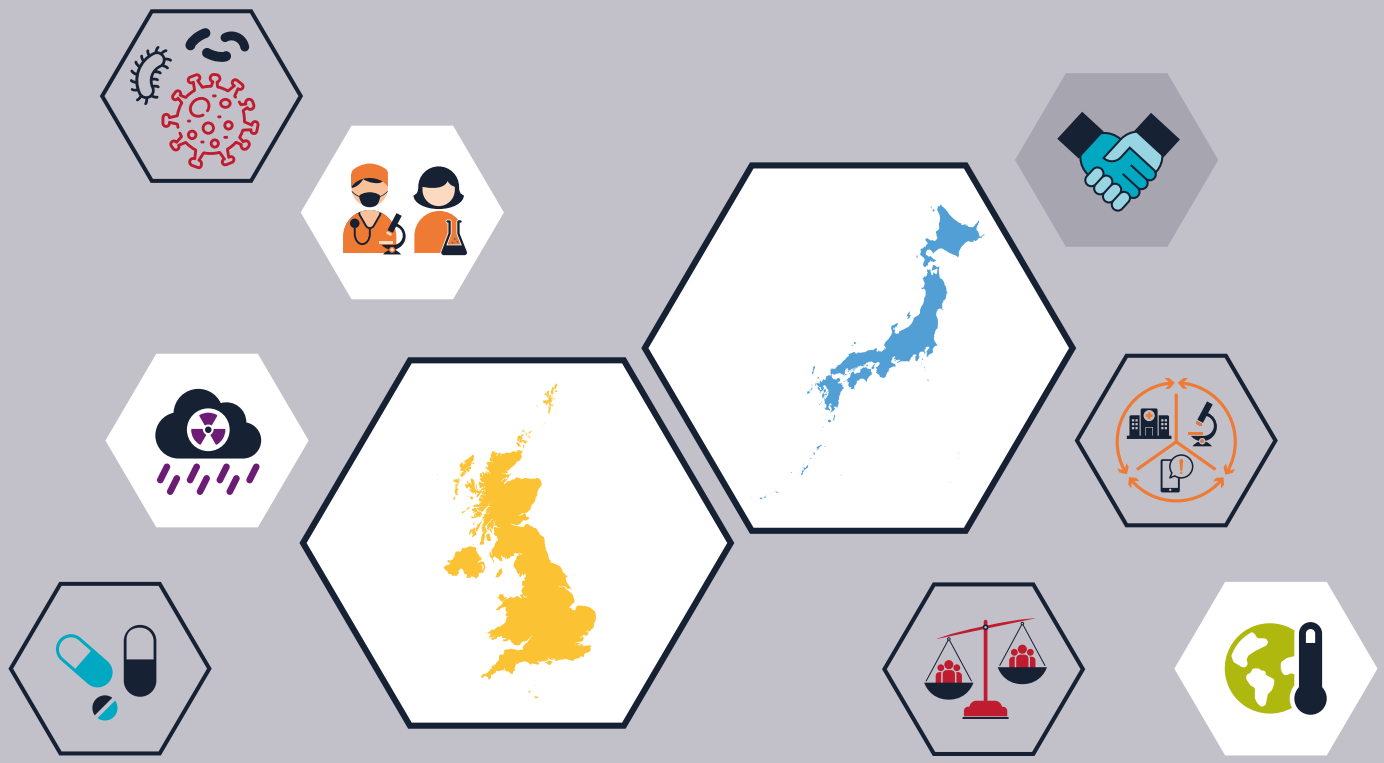

Improving the resilience of health and public health systems to the impact of climate change: learning from Japan and the UK

The Academy of Medical Sciences

JSPS

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Executive summary

The impact of the COVID-19 pandemic shows the importance of having robust health and public health systems. As we move into an increasingly uncertain world due to the impacts of the climate emergency, threat of future pandemics and increased conflict, investing in health systems is ever more important – especially for those who are most vulnerable and disproportionately impacted by these events.

In October 2024, recognising the importance of knowledge sharing and international collaboration, the Japan Society for the Promotion of Science (JSPS), London, and the UK Academy of Medical Sciences convened experts from Japan and the UK for a two-day policy workshop to share country-specific perspectives and lessons learned to identify priorities for policy and research in both countries. Participants represented a diverse range of backgrounds, career stages, and expertise to ensure a broad and inclusive dialogue throughout the workshop.

Through case study presentations, Q&As, breakout groups and plenary discussions participants identified several key themes relevant to resilient health and public health systems. A full agenda can be found in Annexe 1.

Key themes identified

To build resilience on a national scale, an **interconnected approach with cross-government working and transdisciplinary research,** which considers health in other policies such as housing and transport, is required. This, coupled with an enabling environment for the translation of research into evidence-based policy facilitates quick evaluation of new and current interventions to ensure they are fit for purpose.

Resilience on a national scale would also involve considering the health and public health system as something that **extends beyond its traditional boundaries and out into communities.** Increasing the resilience of communities in Japan and the UK was therefore seen as essential; this included **reducing the deep-seated inequalities** experienced by more vulnerable populations. Targeted communication around climate change and health emergencies was noted as a way to reduce the spread of mis- and disinformation and to **gain public trust.**

The **impact of compound pressures** on the health system – such as a pandemic occurring under climate extremes with a cost-of-living crisis – was identified as particularly challenging for resilience. Of particular note, the limited opportunity for the health system to 'bounce back' after the COVID-19 pandemic, and the impact of this on the mental health of healthcare workers. Developing **clear response plans and prioritisation strategies** was suggested as a way of managing these pressures. **Integrated monitoring and analysis** would also be needed, which could enable the system to rapidly respond to threats and ensure evidence-based actions.

