Investment and growth for the 21st Century: sustainability, resilience, and water

Global Water Summit

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Structure

- **Where we are and where we should go: climate crisis and growth opportunity**
- Water resilience: economic resilience, investment, and growth
- Lessons 20 years on from Stern Review: investment and growth in a changing world

Important advances across world since 1950 but with critical damage to our ecosystems

Since 1950:

x4 increase in income per capita
x13 increase in economic output

50% increase in life expectancy

60% to 8% of global population living in extreme poverty

The majority of indicators monitoring nature status show a decline

For example, wildlife populations have declined globally by 73% on average in the last 50 years (WWF, 2024)

Global CO2 concentrations keep rising

Due to human activities, they are now at levels the world has not seen for more than ten million years (Krajick, 2023)

Causing rising temperatures and climate impacts

The world experienced a x7 increase in economic losses associated with extreme weather, climate, and water events (from the 1970s to the 2010s) (WMO, 2021)

Once-in-a-decade heatwaves are now nearly x3 more likely and 1.2°C warmer than in pre-industrial times (IPCC, 2021a)

Climate change is intensifying the water cycle, bringing more intense rainfall and associated flooding, and more intense drought in many regions (IPCC, 2021b)

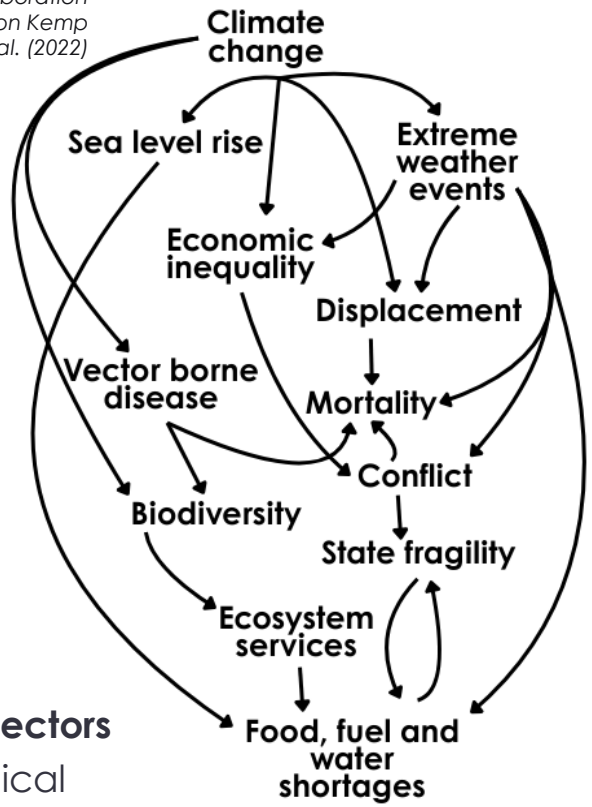
Climate change drives biodiversity loss and biodiversity loss drives climate change

As ecosystem services decline or disappear, their degradation cascades into economic sectors

When an ecosystem is degraded, it becomes more vulnerable to tipping points: ecological degradation + climate change can turn forests into grasslands, and grasslands into deserts

The Complex Interconnections of Climate Change Impacts

Source: Author's elaboration based on Kemp et al. (2022)



Impacts propagate throughout human and natural systems, generating disruption, disequilibrium and instabilities. Deeply damaging to development for all. Poorest hit earliest and hardest. Most effects associated with water (storms, floods, sea-level rise…) or its absence (droughts, fires, desertification).

Extreme events have immense impacts on lives and livelihoods, as illustrated in the following recent events (at present 1.3°C)

In the São Paulo state, **Brazil**, extreme heat led to thousands of fires, **destroying thousands of hectares of crops**, and causing severe **health problems** from smoke (The Guardian, 2024a)

Super Typhoon Man-yi hit the **Philippines**, causing terrifying waves of up to 14 metres on the shores of Catanduanes, requiring **650,000 people to flee** (The Guardian, 2024b)

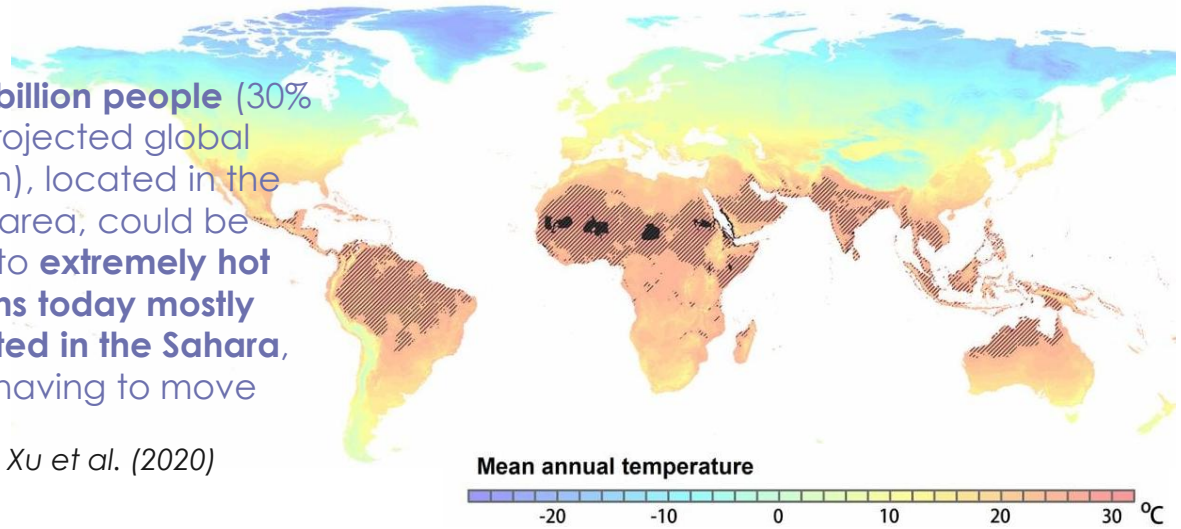
In Los Angeles, **USA**, the massive Palisades and Eaton **wildfires engulfed more than 16,000 structures** (WWA, 2025)

2024 September — October — November — 2025 January — 2070

In Valencia, **Spain**, a year's worth of rain fell in only a couple of hours, **taking with it the lives of more than 200 people** (BBC, 2024)

By 2070 3.5 billion people (30% of the projected global population), located in the shaded area, could be exposed to **extremely hot conditions today mostly concentrated in the Sahara**, possibly having to move

Source: Xu et al. (2020)

