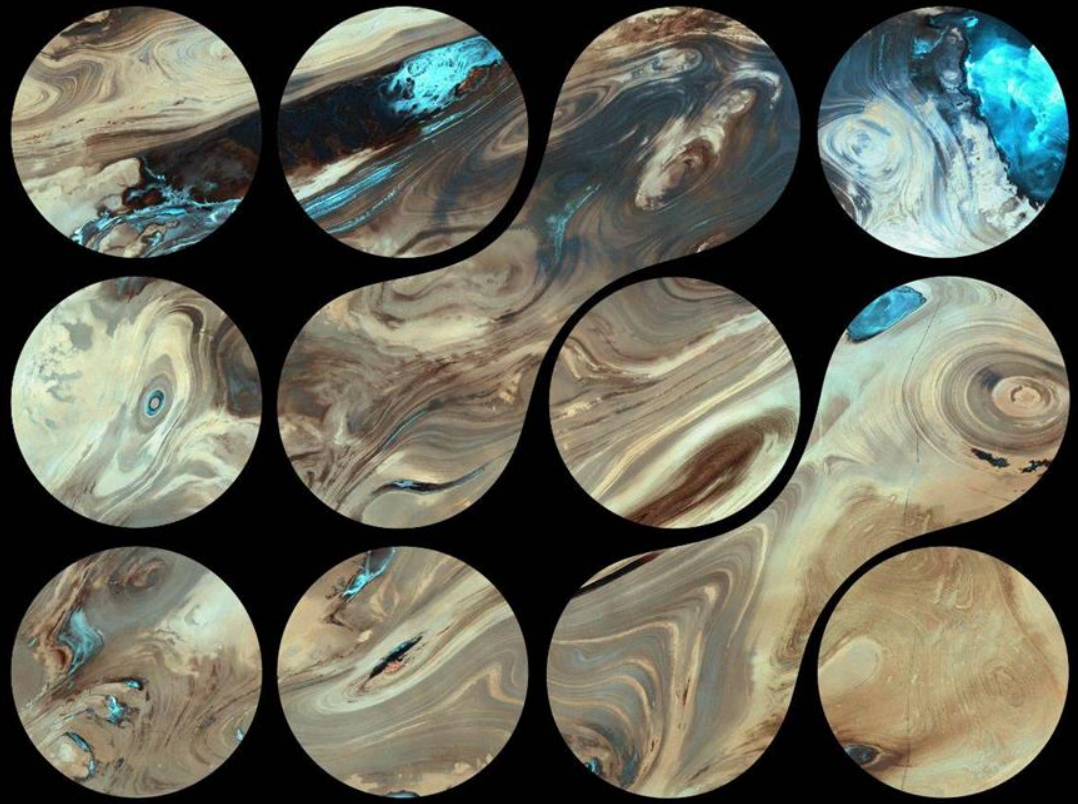
EVIDENCE – NOT GOVERNMENT POLICY

Global Megatrends

10 global megatrends (GMTs) shaping the world we live in

4th edition
2024



Department for Environment Food & Rural Affairs

Contents

Introduction

Our world is increasingly defined by polycrises, where interconnected global challenges in politics, climate, technology, and society converge. Understanding the deep historical roots of these complex issues is now more essential than ever. This global megatrend report for 2024 identifies 10 trends, each with origins stretching from over 50 years to over 12,000 years, that shape today's complex policy landscape. These global megatrends span continents, sectors, and domains, showing how long-standing forces such as demographic shifts, technological evolution, and geopolitical power realignments continue to shape the global context.

The report underscores how these trends are interconnected, revealing the entangled nature of the issues facing government today. To navigate this landscape, decision makers must adopt systems-thinking approaches that address the complexity of overlapping challenges. Understanding these deeply embedded forces is critical to shaping resilient policies and sustainable strategies and providing a clear roadmap for tackling the future ahead.

This report was externally commissioned by Defra for research purposes, produced by futures consultants Andthen, and does not represent Defra's views nor official government policy.

What is a Global Megatrend?

The term 'megatrend' was first coined over 42 years ago by John Naisbitt and since then, there has been a continuous increase in megatrend publications, with the UK ranking as a top 5 'producer'. Only 38% megatrend publications explicitly include a definition, however in their systemic review, Naughtin et al found that megatrends consistently refer to trends that (a) cover multiple domains, (b) exert significant force, (c) have global breadth and (d) have a long-time span (Naughtin et al, 2024). Therefore, for the purposes of this publication, we define a global megatrend as:

A structural force defining the broad nature of future operating environments. As phenomena, they present over large geographical areas (more than one continent) and over a significant period of time (at least a decade). They are transboundary; influencing multiple systems (e.g. food and healthcare) and domains (e.g. air, land, water, space, cyber). Megatrends are aggregates, they homogenise emerging trends; sacrificing nuance and variability for generalisability.

Global megatrends have a forward-moving directionality (ibid) but they are not predictive forecasts. We qualify a potential global megatrend by breaking it down into its three constituent parts (Fig 1). To verify our observation of historical, patterned phenomenon we then ask: Is it global? Is it mega? And is it a trend?

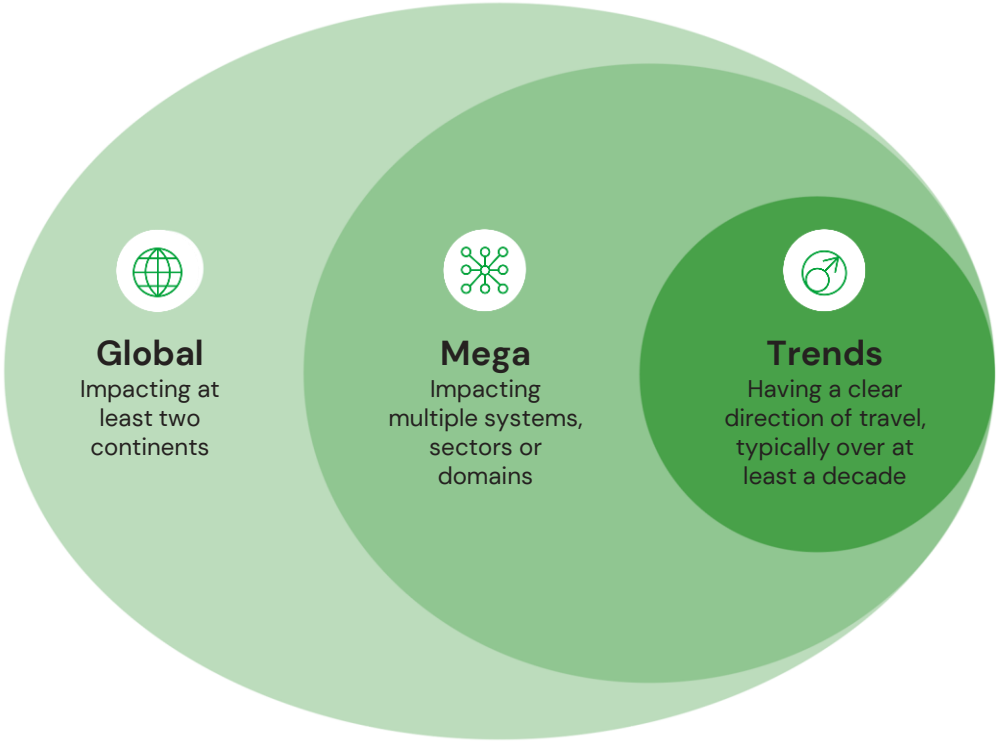


Figure 1. *Constituent parts of a Global Megatrend*

Methodology

An initial comparative analysis of 24 global megatrend reports was conducted - mainly produced by governments, consulting firms and large NGO's - to identify trends most frequently reported as global and mega. Our analysis identified 19 potential megatrends. From this, we conducted a gap analysis with the Defra Group 2022 Global megatrends and shortlisted 13 potential global megatrends to carry forward for initial desktop research of primary and secondary sources from relevant literatures. Noting the importance of semantics (von Groddeck and Schwarz, 2013), we refined and adjusted the global megatrend titles. We eventually developed 12 global megatrends which were individually scrutinised by an international group of 44 experts from government, academia, industry, and NGOs through 'challenge sessions.' From our list of 12 draft global megatrends, 'Declining Democracy' and 'Increased Entanglements of Emerging Technologies' were removed as they did not meet the evidence threshold against our definitional criteria (Box 1).

We used historical analysis to determine the origin point of the trend and then sought metrics that had been tracked over that time period (e.g., global mean surface temperature; Gross Domestic Product (GDP)) to assess the trajectory. Where no single measure captured the global megatrend, we amalgamated metrics (e.g., political stress; global peace; military expenditures and the number of active conflicts).

For methodological limitations, see page 77.

Box 1. Commonly cited megatrends with evidential challenges

Declining Democracy, while covered extensively in other global megatrend products, was removed from this report due to concerns that high-profile western examples of declining democracy are skewing the global perception of democracy, and a lack of sufficient evidence that democracy is in fact declining on a global scale, especially when considered across a deep time perspective.

Increasing Entanglements of Emerging Technologies, was removed due to challenges around definitively measuring and therefore, evaluating the trend. While experts in the corresponding challenge session agreed on an observable change in technological progress, such impacts were challenging to define and uniformly describe across a range of different emerging technologies. No effective measurement of 'entanglements' was defined to support this trend, and no other effective framing of this global megatrend was identified. However, we strongly recommend this as an area of research for subsequent iterations of this report and other megatrend products.

Origin points – a new methodological contribution

Trends, by definition, are historical. Most megatrend publications however are projections. Rather than predictive forecasts, we build on the following suggested use of megatrends - 'to help people identify the bigger movements at play' (James, 1997, von Groddeck and Schwarz, 2013). It is only by distinguishing *when* the trend first originated that we can assess the *force* or *size* of the trend and determine its relative stability over time.

We define an origin point as the point at which there is a clear demarcation between a past and a new operating environment. This represents a discontinuity event, a break from the previous megatrend, or a bifurcation (Laszlo, 1985).

We established a global megatrends' origin points through secondary research to (a) determine the earliest records (e.g., historical texts and artifacts) and/or observations (e.g., through paleoclimate measurements, archaeology, carbon dating) of the phenomena, when it appears in more than one continent and starts impacting multiple systems, sectors or domains. We then (b), identified the preceding trending conditions of the phenomena to ensure the global megatrend is distinctive (for example Table 1).

Period	Global Megatrend
c.1820 – present	'Continued Pursuit of Economic Growth'
c.4300 BC – c.1820	'Increasing accumulation of private-property (neolithic revolution)'

Table 1

Carbon dating of archaeological evidence from burial sites (etc.) shows a clear trend of increased private-property during the neolithic period following a transition from hunter-gathering (epoch a) towards sedimentation (epoch b). We can see a clearly demarcated modification toward the pursuit of *production* from the industrial revolution out of Britain and in two or more continents by c.1820-1850.

What is in each section?

Title slide

This contains the name and summary of the trend with accompanying image, and a depiction of trend origin and length.

Timeline

Each global megatrend has a timeline, starting with the origin point. This includes a 'preceded by' section, highlighting the difference between before and after the origin point. The timeline also includes historical milestones up to present day.

Overview

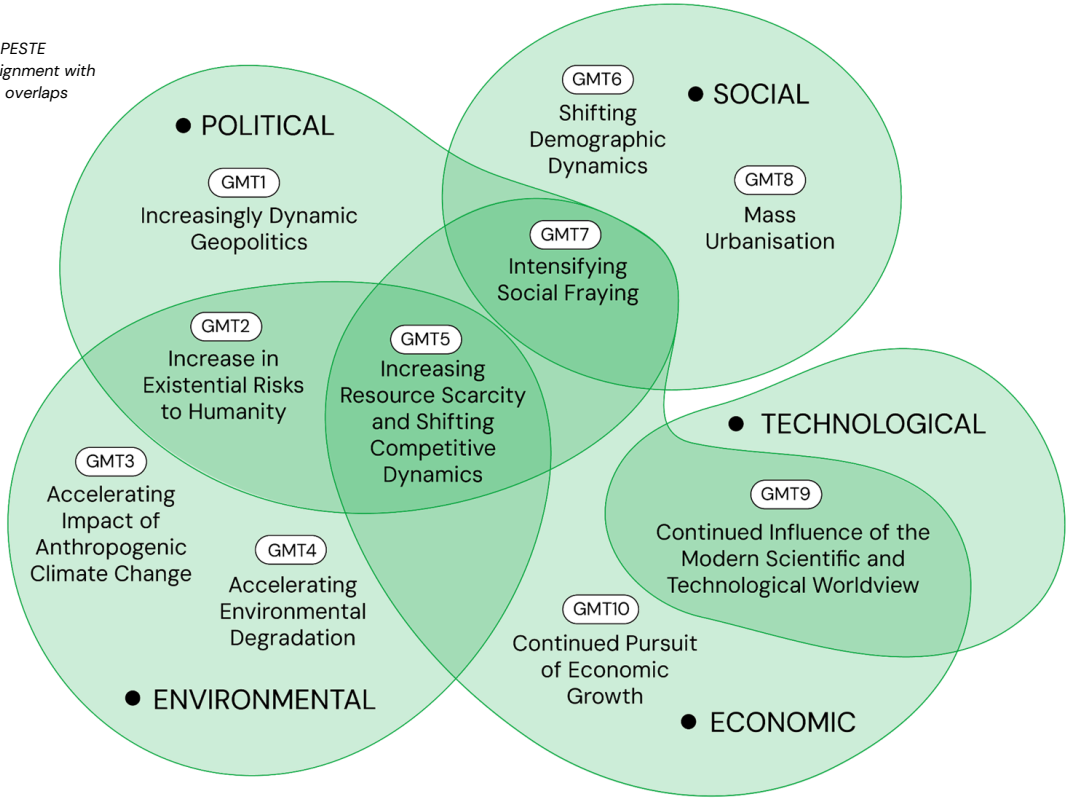
The overview is a referenced description of the trend, touching on historical turning points, and light touch analysis of the implications of the trend. One or two indicators of the trend have been included in graphical or tabular format, showing a change in that indicator over time. This has been used as a proxy as a global megatrend can be measured in a number of ways.