Increasing the resilience of health systems was also seen as an opportunity to **decrease its environmental impact.** Adopting innovation and technology could aid decarbonisation, as well as increase the resilience of health systems. This opportunity was noted to be not without its risks, as new technologies such as artificial intelligence (AI) could lead to greater inequalities if not implemented carefully with the most vulnerable populations in mind.

Participants noted that **education, training and research support underpinned a lot of the actions to increase resilience.** Integrated training, both formally and informally, would be crucial in ensuring that the next generation of health professionals had the necessary knowledge and skills to respond to future threats.

Whilst Japan and the UK have different political, social and cultural contexts, participants discussed that there were still many opportunities to learn and collaborate to address the key themes identified.

As shared endeavours, both countries could:

- Share future-proofing strategies between Japan and the UK, including lessons learned and best practice from each country's deemed relative strengths. Participants noted that much could be learned from Japan's experience of disaster response and from managing an ageing population. Similarly, lessons could be drawn from the UK's actions to reduce the environmental impact of the NHS.

- Identify pathways driving inequitable access to the health system and how the climate emergency exacerbates this for socially disadvantaged and physically vulnerable people. Share interventions targeting these pathways to reduce health inequalities.

- Identify where cross-sector working nationally and internationally is needed, including transdisciplinary research and cross-government departments to bring together traditionally separated sectors, for example health systems research, climate expertise, evaluation experts and public health professionals.

- Compare healthcare system evaluation methods and collaborate on finding the right indicators to monitor success of interventions and policies, and develop responsive research infrastructure to study time-limited natural experiments, to improve rapid evidence-based policymaking.

- Share lessons learned on how to implement integrated planetary health and health system monitoring and analysis, inclusive of developing a skilled workforce and collecting robust data to develop early warning systems.

- Understand which communication strategies work well under different threat scenarios and with different populations within Japan and the UK. Share how best to target communication and engagement with the populations around health emergencies and climate change to lead to short- and long-term behaviour changes.

- Exchange knowledge and best practice about how to co-design interventions with patients and the public to create people-centred resilient health systems. Share strategies to ensure communities who do not normally engage in health systems are reached.

- Identify the pros and cons of using AI and tech-based transformations in health care systems. Understand how to mitigate the risks that AI could exacerbate health inequalities and contribute to climate change.

- Enhance bilateral collaboration to develop integrated education programmes that include the impact of the climate emergency on human health, in particular for early career researchers and healthcare professionals.

Participants agreed that by drawing on each other's strengths, both countries can invest in health systems that can better address immediate and long-term challenges, whilst promoting collaboration, innovation and inclusivity.

Introduction

The devastating impact of the climate emergency is apparent across the globe with intensifying frequency and severity. Relative to other countries, the UK and Japan have experienced moderate climate impacts so far.[1] These impacts are still significant and can be varied, ranging from minor disruptions to loss of life or livelihoods. Forecasts also indicate that these impacts are likely to intensify and become less predictable.

Although the climate impacts in Japan and the UK differ, similar challenges may be felt on varying scales depending on the local context. For example, average annual temperature anomalies are rising in both nations. However, what constitutes a 'hot' summer day differs – in the UK, a hot summer's day is typically around 28°C, whereas in Japan, hot summer days often exceed 30°C, sometimes reaching over 35°C.[2,3] Both scenarios have implications for society by affecting both human health and local infrastructure, including health and public health systems, posing challenges such as increased heat-related illnesses, heightened demand for emergency care, and disruptions to healthcare facilities. These temperatures represent just one example of shared climate-related challenges – other threats include flooding, extreme weather events, and changing disease patterns, which cause further strain on public health systems.

Whilst climate change stands as one of the most severe threats to the globe, it is not the only threat society must prepare for – pandemics, increased conflict, and environmental degradation also pose immediate and future risks, which are interlinked and exacerbated by the climate emergency. All will have a significant impact on human health.

The COVID-19 pandemic tested health systems across the world and demonstrated the importance of investing in resilient health and public health systems. Learning from the pandemic, and other catastrophic events, is essential to protect and prepare the global population to future shocks, especially for those who are disproportionately impacted by them. Increasing the resilience of health systems will better prepare nations for a broad spectrum of future challenges, regardless of their specific nature.

Recognising the urgency of these challenges and the opportunity to share knowledge and experience between Japan and the UK, the UK Academy of Medical Sciences and the Japan Society for the Promotion of Science (JSPS), London, hosted a policy workshop to discuss how to enhance the resilience of health and public health systems – particularly for the most vulnerable – to climate change. Participants from both countries represented a diverse range of backgrounds, career stages, and expertise to ensure a broad and inclusive dialogue throughout the workshop.

Through case study presentations, Q&As, breakout groups and plenary discussions, participants identified several key themes important when considering resilient health and public health systems. A full workshop agenda can be found in Annexe 1.

