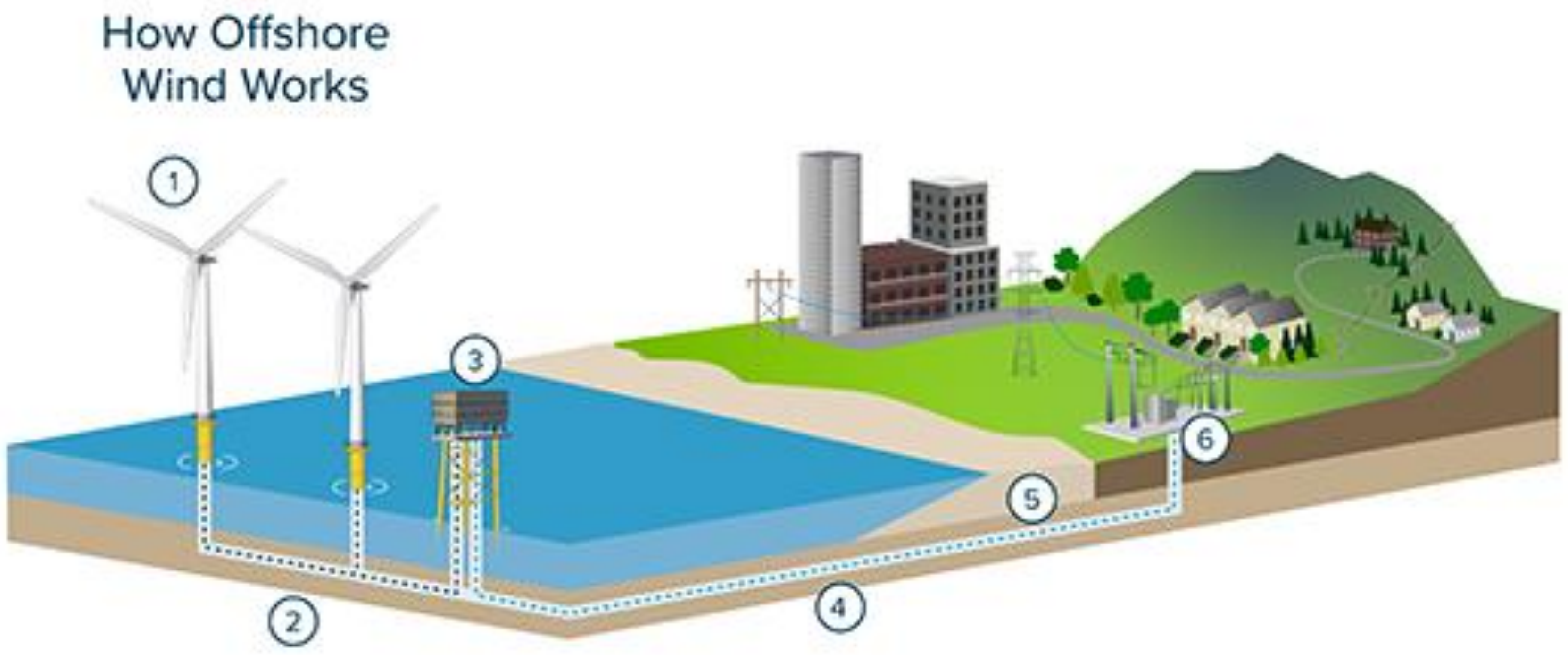
Offshore Wind: Fixed to Floating

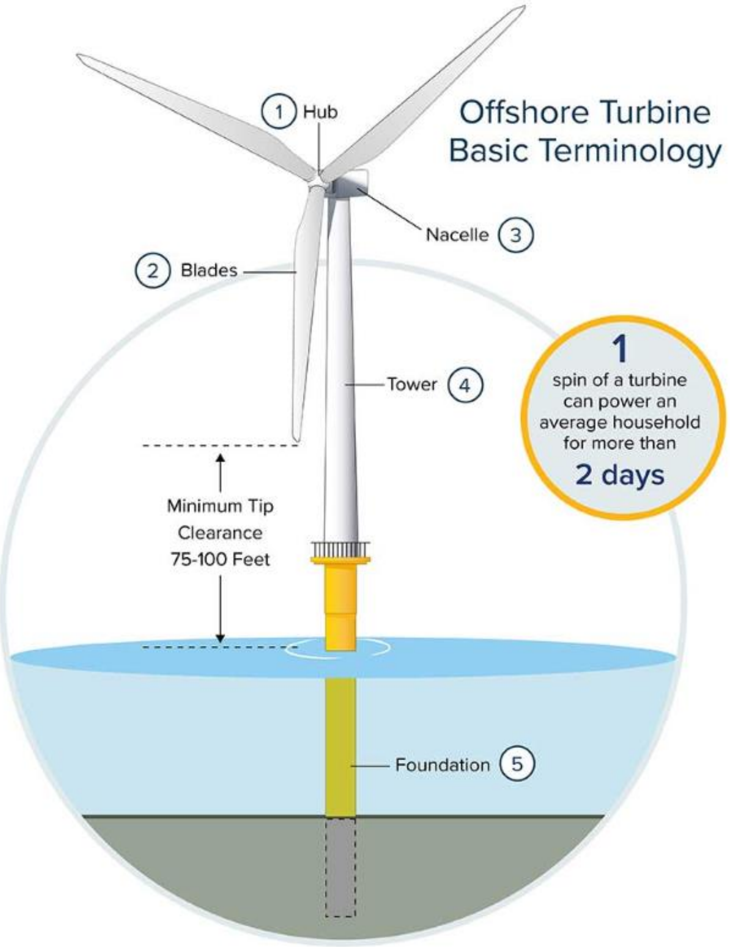
Fixed Offshore Wind Energy

Fixed Offshore Wind Energy



Fixed Offshore Wind Energy

1. The **Hub** supports the blades & houses the pitch system, which optimizes blade angle and rotation speed.
2. **Blades** capture the wind's energy and convert it into mechanical energy.
3. The **Nacelle** houses components that convert mechanical energy to electrical energy.
4. The **Tower** supports the mass of the nacelle, hub, and blades.



Why do we want to go offshore?

- A 1MW wind turbine can generate 1MW of power at maximum output.
- At lower windspeeds, they generate less. At high speeds the blades are braked to avoid damage but this doesn't happen that often.
- All wind turbines have a load factor, basically a ratio setting out actual output against the theoretical maximum output.
- Load factors
  - onshore wind: 25.94%
  - offshore wind: 40.98%
- So an identical UK offshore WT at sea produces about 57% more electricity than a UK onshore WT. This justifies a higher spend on the offshore WT.

Why do we want to go offshore?

- It's really windy at sea: [New European Wind Atlas]
- Sea is smoother than land, giving better interaction with the WT.

- Offshore also lets us build bigger turbines without annoying the neighbours. Generally speaking, the taller the turbine, the faster the wind, and that means more power and more energy generated. But taller turbines are less welcome on land.
- Hornsea 2 has 165 x 8MW turbines, and an area of 462km^2 (178 sq miles). Impossible to find a site that big on land.

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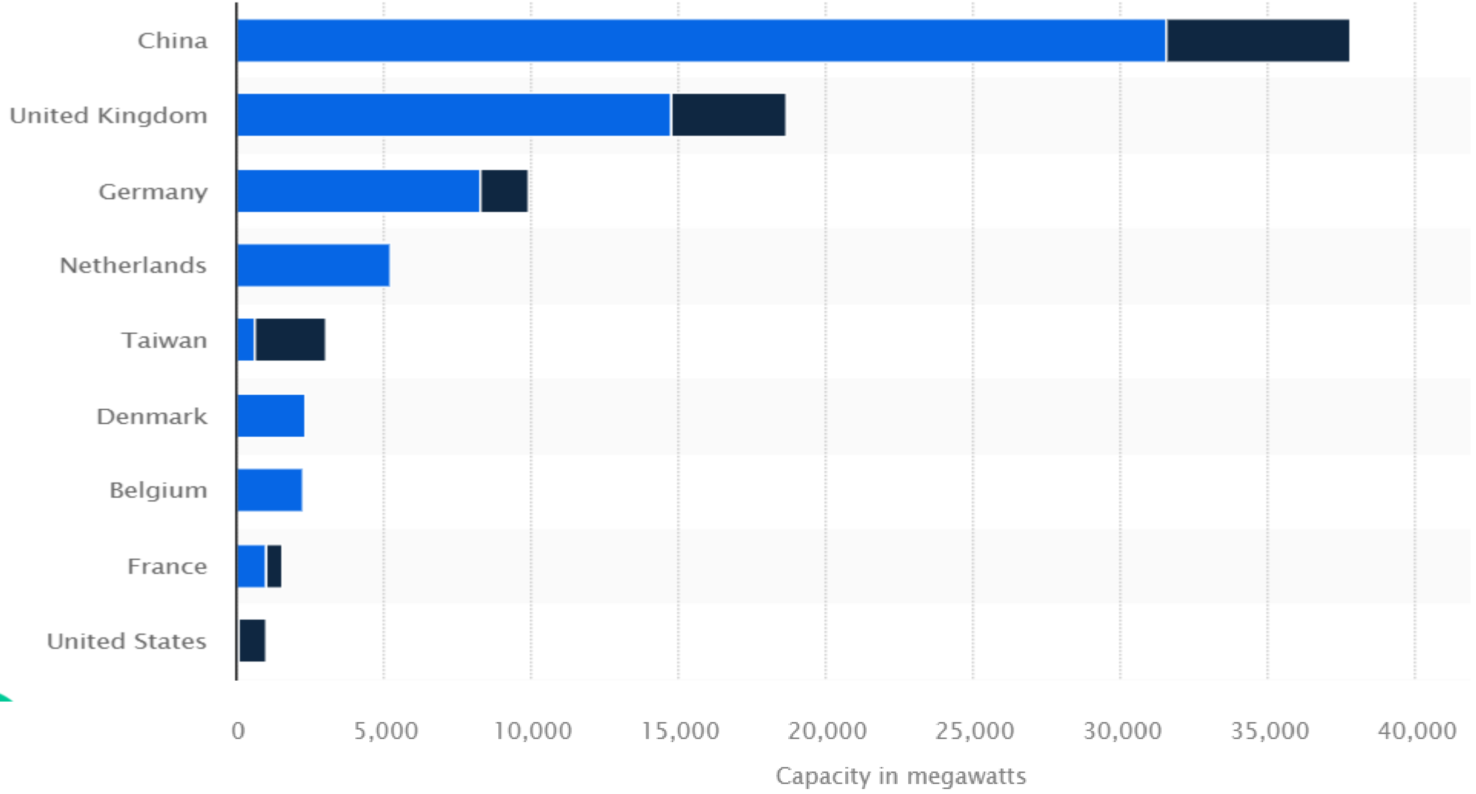
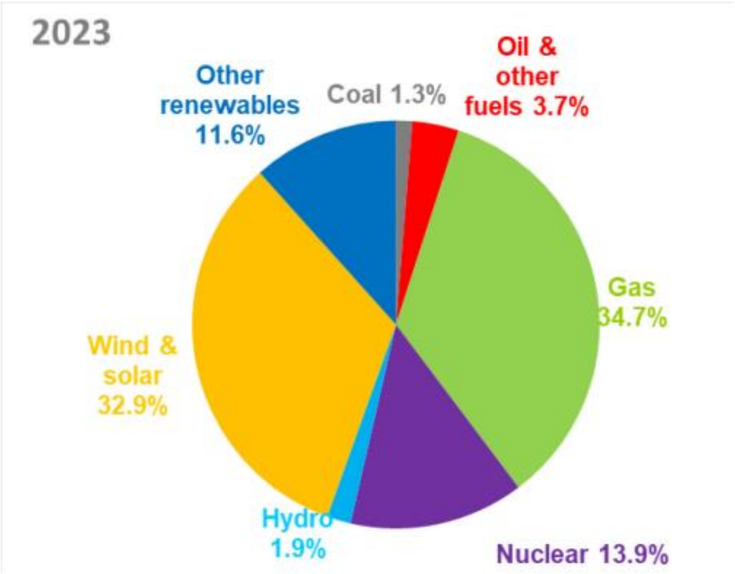
Where is Offshore Wind currently?



Where is Offshore Wind currently?

- [List of offshore wind farms – Wikipedia]
- Until ~2020, the UK was the global leader in offshore wind, with 40% of all the offshore wind farms in the world in UK waters.
- Around half of the UK's 28GW of wind capacity is offshore.
- Globally, offshore wind is less than 10% of all wind energy.



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Fixed offshore wind potential

- This map shows water depth of 50m or less in black. This is where fixed offshore wind is viable in terms of depth.
- You need both one of these sites and a good wind regime, plus no issues with geology for siting.
- Ideally you want these close to shore, to minimize costs of connecting to the grid.
- There are a limited number of such sites.

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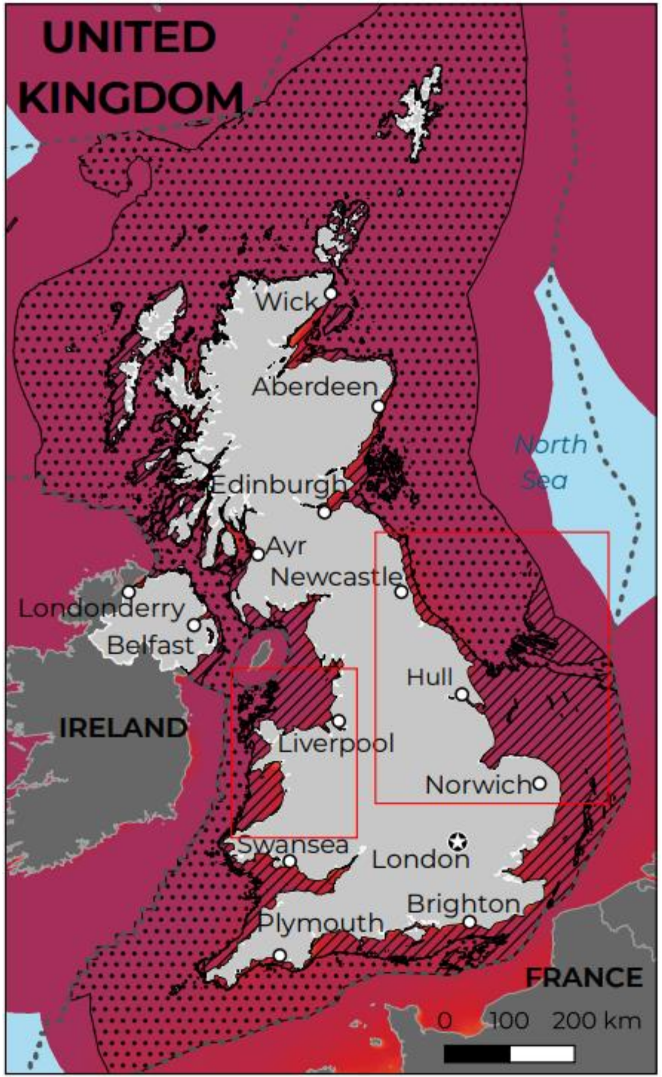
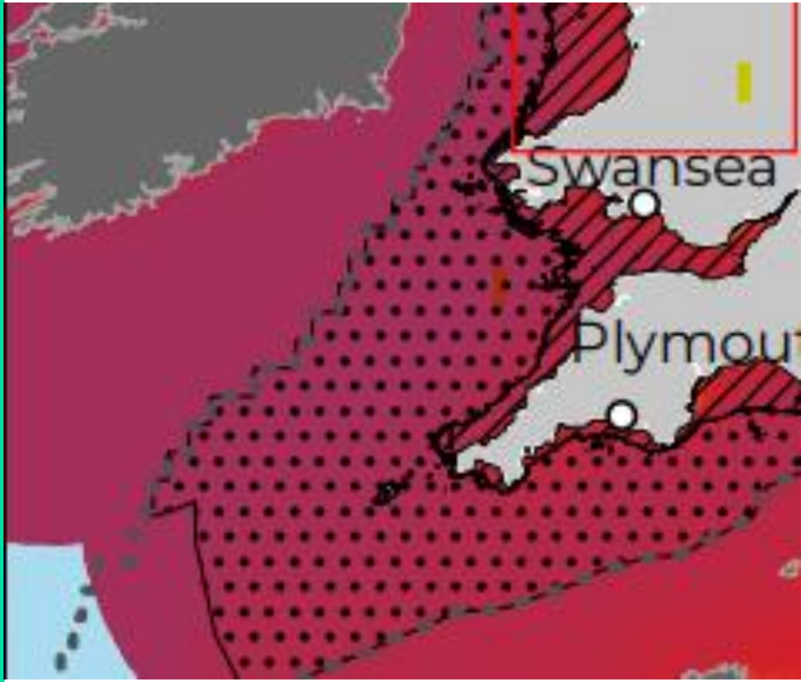
UK Fixed & Floating Offshore Potential

- Other factors may still shape what is exploited:
  - Distance from coast
  - Distance from grid/population centres when coming ashore
  - Planning permission is needed for onshore connection



Celtic Sea Fixed & Floating Offshore Potential



Why do we want to float wind turbines?

- There is huge potential for offshore wind in locations that are too deep to be exploited with fixed tower wind turbines.
- A proven route to exploitation would open up opportunities:
  - in Cornwall and the Celtic Sea
  - around huge parts of the UK
  - across the Mediterranean, and the Atlantic coast of Europe
  - In many other places worldwide including China and Japan

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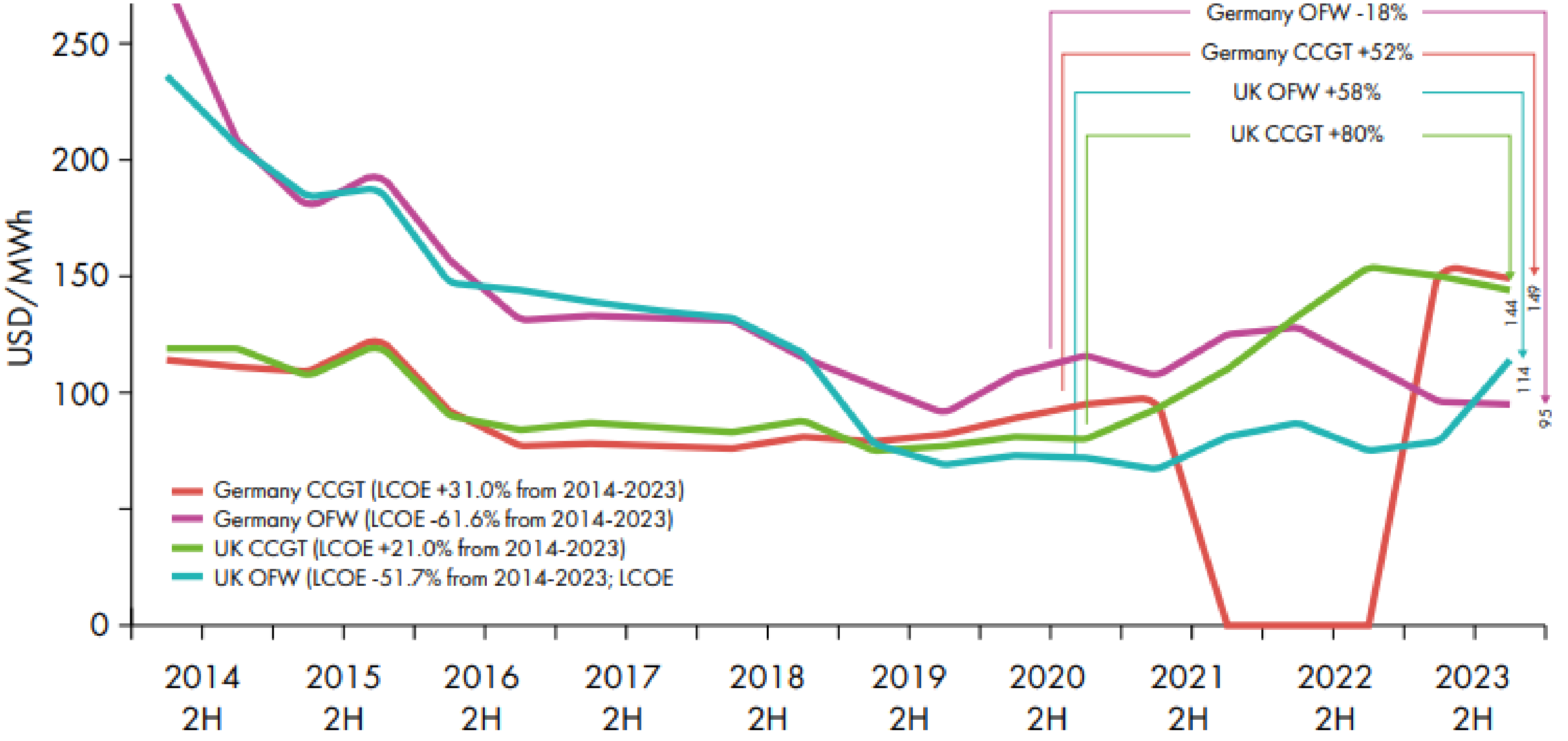
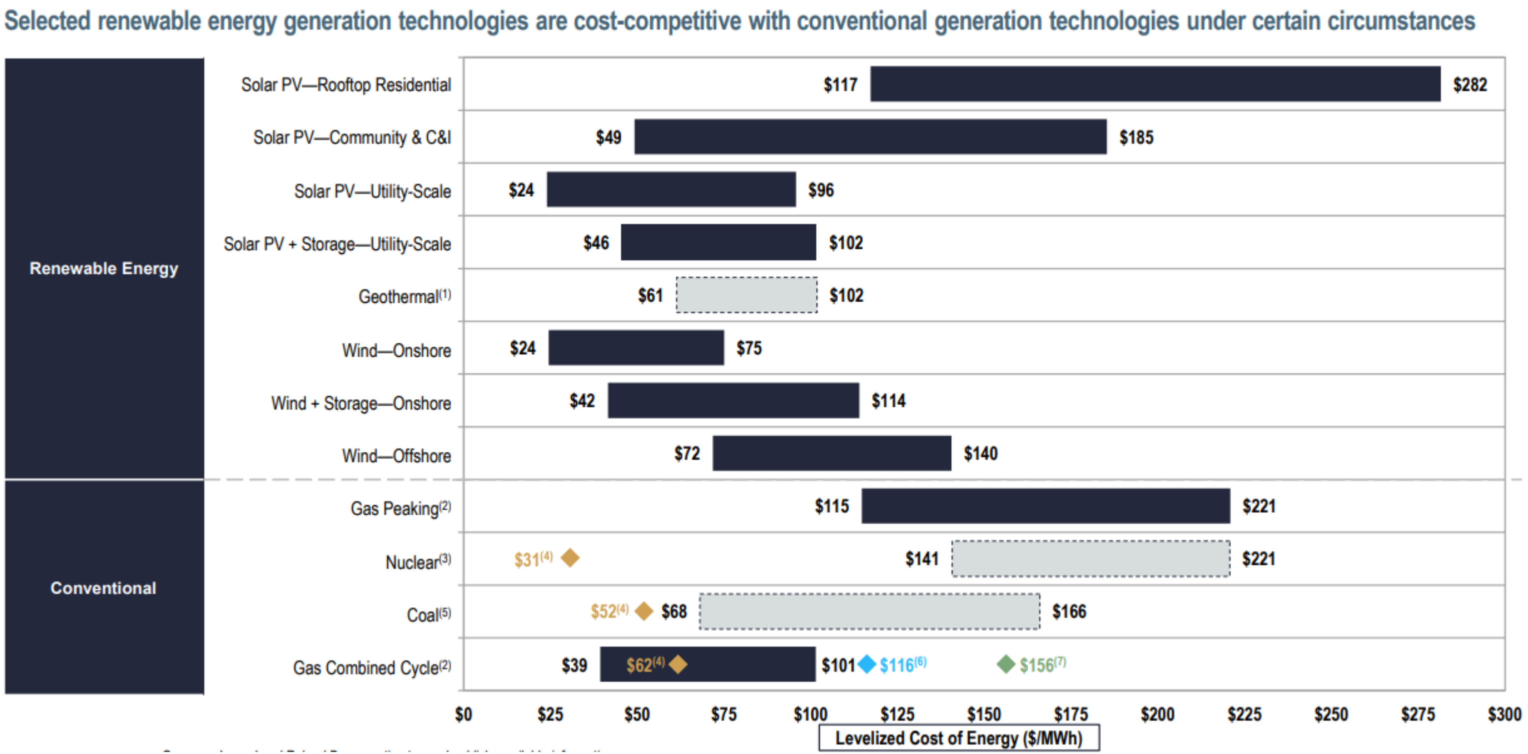
OW v Gas costs, UK & Germany

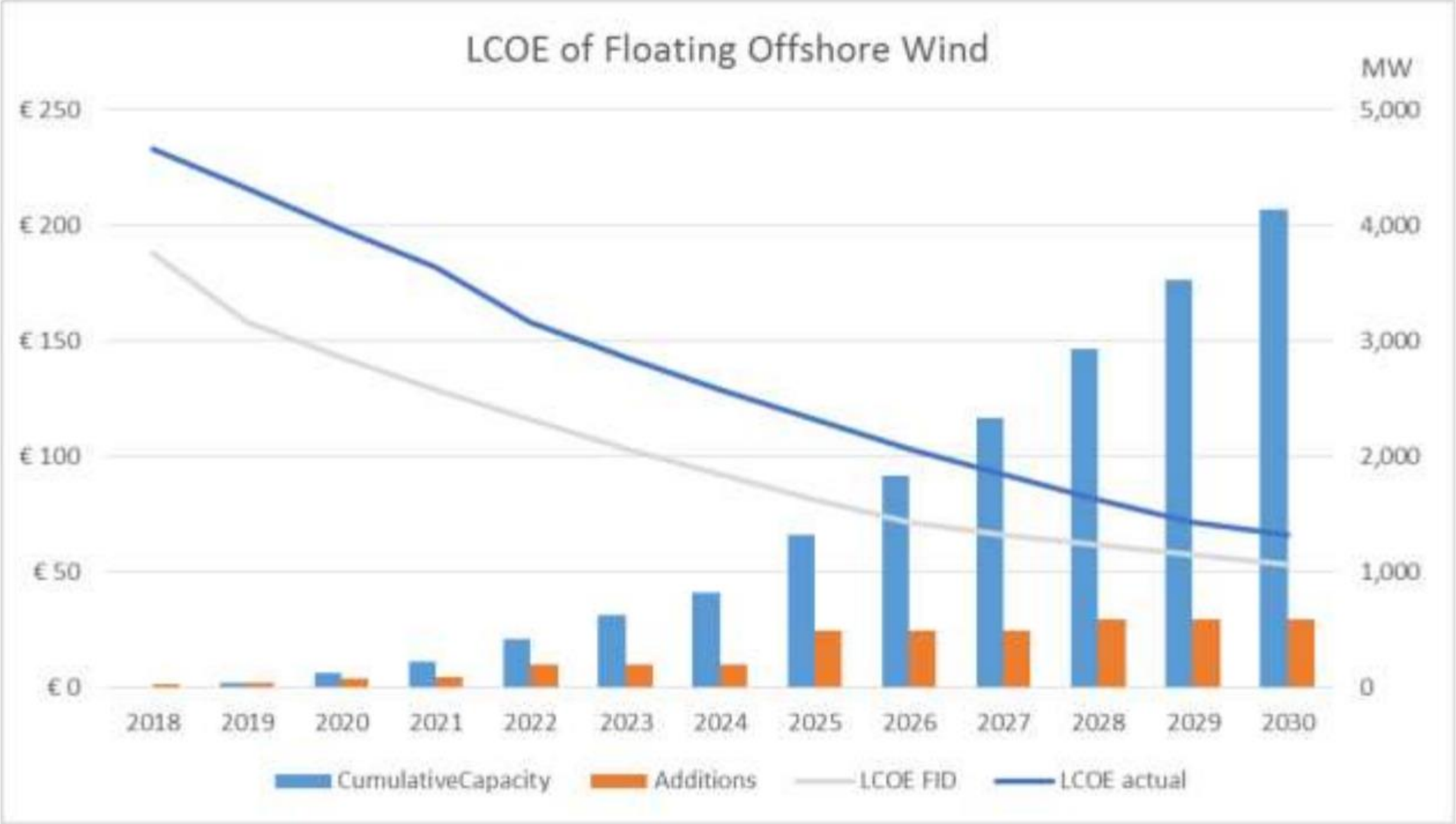


LCOEs for RE & Fossil Fuels, 2023



Costs of offshore wind, CFD – AR6

Technology	Pot		2026/27	2027/28	2028/29	Total Capacity (MW)
Solar PV (>5MW)	Pot 1	£/MWh	50.07	50.07	-	3288.31
		MW	1091.54	2196.77	-	
Onshore Wind (>5MW)	Pot 1	£/MWh	50.9	50.9	-	990.37
		MW	272.58	717.79	-	
Tidal Stream	Pot 2	£/MWh	-	172	172	28
		MW	-	10	18	
Floating Offshore Wind	Pot 2	£/MWh	-	N/A	139.93	400
		MW	-	0	400	
Offshore Wind	Pot 3	£/MWh	-	N/A	58.87	3363.07
		MW	-	0	3363.07	
Offshore Wind Permitted Reduction	Pot 3	£/MWh	-	54.23	N/A	1578.51
		MW	-	1578.51	0	


LCOE of Floating Offshore Wind
MW
€ 250
€ 200
€ 150
€ 100
€ 50
€ 0
5,000
4,000
3,000
2,000
1,000
0
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
CumulativeCapacity
Additions
LCOE FID
LCOE actual

Floating Wind Projects

Wind Farm Name	Country	Capacity (MW)	Commissioning Date
Hywind Scotland	UK	30	2017 (operating)
Windfoat Atlantic	Portugal	25	2020 (operating)
Nautilus	Spain	5	Proposed
Kincardine	UK	50	2021 (operating)
Forthwind Project	UK	20	Consented
EFGL	France	30	Under construction
PGL Wind Farm	France	25.2	Partially commissioned
EolMed	France	30	Under construction
Hywind Tampen	Norway	88MW	2022 (operating)
Poseidon	Italy	1008	Planning
Pentland Floating Wind Demonstrator	UK	15	Consented
Yangxi Shapa	China	5.5	Operating (2021)
Longyuan Nanri Island Floating Project	China	4	Operating (2023)

Benefits of Floating Wind

- New opportunities for UK marine engineering.
- Opens up much larger spaces for domestic electricity generation.
- The Welsh Affairs Committee reported that “there is scope for floating offshore wind in the Celtic Sea to generate 20GW of energy by being situated further offshore.”

Issues for Floating Wind

- Some need to adapt WTs to the different application.
- Contracting to a single model for floating tech may be helpful.
- Rapid growth of supply chain, including growing mass production of floating tech to GW scale.
- Finding the port space for building floating wind may be a problem.
- Financing relatively unproven technology may be an issue, given the need to complete with fixed offshore wind.
- Operationally, the need to reduce the difficulty (& cost) of maintenance including replacing large components.