Advancing/Constraining factors/indicators

The final slide for each trend illustrates a few advancing and constraining factors and/or indicators. These factors, if they came to pass, would have an impact on the future direction of the global megatrend. Additional indicators are also included, as measuring these may show a direction of change of the trend.

The Trends Shaping Our Futures

Figure 2. *Global megatrends mapped according to PESTE categories. The positioning reflects their primary alignment with these categories, though additional, unrepresented overlaps exist across these categories*



GMT Time Horizons

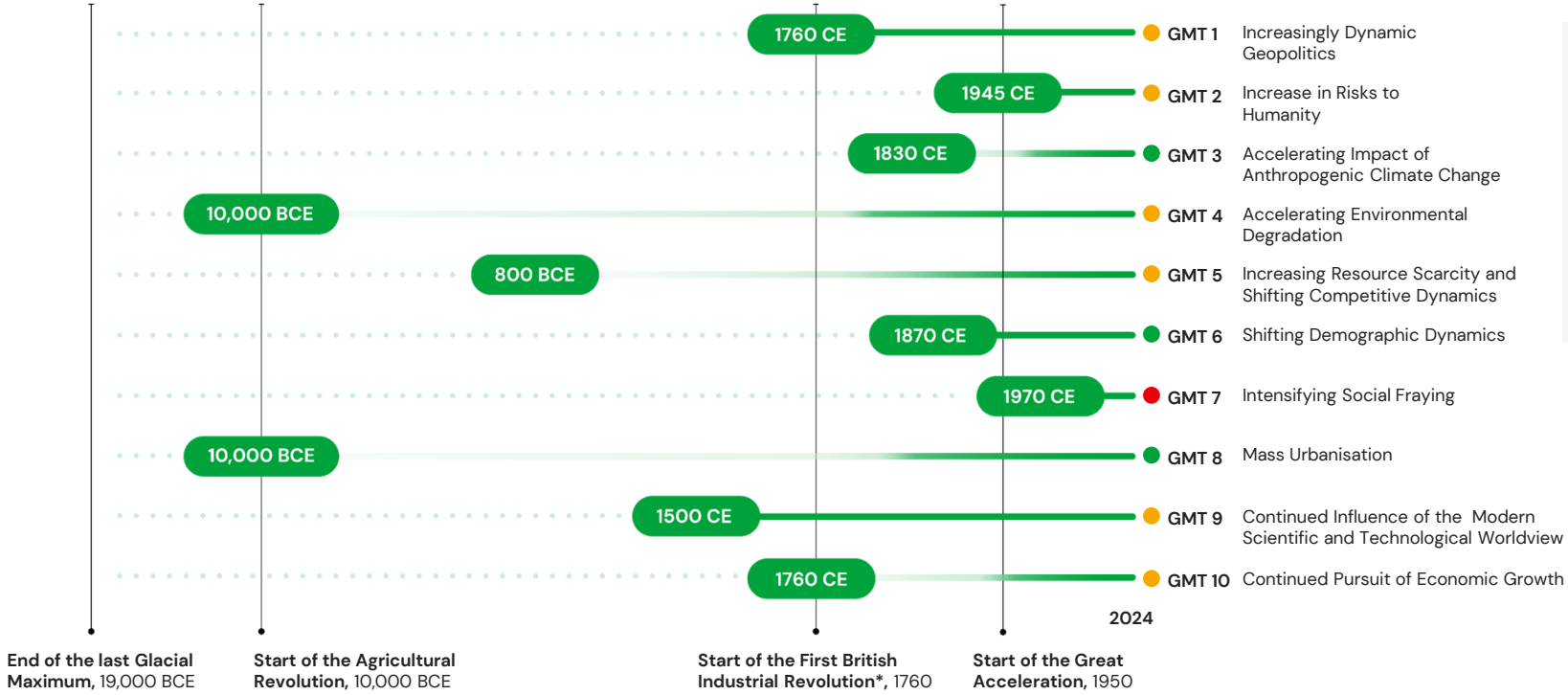


Figure 3. *Origin points of the global megatrends. Note- *hereafter referred to as the Industrial Revolution*

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GMT 01

Increasingly Dynamic Geopolitics

This trend describes the increasing dynamism of geopolitics over the last 260 years, originating with the onset of the first Industrial Revolution in approximately 1760 CE, which initiated a sustained international competition for resources, innovation and progress. It is measured using indicators like Turchin's Political Stress Indicator, and The Global Peace Index, as well as military expenditures and the number of active conflicts.

Trend length: **260 years**

1760 CE

Overview

1760 CE — Present

The first Industrial Revolution in Britain, around 1760 CE, reshaped global competition, driving other nations to industrialise to keep pace. Britain's dominance spurred international rivalries, competition over resources and colonial expansion, transforming economic relations and intensifying tensions, especially across Europe and Asia (Dewanaranya et al, 2021; Al-Rodhan et al 2014). While geopolitical tensions existed earlier (e.g., during the Mongol conquests of the 1200s–1300s), the Industrial Revolution marked a turning point that intensified the focus on resource access, competition, and related geopolitical strife. This period laid the groundwork for the geopolitical landscape of the 19th and 20th centuries, as subsequent industrial revolutions shifted advantages to emerging powers like the United States and later East Asia. Each industrial revolution redefined global competitiveness, with nations that fell behind taking strategic steps to catch up (Dewanaranya et al, 2021).

Following the Soviet Union's collapse in 1991, the rise of the unipolar U.S.-led order was observed. This began fragmenting with China's rise challenging U.S. influence, particularly economically and technologically (De Graff et al, 2020). Russia's 2022 invasion of Ukraine further tested European unity and multilateralism (European Commission, 2023), with military expenditure in 2023 reaching a record $2,443 billion (Fig. 5), indicating a heightening of global tensions (Tian et al, 2024).

Turchin's political stress indicator (Fig. 4), one indicator for geopolitical tension, reveals increasing global instability driven by elite overproduction and rising inequality (Turchin et al. 2020). Meanwhile another notable measure, the Global Peace Index, registered a decline of 0.42% in 2023, and has done so for 13 out of the last 15 years (Institute for Economics and Peace, 2023).

However, geopolitical tensions are both increasing and fundamentally changing. They now include hybrid threats—cyberattacks, disinformation, and economic coercion—extending competition to new arenas like cyberspace, oceans, and space (NATO, 2024). These non-conventional threats often represent a 'battle of narratives' where Western ideals face growing challenges. Additionally, the increasing influence of corporate interests on geopolitical issues, such as access to resources, adds complexity to the geopolitics (Kennedy, 2017).

Figure 4

Turchin's Political Stress Indicator

Source: Turchin et al. 2020

Figure 5

Global Military Expenditure (normalised to US dollars at 2022 prices and exchange rates)

Source: Stockholm International Peace Research Institute, 2024

Figure 4

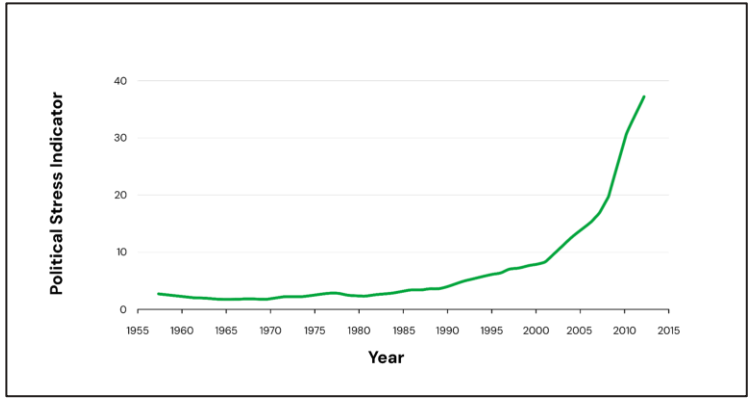
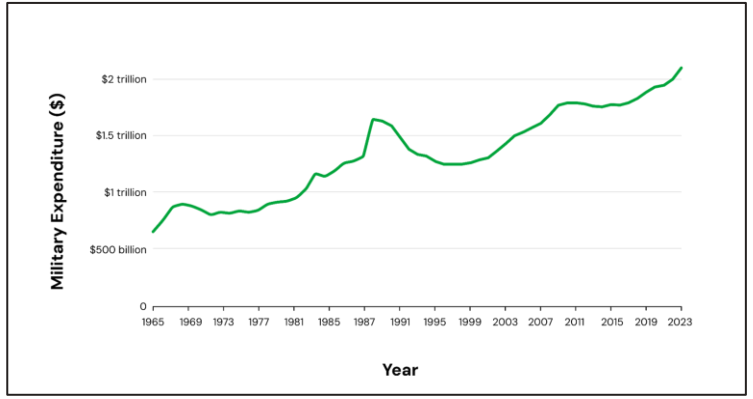


Figure 5



Origin

The First Industrial Revolution

1760 CE - 1840 CE

The First Industrial Revolution marked a significant shift in economic and social structures, particularly in Britain, which transformed global power dynamics through technological advancements and access to resources. With innovations like the steam engine, the British textile and iron industries flourished. This era accelerated European colonial expansion, as the quest for raw materials and markets grew in intensity, fuelling related geopolitical tensions (Mohajan, 2019; Dewanarayana et al., 2021).

Preceded by: **Western Colonialism and Imperialism**
15th-19th Centuries

World War II

1939-1945

World War II caused massive destruction and fundamentally reshaped global power structures. In its aftermath, the United Nations was formed in 1945 to promote collective security and prevent future conflicts, marking a significant step toward global cooperation in addressing international issues (Lowe et al, 2006; Overy, 2013).

Post-Cold War Power Shifts

1990's and 2000's

The end of the Cold War and the dissolution of the Soviet Union in 1991 established a unipolar world with the U.S as the dominant power. However, the rise of other powers, including China, Russia's resurgence (evident in actions in Georgia and Crimea), and the EU's integration, began to challenge this unipolar structure (Ikenberry, 2008; Nye, 2015).

Fourth Industrial Revolution

2010 - Present

The Fourth Industrial Revolution has driven exponential advancements in automation, AI, and digital technologies, reshaping the competitive landscape globally. This era has shifted manufacturing and tech leadership, particularly toward East Asia, challenging traditional Western dominance and intensifying the global race for technological superiority (Schwab, 2019).

1760 CE — 1800 CE — 1919 CE — 1939 CE — 1990 CE — 2001 CE — 2010 CE — 2022 CE

The Great Divergence

1800-1890 CE

England's economic leap ahead of Eurasia in the 1800s, known as the 'Great Divergence', was driven by two key advantages: accessible coal reserves and a wealth of resources from the Americas. This economic shift also reflected increasingly dynamic geopolitics, where Western Europe's closer proximity to these resources gave it a competitive edge over Eastern Eurasia, reshaping global power dynamics and setting divergent economic paths for these regions (Pomeranz, 2000).

Interwar Period and Rise of Totalitarianism

1919-1939

The Treaty of Versailles (1919) redrew national boundaries, fostering resentment and laying groundwork for future conflict, while the Great Depression deepened economic hardship worldwide, fuelling the rise of totalitarian regimes. This period saw an ideological clash between fascism, communism, and liberal democracy, which began to shape global alliances and rivalries (Keylor, 2001; Mazower, 1998).

The Global War on Terror

2001 - Present

The Global War on Terror, launched after the September 11, 2001 attacks, led to prolonged conflicts in the Middle East, including the Iraq War (2003–2011). These interventions contributed to enduring regional instability and intensified geopolitical rivalries, reshaping U.S. foreign policy and international alliances (Byman, 2007; Gerges, 2011).

Russia's invasion of Ukraine

2022 - Present

Russia's full-scale invasion of Ukraine in 2022 led to severe economic sanctions, reconfiguring global alliances and prompting increased military spending and energy crises across Europe. This conflict has heightened East-West tensions and shifted NATO's strategic focus, profoundly impacting the geopolitical balance of power (Mearsheimer, 2022).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Constrains the trend

Race for Global Supremacy

- Military expenditure as % of GDP
- Diplomatic relations indicating rivalries
- Patents in defence-related technologies
- Trade and tariff conflicts

Nationalism and Populism

- Number of nationalist or populist leaders and parties in power
- Policy agendas focused on national sovereignty and anti-globalisation
- Increase in protectionist policies

Regional Conflicts

- Frequency and intensity of military incidents in disputed regions
- Increased tensions and likelihood of conflict escalation

International Cooperation

- Number and scope of joint international agreements
- Financial commitments to global challenges
- Institutional trust in multilateral governance bodies

Economic Interdependence

- Volume and value of international trade and investment flows
- Number of bilateral and multilateral trade agreements
- International corporate supply chains

Technological Collaboration

- Funding of collaborative technological initiatives
- Patents and innovations resulting from international cooperation
- Funding committed to international research and development projects

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GMT 02

Increase in Risks to Humanity

This trend describes growing global concern amid increasing existential risks over the last 79 years, originating with the Trinity atomic bomb test in 1945 CE. This trend marks a shift from the preceding era where overall risk started to increase, as existential risks created by human progress overtook exogenous risks, like natural disasters, due to a combination of their probability and consequence. This trend is measured by the number of risks that have a plausible capacity to cause the extinction of humans as a species or permanently limit its potential.