1. Eckstein D, Künzel V & Schäfer L (2021). Global Climate Risk Index 2021. https://www.germanwatch.org/en/19777
2. Met Office (2024). Temperature extremes and records most affected by UK's changing climate. https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2024/temperature-extremes-and-records-most-affected-by-uks-changing-climate
3. Japan Meteorological Society (2024). Tokyo 2024 (Monthly Values) Temperature. https://www.data.jma.go.jp/stats/etrn/view/monthly_s1.php?prec_no=44&block_no=47662&year=2024&month=&day=&view=g_tem

Key terms for the policy workshop

Recognising the importance of using shared terminology for this workshop, participants heard from speakers outlining the definitions of health system resilience, health inequalities, and planetary health.

Health system resilience

Health system resilience can be defined as 'the capacity of a health system to (a) proactively foresee, (b) absorb, and (c) adapt to shocks and structural changes in a way that allows it to (i) sustain required operations, (ii) resume optimal performance as quickly as possible, (iii) transform its structure and functions to strengthen the systems, and iv) reduce its vulnerability to similar shocks and structural changes in future'.[4]

Without resilient health and public health systems at local, national and international levels, populations will be increasingly vulnerable to emerging threats, and those in society who are most vulnerable will be disproportionately impacted and health inequalities will likely increase.

Participants discussed throughout the workshop the challenges in defining resilience and that the concept can be very abstract. Questions included (a) understanding resilience for whom, (b) the difference between short- and long-term resilience – and how it changes over time, (c) how 'resilience' impacts different demographics, and finally (d) the methods to measure and evaluate resilience.

Health inequalities

Health inequalities can be defined as 'the systematic, avoidable and unfair differences in health outcomes that can be observed between populations, between social groups within the same population or as a gradient across a population ranked by social position'.[5] Health inequalities have multiple axes, such as socioeconomic position, gender identity, ethnicity, geography, age, and disability (not an exhaustive list). The combination of these axes – intersectionality – must also be considered.

4. Zimmermann J, *et al.* (2024). Health systems: a practical handbook for resilience testing. WHO Regional Office for Europe, Copenhagen & OECD Publishing, Paris. Licence: CC BY-NC-SA 3.0 IGO.
5. McCartney G *et al.* (2019). *Defining health and health inequalities.* Public Health **172**, 22–30.

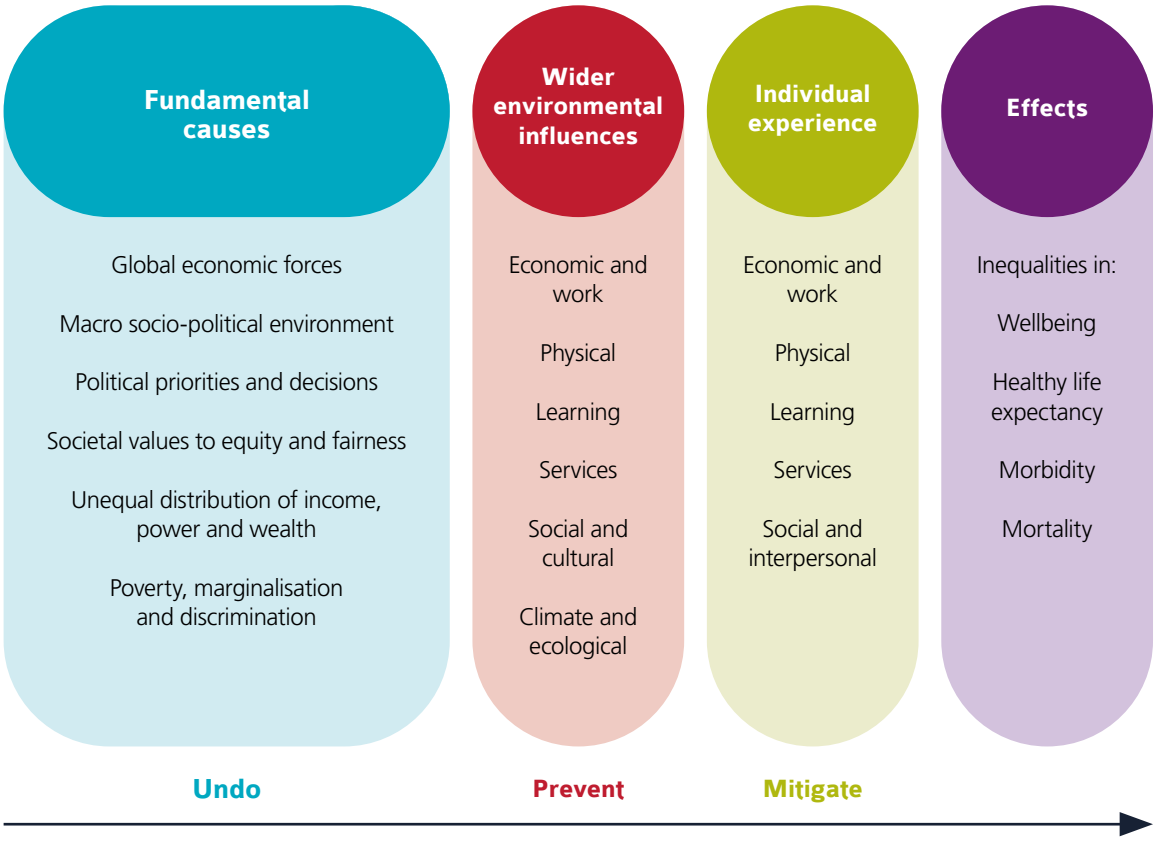

Figure 1: Causes and effects of health inequalities

Health inequalities are primarily caused by the unequal distribution of power and resources within society. This distribution can lead to poverty, marginalisation and discrimination, which then causes varying environmental influences on health and impacts their individual experiences and outcomes. (Figure 1).[6]

When discussing health inequalities, the gap between the most and least advantaged is often considered. However, health inequalities do not only affect the most disadvantaged in society, and often exist across a gradient – people experiencing greater disadvantage are more likely to experience poorer health outcomes.[7]

For the purpose of this policy workshop, participants looked at inequities *within* a country, across social groups, rather than between countries.

