29 April 2025 Session ITS4.15/NH13.8 EGU25-13681 8.45 a.m., PICO spot 3
EGU General Assembly 2025

Earth, Wind, and Fire – plus Water: From strategic knowledge to intelligence for humans

#Geosciences
#ResearchMatters
#ResearchMakesTheWorldGoRound

-1.
The 2-minute introduction

EARTH	WIND		FIRE	WATER
Geosphere	Biosphere		Energy	Hydrosphere
Lithosphere	*Atmosphere*		*Strategy*	*Cryosphere*
Resources	*CO_2, CH_4...*		*Storage*	*Permafrost*
|	|		|	|
Solid Earth	Climate		Sources	Flooding
Hazards	Scenarios		Supply	Drought

...well, some of the fundamental Earth-related components of

HUMAN LIFE

making up just a (significant) bit across our own living experience...

Umberto Fracassi umberto.fracassi@ingv.it
Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy
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I. Davenport (2017), "Giardini colourfall", 57° Biennale d'arte di Venezia. © Pierluigi Palazzi - Shutterstock.com

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Do you remember ?

Do you know anybody more suited than the EW&F?

Everyone on Earth *loves* them – just as everyone supposedly loves these fundamental components of life on planet Earth. Yet, how much do humans really *care* for such irreplaceable elements – and the resources they involve?

How we concretely safeguard the biosphere, our own living environment, implies coming to terms with our binding contract of living on planet Earth.

Life is not boundless or endless; it can be fantastic, but not always, or not everywhere – or not for everyone. The EW&F would say it can't always be *the first of September*. But human resources – intelligence above all – can do *magic*.

Take a ride in the sky, In a land called fantasy ?

Living on planet Earth is such a lucky combination – just the *right* atmosphere, climate, resources. But… just like the dose makes poison and cure, our precious physical reality holds hazards and complexities requiring hindsight and insight.

Contemporary and prospective poly-crises powerfully demand that care for human life, fragile *and* enduring, enters center stage, drawing from experience across risks, environmental safety, and constructive intelligence to build our future.

So, *take a ride in the sk*... No, really, on Earth, across and within

umberto.fracassi@ingv.it

Earth, Wind & Fire (1978), "Fantasy", © ARC / Columbia

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0. The PICO presentation

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29 April 2025 | Session ITS4.15/NH13.8 | EGU25-13681 | 9.00 a.m., screen PICO 3.5 | EGU General Assembly 2025

HISTORY → **HAZARDS** → **KNOWLEDGE**

PATTERNS EVENTS | **EFFECTS RISKS** | **CROSS-DISCIPLINE INSIGHT**

G E O P H Y S I C A L S P A C E & T I M E C O N T E X T

EARTH
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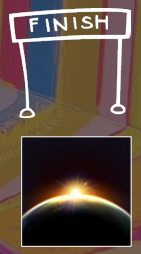
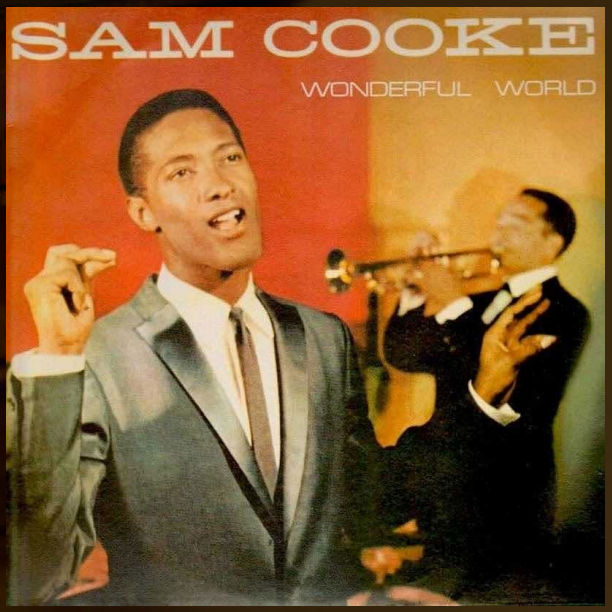
O F O U R C L O S E - R A N G E E N V I R O N M E N T

ACCEPTANCE UNCERTAINTIES | **SAFETY STRATEGY** | **FUTURES EARTHSHOTS**

COMPLEXITY → **INTELLIGENCE** → **OUTLOOK**





I.

Don’t know much about history? Then..

Don’t know much about geography either...

S. Cooke (1960), “Wonderful World”, © A&M

As time goes by, it's just history repeating
Or is it ?

The XXIth century set off quite steeply and it doesn't look very compromising either. Back in the good ol' days, things were so much easier, simpler, *better*. But was this *really* the case?

The XXth began with *la Belle Epoque* – then a couple of things went *far* less nicely. But we got prosperity out of it – though not really for everyone. The XIXth: awful wars and great inventions. The XVIIIth: Enlightenment and revolutions, Newton, Kant, Voltaire. The XVIIth: Galileo and the Inquisition. The XVIth: the Reinassance, Leonardo, Luther's reform.

The XVth: Humanisms, great discoveries – and slavery. The XIVth: the Black Death and banks. The XIIIth: the cornerstones of Europe, universities, Dante – and so on. Not one time on Earth was all serene or all ominous; all was and is complex and intriguing, fatiguing and rewarding.

From the Black Death to the Renaissance

Some workers (e.g., Brooke, 2020; Kline Cohn & O'Brien, 2021; Syprou et al., 2022) have also postulated that the human devastation caused by the 1300s pandemics in Europe may have favoured the onset of Humanism in the 1400s.

Although indirectly and in a spatially discontinuous pattern, this is thought to have ultimately paved the way for the Renaissance in the 1500s – with all its grandiose repercussions we all celebrate (from print to telescopes...). Unthinkable as it might sound, it may not.

Human life requires lifelines, supplies, workforce, etc. As Brooke (2020) recalls, by the end of the 1400s, new discovery routes were being traced to pursue resources, leading to 'globalization' – and to further pandemics at the expense of "conquered" populations.

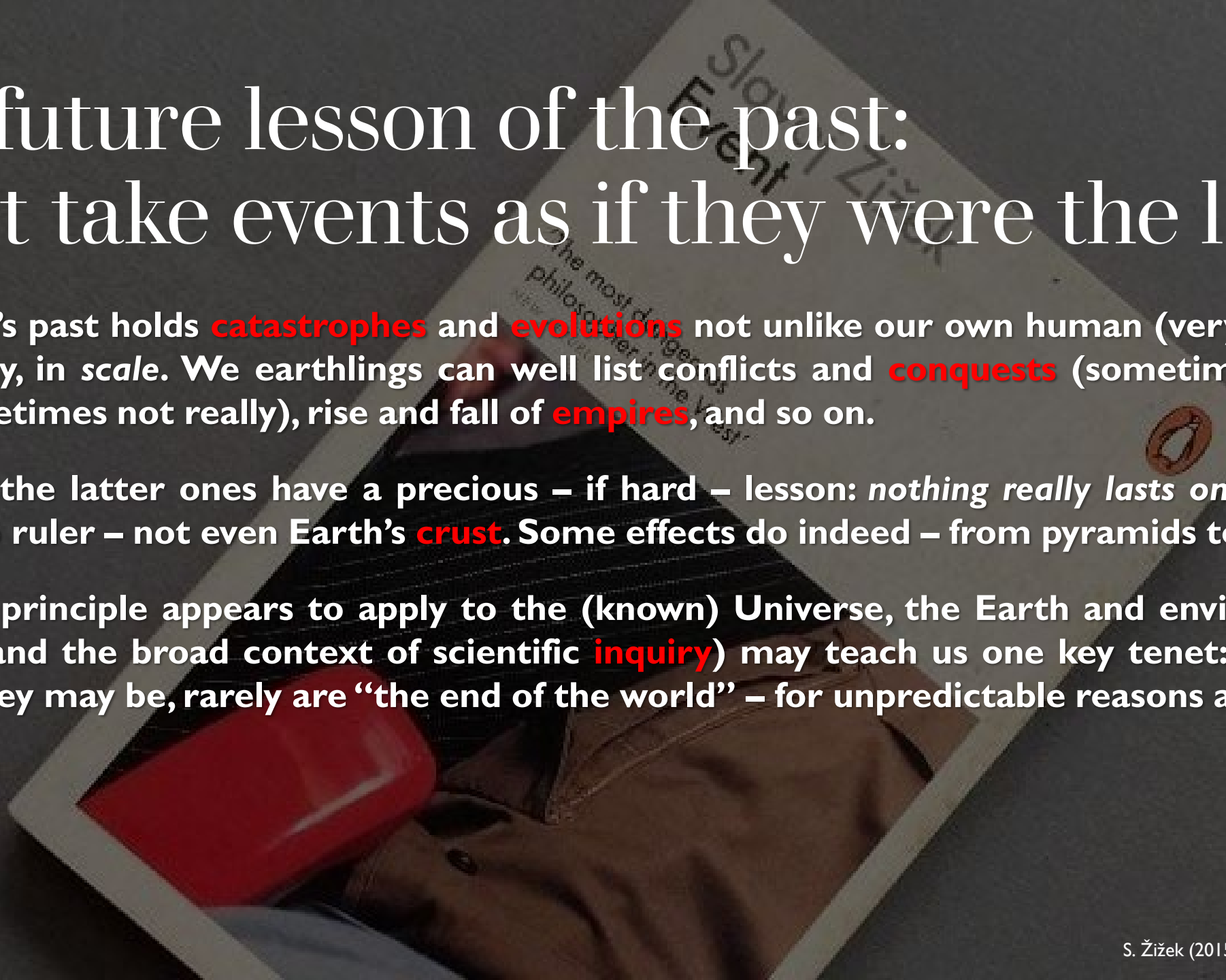
Pieter Bruegel the Elder (1562), "The Triumpf of Death" – Museo del Prado, Madrid

The future lesson of the past: Don't take events as if they were the last

The Earth's past holds catastrophes and evolutions not unlike our own human (very recently) does – only, in *scale*. We earthlings can well list conflicts and conquests (sometimes for the good, sometimes not really), rise and fall of empires, and so on.

Especially the latter ones have a precious – if hard – lesson: *nothing really lasts on Earth*. No empire, no ruler – not even Earth's crust. Some effects do indeed – from pyramids to cultures.

Since this principle appears to apply to the (known) Universe, the Earth and environmental sciences (and the broad context of scientific inquiry) may teach us one key tenet: Events, as large as they may be, rarely are "the end of the world" – for unpredictable reasons and ways.



S. Žižek (2015), "Event" © Penguin

A brief history of the world – as seen by someone extraordinary

"It is the difference between a paradigm and an unassailable theory, with the latter usually being clean and easily understood, rather than a complex paradigm that tends to have a shelf life of *only a few decades*."

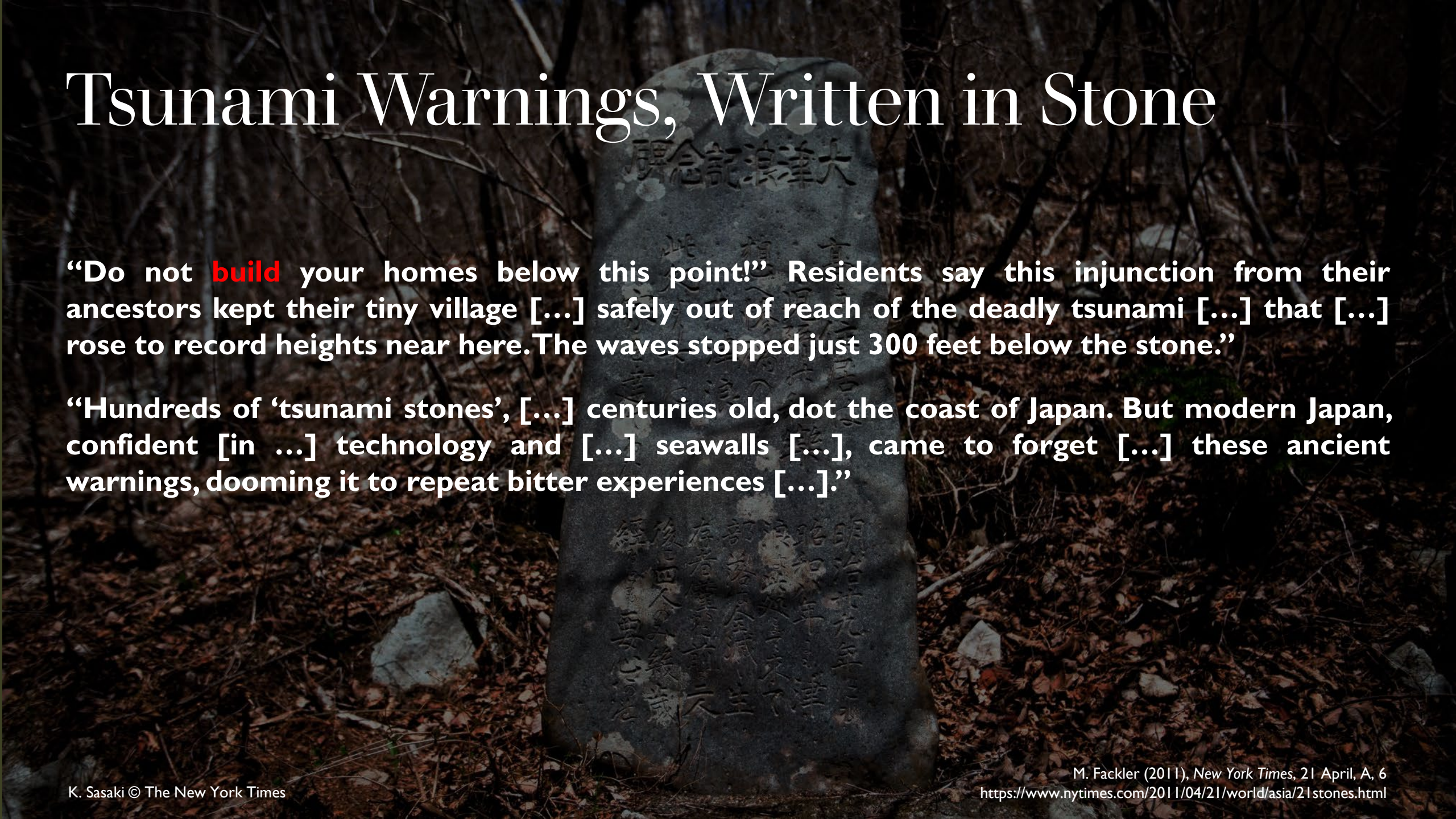
(Prof. J. Syvitski, 2022 – email conversation)

"His fame lasts perhaps two thousand years. And what are two thousands years? What, indeed, if you look from the mountaintop down the long wastes of the ages? The very stone one kicks with one's boots will outlast Shakespeare."

