

UNIVERSITY OF UK BIRMINGHAM

Adaptation and building resilience in a changing world

We adapt We activate

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Foreword

As global temperatures continue to rise and the effects on society and ecosystems become increasingly damaging, there is a huge weight of expectation on this year's United Nations Climate Change summit – the 28th meeting of the Conference of the Parties, COP28 – to deliver a clear plan of action. In 2015, the Paris Agreement (at COP21) enshrined a legally binding, international treaty to limit global warming to 1.5°C above pre-industrial levels.

The COP28 summit will seek to refocus global attention, bringing nations together to agree the actions required to deliver the pledges within the Paris Agreement and wider 2030 Agenda for Sustainable Development. This international effort requires new knowledge and innovation to tackle greenhouse gas emissions and inform adaption strategies to impacts around the world. The location of the COP28 summit, close to our campus in Dubai, presents an opportunity for us to leverage our local, in-country convening power to support policy discussions among UK and international decision-makers.

At the University of Birmingham, we are leading research into the consequences of climate change for our landscapes and infrastructure. We are investigating what mitigations could reduce food waste and ensure food and water security, and we are studying how to protect human health and biodiversity against the threats of extreme climate and pollution.



The changes required will not happen through political will alone; financial resource and behaviour change will be critical too. We are focusing our research to support recommendations on how economic decisions made by governments can affect sustainable climate policy.

These policy briefs set out the steps required to bring about improved resource security, a fairer global economy, a healthier society, and a more climate-resilient planet. The policies and investments made by governments can effect significant change to our climate resilience and provide meaningful contributions to our global collaborative effort. We look forward to working with policymakers, business, and wider society to support this work.

Professor Adam Tickell Vice-Chancellor and Principal University of Birmingham



Introduction

Our changing climate: mitigation, adaptation and resilience-building

There is a widespread scientific consensus that climate change is being caused by human activity with recent climate shifts and more extreme events attributed to increased greenhouse gas emissions. Our researchers are at the forefront of efforts to quantify and predict patterns and trends in our changing climate, as well as the impacts on society and ecosystems.

Our Keeping 1.5°C Alive report, launched in the House of Lords in May 2022 (in response to the UK's hosting of COP26), illustrated how the University of Birmingham's research is powering climate action and sustainability. Importantly, the report gave clear policy-facing takeaways focussed on achieving net-zero ambitions.

The Glasgow COP26 Summit, in November 2021, was recognised as the world's last chance to 'Keep 1.5°C Alive'. We are still nowhere near the scale and pace of emission reductions required for a 1.5°C warmer world. In May 2023, the World Meteorological Organisation (WMO) Global Annual to Decadal Climate Update report indicated that the chances of breaching the 1.5°C threshold for annual average near-surface global temperature (and dangerous climate impacts) had a 66% likelihood between 2023 and 2027. Moreover, this WMO Update states a 98% likelihood that at least one of the next five years, and the five-year period overall, will be the warmest on record. Although such a rise may be temporary (linked to the El Niño phenomenon), there is serious concern about the overall trajectory in global air temperatures. These anticipated changes highlight our need to mitigate and adapt to the impacts of dangerous climate change and make society and ecosystems more resilient – the focus of this report.

Because the climate change picture is complex, it is important to understand what it means when we talk about a globally increased temperature. As individuals, we do not live in the global (spatial) average of an averaged (time) year, but at a certain point in space and time. Thus, mean changes are not necessarily the best indicator for real changes in a region or in a season, which can by far exceed that region's capacity to deal with extreme meteorological or climatological events. It will also mean that all sectors of our natural or social environment may be affected differently, depending on region and time horizons. This variability in those global climate change impacts needs much more focus.

The following four policy briefs offer a very dedicated and targeted view in this context, focusing on four core aspects of current and potential future change: Health and Environmental Quality; Global and Regional Adaptation; Food Security; and Global Finance and Governance. These aspects are discussed separately; but there are also essential interactions between them. The reader will clearly identify, for example, the feedback between the governance of climate financing and regional to global adaptation measures, or the links between health, population increase, water security and sustainable food development.