Planetary health

For the purposes of this workshop, all interventions to increase health system resilience were considered within the context of planetary health.

Planetary health considers and acts for a healthy and sound environment of the Earth, human life and human society, at various scales from local to global. Taking a planetary health approach acknowledges that environmental and societal issues are interconnected and complex and cannot be considered in isolation. Solutions therefore need to be addressed from local to international levels through holistic and systemic approaches, in which human health and health of the planet are interrelated.[8]

6. Adapted from Public Health Scotland (n.d.). Health inequalities: what are they, how do we reduce them? https://publichealthscotland.scot/media/25467/health-inequalities-what-are-they-how-do-we-reduce-them.pdf
7. Sinha IP *et al.* (2023). Inequalities in Respiratory Health. European Respiratory Society. https://reader.ersjournals.com/inequalities-in-respiratory-health/1
8. Nagasaki University (2024). Challenge to Planetary Health. https://www.nagasaki-u.ac.jp/ja/guidance/philosophy/actionplan/file/actionplan.pdf

Pressures on the health system

Speakers provided further information about the health and public health systems in Japan and the UK. This included an overview of how healthcare works in both countries, and how the systems are delivered and regulated, as well as the current pressures faced.

Japan

The healthcare system in Japan works relatively well – the universal health coverage (UHC) service coverage index by the WHO has increased to 83/100 in 2021, higher than the Western Pacific (79/100) and the world (68/100).[9] The universal health system in Japan is one of the few healthcare systems in the world that guarantees access to quality healthcare at affordable costs. The life expectancy for its citizens is good (84.5 years, or 73.4 years for healthy life expectancy, compared to the world average of 71.4 years or 61.9 years for healthy life expectancy). This, coupled with a fall in birth rate to 1.3 in 2022, means that Japan now has an aged population.[10]

By 2030, one in three of the Japanese population will be above 65 years old – this adds enormous pressure to the health system, both in terms of demand for services, but also due to the smaller proportion of people at a working age who are able to provide the care. This ageing population is also closely linked to productivity and therefore economic growth.

The Ministry of Health, Labour and Welfare (MHLW) has been leading efforts to maintain effective and efficient access to healthcare by reorganising delivery methods and systems in response to changes in society. There is currently a paradigm shift in Japan in terms of technology and innovation – this is inclusive of new tools coming into the healthcare sector, which take a personalised approach as well as multi-sectoral and non-pharma approaches.

While Japan is working towards universal healthcare, disparities in access to quality care persist, particularly due to socioeconomic and geographic factors. Rural and remote areas, for example, often face shortages of healthcare professionals and limited access to facilities, which can lead to delays in treatment and inadequate care for chronic diseases or specialised needs. Financial and logistical barriers can also disproportionately impact low-income individuals and elderly patients, especially as the costs of healthcare rise.

Japan's susceptibility to natural disasters such as earthquakes, tsunamis, and typhoons poses significant challenges to the health system. Climate change is compounding these risks by increasing the frequency and intensity of extreme weather events. These disasters disrupt healthcare services, displace populations, and create surges in demand for care during emergencies. Additionally, the psychological toll on survivors heightens the need for robust mental health services.

9. World Health Organization (2024). UHC service coverage index. https://data.who.int/indicators/i/3805B1E/9A706FD#disclaimer-maps
10. World Bank (2020). Fertility rate, total (births per woman) - Japan. https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=JP

The UK

The National Health Service (NHS) is similarly an example of universal health care that guarantees access to quality healthcare at affordable costs. It also has a high UHC service coverage index, at 88/100, slightly higher compared with the average for Europe (81/100).[11] Due to the devolved nature of health in the UK, each of the four nations (England, Northern Ireland, Scotland and Wales) fund, regulate, and deliver health services slightly differently; however, there are still shared challenges between nations.

UK-wide, the NHS is facing significant financial and operational challenges, driven by increasing demand and limited resources, all of which were exacerbated by the COVID-19 pandemic and the UK's exit from the European Union.[12,13] This has resulted in growing treatment waitlists and backlogs, a social care crisis, workforce burn-out, and widening health inequalities. The UK Government's Inquiry into the UK's preparedness and response to the COVID-19 pandemic highlighted the severe impact of the pandemic on health inequalities and noted that 'Emergency planning failed to put enough consideration into existing health and social inequalities'.[14] The ageing population and the amount of people living with multiple long-term conditions in the UK also plays a role in health system capacity by increasing demand and decreasing workforce.[15]

The climate emergency remains one of the most significant long-term threats to human health in the UK. Like the rest of the world, a changing climate will impact the spread of disease, availability of food and water, and unpredictable extreme weather events can lead to flooding causing loss of life and livelihood. How the health system responds to these threats will have a crucial impact on the health of the UK population. Recognising the environmental impact of the NHS, each of the four nations also have plans to address this.[16]

Improving health and building an NHS fit for the future was announced as a key mission for the Labour government, which took office in Summer 2024.[17] Major priorities include moving towards preventative care, reducing waiting times, and modernising healthcare infrastructure.