(V. Woolf, 1927 – "To the lighthouse", Hogarth Press)

J.B. Vrient (1596), "Orbis Terrae Compendiosa Descriptio", Antwerp – The Barry Lawrence Ruderman Map Collection

Tsunami Warnings, Written in Stone



"Do not build your homes below this point!" Residents say this injunction from their ancestors kept their tiny village […] safely out of reach of the deadly tsunami […] that […] rose to record heights near here. The waves stopped just 300 feet below the stone."

"Hundreds of 'tsunami stones', […] centuries old, dot the coast of Japan. But modern Japan, confident [in …] technology and […] seawalls […], came to forget […] these ancient warnings, dooming it to repeat bitter experiences […]."

K. Sasaki © The New York Times

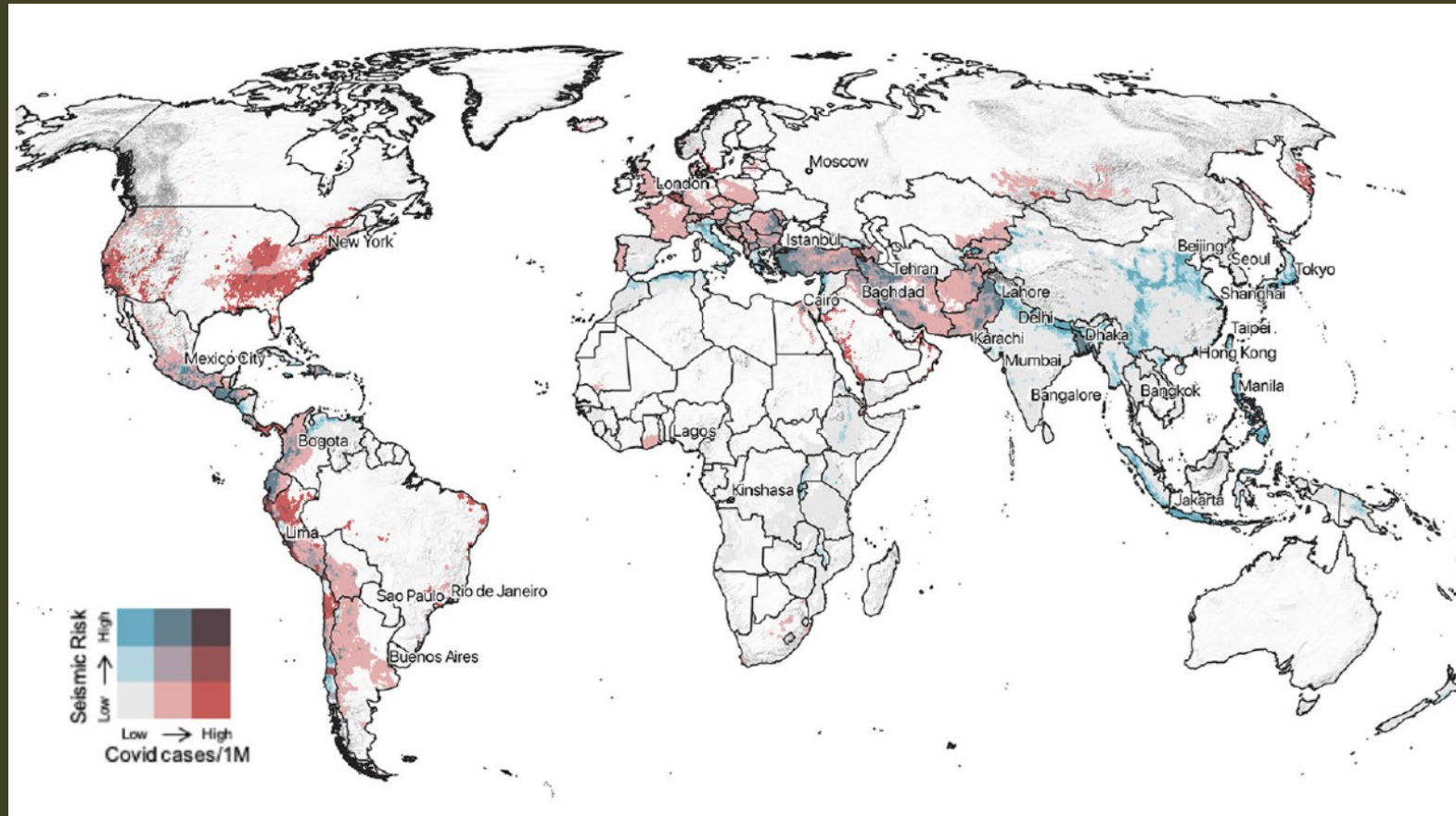
M. Fackler (2011), *New York Times*, 21 April, A, 6
https://www.nytimes.com/2011/04/21/world/asia/21stones.html

2.

Hazards (of all sorts) mingle with our own environment – *including us*

Potential impact of earthquakes during the 2020 COVID-19 pandemic

"Some large urban centers with both high prevalence of COVID-19 cases and earthquake risk include Istanbul, the Po Valley in Italy, Greater Lisbon, the San Francisco Bay Area, Greater Los Angeles, Tehran, Santiago, Lima, Santo Domingo, Panama City, Quito, and Tokyo."

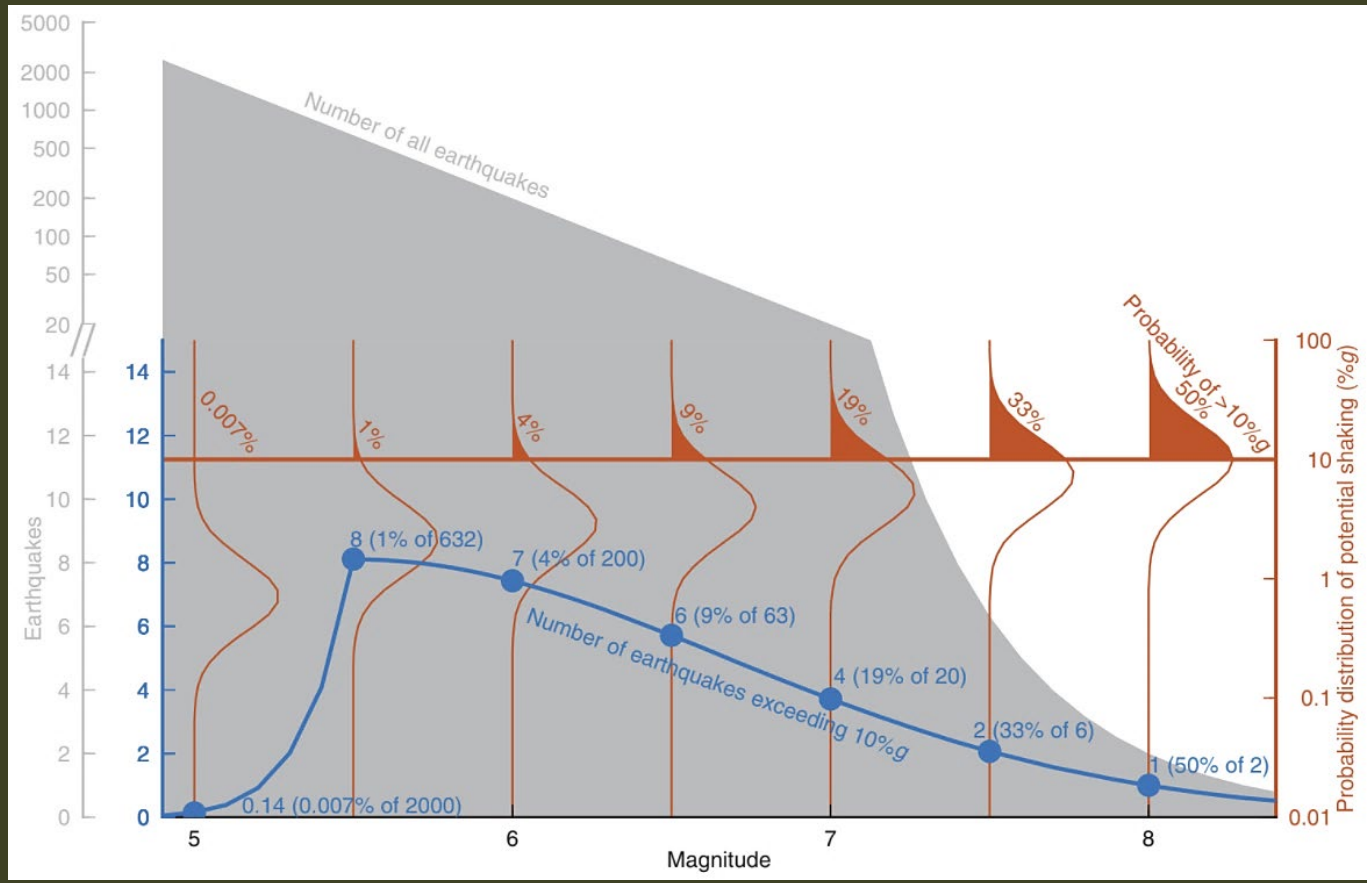


Silva & Paul (2020), *Earthquake Spectra*, 101, https://doi.org/10.1177/8755293020950328

Shaking is Almost Always a Surprise:

"**Fatalism** occurs when the information appears so **overwhelming** that a person interprets that nothing can be done."

"If we **include** the concept that **smaller** earthquakes are more frequent yet damaging but can be **mitigated**, [more] people take **preparedness** actions."



Minson *et al.* (2020), *SRL*, 92, https://doi.org/10.1785/0220200165

The rising tide: assessing the risks of climate change and human settlements

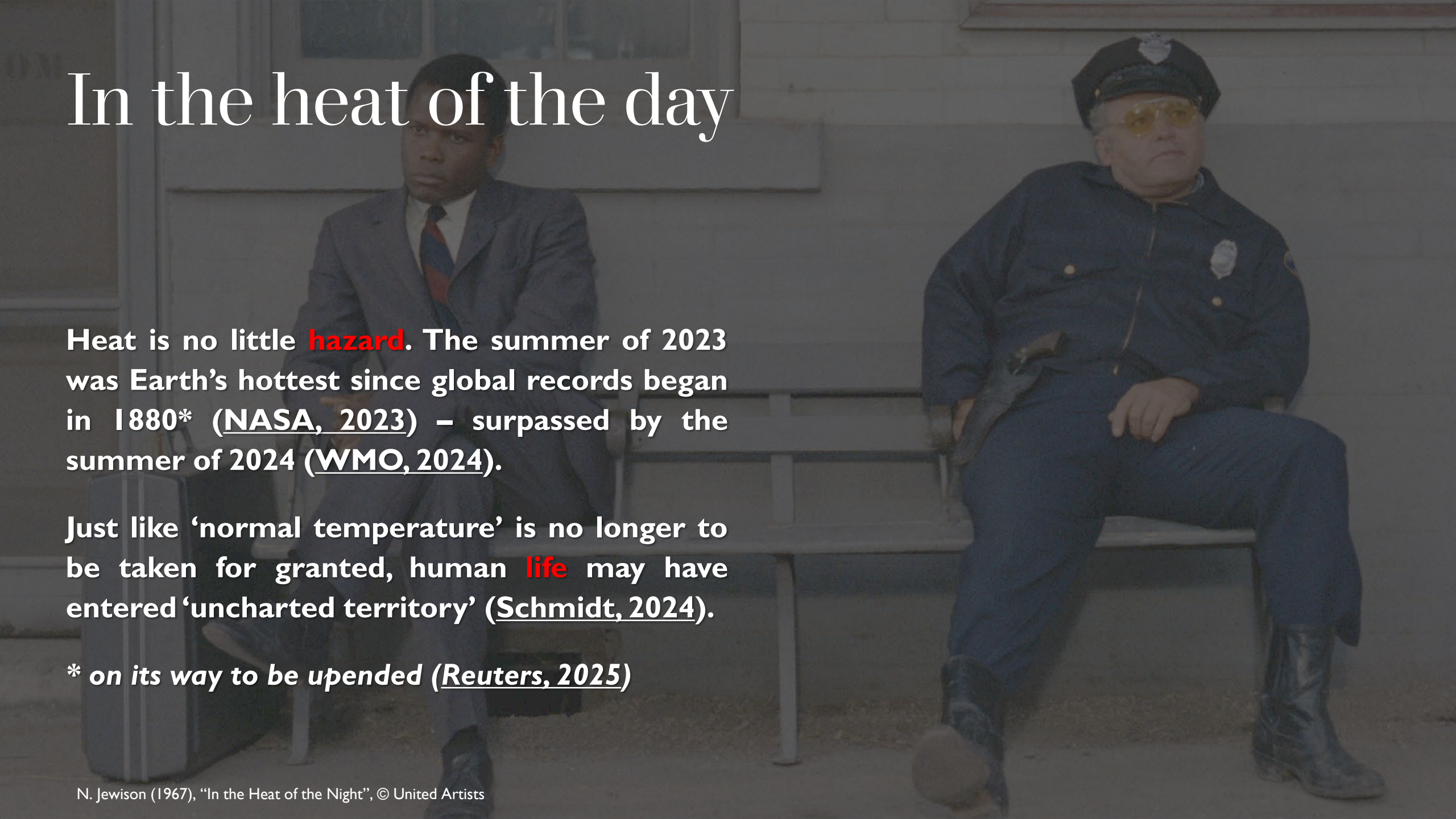
The area of sea under jurisdiction of EU States is larger than the total land area of the EU. The EU has the world's largest maritime territory (EEA, 2015, EU WISE).

The EU coastline is 68 000 km long – more than three times longer than that of the USA and almost twice that of Russia (EEA, 2015, EU WISE).