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Floating Offshore Wind

Professor Philipp Thies
Professor of Renewable Energy
P.R.Thies@exeter.ac.uk

SDG Symposium, Penryn, UK
10th September 2024

The vision

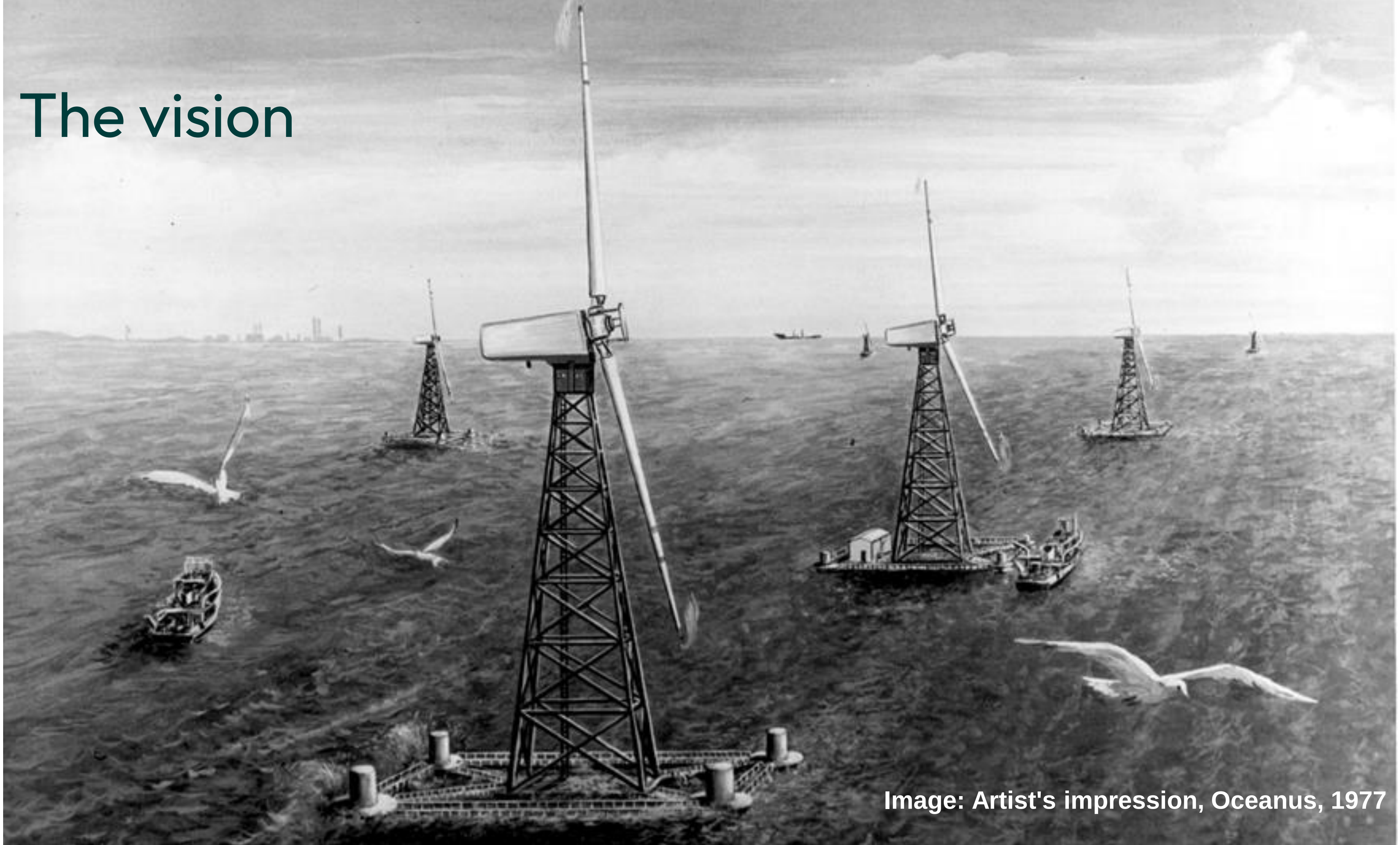
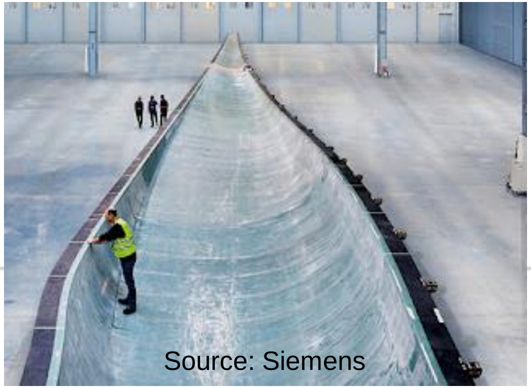
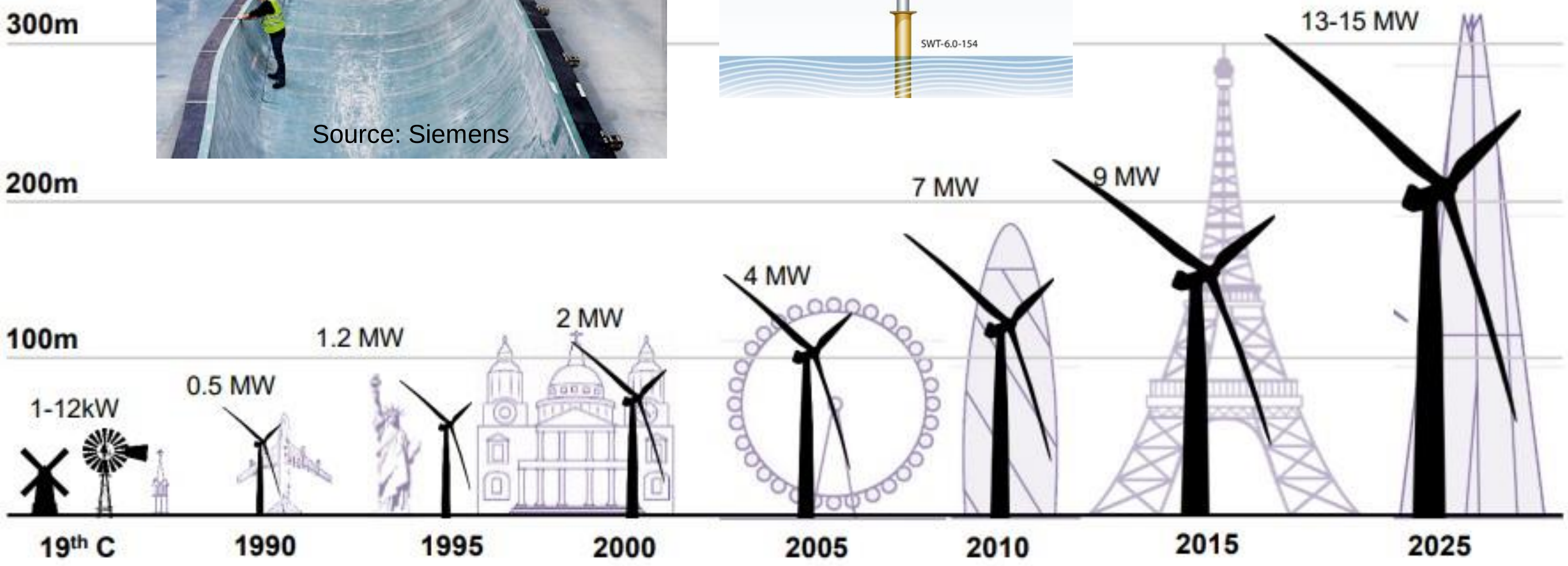


Image: Artist's impression, Oceanus, 1977

Growing Scale



Source: Siemens



Source: Bloomberg

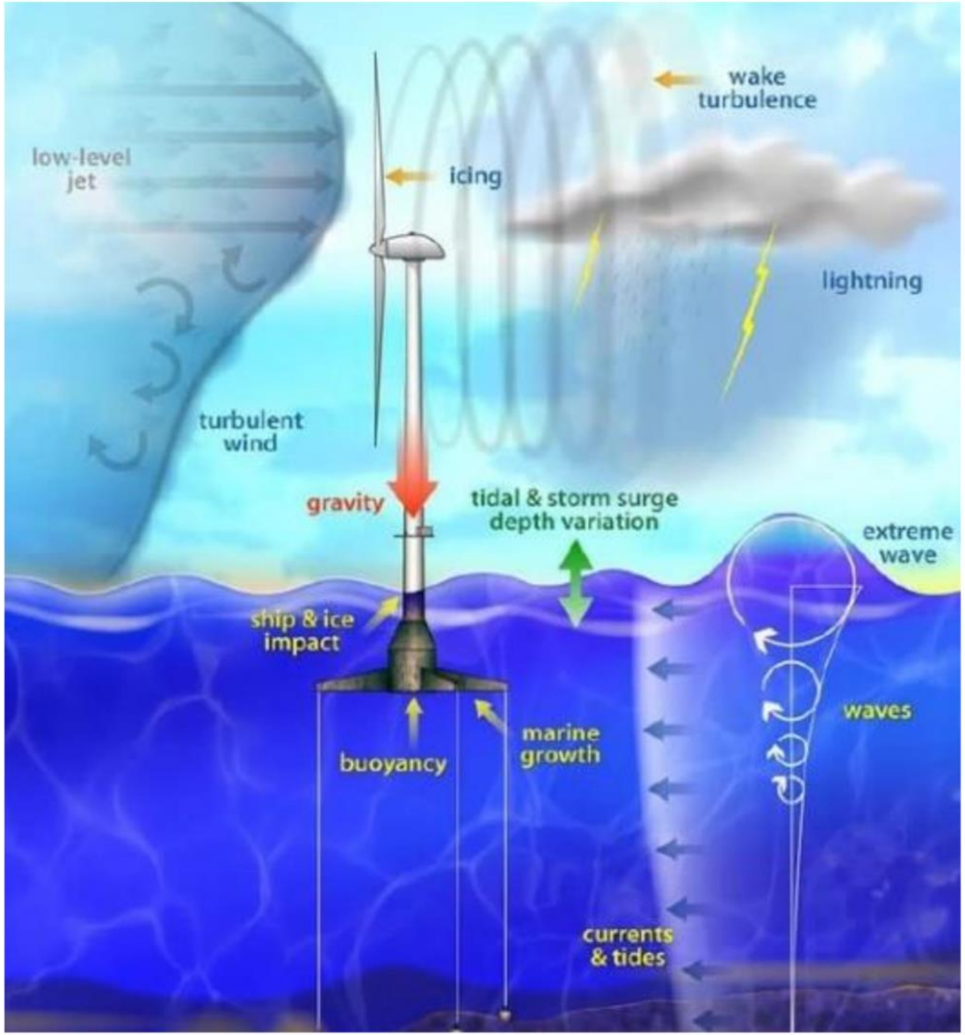
Beyond the horizon

University *of* Exeter Cornwall

Source: Kincardine Offshore Windfarm Ltd

In the sea

Source: Equinor



Loading on the turbine

- Wind
- Waves
- Currents
- Tides
- Gravity
- Centrifugal forces
- Aerodynamics
- Hydrodynamics
- Geotechnics
- …all coupled together…

Source: NREL, 2007

Floating Wind platform concepts

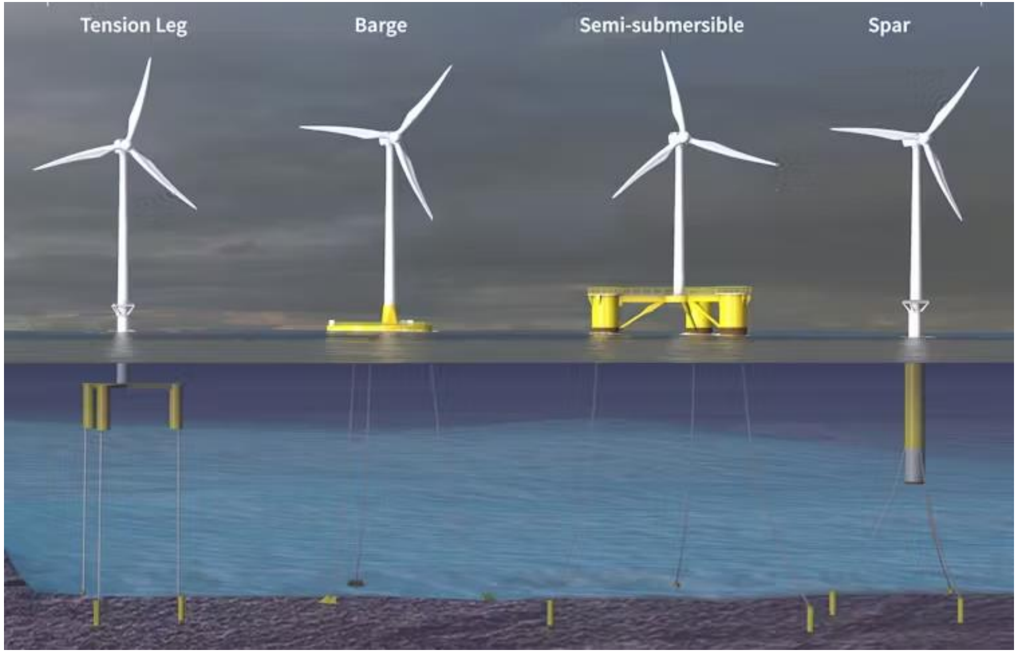
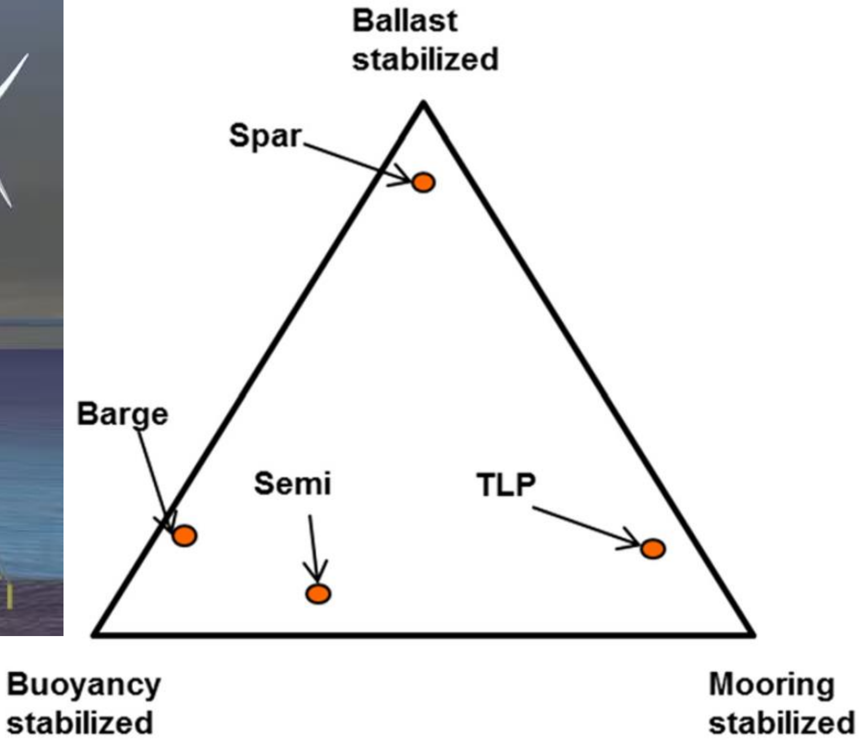


Illustration: Acteon



Thiagarajan, K. & Dagher, H. (2014)

Platform construction

University of Exeter

Principle Power/Ocean Winds.

Moorings

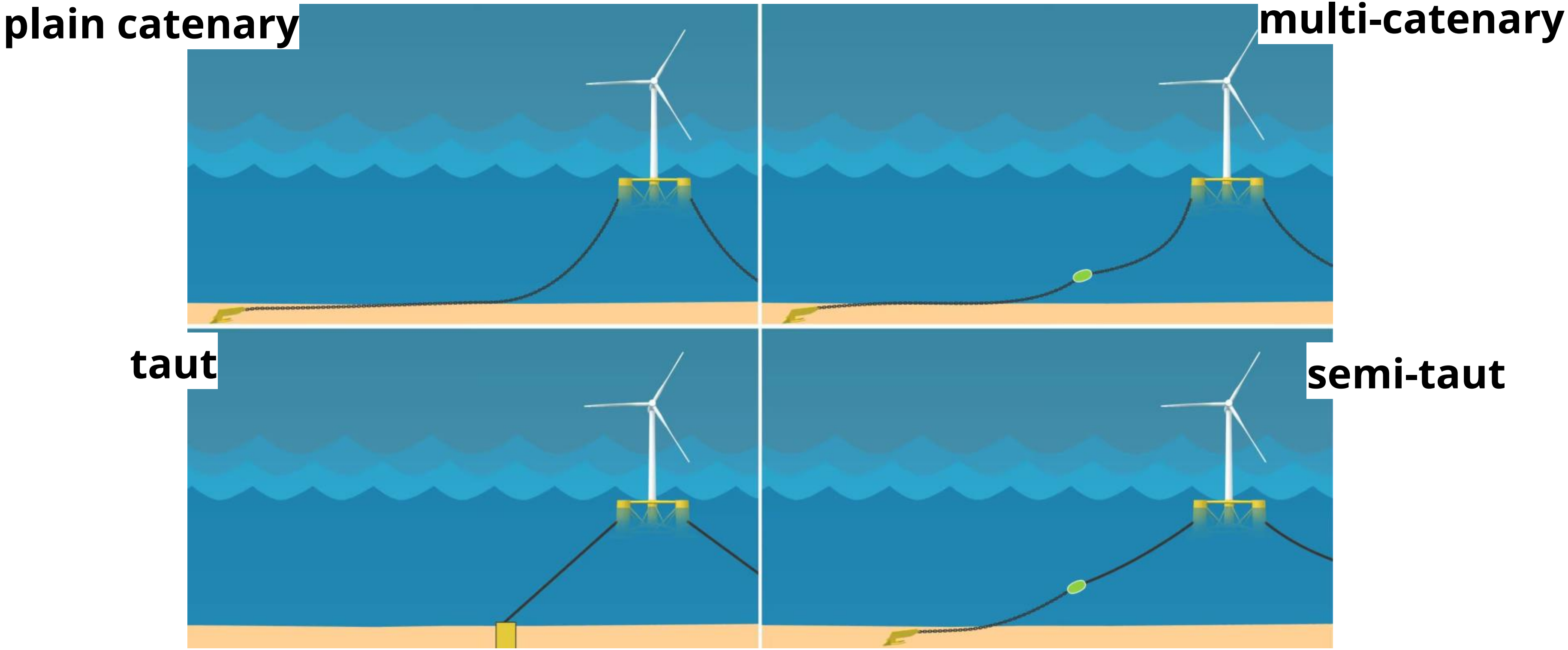


Image: BVG

Anchors

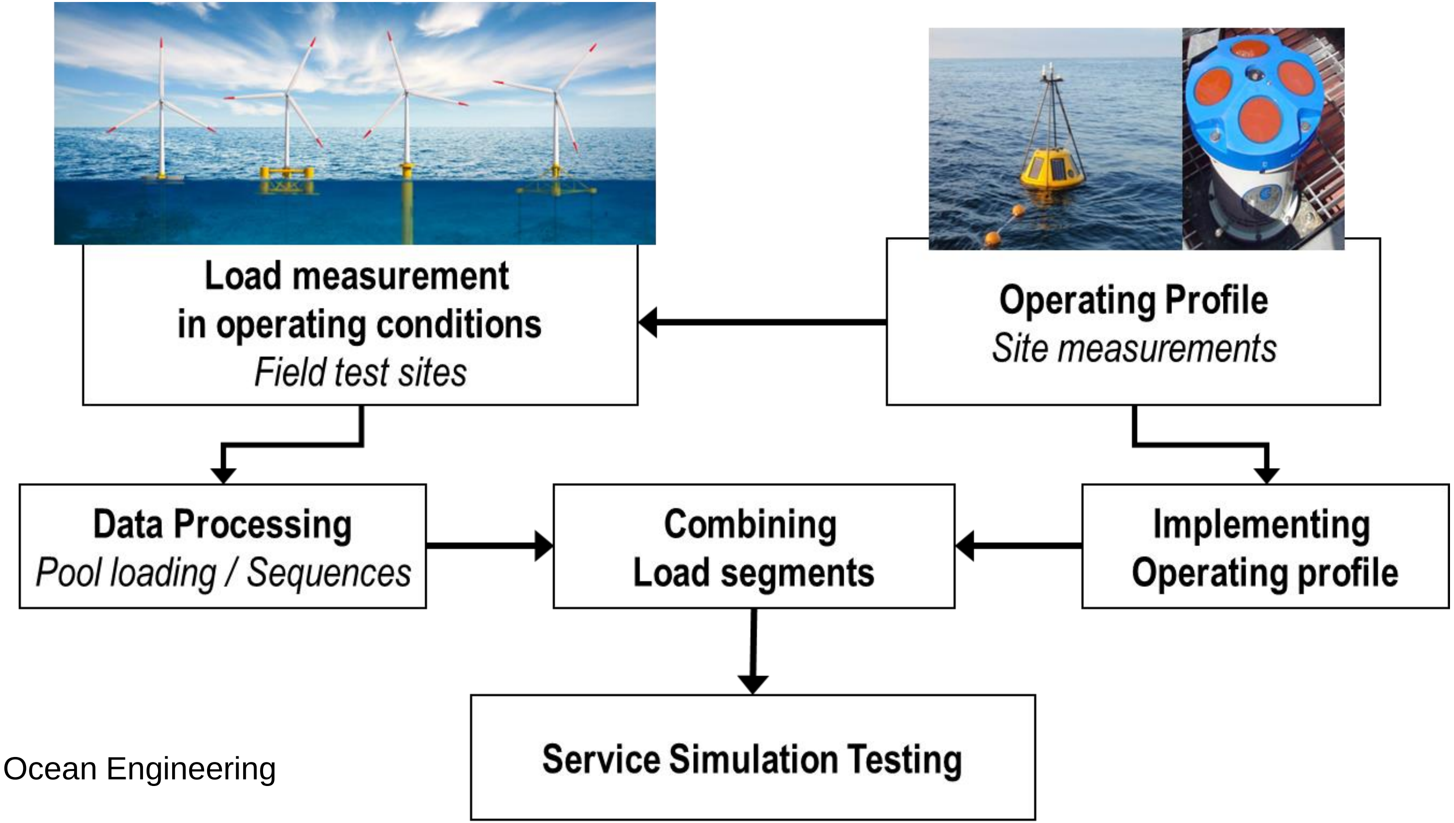
Suction pile anchor **Drag embedment anchor** **Driven pile anchor**

Acteon / Principle Power/Ocean Winds.