The goal of all our efforts is to ensure the best academic evidence and research tools are harnessed to support the best decisions at this critical juncture in human history. To help facilitate this and build on existing work, we have established the Birmingham Institute for Sustainability & Climate Action that creates new knowledge and collaborates with partners, breaking silos to translate research into action on climate change and its impacts in the real world. We need to work together to address the climate crisis along the path to net zero ambitions – while considering necessary adaptations to protect and sustain ecosystems and society in the face of dangerous climate change.

David M. Hannah Professor of Hydrology and UNESCO Chair in Water Sciences University of Birmingham

Gregor C. Leckebusch Professor of Meteorology and Climatology University of Birmingham



Food security

Recent climate-caused food shortages in the UK and beyond, highlight the need for policymakers to accelerate improvements in key legislative and governance frameworks, to address existing food supply issues and prepare for future climate impacts on global food security.

A growing global population means significantly more mouths to feed. Given a projected increase in the world population of 2.4 billion people to 9.8 billion people by 2050 and rising incomes continuing to change diets, we will need to produce more food than ever before. With little new land available for agriculture and rising sea levels reducing land availability - farmers will need to produce more without expanding the agricultural area.

Climate change will also significantly reduce production and alter what farmers can grow in terms of both crops and crop varieties, as heatwaves, cold snaps, droughts, and floods (such as those we've seen recently) significantly reduce crop yields.

University of Birmingham policy brief contributors:

Nigel Maxted - Professor of Plant Genetic Conservation, Dr Helen Onyeaka - Associate Professor in Chemical Engineering, Dr Xinfang Wang - Assistant Professor in Cold Economy.



The United Nations (UN) Food and Agriculture Organisation estimates that all crop production will be reduced by 20% by 2050 and will carry on falling. Equally, maintaining agrobiodiversity poses a major challenge, as modern crop varieties are almost all homozygous - each seed an identical clone - developed to maximise efficiency and predictability in specific regions with constant climate patterns, but less suitable as climate patterns are shifting to extremes.

COP28 offers national and international policymakers a unique opportunity to advocate for impactful interventions which are vital to sustainable food development. This brief sets out recommendations that will build on existing expertise and go some way to addressing the challenges we face.

National policy recommendations

- The Government should invest in systematic in situ and ex situ conservation of UK agrobiodiversity (traditional crop varieties and crop wild relatives) to ensure genetic erosion and species extinction are halted.
- The Government should ensure the full breadth of UK agrobiodiversity is available to all user stakeholders to maintain their role as the foundation of all crop improvement and to facilitate adaptation to a rapidly changing and extreme climate.
- The Government should encourage diversification, both in crops and crop varieties, to spread the risks of climateinduced crop failure and to sustain food production and security.
- The Government should provide education and outreach programs to consumers to reduce food waste and promote sustainable food choices. Education programs can increase food security by redirecting food to those in need.
- The Government should invest in infrastructure and technology to support food waste valorisation, such as anaerobic digestion and composting. Investing in infrastructure and technology can help to reduce greenhouse gas emissions and the amount of waste sent to landfill, while also creating new jobs and industries.

- The Government must support research and development of new technologies and practices to promote sustainable food systems. The development and utilisation of biotechnology can help to increase the efficiency of food production, reduce food waste, and improve the nutritional content of food. New process developments can also be developed to convert food waste into value-added products, such as food supplements, biofuels and bioplastics.
- The Government should develop a regulatory framework that facilitates access, use, and equitable benefit-sharing of in situ conserved agricultural plant diversity. This will help to ensure that the UK is prepared for the major problems facing agriculture due to climate change.