Almost half of the EU population lives < 50 km from the sea, primarily in urban areas along the coast in low-elevation coastal zones. In 2011, 206 million people (41 % EU population) lived in Europe's coastal regions (EEA, 2015, Eurostat).

McGranahan *et al.* (2007), *Environm. & Urbanis.*, 19, https://doi.org/10.1177/0956247807076960

In the heat of the day



Heat is no little hazard. The summer of 2023 was Earth's hottest since global records began in 1880* (NASA, 2023) – surpassed by the summer of 2024 (WMO, 2024).

Just like 'normal temperature' is no longer to be taken for granted, human life may have entered 'uncharted territory' (Schmidt, 2024).

**** on its way to be upended (Reuters, 2025)***

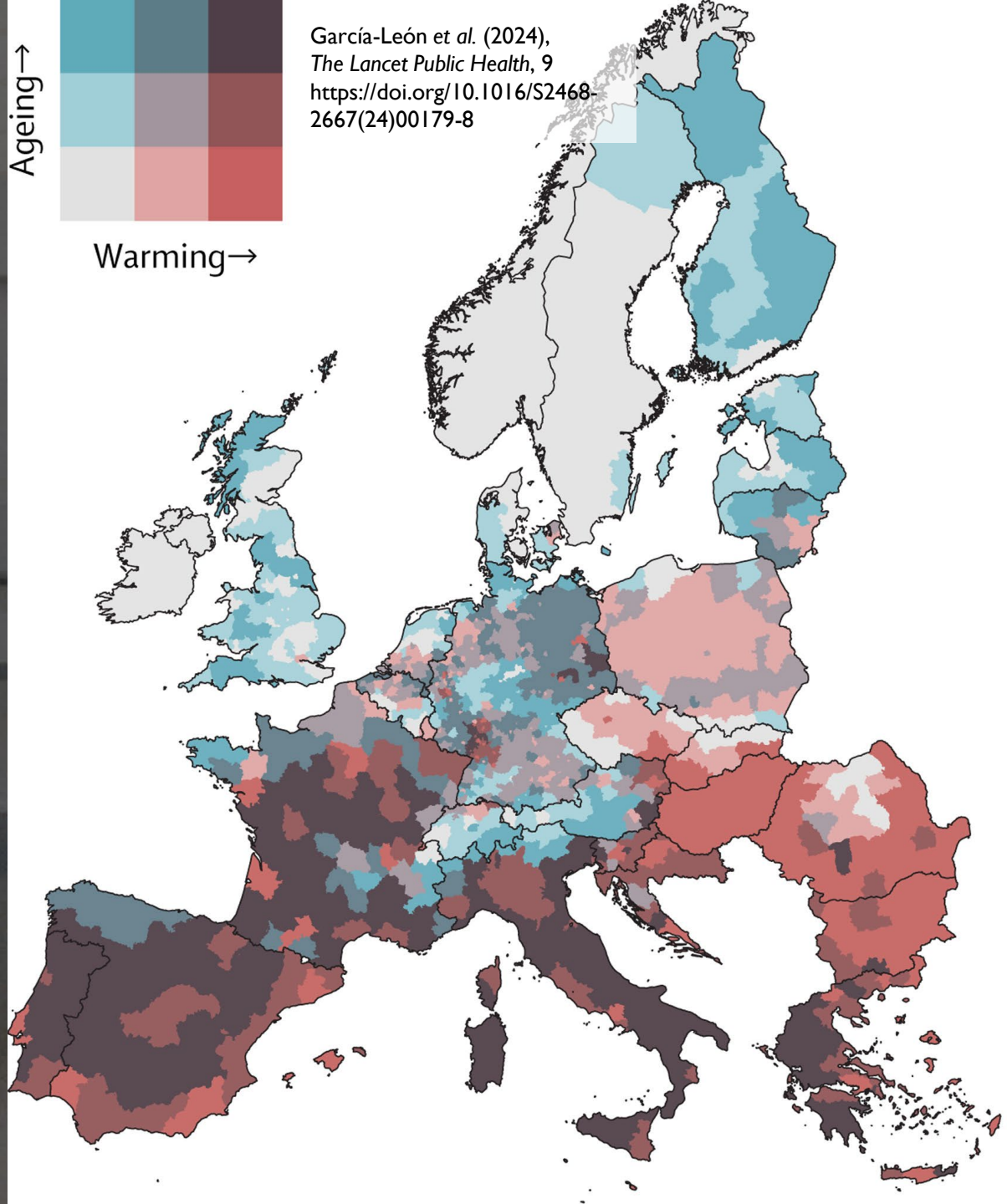
N. Jewison (1967), "In the Heat of the Night", © United Artists

In the heat of the day

"Regional disparities in temperature-related mortality risk in Europe are **substantial** and will continue to **increase** due to the effects of **climate** change and an ageing **population**."

"In the projected areas of heightened risk, policy intervention for **building** adaptation and enhancing **resilience** should be prioritised."

N. Jewison (1967), "In the Heat of the Night", © United Artists

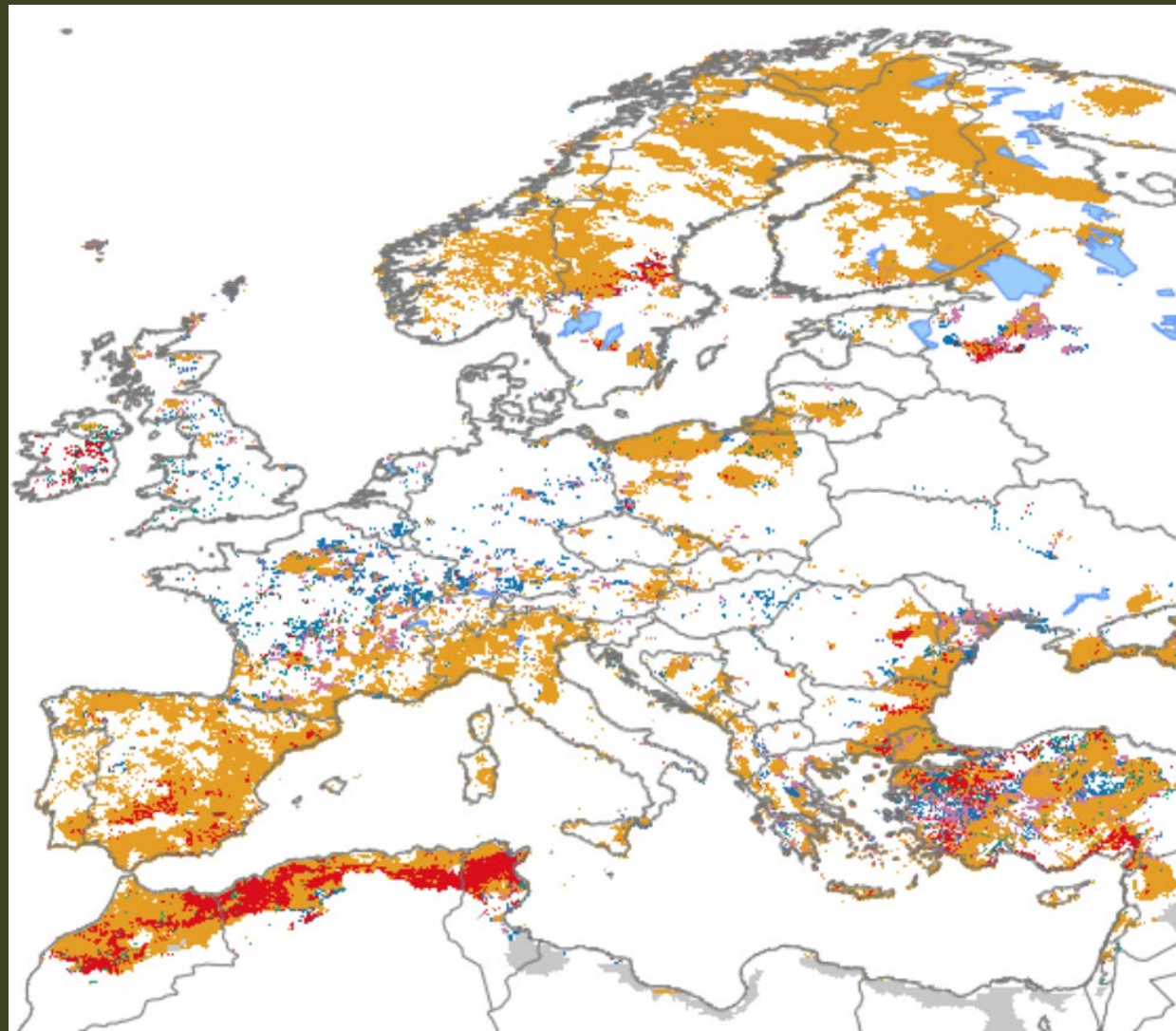


García-León *et al.* (2024), *The Lancet Public Health*, 9 https://doi.org/10.1016/S2468-2667(24)00179-8

Europe's next crisis: Water

"Satellite data confirmed that Europe has suffered from severe drought since 2018. Rising temperatures are making it difficult to recover, exposing the Continent to a dangerous cycle."

"Governments are now scrambling to address both current and future shortages – while managing the tensions arising from growing competition over water."

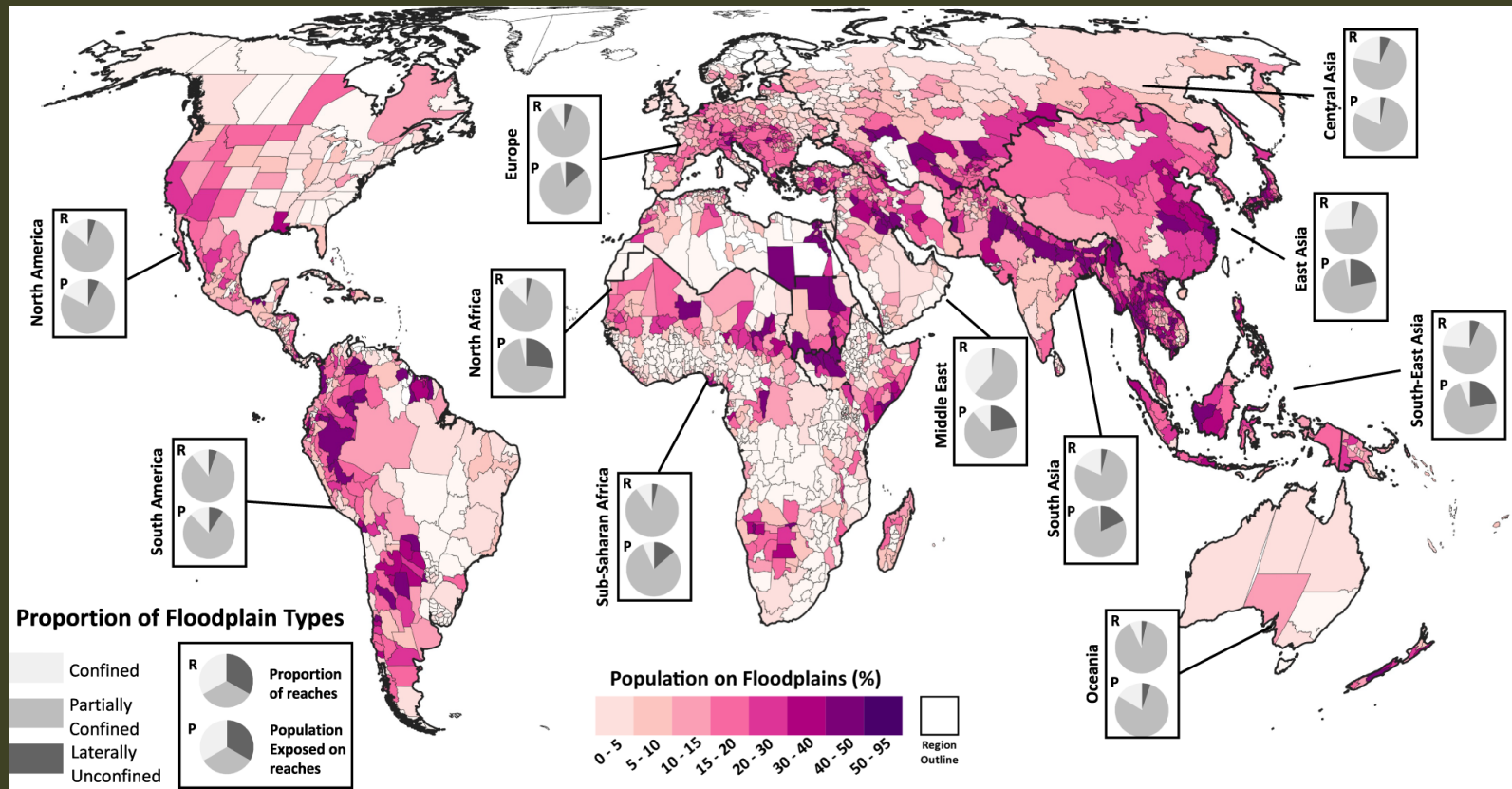


Weise & Zimmermann (2023), *POLITICO*, 407, https://www.politico.eu/article/europe-next-crisis-water-drought-climate-change/

Flood hazard potential reveals global floodplain settlement patterns

"**Floodplains** most sensitive to frequent, low magnitude events suggest that people have **adapted** to this risk."

"In contrast, floodplains subject to **extreme**, rare events tend to be most **densely** settled, being exposed to hazard potentially **rising** due to climate change."