11. World Health Organization (2024). UHC service coverage index. https://data.who.int/indicators/i/3805B1E/9A706FD#disclaimer-maps
12. The King's Fund (2023). The rise and decline of the NHS in England 2000–20. https://www.kingsfund.org.uk/insight-and-analysis/reports/rise-and-decline-nhs-in-england-2000-20?gad_source=1&gclid=EAIaIQobChMIht3k8fGLigMVc5JQBh1GqTo7EAAYASAAEgKGJ_D_BwE
13. Nuffield trust (2022). Health and Brexit: six years on. https://www.nuffieldtrust.org.uk/sites/default/files/2022-12/1671199514-health-and-brexit-web.pdf
14. UK COVID-19 Inquiry (2024). Module 1 report: The resilience and preparedness of the United Kingdom. https://covid19.public-inquiry.uk/reports/module-1-report-the-resilience-and-preparedness-of-the-united-kingdom/#section_13_appendix-4-list-of-recommendations-made-in-this-report
15. NHS England (n.d.). Evolving to meet a changing world. https://www.england.nhs.uk/future-of-human-resources-and-organisational-development/the-future-of-nhs-human-resources-and-organisational-development-report/evolving-to-meet-a-changing-world/#:~:text=There%20is%20a%20rising%20demand,more%20individuals%20managing%20multiple%20conditions.
16. NHS England (2022). Delivering a net zero NHS. https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/
17. Labour (2024). Labour Party Health Policy: How we will build an NHS fit for the future. https://labour.org.uk/updates/stories/labour-party-health-policy-how-we-will-build-an-nhs-fit-for-the-future/#:~:text=As%20a%20first%20step%2C%20Labour%20will%20cut%20NHS,Dentistry%20-Rescue%20Plan%208%2C500%20additional%20mental%20health%20staff

Key themes identified

Several key themes that should be addressed to build resilient health and public health systems were identified from case study presentations, breakout groups and plenary discussions.

Creating resilient communities

Participants discussed that to build resilience on a national scale, an interconnected approach to considering resilience is required as the health and public health system extends far beyond its traditional boundaries and out into the community.

The negative impacts of social isolation on the physical and mental health of the population were discussed. By adopting a community-wide approach, which leads to greater social cohesion, individuals can be better supported, especially those who are disproportionately impacted by threats and may otherwise fall through social safety nets. This is particularly important in Japan and the UK, which are both facing ageing populations. It was also noted that the impact of climate change on maternal and child health is not yet well recognised in Japan, despite recent studies revealing a link between heat exposure and preterm birth, asthma, Kawasaki disease, or other paediatric diseases in the country.

Additionally, participants discussed the challenges arising from prioritisation of short-term economic and capitalist benefits, which may limit sustainable approaches to strengthening health system resilience. Participants discussed that moving from a less individualistic and extractive society, towards a more inclusive, regenerative society, could ensure that society remains within planetary limits, whilst also increasing resilience to threats.

Moving towards preventative care was also discussed as a way to increase resilience by reducing the burden on the health system at the time of the shock.

Reducing health inequalities

Climate change and future/current threats, such as pandemics, can increase inequalities – as seen by the COVID-19 pandemic.[18] Participants discussed that any action to improve health system resilience must also address the deep-seated inequalities in both Japan and the UK.

To address this, participants noted the need for a greater understanding of who the vulnerable populations in each country are – this may be those who are not accessing health services, and the reasons why. Similarly, data on the social determinants of health and health inequalities are needed. Connected and coordinated data and robust monitoring was mentioned as a mechanism to understand this; however, participants noted that the data must be integrated across sectors and inclusive of different demographics to not exacerbate inequalities.

Co-designing solutions with patients and the public was noted as an important approach to creating people-centred resilient health systems. As this is being done to varying degrees in both countries, it could be an opportunity to share knowledge and best practice.

18. UK COVID-19 Inquiry (2024). Module 1 report: The resilience and preparedness of the United Kingdom. https://covid19.public-inquiry.uk/reports/module-1-report-the-resilience-and-preparedness-of-the-united-kingdom/#section_13_appendix-4-list-of-recommendations-made-in-this-report

Working across silos

Participants discussed the importance of moving away from traditional sector and departmental working, towards cross-government working and transdisciplinary research to assist with rapid response to shocks.

Including health in all policies (such as housing and the built environment) was recognised as an opportunity that would enable this. It was also recognised that good health is often ultimately determined by non-medical factors, therefore reframing resilience and health as a society-wide issue is essential.

Extending wider than government, participants discussed that collaboration between researchers, citizens and the public and private sectors can enable greater innovation and could result in a system that is centred around people.

Although working across silos does not come without its challenges, participants noted that the funding landscape could be an example of where reform could be implemented to better support transdisciplinary research.