Power cables

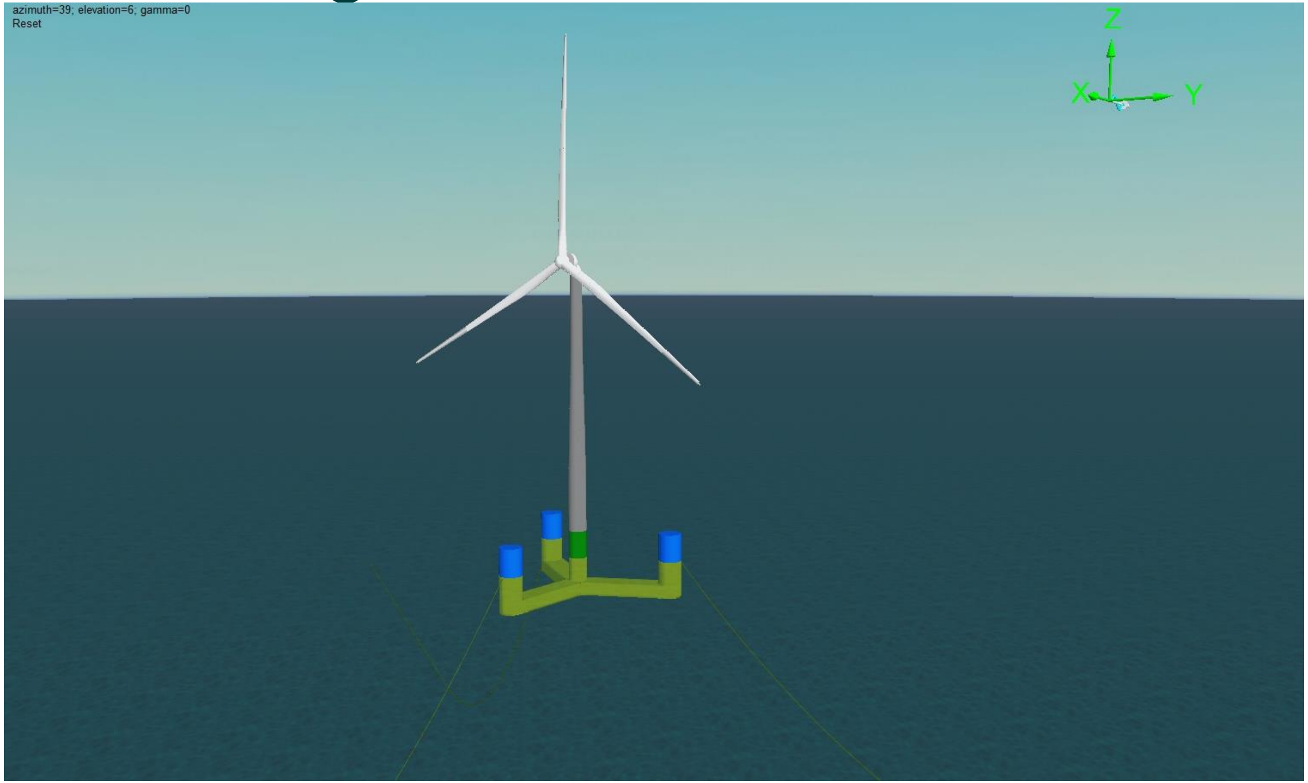
Image: EXSTO

Service simulation testing



Thies et al, 2011, Ocean Engineering

Coupled aero-hydrodynamic modelling

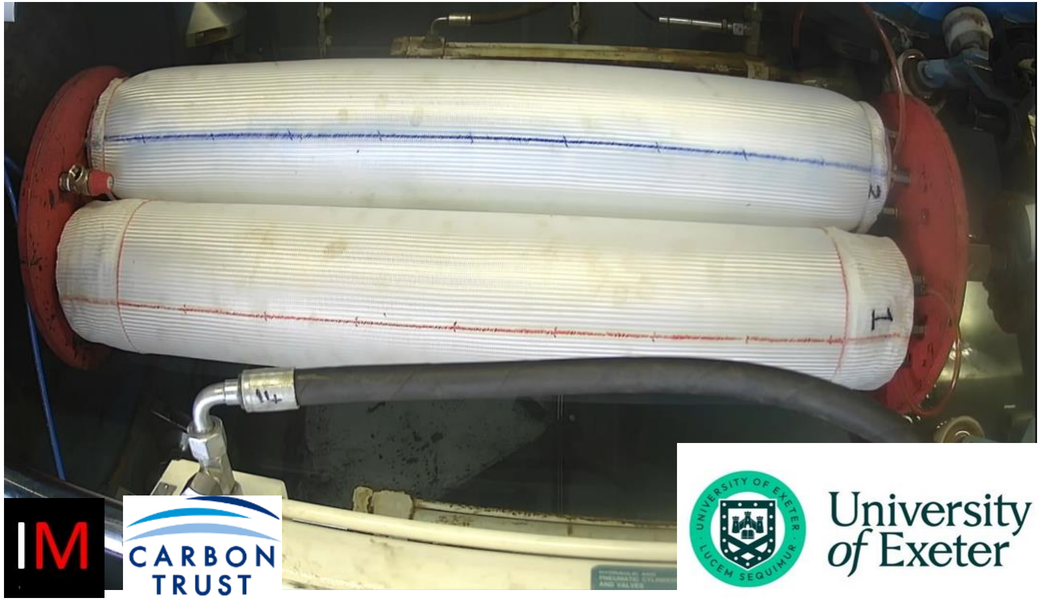


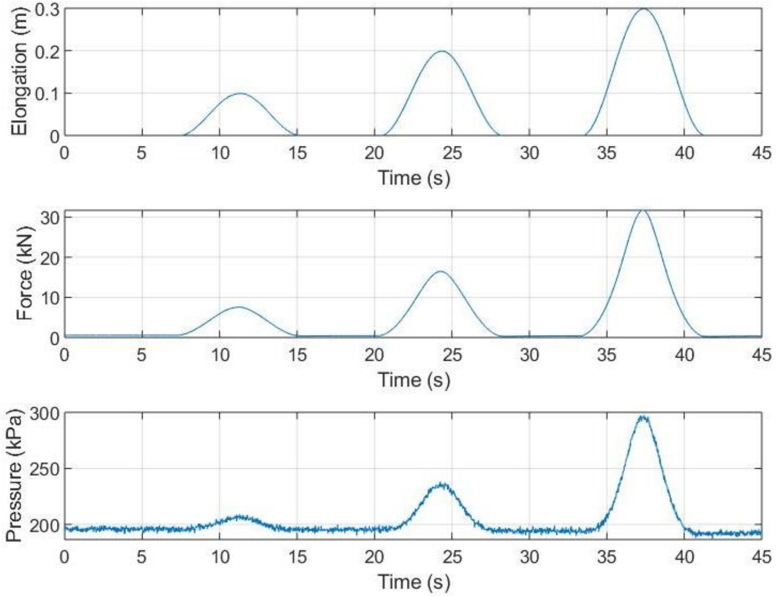
Software: Orcaflex by Orcina

Cable & bend restrictor testing

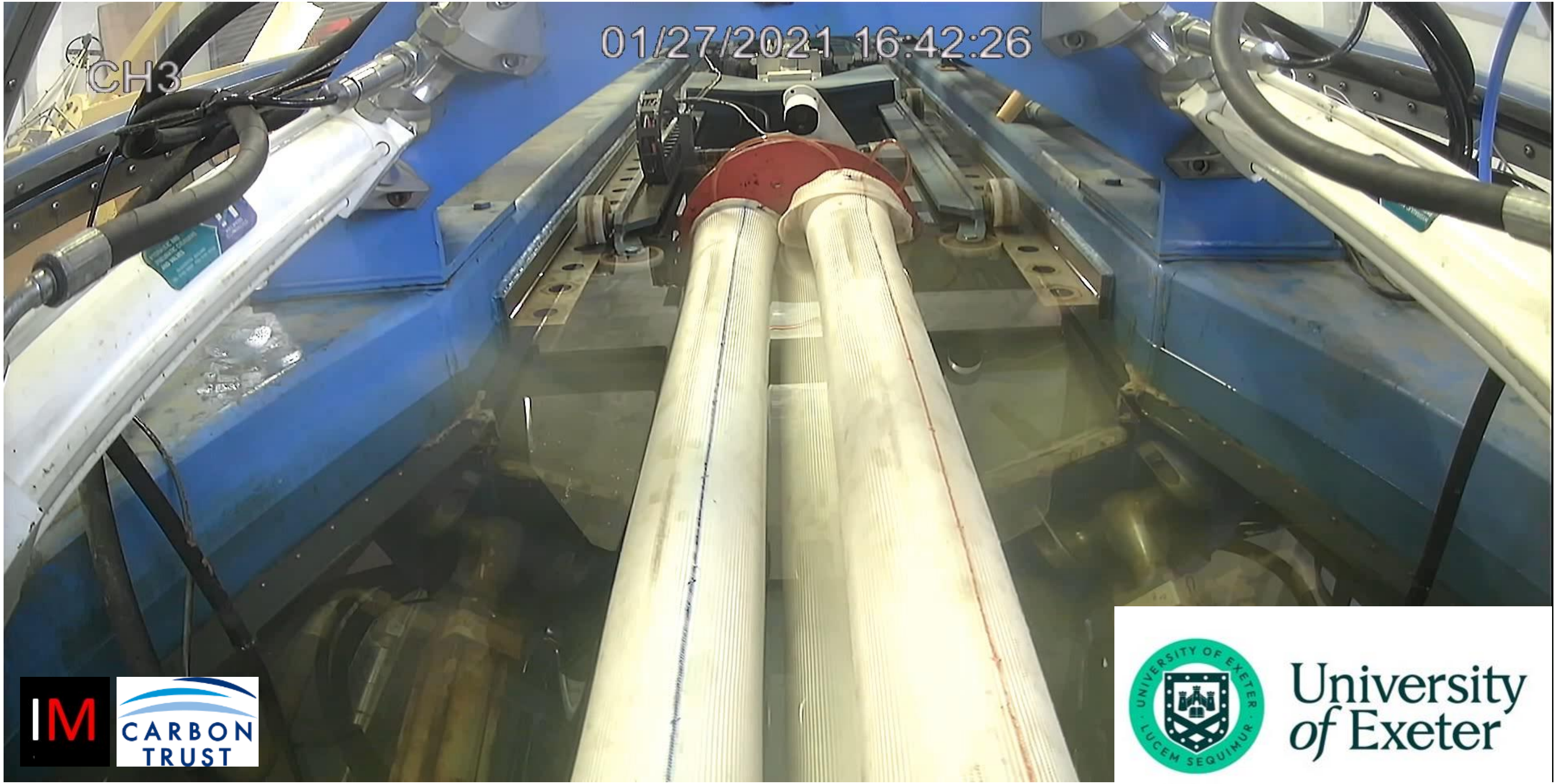
Thies et al, 2016

Mooring component testing





Mooring component testing



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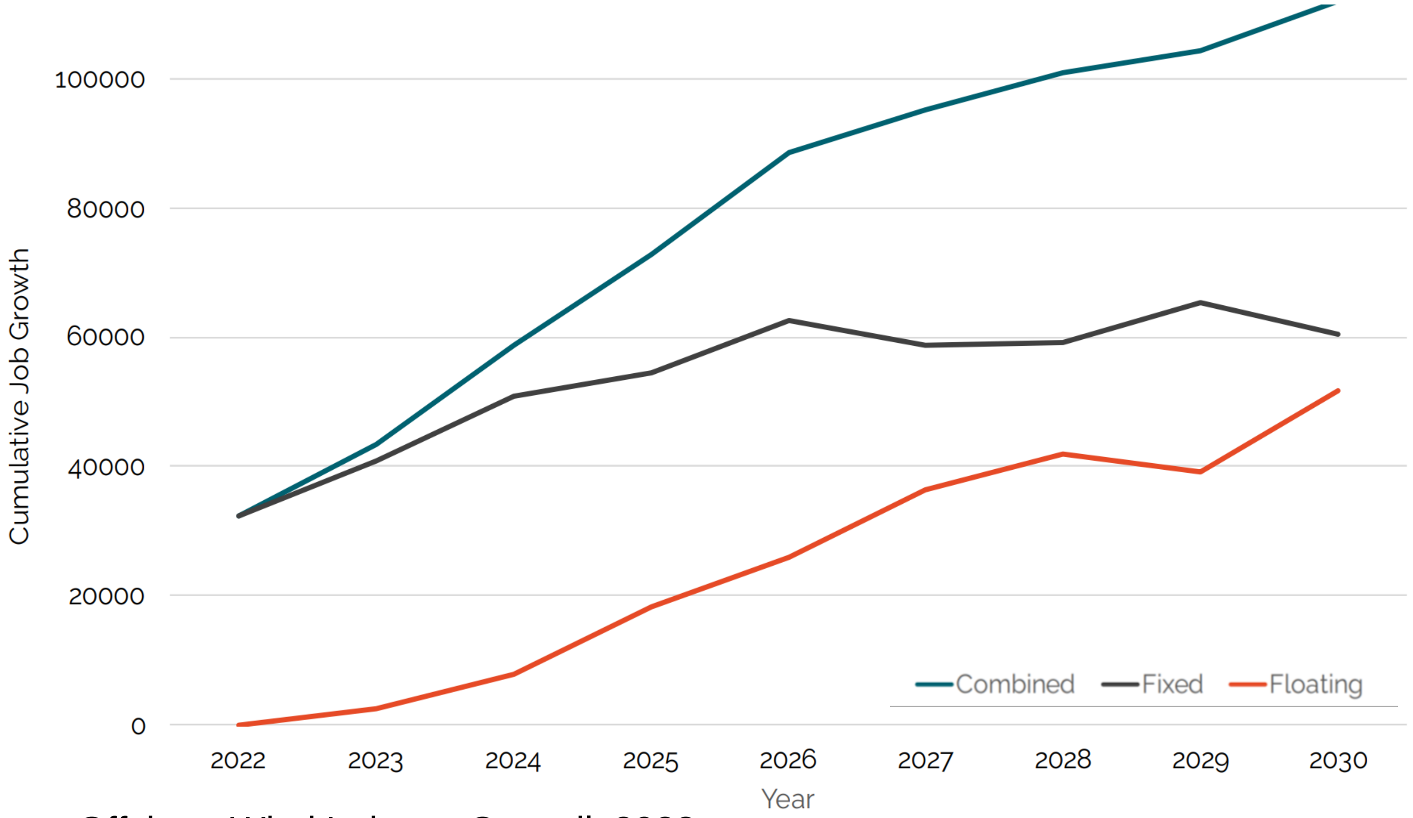
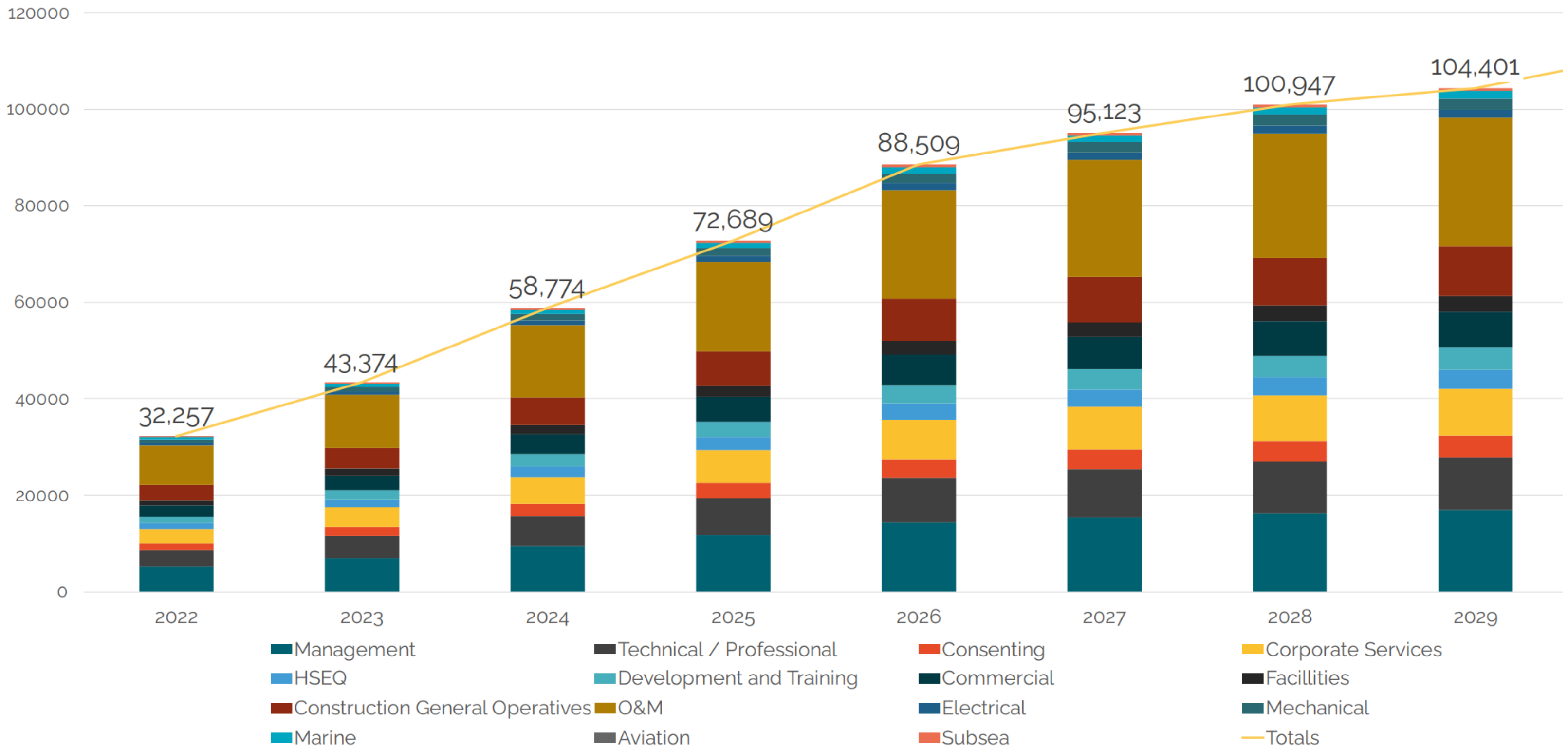
Wind workforce development



Source: Offshore Wind Industry Council, 2023

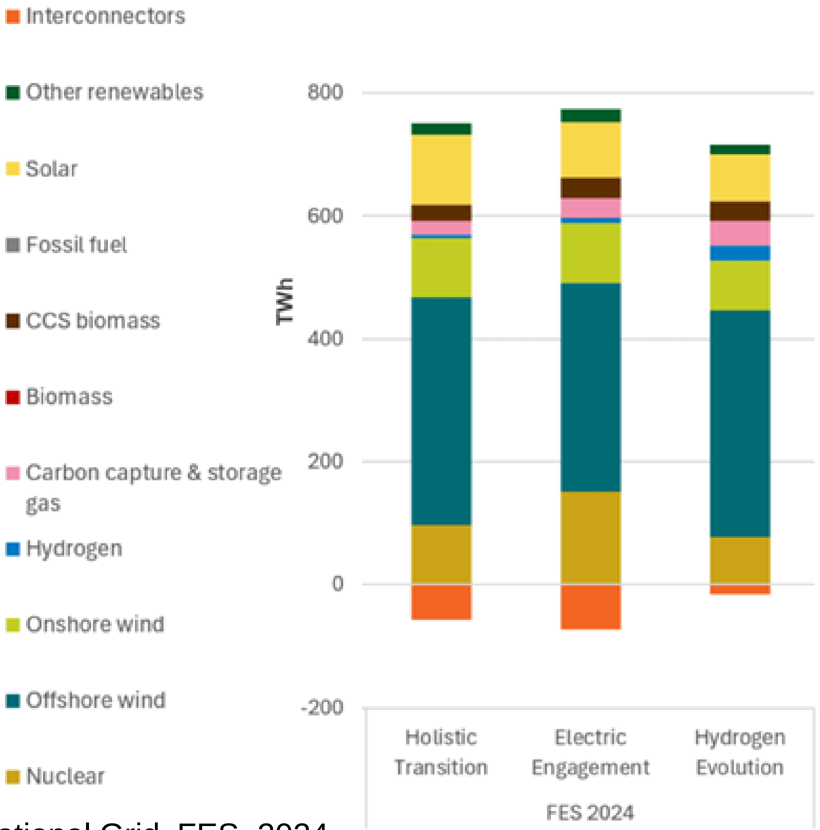
Diverse expertise needed



Source: Offshore Wind Industry Council, 2023

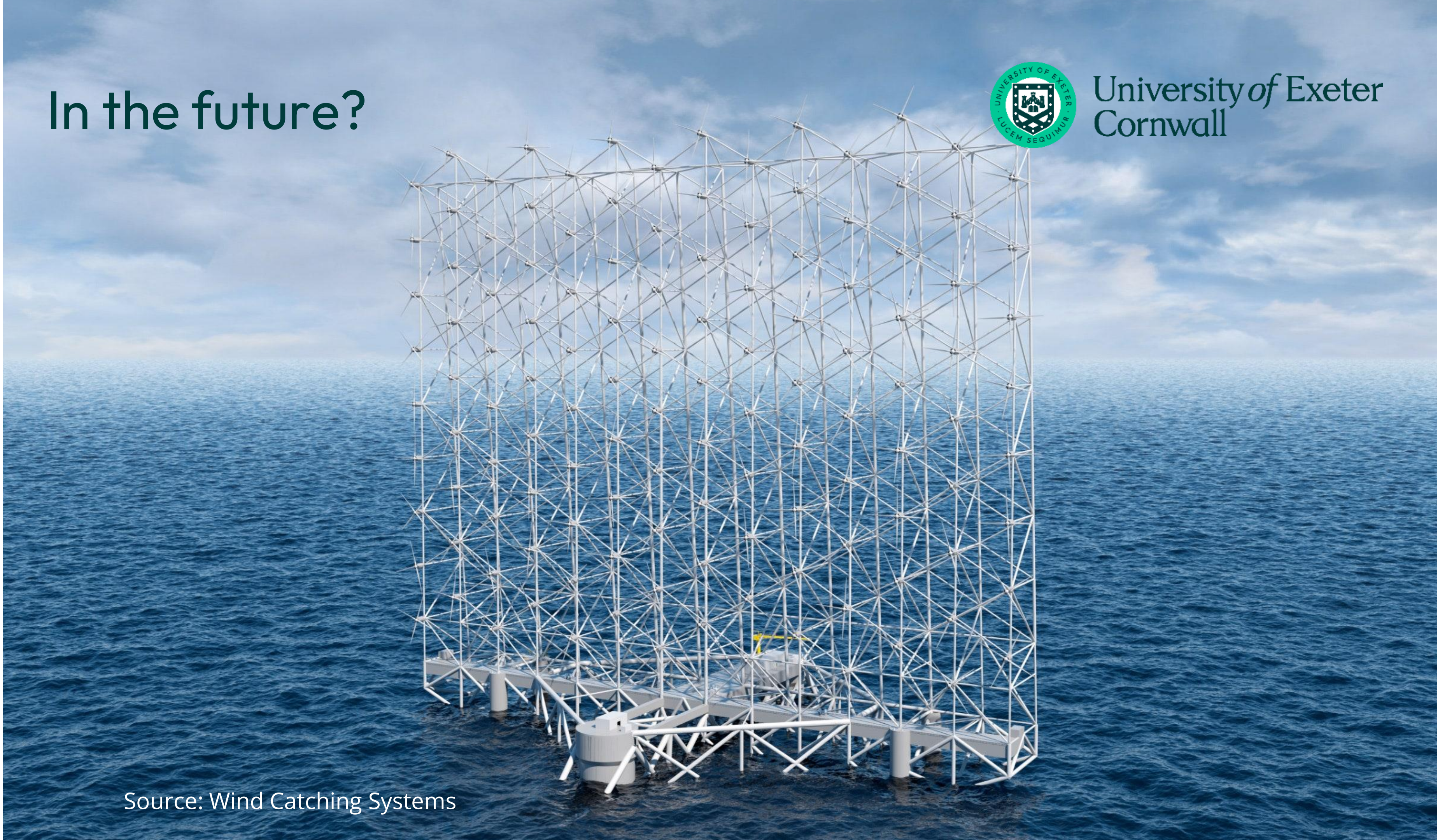
Summary & outlook

- Feat of human ingenuity
- Combines several engineering disciplines
- Skill / job requirements outstrip supply
- National Grid Future Energy **Scenarios**



Source: National Grid, FES, 2024

In the future?



Source: Wind Catching Systems

References

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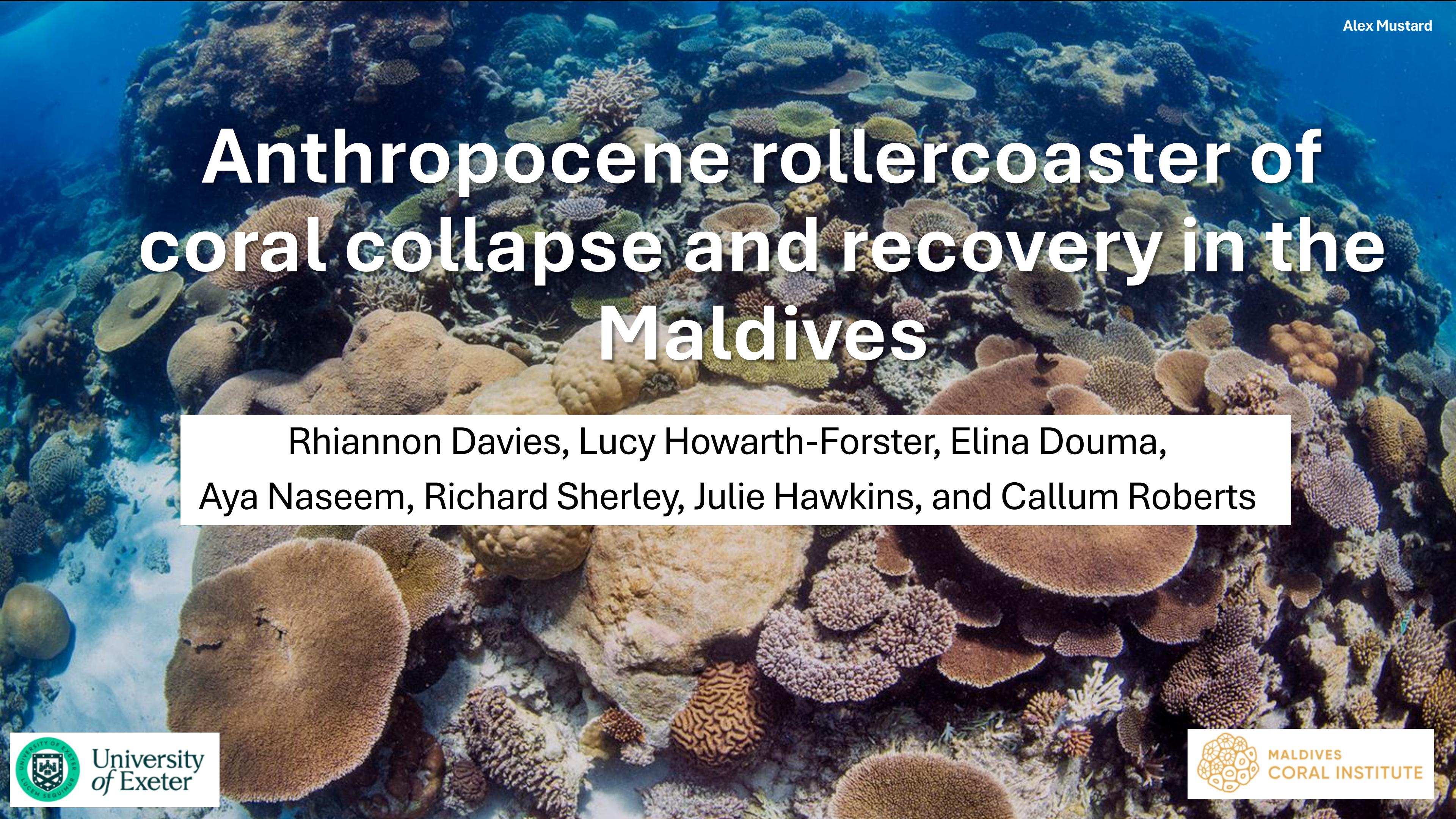
University of Exeter Cornwall

Blue Planet, Green Future:
Ensuring the health of marine environments

Professor Callum Roberts,
Professor of Marine Conservation, &
Rhiannon Davies, PhD Researcher,
Centre for Ecology & Conservation


Alex Mustard

Anthropocene rollercoaster of coral collapse and recovery in the Maldives

Rhiannon Davies, Lucy Howarth-Forster, Elina Douma,
Aya Naseem, Richard Sherley, Julie Hawkins, and Callum Roberts

University of Exeter

MALDIVES CORAL INSTITUTE

Coral reefs and climate change

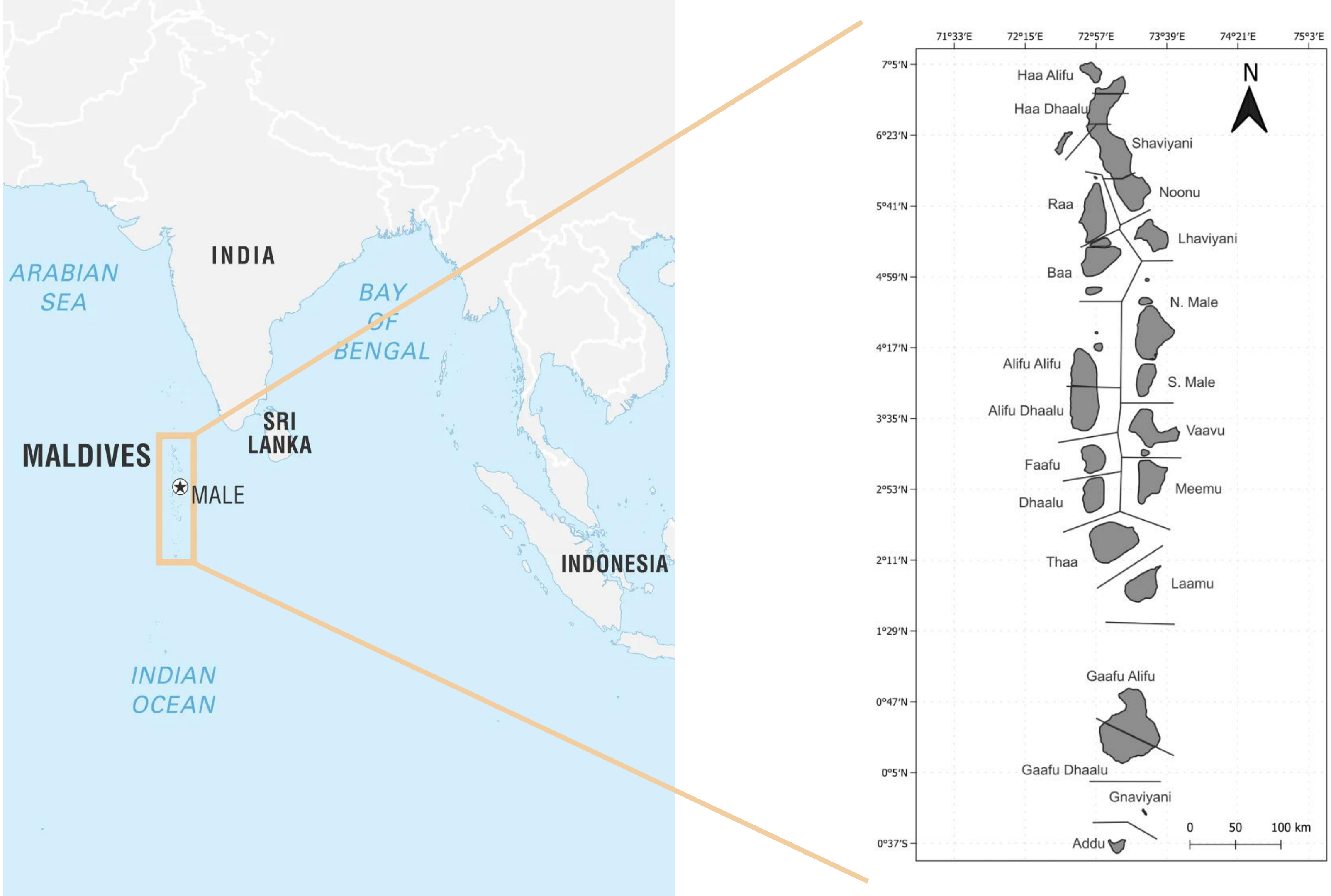
Coral reefs are important but vulnerable habitats

- 50% of reefs are considered degraded
- High sea temperatures cause coral bleaching

Globally, coral reefs have experienced multiple mass coral bleaching events:

- 1997-98
- 2015-17.

2024 was the start of the fourth global mass bleaching event.



INDIA
ARABIAN SEA
BAY OF BENGAL
SRI LANKA
MALDIVES
MALE
INDONESIA
INDIAN OCEAN
71°33′E
72°15′E
72°57′E
73°39′E
74°21′E
75°3′E
7°5′N
6°23′N
5°41′N
4°59′N
4°17′N
3°35′N
2°53′N
2°11′N
1°29′N
0°47′N
0°5′N
0°37′S
N
Haa Alifu
Haa Dhaalu
Shaviyani
Noonu
Raa
Lhaviyani
Baa
N. Male
Alifu Alifu
S. Male
Alifu Dhaalu
Vaavu
Faafu
Meemu
Dhaalu
Thaa
Laamu
Gaafu Alifu
Gaafu Dhaalu
Gnaviyani
Addu
0
50
100 km

The Maldives

Maldives is heavily reliant on coral reefs for:

- Tourism
- Reef fisheries
- Coastal protection
- Island creation

Maldives demonstrates a clear signal of heat stress.

Study aims:

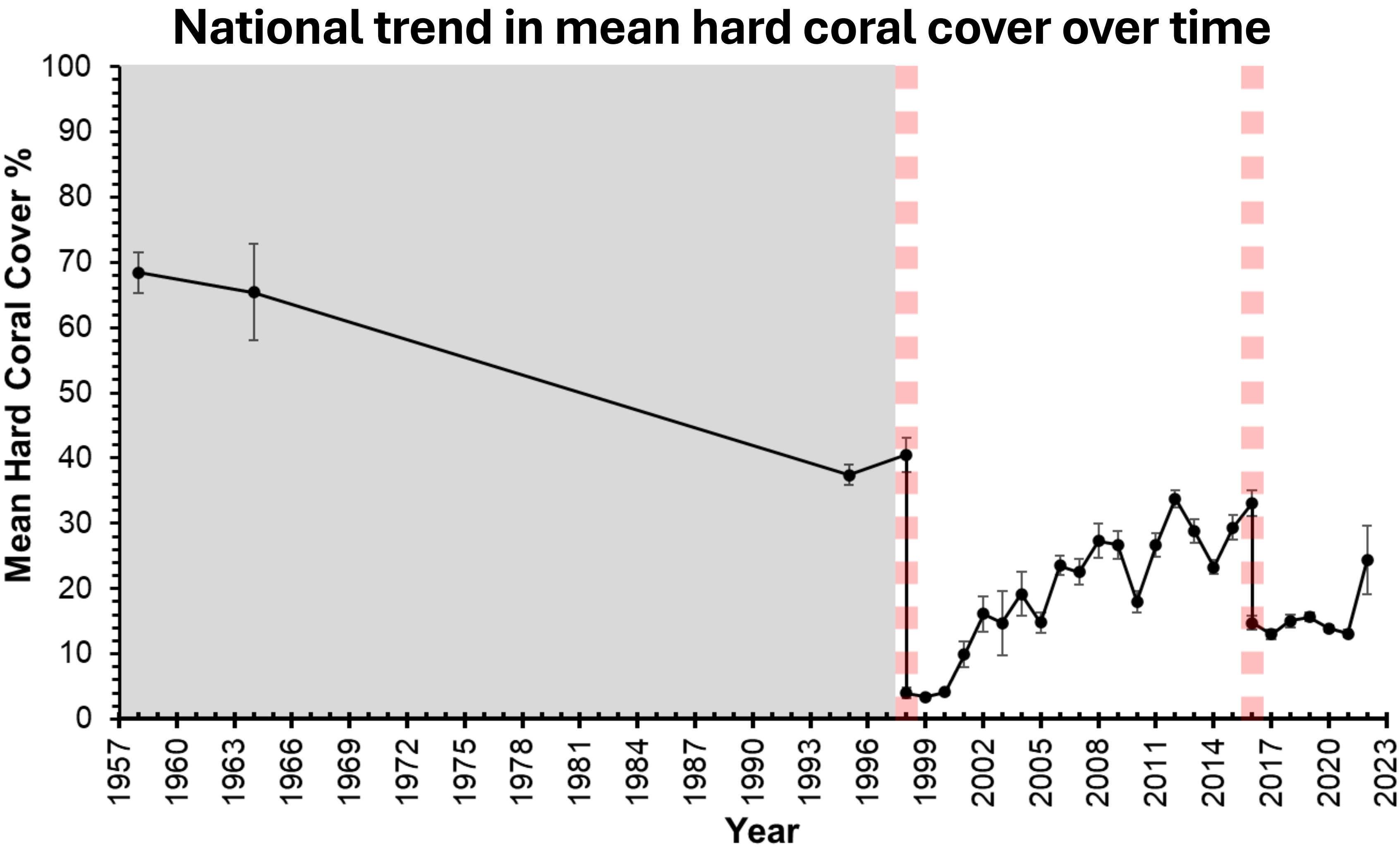
- Build a historical data set of Maldivian coral cover
- Identify present and historical trends in coral cover

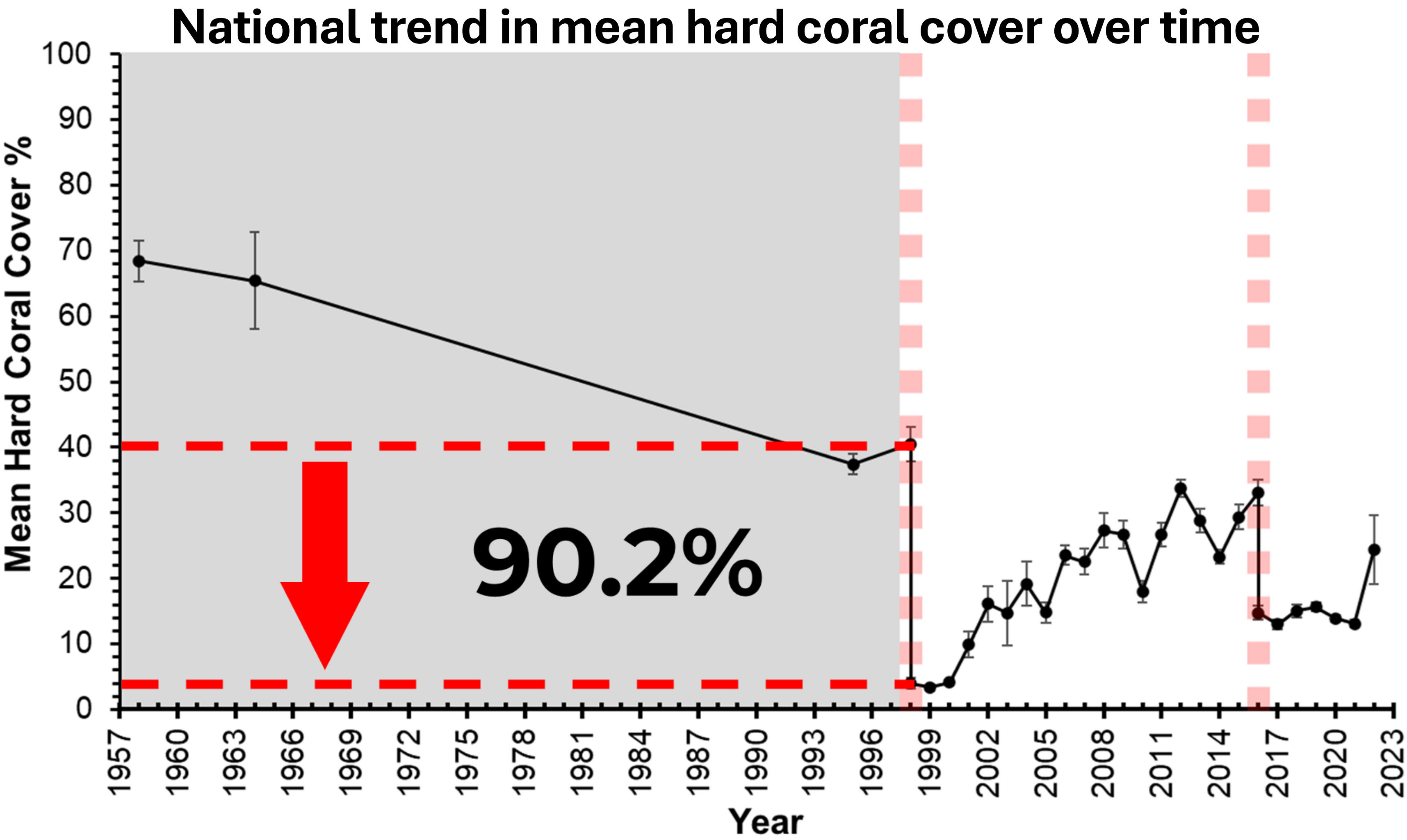
Reconstructing trends in coral cover

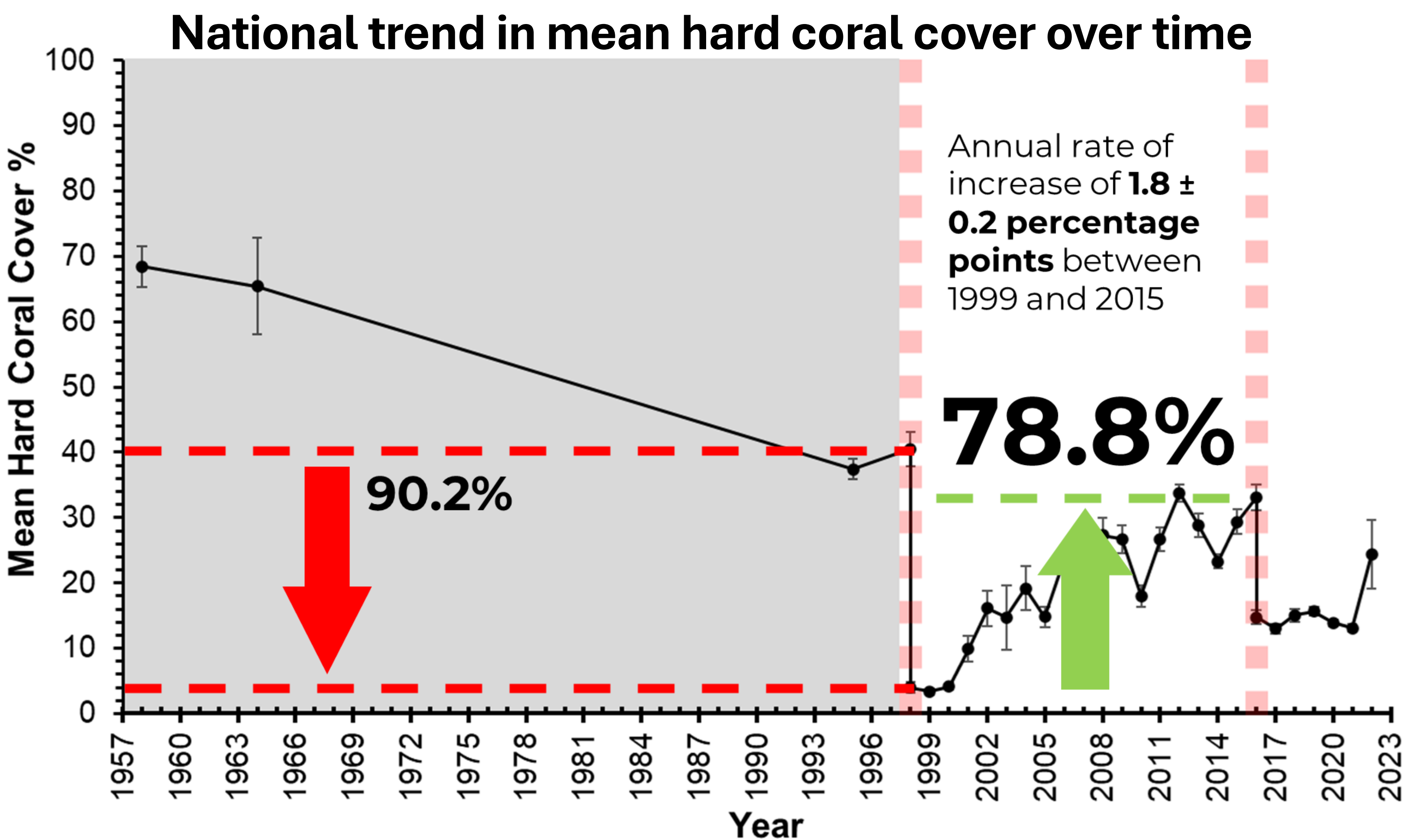
Created a database of Maldivian coral reef research