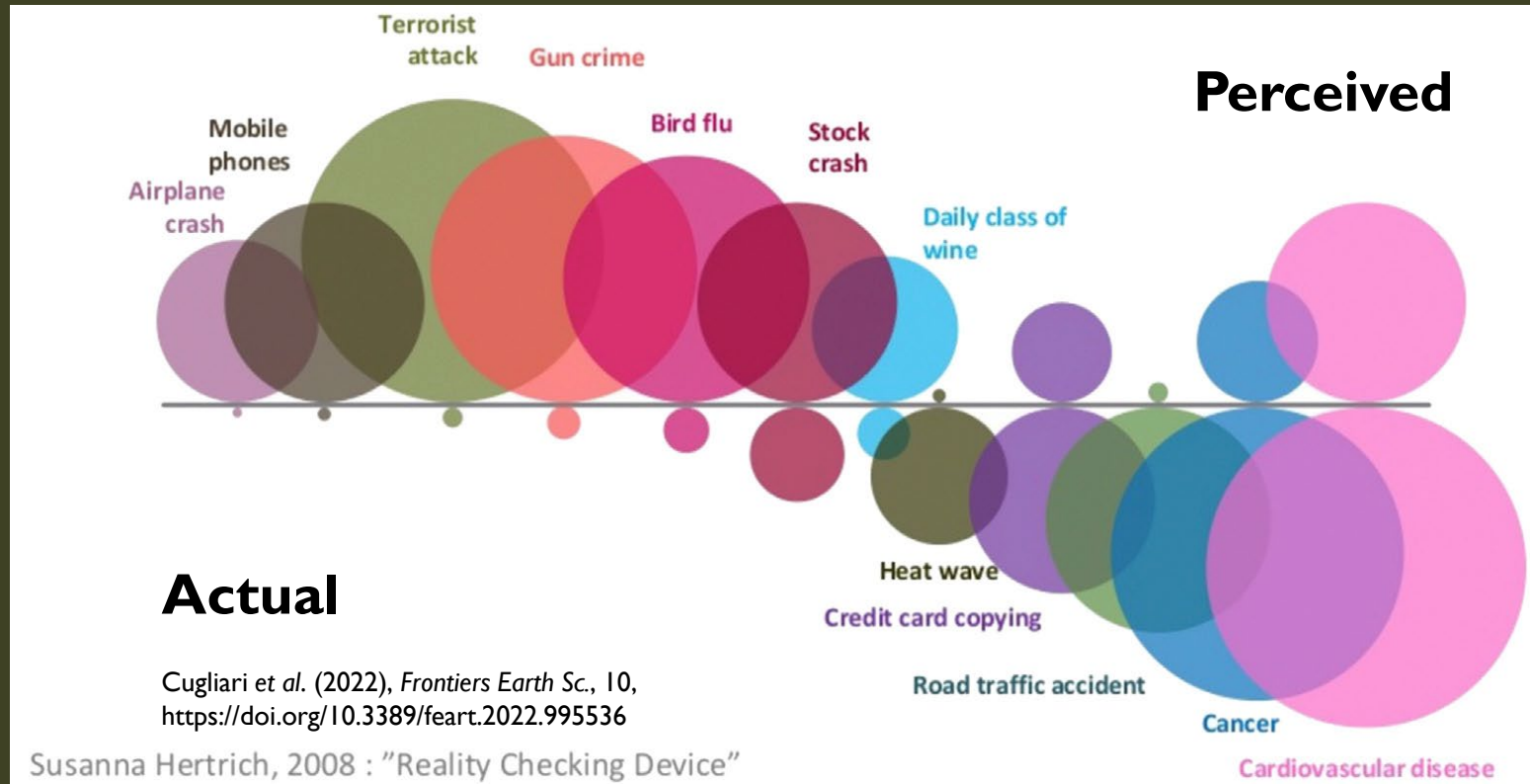


Devitt et al. (2023), *Nature Communications*, 14, https://doi.org/10.1038/s41467-023-38297-9

Shapes of risks to come

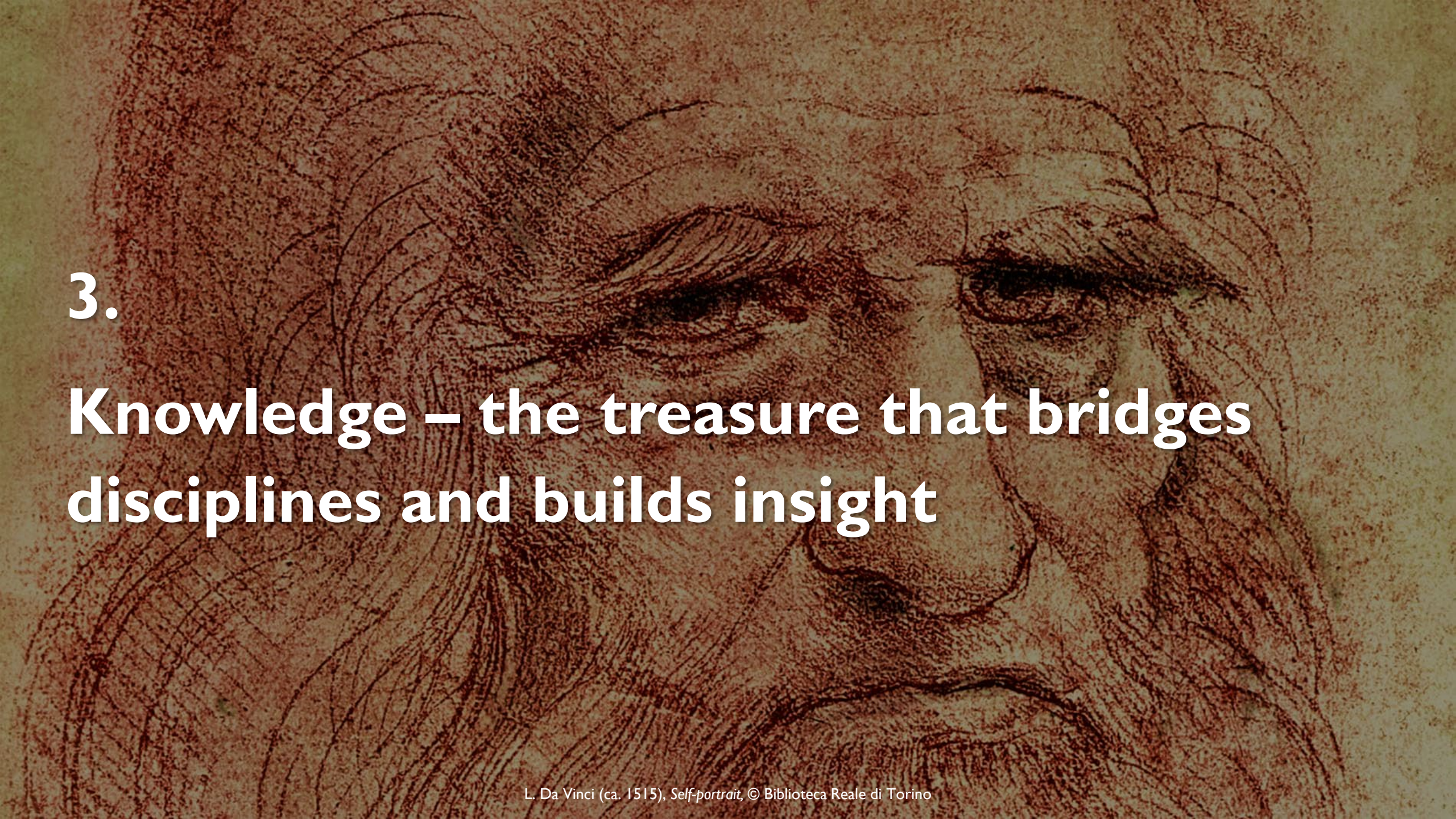
"Individual risk elaboration depends on social models, context, and media. While some risks with high probabilities and strong impact tend to be downplayed or neglected, other risks with minor consequences may trigger strong public concerns and severe social impacts."

"Risk perception studies highlight psychological conditions and sociocultural processes by which some risks are underrated whilst other ones are overestimated."



Cugliari *et al.* (2022), *Frontiers Earth Sc.*, 10, https://doi.org/10.3389/feart.2022.995536

Susanna Hertrich, 2008 : "Reality Checking Device"



3.

Knowledge – the treasure that bridges disciplines and builds insight

L. Da Vinci (ca. 1515), *Self-portrait,* © Biblioteca Reale di Torino

Wonder, curiosity, understanding
A beautiful path to insight

"Water dismantles mountains and fills in valleys, and would round the Earth in perfect sphericity, if it only could." This neat and accurate statement by Leonardo is a vivid declaration of how the XVIth century genius deserved its place in modern history.

"It's a bit of a lost art these days – even though, in the age of Wikipedia and YouTube, it's easier than ever to satisfy your curiosity. It's ironic that we can be reminded about the wonders of modern life by a man who lived 500 years ago." (Bill Gates)

L. da Vinci (ca. 1504-8), *Codex Leicester*. © Bill Gates

Solutions will come from inquiry across disciplines – and beyond

Probably the founding father of Geology, Sir James Hutton was raised as a doctor but his passions for the nature surrounding his farm led him to rocks, then specimens, then fossils. A comparative physician, if you will – the first paleontologist, in fact.

Not only did the lack of a specific scientific discipline bring Sir Hutton to devise a novel field of study of his own – it also molded his formal learning into a synthesis of intellectual tools.

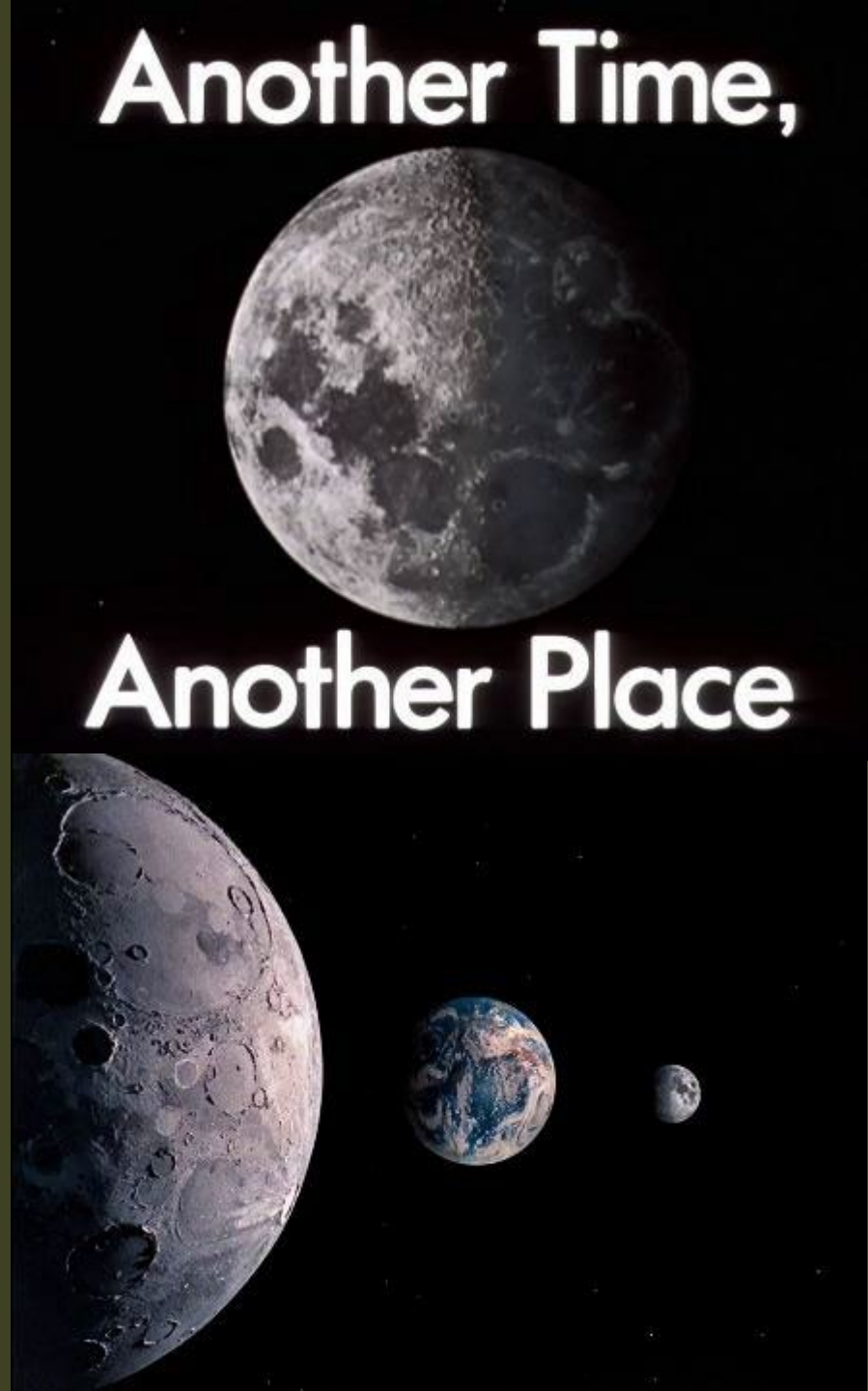
In today's overly specialized scientific arena, cross-disciplinarity is destined to be an asset in front of cascading, complex events that evade any given single field.

H. Raeburn (1776) – *James Hutton, 1726-1797, Geologist*. Scottish National Portrait Gallery, Edinburgh

Is there more than one planet Earth for us?

Rising global population, long-term migration shifts – due to hazards, climate, resources – and unpredicted factors – from vulnerabilities to instabilities – pressure on the environment (natural/built) on an unprecedented scale.

Although science fiction may be based on physical nonsense, collective handling of resources and (associated) hazards on Earth is all but devoid of poor planning – well, nonsense – more often than we are eager to admit.