Participants emphasised that greater connections between academia and policymakers would enable both countries to better translate research into policy and practice. They highlighted that sharing learning on the barriers faced in both countries could help identify solutions and overcome these challenges in both contexts.

Managing compound pressures

Another theme was managing the impact of compound pressures on health systems, such as a pandemic occurring under climate extremes with a cost-of-living crisis. This combined pressure is particularly challenging because the system, already stretched by the initial crisis, becomes even more vulnerable under added pressure. Participants noted that our health systems never truly recovered from the COVID-19 pandemic, and that they are experiencing heightened pressures due to their limited opportunity to recover and 'bounce back' from the pandemic. This raised the discussion around a need for a new benchmark for what 'bouncing back' really means.

Participants noted the impact this has on the mental health of healthcare workers, as well as the wider population. They noted mental health of healthcare professionals is often seen as secondary to physical health.

Establishing clear response plans and protocols for prioritising resources and services during crises was seen as crucial to maintaining resilience in times of compound pressures.

UK participants noted that Japan is further ahead in disaster planning and that it would be a good opportunity to learn from Japanese colleagues' experiences, particularly in terms of training and preparing the medical systems. During presentations, participants discussed the important role that nurses play in contributing to community mitigation and disaster response. For example, the EpiNurse initiative in Japan aims to equip nurses with an epidemiological approach to respond to health inequalities in a community crisis. The programme combines emerging techniques with traditional knowledge of nursing to address the interconnected challenges of human care and environmental resilience in the context of inclusiveness.[19]

Integrated monitoring and analysis for rapid response

A rapid, evidence-based response will be needed for any future threat. Participants discussed the importance of having integrated planetary health and health system monitoring and analysis across different sectors to inform a rapid response. This would be underpinned by robust data, as well as education and training – in curriculum, and wider – for stakeholders involved to understand both planetary and population health.

19. Kanbara S, Miyagawa S & Miyazaki H (2022). *Disaster nursing, primary health care and communication in uncertainty.* Springer.

Ensuring resilient health system infrastructure is in place and ready to respond was also noted to be crucial for increasing resilience. This included having contingency plans and early warning systems that are inclusive of vulnerable populations.

Participants shared lessons learned from the early warning systems in Japan and the UK. Heat-related illnesses due to climate uncertainty pose significant risks to public health, particularly for Japan's super-aged population, 90% of whom live in urban areas and are highly vulnerable to extreme heat events.[20] Prefecture-level estimates project 3- to 4-fold increases in mortality and morbidity rates due to high temperatures during the 2090s compared to the 2010s under a 2-degree warming scenario.[21] Since 2021, Japan has implemented a national heat alert system to mitigate these risks. However, ongoing evaluation of its effectiveness is crucial to support evidence-based policymaking and improve adaptive strategies.

In England, the government transitioned to an impact-based Weather-Health Alerting system, which provides the population with information on expected impacts as a result of the hazardous weather conditions forecast, and forms one of the key areas of action of the Adverse Weather and Health Plan.[22] This approach provides more nuanced information on both the level of impact possible, and the likelihood of those impacts being observed. Combining the impact assessment and the likelihood of those impacts occurring results in an appropriate alert being issued, which are categorised into green, yellow, amber and red in terms of overall risk.[23] Evidence suggests that yellow alerts are not viewed by all as requiring specific action, which potentially may have led to an increased amount of heat-associated mortality during yellow alert periods in the summer of 2023.[24]

In both scenarios, participants discussed how closely linked trust in the government is with these early warning alerts, and the importance of tailoring methods of communication to different groups. Furthermore, a shared challenge identified was how to encourage long-term behaviour change in the population, rather than relying on alerts that are short-term solutions. Therefore, the need to embed behavioural science into alert systems was discussed.

Evaluation

Participants discussed the importance of evaluating interventions to help inform evidence-based policy. They highlighted that closing the evidence gaps in measuring the effectiveness of some interventions already in place was a crucial first step, the heat alert system in Japan was an example presented during the workshop.

To assist with success measures, during presentations, participants discussed examples of indicators that can be used to measure the resilience of health systems. Researchers working on the 'Resilient Health Systems' project in the UK co-designed a resilience-focused conceptual framework with key stakeholders, which was used to understand how and why innovations in response to COVID-19 were introduced. Using a range of research and evaluation methods, the framework has been used to explore the resilience capacities of the South East London Integrated Care System and aid decision-making to increase the resilience of programmes and services provided at the local level. Key lessons from this process (still on going as of February 2025) include focusing on ameliorating system stressors to prepare for shocks and building local adaptation and absorption processes.

20. Yoonhee K *et al.* (2023). *Enhancing health resilience in Japan in a changing climate.* Lancet Regional Health Western Pacific. **40**, 100970.
21. Yuan L et al. (2024). *Non-optimal temperature-attributable mortality and morbidity burden by cause, age and sex under climate and population change scenarios: a nationwide modelling study in Japan.* Lancet Regional Health Western Pacific. **52**, 101214.
22. Public Health England (2021). Adverse weather and health plan. https://www.gov.uk/government/publications/adverse-weather-and-health-plan.
23. Public Health England (2019). WHA user guide. https://assets.publishing.service.gov.uk/media/6661d77d1669db82a64c1b95/WHA_User_Guide.pdf.
24. Public Health England (2023). Heat mortality monitoring report 2023. https://www.gov.uk/government/publications/heat-mortality-monitoring-reports/heat-mortality-monitoring-report-2023.
25. King's Health Partners (n.d.). Resilient health systems. https://www.kingshealthpartners.org/our-work/clinical-academic-integration/women-and-childrens-health/resilient-health-systems.