Collated percentage hard coral cover from:

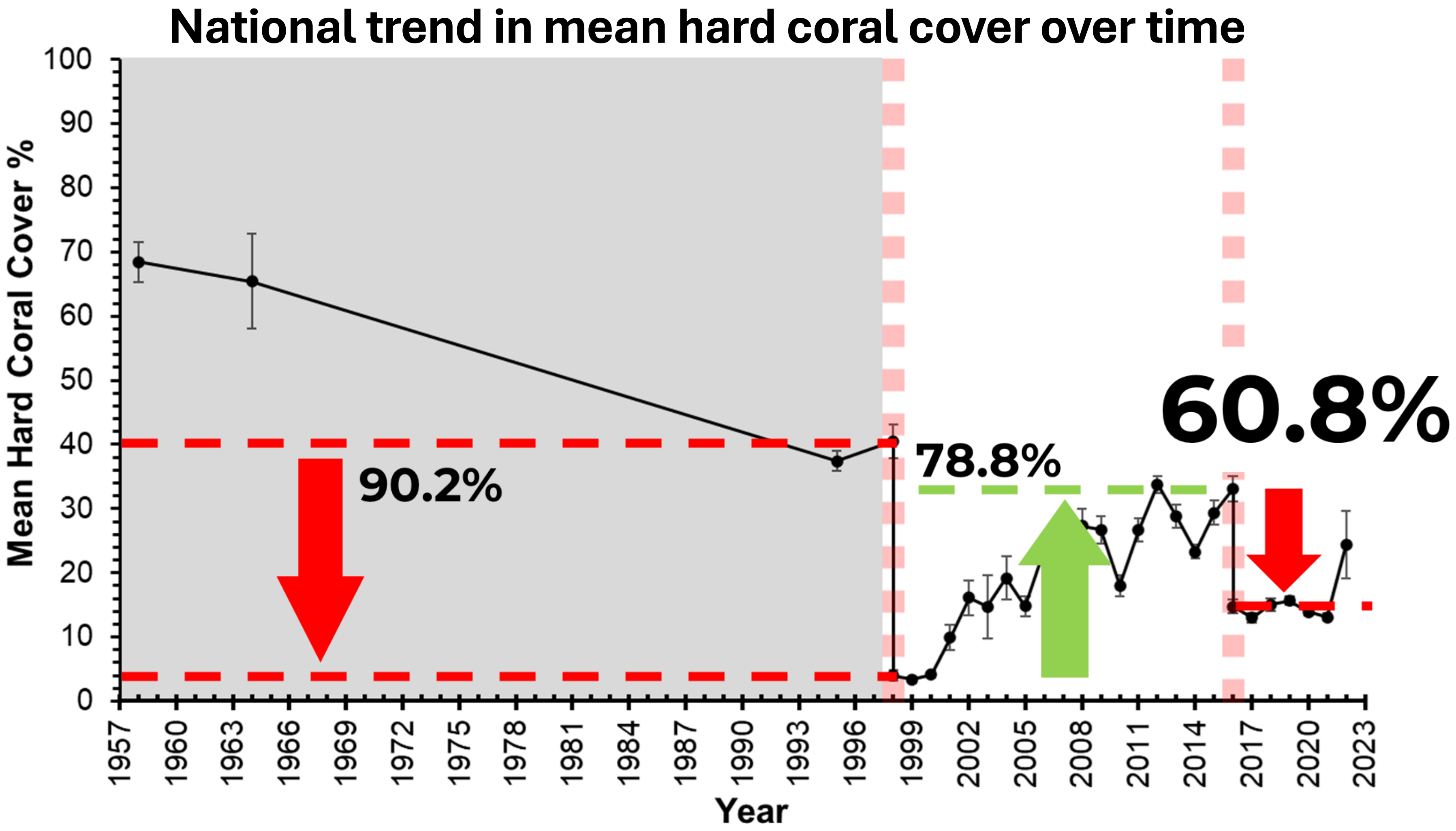
- 81 peer-reviewed studies
- 495 Environmental Impact Assessment (EIA) reports by the Environment Protection Agency
- Two major expeditions:
  1. Catlin Seaview Survey in 2015
  2. Waitt Institute expeditions in 2020/2021


National trend in mean hard coral cover over time
Mean Hard Coral Cover %
0
10
20
30
40
50
60
70
80
90
100
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
Year

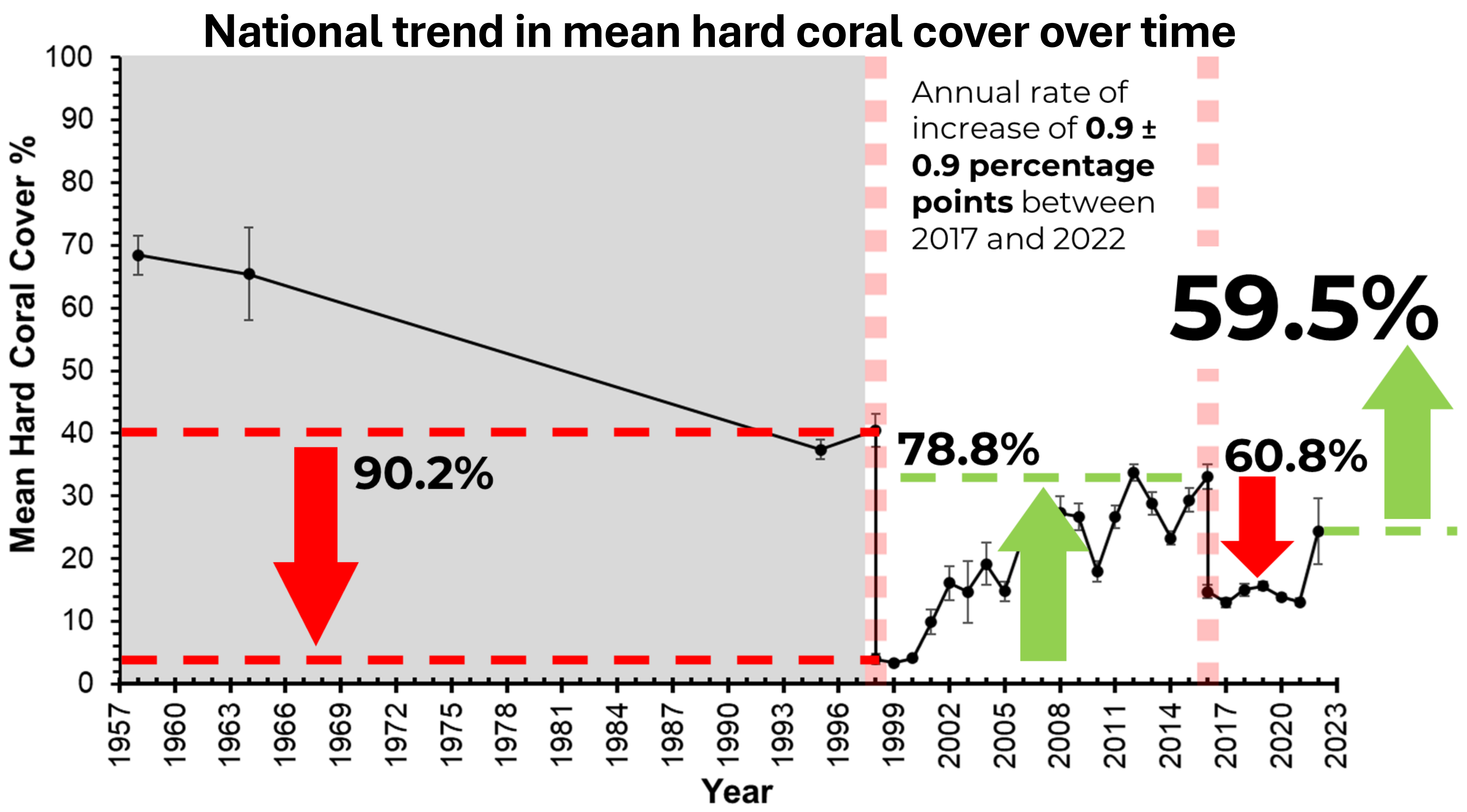

National trend in mean hard coral cover over time
Mean Hard Coral Cover %
100
90
80
70
60
50
40
30
20
10
0
90.2%
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
Year



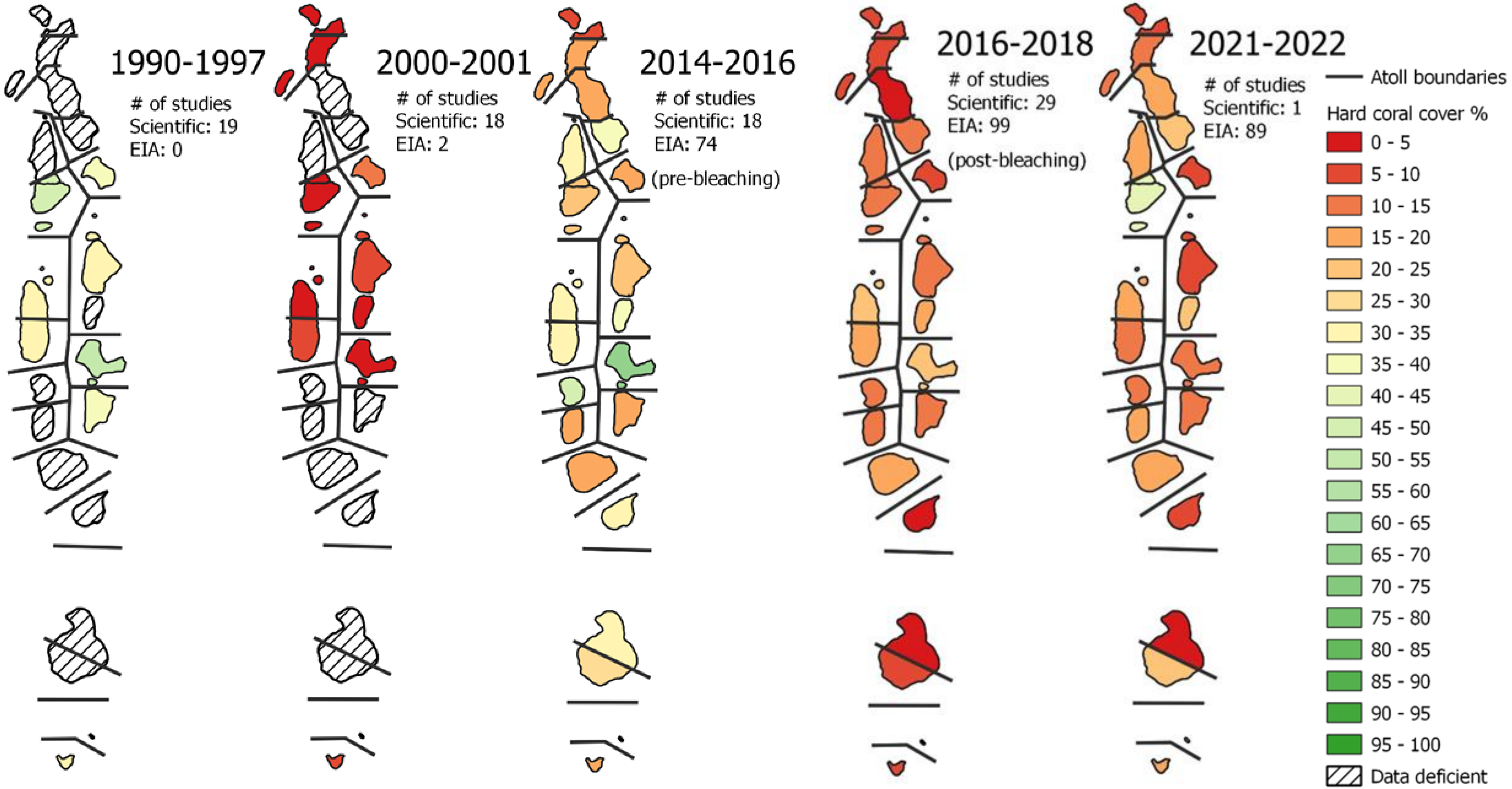
National trend in mean hard coral cover over time
Mean Hard Coral Cover %
100
90
80
70
60
50
40
30
20
10
0
Annual rate of increase of **1.8 ± 0.2 percentage points** between 1999 and 2015
78.8%
90.2%
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
Year



National trend in mean hard coral cover over time
Mean Hard Coral Cover %
100
90
80
70
60
50
40
30
20
10
0
90.2%
78.8%
60.8%
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
Year


National trend in mean hard coral cover over time
Mean Hard Coral Cover %
Year
Annual rate of increase of **0.9 ± 0.9 percentage points** between 2017 and 2022
59.5%
78.8%
60.8%
90.2%
0
10
20
30
40
50
60
70
80
90
100
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023

Spatial patterns in hard coral cover across the Maldives over time



Key conclusions

Maldives has experienced repeated collapses in coral cover followed by periods of recovery

Coral cover declined before the 1998 bleaching event

Coral mortality following the 2016 bleaching event was less severe, but on average recovery has been slower

The rollercoaster of coral collapse and recovery is expected to continue…

2023 – 2024 global mass bleaching event

Jessica Hodge

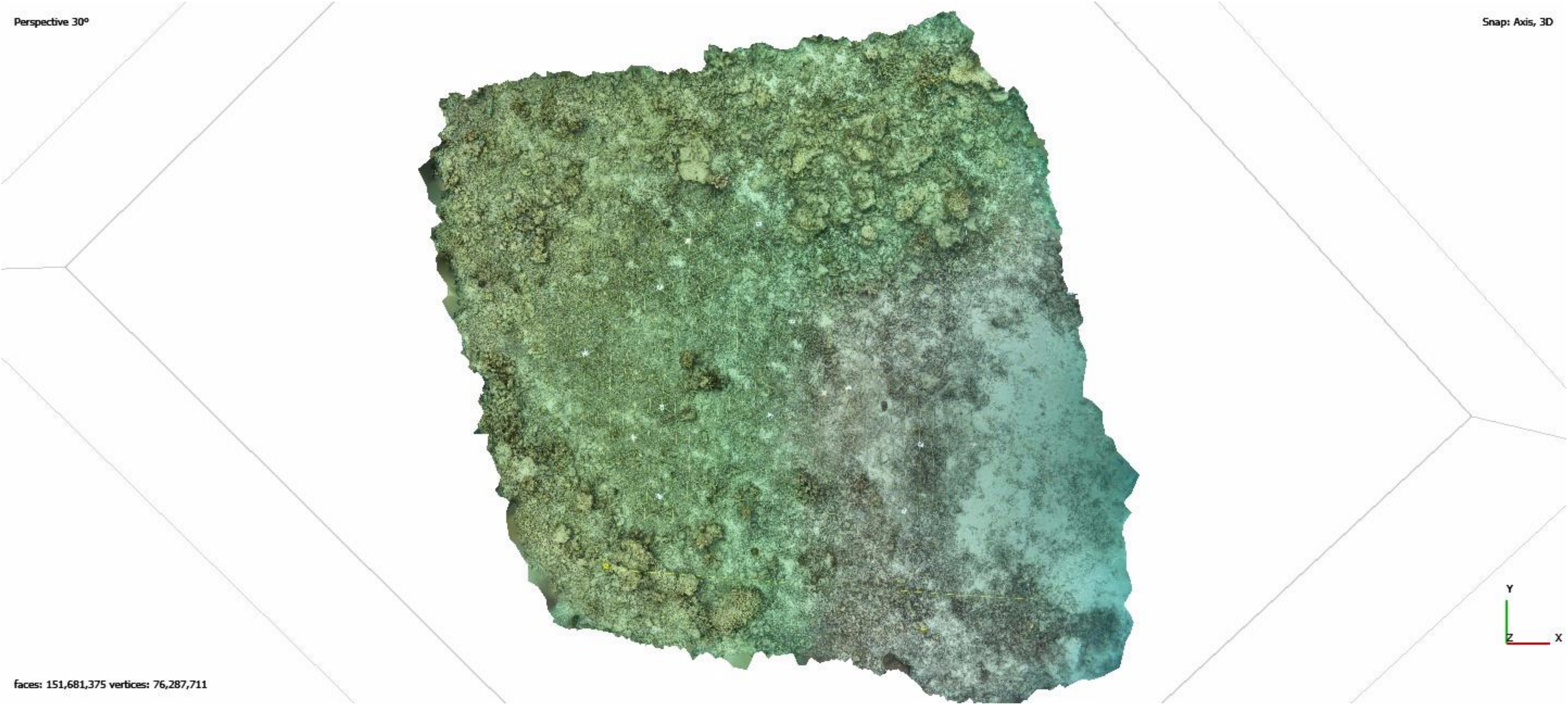
Response of restored reefs to heat stress

We monitored three locations during three different time periods over the bleaching event

- Before: December 2023
- During: April/May 2024
- After: July 2024

Surveys were completed by taking thousands of images of the reef and stitching them together to create 3D models and 2D orthomosaics.

Coral bleaching resistance and resilience in natural and restored reefs

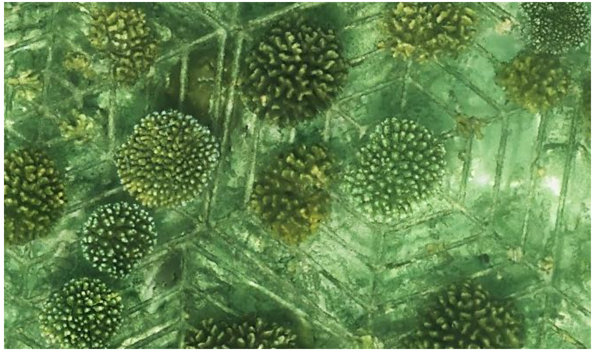


Coral bleaching resistance and resilience in natural and restored reefs

Temperature peaked in May 2024, reaching 31.93°C.

- Bleaching threshold of 30.5°C and significant bleaching above 30.9°C

Before – December 2023

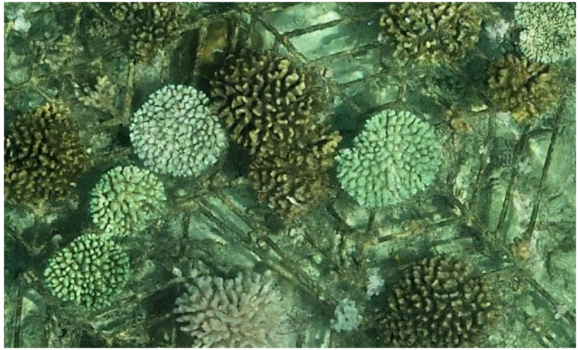


Number of **healthy** colonies

Restored | Natural

85% 66%

During – May 2024



Number of **bleached** colonies

Restored | Natural

49% 62%

After – July 2024

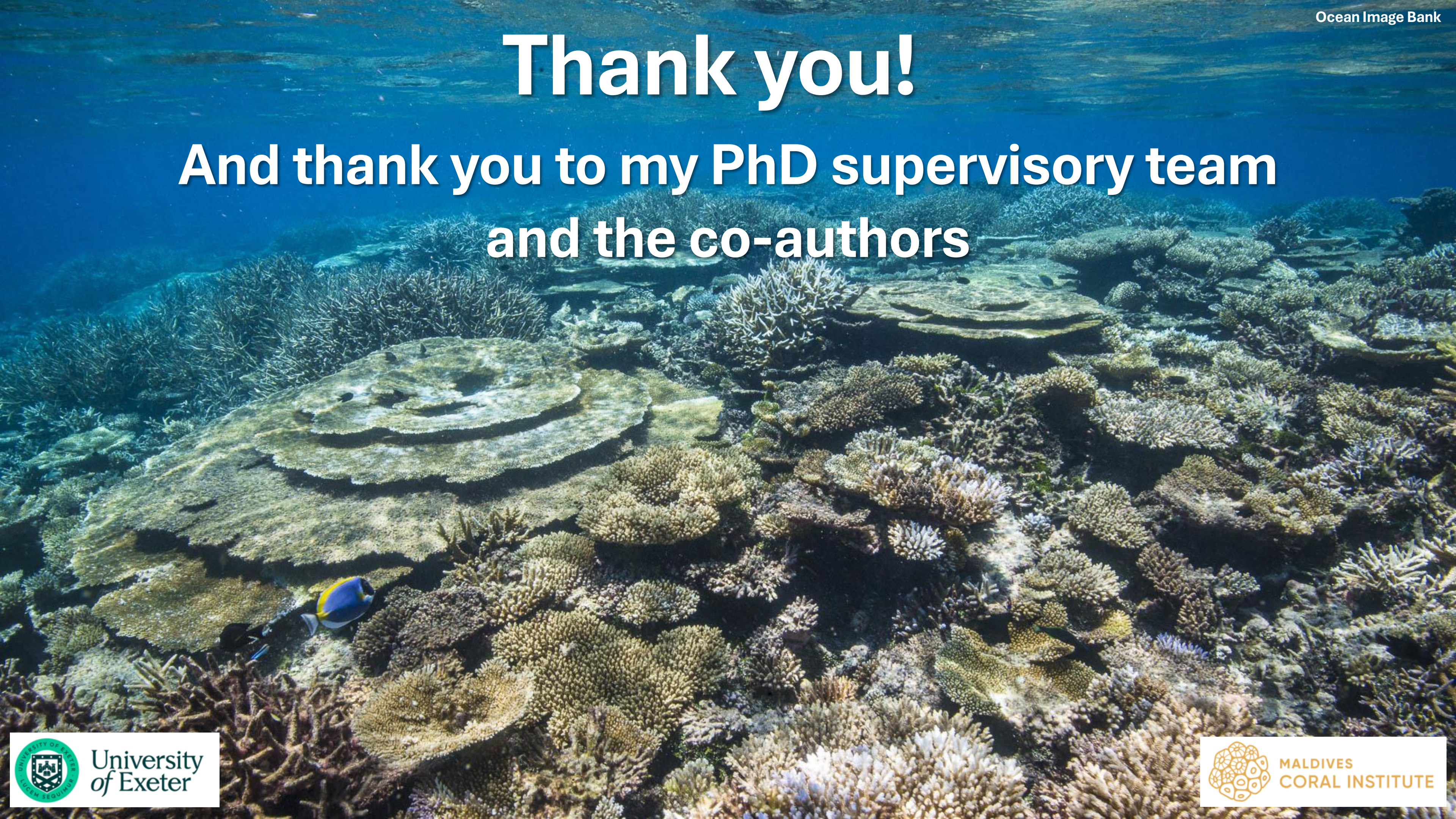
Number of **dead** colonies

Restored | Natural

36% 21%

Thank you!

And thank you to my PhD supervisory team and the co-authors



Ocean Image Bank

University of Exeter

MALDIVES CORAL INSTITUTE

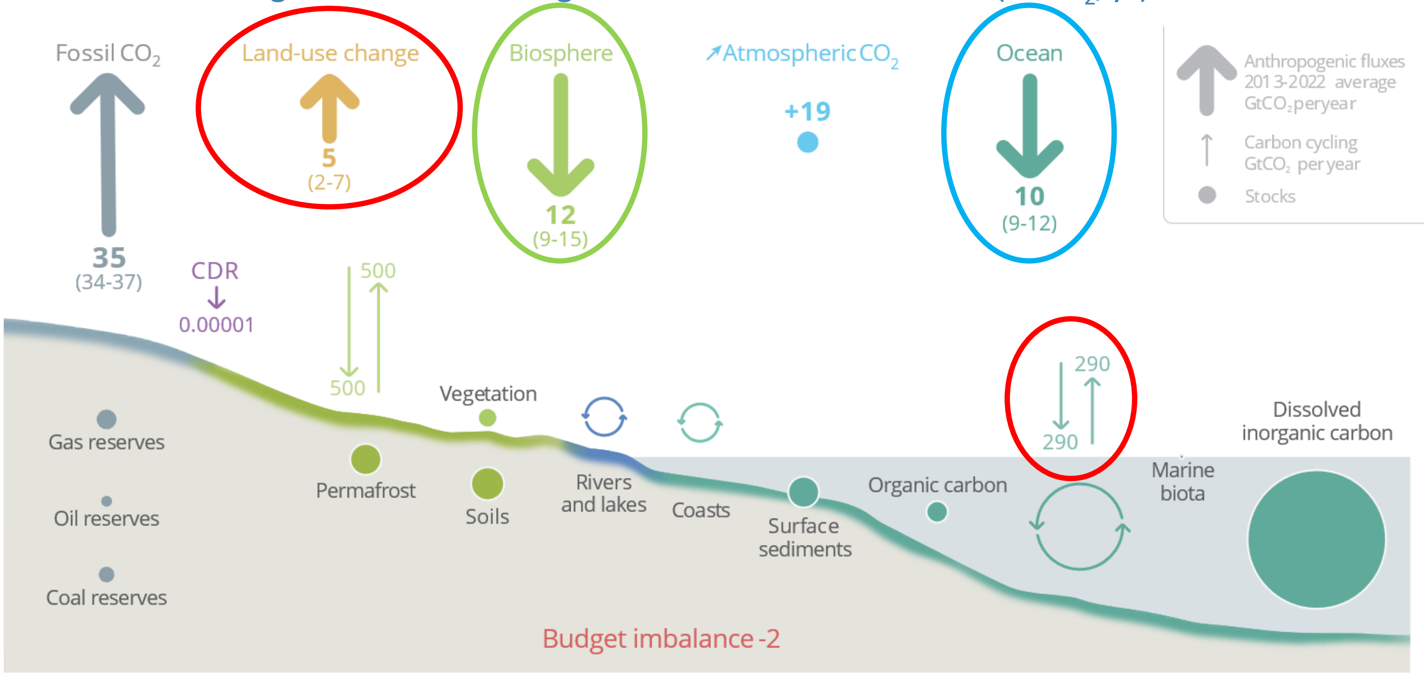
convex SEASCAPE SURVEY

Professor Callum Roberts
University of Exeter

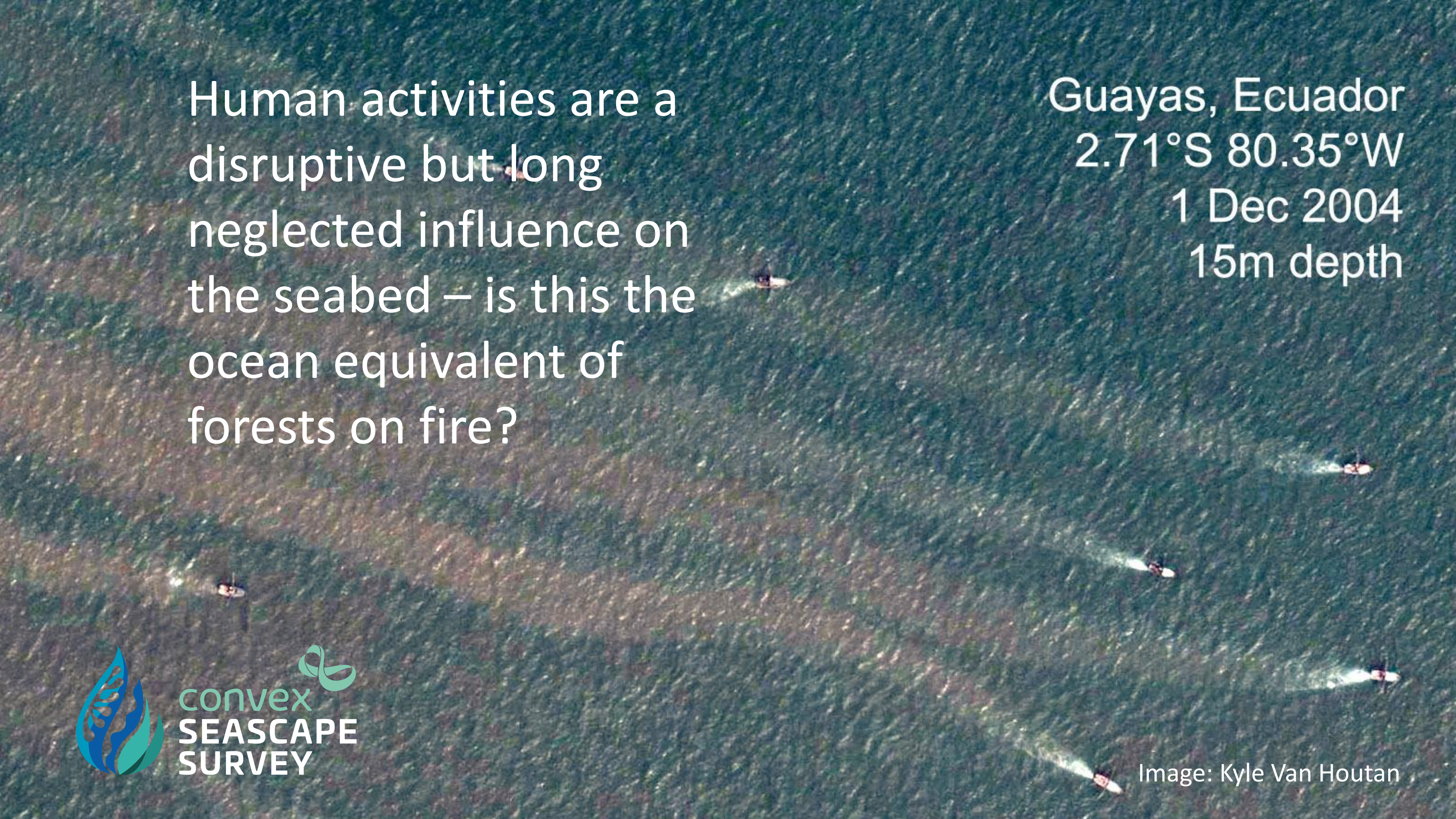

What is blue carbon?

Anthropogenic perturbation of the global carbon cycle

Perturbation of the global carbon cycle caused by anthropogenic activities,
global annual average for the decade 2013–2022 ($GtCO_2$/yr)



CDR here refers to Carbon Dioxide Removal besides those associated with land-use that are accounted for in the Land-use change estimate.
The budget imbalance is the difference between the estimated emissions and sinks.
Source: NOAA-GML; Friedlingstein et al 2023; Canadell et al 2021 (IPCC AR6 WG1 Chapter 5); Global Carbon Project 2023



Human activities are a disruptive but long neglected influence on the seabed – is this the ocean equivalent of forests on fire?

Guayas, Ecuador
2.71°S 80.35°W
1 Dec 2004
15m depth

convex SEASCAPE SURVEY

Image: Kyle Van Houtan

The New York Times

Trawling for Fish May Unleash as Much Carbon as Air Travel, Study Says

The report also found that strategically conserving some marine areas would not only safeguard imperiled species but sequester vast amounts planet-warming carbon dioxide, too.

Share full article 23

A trawler on Georges Bank, between Massachusetts and Nova Scotia. A new study found that bottom trawling accounts for as much carbon emissions as global aviation.
Jeffrey Rotman/Alamy

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Environment ▶ Climate crisis Wildlife Energy Pollution

Seascape: the state of our oceans
Fishing

This article is more than **1 month old**

Carbon released by bottom trawling 'too big to ignore', says study

Fishing nets churn up carbon from the sea floor, more than half of which will eventually be released into the atmosphere

Seascape: the state of our oceans is supported by
the guardian .org
About this content
Karen McVeigh
Thu 18 Jan 2024 09.05 GMT
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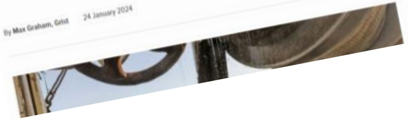
Eos
ABOUT SPECIAL REPORTS TOPICS NEWSLETTER PROJECTS SUBMIT TO EOS

Bottom Trawling Shreds the Seafloor. It May Also Be a Huge Source of Carbon Emissions.

Dragging nets along the ocean bed wrecks marine life, but researchers can't agree on how bad it is for the climate.