Trend length: **79 years**

1945 BCE

Overview

1945 CE — Present

Existential risks are threats that could annihilate humanity or permanently limit its potential (Bostrom, 2002). Though no such disaster has occurred, the closest humanity came to extinction was around 70,000 years ago when a series of extreme weather events left only a few thousand human survivors (UNDDR, 2023).

While exogenous risks such as natural disasters have always existed, the first atomic weapons test in 1945 marked the beginning of existential risks generated by human progress, and the origin point of this global megatrend. Whilst the destructive potential of first-strike warheads peaked at more than 15,000 Mt in the early 1980s, enough to destroy 40% of urban land worldwide, it still stands at >2,500 Mt, with the potential to directly destroy almost 7% of urban land worldwide (Fig. 6) (Herre et al, 2024). Furthermore, atmospheric soot loadings from nuclear weapon detonation would cause disruptions to the Earth's climate, limiting terrestrial and aquatic food production, with estimates of up to 5 billion deaths from a 1 week nuclear war between the United States and Russia (Xia et al, 2022).

Nuclear technology introduced risks on a planetary scale, surpassing natural events as the primary threat to humanity's survival. Nuclear technology also revealed the interconnected nature of global risks, highlighting how geopolitical tensions and technological advancements add layers of risk (Beard et al, 2024; UNDDR, 2023).

However, aggregated estimates suggest a probability of somewhere between 1.9%–14.3% for an existential event this century (UNDDR, 2023) and there is agreement that overall catastrophic risk has been increasing in recent years, particularly from AI, nuclear war, climate change and engineered pandemics (Fig. 7) (Willis et al, 2024). All of them are anthropogenic existential risks which have emerged or significantly intensified since the origin point of this megatrend.

Today, existential threats are compounded by a state of polycrisis, eroding global resilience, and heightening vulnerability to cascading crises, ultimately increasing the levels of existential risk (Manheim, 2020). For example, climate change, which contributed to approximately 5 million deaths between 2000 and 2019 (Zhao et al., 2021), exacerbates interconnected risks such as biodiversity loss, resource scarcity, food security, and zoonotic pandemics, many of which can fuel geopolitical conflicts (UN, 2024; Meadows et al, 2023; Willcock et al, 2023).

Figure 6

Estimated explosive power of nuclear weapons over time by certain nuclear powers.

Source: Herre et al, 2024

Figure 7

Analysis of Changes in Individual Global Catastrophic Risks in the Next Decade

Source: RAND, 2024

Figure 6

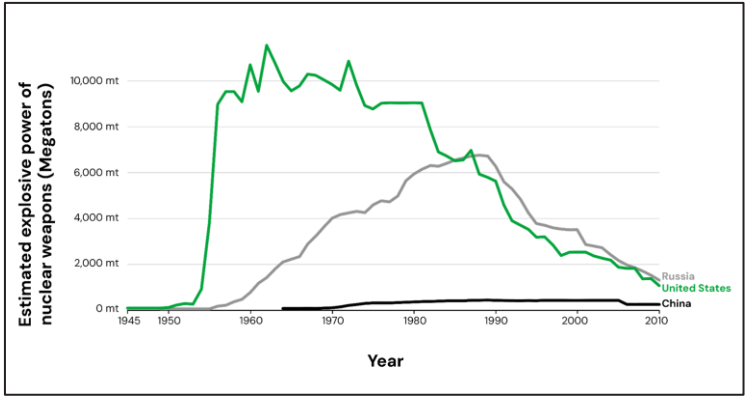

Figure 7

Changes in Individual Global Catastrophic Risks in the Next Decade

Threat or Hazard	Change in Risk	Hazard-specific Reason for Potential Change	
		Increase	Decrease
AI	↑	Advance of technology	Global agreement on norms, regulations, and policies and advancement or technologies for safe AI development
Nuclear War	↑	Increased potential for conflict among nuclear armed powers caused by nuclear proliferation and increased potential for conflict among existing nuclear-armed states	Increase global agreement on nuclear weapon development and control
Climate change	↑	Increased emissions, latent warming, large gaps between policy action and policy goals, adverse climate feedback	Rapid advance of decarbonization and adaptation technology and implementation; increased global cooperation on climate policy
Pandemic	↑	Increased capability for bioterrorism; increasing human travel and contact with novel pathogens in nature	Improved detection, treatment, and vaccines; improved global coordination on biosurveillance and MCM development and production

Origin:

The Trinity Atomic Bomb Test

1945 CE

The Trinity Atomic Bomb Test marked the advent of nuclear weapons, initiating an era of mass destruction capability and leading to subsequent conflicts, an arms race, and existential risks tied to nuclear proliferation. This initial test underscored the devastating potential of atomic energy, prompting international efforts for control and raising ethical and security concerns (Rhodes, 1986).

Preceded by:
World Wars Period
1914 CE - 1945 CE

Climate Change

1970s CE- Present

Since the 1970s, climate change has increasingly been recognised as a profound risk to humanity. Early warnings by scientists, like the U.S. National Academy of Sciences in 1979, highlighted the potential of CO_2 emissions to drive global temperature increases and destabilise ecosystems (NAS, 1979). The 1988 establishment of the Intergovernmental Panel on Climate Change (IPCC) solidified this concern, and by 1990, the IPCC's First Assessment Report underscored the likelihood of severe impacts on natural and human systems due to rising temperatures (IPCC, 1990).

Covid-19

2020 CE - 2022 CE

The COVID-19 pandemic highlighted the risks of zoonotic diseases and global pandemics; threats identified as early as the 1980s was due to increased human-wildlife interactions and disease surveillance (Morse et al, 1990). Accelerated human encroachment into natural habitats, globalised trade and travel have heightened the risk of outbreaks, with COVID-19 exposing vulnerabilities in health systems and global preparedness. This pandemic showed how a novel pathogen could disrupt societies and economies on a global scale, emphasising the critical importance of pandemic preparedness to mitigate existential risks (Jones et al., 2008).

Cold War

1947 CE - 1991 CE

After World War II, intense geopolitical rivalries between the United States and Soviet Union led to an arms race, with both superpowers amassing nuclear arsenals and establishing nuclear warfare as a probable existential risk (Gaddis, 2005; Rhodes, 1986). The Cuban Missile Crisis in 1962 brought the world to the brink of nuclear conflict, highlighting the dangers of escalation and catalysing policies for nuclear de-escalation, such as the 1968 Nuclear Non-Proliferation Treaty (Allison, 1971; Freedman, 2003).

Recombinant DNA

1974 CE

The development of recombinant DNA technology allowed scientists to splice genetic material across different organisms, marking a transformative moment in biotechnology (Jackson et al., 1972). This capability sparked ethical debates, as scientists and policymakers began to consider the potential risks of genetic engineering (Schleidgen et al, 2020). Recombinant DNA technology opened pathways for genetic manipulation, laying the groundwork for advanced gene-editing tools like CRISPR, with implications for both medical breakthroughs and bioterrorism.

Dual-use Risks of Artificial General Intelligence

2022 CE - Present

Advancement of artificial general intelligence (AGI) is reshaping industries and societies at a rapid pace. ChatGPT reached 100 million users in two months, the fastest growth of a service ever (Ebert et al, 2023). AGI's potential for unrestricted development, deployment and access elevates its dual-use risks that can accelerate existential threats, such as biowarfare (Mouton, 2023) and engineered pandemics (Bloomfield et al, 2024).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Armed Conflicts

- Increase in global military spend
- Increase in active armed conflicts
- Increasing size of nuclear arsenals
- Frequency and intensity of cyber warfare incidents

Climate Change

- Rise in emissions
- Increase in species extinction rates
- Deforestation rates in critical regions
- Frequency of extreme weather events
- Exceeding planetary boundaries

Global Fragility

- Fragile States Index
- Decreased participation in multilateral bodies
- Erosion of trust in political institutions
- Social polarisation

Constrains the trend

Technological safeguards

- International agreements to mitigate technology risks
- Ethical guardrails in AI and biotech
- Investment in cybersecurity
- Increase in regulations focusing on technological safeguards

Eco centric Policies

- Expansion of protected natural areas
- Increase in carbon pricing mechanisms and incentives
- Successful fossil fuel phase-out targets
- Commitments to international ecological agreements, regulations and standards

International Trust and Cooperation

- Increased number of diplomatic agreements and treaties signed
- Increased participation in multilateral bodies
- Global alignment and collaborative action on critical and existential issues

Existential Risk Management

- Development and adoption of existential risk frameworks
- Funding for research on global existential risk reduction

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GMT 03

Accelerating Impact of Anthropogenic Climate Change

This trend describes the global and accelerating impact of human-induced climate change, originating in the 1830s, because of changes to atmospheric chemistry driven by the Industrial Revolution. This trend marks a shift from the previous era, where Earth's temperature has remained stable for approximately 11,700 years. This trend is measured by global temperature rise, greenhouse gas concentrations, and the increasing frequency and intensity of extreme weather events.

Trend length: **194 years**

1830 CE

Overview

1830 CE — **Present**

Anthropogenic climate change originated towards the end of the first industrial revolution, in around 1830, as human efforts to industrialise started to change the chemistry of the atmosphere, adding carbon dioxide to the air, and contributing to a sustained increase in global average temperatures (Fig. 8) (Abram et al, 2016). This was a significant change from the preceding era, marked by the end of the last glacial maximum and the start of the Holocene around 9700 BCE, across which Earth's climate remained stable.

While the anthropogenic impacts of climate change were not seen until the early 19th century, the roots of this impact can be traced back further to the early human-environment relationship in Ancient Greece, where distinctions were made between the material and spiritual worlds, a paradigm that laid the foundation for ideas of ownership and exploitation of nature (Glacken, 1967).

The accelerating impact of human-induced climate change has led to unprecedented shifts in the Earth's climate system, with global temperatures rising by between 1.2 and 1.3°C since pre-industrial times (Met Office, 2024). Increasing concentrations of greenhouse gases have now reached levels higher than at any time in at least 2 million years (IPCC, 2021). This has resulted in an increased frequency and intensity of extreme events such as heatwaves, floods, droughts, tropical cyclones, and wildfires. Further increases in global temperatures are likely to trigger critical tipping points, such as the collapse of major ice sheets in Greenland and West Antarctica, the thawing of permafrost, and the disruption of the North Atlantic subpolar gyre circulation (Nature, 2019). These changes would have profound impacts, potentially resulting in sea-level rise that would threaten coastal communities worldwide, loss of biodiversity through mass die-offs of ecosystems such as coral reefs, and heightened risks to global food and water security (UN, 2022; IPCC, 2019).

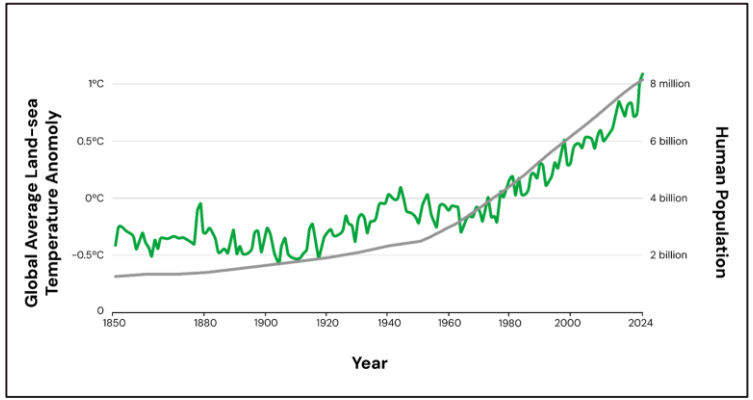
According to data presented to COP27 in 2022, unabated climate change will cause 3.4 million deaths annually by 2100 (V20, 2022). Impacts vary widely across regions, disproportionately affecting the Global South, which accounts for a small share of historical emissions yet experiences some of the most severe consequences (Science Advances, 2021).

Figure 8

Global temperature change mapped against global population

Source: Our World In Data

Figure 8



Origin

End of the First Industrial Revolution

1830 CE - 1840 CE

The onset of the Industrial Revolution marked a major turning point, with the transition from agrarian economies to industrial production powered by coal. The widespread use of fossil fuels for manufacturing, transportation, and energy dramatically increased carbon dioxide emissions (Steffen et al., 2008).

Preceded by:
Stable temperatures of the Holocene
9,700 BCE - 1830 CE

The Great Acceleration

1950s CE - Present Tipping Point

Post-World War II economic growth saw a sharp increase in global consumption, urbanisation, and technological development. This period witnessed unprecedented levels of resource extraction, fossil fuel use, deforestation and population growth, solidifying the impact of human activities on climate (Steffen et al., 2015). Globally, there was a net loss of 817,000 square kilometres in forest area between 1960 and 2019 (Estoque et al., 2022).

Third wave of Globalisation

1980s CE - Present

Globalisation, accelerated economic integration and global trade spread industrial production worldwide. Developing economies rapidly industrialised, increasing emissions as they did, while the global spread of consumer culture boosted demand for energy-intensive goods and services (Sachs, 2015).

1830 CE — 1870 CE — 1950 CE — 1970 CE — 1980 CE — 1990 CE

Second Industrial Revolution

1870 CE - 1914 CE

The advent of electricity, steel production, and the internal combustion engine accelerated industrial growth. Oil joined coal as a primary energy source, and the rise of automobiles, railroads, and shipping intensified fossil fuel reliance (McNeill, 2000).