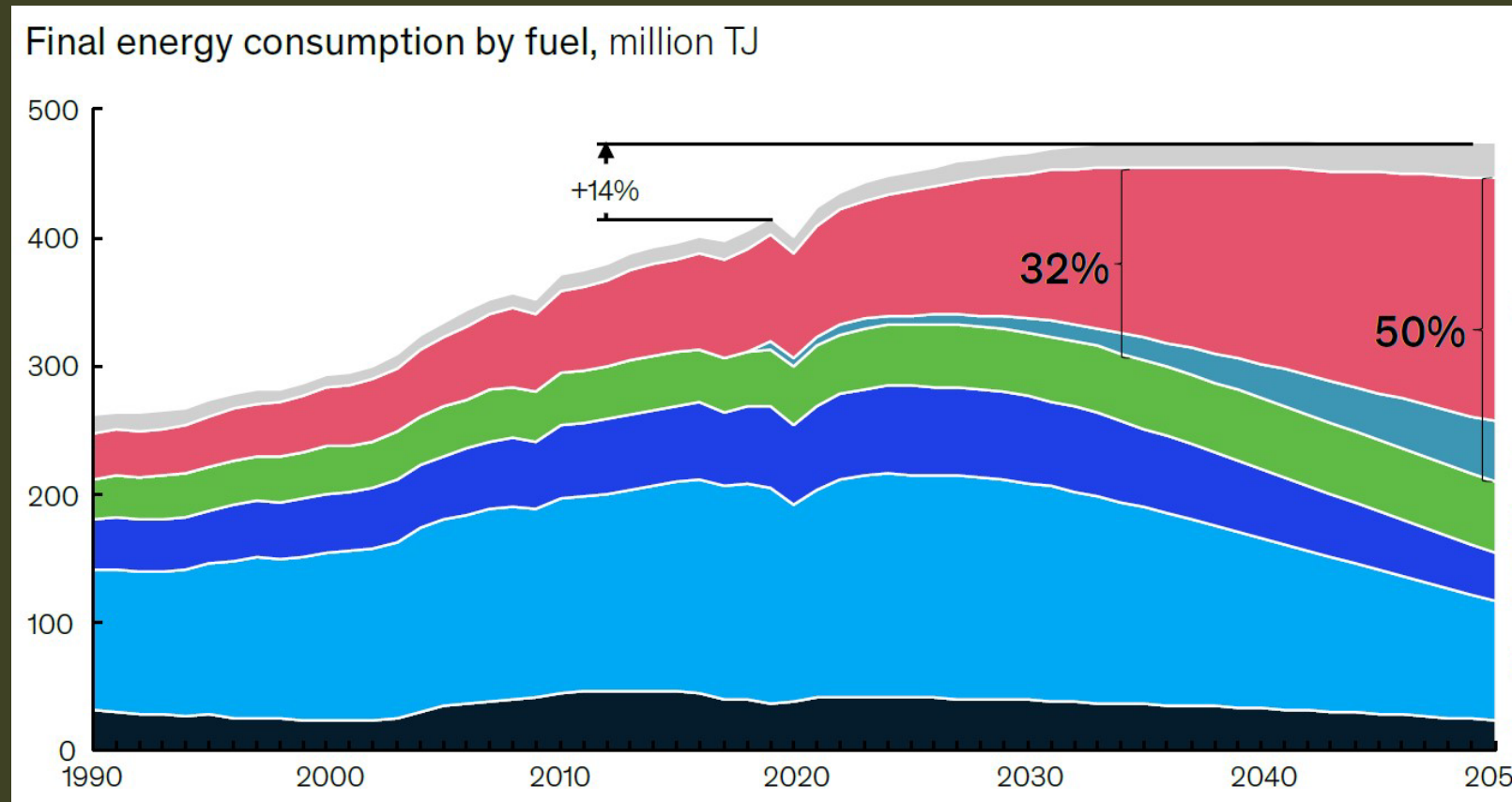


D. Tomblin (1975), "Another Time, Another Place" – Space 1999, © Group Three Prod., ITC, RAI

Feedbacks and links in the Earth system – with climate change and population

Population growth (~ 10 bn by 2050; UN, 2022) and societal shifts (in China, India, E. Africa) are expected to drive energy demand (OECD, 2011).

This will increase CO_2 release and thus reflect on the scale of targeted efforts (like CCS – carbon capture & storage).

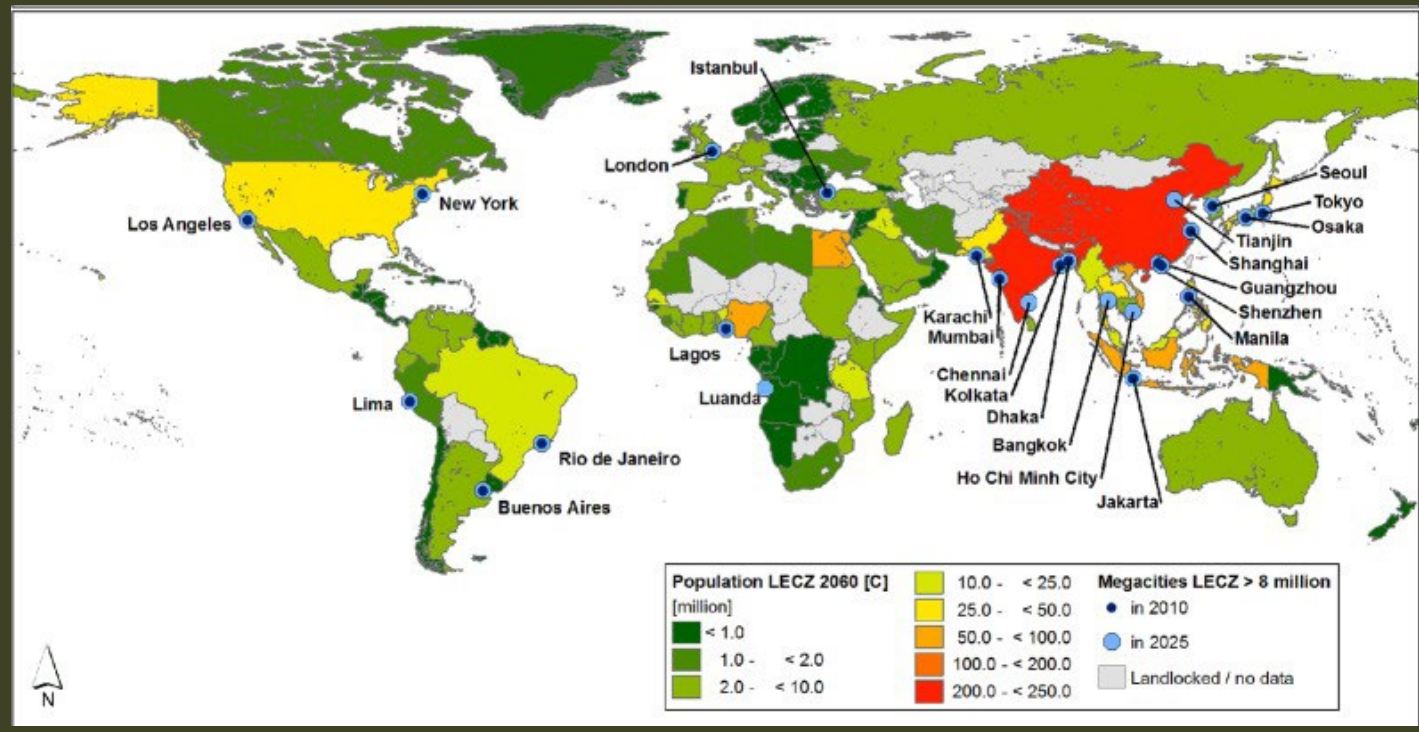


© McKinsey (2022), Global Energy Perspective

Feedbacks and links in the Earth system – with climate change and population

Major population relocation towards coastal areas (UN, 2018) may follow routes due to climate (WB, 2018), driving migrations not just *towards* the "Global North" but also *away* from regions affected by permafrost thawing (Ramage et al., 2021).

Urban population exposed to geophysical hazards is estimated to ~ double by 2050 (WB, 2013).

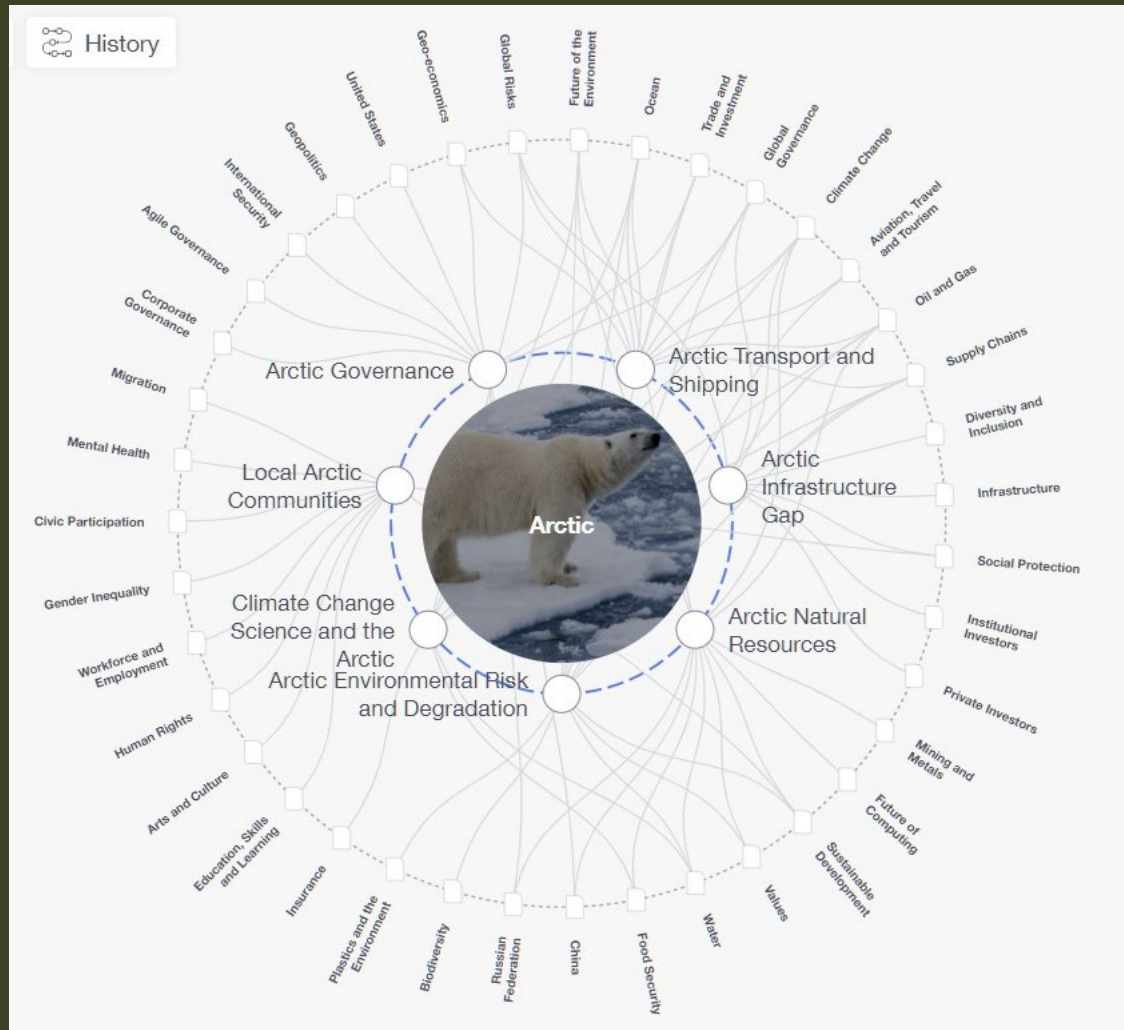


Neumann *et al.* (2015), *PLOS One*, 10
https://doi.org/10.1371/journal.pone.0118571

Feedbacks and links in the Earth system – with climate change and population

Ex-permafrost areas will affect (Miner et al., 2022) or boost (due to accessibility) HC exploration and transportation lanes (Mian, 2018) – shipping being a hard-to-abate CO_2 sector (WEF, 2020).

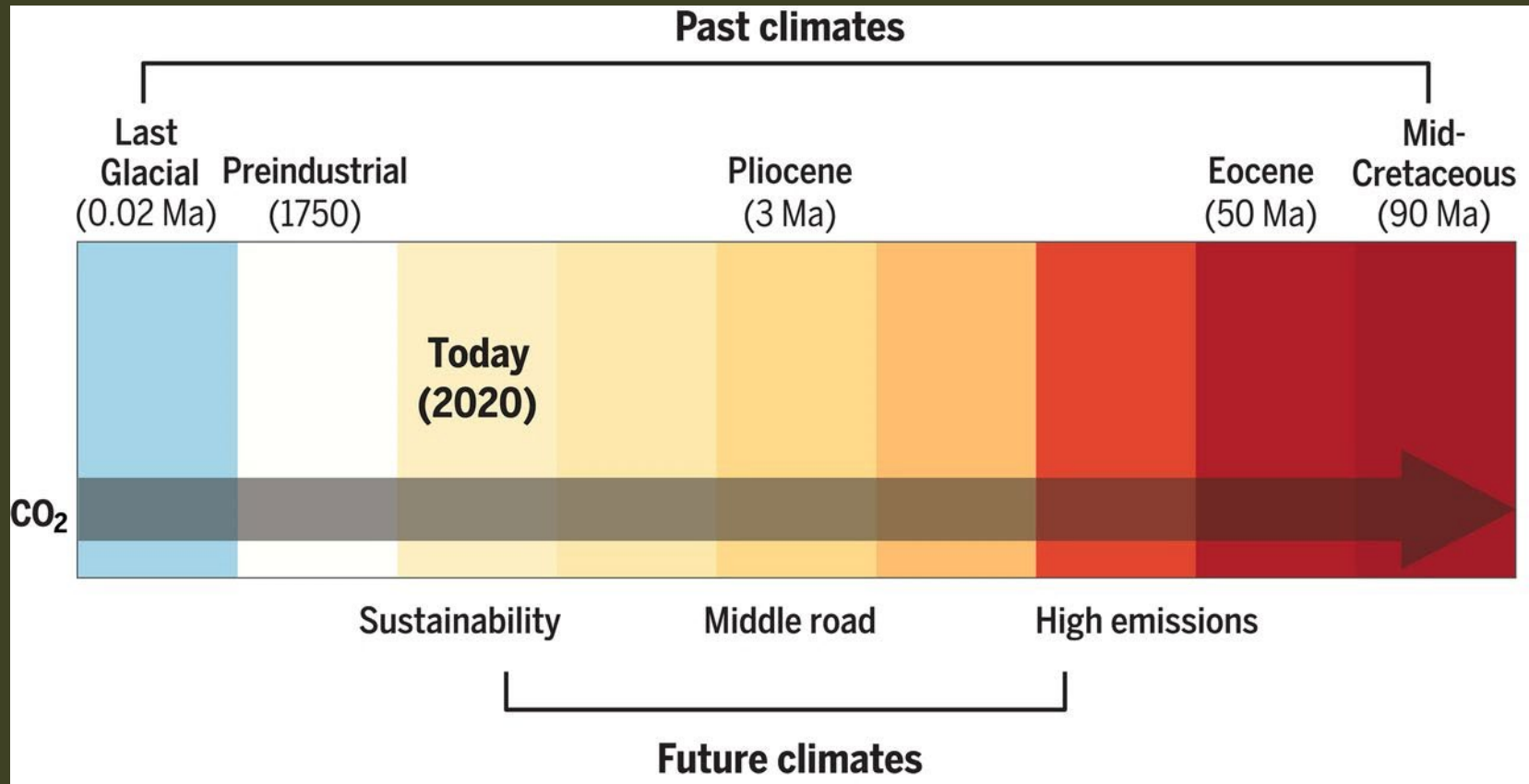
Given expected carbon release due to thawing (Turetsky et al., 2020), this is likely to render CCS even more pressing (per industry and by volume) – if enough financially de-risked (Wang et al., 2021).