Global policy recommendations

- International agencies such as the Food and Agriculture Organization of the UN should promote the systematic in situ and ex situ conservation of global agrobiodiversity to ensure it is available to stakeholders to maintain crop improvement and facilitate adaptation to a rapidly changing and extreme climate.
- International agencies like the Food and Agriculture Organization of the UN should encourage crop diversification to lower the risk of climate induced crop failure and to sustain sufficient production.
- Cold chain is essential in reducing food loss and food waste. We need government investment in the cold chain infrastructure globally, and development of a 'cooling-as-aservice' business model to enable small and marginal farmers to access the cooling services, especially in low-income areas.
- Sustainable cooling and cold chain for food delivered with renewable sources and energy storage technologies could provide nutritious food, reduce hunger, reduce carbon emissions from fossil fuels and from refrigeration leakage.



f the total food produced :

of the total food produced that could feed an estimated 1 billion people globally is lost due to lack of effective refrigeration.





of the UK population were supported by charitable food support, including food banks. We need to develop an information technology support framework (platform development, user interface) for in situ plant conservation equal to that of the IT network for managing agricultural plant diversity in gene banks (EURISCO). This will help safeguard our agricultural plant diversity and provide a foundation for the future of the agricultural economy and food and nutrition security in Europe.





Adaptation

Climate change is an established fact. Whilst global efforts to cut emissions, transition to carbon-neutral economies, and slow the pace of global warming are essential, it is imperative that we simultaneously adapt to the many climate consequences we face so we can protect our communities.

These consequences vary depending on where you live, and in the immediate term might mean fires or floods, droughts, hotter or colder days, or sea-level rise. In the longer term, however, these consequences will have undeniable global impacts through the migration of displaced people, implications on food production, and an increased need to support the Global South's response to environmental disasters.

Adaptation is essential to ensuring that global policymakers understand the necessary changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Put simply, policymakers around the world must develop solutions and implement actions to respond to current and future climate change impacts, both domestically, and on a global scale.

University of Birmingham policy brief contributors:

Dr Adriane Esquivel Muelbert – Lecturer in Global Forest Ecology, **David Hannah** – Professor of Hydrology, **Nicole Metje** – Professor of Infrastructure Monitoring, **Clive Roberts** – Professor of Railway Systems, **Harriet Thomson** – Professor of Energy, Sustainability and Society.

These solutions will take varied forms, depending on the unique context of a community, organisation, country, or region. There is no 'one size fits all' solution and adaptation will range from building flood defences, setting up early warning systems for extreme weather activity, and switching to climate-resistant crops, to redesigning the way we communicate risk, business behaviour and government policy. This work is already underway but sustained action and ambition are needed to manage risks cost-effectively, both now and in the future.

National policy recommendations

- The Government must engage with local communities to better understand the risks posed by flooding and the uniqueness of watershed characteristics to improve flood preparedness, response and mitigation.
- The Government should collect information to generate knowledge on the localities and communities at risk of flooding so that we can design a purposeful early warning system.
- The Government should invest in management to protect and promote natural regeneration to secure the sustainability of existing woodlands in the coming decades, including (but not restricted to) reducing large populations of herbivores, such as deer, and controlling bracken growth in regeneration sites.
- The Government should ban the commercialisation of products derived from deforested areas and certify more strongly the origin of products imported to the UK.

- The Government needs to prioritise updating our buried infrastructure which is essential for providing everyday services such as gas, electricity and water. The network is ageing and needs adaptation to changes in climate and demand.
- The Government must utilise existing and novel sensing technologies to move from reactive to proactive asset management of buried infrastructure. It is important to move away from an 'out of sight, out of mind' culture.
- The Government should explore green hydrogen as a solution to railway emissions.
- The Government can draw on academic expertise in supporting the rail sector to address two key challenges: optimising the current rail system – including reducing emissions and increasing accessibility – and making optimal choices when commissioning new rail infrastructure.

Global policy recommendations

- Global governments must come together to develop a truly shared international agenda on climate research and impacts, a stable framework for international funding, and a global environment that enables rapid innovation.
- Governments, industry and the scientific community across the world must intensify their efforts to help bridge the gaps between research, education, policy, and practice.
- Large-scale programmes of tree planting should aim to restore ecosystems and improve the lives of local communities. Failure to implement these can lead to biodiversity loss, carbon released into the atmosphere, and social crises. The carbon market should be structured and regulated to protect nature and vulnerable societies, not only to store carbon.
- International agencies should promote the protection of old-growth forests, their biodiversity, and their people. For that to happen, financial incentives should be provided to the people that depend on this land and the countries opting to keep their territory as natural vegetation, aiming for the development of sustainable management practices and ethical sourcing, and avoiding carbon colonialism.





per year is spent in the UK on repairing damage to buried pipes and cables caused by digging and excavating.





people live in water-stressed countries, expected to be exacerbated in some regions as a result of climate change

- Governments across the globe must take action to ensure potable (drinking) water is not lost due to ageing buried infrastructure.
- The international community can draw on academic expertise to help deliver financially sustainable rail infrastructure in developing countries.