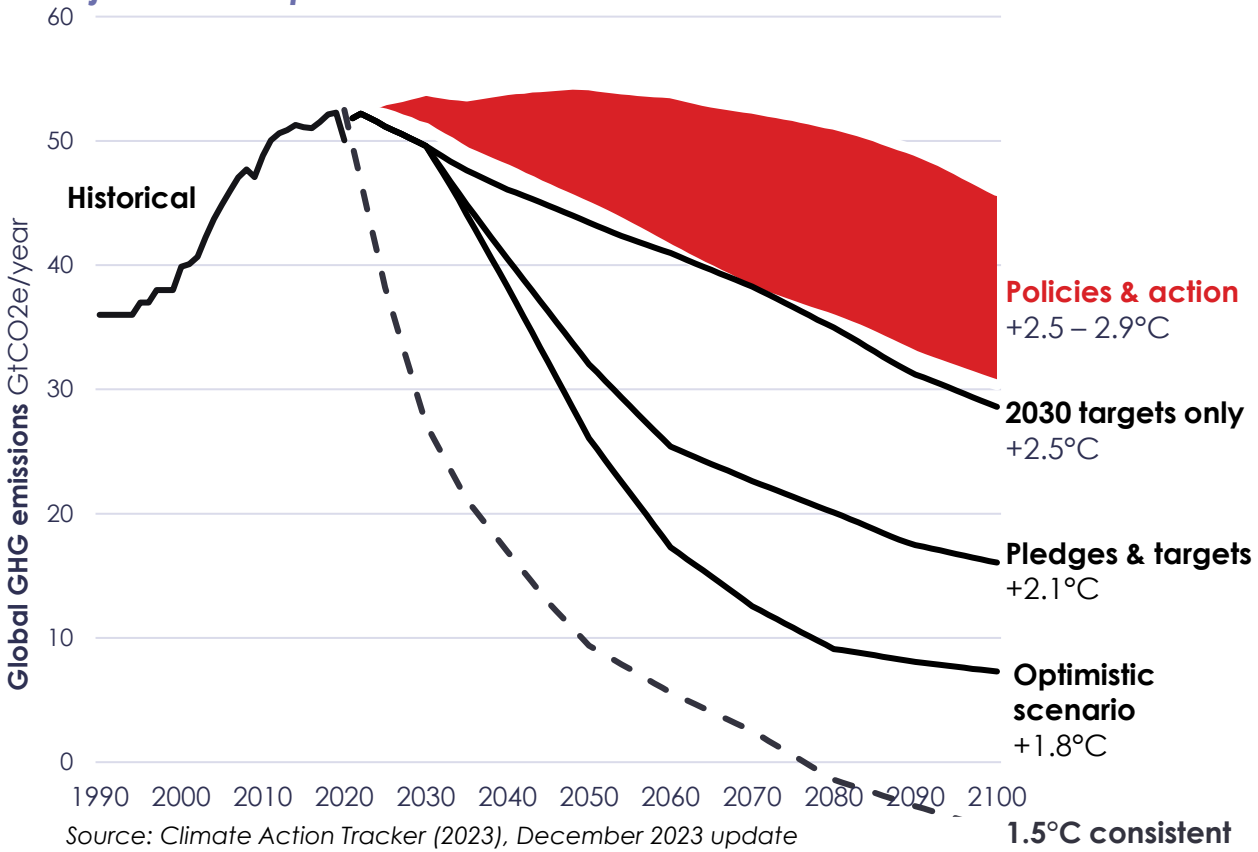


Current paths involve huge risks; radical and urgent change now necessary

Under current policies temperatures are headed to potentially catastrophic warming of close to 3°C by 2100. Sea levels were 10–20 metres higher when last at 3°C around 3 million years ago (Miller et al., 2012). Whole areas of the world might become uninhabitable. Growth and development for many would be set in reverse. **And 2°C would be reached in around 2 or 3 decades.**

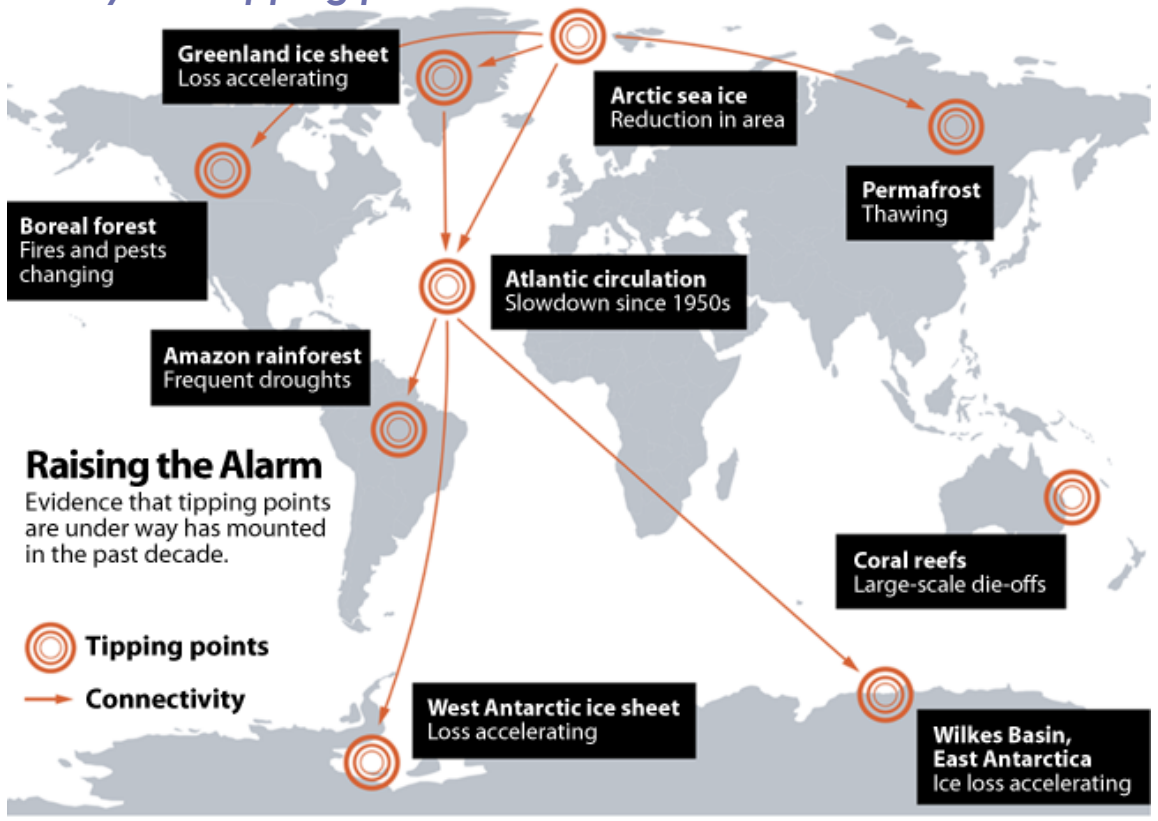
Future risks escalate rapidly with every fraction of degree of warming, particularly since 'tipping points' could be passed, such as loss of major ice sheets, thawing of permafrost and collapse of the Amazon forest system. **Tipping points would create powerful dynamic feedbacks and rapid further temperature increases.**

Projected temperature increases



Source: Climate Action Tracker (2023), December 2023 update

Earth system tipping points



Source: Lenton et al., 2019

The centrality of the Paris Agreement (COP21 of UNFCCC, December 2015): committed more than 190 nations to a global target of well-below 2°C and to pursue efforts to hold at 1.5°C.