Participants also discussed the National University of Singapore (NUS)-Lancet Pandemic Readiness, Implementation, Monitoring, and Evaluation (PRIME) Commission, which has taken a grassroots, cooperative approach to developing indicators of health systems resilience by evaluating the response to the COVID-19 pandemic in 20 countries.[26] The Commission's research highlights the critical role of trust, governance, and equity in shaping pandemic preparedness. It underscores the need for a shift from reactive crisis management to proactive, inclusive strategies that integrate community engagement, cross-sectoral collaboration, and adaptive policy responses. The findings emphasise that future preparedness must go beyond technical solutions and incorporate structural changes that address social determinants of health, governance challenges, and disparities in resource allocation. By drawing on comparative case studies and diverse political, economic, and social contexts, the Commission aims to propose a new framework for pandemic preparedness that prioritises equity, agility, and a whole-of-society approach.

Building on these presentations, participants discussed the need for a standardised approach to evaluating interventions, and the importance of considering equity in these approaches as not everything will work in different contexts. Participants also noted the importance of preparing for evaluation opportunities so that the infrastructure and governance is already in place in advance of shocks – there were examples of good practice observed in the UK during the COVID-19 pandemic, where pandemic response research infrastructure had been established in advance. This would allow natural experiment studies to be developed in a timely manner and would maximise learning opportunities.

Environmental impact of health systems

Health systems are carbon intensive and have a large impact on the environment – around 4%–5% of Japan's and the UK's emissions are from healthcare.[27,28] Participants discussed that transitioning to more resilient health systems should also be an opportunity to reduce their environmental impact. Actions to reduce this impact vary in the UK and Japan due to the differences in healthcare systems, and different stages of awareness and buy-in from stakeholders. It was therefore highlighted as a key opportunity for collaboration and knowledge-sharing.

Various initiatives are ongoing across the UK's devolved nations to create a net-zero health service. At NHS England, the Greener NHS programme, launched in 2020, is structured around key areas of action, which span every part of the organisation and care delivery, including working with suppliers responsible for 62% of the healthcare emissions, estates and facilities, transport, medicines, etc.[29]

In research and innovation more specifically, the programme worked with partners to stimulate and create new research partnerships between academics and NHS staff (clinical and non-clinical) to respond to real NHS challenges and therefore create evidence towards greener and more resilient healthcare solutions. The programme also supported greener innovations through funding greener design and innovative interventions to be implemented in the healthcare system.

In Japan, it was discussed that the healthcare industry is not yet recognised as a large contributor to greenhouse gas emissions, and challenges included the buy-in from stakeholders and insufficient direction from government policy, including guidelines for calculating emissions.

Building on this, participants discussed in some breakout groups that perhaps the environmental impact of an intervention should be included in future decision-making processes, along with costs and clinical outcomes. Additional considerations should however, be built in and were discussed, including the ethical and operational considerations.

26. Legido-Quigley H *et al.* (2023). *Reimagining health security and preventing future pandemics: the NUS–Lancet Pandemic Readiness, Implementation, Monitoring, and Evaluation Commission.* Lancet **401**, 2021-23.
27. NHS England (n.d.). National ambition: Greener NHS. https://www.england.nhs.uk/greenernhs/national-ambition/.
28. Nansai *et al.* (2020). Carbon footprint of Japanese health care services from 2011 to 2015. Resources, Conservation and Recycling **152**, 104525.
29. NHS England (2020). Delivering a net zero national health service. https://www.england.nhs.uk/greenernhs/publication/delivering-a-net-zero-national-health-service/

Participants also noted the impact of over-treatment, in the context of as well as being a drain on resources for a resilient health system, over-treatment also has a negative impact on the environment. Behaviour changes of both practitioners and patients/the public was noted as a key solution to overcome this.

Adopting innovation and technology

Participants noted the opportunities and challenges of adopting innovation, particularly the use of artificial intelligence (AI) in health and social care.

AI was noted as one of the biggest opportunities for improving health systems. Examples included the opportunity to transform treatment for some groups, for example through its diagnostic capabilities, and how AI can automate some time-consuming tasks and therefore help to reduce the increased pressure on the health service.

Participants also noted the risk associated with the use of AI – automation could lead to increased inequalities for those who do not have access to or who cannot use certain technologies. Furthermore, due to the predominantly European and North American data sets used to train AI, there is a major risk that AI continues to demonstrate racial biases against marginalised groups, exacerbating existing health inequalities.[30] It was also noted that AI is highly carbon-intensive so can contribute to the climate emergency during a period where the health system is decarbonising.

Participants discussed how health systems in Japan and the UK could learn from the private sector, such as creating the infrastructure for next-day delivery to rural and remote areas. This could be revolutionary for those who have less access to healthcare services; however, by removing an element of human contact, there could be an increased risk of isolation.

Communication and tackling misinformation

Participants noted the importance of targeted and effective communication around climate change and health emergencies, including the complexities in tackling mis- and disinformation. Discussions focused on the need to translate science into language that can be easily understood by the population, especially during pandemics, which was a shared priority in both Japan and the UK.