Energy Crisis and Expansion of Global Fossil Fuel Industry

1970s CE - Present

The OPEC oil embargo of 1973 demonstrated the fossil fuel industry's power over global politics, as oil prices quadrupled, affecting economies worldwide. The expansion of fossil fuel extraction, exploration, and consumption increased access to energy but also intensified greenhouse gas emissions (Yergin, 1991). In 1970 2,240 million metric tons of oil was used globally. By 2023 that had doubled to 4,530 (Statista, 2024).

Rise of China and India as Economic Powers

1990s CE - Present

The rapid industrialisation and economic growth of China and India, each with large populations, have been major contributors to global greenhouse gas emissions. In 2006, China overtook the US to become the world's largest annual emitter of greenhouse gases. However, its cumulative and per-capita emissions remain about half of the US's today (Liu, 2023).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Increased Consumerism

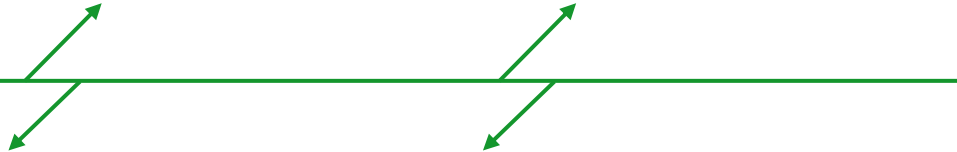
- Increased carbon emissions
- Resource depletion rates
- Increase in GDP (that has not been decoupled)
- Higher consumption rates

Climate Change Denial or Inaction

- Disinformation metrics
- Public belief in climate change
- Government investment and subsidies of fossil fuels

Ecological Degradation

- Soil erosion, deforestation, ocean acidification
- Carbon sequestration capacity
- Habitat destruction
- Decline in biodiversity index
- Air and water pollution



Constrains the trend

Carbon Policies and Leadership

- Stricter carbon accounting standards
- and protocols
- Adoption of carbon pricing mechanisms
- Investment in renewable energies
- Coordination between nations on climate policies
- Subsidies for renewable energy

Advancements in Renewable Energy

- Electrification of national grids
- Increase in renewable energy
- Reduction in cost of renewable energy technologies
- Increasing energy efficiency improvements

Global Climate Agreements

- Number of countries signing up to net zero targets aligned with 1.5 degrees climate threshold
- Nations meeting net zero targets
- Financial support for climate action in developing countries

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GMT 04

Accelerating Environmental Degradation

This trend describes the increasing pace at which natural ecosystems are experiencing degradation over approximately the last 12,000 years, originating with the innovations that transitioned humans to an agrarian society around 10,000 BCE. The trend marks a shift from the preceding Late Pleistocene hunter-gatherer societies, which were responsible for much lower impacts on their natural environments compared to post-agricultural humans. The trend is measured by an increase in biodiversity loss, soil degradation, air and water pollution, and destabilisation of ecosystems leading to ecological tipping points.

Trend length: **12,000 years**

10,000 BCE

Overview

10,000 BCE — Present

Humans began altering ecosystems as early as the Late Pleistocene (Boivin, et al., 2016) contributing to the Quaternary megafauna extinction (Bergman, et al., 2023). However, the onset of agriculture around 10,000 BCE accelerated environmental degradation significantly (Kirch et al, 1992). Since then, approximately 1.8 billion hectares, one third of the world's total forest area, has been cleared. Forest loss in the last century alone matches that of the previous 9,000 years, with 75% directly due to agricultural expansion (UN DESA, 2018). Between 1800 and 2000 CE, rapid urbanisation contributed to 75–80% of habitat loss and fragmentation since humans first adopted agrarian lifestyles (Liu, et al, 2016).

Biodiversity decline, largely caused by habitat degradation (Haddad, 2015; Horváth, 2019) has led to an acceleration in species loss (Fig. 9) (Fahrig, 2002). Biosphere integrity is the most critically breached planetary boundary and is deteriorating rapidly (Wilcock et al., 2023). Between 10,000 BCE and 2018, the biomass of wild mammals has declined by 80% (Bar-on, et. al, 2018; Greenspoon, 2023). Extinction rates are now 300 times higher than natural background rates (McCallum, 2015; Johnson, n.d.), with vertebrate extinctions increasing by 0.25–0.85% between 1800 and 1900, and accelerating sharply by 1.5–2% between 1900 and 2014 (Ceballos, et al., 2015), spurred by 'extinction debts' since the Second Industrial Revolution (Liao, 2022).

Although the average size of animal populations between 1970 and 2020 has declined (WWF, 2024), the overall picture on biodiversity is mixed, as a similar proportion of species are experiencing improvement to those experiencing decline. (Deinet, et al., 2024). While species recovery looks promising (IUCN, 2019), the overall number of threatened species is still growing (IUCN, 2024), 90% of which are experiencing decline, with only 9% of populations stable, and 1% of them increasing (NWF, 2020).

Environmental degradation and climate change mutually accelerate one another (Abbas, 2022; IPCC, 2022). Climate change intensifies wildfires, degrades land and destabilizes ecosystems in a chain reaction (MacCarthy, 2024).

Figure 9

Total Species Extinctions

Source: Scott, 2008

Figure 10

Mass extinction events

Source: HYDE, 2023

Figure 9

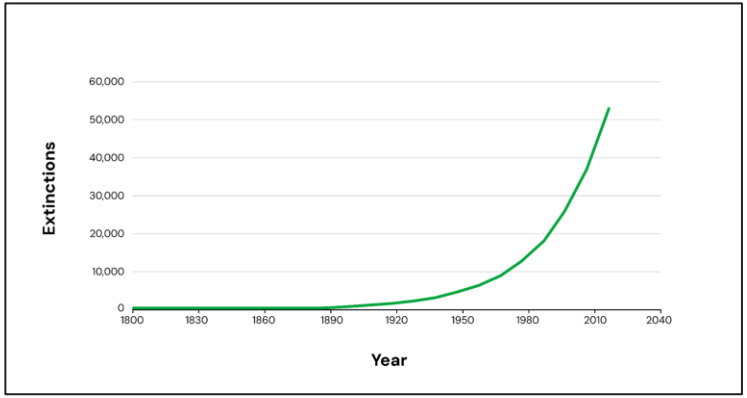
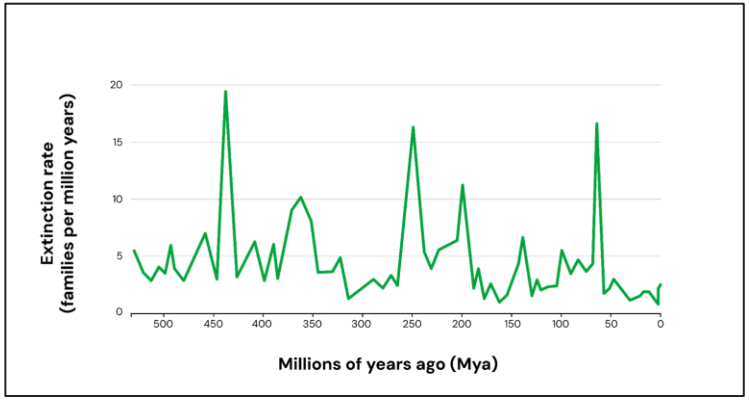


Figure 10



Origin:

Meso-neolithic Agrarian Revolution

10,000 BCE - 5000 BCE

The shift from hunter-gatherer lifestyles to settled farming communities marked the beginning of plant and animal domestication and land-use changes. Around 10,000–8,000 years ago, farmers and pastoralists began transforming landscapes (Stephens et al., 2019). This period introduced environmental degradation linked to agriculture, laying the foundation for habitat fragmentation, biodiversity loss, and human-induced warming (Vavrus et al., 2018).

Preceded by: **Late-Pleistocene Anthropogenic Activity**
129,000 BCE - 11,700 CE

World Wars & Atomic Tests

1914 CE - 1960s CE

The World Wars drove destruction of vast ecosystems due to combat, wartime resource needs, and the introduction of synthetic chemicals into natural systems (Swintek, 2007). Post-war atomic testing contributed to significant, long-lasting environmental damage through radiation contamination and atmospheric pollution. (Prăvălie, 2014).

The First Green Revolution

1966 CE - 1985 CE

The Green Revolution introduced high-yield crop varieties and chemical fertilisers, boosting agricultural productivity. However, it also led to soil degradation, water pollution, and negative ecosystem impacts that cascaded into adverse impacts on biodiversity. (Pingali, 2012).

Environmental Polarisation

1990s CE - Present

This period has been marked by conflicting narratives on environmentalism, often driven by political and corporate interests, particularly fossil fuel lobbying aimed at obstructing eco-centric progress (Farrell, 2016). These efforts have accelerated environmental degradation by fostering widespread disinformation, increasing political polarisation, and deepening social divisions over environmental issues. The result is a fragmented public response to environmental crises (Smith et al.,2024).

10,000 BCE — 5,000 BCE — 1750 CE — 1914 CE — 1950 CE — 1966 CE — 1990 CE

Pre-Industrial Anthropogenic Activity

5,000 BCE - late 1700s CE

Intensified agriculture, forest clearance (Yasuda et al., 2000), and habitat fragmentations began impacting ecosystems at increasing scales (Ellis, et al., 2013). While relatively modest compared to post-industrial periods, human activities driven by increases in population and land use had widespread influence on natural environments (Uglietti et al., 2015; Guiry et al., 2018).

First and Second Industrial Revolutions

1750 CE - 1920 CE

The First Industrial Revolution marked the start of widespread mechanisation, increasing the extraction and consumption of natural resources which significantly increased the toll on critical ecosystems (Stanford University, 2015). The Second Industrial Revolution drove the expansion of railroads and factories, leading to large-scale deforestation, air and water pollution, and habitat loss. (Mohajan, 2019).

Postwar 'Great Acceleration'

1950 CE - Present Tipping Point

Following WWII, rapid economic growth and technological advancements fuelled global industrialisation and urbanisation. This period saw exponential increases in consumption, resource use, and environmental impact, often termed as 'The Great Acceleration' (McNeill, Engelke, 2016). Globalisation (Xia, 2022) and neo liberalisation increased trade volumes that further drove widespread adverse impacts on ecosystems and biodiversity. (Long, et al., 2024).

Plastics and overconsumption

1950s CE - Present

Plastic pollution has escalated since the 1950s, presenting long-term risks to biodiversity and human health (IUCN, 2024). Following WWII, global plastic production grew exponentially, reaching 9.2 billion metric tons within 60 years (UNEP, n.d.). These synthetic materials, now pervasive across ecosystems, have contributed significantly to environmental degradation due to their persistence and accumulation. In 2015, an estimated 60 to 99 million Mt of plastic waste was generated globally. (Lebraton, 2019)

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Unsustainable Consumption

- Increase in energy consumption and growth of digital footprints per capita
- Increased material consumption
- Increase in landfill usage

Unrestricted Economic Growth

- Continued GDP growth from resource extraction, agriculture and energy use, without emissions decoupling
- Growth in emissions from industrial sectors
- Continued reliance on fossil fuels

Unrestrained Urbanisation and Agricultural Land-use

- Increased urban sprawl into biodiverse rich habitats
- Degraded air and water quality
- Increased conversion of natural habitats into farming lands

Climate Change

- Increased harm to ecosystems from climate disasters
- Decreased soil health
- Increased ocean acidification
- Increase in water shortages
- Increased vulnerability of food chains
- Increased species extinction rates

Constrains the trend

Eco-centric Policies

- Environmental protections
- A decrease in deforestation and an increase in reforestation rates
- Increase in financial support to transition to environmentally sustainable practices
- Carbon accounting regulation and reduction targets
- Renewable energy adoption rates

Renewables and Electrification

- Increasing investments and subsidies in renewable energy
- Increased divestments from fossil fuel
- Increase in electric vehicle adoption
- Increased patents and market innovations in renewable energy and technologies

Regenerative Agricultural Practices

- Increased adoption and implementation of regenerative farming techniques
- Reduction in synthetic fertilisers, pesticides and herbicides
- Improved soil health and soil carbon stock
- Improved water use efficiency and reduction in runoff

Cultural and Value Shifts

- Decrease in consumption
- Increased environmental education
- Increase in use of indigenous thinking and application of traditional ecological knowledge
- Increase in corporates achieving eco certifications
- Increased environmental activism

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GMT 05

Increasing Resource Scarcity and Shifting Competitive Dynamics

This trend describes the intensifying global scarcity of essential resources such as water, ores, fossil fuels and biomass, and the shifting competitive dynamics around these over the last 2800 years. It originates from increased resource demand in 800 BCE from the Ancient Greek Civilisation, and then subsequently the Roman Empire fuelling colonisation efforts. It marks a shift from the preceding era of relative resource abundance during the neolithic agricultural revolution, and is measured by global material extraction, declining freshwater availability, shrinking arable land, and rising demand for critical minerals.

Trend length: **2800 years**

800 BCE

Overview

800 BCE — Present

Economic activity, infrastructure, and living standards depend heavily on a steady supply of materials (Schandl et al. 2018). Consequently, global demand for materials has seen sustained growth over 2800 years, as agricultural expansion, shipbuilding and urbanisation in Ancient Greece followed by the Roman Empire drove demand for resources and related colonisation efforts in multiple continents (Hughes, 2014; Thirgood, 1981). Similarly, large-scale deforestation in ancient China fuelled agriculture, metallurgy, and construction as early as the Zhou Dynasty (Elvin, 2004), and India caused significant environmental impacts through agriculture and urban expansion, especially during the Indus Valley Civilization (Fuller, 2008). By 1900, global extraction of materials was at 7 billion tonnes per year (Krausmann et al, 2009), growing modestly at 1.2% per year until 1945. After World War II, between 1945 and 1973, the rapid industrialisation era saw the growth rate jump to 3.7% annually, with global extraction reaching 30.9 billion tonnes by 1970 (Krausmann et al, 2018). Growth in global material extraction slowed between 1970 and 2000, only to accelerate to 3.5% annually from 2000 to 2012, driven by infrastructure expansion and rising living standards (Fig. 11). By 2024, extraction is projected to be 106.6 billion tonnes (UNEP, 2024). Rising population intensifies demand, straining resources like water, arable land (Fig. 12), and minerals. Six of nine planetary boundaries, including freshwater use, have already been breached, underscoring Earth's sustainable limits (Stockholm Resilience Centre, 2023).