A critical decade, with the Global South at centre stage

The next decade is critical. Choices made on infrastructure and capital now will either lock us into high emissions or set us on a low-carbon growth path which can be sustainable, resilient, and inclusive.

Likely global growth and change in the next decades: three doublings

15-20 years	Stock of Infrastructure	2x	**Strong growth in EMDCs through income levels with strong demand for infrastructure**, including water-related.
20-25 years	GDP	2x	Growth of approximately 3% per annum. **Led by emerging and developing countries.**
30 years	Urban Population	>2x	Urban population will more than double by 2050, at which point 7/10 people will live in cities. **Towns and cities shaped in the next 20 years.**

At the same time

- ↓ CO2 emissions
- ↑ Adaptation and resilience

The challenge is to both change nature of investment and to increase it. If we fail to do this quickly, then growth and development will likely be halted, reversed or undermined as a result of the hostile environment created.

It is in the developing world where the majority of world growth will occur, and infrastructure and other investments will be made in the coming two decades. Huge leapfrogging opportunity.

Since 2000, EMDCs have contributed an average of 60% of annual global growth – double their share in 1990s – and this figure is set to rise to 65% by 2035 (World Bank, 2025; S&P Global, 2024).

Even in a middle-income country like **India the majority of the urban infrastructure likely to exist in 2047 will be built between now and then** (World Bank, 2024b).

Because much of their infrastructure has yet to be built, **many of them can leapfrog straight to cleaner, more efficient technologies and structures.**

Many are rich in renewable energy – 70% of the world's solar and wind resources and 50% of critical minerals are in the Global South (RMI, 2024).

Where we should go: investment and growth for the 21st Century

The investments necessary to tackle the climate and biodiversity crises carry immense opportunities for a new growth story.

Short term

Investment in sustainable infrastructure and other assets can boost shorter-run demand and growth, sharpen supply and efficiency, reduce waste and pollution, promote sustainable development and reduce poverty.

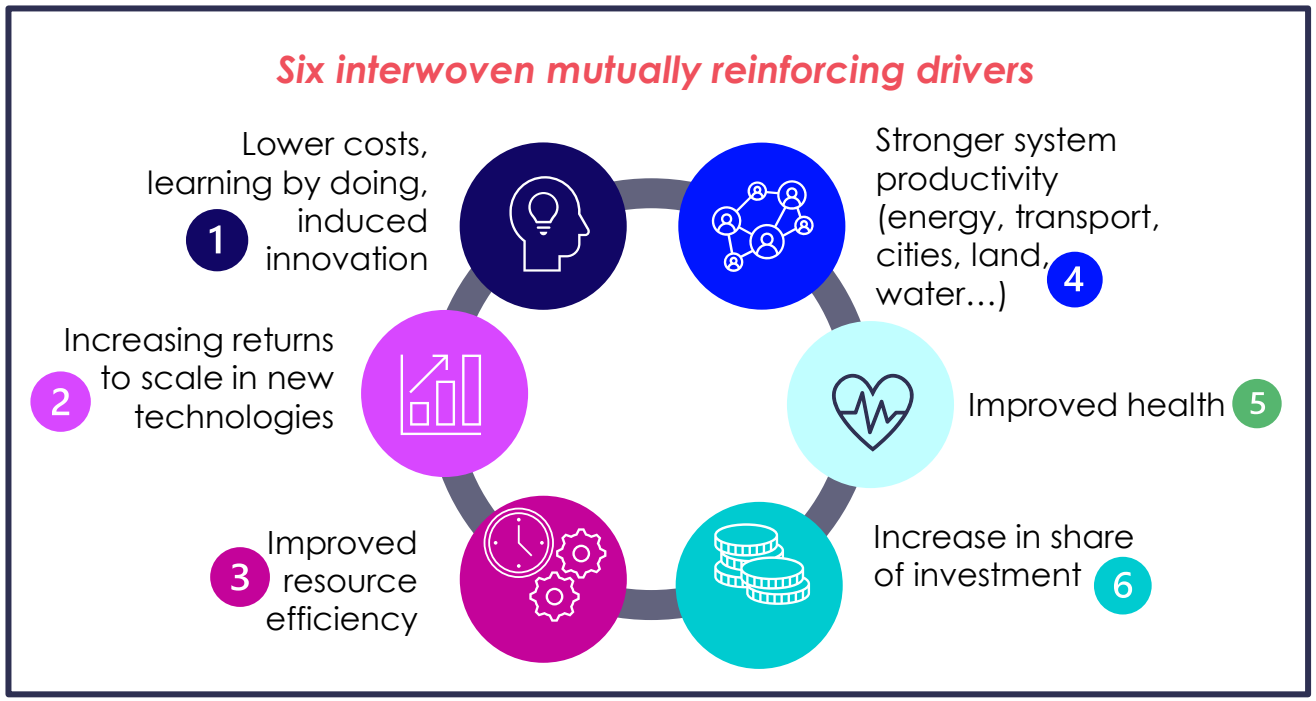
Medium term

Spur innovation, creativity and growth in the medium term, unleash new waves of innovation and discovery.

Long term

Low-carbon is the only feasible longer-run growth on offer; high carbon growth self-destructs.

These six drivers can simultaneously reduce emissions and damage to our ecosystems and create much more productive economies and societies.



Most processes embodied in these growth drivers tend to be excluded from standard macroeconomic or general equilibrium modelling. And generally such modelling ignores or downplays the losses from failing to adapt.