By Max Graham, Grist 24 January 2024



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NEW RESEARCH PAPER EXPOSES 'AIRLINE EMISSIONS' BLUE CARBON MYTH

18th May 2023

The science of sustainable seafood, *explained*

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Officially bogus: Bottom trawling does not release as much carbon as airline travel

Max Mossler

June 14, 2023

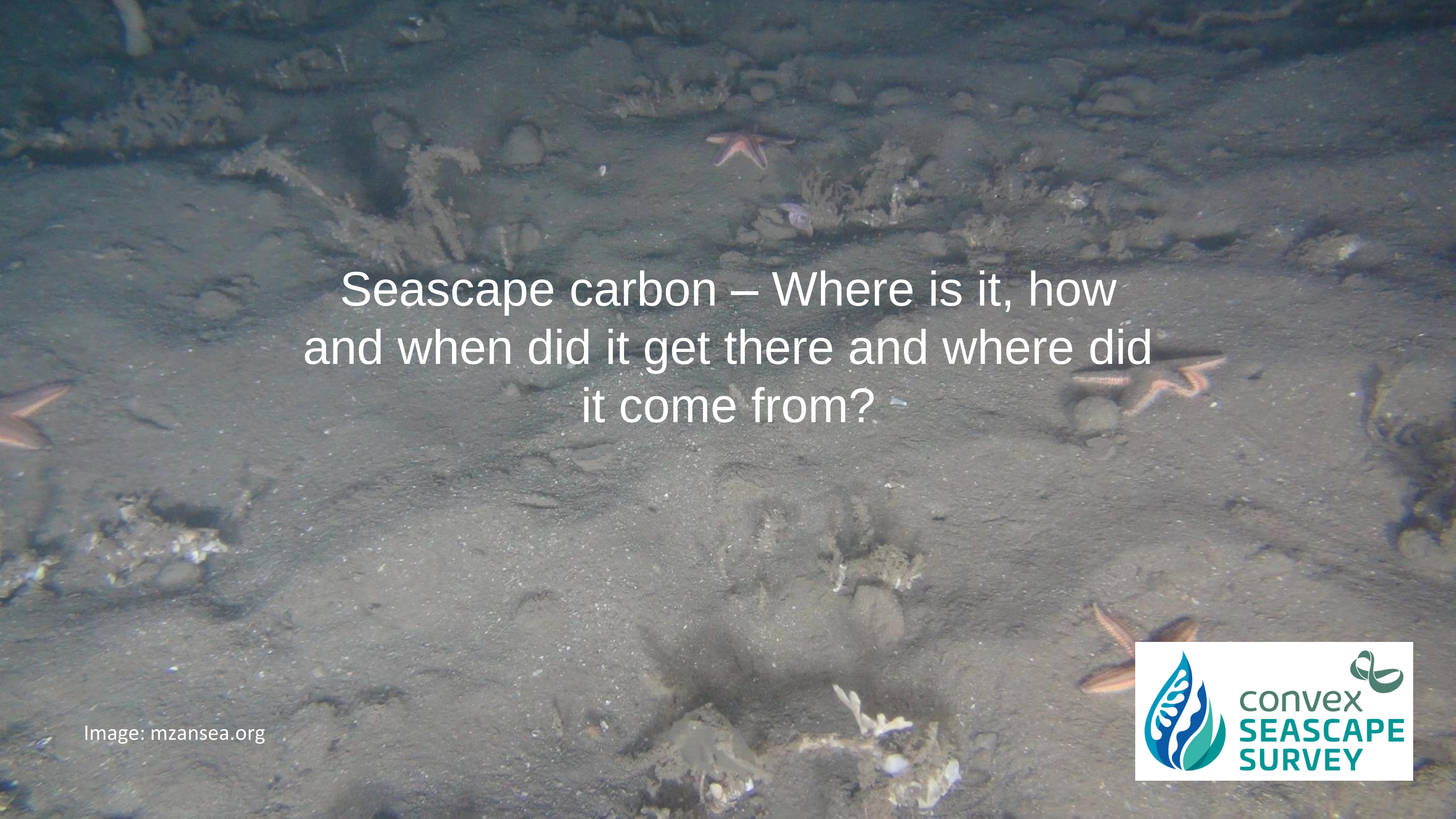
The Convex Seascape Survey is…

"A pioneering collaboration of world-leading experts working to quantify and understand blue carbon stored in the coastal ocean floor.

We will deliver new, reliable, open-source data which will educate, inspire and enable informed decisions on ocean use, to harness the power of the ocean against climate change."

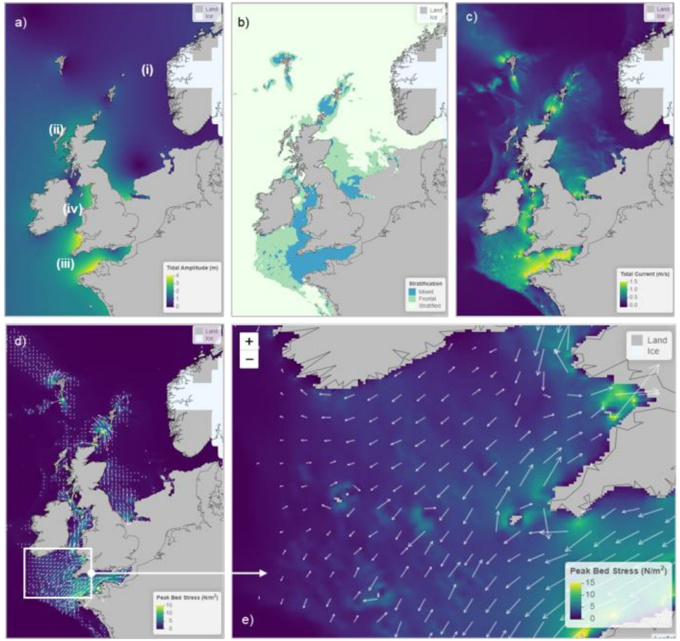
convex SEASCAPE SURVEY

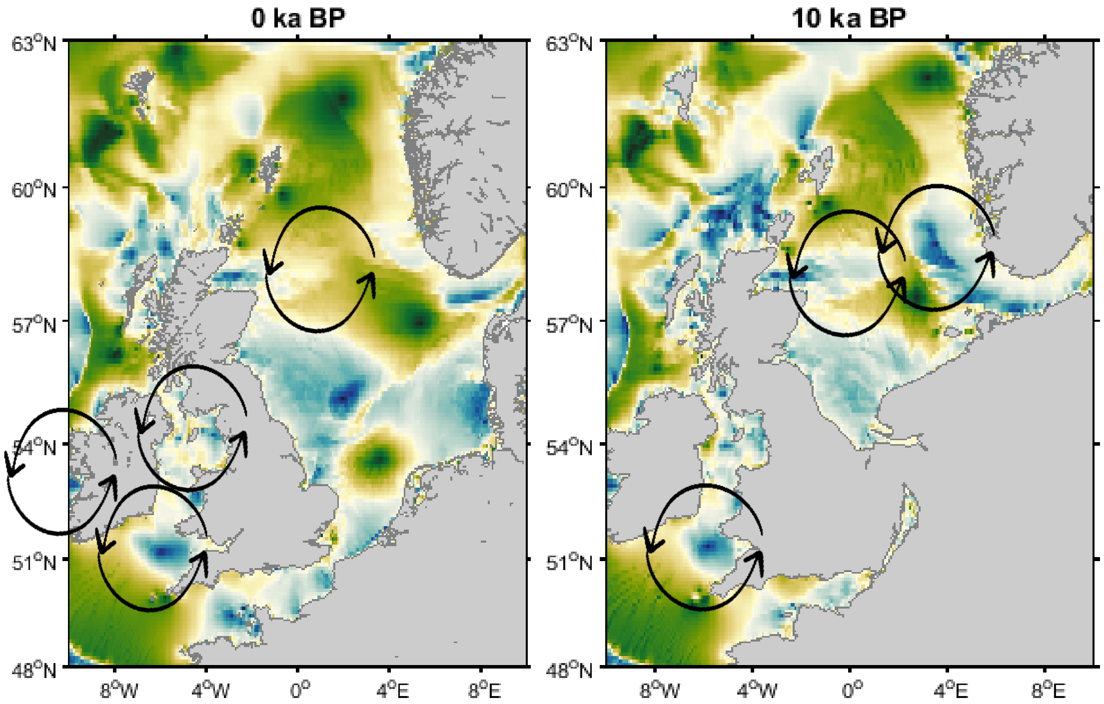

We are two years into a five year effort
The project has grown to than 100 experts from 21 institutions/ organizations in 9 countries of the world (so far)
Photo: Matt Jarvis


Seascape carbon – Where is it, how and when did it get there and where did it come from?
Image: mzansea.org
convex
SEASCAPE
SURVEY

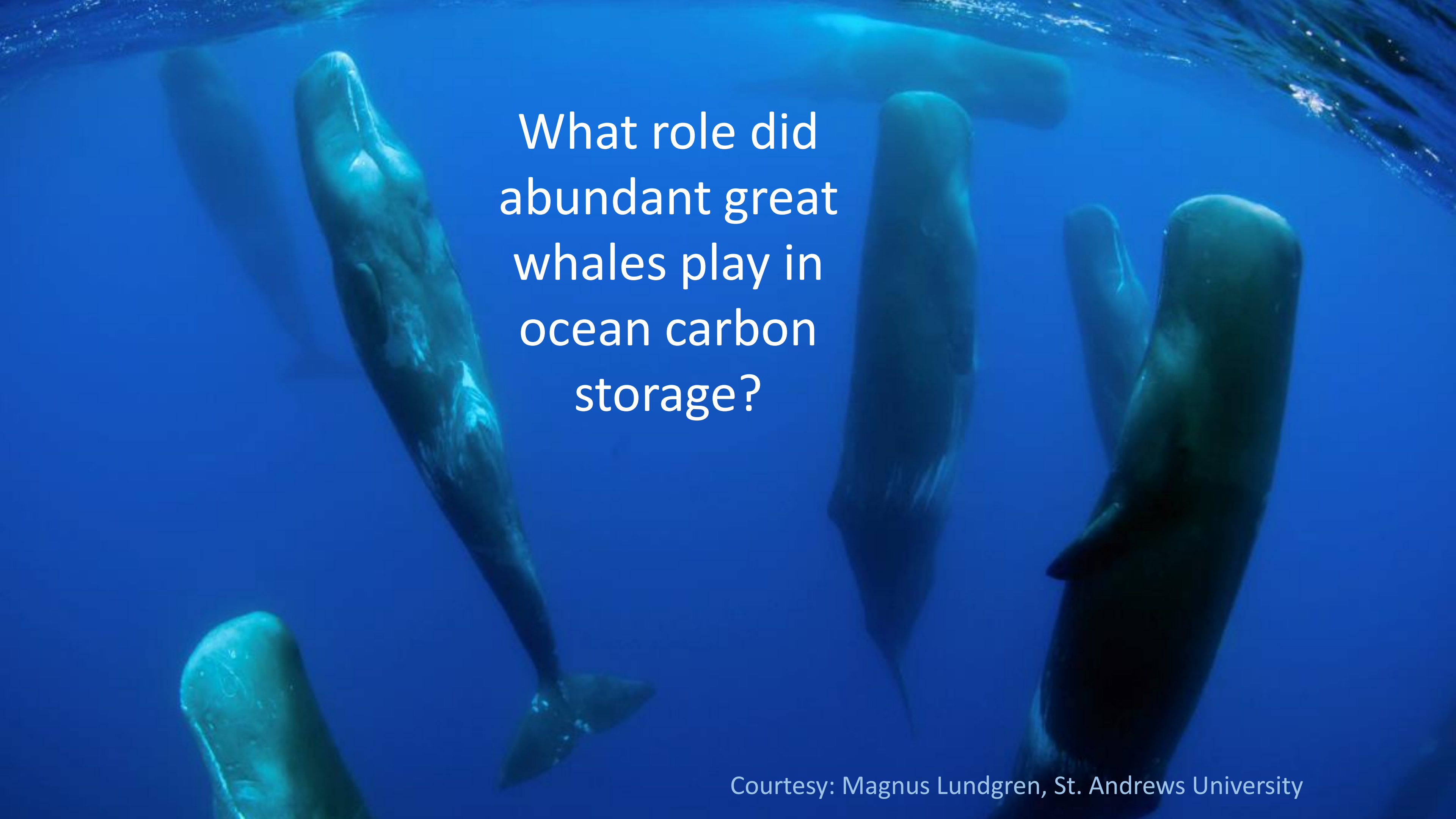
Carbon stocks have built over very long timescales

Where is the carbon? Oceanographic modelling to predict carbon accumulation over 20,000 years





Team: James Scourse, Sophie Ward, Sarah Bradley, Zoe Roseby



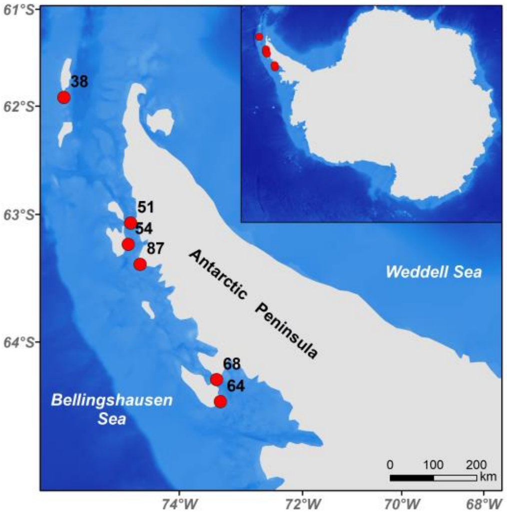
Courtesy: Magnus Lundgren, St. Andrews University

The biological pump: feed deep, poop shallow

Courtesy Black Iowa Dirt

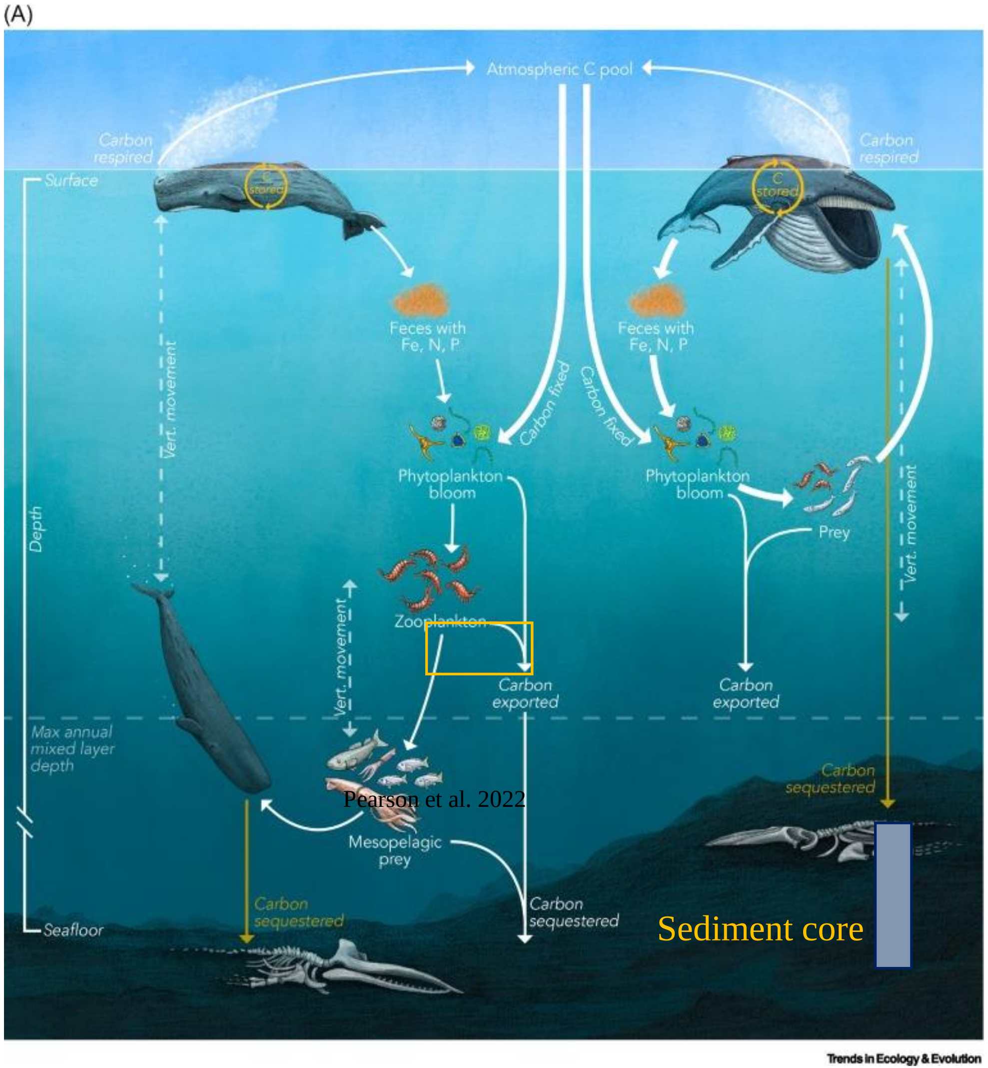
Team: Carlos Duarte, Carlos Preckler, Chuancheng Fu

Photo: Tony Wu



Analysis of algal pigments and eDNA in sediment cores

Team: Duarte, Preckler and Fu



Where did the carbon come from? Environmental eDNA analyses of sediments

Team: Richard Tennant, Torsa Sengupta, Anna Smith, Tom Roland, Rebecca Parker, Riyad Bhuiyan, Zoe Roseby, Callum Roberts, Chris Laing, Dan Charman

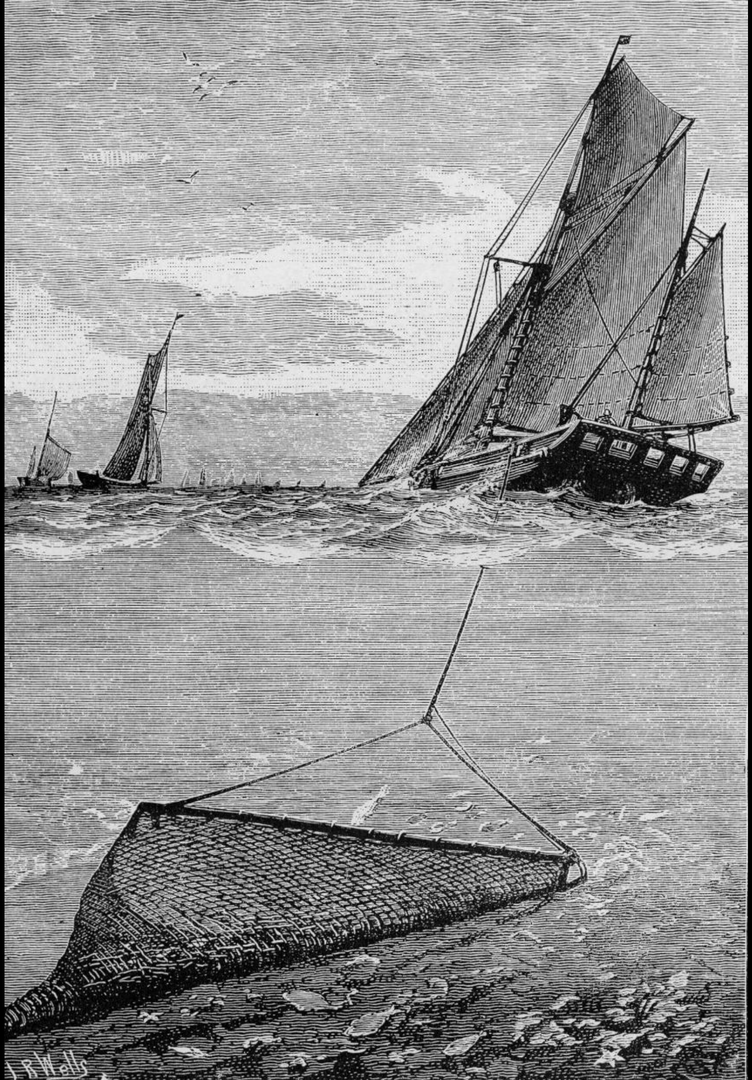
What have we done to seabed carbon over centuries?

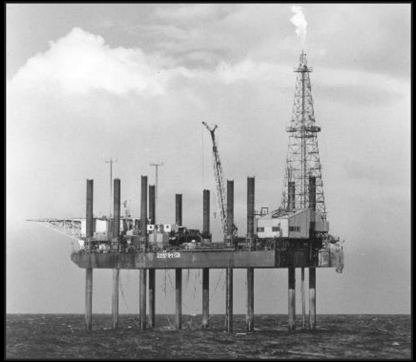
What are we doing now?

What are the risks and consequences?

convex SEASCAPE SURVEY

We’re writing a new history of the sea by documenting the spread of human industry across the ocean floor over hundreds of years





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SURVEY


We aim to reset shifted environmental baselines for the coastal ocean: what does a natural seabed look like?
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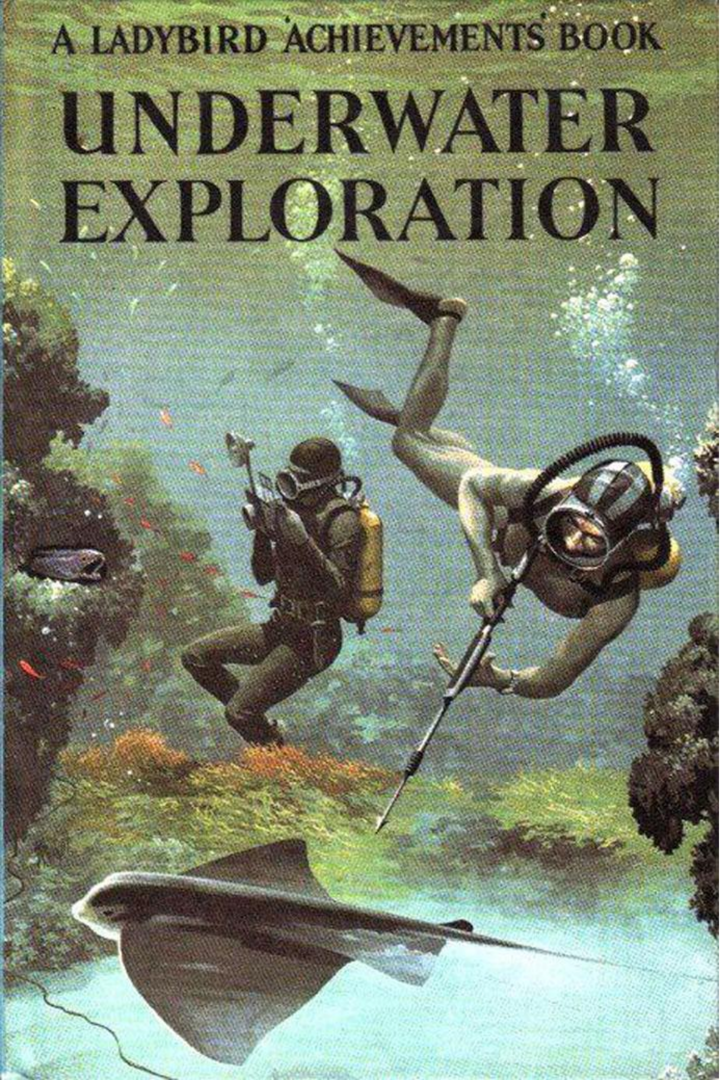
SEASCAPE
SURVEY



Marine science is a young discipline

When we first ventured underwater, we mistakenly assumed what we found to be natural and wild

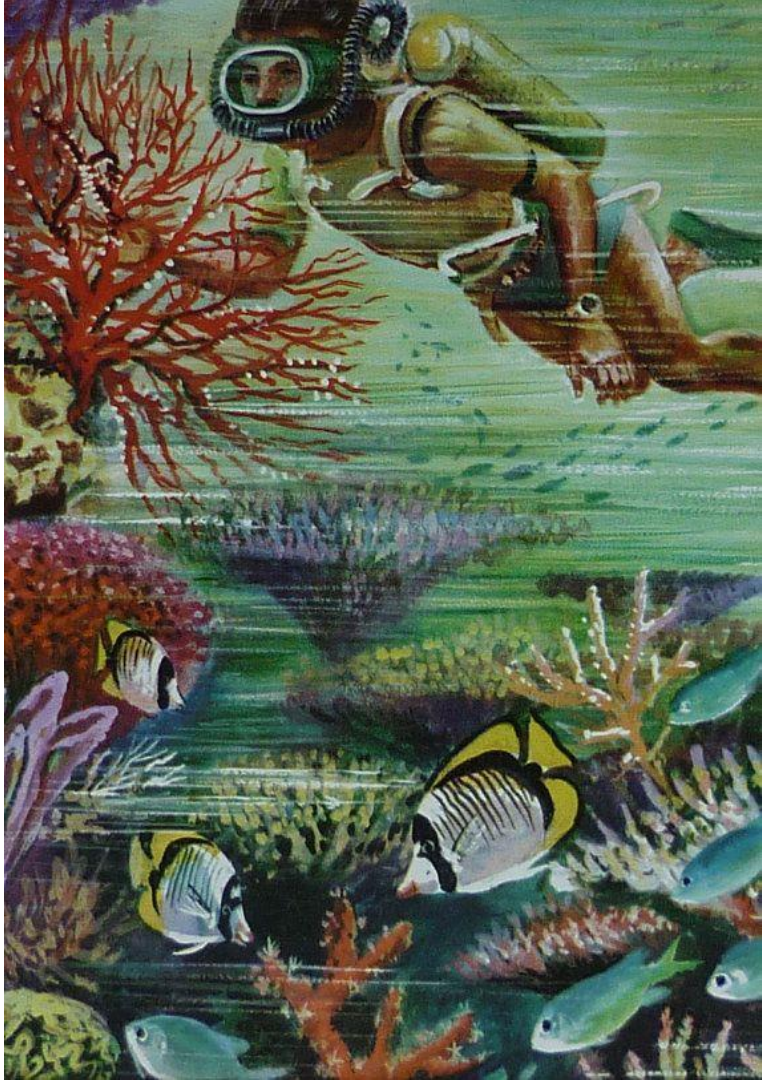
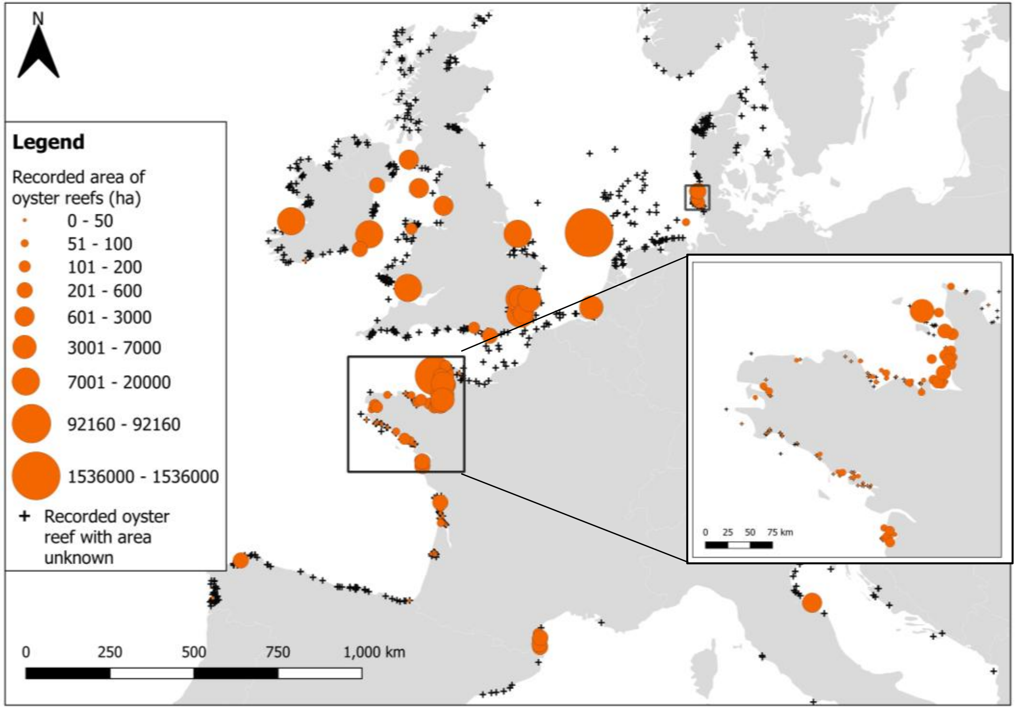


Photo: Alex Mustard

Oysters offer insights into the antiquity of seabed transformation by trawling and dredging

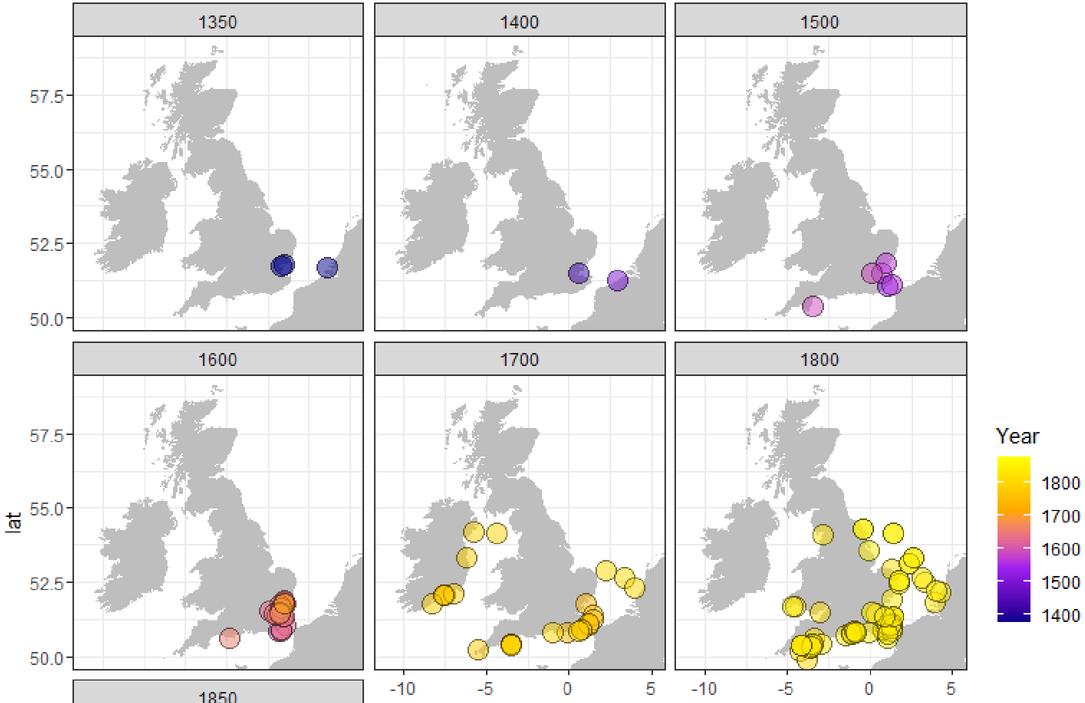
Flat oyster (*Ostrea edulis*) beds

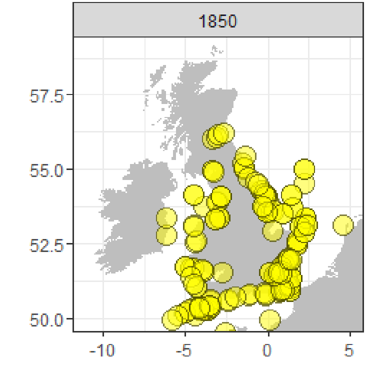


(Thurstan & zu Ermgassen et al, in review)

Report on the Fisheries of Norfolk - *"…an* ***enormous oyster bed in the North Sea****, east of the Silver Pits, in about 27 fathoms. It is nearly* ***80 miles long and 25 miles wide****."* **(1875)**

Team: Ruth Thurstan, Tara Williams, Ciaran McClaverty, Julie Hawkins, Callum Roberts