The shift to renewables, digitisation, and advanced technology increasingly depends on a limited set of critical minerals (McMaster, 2024). Projected demand for transition minerals is set to spike by 2040 for infrastructure, with copper demand up 50%, nickel and cobalt by 100%, graphite by 400%, and lithium by 800% (International Energy Agency, 2024). This short-term demand for renewables' "capital" infrastructure will replace fossil fuels' ongoing, higher extraction needs (Ritchie, 2023), However, this current growth is intensifying competition among nations and non-state actors for resource access essential to high-demand sectors (NATO, 2024). The European Critical Raw Materials Act (2024) aims to mitigate the EU's supply risks, especially for rare earth elements where China currently holds over 70% of production (Van Gosen et al., 2017; European Council, 2024). Ongoing resource scarcity fuels economic and geopolitical instability, particularly in sub-Saharan Africa (Müller, 2023) and South America (Ahmad, 2020), where minerals such as cobalt and lithium are heavily concentrated.

Figure 11

Global material extraction of non-metallic minerals, ores, fossil fuels and biomass

Source: Krausmann et al, 2017 and UNEP, 2023

Figure 12

World population (billions) versus arable land (hectares per person)

Source: Gupta et al, 2021

Figure 11

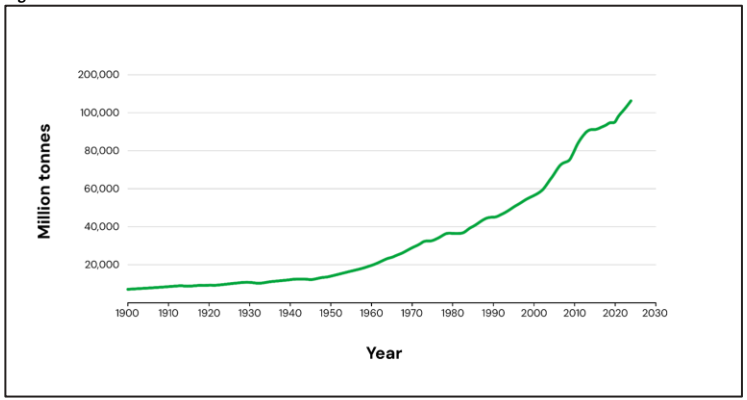
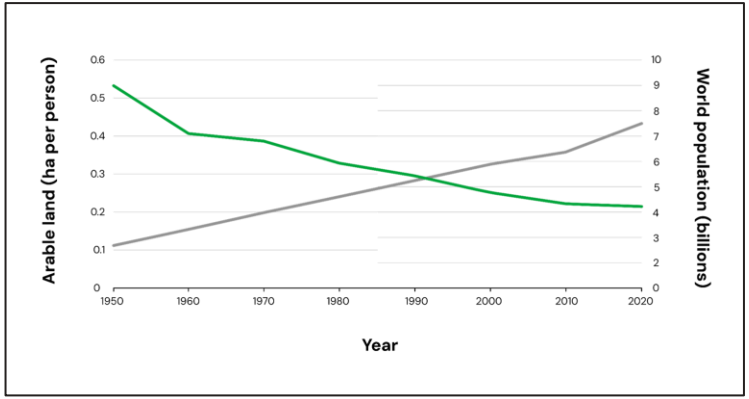


Figure 12



Origin:

Deforestation in Ancient Greece and the Roman Empire

800 BCE - 500 CE

Deforestation was primarily driven by agricultural expansion, shipbuilding demands, and urban development. This period is among the earliest recorded instances of significant environmental impact due to resource exploitation, leading to soil erosion and a decline in agricultural productivity (Hughes, 2014). Use of wood for maritime fleets, combined with clearing land for crops and settlements, resulted in widespread deforestation, altering ecosystems and reducing the land's long-term fertility (Thirgood, 1981).

Preceded by:
Neolithic Agricultural Revolution
10,000 BCE - 5,000 BCE

Post-World War II Economic Boom

1945

The economic expansion following the conflict led to a substantial increase in resource demand, driven by rapid industrialization and rising consumer markets. This period intensified the extraction of oil, metals, and agricultural products, accelerating global resource depletion and environmental impact (Marglin et al, 1992).

Russia-Ukraine War

2022

Disruptions in grain exports from Ukraine, a key global supplier, led to increased food insecurity in regions reliant on imports, such as North Africa and the Middle East (Chatham House, 2022). Similarly, energy supply shocks due to sanctions on Russia underscored Europe's dependency on imported gas and oil, intensifying efforts to diversify energy sources and investments in renewables (IEA, 2022).

Record Temperatures and Droughts

2023

Extreme weather events intensified by climate change have worsened water and food scarcity, affecting millions and straining global agricultural systems. Studies link increasing droughts, floods, and heatwaves to rising food insecurity, with vulnerable regions facing the most severe impacts (IPCC, 2021; FAO, 2022).

800 BCE — 1450 — 1760 — 1945 — 1970 — 2010 — 2022 — 2023

European Age of Exploration

1450-1650

This period was marked by the pursuit of new resources and trade routes, leading to the extensive exploitation of newly encountered lands and resources. This period significantly shifted global resource distribution and signalled the onset of the first era of systematic global resource extraction (Wallerstein, 2011).

Industrial Revolution

1760 CE - 1840 CE Tipping Point

The rapid expansion of industrial activities significantly increased the consumption of natural resources, particularly coal and metals. The growth of coal mining, led to a massive increase in coal-powered technologies, such as steam engines and iron smelting (Horns, 2020). By the 19th century, Britain was producing two-thirds of the world's coal (Clark, 2004).

Amazon Rainforest Deforestation

1970's - present

The large-scale deforestation of the Amazon rainforest has significantly reduced the availability of critical natural resources, including timber, arable land, and various plant species essential for global industries including agriculture, logging, and pharmaceuticals (Fearnside, 2005; Nepstad et al. 2006).

Rare Earth Elements Crisis

2010

Imposed in 2010, China's export restrictions on rare earth elements, essential for electronics, highlighted global dependency on China for these critical materials, and prompted countries to diversify supply chains and explore alternatives(Hurst, 2010; Humphries, 2013).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Electrification of Industries, Transport and Other Technologies

- Growth in electrified transport systems
- Lithium, cobalt, and rare earth element price increases
- Rising investment levels in battery technology, energy storage, and recycling technologies
- Policy shifts favouring EV adoption, such as subsidies, mandates, and regulatory frameworks

Unforeseen Geopolitical Conflicts in Resource-rich Regions

- Number of armed conflicts
- Global supply chain disruptions
- Changes in the output levels of critical minerals

Increased Resource Use from Emerging Technologies

- Growing global investment levels in hardware (semiconductors, GPUs, and data centre infrastructure)
- Government regulations or policies aimed at accelerating energy and resource-heavy tech such as AI or blockchain

Constrains the trend

Breakthroughs in Material Science for Substitution

- Greater number of patents filed for new materials and substitutes
- R&D funding levels in material science and substitution technologies increasing
- Greater collaboration between academia, industry, and government in material science research
- Increased governmental regulation of resources

Innovations in Material Efficiency

- Growing investment in material recovery and material efficiency technologies and processes
- Greater government support for material efficiency through regulations, tax incentives, and standards
- Decoupling GDP from resource extraction rates

Global Shift Toward a Circular Economy

- Reduction in waste generation
- Reduction in virgin resource use
- Value and structural changes to 5 R's.
- Adoption of circular business models
- Adoption of policies and regulations that promote circular practices (e.g. true cost pricing)

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GMT 06

Shifting Demographic Dynamics

This trend describes global changes in population structures over the last 154 years, originating with the intersection of decreasing mortality and declining birth rates in approximately 1870. This trend marks a shift from the preceding Early Modern era, where global birth rates were estimated to be between 4.5 - 7 births per woman, and where life expectancy experienced no sustained change over time. This trend is measured by changes to the median age, life expectancy, and birth rates.

Trend length: **154 years**

1870 CE

Overview

1870 CE — Present

The world is undergoing a significant demographic shift as its population ages. The global ageing population is a product of two primary factors: reduced mortality rates and declining fertility rates (ONS, 2018). While signs of an ageing population only began to emerge around 1970, the roots of this trend trace back to approximately 1870, when rising life expectancy (Fig. 13) started intersecting with decreasing birth rates. Initially, both trends were largely limited to developed countries in Europe and North America.

Thanks to innovations in healthcare and public health—originating in Europe and North America and gradually spreading worldwide through colonial influence—global life expectancy has been steadily rising since around 1800. At that time, average life expectancy was 28.5 years, increasing gradually over the next century to reach 32 by 1900. After this point, life expectancy started to increase at a faster pace, reaching 46.5 by 1950, and then 71 by 2021. Before 1800, life expectancy saw only marginal and inconsistent improvements, often declining due to epidemics like the Black Death and famines (UN WPP, 2023; HMD, 2023; Zijdeman et al., 2015; Riley, 2005; Davenport, 2021). Meanwhile, around 1870, fertility rates entered a phase of sustained decline across most developed countries, although it took over 50 years for fertility rate decline to become a global phenomena. While in the pre-modern era birth rates were approximately between 4.5 to 7 births per woman, by 1950 this had reached 4.9 births globally, and declined to 4 births by 1976, and 2.3 in 2023 (UN, 2024; Roser, 2019; Rowland, 2009).

Together, these factors have steadily increased the global median age, from 20.3 in 1970 to 30.4 in 2023 (Fig. 14). Europe and North America have the highest median ages globally, at 42.2 and 38.3, respectively. Africa remains the only continent where the population is not ageing; its median age in 2023 is 19, only slightly higher than in 1950, when it was 18.1 (UN, 2024).

As global demographics shift, broad consequences can be observed—crossing domains and sectors—from strained healthcare systems, and a shifting workforce, to changing consumption patterns and wealth distribution (CIFS, 2022).

Figure 13

Global life expectancy

Source: UN WPP, 2022; HMD, 2023; Zijdeman et al., 2015; Riley, 2005

Figure 14

Global median age

Source: UN, 2024

Figure 13

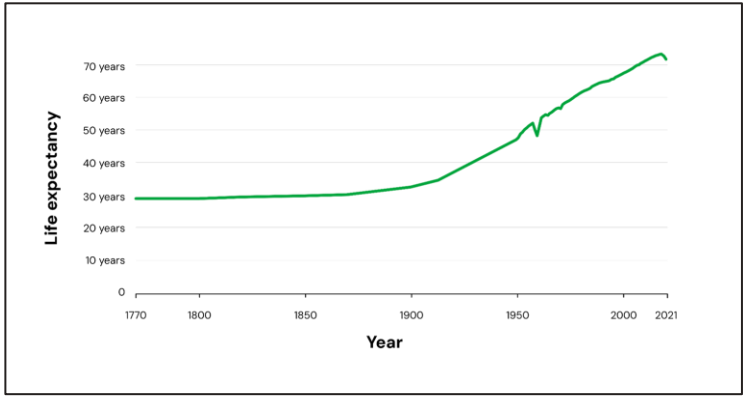
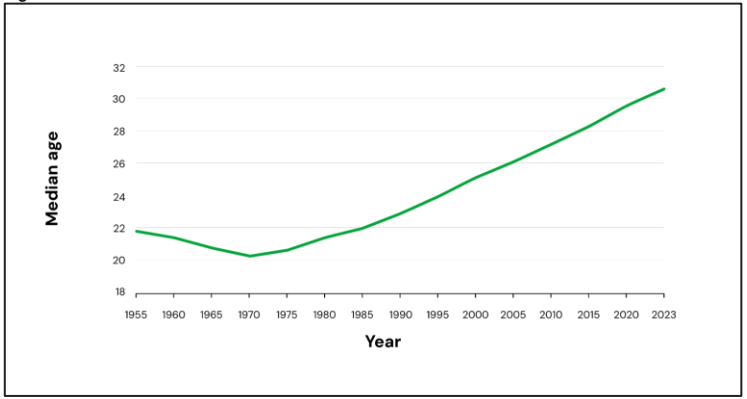


Figure 14



Origin

Declining Birth Rates

1870 — present

In the 1870s birth rates in developed countries started to decline. While this took over 50 years to manifest as a global phenomena, this marks the point where declining birth rates and decreased mortality intersect, driving a sustained increase in median age a century later. While in the pre-modern era birth rates were approximately between 4.5 to 7 births per woman, this has declined to 2.3 in 2023 (UN, 2024; Roser, 2019; Rowland, 2009).

Preceded by:

Western Medical Innovation and Victorian Health Reform

19th Century

The Great Acceleration

1950s CE - Present Tipping Point

The postwar economic boom fed into the onset of The Great Acceleration which saw an exponential rise in medical advancements that increased life expectancies, while economic expansions drove global birth rates higher, rapidly changing age structures (Steffen et al., 2015). This period set the stage for population surges in regions beyond the western nations, reducing global infant mortality rates while increasing lifespans, thereby shifting global dynamics in demographics and age structures.