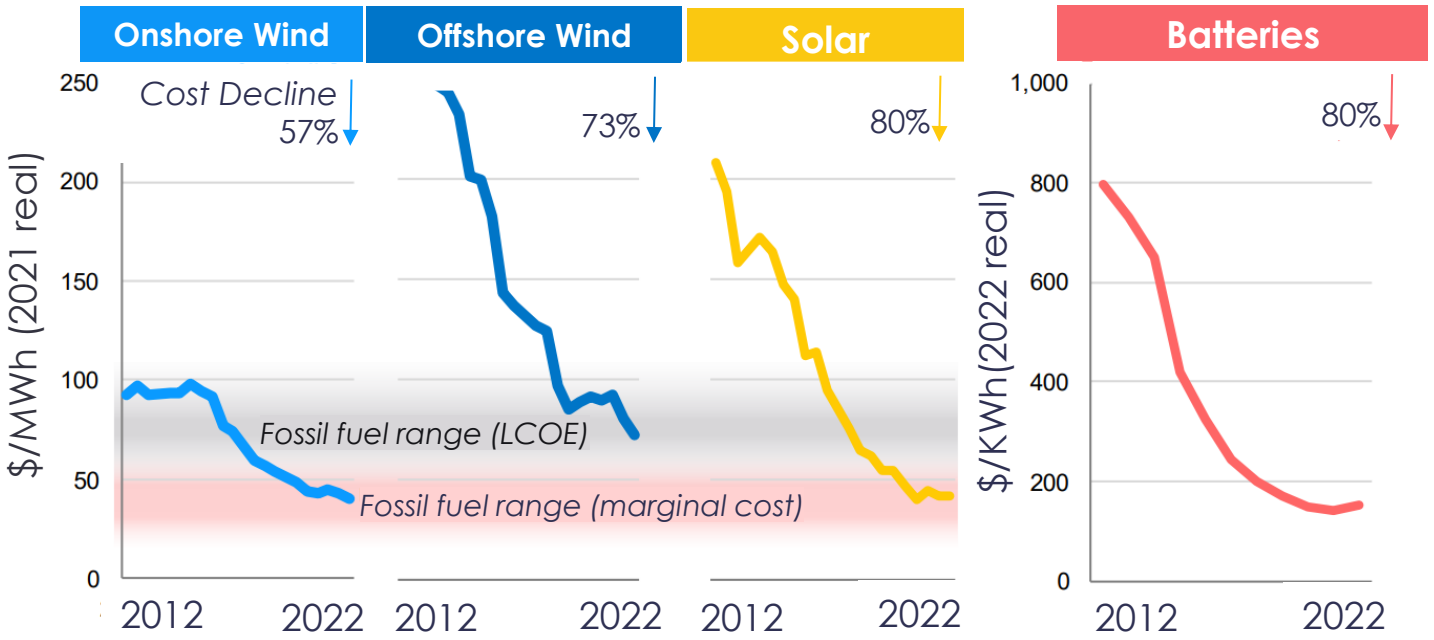
High on the research agenda for economists should be to better integrate these crucial drivers into their analyses. It is a new growth story both in theory and in practice.

The driving forces of a new growth story:

1 Lower costs, learning by doing, induced innovation

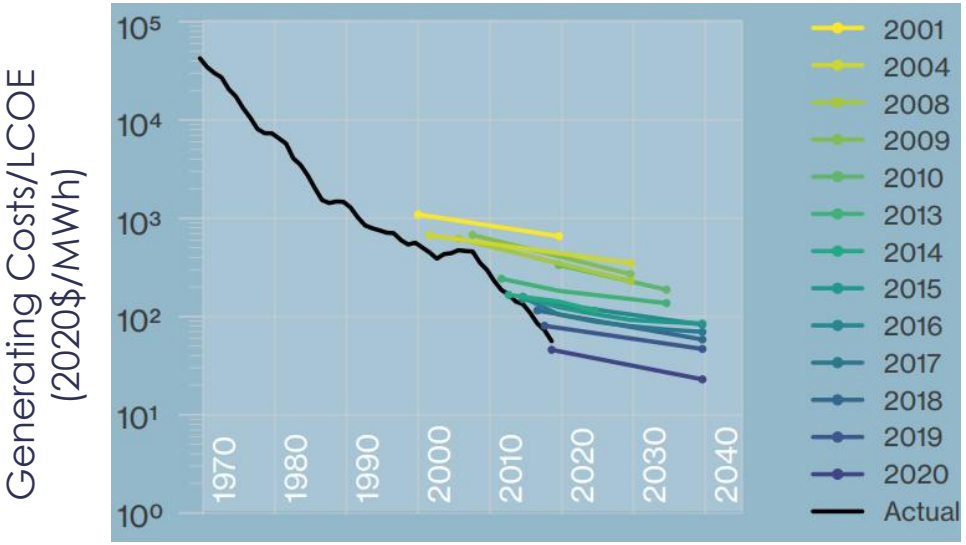
The pace of technology advancement and cost reductions has been rapid and faster than expected. Capital costs for renewables continue to fall much faster than those for conventional technologies. Standard models do not embody the rapid, structural/systemic change, disruptive technological change, and increasing returns to scale, that can, with strongly increased investment, drive an early transition.

Renewable power technologies: decreases in levelized cost of electricity



Source: RMI (2023)

Actual versus IEA projected LCOE of solar PV



Source: Ives et al (2021)

Economic and technological tipping points. Through learning by doing, innovation and economies of scale costs can be reduced below incumbents, attracting new investments and markets. Thus tipping points.

- **In 2022 to 2023 alone, cost of solar PV declined by 12%, and between 3-7% for wind** (IRENA, 2024).
- **In 2024, battery storage costs fell by a third** (BNEF, 2025).

The driving forces of a new growth story:

2 Increasing returns to scale in new technologies

Remarkable cost reductions in last dozen years - part scale, part network/systems, part discovery/innovation. On back of modest policy and broad sense of direction. Change can be still faster with stronger policy.

Cost of renewables: down by a factor of around 10. Scale a major influence.

Network/scale effects. Clustering effects of scale. AI management of systems.

Electric vehicles. Set-up costs, charging infrastructure. Learning-by-doing and mutual learning. Stronger with scale.

New materials. Discovery costs imply scale effects.

3 Improved resource efficiency

Greater efficiency in resource use means higher productivity. Countries and the private sector are already moving on resource efficiency, particularly energy efficiency. Among the G20 countries, resource productivity grew by about 40% between 2000 and 2017 (OECD, 2021).

5 Improved health

Reducing fossil-fuel combustion will reduce impacts of air (and other) pollution on health, increase productivity, and reduce the associated burden on the economy. 10%–20% of annual global deaths are linked to air pollution. Much is associated with fossil-fuel burning.

4 Stronger system productivity

Energy, cities, land, transport, water systems can be much more productive through improvements in how each operates and how these systems interact. Cities where we can move and breath are more productive. Digital management and AI have great potential. Huge possibilities from use of IT and AI for efficiency, integration, congestion and system management.