Past climates inform our future

"Anthropogenic emissions are rapidly altering Earth's climate, pushing it toward a warmer state for which there is no historical precedent."

"Past climates provide the opportunity to observe how the Earth responds to high carbon dioxide, with a fundamental role to constrain future climate change."



Tierney *et al.* (2020), *Science*, 370, https://doi.org/10.1126/science.aay3701

4.

Complexity is a trait of nature – *so we need to react flexibly to inflexible variables*

The brine that came in from the cold – only, it's *much* less cold that it used to be

Permafrost thawing causes widespread, short-wave terrain deformation and disruption to infrastructure (Hijort et al., 2022) over regions far broader than earlier estimated (Smith et al., 2022), possibly with relevant medium-term economic consequences (Burke et al., 2015).

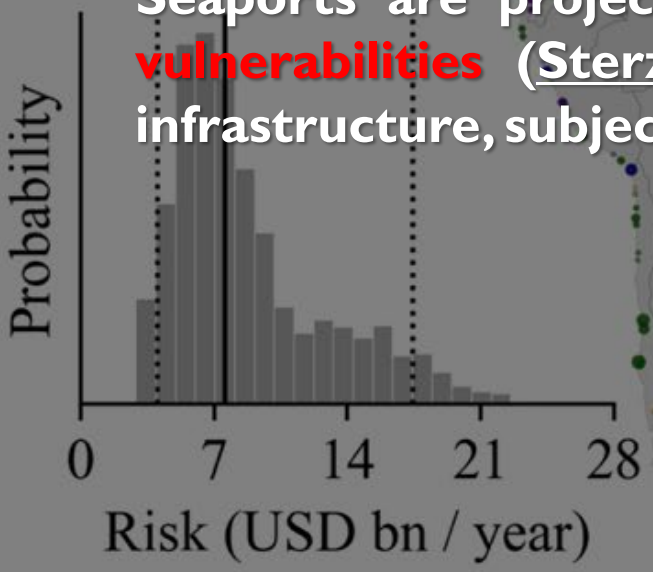
Despite common perception, permafrost is not "up there where it's cold": The area is immense, strategic, a potential pathogen (Wu et al., 2022) and methane reservoir (Rößger et al., 2022), with prospective consequential effects on climate change (Peng et al., 2023).

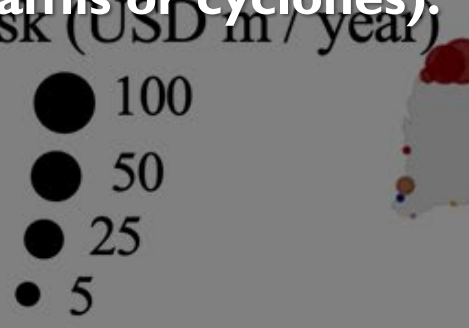
Smith *et al.* (2022), *Nature Rev. Earth & Env.*, 3
https://doi.org/10.1038/s43017-021-00240-1

Of transformations, climate, energy, subsurface – and a jigsaw of hazards

Climate change is creating greater **systemic** risk than previously recognized for coastal areas and critical infrastructure subject to sea-level **rise** (UNDRR, 2022). Coastal exposure will be augmented by **subsidence** too, induced by expanding coastal **megacities** (Parsons, 2021).

Seaports are projected to grow in number and ship **traffic** (Lester, 2020), with accrued **vulnerabilities** (Sterzel et al., 2020), in part due to expanding/aging building stock and infrastructure, subject to pre-existing **geophysical** hazards (such as tsunamis or cyclones).





Verschuur *et al.* (2023), *Nature Comm. Earth & Env.*, 4
https://doi.org/10.1038/s43247-022-00656-7

Of transformations, climate, energy, subsurface – and a jigsaw of hazards

Among the strategies at hand, CO_2 storage (CCS) may be deployed across diverse subsurface settings (IPCC, 2005), at Gton/y scale (Mton/y in pilot projects; IEA, 2022) to be an effective game changer to help dent CO_2 stock (IEA, 2022) and defray hard-to-abate emitters.

CCS can be a potentially enormous geoscience opportunity, for hazard monitoring (seismic, environmental) and subsurface exploration (or knowledge transfer) purposes. As such, it may help revive geoscience academic enrollments, now at a record low worldwide (NREE, 2021).

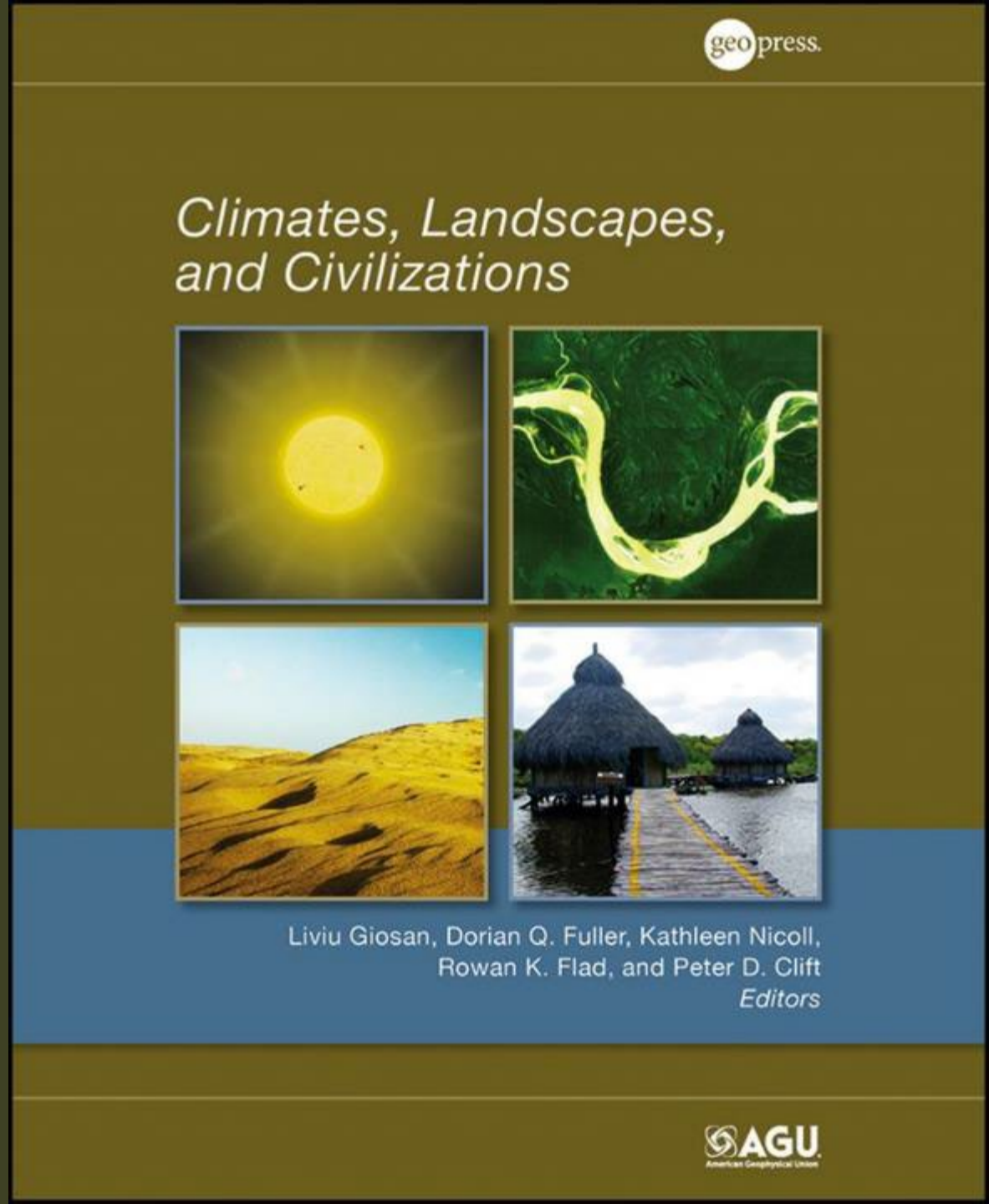
Bradshaw & Dance (2005), *GHG Control Techn.*, 1
https://doi.org/10.1016/B978-008044704-9/50059-8

Active tectonics vs. human development

"Active tectonism forced the pace of cultural change in antiquity, accelerating the onset of cultural complexity compared to [neighboring communities] in tectonically quiescent areas."

This can be observed – if grimly – '*in vivo*' in the aftermath of major geophysical, high-impact events (like earthquakes, tsunamis, cyclones…), when large swaths of population flee their areas.

Force & McFadgen (2012),
in: *Climates, Landscapes, and Civilizations,*
https://doi.org/10.1029/2012GM001215



The Bold Rush – Knowledge (and insight) is resource n. 1

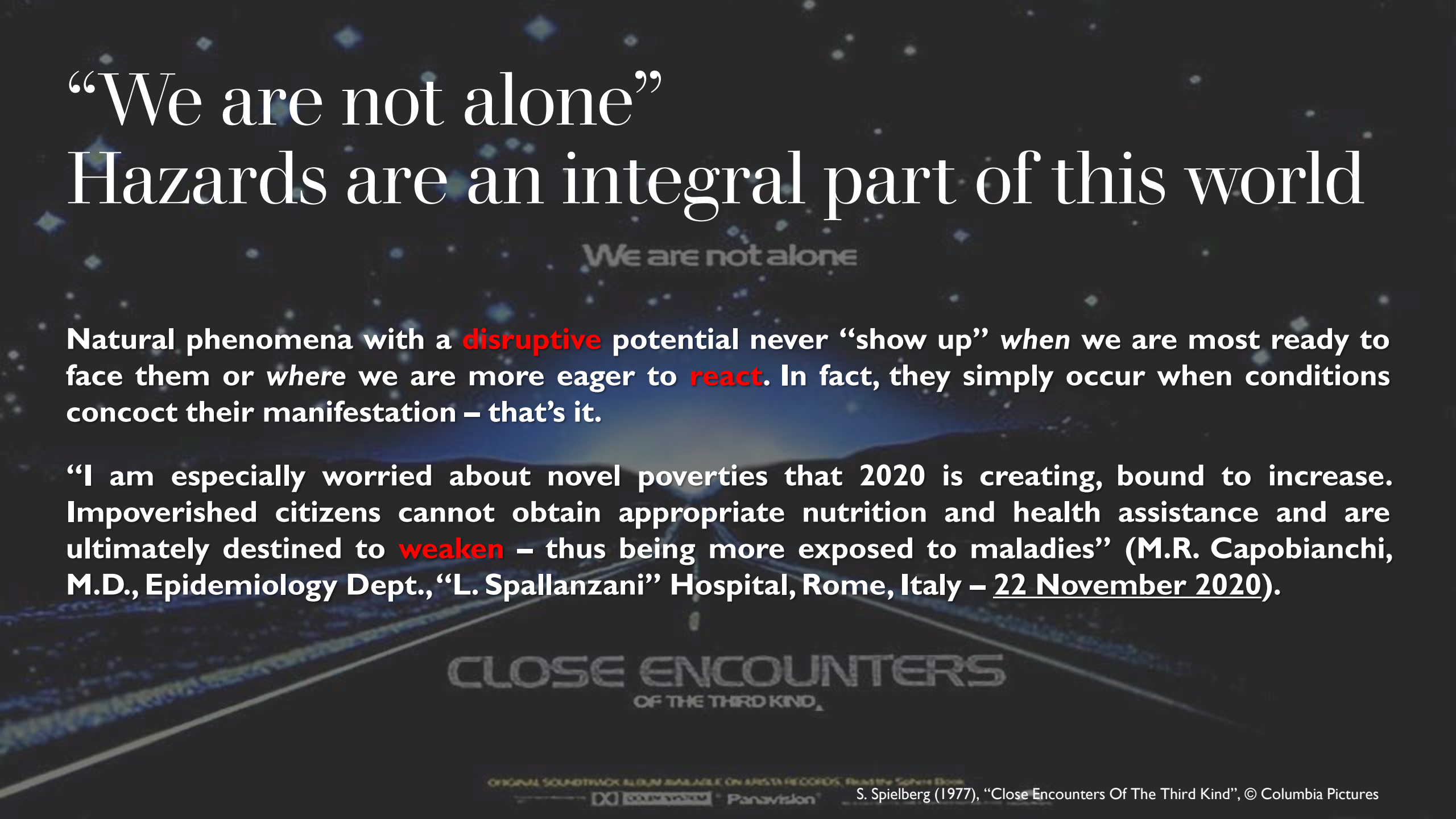
By various factors, we are concentrating more people in areas offering easier access to development and resources, yet more exposed to expectedly accrued effects of natural hazards.

More people need more energy – reliable *and* affordable. All of this while curbing their carbon footprint (headed for neutrality; UNFCCC CoP26), which may include further resources and strategies, from H_2 to massive upscaling of CCS (IEA, 2020).

In turn, the latter is not devoid of potential associated hazards (Global CCS, 2016) – like any industry probing the subsurface – that may complement pre-existing geophysical ones.

Pieter Bruegel the Elder (1563), "The Tower of Babel" Kunsthistorisches Museum, Vienna

“We are not alone”
Hazards are an integral part of this world



Natural phenomena with a disruptive potential never “show up” *when* we are most ready to face them or *where* we are more eager to react. In fact, they simply occur when conditions concoct their manifestation – that’s it.

“I am especially worried about novel poverties that 2020 is creating, bound to increase. Impoverished citizens cannot obtain appropriate nutrition and health assistance and are ultimately destined to weaken – thus being more exposed to maladies” (M.R. Capobianchi, M.D., Epidemiology Dept., “L. Spallanzani” Hospital, Rome, Italy – 22 November 2020).