Economic Modernisation in East Asia

1960s CE - Present

Since the 1960s, East Asia has undergone transformational economic growth, led by high-performing economies including Japan, South Korea, Singapore, Taiwan, and Thailand. Strategic public policies stabilised growth, raising human welfare and income equality. East Asia's GDP per capita increased nearly 40-fold between 1960 and 2019, reflecting substantial improvements in living standards (World Bank, 1993; Maddison, 2007).

1870 CE — 1946 CE — 1950 CE — 1960 CE — 2000 CE

Postwar Baby Boom

1946 - 1964

Following WWII, western nations experienced a temporary increase in fertility rates in the context of postwar economic recovery. Globally, the total fertility rate was about 5 children per woman in 1950 (UN, 2024; Roser, 2019; Rowland, 2009). Job stability, housing expansion, and rising living standards encouraged large families (Doepke, 2007). This demographic surge later contributed to a large aging population in these countries.

Growing commercial access to contraceptive pills

1960 - 1970s CE

The first hormonal contraceptive pill was approved by the FDA in 1960 (Christin-Maitre, 2013). By the 1970s, widespread adoption of contraceptive pills in many countries led to a marked decline in fertility rates. Studies show a causal link between increased use of oral contraceptives and shifts in fertility patterns observed across Europe over the past several decades (Leridon, 2006).

Shifting Economic Centres

2000s CE - Present

Emerging economies in regions including India, Africa, and Southeast Asia, and which are experiencing a 'youth bulge', are benefiting from a demographic dividend that is gradually shifting economic power from the Global North to the Global South. A growing young population entering the workforce are creating new opportunities and challenges in education, employment, resource access, and social integration (UN, 2024; Bloom et al., 2003).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Economic Opportunities and Reduction of Inequalities

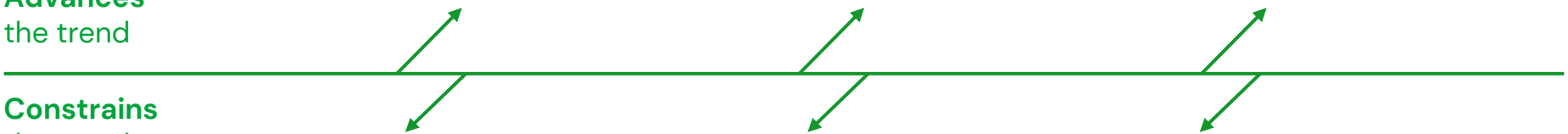
- Increase in GDP, GDP per capita and Gross National Income
- Increased education and literacy levels
- Reduction in poverty levels
- Increased employment levels
- Increased cost of living in urban areas

Shifting Attitudes to Parenthood

- Increased instances of 'Birth Strikes' due to climate change
- Increase in couples not having children
- Births happening later on in life

Better Healthcare

- Greater access to reproductive health services, contraception and abortion plans
- Increase in palliative care funding and standards
- Increased life expectancy
- Decrease in infant mortality rates



Constrains the trend

Pro-Natal Policies

- Greater financial incentives for procreation
- Tax exemptions for families
- Increased IVF clinics

Career-family Compatibility

- More generous parental leave policies
- Increased flexible timings for parents
- More affordable and accessible childcare support
- Fairer gender pay equity regulations / laws
- Better family tax benefits and breaks
- Further family-friendly housing subsidies

Higher Mortality due to Emerging Threats and Risks

- Increased mortality from climate change related threats
- Increased mortality from potential zoonotic or biosecurity outbreaks
- Increase in conflict related deaths
- Increasing global catastrophic risk and existential risk profile

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GMT 07

Intensifying Social Fraying

This trend describes increasing erosion of the social fabric, marked by the continued weakening of social bonds and cohesion within communities, nations, and societies globally. Heightening socio-economic disparities and inequalities are evident as seen over the last 55 years, with the 1970s being the point from which a sustained increase in global inequality is observed. This trend is preceded by both World Wars, ~500 years of colonialism and imperialism, and the Industrial Revolution that observed the rise of worldviews, systems and structures instrumental in creating societal inequities and economic fragmentations. This trend is measured by a decline in interpersonal and institutional trust and increased polarisation.

Trend length: **53 years**

1970 CE

Overview

1970 CE — Present

Social fraying refers to the gradual weakening of societal bonds — trust, mutual responsibility, and collective norms — that hold communities together. As these ties erode, people experience greater alienation, distrust, and division, resulting in more polarised and less cohesive communities. It is a complex phenomena, with several key contributing factors, which all have separate origin points. Economic inequality drives social fragmentation (Kawachi & Kennedy, 1997). Net Gini coefficients exceeding 0.4 is linked to greater social unrest; over 45% countries globally, including one-third of Asian economies, are above this level (IMF, 2020). While on average inequality within countries rose marginally between 1945 to 1975 (Sherman, et al., 2020), it has done so at a much greater pace in the last 40 years (Jacobs & Hacker, 2008). Since 1990, income inequality has increased across most high- and middle-income countries, affecting 71% of the global population, with income disparity between the top 10% and bottom 50% nearly doubling over the past two decades (World Inequality Lab, 2022; UN, 2020).

Income inequality is also positively correlated with political polarisation (Gu & Wang, 2023) that then drives social fraying (Bluic, et al., 2024). Every continent apart from Oceania has experienced an increase in polarisation since 2005 (McCoy et al, 2022). With a steady rise since 1960s, polarisation is highest in the US since the Civil War (Paisley, 2016). Furthermore, Bangladesh, Brazil, Colombia, India, Indonesia, Kenya, Poland, and Turkey shared root drivers of polarisation with the US, showing common patterns of influence (Carothers et al, 2019). The positive or negative impact of social media on 'affective polarisation' is still debated (Levy, 2021; Overgaard, 2024; Bisbee, 2022), as is its impact on fragmentation through filter bubbles (Haroon, 2023) and information fabrication (Bradshaw et al., 2020; Kelly, 2017; Bailon & Wang, 2016).

Along with polarisation, symptoms of social fraying include erosion of trust, causing increased protests (Khan, 2024; Van Prooijen et al., 2022). Large-scale protests reflect social instability, with protest frequency rising by an average of 11.5% annually since 2009, surpassing previous waves from the 1960s to the 1990s (Fig. 16) (CSIS, 2020). Trust in governments remains low; in 2023, 41% of people expressed little trust in their governments (OECD, 2023), similar to the levels in 2010 (OECD, 2023). In the UK, trust in political institutions is the lowest in 50 years (NatCen, 2024), while trust in the U.S. has fallen from 73% in 1958 to 22% in 2024 (Pew, 2024). Many regions, including Africa, Latin America, and MENA, face similar crises (Abouzzohour et al, 2024; Carter, 2024; Din-Kariuki, 2024; OECD, 2024).

Figure 15

Average gap in trust between informed public and mass public of media, government, business, and NGO's

Source: Edelman, 2020

Figure 16

Civilian anti-government protests

Source: CSIS, 2020

Figure 15

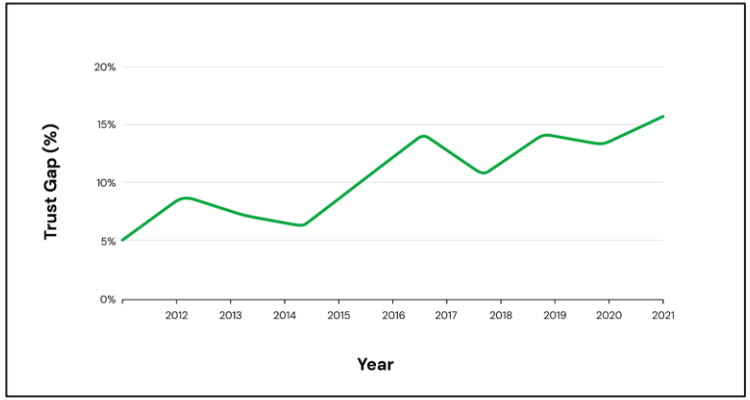
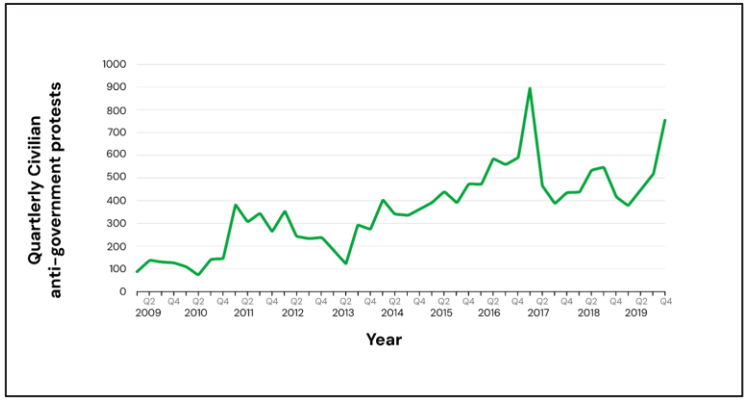


Figure 16



Origin:

Neoliberal Globalisation

1970s CE - 2000s CE

The shift towards neoliberal economic policies in the late 20th century amplified socio-economic inequalities, weakened public welfare structures, and encouraged a 'winner-takes-all' mentality (Stiglitz, 2012; Harvey, 2005). While fostering economic growth, this era intensified wealth disparities and undermined local industries, fuelling economic disempowerment and cultural alienation (Sassen, 1999).

Preceded by:
Colonialism, Imperialism and Industrial Revolutions
1550 CE - 1920 CE

The Global War on Terror

2001 CE - Present

After 9/11, the Global War on Terror intensified divisions between the West and Muslim-majority nations, fuelling Islamophobia. 'Us vs. them' rhetoric polarised Western societies, while heightened surveillance and civil liberties debates eroded trust in government and increased social tensions (Mamdani, 2004; Jackson, 2005).

Arab Spring

2010 CE - 2012 CE

The Arab Spring toppled multiple authoritarian regimes but also incited civil wars and prolonged instability in Syria, Libya, and Yemen. Initially driven by hopes for democratic reform, the movement led to power struggles and the growth of extremist groups (Goldstone, 2011). The Syrian Civil War alone displaced over 12 million people, causing a refugee crisis that strained resources and heightened political and social tensions in Europe, contributing to nationalist and anti-immigrant sentiments (Berti, 2015).

1970 CE — 1980 CE — 1990 CE — 2001 CE — 2008 CE — 2010 CE — 2018 CE

Trickle Down Economics

1980s - Present

Tax cuts for the wealthy, deregulation, and minimal government intervention—hallmarks of Reaganomics and Thatcherism—aimed to stimulate growth yet also concentrated wealth and increased economic inequality (Piketty, 2014; Stiglitz, 2012).

The era of digital and social media

1990s CE - Present

Digital media transformed information sharing, but also heightened exposure to disinformation, undermining social cohesion. The spread of divisive content fosters mistrust, deepens ideological divides, and creates 'echo chambers', increasing vulnerability to manipulation (Sunstein, 2001; Arguedas et al., 2022).

The Great Recession

2008 CE

The Great Recession led to significant economic disparities, with ~2.7 million people looking for work by the end of 2011 in the UK (ONS, 2018). Among the economies that experienced a banking crisis in 2007–08, ~85% were operating at output levels below pre-crisis trends a decade later (Mrkaic and Nabar, 2018). As families faced foreclosures, job insecurity and reduced social mobility, feelings of disenfranchisement grew, leading to increased social fraying and resentment toward elites and governing bodies (Mishkin, 2011).

Climate Protests

2018 - Present

The surge in global climate protests has widened generational divides, with younger people challenging political systems that are seen as inadequate on climate action. These protests also reveal an ideological rift, as climate policies are often viewed as threats to traditional industries and fossil-fuel-dependent rural areas. While fostering cohesion among activists, these movements have heightened polarisation, with 60% of youth viewing climate inaction as a governmental betrayal (UNICEF, 2021).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Increased Inequalities and Inequities

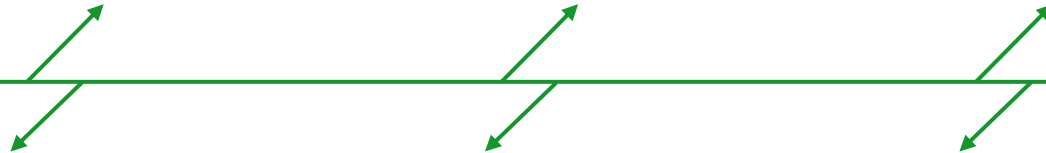
- Increase in the global multidimensional poverty index
- Increase in the Gini coefficient
- Decrease in global social mobility index
- Decreasing equitable access to opportunities

Misinformation and Disinformation

- Increase in fabricated 'truths'
- Increased volume and pace of spread of disinformation and misinformation
- Increase in digital echo chambers
- Trust erosion in institutions
- Increased polarisation of news sources

Populist Politics and Nativist Movements

- Increase in hate speech
- Increase in nationalist movements
- Protectionist and exclusionary policies
- Anti-immigration sentiments
- Reduced cooperative attitudes
- Increased socio-political unrest



Constrains the trend

Social Mobility and Reduced Disparities

- Increased social mobility
- Reduced inequalities
- More inclusive economic growth

Digital Regulations and Ethical Guardrails

- Better legislation to minimise mis/disinformation
- Increased use of 'fact-checkers'
- Increase in digital media literacy
- Increased budgets and investments in anti-disinformation technologies

Equitable Social and Cultural Infrastructures

- Access to community centres and public spaces
- Better educational programs on cultural awareness
- Increased community engagement
- Increased global civil society participation index

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GMT 08

Mass Urbanisation

This trend describes the sustained rise of urban populations over the last 12,000 years, originating with the first permanent human settlements which coincided with the development of agricultural technology around 10,000 BCE. This trend marks a shift from the previous nomadic hunter-gatherer societies (200,000-10,000 BCE). This trend is measured by the increase in the share of the global population living in cities.