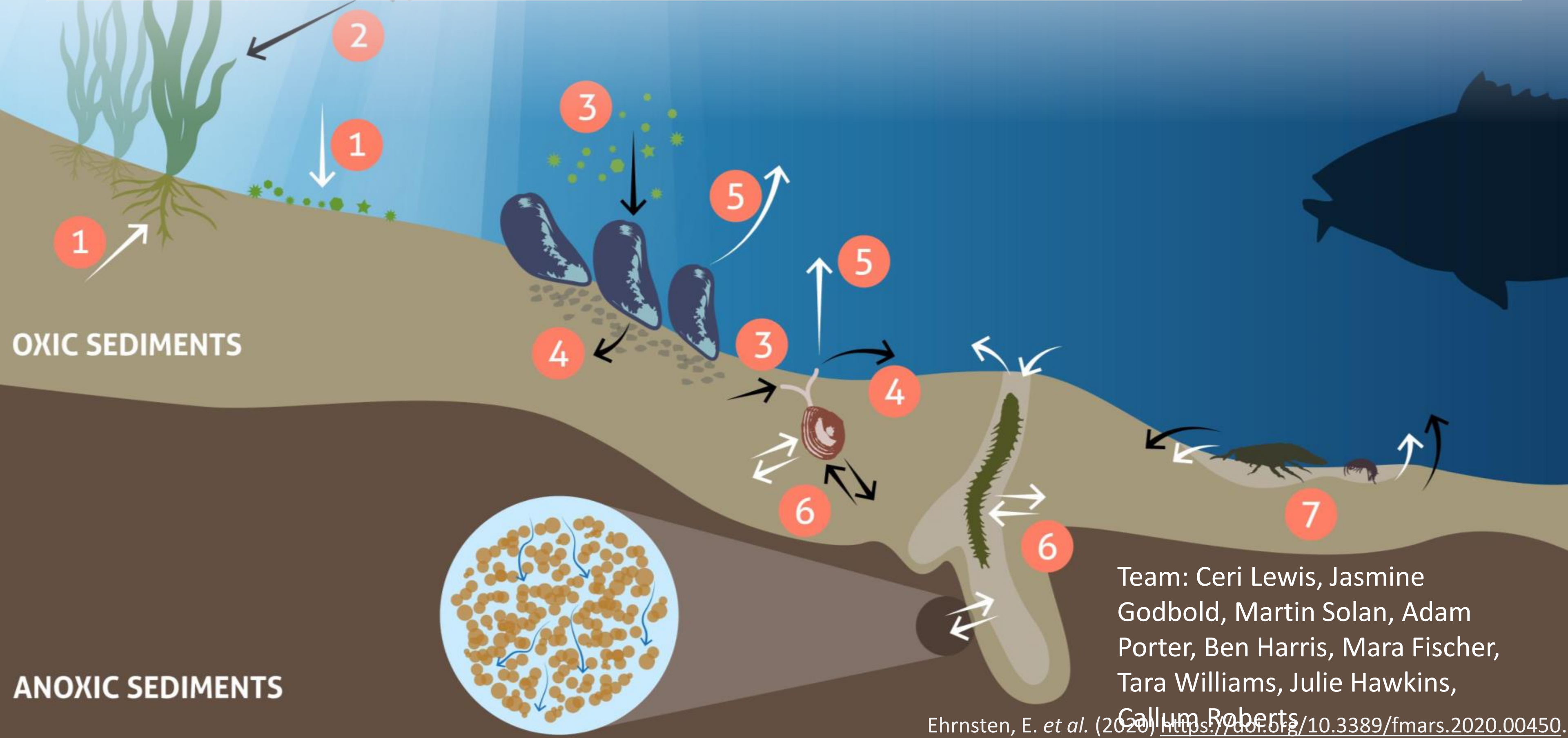


Tracing the historic development of bottom trawling around Britain

Team: Ciaran McLaverty, Ruth Thurstan and Callum Roberts

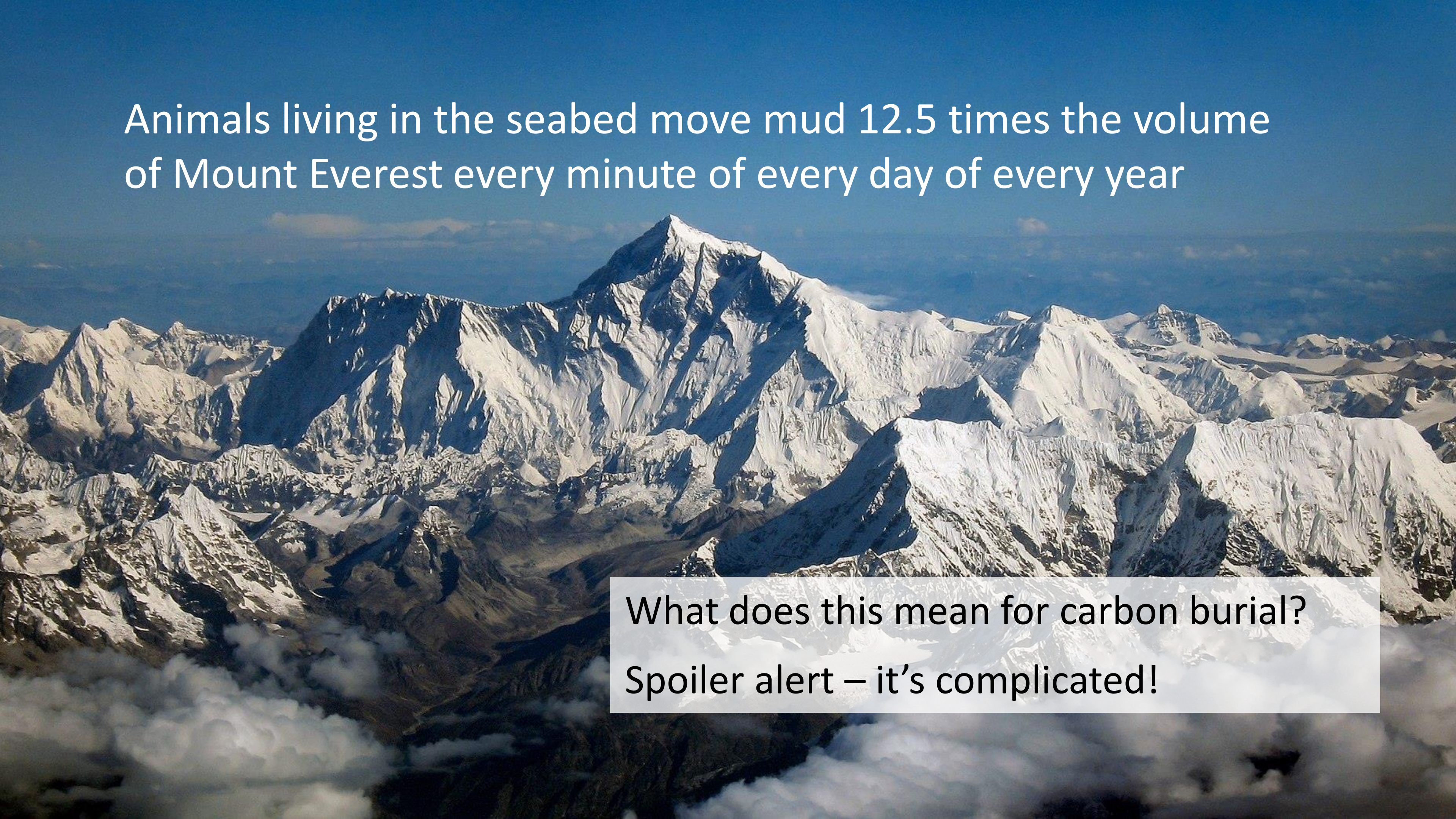
Image: Henley Spiers

What is the role of seabed species in carbon flux?



Team: Ceri Lewis, Jasmine Godbold, Martin Solan, Adam Porter, Ben Harris, Mara Fischer, Tara Williams, Julie Hawkins, Callum Roberts

Ehrnsten, E. *et al.* (2020) https://doi.org/10.3389/fmars.2020.00450.


Animals living in the seabed move mud 12.5 times the volume of Mount Everest every minute of every day of every year
What does this mean for carbon burial?
Spoiler alert – it's complicated!

Do degraded habitats store less carbon?

Carbon loss

- Trawl disturbance mobilises carbon and some is lost
- Trawling flushes sediments with oxygen encouraging carbon breakdown
- Fewer animals so less embodied carbon
- Less 'bioturbation' to bury carbon

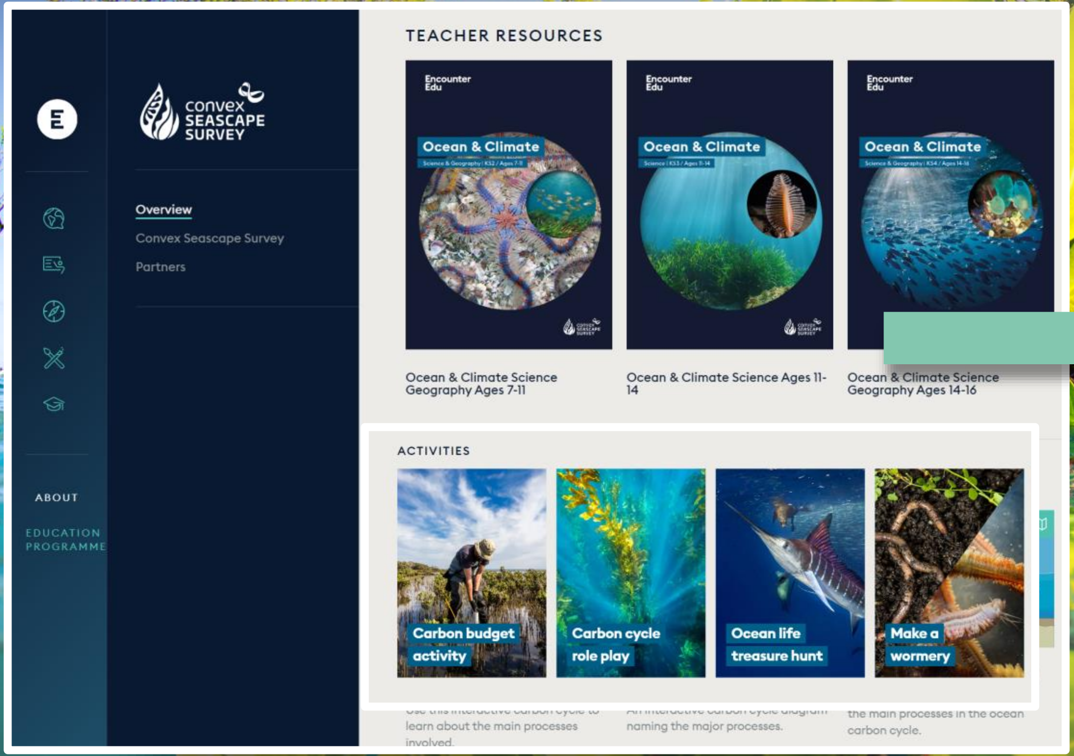
Carbon gain

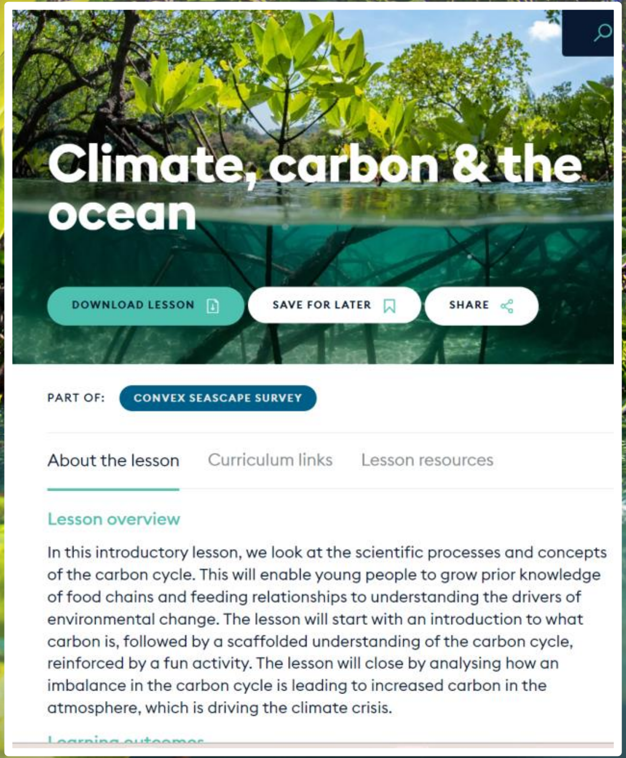
- Fewer animals = less respiration & carbon dioxide production
- Less 'bioturbation' to mobilise carbon into overlying waters

Source: Oceanographic magazine


convex
SEASCAPE
SURVEY

EDUCATION PROGRAMME





convex SEASCAPE SURVEY

Outcomes

- Better understanding
- Better data, made freely available
- Better decisions
- Safer planet

Photo: Alex Mustard

convex SEASCAPE SURVEY

convex SEASCAPE SURVEY

Thank You

LUNCH

University of Exeter Cornwall

13 CLIMATE ACTION

7 AFFORDABLE AND CLEAN ENERGY

14 LIFE BELOW WATER

3 GOOD HEALTH AND WELL-BEING

17 PARTNERSHIPS FOR THE GOALS

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

University of Exeter Cornwall

Healthy Planet, Healthy People:

Understanding the opportunities of nature-based solutions for health and wellbeing

Professor Conny Guell, Associate Professor in Anthropology of Health & Environment, European Centre for Environment and Human Health

University of Exeter

European Centre for Environment & Human Health

Healthy Planet, Healthy People: Understanding the opportunities of nature based solutions for health and wellbeing. SDG3: Good Health and Wellbeing

Shaping a sustainable future SDG symposium, University Exeter Graduate School of Environment and Sustainability
September 2024

Conny Guell, Becca Lovell, Lewis Elliott and Ben Wheeler
European Centre for Environment and Human Health
University of Exeter Medical School
r.lovell@exeter.ac.uk C.Guell@exeter.ac.uk l.r.elliott@exeter.ac.uk
b.w.wheeler@exeter.ac.uk **www.ecehh.org**

European Centre for Environment and Health

University of Exeter

Blue Environments & Health

Climate Change

Antimicrobial Resistance & Microbiology

Nature, Biodiversity and Health

Communities and Social Inequalities

Food Systems & Planetary Health

SDG3 good health and the environment?

- Target 3.4: By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being.
- Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

- **'Upstream' structural – environmental – drivers to health and wellbeing.** For example: fresh fruit and vegetables need to be available and affordable for healthy nutrition; cities need to be 'greened' to support physical and mental wellbeing and mitigate climate change risks such as heat and flooding

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SDG3 and its synergies

Example Food Systems and Planetary Health:

Food systems transformation for healthier, more sustainable, socially more just nutrition addresses:

SDG3 Good health: Prevention of non-communicable diseases

SDG2 Zero hunger: Sustainable and resilient food production; access to food

SDG 15 Life on land: Protection of biodiversity

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Examples for nature-based solutions for SDG3: Good Health and Wellbeing:

Becca Lovell: Complexity of understanding and realising health benefits of NBS
Conny Guell: Transforming food systems for better health?
Lewis Elliott: Quantifying the public health benefits of (recreation in) natural environments
Ben Wheeler: Panel discussion

Complexity of understanding and realising health benefits of NBS

Becca Lovell (R.Lovell@exeter.ac.uk)

Nature Based Solutions to meet the SDGs?

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- NBS present opportunities to adapt to and mitigate climate change with health benefits and protection from harms
- NBS done correctly result in multiple benefits for people and the ecosystems we are a part of
- NBS include actions that aim to:
  - Change the environment itself
  - Change how we interact with the environment
  - Change how we experience the environment
  - Change environment/health-related policy and practice, including health care

Complexity of understanding and realising health benefits of NBS

REGREEN H2020 programme, led by Aarhus University

REGREEN
NATURE-BASED SOLUTIONS

REGREEN built on URBAN LIVING LABS (ULLs) as central elements of the project:

- 3 European (Aarhus, Paris, Velika Gorica)
- 3 Chinese cities (Beijing, Shanghai, Ningbo)

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Complexity of understanding and realising health benefits of NBS

REGREEN H2020 programme, led by Aarhus University

- We aimed to take a complexity-informed approach to considering the interconnections between Nature Based Solutions and mental health
- Street trees are an example of a nature-based solution with the potential to provide a range of ecosystem services including climate regulation, air quality regulation and aesthetic and cultural services.
- Interest in the potential of street trees to mitigate the impacts of a changing environment is increasing. As a result, there are now a number of large scale street tree ambitions and strategies.

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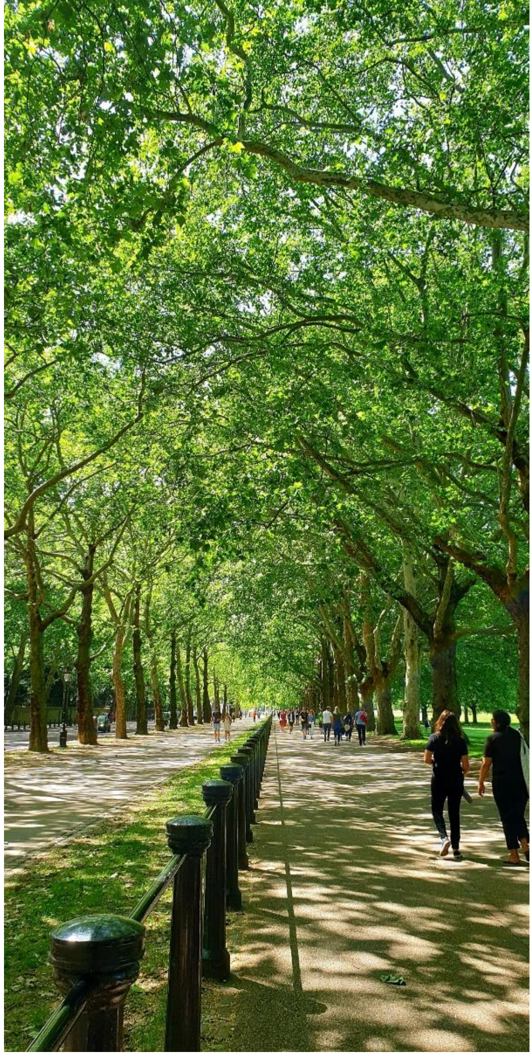
REGREEN NATURE-BASED SOLUTIONS



Street trees and mental health

- Multiple reviews of evidence have highlighted the health and social potential of street trees.
- **Few syntheses or conceptual models have sought to demonstrate *how* street trees operate within the systems they are situated, nor do they describe *the conditions* in which impacts do or do not come about.**
- The challenges in considering the multiple pathways (i.e. the processes which link cause and outcome) through which street trees are thought to operate, unexpected consequences, and evaluating impact.

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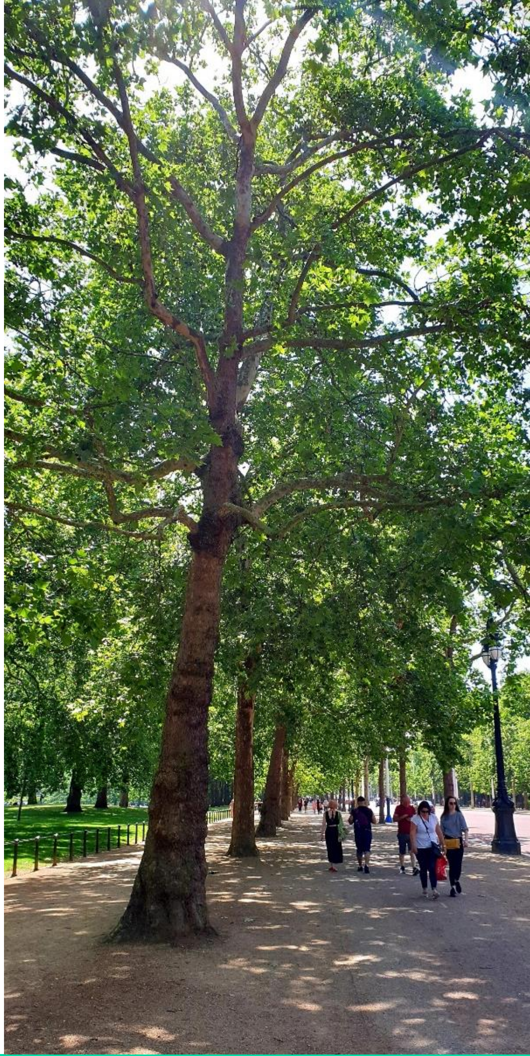
REGREEN NATURE-BASED SOLUTIONS



Complexity methods:

We used a system thinking approach:

- To consider multiple outcomes, non-linearity, feedback loops and unexpected consequences.
- Offering new insights around the structures of systems – for example, conceptualising 'mental health' as a system rather than as an 'outcome'.

Causal loop diagrams provide a useful tool for synthesizing the complex interrelationships between street trees and the 'system' relating to mental health.

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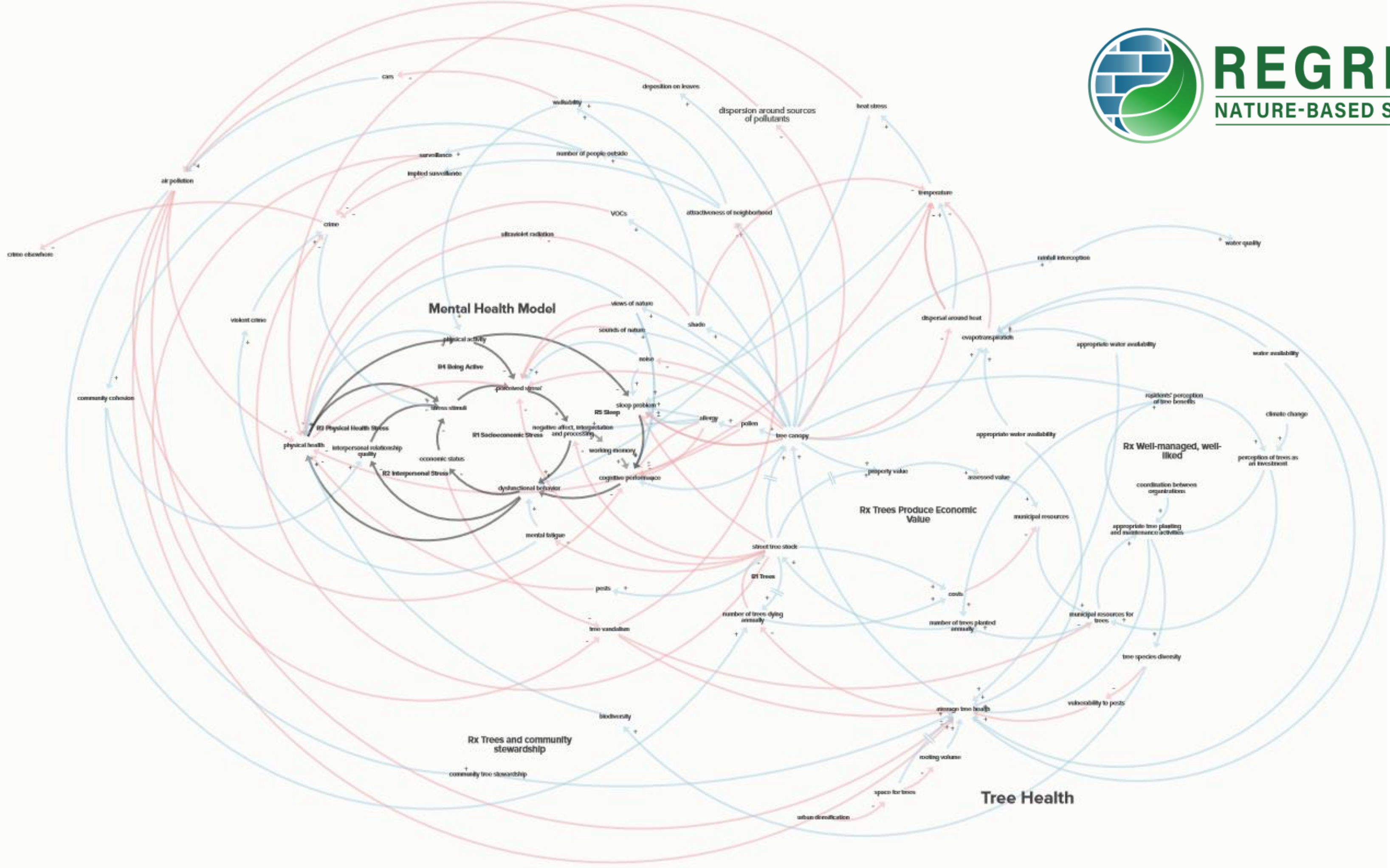
REGREEN NATURE-BASED SOLUTIONS

REGREEN
NATURE-BASED SOLUTIONS



Interactions between street trees, mental health and wider systems: considerations for SDG3 Good Health and Wellbeing

1. Although there are many ways in which street trees may improve mental health, tree health is critical in realizing many of these benefits and minimizing dis-benefits.

2. Communities which have benefited from street trees in the past are more likely to be able to advocate for additional trees, further entrenching historical inequities in street tree distribution.

3. Efforts to address these inequities through new tree planting initiatives may ultimately fail or even exacerbate existing challenges if they do not include sustained resources for tree maintenance, with direct and indirect impacts on inequities in mental health.

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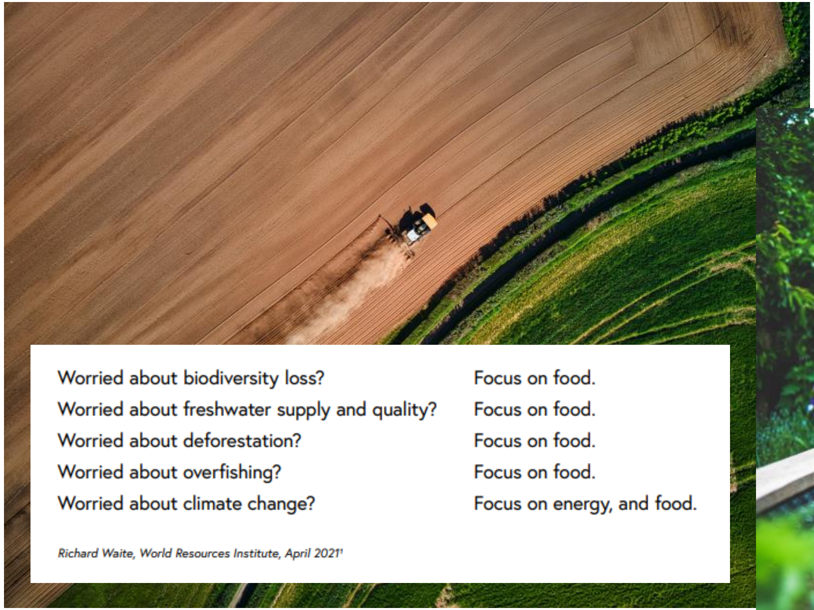
REGREEN NATURE-BASED SOLUTIONS

Transforming food systems for better health?

Conny Guell (C.Guell@exeter.ac.uk)

Transforming food systems for better health?



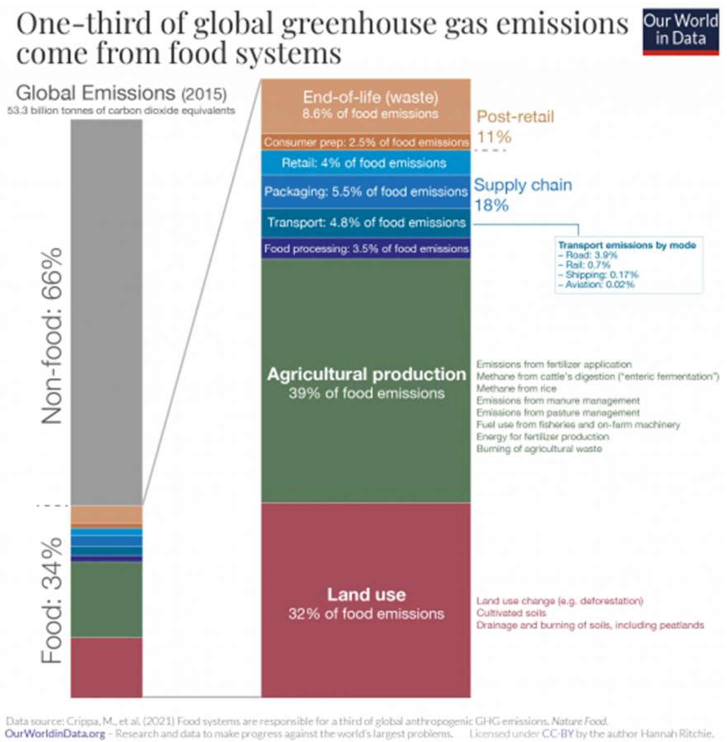
Worried about biodiversity loss?	Focus on food.
Worried about freshwater supply and quality?	Focus on food.
Worried about deforestation?	Focus on food.
Worried about overfishing?	Focus on food.
Worried about climate change?	Focus on energy, and food.

Richard Waite, World Resources Institute, April 2021[1]

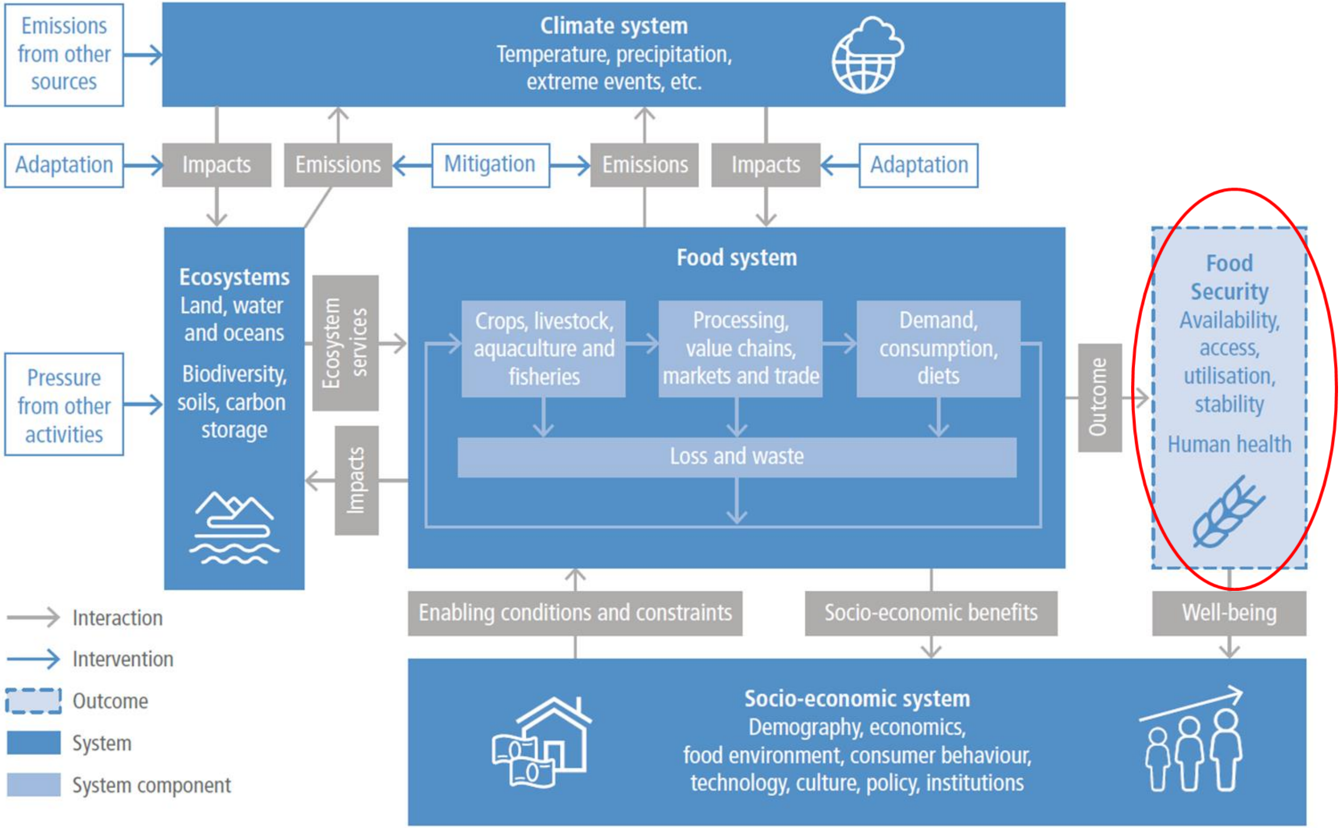
Photos: Unsplash

Impact of food systems on climate change

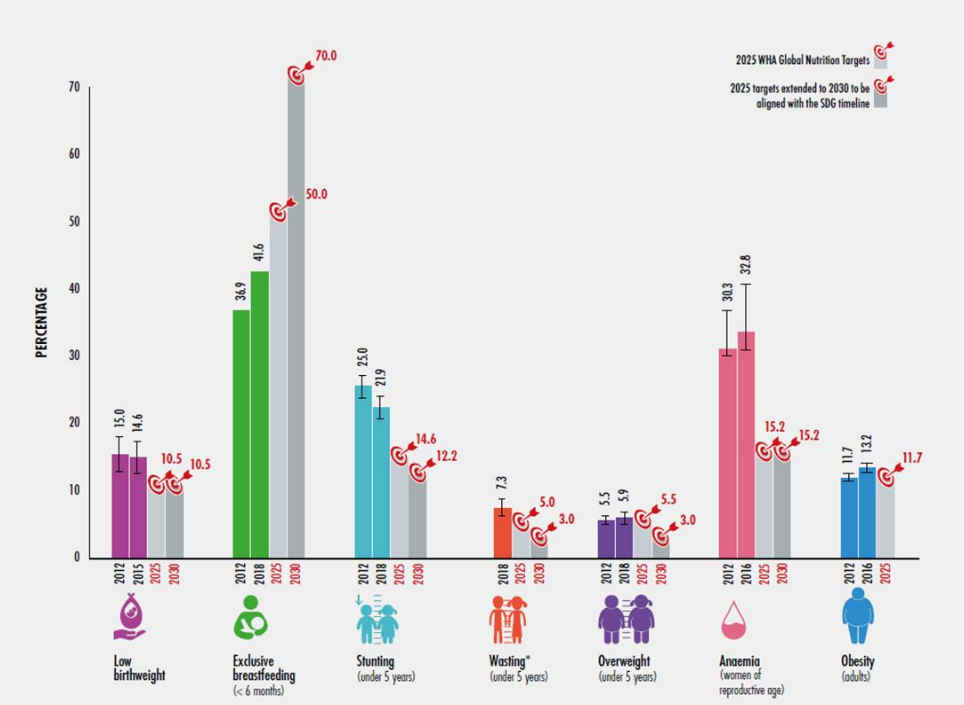
Our food system affects our environment by contributing to global greenhouse emissions, soil degradation, water quality etc.