S. Spielberg (1977), “Close Encounters Of The Third Kind”, © Columbia Pictures

“We are not alone”
Hazards are an integral part of this world

Being pressed by crucial, incompressible needs (water, food, shelter, sanitation) puts non-negligible sectors of populations – even in *statistically* affluent societies – in conditions that set them astray of care for further societal issues. And with some reason, too.

It is (tragically) ironic that measures that can positively make a difference between life and death (fleeing a perilous building or wearing protective gear to shield a pandemic off – it’s the same) end up being perceived as “less critical”, even with a fully rational approach.

Watkis (2015), “What can marketers do to minimise the effect of Murphy's law?”, Mycustomer.com

5.

Intelligence stems from wisdom – of societies, continents, planets

J. Glen (1985), “A View to a Kill”, © MGM / United Pictures

Energy, hazards, needs, costs
Where do you put your money (first) ?

How does decarbonizing human activities mix with complexities in reducing natural hazards? Curbing CO_2 for transportation, agriculture, cement and steel – and households – is going to cost gargantuan amounts globally – and unequally distributed worldwide.

For seismic hazard, enforcing building codes to protect at least public institutions (schools, hospitals, etc.) costs large sums that may be averted from other budget chapters.

From a seismic hazard perspective, seismic safety is conceivably "more important" and should come first among other compelling societal needs. But aren't phasing out fossil fuels, famine, inequalities, mass migrations equally "more important"?

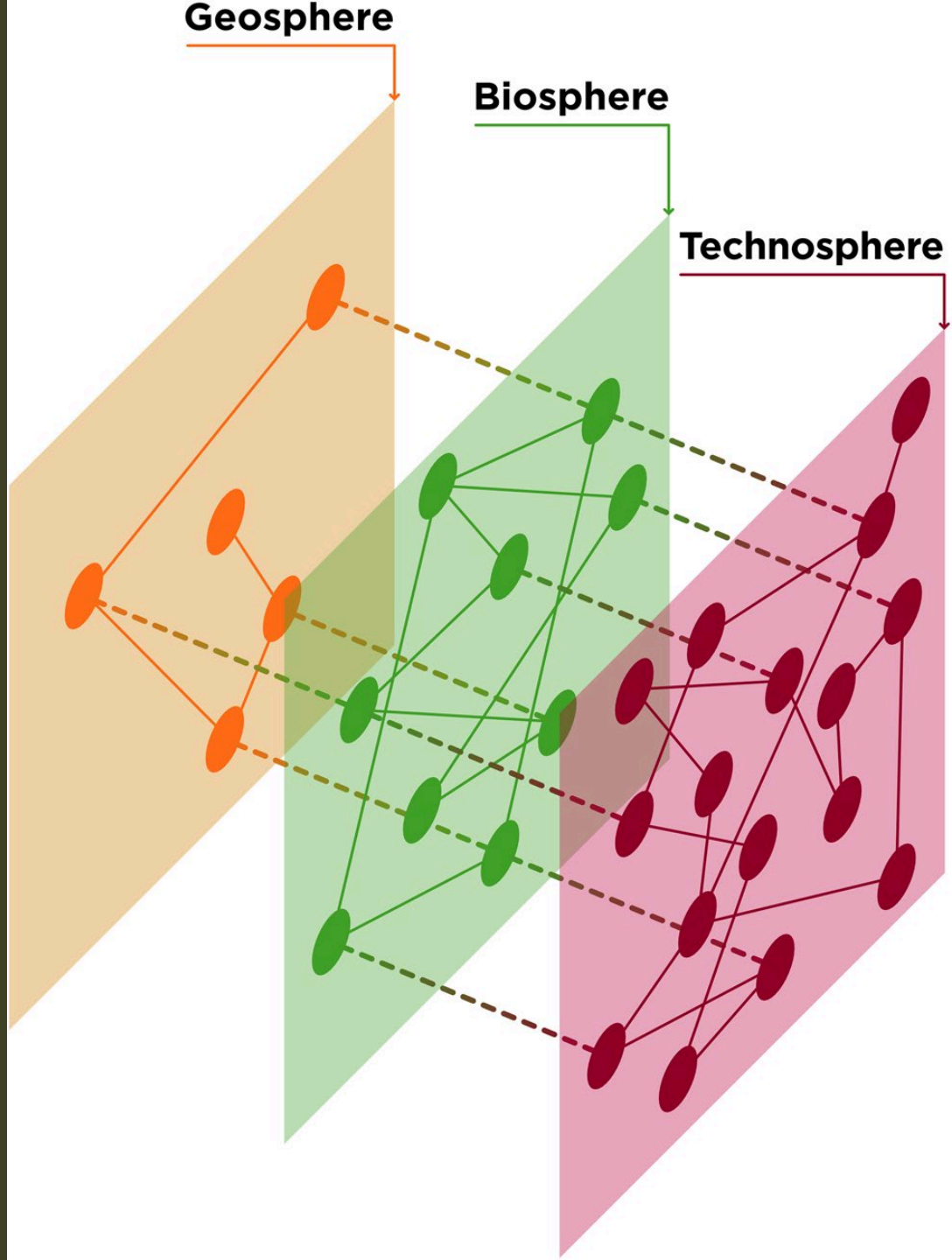
R. Stevenson (1964), "Mary Poppins", © Walt Disney Productions

Intelligence as a planetary scale process

"**Planetary** intelligence, i.e. acquiring and applying collective knowledge at a planetary scale, can prove a useful framework for understanding possible paths of the long-term **evolution** of inhabited planets."

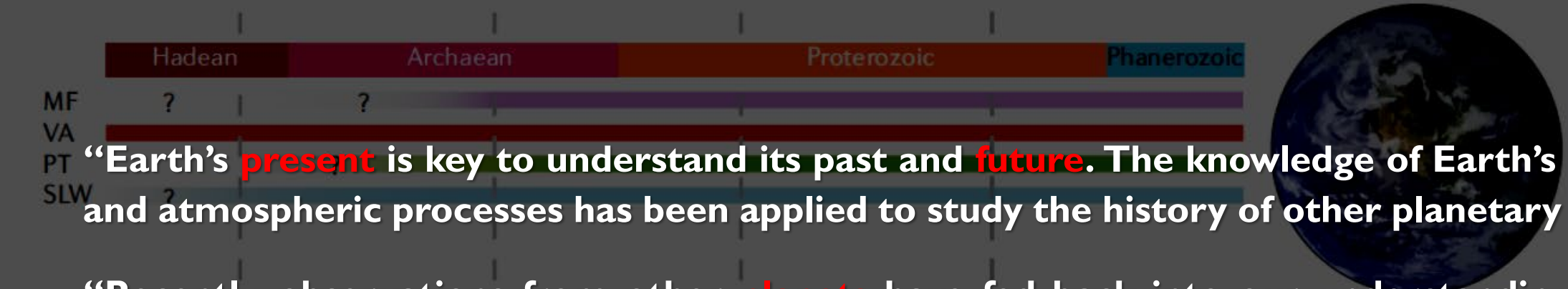
"This includes future trajectories for **life on Earth** and features of intelligentially steered planetary evolution on other worlds."

Frank *et al.* (2022), *Intern. J. of Astrobiology*, 21, https://doi.org/10.1017/S147355042100029X



Probing space to understand Earth

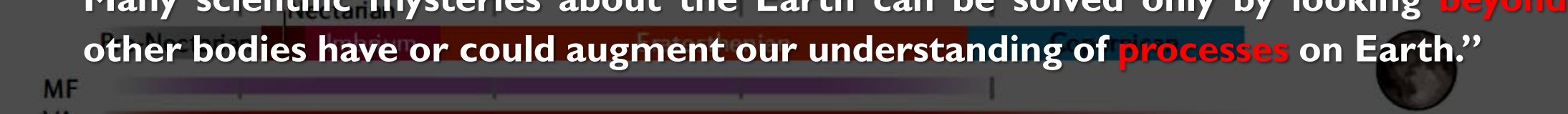
Venus
$R = 6{,}052\,\mathrm{km}$
$g = 8.87\,\mathrm{m\,s^{-2}}$
$T = 740\,\mathrm{K}$
$p = 92\,\mathrm{bar}$



Earth
$R = 6{,}371\,\mathrm{km}$
$T = \sim 185$–$330\,\mathrm{K}$

"Earth's present is key to understand its past and future. The knowledge of Earth's geological and atmospheric processes has been applied to study the history of other planetary bodies."

"Recently, observations from other planets have fed back into our understanding of Earth. Many scientific mysteries about the Earth can be solved only by looking beyond it, where other bodies have or could augment our understanding of processes on Earth."



Moon
$R = 1{,}737\,\mathrm{km}$
$g = 1.62\,\mathrm{m\,s^{-2}}$
$T = \sim 40$–$400\,\mathrm{K}$
$p = 10^{-15}$–$10^{-12}\,\mathrm{bar}$

"Future missions offer the opportunity to probe the rich diversity of planetary environments and compositions, and further explore how they might serve as analogues […] and archives."

Mars
$R = 3{,}390\,\mathrm{km}$
$g = 3.71\,\mathrm{m\,s^{-2}}$
$T = \sim 140$–$300\,\mathrm{K}$
$p = (4$–$9) \times 10^{-3}\,\mathrm{bar}$

Lapôtre et al. (2020), *Nature Rev. Earth & Env.*, 1
https://doi.org/10.1038/s43017-020-0029-y

The Earth Sciences are a strategic asset

In early 2023, Kim Cobb, a prominent climatologist and a co-author of IPCC's AR6 Report, was appointed by the White House* as a member of the U.S. National Intelligence Council. She was trained as a geologist and oceanographer.

Surprised?

Biden administration appoints Brown climate scientist Kim Cobb to President's Intelligence Advisory Board

Cobb, a Brown University professor and director of the Institute at Brown for Environment and Society, will join a White House advisory board charged with providing independent counsel on U.S. intelligence matters.

White House (2023), Statements and Releases, Briefing Room

True, it wouldn't have occurred in 2025's Whie House but…

The Earth Sciences are a strategic asset

You need not. The U.S. Pentagon and EU's JRC – among *others* – have long been focusing on hazards posed by climate change upon existing systems (both military and civilian), while defense planning is bound to include the protection of resources.

Hazards bake in the (novel) vulnerabilities' cake...

Before the end of this century, we will know what a 2-4°C global temperature rise (source: IPCC AR6) looks like in *concrete* and *solid* terms (buildings, water, seaports).

While, say, seismic hazard may be intrinsically invariant over human life span, its impact may increase due to growth of population, infrastructure, lifelines (exposed capital). And vulnerabilities are spatially expanding, as infrastructures straddle broader, diverse terrain.

...and overlie in a diverse risk matrix

Time is of help in devising and strengthening knowledge and defense measures. It is of hamper too, as vulnerabilities peer through missed measures or incorrect interventions, with resulting layers of complexity on the predictions of adverse phenomena and potential solutions.

While the urban environment is projected to grow in the next 30 years as population shifts towards coastal megacities, any crisis (of any nature) may alter this scenario and redirect populations, say, toward more scattered dwelling. Would such outlook be better or worse ?

L. Wachowski (1999), "The Matrix", © Warner Bros.

Is climate change the perfect foe? Beware of simplifications...

Climate change indeed is an existential crisis of historical remit – we have known this for decades now. However, humanity should refrain from blaming all troubles on Earth to it.

It does trigger novel threats (natural, human, socio-economic), eliciting effects that cascade in unusually complex ways, requiring complex, all-round thinking of *truly* unprecedent breadth.

However, this is far from being the first (or the last) time that humankind has been faced with unprecedent, life-challenging crises that required swift, concrete action to keep out of danger.

W.A. Wellman (1931), "The Public Enemy", © Warner Bros.

6.

Cross-disciplinary insight into our collective future

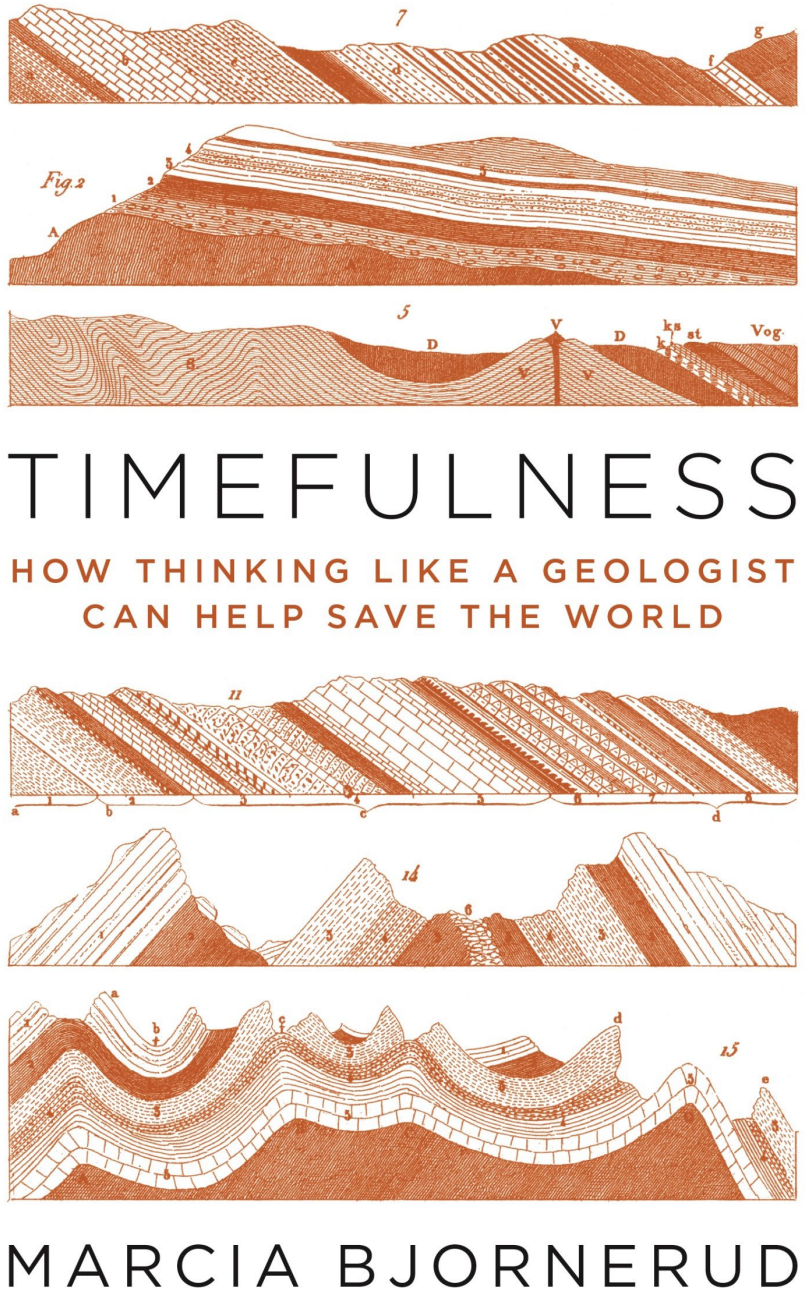
American Geosciences Institute (2020)

Geologists can help save the world

"Natural scientists already serve as a kind of impromptu international diplomatic corps who demonstrate that it is possible for people to cooperate, debate, disagree, and move toward consensus."