Trend length: **12,000 years**

10,000 BCE

Overview

10,000 BCE — Present

The process of urbanisation began in approximately 10,000 BCE with the Neolithic Revolution, where innovations in animal husbandry and farming spurred the formation of early settlements. Agricultural techniques developed independently in various regions, enabling societies to shift from nomadic to settled life, with each region following its own development path (Svizzero, 2014). By 6000 BCE, cities emerged in Mesopotamia (OECD, 2015), though fewer than 0.1% of people lived in urban areas until pre-industrial cities gradually increased urban populations, reaching 5% by 1000 CE. Only with the Industrial Revolution did urbanisation accelerate, from 7.1% in 1700 to 16.2% by 1900. By 2000, nearly half the global population was urbanised, and in 2024, over half reside in cities (56.6%) (Fig. 17) (Ritchie et al, 2024). While the first mega-city appeared in 1950, there are now 34 mega-cities, with the highest urban population growth seen in cities of over 5 million people (UN Habitat, 2022).

While urban populations continue to grow, regional trends vary. In high-income nations over 80% of people live in cities, though growth is slowing, plateauing or is even declining, as seen in New York ((US Census Bureau 2023) and 52 other cities, mainly in Europe and North America (Our World in Data, 2024; UN Habitat, 2022). Meanwhile, low- and middle-income nations experience rapid urbanisation. Between 2015 and 2020, urban populations in less developed regions grew by 2.4% annually, especially in Africa and Asia, compared to 0.5% in developed areas (UN Habitat, 2022).

However, many cities in low-income countries are under strain, as unmanaged urban expansion results in cities which fail to register the benefits of urbanisation (such as reduced poverty and increased productivity) and instead increase social exclusion, crime and notably environmental degradation (Elfversson et al, 2022; UN Habitat 2020), with urban areas producing approximately 70% of global emissions (IPCC, 2022). Rapid population growth has also increased informal settlements, which both result from and drive urbanisation. Currently, over a billion people, or roughly 1 in 4 urban residents globally, live in slum-like conditions (UN Habitat 2023).

Figure 17

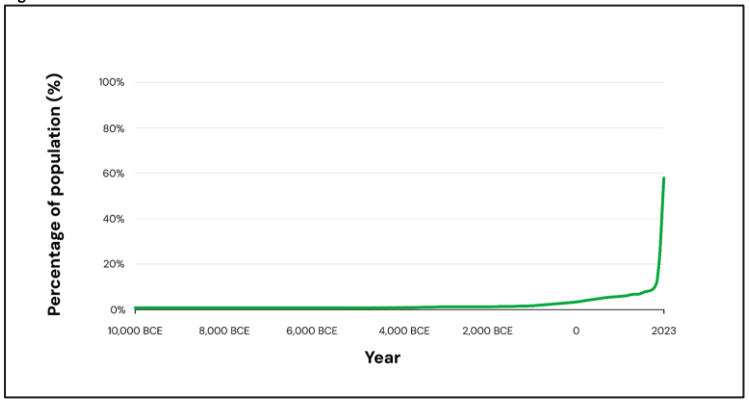


Figure 17

Share of the population living in urbanised areas

Source: HYDE, 2023

Origin:

Permanent Settlements

10,000BCE - 5,000BCE

Technological improvements, such as simple tools and knowledge around agricultural techniques, allowed people to settle in one place and establish villages. Most are estimated to have had only a few hundred people living in each, and produced just enough food for themselves (Svizzero, 2014).

Preceded by:

Nomadic Societies

200,000-10,000BCE

Metropolis and megalopolis cities

Early 1900s - 1950s CE

Urbanisation accelerated globally, and with the advent of the skyscraper, and then increasing levels of car ownership and improved public transport, cities started building outwards as well as upwards, with increased development of suburban areas (Fishman, 1990).

Global Pandemic

2020 - 2024 CE

The COVID-19 pandemic caused a significant disruption to urbanisation trends worldwide, highlighting the vulnerability of densely populated areas (UN Habitat, 2021), yet also accelerating technological trends enabling an increase in remote work (Clark 2024), and driving relocation to smaller cities or more rural areas in Western countries (González-Leonardo, et al., 2022).

10,000 BCE — 5,000 BCE — 1700 — 1880 — 1900 — 1950 — 2020

Pre-industrial Cities

5,000BCE - late 1700s

Further innovations allowed villages to produce an excess of food beyond their immediate needs. The surplus of food allowed people to explore non-agricultural activities, stimulating commerce, and leading to the eventual formation and growth of cities, which first arose in the Middle East, Egypt and China, housing populations of around 10,000 (Childe, 1950).

Industrial Cities

Late 1700s - early 1900s CE Tipping Point

Industrialisation produced the mechanisation of agriculture, which, in turn, reduced the amount of manual labour on farms. (Overton, 1996). This lack of employment forced farm labourers to move to cities to find work. This migration of workers from rural to urban areas then gave rise to the industrial city, which had more diverse and more international populations. By 1800 8.4% of the world's population lived in cities, however by 1900 this had almost doubled to 16.2% (Ritchie et al ,2024).

Elevators and Skyscrapers

1880 - 1900 CE

The innovation of the mechanised elevator in the 1800s, as well as improvements made across this century, unlocked the ability to build taller buildings, leading to the emergence of skyscrapers, a major driving force of urban density (Al-Kodmany, 2023).

Megacities

1950s - 2020 CE

The urban shift over time had led to the emergence of the megacity, cities with over 10 million inhabitants. The first megacities were New York and Tokyo in the 1950s (McGrath, 2012). Over half the global population lived in cities by 2007. By 2018 there were 33 mega cities globally (UN, 2018).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Access to Opportunity

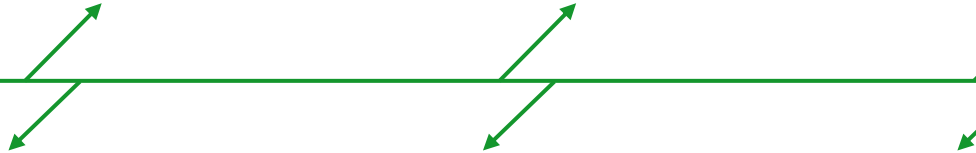
- Increased concentration of GDP in urban areas
- Increased job vacancy disparity between rural and urban areas
- Increased wage disparity between rural and urban areas

Population Growth

- Growing birth rates
- Growing life expectancy
- Accelerating population growth rate

Improved Infrastructure

- Increased investment in urban transit
- Improved housing quality in urban areas
- Improved telecoms and digital infrastructure investment



Constrains the trend

Structural Economic Inequalities and Geographic Disparities

- Increased cost of living variations (housing, utilities, and basic goods in urban centres vs other regions) resulting in fewer people moving to cities

Environmental Threats and Vulnerability

- Increased frequency of climate-related disasters and impact on urban population and infrastructure

Urban Infrastructure Deficit and Resource Shortages

- Decreased rate of urban infrastructure development (housing units, hospitals, schools, etc.)
- Decreased public satisfaction with urban infrastructure (housing affordability, healthcare access, transport congestion, etc.)

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GMT 09

Continued Influence of the Modern Scientific and Technological Worldview

This trend describes the convergence, subsequent expansion and then continued influence of modern science, in particular its empirical worldview, knowledge schema (i.e. approach to organising knowledge) and Eurocentric ideals. Beginning in 1500 CE with the Scientific Revolution, this trend marked a shift away from the dominance of previous spiritual or religious knowledge systems. This trend is measured primarily by the absence of an alternative dominant global knowledge schema.

Trend length: **524 years**

1500 CE

Overview

1500 CE — Present

The Scientific Revolution, starting around 1500 CE, catalysed a convergence of, and subsequent expansion of 'modern science'; a systematic study, accompanying an empirical worldview and knowledge schema based on observation and experimentation, yet also coupled with Eurocentric ideals (Dunyach, 2020). Before this point, other types of more spiritual worldviews and ways of knowing were common, often linked to theological ideas or indigenous ontologies (Kincheloe, 2011). For instance, the European medieval knowledge system relied on classic and religious authority, where knowledge was preserved rather than questioned (Cadden, 2013).

By the 20th century, rapid advancements in scientific knowledge, from relativity theory to quantum mechanics, reshaped entire fields of physics, chemistry and biology, and laid the groundwork for modern technology-driven industries (Betz et al. 2023). Across this century, scientific study developed, with the advent of the peer review process in the 1970s (MIT, n.d.) driving a significant increase in the number of academic publications each year (Fig. 18). There was also increasing support for science from government through the military industrial complex (Williams, 2010) and large-scale national scientific endeavours such as the space race (Arnold, 2022).

Presently, scientific and technological development drives profound shifts across sectors, with biological, environmental, health and physical sciences increasingly merging with technological innovations in AI, quantum computing and genetic engineering. In the year 2020 over 350,000 utility patents (patents for inventions) were granted in the US alone, a 60% increase from 10 years earlier (Fig. 19) (USPTO, 2020), while there has been a growth rate of the number of patent filings internationally of 2.9% annually over the last 10 years (WIPO, 2023).

As this megatrend has evolved, it has become increasingly intertwined with *GMT10 Continued Pursuit of Economic Growth*. Scientific research has become increasingly funded by private sources; 74% of biopharmaceutical research came from private sources in 2020 (Fowler et al, 2024). In the US, one of the largest markets for privately funded research, privately funded research expenditures grew by 37% between 2018 and 2020, totalling over $600bn in 2020 (NCSES, 2023). Meanwhile private technology companies' stock prices show strong growth globally.

Figure 18

Total number of academic publications per year

Source: Bornmann et al. 2021

Figure 19

Utility patents granted per Year in the US

Source: USPTO, 2023

Figure 18

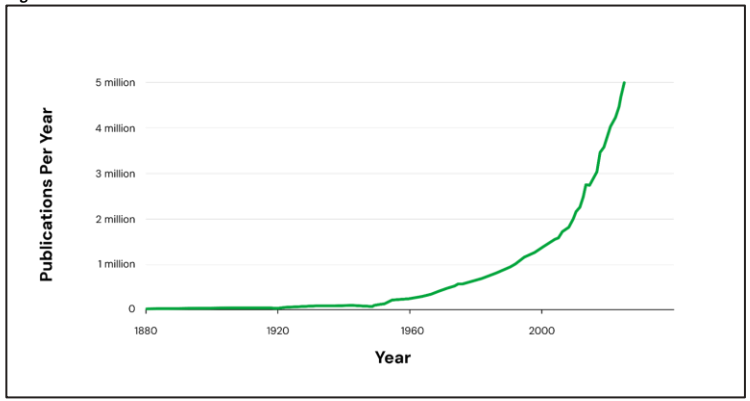
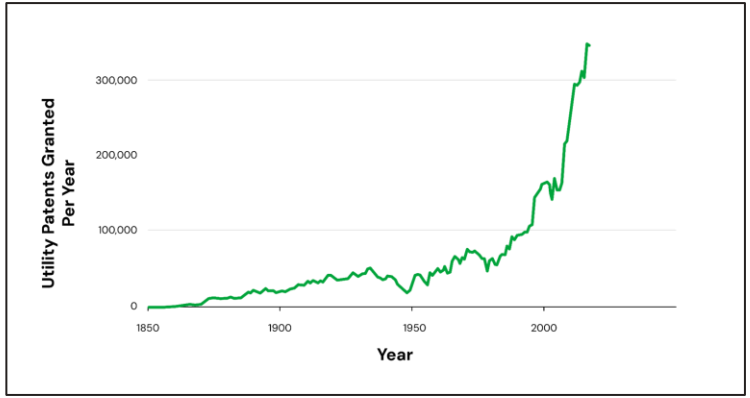


Figure 19



Origin:

Scientific Revolution

1500-1700 CE

This period saw the emergence of modern science as a systematic and empirical method of inquiry, which challenged long-held beliefs and established the foundation for future technological and scientific advancements. This includes Isaac Newton's 1687 Principia Mathematica, which formulated the laws of motion and gravitation, a foundation for classical mechanics (Westfall, 1981; Cohen, 2004).

Preceded by:
Medieval knowledge systems
5th-15th Centuries

The growth of the military industrial complex

1900-2000

Government investment in defence and weaponry spurred advancements in fields including aerospace, computing, and materials science, with military needs driving rapid innovation. This period solidified close ties between research institutions, industries, and governments, fostering a steady flow of funding and resources that boosted scientific progress and laid groundwork for technologies that would later permeate civilian life (Ritter, 2008; Leslie, 1993).

The Internet and Digital Revolution

1980s-1990s

Initially developed through U.S. military and academic collaborations, the internet rapidly expanded in the 1990s, fundamentally transforming information sharing, communication, and commerce. This digital network facilitated unprecedented access to scientific research and collaboration, accelerating the dissemination of knowledge. The advent of personal computers further lowered the barrier for participation (Abbate, 2000; Castells, 2002).

1500 — 1700 — 1760 — 1900 — 1955 — 1980 — 2020

Age of Enlightenment

1700-1800

An intellectual and cultural movement marked by an emphasis on reason, individualism and scepticism of traditional authority defined the Age of Enlightenment. This era encouraged scientific advancements and championed the belief that human progress could be achieved through rational thought and empirical evidence (Porter, 2001; Outram, 2013). Notably, exporting western science through colonisation was to the detriment of other non-Western sciences (e.g., eastern, African, Maori, Cree) (Held, 2023) .