Health and environmental quality

Climate change affects not only our planet but our ability to live and work. The potentially deadly impacts of extreme heat on human health are already being felt all over the world, and record temperatures and wildfires in the UK last year remind us that we must act now to prevent further risk.

Beyond the immediate risk posed to our global health by extreme weather, increased emissions from the way we travel are impacting the quality of our air, plastic pollution in our water threatens marine species as well as humans, and our access to a varied diet is under threat from climate-caused food shortages. Many of these consequences of climate change, which have felt like far-off dystopian outcomes, have been made to feel very real over recent years.

University of Birmingham policy brief contributors:

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The Global South is at a higher risk from these consequences. Rising global temperatures, whilst inconvenient for us in the UK, make working – and even living – almost impossible in many geographies around the world. It is also the case that those with the least agency over their transition to a net zero economy will be the first to be permanently displaced by climate change, with the rest of the world woefully unprepared to support the humanitarian crisis triggered by the mass movement of people.

To better alleviate these pressures on global health services, our food supply, and our wellbeing, policymakers must work with academia to advocate for emerging solutions which allow us to identify, map, and mitigate the impacts of climate change on global health.

National policy recommendations

- The Government must develop a strategy for securing access to critical minerals. As countries around the world seek to reduce their carbon emissions, there is an evergrowing demand for those critical minerals that are vital for the transition to renewable energy and a greener economy. We expect demand for these minerals to grow rapidly and this will be exacerbated by vulnerabilities in their supply chains. This strategy may involve domestic primary extraction of minerals and greater processing capacity, coupled with robust governance structures to ensure high levels of environmental protection.
- The Government needs to develop an appropriate regulatory regime for non-exhaustant emissions from road transport. Non-exhaustant emissions are now more prominent due to tyre, brake and road wear. Electric cars will continue to produce non-exhaustant emissions despite being better for the environment overall and this must be taken into consideration.
- The Government should launch a thorough review of the potential benefits of promoting e-cycling as an alternative to motor vehicles. The true potential of promoting e-bike use in the UK is not fully understood due to a lack of data collection and monitoring of e-bike initiatives. E-bike use has the potential to reduce transport-related emissions and traffic congestion to a greater extent than electric cars while providing physical and mental health benefits.

Global policy recommendations

- The international community must develop effective circular economy models which will ensure a supply of secondary critical materials through effective systems of sustainable production and consumption and the effective recycling and reuse of critical minerals.
- Governments must utilise scientific evidence to inform future place-based air quality solutions. For example, Clean Air Zones and Low Emission Zones aim to discourage the use of the most polluting vehicles, typically in urban areas. They are being increasingly introduced by local authorities to achieve compliance with legally binding air quality objectives. However, many questions remain regarding their effectiveness to improve air quality, health, and their impacts on wider society.
- Global governments should work together to create sustainable cooling and cold chain for food which when delivered with renewable sources and energy storage technologies could provide nutritious food, reduce hunger, reduce carbon emissions from using fossil fuels and direct emissions from refrigeration leakage.





is the estimated value of the global e-bike market by 2030.



90% of all road transport PM2.5 emissions will

come from non-exhaust emissions by 2030.



low emission zones are expected to be in place across Europe by 2025.

References: Vision Research Reports (2023); Air Quality Expert Group/ Department for Environment, Food and Rural Affairs (2019); The Guardian (2022); iea (2023)





the market in key energy transition minerals reached \$320 billion in 2022, doubling in size since 2017.