IPCC Report Climate Change and Land (2019)



Interlinkages between the climate system, food system, ecosystems (land, water and oceans) and socio-economic system



"Progress in malnutrition is too slow to achieve the 2025 and 2030 Global Nutrition Targets."

FAO, IFAD, UNICEF, WFP and WHO. 2019. *The State of Food Security and Nutrition in the World 2019. Safeguarding against economic slowdowns and downturns.* Rome, FAO.

Nutrition-related chronic non-communicable diseases (NCDs)

- Leading cause of death globally - 68% of the world’s 56 million deaths in 2012.
- More than 40% of those were premature <70 years old.
- Almost three quarters of all NCD deaths and the majority of premature deaths (82%) occur in Low and Middle Income Countries.

Global Burden of Disease Study Lancet 2017

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Food growing / agriculture as a Nature-Based Solution

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European Commission

EN

Food, Farming, Fisheries

Food Safety

Home | Food | Animals | Plants | Horizontal topics

Home > Horizontal topics > Farm to Fork strategy

Farm to Fork strategy

for a fair, healthy and environmentally-friendly food system

PAGE CONTENTS

About the Strategy

The Farm to Fork Strategy is at the heart of the European Green Deal, aiming to make food systems fair, healthy and environmentally-friendly.

Food systems cannot be resilient to crises such as the COVID-19 pandemic if they are not sustainable. We need to redesign our food systems which today account for nearly one-third of global GHG emissions, consume large amounts of natural resources, result in biodiversity loss and negative health impacts (due to both under- and over-nutrition) and do not allow fair economic returns and livelihoods for all actors, in particular for primary producers.

Putting our food systems on a sustainable path also brings new opportunities for operators in the food value chain. New technologies and scientific discoveries, combined with increasing public awareness and demand for sustainable food, will benefit all stakeholders.

Farm to Fork Strategy - European Commission (europa.eu)

ELSEVIER

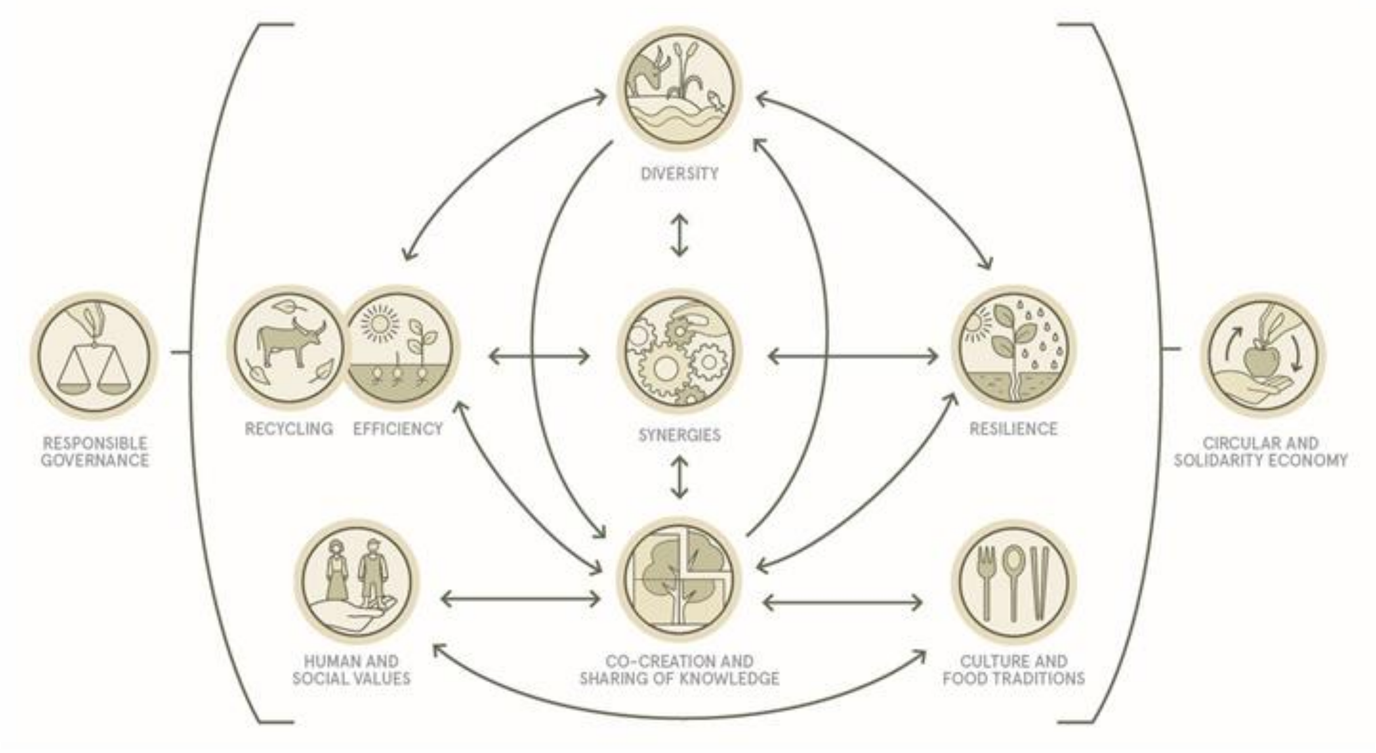
Environmental Research

Volume 159, November 2017, Pages 264-275

Cultivating nature-based solutions: The governance of communal urban gardens in the European Union

Alexander P.N. van der Jagt [a] [b], Luca R. Szaraz [c], Tim Delshammar [d], Rozalija Cvejić [e], Artur Santos [f], Julie Goodness [g], Arjen Buijs [h]

Agroecology as a Nature-Based Solution



https://www.fao.org/agroecology/home/en/

Agroecology as a Nature-Based Solution

A set of practices and a social movement to move away from industrial agriculture

"A holistic and integrated approach that simultaneously applies ecological and social [..] principles to the design and management of sustainable agriculture and food systems",

"To optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems"

Has entered mainstream, particularly endorsed by the Food and Agricultural Organization

The FAO has played an important role in facilitating global and regional dialogues on agroecology, strengthening policy processes and gathering and disseminating evidence, best practices and tools, and providing technical assistance.

https://www.fao.org/agroecology/home/en/

ELSEVIER

Global Food Security
Volume 29, June 2021, 100540

Can agroecology improve food security and nutrition? A review

Rachel Bezner Kerr [a], Sidney Madsen [a], Moritz Stüber [b], Jeffrey Liebert [c], Stephanie Enloe [a], Noélie Borghino [b], Phoebe Parros [b], Daniel Munyao Mutyambai [c], Marie Prudhon [b], Alexander Wezel [b]

- 56 agroecology studies had evidence for food security & nutrition (FSN) outcomes.
- 78% of studies showed positive FSN outcomes from agroecological practices (in LMIC settings).
- Agroecological practices included crop diversification, intercropping, agroforestry, integrating crop and livestock, and soil management measures.
- Increased complexity of agroecological system more positively associated with FSN.
- Farmer networks and attention to social equity dimensions were important.

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Bezner Kerr et al, 2021

Global Community Food for Human Nutrition and Planetary Health in Small Islands (Global CFaH)

Tagged:

Food Systems and Planetary Health

Improving household health and food security by promoting agroecological community-based food production

Aim

Global CFaH aims to understand the potential for improving household diet, nutrition, and food security, and reducing the burden of nutrition related diseases by promoting increased community-based food production based on agroecological principles, in small island countries.

The project, funded by the National Institute of Health and Care Research, will review the available data on dietary quality, nutrition-related diseases, food

Authors

Amanda Goodwin

Prof Nigel Unwin

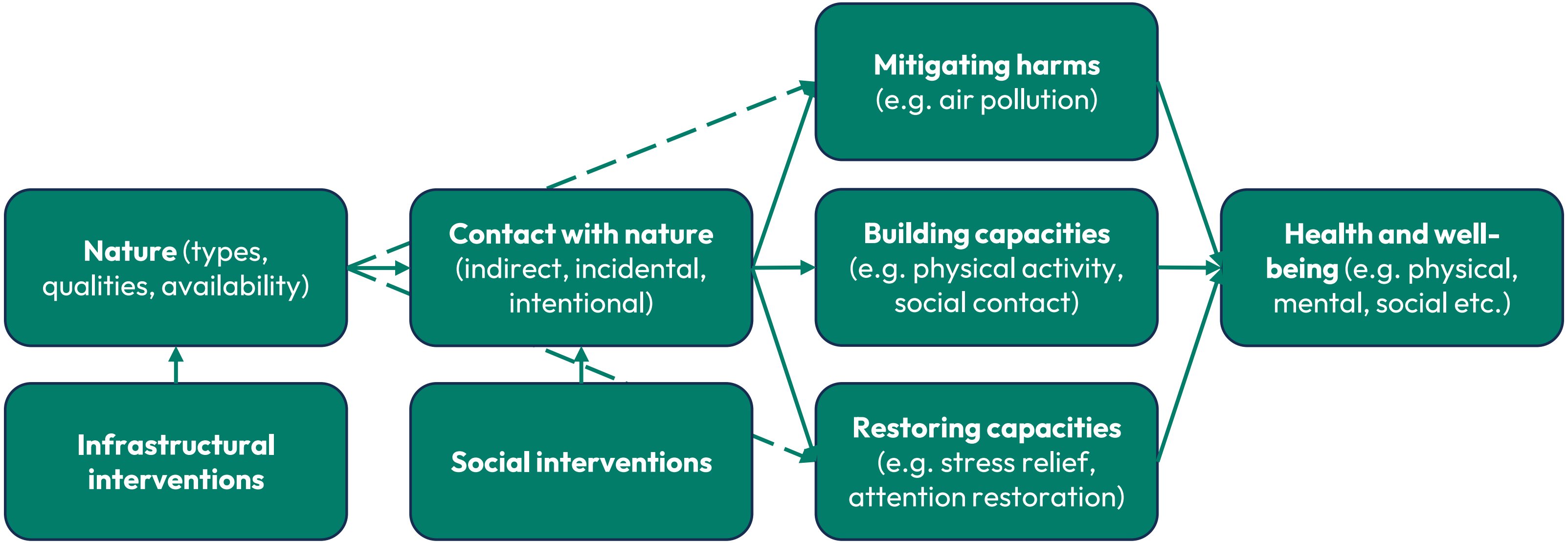
Prof Cornelia Guell

University of Exeter

Quantifying the public health benefits of (recreational interactions with) natural environments

Lewis Elliott (L.R.Elliott@exeter.ac.uk)

A research framework



Adapted from: Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and Health. Annual Review of Public Health, 35(1), 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443; Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., de Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M. J., Lupp, G., Richardson, E. A., Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., & Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. Environmental Research, 158, 301–317. https://doi.org/10.1016/j.envres.2017.06.028; White, M. P., Elliott, L. R., Gascon, M., Roberts, B., & Fleming, L. E. (2020). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. Environmental Research, 191, 110169. https://doi.org/10.1016/j.envres.2020.110169; Marselle, M. R., Hartig, T., Cox, D. T. C., de Bell, S., Knapp, S., Lindley, S., Triguero-Mas, M., Böhning-Gaese, K., Braubach, M., Cook, P. A., de Vries, S., Heintz-Buschart, A., Hofmann, M., Irvine, K. N., Kabisch, N., Kolek, F., Kraemer, R., Markevych, I., Martens, D., … Bonn, A. (2021). Pathways linking biodiversity to human health: A conceptual framework. Environment International, 150, 106420. https://doi.org/10.1016/j.envint.2021.106420

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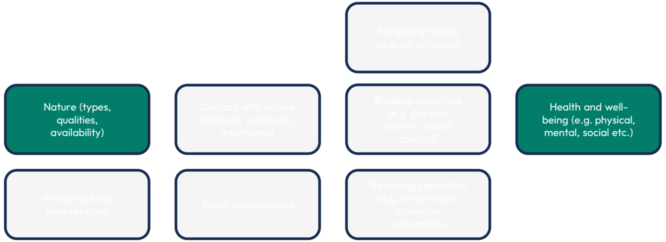
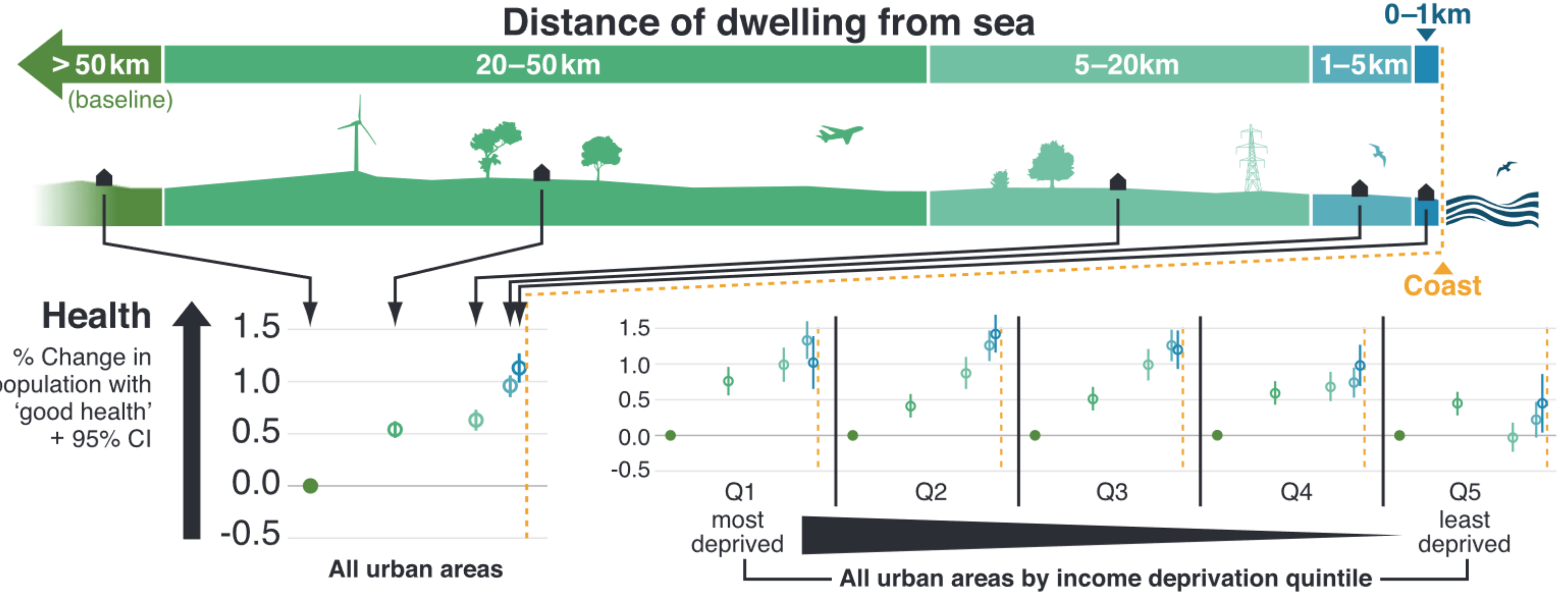


Coastal proximity and health



Wheeler, B. W., White, M., Stahl-Timmins, W., & Depledge, M. H. (2012). Does living by the coast improve health and wellbeing? Health & Place, 18(5), 1198–1201. https://doi.org/10.1016/j.healthplace.2012.06.015

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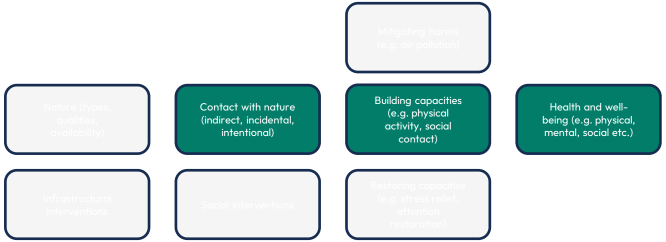
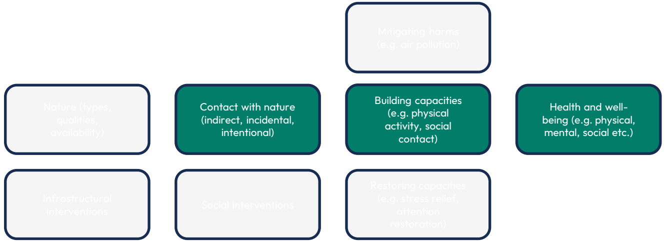


Nature visits and health costs

- Total costs associated with disease that are potentially prevented through **nature-based physical activity** in England for 2019.

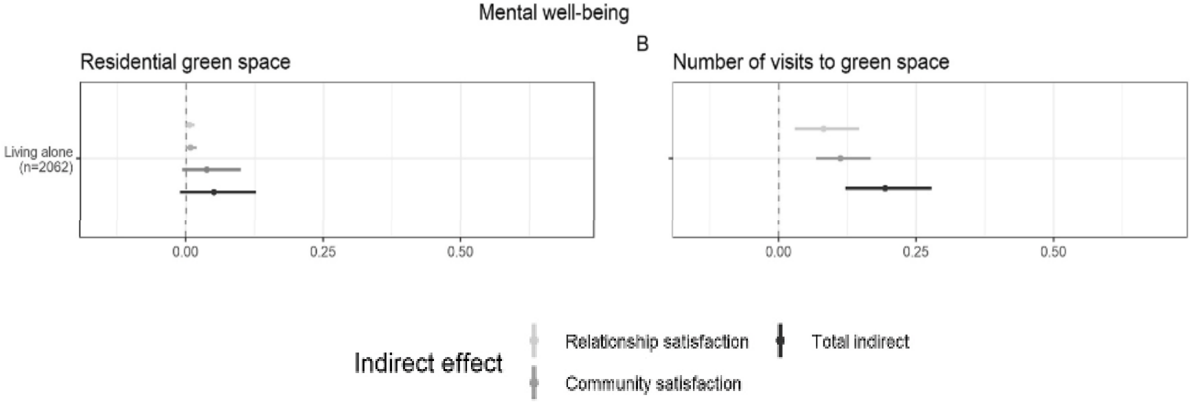
Disease	**Total costs**
Ischaemic heart disease	£2.9m (£2.5m - £3.3m)
Ischaemic stroke	£1.5m (£1.3m - £1.8m)
Type 2 diabetes	£11.1m (£8.8m - £13.7m)
Colon cancer	£0.3m (£0.2m - £0.4m)
Breast cancer	£0.1m (£0.1m – £0.1m)
Major depressive disorder	£92.7m (£57.4m - £131.3m)
Total	**£108.6m (£70.4m - £150.6m)**

Grellier, J., White, M. P., de Bell, S., Brousse, O., Elliott, L. R., Fleming, L. E., Heaviside, C., Simpson, C., Taylor, T., Wheeler, B. W., & Lovell, R. (2024). Valuing the health benefits of nature-based recreational physical activity in England. Environment International, 187, 108667. https://doi.org/10.1016/j.envint.2024.108667



Nature visits and social isolation

- Across 18 countries/territories (inc. Hong Kong), **visits to nature buffer the impact of living alone on poor mental health** via greater **relationship and community satisfaction.**



Pasanen, T. P., White, M. P., Elliott, L. R., van den Bosch, M., Bratman, G. N., Ojala, A., Korpela, K., & Fleming, L. E. (2023). Urban green space and mental health among people living alone: The mediating roles of relational and collective restoration in an 18-country sample. Environmental Research, 232, 116324. https://doi.org/10.1016/j.envres.2023.116324

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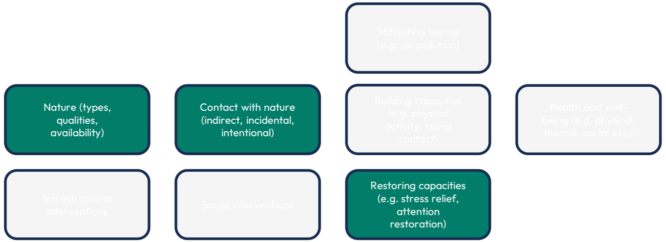
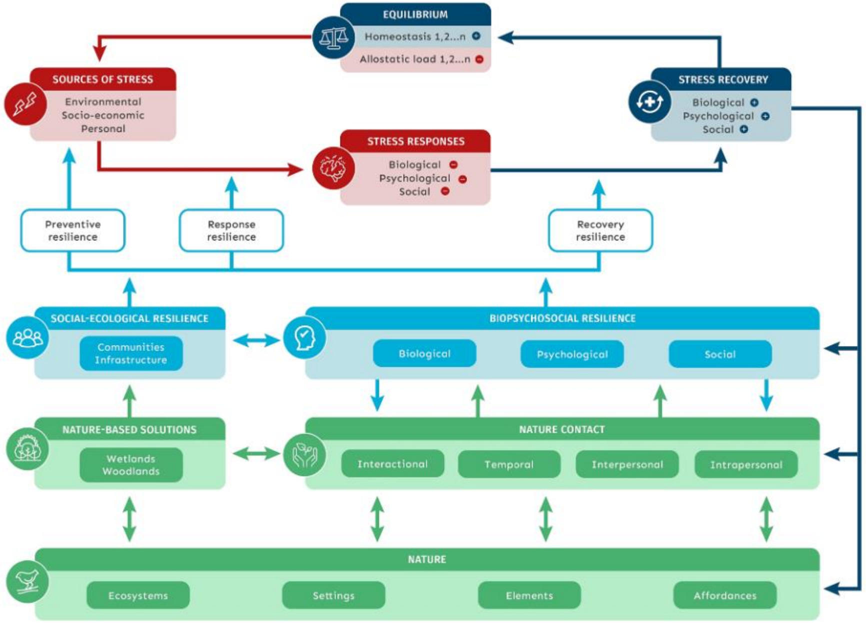
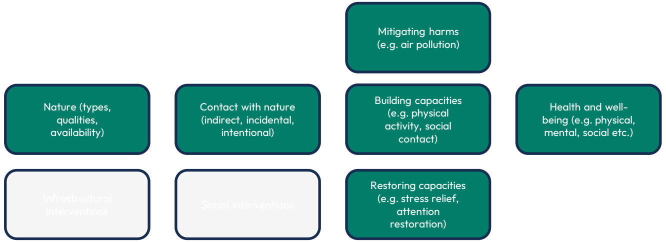


Nature-based biopsychosocial resilience theory

- NBS can **prevent stress** altogether, or make stressors **less potent** (preventive resilience)
- Nature can also help us **cope with stress** (response resilience)
- Nature can help us **recover more quickly/completely from stress** (recovery resilience)

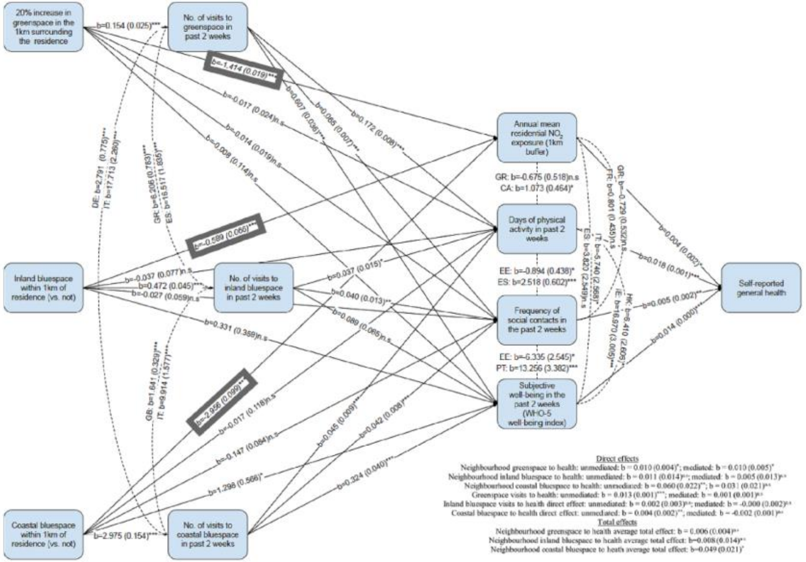


White, M. P., Hartig, T., Martin, L., Pahl, S., van den Berg, A. E., Wells, N. M., Costongs, C., Dzhambov, Angel. M., Elliott, L. R., Godfrey, A., Hartl, A., Konijnendijk, C., Litt, J. S., Lovell, R., Lymeus, F., O'Driscoll, C., Pichler, C., Pouso, S., Razani, N., ... van den Bosch, M. (2023). Nature-based biopsychosocial resilience: An integrative theoretical framework for research on nature and health. Environment International, 181, 108234. https://doi.org/10.1016/j.envint.2023.108234

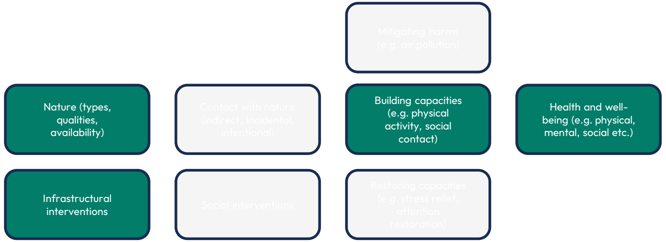


Testing pathways

- The most consistently supported pathways to health from neighbourhood nature across countries, environment types, and sociodemographic strata were via **visits**, greater **physical activity attainment**, and improved **subjective well-being.**

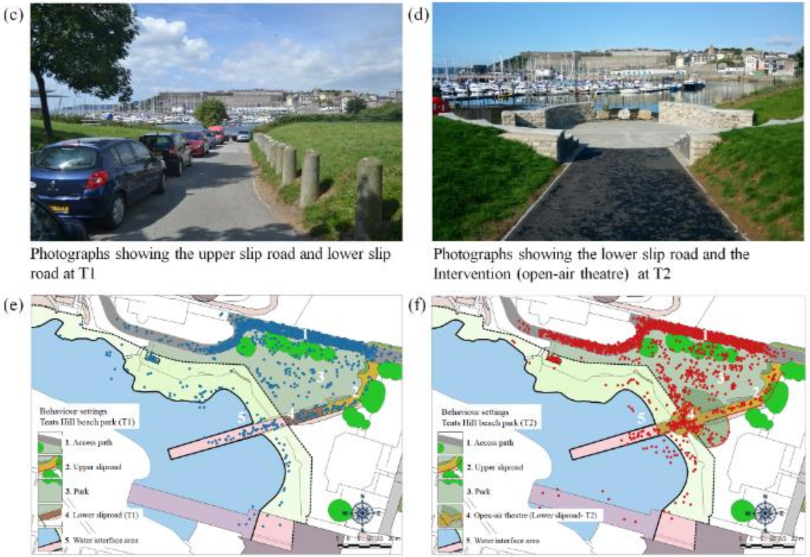


Elliott, L. R., Pasanen, T., White, M. P., Wheeler, B. W., Grellier, J., Cirach, M., Bratman, G. N., van den Bosch, M., Roiko, A., Ojala, A., Nieuwenhuijsen, M., & Fleming, L. E. (2023). Nature contact and general health: Testing multiple serial mediation pathways with data from adults in 18 countries. Environment International, 178, 108077. https://doi.org/10.1016/j.envint.2023.108077



Landscape redesign

- Both recent and stable measures of **subjective well-being improved** after the intervention.
- Effects were mediated by **improvements in community cohesion**.



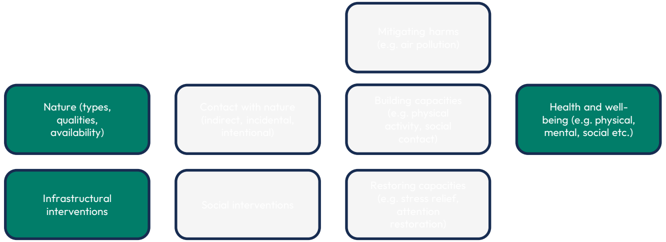
(c) Photographs showing the upper slip road and lower slip road at T1

(d) Photographs showing the lower slip road and the Intervention (open-air theatre) at T2

(e) Figure showing mapped activity points using the BBAT at Teats Hill behaviour settings during the warm period (July-September) for T1- 2017: 1881 observation points, 28 observation episodes, 56 hrs of observation time.

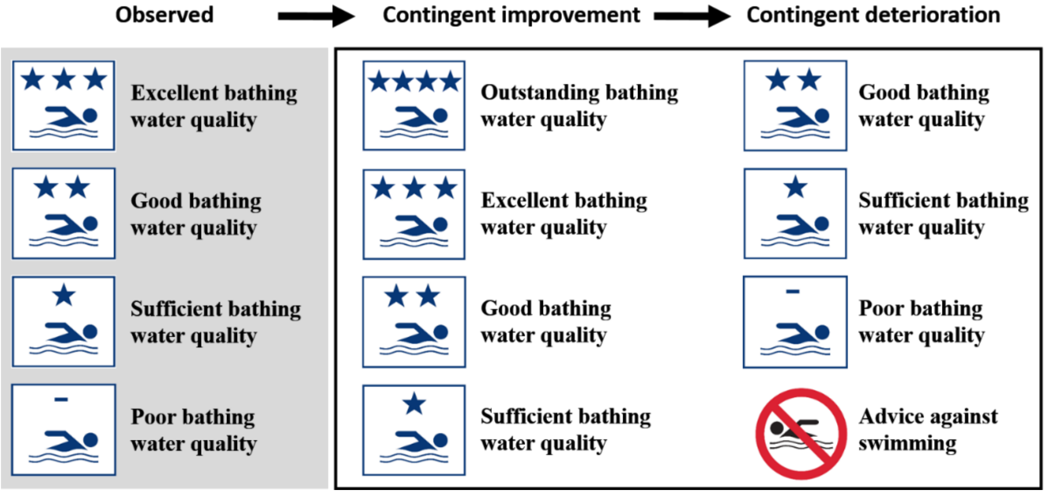
(f) Figure showing mapped activity points using the BBAT at Teats Hill behaviour settings during the warm period (July-September) for T2-2018: 2313 observation points, 29 observation episodes, 58 hrs of observation time.