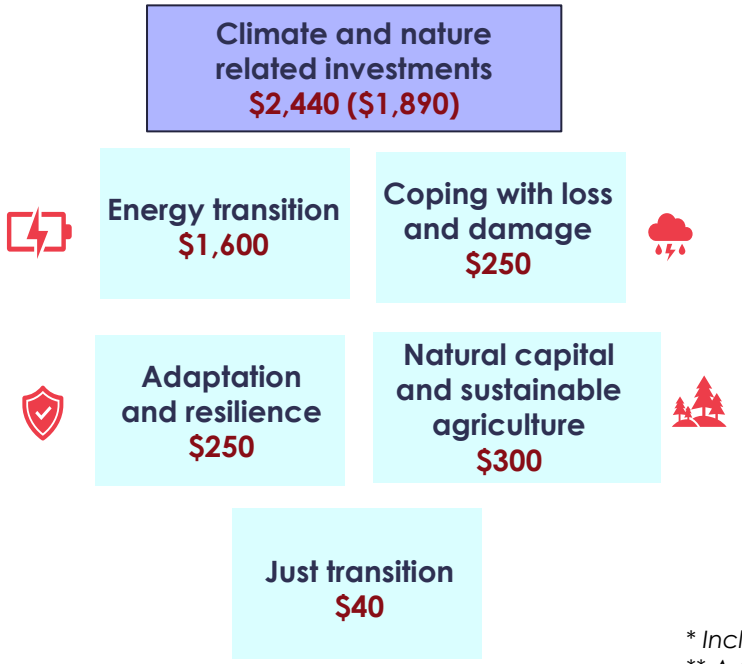
More compact, connected, and coordinated cities are worth up to **$17 trillion in economic savings** to 2050 and could **reduce infrastructure capital requirements** by over $3 trillion between 2015 and 2030 (NCE, 2018).

The driving forces of a new growth story: 6 A major increase in investment: an imperative and an opportunity

Investment is at the core of the new growth story. If strategic action is well executed, this increment in investment will have high returns in terms of productivity and will foster and embody innovation, driven by the benefits associated with all the interlinked six key drivers. **Further, adaptation and the building of resilience** will increase output and productivity relative to strategies which act as if climate change is not happening or is minimal.

Investment / Spending Requirements for Climate and Nature ($ billion per year by 2030) in EMDCs (other than China)

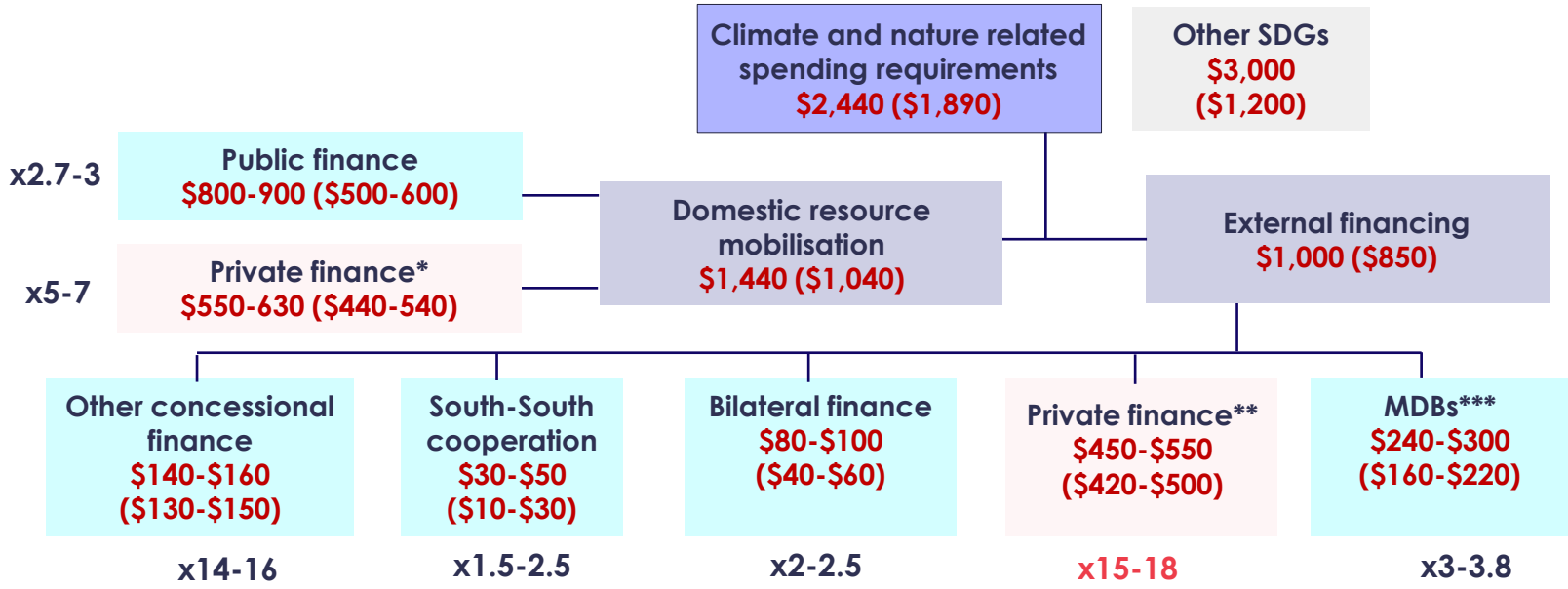
Five main investment areas



Source: Bhattacharya et al. (2024).
Increment from current in parentheses.

Financing the Green Transition ($ billion per year by 2030)

Four main sources (DRM, private, MDBs, concessional) which are complementary and mutually supportive



** Includes household savings.*
*** A significant proportion of this private finance would be directly and indirectly catalysed by MDBs, other development finance institutions and bilateral finance*
**** Includes multilateral climate funds.*

Most of the investment and innovation in this new form of growth will be from the private sector

Structure

- Where we are and where we should go: climate crisis and growth opportunity
- **Water resilience: economic resilience, investment, and growth**
- Lessons 20 years on from Stern Review: investment and growth in a changing world

Water resilience and economic resilience (I): stresses and risks

In the past three decades, total water **withdrawal per capita increased by more than 650% but per capita water resources decreased** in the majority of nations (WEF, 2025).

The largest change in water demand by 2050 is expected to occur in Sub-Saharan Africa, with a projected increase of 163%, followed by Latin America at 43% - mainly due to irrigation and domestic water supply (WRI, 2023).

Water shortages can lead to power outages, agricultural losses, industrial disruptions, and health problems, hindering growth and development (WRI, 2023).

The agriculture sector accounts for 70% of global freshwater withdrawals (UN, 2024).

Nearly 3 billion people and >50% of food production are in areas where total water storage is projected to decrease (GCEW, 2024).

Land use changes over the last half century have had the largest negative impact on freshwater ecosystems, with agricultural expansion being the primary driver of deforestation, altering the role of green water in the hydrological cycle, and impacting rainfall patterns – over 50% of the world's food production is rainfed (GCEW, 2024).