Global finance and governance

Considerable financial resources and targeted investments are needed to address climate change at both a domestic and global level – not only to reduce emissions, but to promote adaptation to the impacts that are already occurring, and to build global resilience to the impacts of a shifting climate. As made clear by multiple financial assessments, including Chris Skidmore's recent Net Zero Review, the benefits of these investments – both societal and economic – vastly outweigh the upfront costs.

The focus of previous COP summits has rightly been on garnering financial support for the global transition. COP27 closed with countries delivering a package of decisions that reaffirmed their commitment to limit global temperature rise to 1.5°C above pre-industrial levels. The package also strengthened action by countries to cut greenhouse gas emissions and adapt to the inevitable impacts of climate change, as well as boosting the support of finance, technology and capacity building needed by developing countries. The Glasgow Financial Alliance for Net Zero, established in the lead-in to COP26, has raised some \$130tn of assets with more than 450 finance companies involved.

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Hisham Farag - Professor of Finance, Dr Yuli Shan - Associate Professor in Sustainable Transitions.

Despite this momentum, tensions exist over the intended beneficiaries of the finances raised. To add to an already complex problem, issues on the governance of climate financing, and the impact of global economies on the climate, remains a murky world. With financing now firmly embedded in the COP agenda, policymakers must play a vital role in securing commitments to implementation, measurement, and reporting.

Policymakers should focus on ensuring that committed funds are channelled effectively, implemented efficiently, and reported on transparently – allowing the global community to fully understand the impact of global finance initiatives.

National policy recommendations

- The Government should closely monitor the public and private firms that have financial ties with Sovereign Wealth Funds originating from countries with weak governance mechanisms and institutional features and limited institutional ties.
- The Government should develop a comprehensive regulatory framework, surpassing the standards set by the Santiago Principles, that would require any Sovereign Wealth Funds to be transparent and accountable regarding their investment objectives, funding sources, governance structure, state independence, and public holdings.
- The Government must enhance its governance codes and practices and bolster its monitoring capability to help limit and mitigate the negative externalities of Sovereign Wealth Funds investments, especially related to ESG risks, while also benefitting from the positive externalities such as a source of cheaper financing.

Global policy recommendations

- International policymakers should encourage firms to adopt climate adaptation and risk management strategies to mitigate the negative impact of extreme weather events on their financial performance.
- Global coordination is imperative to strengthen the Santiago Principles and broaden its outreach to countries where Sovereign Wealth Funds exhibit deficiencies in their transparency, disclosure, and accountability. An increase in SWFs transparency and accountability would help reduce the unintended negative consequences while also allowing countries to benefit from the increased capital inflow.
- Given the substantial size and influence of Sovereign Wealth Funds as institutional investors, all states must ensure that these Funds adopt sustainable investment practices and integrate Environmental, Social, and Governance (ESG) considerations into their decision-making processes, taking inspiration from the investment model successfully implemented by the Norwegian Government Pension Fund Global.









per year in climate finance for developing nations was agreed in the 2009 Copenhagen Accord.

- Governments should consider the indirect effects of global supply chains, and develop a new economic impact model based on the input-output techniques.
- Governments worldwide should use the fallout of the Covid-19 crisis as an opportunity to tackle global climate change, at the very least to avoid further carbon lock-in effects of 'dirty' energy infrastructure.



of low income countries are spending 5x more on debt servicing than on climate adaptation each year.



Afterword

Education is at the heart of UNESCO's mission, and it is at the heart of the climate crisis, too. Universities have a vital role to play, not only in developing new technologies, and gathering new evidence and data, but in educating our leaders in the actions and priorities that they should be accepting and championing in this collective endeavour.

I very much welcome, therefore, the ideas and recommendations set out in these Policy Briefs which rightly emphasise collaboration and shared ownership of the climate crisis. In his introduction, Professor Leckebusch illustrates the essential interconnectedness of challenges we all face, and the Briefs themselves recommend cooperation at both national and global levels.



It is clear these approaches will prove critical to delivering climate action that is equitable and just, as well as being effective in both low-income countries and the world's richer nations.

The COP28 summit is presented as an opportunity to take stock, to reset, and to correct our course. As a priority, we must address the fractures between the actions we all know we must take to preserve our shared humanity, and the day-to-day demands of power and profit.

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