Bell, S., Mishra, H. S., Elliott, L. R., Shellock, R., Vassiljev, P., Porter, M., Sydenham, Z., & White, M. P. (2020). Urban Blue Acupuncture: A Protocol for Evaluating a Complex Landscape Design Intervention to Improve Health and Wellbeing in a Coastal Community. Sustainability, 12(10), Article 10. https://doi.org/10.3390/su12104084; Mishra, H. S., Bell, S., Roberts, B. R., & White, M. P. (2023). Theory-based design for promoting positive behaviours in an urban blue space: Pre-and-post observations of a community co-created intervention in Plymouth, United Kingdom. Landscape and Urban Planning, 233, 104708. https://doi.org/10.1016/j.landurbplan.2023.104708; van den Bogerd, N., Elliott, L. R., White, M. P., Mishra, H. S., Bell, S., Porter, M., Sydenham, Z., Garrett, J. K., & Fleming, L. E. (2021). Urban blue space renovation and local resident and visitor well-being: A case study from Plymouth, UK. Landscape and Urban Planning, 215, 104232. https://doi.org/10.1016/j.landurbplan.2021.104232; Bell, S., Fleming, L. E., Grellier, J., Kuhlmann, F., Nieuwenhuijsen, M. J., & White, M. P. (Eds.). (2021). Urban Blue Spaces: Planning and Design for Water, Health and Well-Being. Routledge. https://doi.org/10.4324/9780429056161



Water quality and travel costs

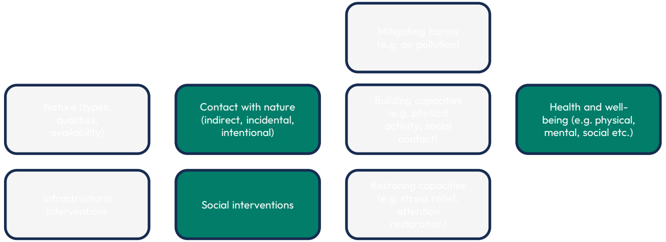
- *Increases* in water quality associated with **€41.89bn** added value
- *Decreases* in water quality associated with **€130.79bn** less value



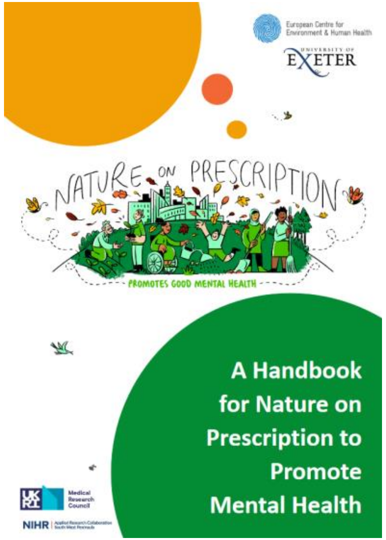
Börger, T., Campbell, D., White, M. P., Elliott, L. R., Fleming, L. E., Garrett, J. K., Hattam, C., Hynes, S., Lankia, T., & Taylor, T. (2021). The value of blue-space recreation and perceived water quality across Europe: A contingent behaviour study. Science of The Total Environment, 771, 145597. https://doi.org/10.1016/j.scitotenv.2021.145597

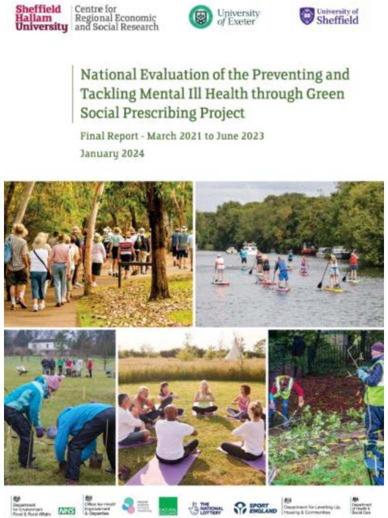
University of Exeter

European Centre for Environment & Human Health



Green social prescribing





Nature on Prescription for Mental Health: Feasibility Stage for the 'greENGAGE' Trial Stage

Tagged:

Nature, Biodiversity and Health

Fullam, D. J., Hunt, D. H., Lovell, D. R., Richards, D., Bloomfield, D. D., Warber, S., Tarrant, D. M., Jenny, D., Orr, D. N., Burns, L., & Garside, R. (2021). A Handbook for Nature on Prescription to Promote Mental Health (p. 66). University of Exeter. https://www.ecehh.org/research/nature-prescription-handbook/; Haywood, A; Dayson, C; Garside, R; Foster, A; Lovell, R; Husk, K; Holding, E; Thompson, J; Shearn, K; Hunt, H.A; Dobson, J; Harris, C; Jacques, R; Witherley, D;, Northall, P; Baumann, M; Wilson, I. (2024). National Evaluation of the Preventing and Tackling Mental Ill Health through Green Social Prescribing Project: Final Report. Department for Environment, Food and Rural Affairs (London). Retrieved 4 September 2024, from https://beyondgreenspace.net/2024/09/04/green-social-prescribing-test-and-learn-pilots-national-evaluation-final-report-published/; Resonate. (n.d.). Retrieved 30 May 2024, from https://resonate-horizon.eu/; ECEHH. (n.d.). Nature on Prescription for Mental Health: Feasibility Stage for the 'greENGAGE' Trial Stage | ECEHH. European Centre for Environment and Human Health | ECEHH. Retrieved 7 June 2024, from https://www.ecehh.org/research/7837-2/

University of Exeter

Quick links

Study - Research - For business Global - Our departments About us -

POSTGRADUATE TAUGHT

MSc Environment and Human Health

Overview | Entry requirements | Course content | Specialisms | Fees | Funding | Teaching and research | Careers

Home / Study / Postgraduate Taught home / Courses / Healthcare and Medicine / **Environment and Human Health MSc**

MSc Environment and Human Health

Duration	1 year full time 2 years part time 3 years part time	**Typical offer** View full entry requirements	2.2 Honours degree (or equivalent) in a relevant discipline
Entry year	September 2024		
Campus	Penryn Campus		
Discipline	Healthcare and Medicine		

Apply online

Select date of entry

Apply for individual modules 2024/25

Fast Track (current Exeter students)

Accreditation of prior learning (APL)

University of Exeter

"The MSc in Environment and Human Health from Exeter University has been very instrumental in setting me on the right path to achieve my aspirations. Read more"

Gameli Adzaho, MSc Environment and Human Health

Panel Discussion

University of Exeter

European Centre for Environment & Human Health

We are a world leading, transdisciplinary research and education Centre informing the future health of the planet and people. We conduct world-class research, investigating the complex interdependencies between environment and human health, influencing decision makers at local, national and international scales.

Blue Environments & Health

Climate Change

Antimicrobial Resistance & Microbiology

Nature, Biodiversity and Health

Communities and Social Inequalities

Food Systems & Planetary Health

Conny Guell, Becca Lovell, Lewis Elliott and Ben Wheeler
European Centre for Environment and Human Health
University of Exeter Medical School
r.lovell@exeter.ac.uk C.Guell@exeter.ac.uk
l.r.elliott@exeter.ac.uk
b.w.wheeler@exeter.ac.uk **www.ecehh.org**

Thank you

University of Exeter Cornwall

Collaborative Pathways:

Partnerships for sustainable leadership development

Dr Edvard Glucksman,
Senior Lecturer in Sustainable Futures,
University of Exeter Business School

Sustainable Leadership

Impactful industry partnerships for a sustainable future

Dr Edvard Glücksman

Senior Lecturer in Sustainable Futures, University of Exeter Business School
Faculty Director for Sustainability Education, Faculty of Environment, Science and Economy

1st globally for Clean Water and Sanitation **(SDG 6)**

6th globally for Life Below Water **(SDG 14)**

=7th globally for Responsible Consumption and Production **(SDG 12)**

12th globally for Climate Action **(SDG 13)**

Top 20 globally for Zero Hunger **(SDG 2)**

My role at the university

- **Senior Lecturer** in Sustainable Futures, Business School

- **Associate Director** for Student Engagement, ESI
- **Faculty Director** for Sustainability Education
- Member of the **University Senate**

- **Academic Lead**, Future17 SDG Challenge Programme
- **Programme Director**, Capgemini Sustainability Leadership Programme

PENNSKOL
GARESK
KERNOW
A'GAS
DYNNERGH

University of Exeter Cornwall

Sustainable Futures

Part of UEBS

- Technological transformation
- Environmental sustainability
- Responsible leadership

FIGURE C

Global risks ranked by severity over the short and long term

"Please estimate the likely impact (severity) of the following risks over a 2-year and 10-year period."

Risk categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

	2 years	10 years
1st	Misinformation and disinformation	Extreme weather events
2nd	Extreme weather events	Critical change to Earth systems
3rd	Societal polarization	Biodiversity loss and ecosystem collapse
4th	Cyber insecurity	Natural resource shortages
5th	Interstate armed conflict	Misinformation and disinformation
6th	Lack of economic opportunity	Adverse outcomes of AI technologies
7th	Inflation	Involuntary migration
8th	Involuntary migration	Cyber insecurity
9th	Economic downturn	Societal polarization
10th	Pollution	Pollution

Source

World Economic Forum Global Risks Perception Survey 2023-2024.

Challenge-based education

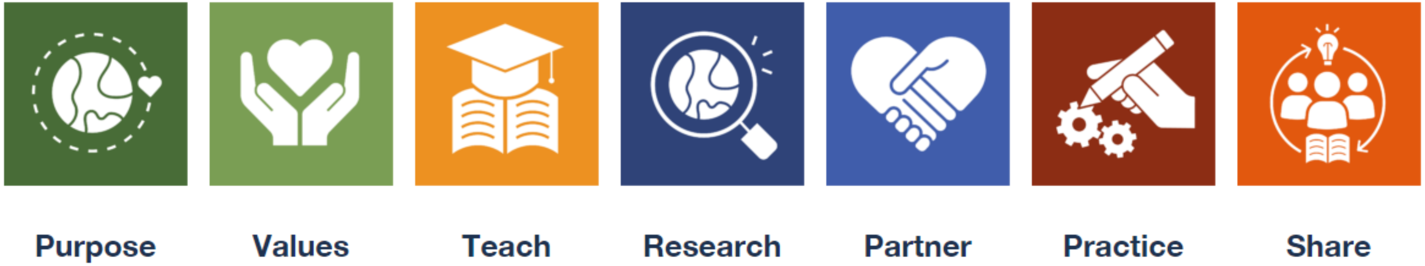
"To be responsible is to be attentive to **impact** and time. Responsible decision makers look forward and back as they live in the moment. Looking ahead, they are responsible not just to current and future generations but to all life on the planet. Looking back, they are accountable for their actions, those taken and those avoided."

University of Exeter

Risk categories

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

The Principles for Responsible Management Education



https://www.unprme.org/what-we-do/

The *Future17* SDG Challenge Programme

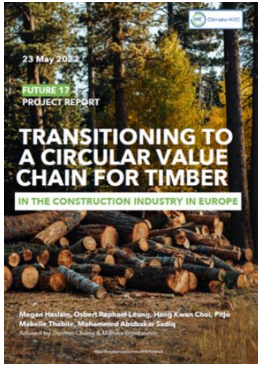
Joint founding partner. Programme development incl. new universities and project partners, employability and careers intelligence. Based globally.

Joint founding and lead academic partner. Programme management, academic support for students and mentors, and module integrity.

Network of university partners worldwide, providing students and mentors. Each has academic lead and programme manager. New partners expected soon.

Dozens of business and NGO partners based worldwide, issuing challenges relating to the UN SDGs. Engage with students, receive outputs and provide employability opportunities.

Case study 1



Partner	**Location**	**Project**	**Group composition**	**Output**
Climate KIC (The EU's main innovation pipeline)	EU	Transitioning to a circular value chain for timber in the construction industry in Europe.	*Students:* Exeter, CUHK, USP, Stellenbosch *Mentors:* Exeter, Stellenbosch	Analysis of the timber value chain and scoping to make it more circular, including developing a clear set of recommendations.

Risk categories
- Economic
- Environmental
- Geopolitical
- Societal
- Technological

FUTURE17
Sustainable Development Goals Challenge Program

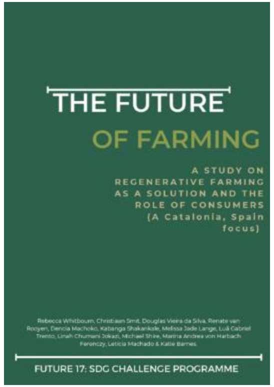
Case study 2

University of Exeter

Partner	Location	Project	Group composition	Output
Refillable (Zero-waste grocery delivery service)	India	Market research on packaging alternatives and additional business opportunities.	*Students:* Cairo, Stellenbosch, Auckland *Mentors:* Cairo, Auckland	Proposal for use of a novel, more sustainable packaging material.

Risk categories
- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Case study 3



Partner	Location	Project	Group composition	Output
Green Rebel (Regenerative agroforestry farm in Catalonia)	Spain	Regenerative farming as a solution and the role of consumers	*Students:* Exeter, Stellenbosch, USP *Mentors:* USP, Stellenbosch	Scoping paper examining feasibility of a pick-your-own farm comprising multiple crops, designed to benefit the local community.

Risk categories
- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Partnerships in sustainability: **case study in professional education**

Professional education

Faculty of Environment, Science and Economy | Faculty of Health and Life Sciences | Faculty of Humanities, Arts and Social Sciences

- Our PE addresses **specific business or industry needs**
- Clients can be **individual businesses or consortia** (e.g. Chamber of Commerce)
- **Custom-made** courses, tailored to a business or industry, **co-created** with client
- Programmes are typically **short, flexible and non-credit-bearing**
- **Delivery can be in partnership with local partners**
- Support from **across the university**, e.g. academic + Professional Services
- Academic portfolio from all **three** faculties with Business School leadership

Cutting-edge research → Day-to-day practice → Boardroom

Executive education with Capgemini

University of Exeter

Capgemini

The Sustainable Solutions Leadership Programme (SSLP)

- Co-created with Capgemini Invent UK
- 550 graduates 2022-23
- 5 cohorts over 18 months, 5 weeks each
- Blended learning: 2-hr 'fireside' masterclasses, regular live 'office hours'
- 2 marked assessments
- Certificate of completion + internal access to Champions Network
- Stepping-stone to executive-level global curriculum

Exeter-Capgemini SSLP

Learning objectives

Participants supported to:

1. **Demonstrate individual knowledge and expertise** about sustainability challenges, and how these relate to the work done by Capgemini's client organisations;
2. **Demonstrate gravitas and confidence** in describing the relationship of these issues to client problems and opportunities;
3. **Develop case studies in which emergent science**, policy and management practice is applied to specific 'real world' client situations;
4. **Build and recognise networks of practice** that allow Capgemini Invent to develop collaborative solutions to client problems and opportunities; and
5. **Build and recognise networks of capability and experience** in specific topics across the Capgemini Invent sustainability consulting practice.

Exeter-Capgemini SSLP
Overarching themes

Curriculum delivered across **five themes**:

1. Our planet as a system
2. Powering clean growth
3. Understanding and managing value
4. Interdisciplinary approaches to resilience and adaptation
5. Realities of the clean growth transition: bringing sustainability to the boardroom

Each theme is covered over a week of the **five-week course**.

Exeter-Capgemini SSLP

Course components and structure

Blended structure comprising:

1. Live masterclasses
2. Live webinars
3. Asynchronous sessions
4. Virtual office hours

Week	1	2	3	4	5
Live	Face-to-face in London	Webinar Online office hours	Online office hours	Webinar Online office hours	Face-to-face in Exeter
Asynchronous	Lectures	Lectures	Lectures	Lectures	Lectures

Exeter-Capgemini SSLP
Assessment

All participants required to complete **formative and summative assessments**

- Formative
  - Learning diary
  - Pitch presentation proposal
- Summative
  - Written piece: blog post (individual)
  - Oral piece: pitch presentation (in groups)

Assessments marked in accordance with the **University's Masters-level criteria**

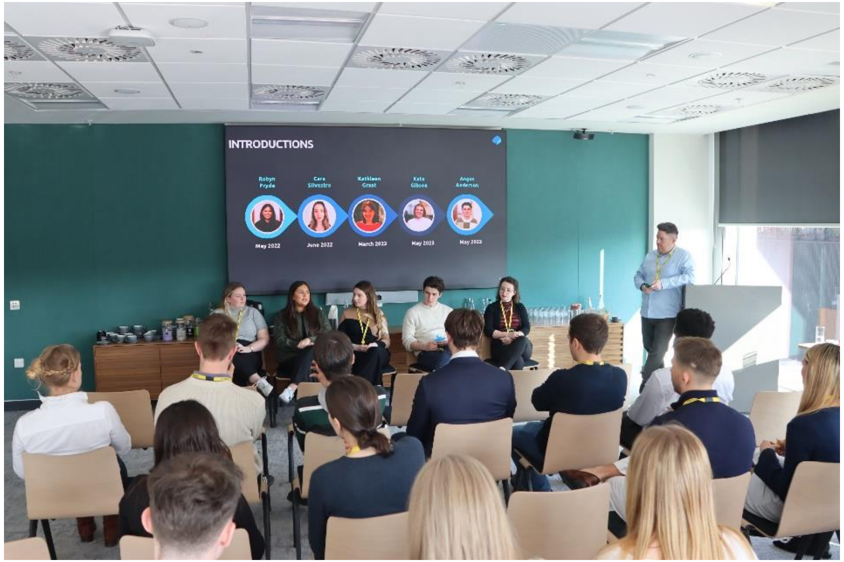
Exeter-Capgemini SSLP

Topics covered

- The latest in climate science
- Circular economy
- Systems thinking
- Positive tipping points
- Social science approaches on the path to net zero
- Climate justice and ethics
- Life-cycle analysis
- Energy futures and policy development
- Sustainable finance
- Comparative methods
- AI and data science for sustainability
- Sustainable mining
- Digital economy
- Ecosystem services and biomimicry
- Land use and natural capital
- Climate in the boardroom

Exeter-Capgemini SSLP
Origins and reflections

- Relationship developed with Capgemini Invent UK's **VP Sustainable Futures**
- Strength in **co-creation and alignment of learning outcomes to requirements**
- Steppingstone to successful partnership with **Capgemini Group's Global Upskilling team (Paris)** to deliver training to 100+ key strategic account holders worldwide
- Collaboration has since **extended into education**
- Informs several **additional professional education opportunities**
- **Courtney Holm** now affiliated with the University



Exeter-Capgemini SSLP
Direct contributions and benefits

- **Translation** of high-impact research to client-facing industry practitioners and corporate leaders
- New **internal collaborative pipelines** across faculties and service areas
- Academic team benefitted from **novel experience and partnership opportunities**
- Clear benefits for Capgemini: sustainability leadership and Champions Network, **substantial uptick in sustainability-related sales**

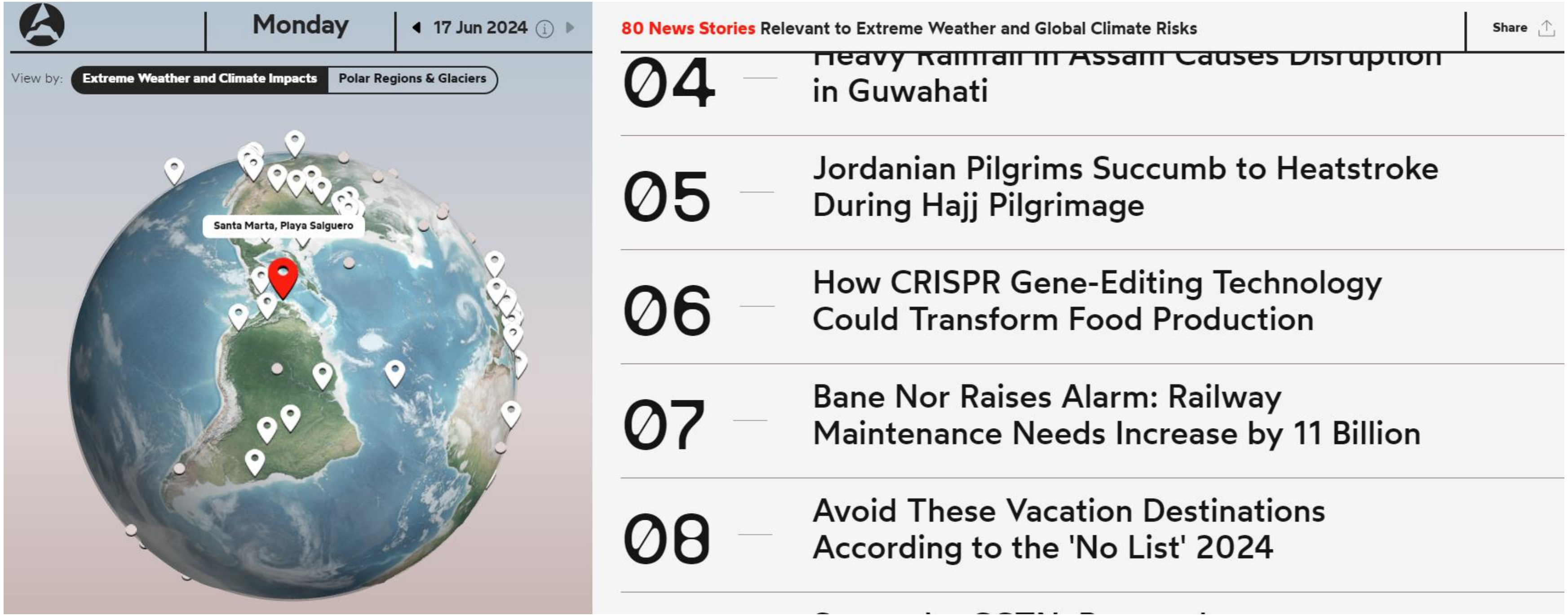
Final thoughts

Embed sustainability ‘by default’

University of Exeter

Harness technology 'for good'

University of Exeter



https://ai.globalclimaterisks.org/

Adopt skills-first best practices

KNOWLEDGE

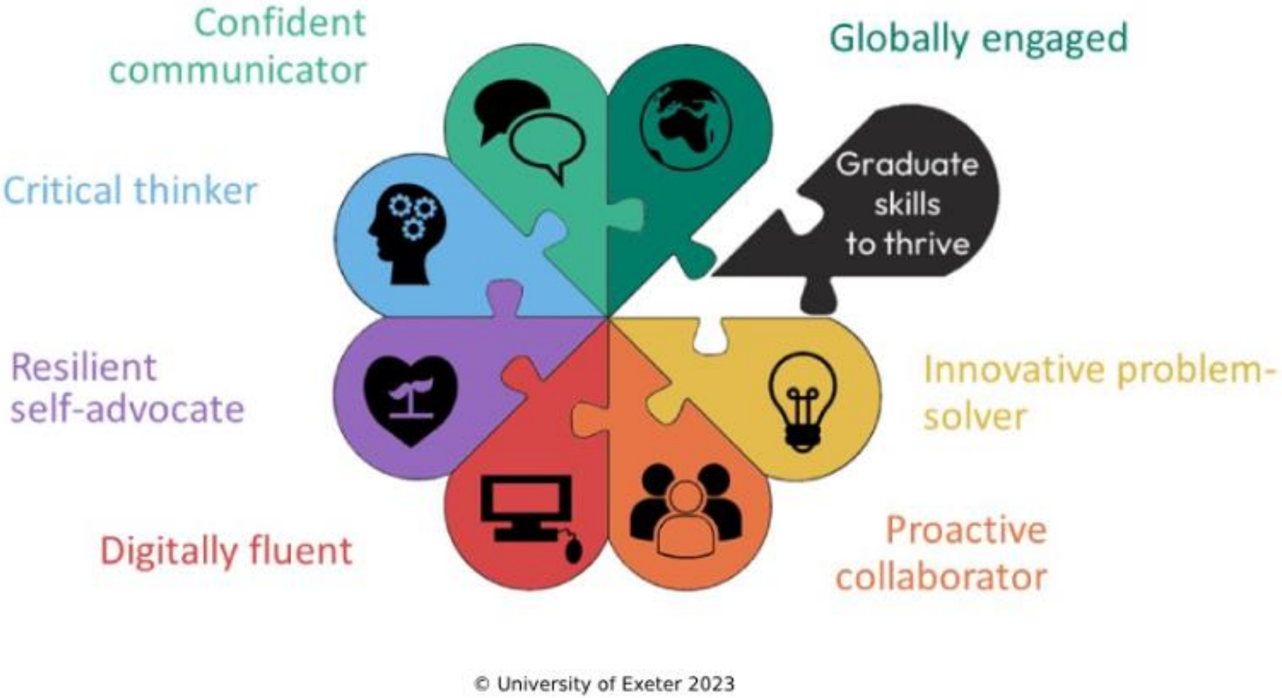
Learning

SKILLS

Doing

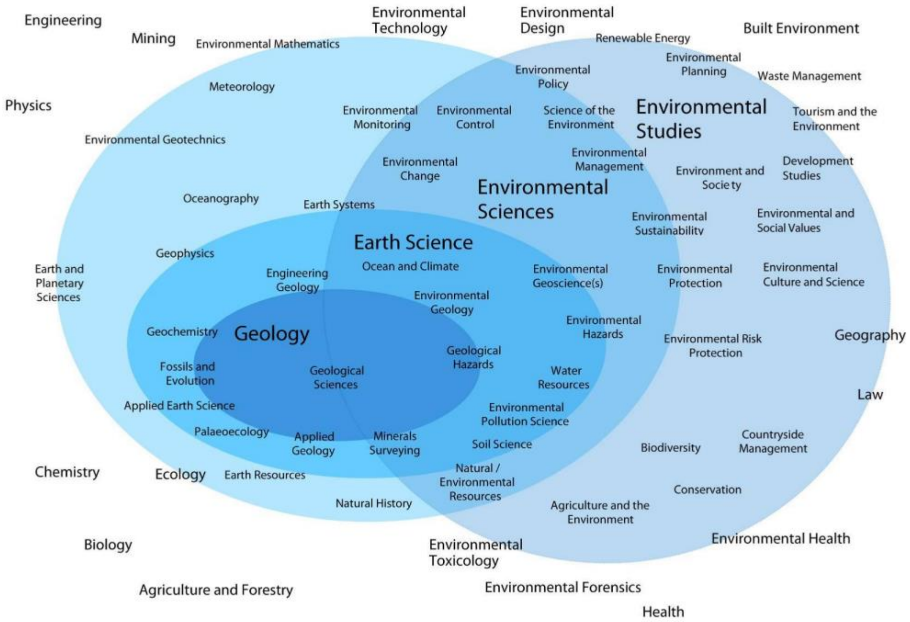
BEHAVIOUR

Being

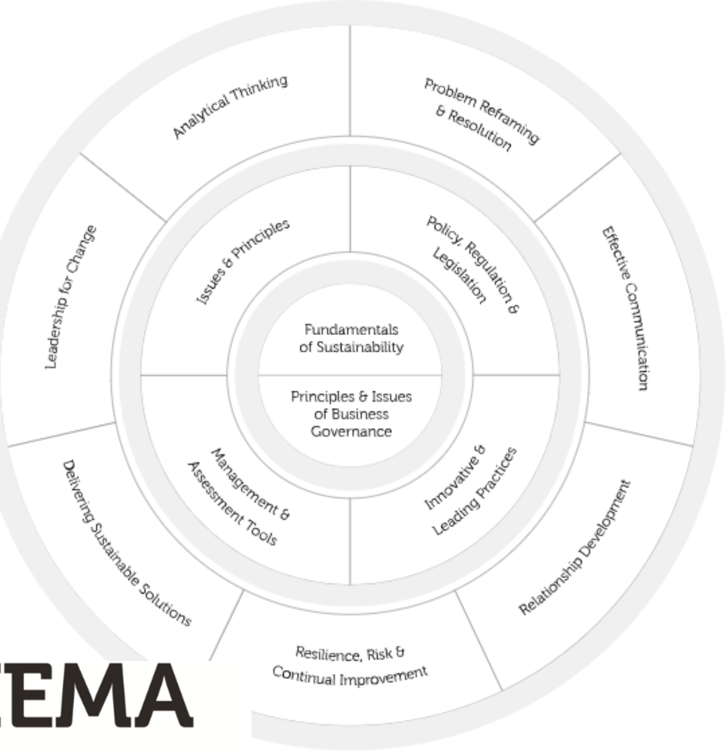


Embrace professional development

University of Exeter



The institution of environmental sciences



IEMA
Transforming the world to sustainability

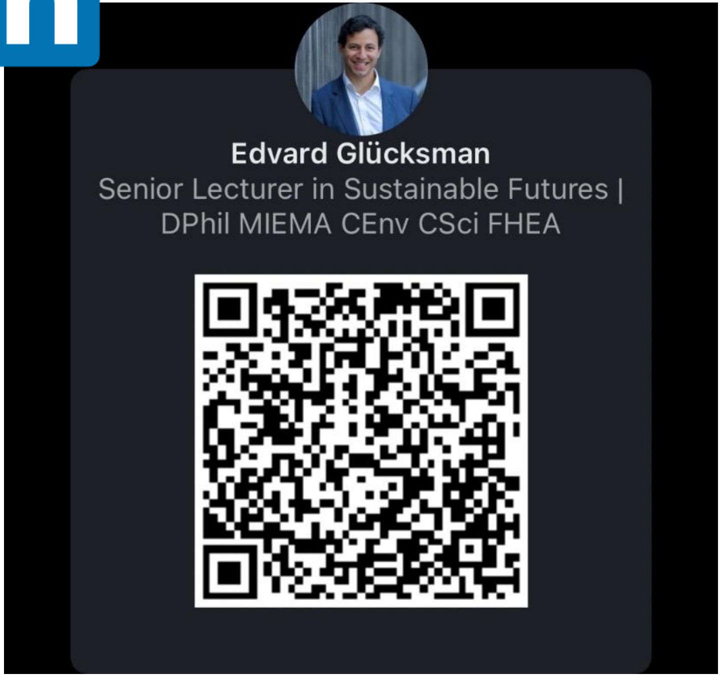
Revised Subject Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (ES3) 2006

https://www.iema.net/sustainability-skills-map

Contact details:

Dr Edvard Glücksman
Senior Lecturer in Sustainable Futures
University of Exeter Business School

e.glucksman@exeter.ac.uk



University of Exeter

SUSTAINABLE SOLUTIONS LEADERSHIP DEVELOPMENT PROGRAMME

Capgemini

UNIVERSITY OF EXETER

BREAK

University of Exeter Cornwall

13 CLIMATE ACTION

7 AFFORDABLE AND CLEAN ENERGY

14 LIFE BELOW WATER

3 GOOD HEALTH AND WELL-BEING

17 PARTNERSHIPS FOR THE GOALS

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

University of Exeter Cornwall

Planet and People:
Advancing social and environmental justice

Dr Tiago de Melo Cartaxo,
Senior Lecturer in Environmental Law,
Humanities and Social Sciences
Cornwall

University of Exeter Cornwall

Planet and People

Advancing social and environmental justice

Dr Karen Scott, Politics
Dr Emma Kluge, Humanities
Dr Tiago de Melo Cartaxo, Law

Humanities and Social Sciences, Cornwall

Planet and People: Advancing social and environmental justice

University *of* Exeter
Cornwall

Humanities and Social Sciences, Cornwall

Societies, Culture and Justice in the Past, Present and Future

An interdisciplinary endeavour that interweaves insights from the disciplines of History, Law, Politics, Modern Languages and Literature

Teaching, Research & Impact

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Humanities and Social Sciences, Cornwall

Themed Research Clusters

- Environmental Justice
- Memory, Heritage & Identity
- Voice, Participation & Governance
- Decolonising Knowledges Collective

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Politics

Politics in Cornwall is characterised by its focus on some of the biggest political challenges facing the world today such as inequality, climate change, the global financial crisis, conflict, and the depletion of natural resources, public disillusionment with politics, and the changing balance in world power.

Understanding power and challenging injustice are our central concerns and the main lenses through which we analyse/teach.

POC3095 Environmental Knowledge Controversies – Just Stop Oil actions 2023
Prof. Clare Saunders – expert in Social Movements and Environmental Activism

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Politics – example of modules:

POC1026 Power, Inequality and Global Justice
POC1033 Political Communication
POC1014 Public Policy Process
POC2103 Introduction to Postcolonialism
POC2114 Green Politics in Theory and Practice
POC2128 Political Geographies: Global - Local
POC2131 Political Economy
POC3097 Gender and Politics in Africa
POC3095 Global Sustainability Challenges
POC3154 Environment and Conflict in the ME
POC3103 The Resource Paradox
(SDG mapping)

Planet and People: Advancing social and environmental justice

Politics - Research

Social movements and environmental activism
The politics of water quality in Asia
Politics of measuring wellbeing and sustainability
Female political participation in Africa
Migration and conflict in Middle East
The rise of Authoritarianism
Reproductive Rights
More-Than-Human politics
Skills gaps in Cornwall
People and Mining

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Politics

POC3103 Resource Paradox
Dr Deborah Johnson

This research led module looks at the politics of mining. Links with Deborah's research in global conflict studies. SDG mapping exercise.

People and Mining Network at CSM

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Humanities

BA Environmental Humanities: global interdisciplinary & transdisciplinary field of study with sustainability at its core

BA History: teaching the histories of the modern world from British and European to the Americas and the Pacific (joint degrees: with politics; with business; with geography; with international relations).

Both programmes critically engage with the intractable global challenges that we face

Planet and People: Advancing social and environmental justice

University *of* Exeter Cornwall

Example of modules:

HIC1610: An Introduction to the histories of science and the environment
HIC1605: European History: Politics and Society
HIC1611: Global History: Twentieth Century Transformations
HUM1005: Climate Emergency: An Introduction to the Environmental Humanities
HIC1010: Foundations of Environmental Humanities

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HIC2037: Earth Matters: Soil, Society and the Humanities
HIC2038: Caribbean Histories: Colonialism, Resistance and Environmental Crisis
HIC2009: Ecology and Empire
HIC3009: Pacific Histories: Environment, People and Politics
HIC3008: New American Century: History, Culture, and Crisis
HUC3048: Writing Nature

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University of Exeter Cornwall

Humanities: Research

climate change and environmental justice
place and identity
conflict and violence
democracy and authoritarianism
and science and technology
disaster studies / Disaster risk reduction

The Centre for Environmental Arts and Humanities

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Law

- LLB in Law with Business (& BBL in Business with Laws)
- Teaching UG modules cross-discipline: teaching Law for Sustainable Development
- Exeter Centre for Environmental Law
- Engaging with the Local Community, Nationally and Internationally

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Law: Teaching for SDGs

- LAW1016C A Legal Foundation for Environmental Protection
- LAW2016C Environmental Regulation and Redress
- LAW3301C Law and Policy for Sustainable Organisations

PG modules in the future

Planet and People: Advancing social and environmental justice

University *of* Exeter Cornwall

Law: Research

Exeter Centre for Environmental Law (ExCEL)

- Making Cornwall and the Isles of Scilly a UNESCO Biosphere Reserve? (RE/PSF)
- Effectiveness of Environmental Compliance Regimes in Cornwall and the Isles of Scilly (RE/OIP + Cornwall Council & CIoSLNP)
- Environmental Justice Cafés (monthly)

Planet and People: Advancing social and environmental justice

University of Exeter Cornwall

Law: Engagement

Exeter Centre for Environmental Law (ExCEL)

- Earth Law Center (2023)
- UNESCO Biosphere activities (2023)
- Ecocide Workshop (2024)
- Green Finance & Nature Markets Roundtable (2024)

Planet and People: Advancing social and environmental justice

University *of* Exeter
Cornwall

Thank you!
Meur ras!

University *of* Exeter
Cornwall

CELEBRATING 20 YEARS
Penryn Campus
2004-2024

Thank you

SUSTAINABLE DEVELOPMENT GOALS