A higher proportion of **jobs** are water-dependent in low-income economies (79%) than in high-income ones (51%) due to the dominance of **agriculture** in the former (UNESCO, 2024).

However, developed economies depend on **virtual water trade** (the amount required to produce a good), which accounts for around 30% of freshwater withdrawals globally (Weko, 2024).

In the agricultural sector, the reliance on large water quantities must be reshaped. Increasing yield per water used is vital, and so too is preserving soil moisture (GCEW, 2024).

The energy sector accounts for around 10% of global freshwater withdrawals (IEA, 2024a).

At the same time, water supply depends on energy, and the growing pressure from climate change is projected to increase the energy consumption of water supply – e.g. with more water transport and desalination plants expected to be needed (IEA, 2024a).

Different pathways towards net-zero have different water use implications. In the energy sector, for example, wind energy needs less water than coal-based generation but, for example, bioenergy and the new hydrogen market are water intensive. Hydropower and nuclear are vulnerable to water stress (IEA, 2024b).

According to the Global Commission on the Economics of Water (GCEW) climate change-driven changes in rainfall patterns and rising temperatures, combined with declining total water storage and lack of access to clean water and sanitation could **cut on average GDP by 8% in high-income countries by 2050, and by between 10% -15% in lower-income countries** (GCEW, 2024). **Increased variance:** probabilities of droughts and floods both rising. Implications for investment, next slide.

Water resilience and economic resilience (II): systems and investment

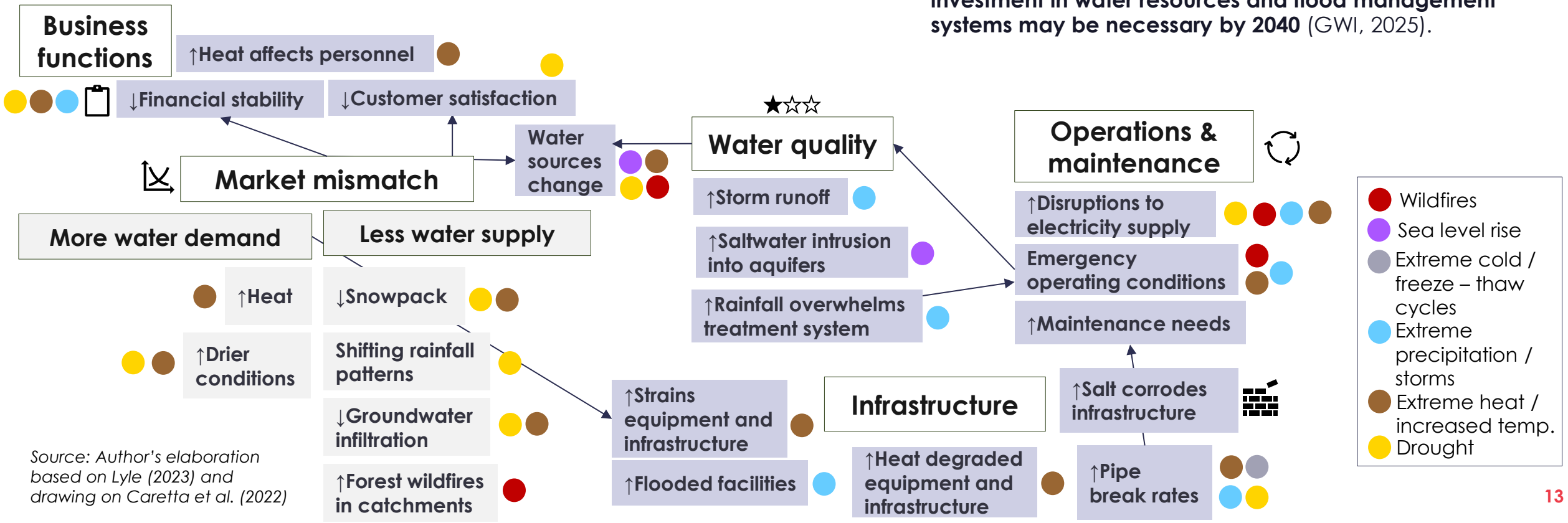
- **Given the impact of climate change on water, investing in adapting and building resilient water utilities is of the utmost importance. 90% of natural disasters are water-related (WaterAid, 2025).**

- **However, water supply and sanitation have been chronically underfunded (WEF, 2025), facing pressing issues such as ageing infrastructure.** McKinsey (2025) found that the US water utility sector faced an estimated $110 billion annual funding gap in 2024 (60% of utilities' overall spending), and that "three out of five utilities reported being underprepared to deal with future climate hazards" (p.4).

- **Considering climate impacts and risk analysis is crucial for informed decision-making and achieving future-proof investments.** Similarly, pricing climate risks into business models and linked revenue streams is also important (CPI, 2023). For example, investing in large-scale, single-crop agriculture, where total water storage may decline, can lead to the need for new dams, irrigation systems, etc. (GCEW, 2024).

- To achieve the same water security level that cities had in the past, **as much as a sixfold increase in capital investment in water resources and flood management systems may be necessary by 2040** (GWI, 2025).

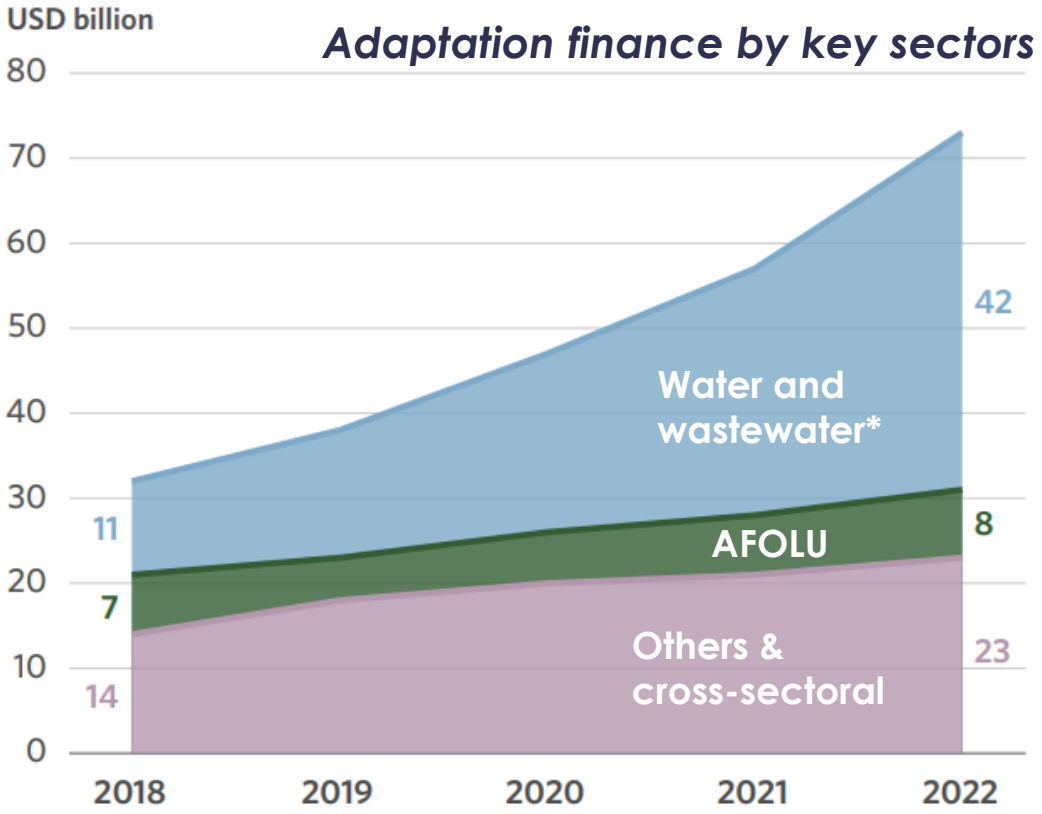
Climate change impacts water utility systems