Industrial Revolution

1760 CE - 1840 CE

The Industrial Revolution drove the dominance of science and technology by rapidly advancing factories, enhancing transportation networks, and accelerating urban growth. Innovations such as the steam engine not only transformed industry and transportation but also underscored the value of scientific knowledge and technological application, establishing a foundation for continuous industrial and economic progress (Ashton, 1997; Landes, 2003). This era shifted societies towards a reliance on systematic technological improvements.

The Space Race

1955-1969 CE

Driven by Cold War competition, the U.S.-Soviet Space Race led to unprecedented investments in space exploration, culminating in humanity's first moon landing in 1969. This era also spurred significant advancements in materials science, computing, telecommunications and automation, as technological innovations became critical to achieving spaceflight milestones (McDougall, 1985; Launius, 2019).

COVID-19 Pandemic

2020 - Present

The pandemic accelerated scientific and technological development, with over 200 vaccine candidates in rapid development and several reaching public use within a year (Amanat & Krammer, 2020). However, scepticism of science grew along with anti-vaccine sentiments which spread widely on social media and intersected with other anti-science movements like anti-vaxx and flat earth (Caceres et al., 2022).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Strong Trust in Science

- Improvement in public opinion on science
- Stronger science literacy rates
- Better compliance with health guidelines
- Lower resistance to scientific innovations
- Sustained support for science-based policies

Government Funding of Science and Technology

- Increase in research grants
- Growth in STEM education funding
- Increased infrastructure for R&D expansion
- Better public-private research partnerships

Better Communication of Scientific Research

- Media prioritisation of scientific sources
- Rise in open-access publications
- More public science education programs
- Increased science presence on social media
- Growth in science journalism and podcasts



Constrains the trend

Conspiracy Theories

- Increased social media engagement with disinformation
- Escalation of 'alternative' news sites and platforms
- Growth in conspiracy-related internet searches
- Rise in distrust of mainstream media and scientific consensus

Privatisation of Scientific Studies

- Higher percentage of restricted research data
- Narrowing of focus or misaligned research priorities
- Increase in less rigorous research methods used to produce favourable conclusions

Increase in Acceptance of Other Knowledge Systems

- Growth in funding and support for non-Western scientific knowledge systems
- Educational curricula changes that broaden or change focus of knowledge systems
- Increased belief in religious or spiritual understanding over empirical approaches

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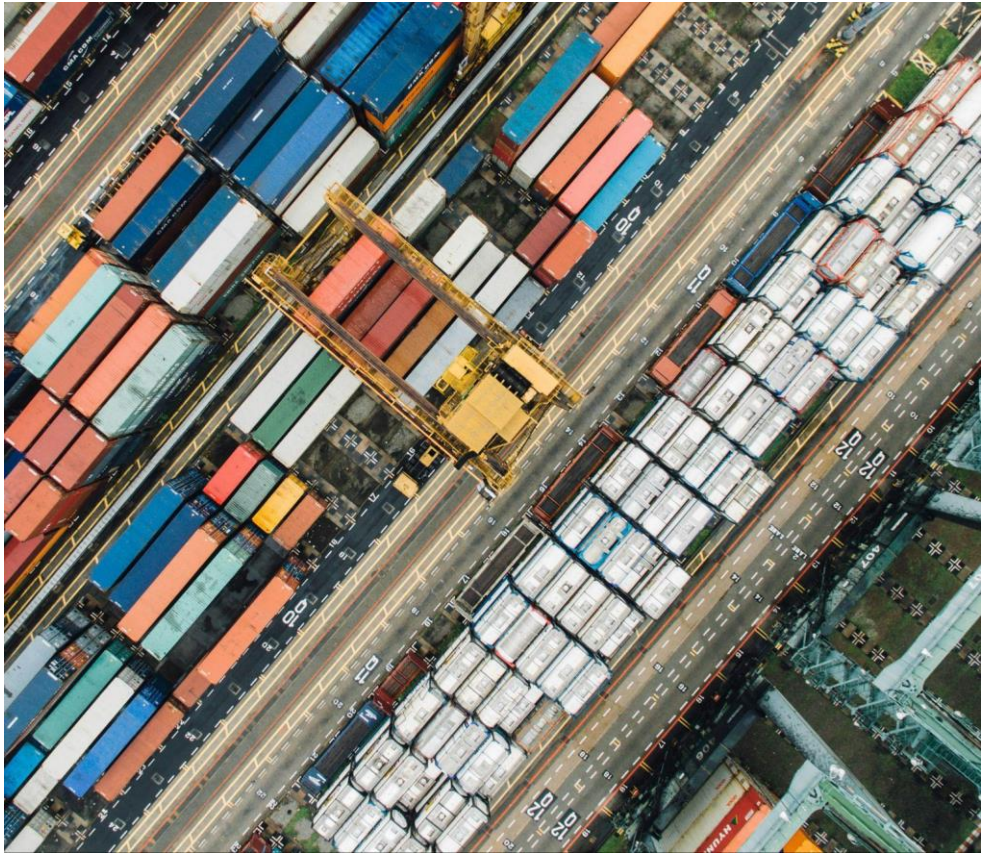
GMT 10

Continued Pursuit of Economic Growth

This trend describes the intentional and sustained global pursuit to increase economic output over the last 260 years, originating with the onset of the first Industrial Revolution in c. 1760 CE. The trend marks a shift from the preceding agrarian economies (c. 200 BCE – 1759 CE), which experienced no upward trend in output or capital per person. This trend is measured by the increase in global Gross Domestic Product (GDP).

Trend length: **264 years**

1760 CE



Overview

1760 CE — Present

The first Industrial Revolution in Britain around 1760 CE catalysed an exponential increase in the efficiency and volume of the production of goods and accumulation of capital, driven by technological improvements (Mokyr, 2005). Before this, global efficiency advancements were minimal, with growth averaging less than 0.01% annually as economies cycled through good and bad periods without any upward trend in output or capital per person (Clark, 2015). Global GDP grew slowly from $213.49 billion in 1 CE to $751.59 billion in 1700 CE (Our World in Data, 2023).

Since the Industrial Revolution, economic growth has remained a primary global objective, fundamentally reshaping societies and the environment (Schmelzer, 2015). Between 1820 and 2022, global GDP surged from $1.4 trillion to $139 trillion—a near 9,821% increase, with an annual growth rate of 2.3% (Our World in Data, 2023). Global per capita income rose nearly 15-fold, from $1,128 in 1820 to $16,667 in 2022 (Madison Project Database, 2023). An underlying rationale for continued economic growth is its capacity to address social welfare, foster innovation, and support resilience against future uncertainties. Growth has also been considered as a vehicle to sustain a liberal democratic ethos, where openness and tolerance are nurtured by economic opportunity (Emizet, 2000).

Additionally, the drive for growth is linked to advancing technologies and improving efficiencies, which enhance societal resilience by helping economies manage crises and shifts (Coccia, 2019). Recent studies suggest that these objectives - equity, stability, and adaptability - could potentially be met without prioritising GDP expansion, as non-growth approaches can still promote justice, opportunity, and resilience (Rose, 2019).

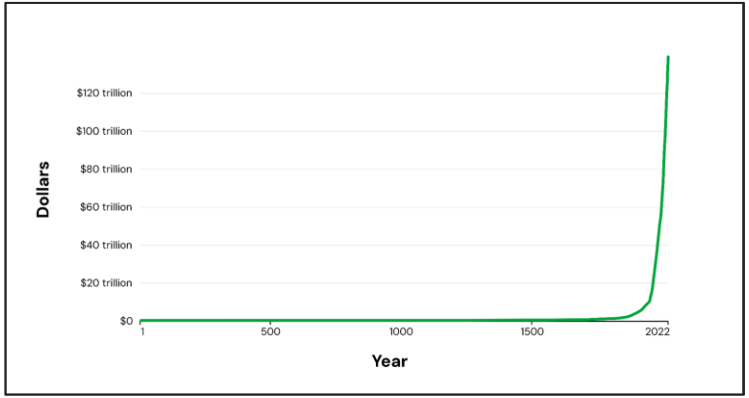
Increased productivity, driven by technological advances and knowledge, has supported growth beyond labour and capital limitations, as illustrated in total-factor productivity metrics (Shackleton, 2013). Growth has reduced extreme poverty and increased life expectancy, while also driving CO_2 emissions, presenting a complex legacy (Miladinov, 2020; Acheampong & Opoku, 2023). Today, the focus on growth persists globally, but government roles are shifting, with industrial policies becoming central, and economic development is increasingly linked to geopolitical competition (Shih, 2023). While still a prevailing economic aim, it also faces evolving perspectives that question its centrality in meeting societal needs (Herrington, 2020).

Figure 20

Total GDP output of the world economy from 1 CE to 2022 CE

Source: Our World in Data, 2023

Figure 20



Origin:

The First Industrial Revolution

1760 CE - 1840 CE

The First Industrial Revolution marked the beginning of modern economic growth (Broadberry and Fukao, 2021). It relied on empirical knowledge and practical invention to increase economic growth from almost 0% to 1% within 50 years (Clark, 2014).

Preceded by:

Agrarian Economies

200 BCE - 1759 CE

The Great Divergence

1800-1890 CE

England's economic leap ahead of Eurasia in the 1800s, known as the 'Great Divergence', was driven by two key advantages: easily accessible coal reserves and the wealth of resources from the Americas. The closer proximity of these advantages to Western Europe rather than Eastern Eurasia played a decisive role in altering the economic trajectories of these regions (Pomeranz, 2020).

Post-WW2 Economic Boom

1945 CE - 1970s CE

The European countries that received aid through the US Marshall Plan saw a 55% increase in industrial production over just four years from 1947 to 1951. (World Bank, 2010).

Third wave of Globalisation

1980s CE onwards

The Third Wave of Globalisation is marked by market liberalisation, technological advancements, and the rise of global supply chains. (WEF, 2019) The share of manufacturing in developing country exports grew dramatically, from roughly 15 percent in 1965 to over 80 percent by 1998 (IMF, 2001) The value of global trade as a percentage of world GDP rose from 42.1% in 1980 to 62.1% in 2007, while foreign direct investment grew from 6.5% of world GDP in 1980 to 31.8% in 2006. (IMF, 2008)

The Second Industrial Revolution

1870 CE - 1914 CE

The Second Industrial Revolution was characterised by scientific discoveries directly fuelling technological advancements and economic growth (Mokyr, 1998). In the second revolution, GDP growth was approximately 68% higher and nearly 1.7 times the amount of growth in the First Industrial Revolution (Madison Project, 2023).

The (First) Green Revolution

1966 CE - 1985 CE

The Green Revolution was characterised by the widespread adoption of high yielding crop varieties, synthetic fertilisers and irrigation. Norman Borlaug, renowned as the father of the Green Revolution, was highly instrumental in the above, facilitating a significant increase in food production in developing countries, saving millions from famine and starvation (Ortiz et al, 2007). This drove a 208% rise in wheat yields, 109% in rice and 157% in maize, with just a 30% increase in cultivated land. The increased crop yields contributed to a 1.56% rise in agricultural total factor productivity between 1990 and 2006. A 10 year delay of the Green Revolution would have cost 17% of GDP in 2010 (Gollin et al, 2021).

The Digital Age

1970s onwards

The Digital Age began with the introduction of the personal computer in the 1970s and the subsequent technology that provided the ability to transfer information freely and quickly. Rapid digitalisation was seen throughout the 2000s and had significant multiplier effects on economic growth (World Bank, 2004). By 2016, the digital economy contributed 15.5% of global GDP (Huawei & Oxford Economics, 2017).

Illustrative, non-exhaustive examples of factors and/or related indicators, which may **advance** or **constrain** this global megatrend.

Advances the trend

Technological Innovation

- Greater number of patents filed for technologies and innovation
- Increased global investment in technology
- Increase in research and development spending

Trade Expansion and Efficiency

- Increased global trade volumes
- Reductions in trade barriers

Net Zero Transition

- Increased investments in clean energy
- Lower energy costs leading to leading to lower production cost and can lead to increased consumer spending

A Growing Global Workforce

- Increase in global working age population size
- Increasing GDP growth through productivity and consumption

Constrains the trend

Slowdown of Globalisation

- Reduced international policy and diplomacy
- Weaker trade growth, increase in 'trade wars'
- Weaponised subsidies and sanctions, increased export controls and rise in protectionism
- Values and mindset shift away from economic growth objectives

Environmental Degradation and the Climate Crisis

- Increased frequency and intensity of climate disasters
- Ecosystem collapses restrict or block use of natural resources
- Climate-induced immigration puts strain on state spending in the short term

Economic Shocks or Disruptions

- Global economic recessions or depressions
- Global effect of energy cost rises
- Breakdown of global supply chains

Ageing Population

- Reduced labour market and productivity
- Growing percentage of GDP spent on elderly healthcare.
- Declining population growth

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Annex 2.
Methodological Limitations

- **Generalised:** The global megatrends featured here sacrifice nuance and variability for generalisability.
- **Non-exhaustive:** The global megatrends featured here are not an exhaustive list. Instead they represent 10 of the global megatrends which were identified as most significant to Defra's operating context, based on expert assessment.
- **Differing methods to measure trends:** Global megatrends each have different characteristics, and as such they cannot all be measured in the same way. Some, like 'Mass Urbanisation' are easily quantifiable, however others, like 'Increased Risk' are not, and rely on qualified assessments based on observations of sub-trends that make up each megatrend.
- **No projected data:** This report focuses on the historical context and existing data about each megatrend's evolution and current manifestation. As such, this report does not include projected data, implications, and scenarios.
- **Relies on secondary research:** This report did not involve any primary research, and data referenced here is illustrative.

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