"The Earth itself, with its immensely deep history, can provide a politically neutral narrative from which all nations may agree to take counsel."

Bjornerud (2018), *Timefulness*, Princeton Univ. Press
https://doi.org/10.2307/j.ctvc772cs



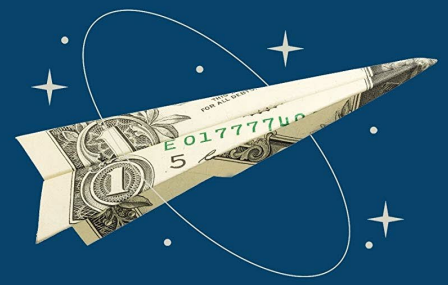
The Moon is always a brilliant teacher

"Missions inspire because of their wider societal relevance. Apollo demonstrated the need to encourage multiple solutions instead of focusing on one technology. Today, many challenges would fit the mission approach."

"These 'Earthshots' are much harder (Nature, 2019) to accomplish because they involve global commons such as air and water, they are affected by social and political complexities, involving competing interests and concerns."

Ghosh (2021), *Nature*, 589
https://doi.org/10.1038/d41586-021-00076-1

MARIANA MAZZUCATO

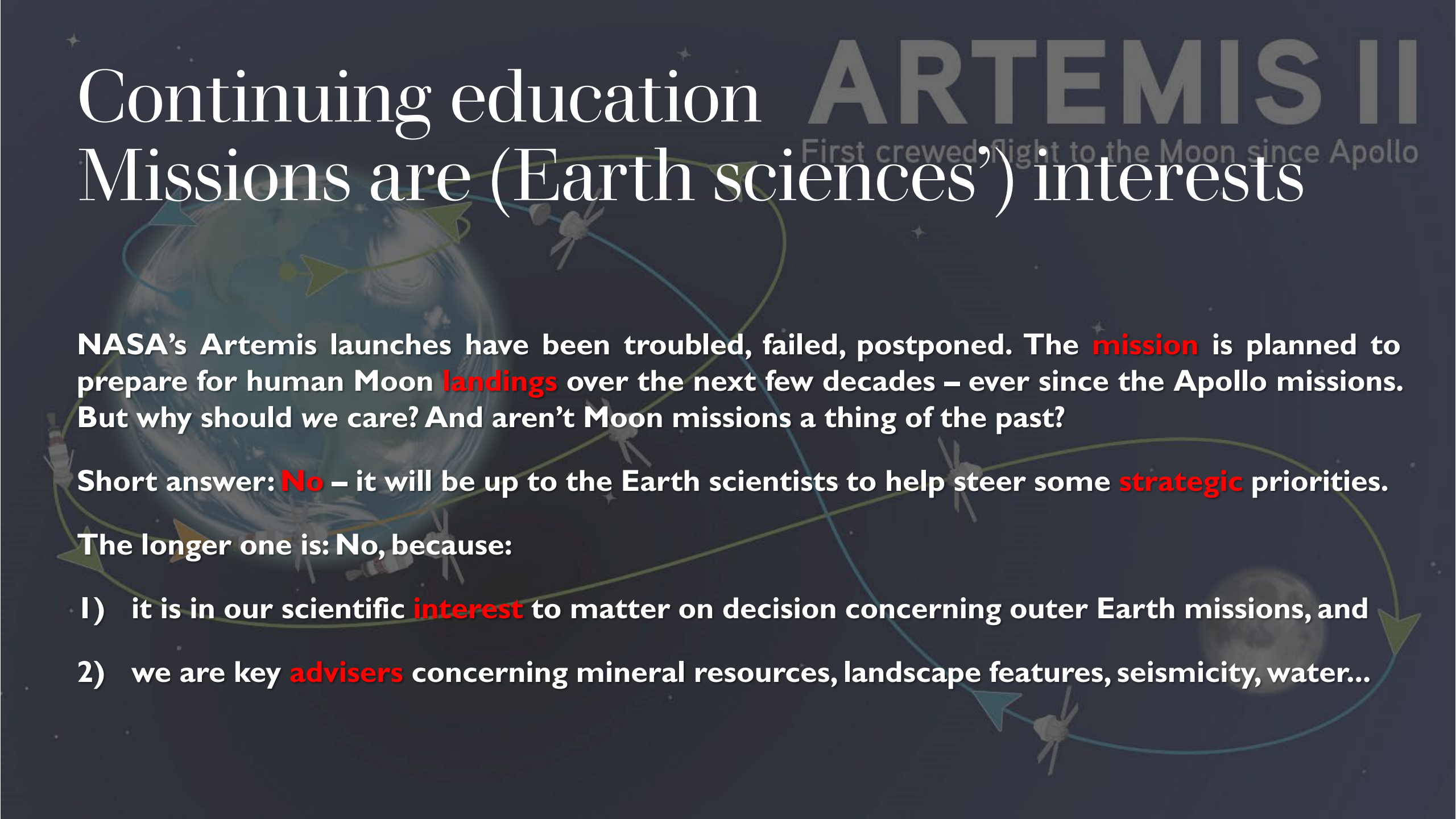


MISSION ECONOMY

A Moonshot Guide to Changing Capitalism

allen lane

Continuing education
Missions are (Earth sciences') interests



NASA's Artemis launches have been troubled, failed, postponed. The mission is planned to prepare for human Moon landings over the next few decades – ever since the Apollo missions. But why should *we* care? And aren't Moon missions a thing of the past?

Short answer: No – it will be up to the Earth scientists to help steer some strategic priorities.

The longer one is: No, because:

1) it is in our scientific interest to matter on decision concerning outer Earth missions, and

2) we are key advisers concerning mineral resources, landscape features, seismicity, water...

Continuing education
Two good lessons out of a *very* bad story

The number of things that went wrong in the Apollo 13 mission is unbelievably high: oxygen was running out, CO_2 was going to kill the crew, who had to turn the computer off (in 1973!), and even weighed too little, destined to bounce off the atmosphere (and get lost in space).

It was already a miracle they were still alive, and many argued that Moon missions were by then pointless. However, this frightening story consigns us (at least) two existential takeaways:

1) ***Immediate*, capable reaction goes hand-in-hand with clear vision and dedication. You have to know what to do – and you must be willing to outdo yourself to accomplish it;**

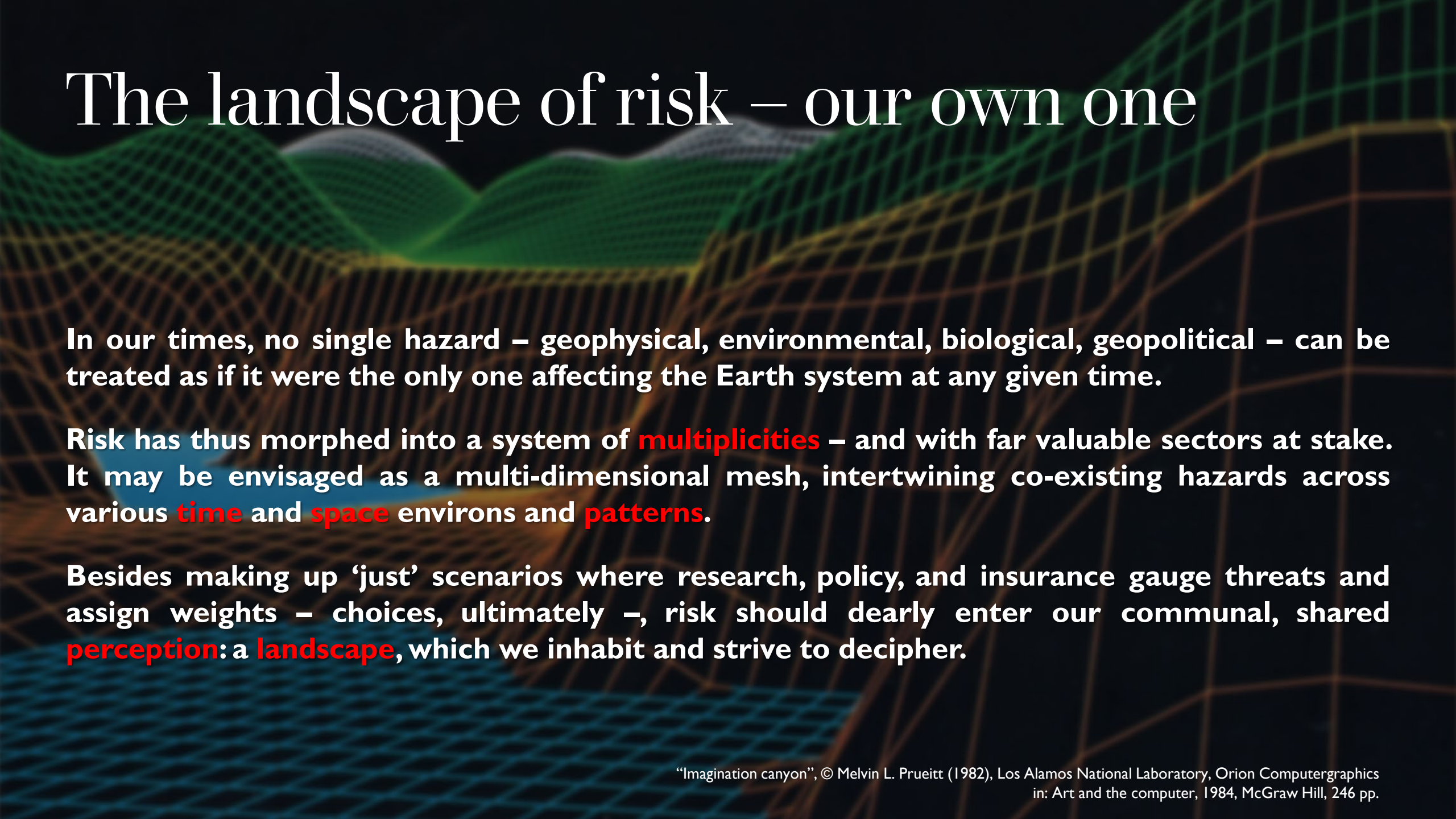
2) **Don't let precious, costly, collective know-how fade away – when you most need it, you'll regret you undervalued and dismantled it. Knowledge is like fitness: *keep training*.**

The landscape of risk – our own one

In our times, no single hazard – geophysical, environmental, biological, geopolitical – can be treated as if it were the only one affecting the Earth system at any given time.

Risk has thus morphed into a system of multiplicities – and with far valuable sectors at stake. It may be envisaged as a multi-dimensional mesh, intertwining co-existing hazards across various time and space environs and patterns.

Besides making up 'just' scenarios where research, policy, and insurance gauge threats and assign weights – choices, ultimately –, risk should dearly enter our communal, shared perception: a landscape, which we inhabit and strive to decipher.



"Imagination canyon", © Melvin L. Prueitt (1982), Los Alamos National Laboratory, Orion Computergraphics
in: Art and the computer, 1984, McGraw Hill, 246 pp.

Space elevators are less sci-fi than you think – just don't stick with elevators

"Imagine a 100,000 km cable extending up from Earth, fixed to a satellite at the far end. The system spins along with the Earth. Climbers can scale the cable transporting payloads and then releasing them in space. I was thinking you might study the dynamics of this system."

Sounds absurd and pointless but the thesis was not to demonstrate that it was *doable* – rather, to define the problem from a physical basis, describing how to possibly break it down. Whether or not it could be achieved, the goal is to learn how to manage scientific challenges that appear impossibly difficult. Further, colossal issues will follow in human history anyway…

Cohen (2022), *Scientific American*, https://www.scientificamerican.com/article/space-elevators-are-less-sci-fi-than-you-think/

Space elevators are less sci-fi than you think – just don’t stick with elevators

Missions to Mars or to Jupiter's moons will probably occur because of their resources but don’t focus on today's technology: just assume it can be done with tomorrow's one. This is a legacy on how to face complexities that may look absurdly impossible to tackle.

Since poly-crises are overly complex and can look disheartening, nurturing informed trust and confident outlook is the key. After all, if nuclear fusion appears much more attainable today than it looked unthinkable yesterday, then other capabilities may be in the pipeline.

Garber (2013), “The Decision to Go to the Moon”, NASA History Office – https://history.nasa.gov/moondec.html

A body (human or planetary) can be prison and haven – at the same time

Masses through time and space may look sturdy, immutable, unshakable – even stars do. But none is more vulnerable than our own body, the same that makes up societies and shelter life.

Our own planet too is exposed to a number of stressors, not merely environmental, and shows some signs of fatigue. But it is also the most durable, and most delicate, of its own resources.

Personal experiences that straddle ailments and salvation can endow with a novel, profound consciousness of words like threat, vulnerability, fragility. Above all, they also reveal the true nature of intelligence, strategy, and planning when aimed at protection and advancement.

#ResearchMakesTheWorldGoRound
#ResearchMatters
#Geosciences

Thank you

For questions, comments, etc.,
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https://www.ingv.it/organizzazione/chi-siamo/personale/#204 ➡
https://www.linkedin.com/in/umberto-fracassi-1a535833/ ⬅