Source: Author's elaboration based on Lyle (2023) and drawing on Caretta et al. (2022)

Water resilience and economic resilience (III): investment and finance

Between 2018 and 2022, most adaptation finance (44%) went to water and wastewater. This high share is both due to its relevance for floods and drought, and because large water and wastewater treatment and desalination plants are very capital-intensive. **These investments target climate-driven water stress through supply & treatment projects** (CPI, 2024; 2023).



Source: CPI, 2024

The annual investment gap for achieving SDG 6 (clean water and sanitation) in low-income nations is around USD 500 billion for 2023-2030. This includes investment in water sources, sanitation facilities, and wastewater management. **They should not be viewed as a cost, but as an investment to derive larger economic and social returns**. Indeed, investing in water infrastructure can generate multiple positive effects, including health benefits and increased job opportunities (GCEW, 2024). **Every $1 invested in adaptation can result in up to $10 in net economic benefits** (GCA, 2019).

Though water and wastewater adaptation finance grew between 2018 and 2022 (39% of total adaptation finance), funding and action in the water sector are still insufficient, with water-related climate finance representing a very small share of total climate finance (3% between 2016-20)(WaterAid, 2022).

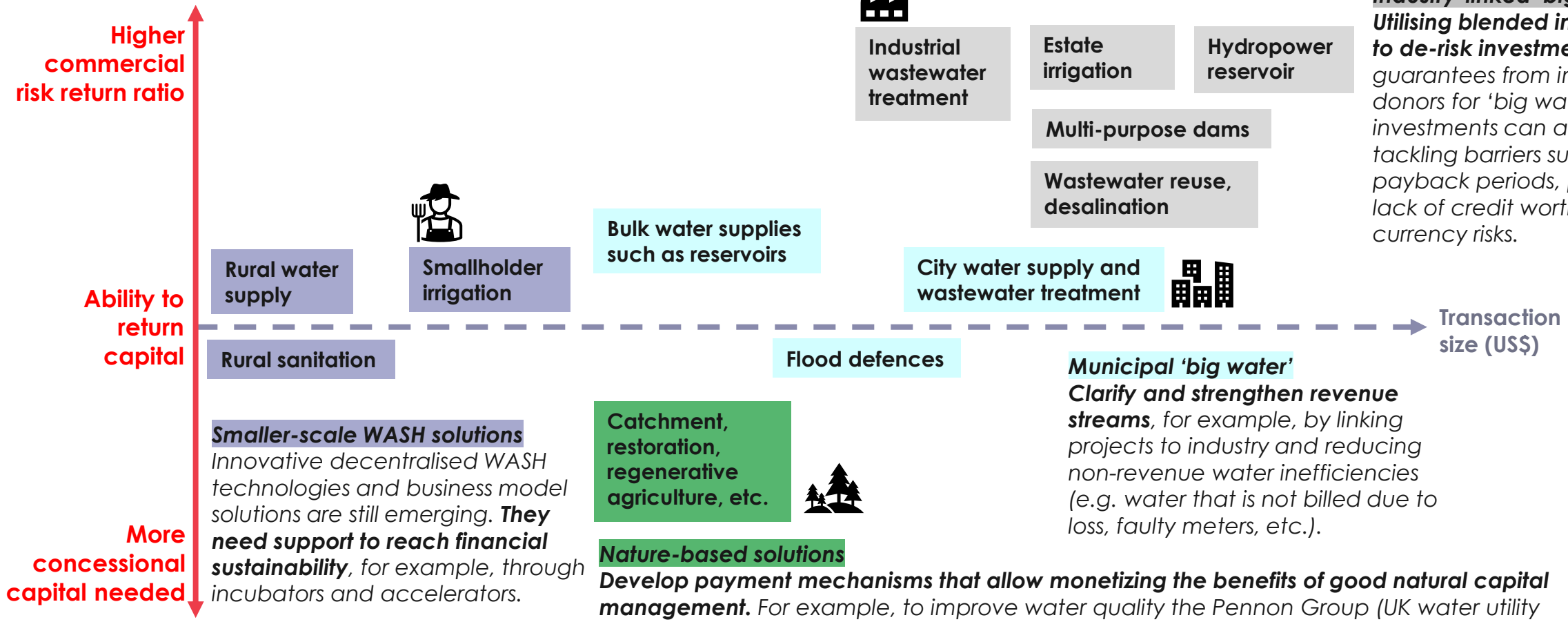
Public funding dominated adaptation flows, accounting for 92% in 2022. And 88% in the water and wastewater sector - but represents a small share of public budgets and is often a low priority. Investment in adaptation and resilience from private and public entities needs to increase (CPI, 2024).

It is important to crowd-in private finance in water-associated investments that could attract private finance at scale, such as large facilities to supply water and sanitation services**. Challenges include:** undervaluation of water, lack of standardised financing instruments, and the fragmentation of small-scale water-associated investments (GCEW, 2024) **(see next slide)**.

Unlocking investment: business models and blended finance

Water associated projects tend to have different returns and capital requirements from 'standard' projects. However, solutions can be identified when assets and services that require funding do not align with standard patterns of investor criteria (Blended Finance Taskforce & Systemiq, 2022). Different concessionality and blending necessary for different projects.

Examples of different water projects and examples of measures to unlock private investment (illustrative)



Industry-linked 'big water'
Utilising blended instruments to de-risk investments: *guarantees from international donors for 'big water' investments can aid in tackling barriers such as long payback periods, perceived lack of credit worthiness, and currency risks.*

Municipal 'big water'
Clarify and strengthen revenue streams*, for example, by linking projects to industry and reducing non-revenue water inefficiencies (e.g. water that is not billed due to loss, faulty meters, etc.).*

Smaller-scale WASH solutions
Innovative decentralised WASH technologies and business model solutions are still emerging. ***They need support to reach financial sustainability****, for example, through incubators and accelerators.*

Nature-based solutions
Develop payment mechanisms that allow monetizing the benefits of good natural capital management. *For example, to improve water quality the Pennon Group (UK water utility company) funds nature-based solution activities by farmers/landowners who then benefit from selling carbon credits. They use an independently verified Sustainable Financing Framework and reporting process that enables pooling smaller projects into green bonds while providing transparency to investors and avoiding having to raise finance deal-by-deal.*

Source: Author's elaboration drawing on Blended Finance Taskforce, & Systemiq (2022)

The opportunity ahead: smarter, climate-resilient water systems

Innovations, capacity-building and other investments must be evaluated beyond their short-run costs and benefits, considering how they can "catalyse long-run, economy wide benefits and hence dynamic efficiency gains through learning, scale economies and cost reductions" (GCEW, 2024, p.12).

Technology can aid in improving water productivity and lowering energy and chemical demand

For example, alongside smart meters to collect data, AI can improve the efficiency of water networks by predicting water demand fluctuations and trends, enabling sustainable usage patterns. Another example is internet of things-based irrigation systems, which can be used for applications to aid water users, e.g. farmers monitoring indicators such as soil moisture. And so too leakage detection, e.g. through fibre-optic leak detection technologies – currently, around 40% of urban water is lost through leakage due to ageing pipes.

Technology can aid in water recycling, desalination and conservation

For example, wastewater from one industrial process can often be reused with little or no treatment in another process. Around 8% of total freshwater withdraws could be reclaimed from wastewater every year – around the amount distributed by municipalities globally.

Technology can aid in measuring and maintaining high water quality

For example, AI algorithms can enhance treatment processes by predicting water quality and enhancing pollutant removal. Also, off-grid water treatment solutions can now deliver clean water to communities.

AI can also play a major role in identifying and understanding risks from climate change and thus helping design and manage adaptation and resilience

Building resilience depends, in large measure, on the integration of place-specific analysis of impacts and physical and other details of the place itself. AI can be a powerful tool in learning about and fine-tuning that integration.

Sources: WEF (2025) and GCEW (2024)

At the same time, data centres require water both directly, for cooling, and indirectly, e.g. for semiconductor manufacturing. But water use varies by centre (due to cooling technology, local climate and electricity supply source). **Upstream design and planning are vital to increase water efficiency and prevent unsustainable extractions** – e.g. Google's data centre in Hamina, Finland, leverages its sea proximity by using seawater for cooling (GCEW, 2024).

Can greatly improve productivity and quality in water usage and management. Reliability, quality and adequate water improves overall productivity and health. Together, these provide **stronger and better growth**.

Structure

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Reflections 20 years on from Stern Review

The risks of inaction increased

The IPCC warnings on the strength of the effects of climate change and the confidence in the conclusions have grown ever stronger.

- For example, in contrast to 1990, when the IPCC could not confirm that climate change was human-induced, the 2021 AR6 report states **there is 'overwhelming' evidence of climate change and identifies human activities as its primary cause.**

From cost to investment opportunity

Back then, it was assumed that low-carbon sources of energy and activity were more costly than fossil-fuel sources. For example, for the UNFCCC, 1992, the question of who pays for the extra cost of the clean was central.

That has changed. For example:

- We did not anticipate that **the cost of solar electricity would drop by 80% over the next decade and continue falling rapidly thereafte**r.
- Nor that by 2024, most car manufacturers would build their planning around the **end of the era of the internal combustion engine.**

Achieving net zero is essential

The Paris Agreement looks to a balance of sources and sinks or net zero, whereas the Stern Review (on which we began to work on a decade before) took the weaker criteria of cutting emissions by 80% between 1990 and 2050 – net-zero is a 100% reduction.

- **Net zero is a criterion which should be embraced by all since the amount of net negative emissions is likely to be small.** With an 80% target, all too many could see themselves in the remaining 20%.

The role and importance of natural capital

I would now give still stronger emphasis to natural capital as a whole, particularly biodiversity. Now I would speak of sustainability rather than narrowly climate.

- **Sustainability is about offering to future generations opportunities at least as good as ours** and that is clearly broader than climate.
- **Water systems and resources as natural capital:** we need to "redefine the way we value water and govern the water cycle as a global common good" (GCEW, 2024, p.12).

Notwithstanding, the three central conclusions of the Stern Review stand:

! *(1) 'the benefits of strong and early action far outweigh the economic costs of not acting.' (Stern, 2007, p. xv).*

$ *(2) the 'world does not need to choose between averting climate change and promoting growth and development' and 'tackling climate change is the pro-growth strategy for the longer term' (Stern, 2007, p. xvii).*

⚖ *(3) '[c]limate change is the greatest market failure the world has ever seen' (p. xviii) and '[a] range of options exists to cut emissions; strong, deliberate policy action is required to motivate their take-up.' (p. xvii).*

Strategic and clear long-term policies, public action, private investment and innovation. A changing world.

It is the private sector that has special insight into obstacles to entrepreneurship, creativity, and investment and into how they can be overcome. And it can identify opportunities and expand options for action. Including in system design.

- The private sector has driven down the costs of clean energy and transport, along with significant advancements in battery technology and cost reduction.
- The private sector is also being instrumental in driving the transformation brought by AI, which has a huge potential to accelerate the process of investment and transformation of our economies. Public-private participation in system design is likely to play an increasing role in the future of the transition.

It is the state which sets the framework, country by country.

- Substantial and coordinated public, concessional, and private capital are needed to correct for many decades of underinvestment in the water sector. Nearly $7 trillion in water-related infrastructure will be required globally by 2030 (World Bank, 2024a).
- Public and private investment in water infrastructure should be forward looking and strategic, not short-term and reactive. The latter approach leads to service disruptions, leakage and higher long-term costs (GCEW, 2024).
- Multi-level and multi-stakeholder coordination is central: water governance has typically been limited by inadequate and siloed capacities, with insufficient coordination (WEF, 2025).
- No single policy can achieve increased efficiency, equity, and environmental sustainability at the same time. Important to implement policy packages that address trade-offs – e.g. higher water prices might lead to higher efficiency but damaging for poor people, compensation might be needed there (GCEW, 2024).

International action in a changing world.

- The Paris Agreement set a lasting framework and sense of direction.
- Vacillation damages investment and raises the cost of capital.
- The transition to a low-carbon and resilient economy is inevitable but must accelerate.
- When some countries or international institutions step back others will step forward.

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