Education, training and research support

Participants noted that integrated training and education will be needed across many sectors, including for early career researchers and health professionals. This encompasses both informal – through development of soft skills – and formal training – via the development of curriculum. Suggestions included embedding climate and health education into medical training to ensure the next generation of health professionals had the necessary knowledge and skills to respond the future threats.

30. O'Brien N *et al.* (2022). Addressing racial and ethnic inequities in data-driven health technologies. https://ora.ox.ac.uk/objects/uuid:76cf09cf-ddf7-43ae-a724-9b447136356a/files/ssn009z94p

Opportunities for collaboration between Japan and UK

Whilst Japan and the UK have different political, social and cultural contexts, participants discussed that there were still many opportunities to learn and collaborate to address the key themes identified.

As shared endeavours, both countries could:

- Share future-proofing strategies between Japan and the UK, including lessons learned and best practice from each country's deemed relative strengths. Participants noted that much could be learned from Japan's experience of disaster response and from managing an ageing population. Similarly, lessons could be drawn from the UK's actions to reduce the environmental impact of the NHS.

- Identify pathways driving inequitable access to the health system and how the climate emergency exacerbates this for socially disadvantaged people. Share interventions targeting these pathways to reduce health inequalities.

- Identify where cross-sector working nationally and internationally is needed, including transdisciplinary research and cross-government departments to bring together traditionally separated sectors, for example health systems research, climate expertise, evaluation experts and public health professionals.

- Compare healthcare system evaluation methods and collaborate on finding the right indicators to monitor success of interventions and policies, and develop responsive research infrastructure to study time-limited natural experiments, to improve rapid evidence-based policymaking.

- Share lessons learned on how to implement integrated planetary health and health system monitoring and analysis, inclusive of developing a skilled workforce and collecting robust data to develop early warning systems.

- Understand which communication strategies work under different threat scenarios and with different populations within Japan and the UK. Share how best to target communication and engagement with the populations around health emergencies and climate change to lead to short- and long-term behaviour changes.

- Exchange knowledge and best practice about how to co-design interventions with patients and the public to create people-centred resilient health systems. Share strategies to ensure communities who do not normally engage in health systems are reached.

- Identify the pros and cons of using AI and tech-based transformations in healthcare systems. Understand how to mitigate the risks that AI could exacerbate health inequalities and contribute to climate change.

- Enhance bilateral collaboration to develop integrated education programmes that include the impact of the climate emergency on human health, in particular for early career researchers and healthcare professionals.

Conclusion

Building resilient health and public health systems in Japan and the UK requires a multifaceted approach that addresses both immediate and long-term challenges while promoting collaboration, innovation, and inclusivity.

The workshop indicated that both countries share valuable opportunities for collaboration and mutual learning. By drawing on each other's strengths, particularly in disaster response, ageing populations, and environmental sustainability, both countries can invest in health systems that can better prepare for future shocks.

Participants discussed the importance of reframing a resilient healthcare system to something that extends beyond its traditional boundaries and into the community. As both countries face an ageing population with a low birth rate and the negative impacts of social isolation, adopting a community-wide, inclusive approach can strengthen social cohesion and ensure better support for vulnerable people and improve health outcomes. Participants argued that any action to increase resilience must also reduce the health inequalities more vulnerable people face, and that transitioning to a resilient health system is also an opportunity to reduce its environmental impact.

A unified cross-departmental approach that incorporates health in all policies can help to reframe resilience as a broader societal issue; this was also a key theme from the workshop. Transdisciplinary research, which evaluates existing interventions, along with connections between policymakers and academia, can facilitate evidence-based policymaking and allow for rapid response when society is faced with a shock. This, coupled with integrated planetary health and health system monitoring and analysis, can ensure better preparedness for future health crises.

Underpinning much of this work is the adoption of innovation and technology, which participants noted as one of the biggest opportunities for creating resilient health systems. However, not without associated risk, adopting this type of innovation can lead to worse health inequalities for some populations, so its implementation must be carefully considered.

Whilst Japan and the UK have different healthcare settings, the workshop highlighted multiple priority areas to improve the resilience of health systems in the near future. It also demonstrated the great value in international collaborations and future opportunities for working together.

Annexe 1: Workshop programme

09:00–09:30	**Registration and morning tea**
09:30–09:50	**Welcome and background to AMS–JSPS** Opening from UK Academy and JSPS **Professor Naoto KOBAYASHI,** Director, JSPS London, and **Professor Tom Solomon CBE FMedSci,** Vice President International, AMS Intro presentation from **Dr Yumiko MYOKEN,** Deputy Director, JSPS London Intro presentation from **Martin Gadsden,** Japan Agency for Medical Research and Development (AMED)
09:50–10:15	**Opening of workshop** Workshop co-chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi FMedSci** This session will aim to set the context, scope and the aims of the workshop. Co-chairs will provide some background information of the climate impacts Japan and the UK are experiencing, and the definition of health inequalities for this workshop.
10:15–11:15	**Session 1: Scene-setting presentations** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** This session will set the scene for the policy workshop. It will go into some detail about what we mean by resilient health and public health systems and will set the context of what the health system is like in Japan and the UK. 1) Preparing for an uncertain future, **Professor Martin McKee CBE FMedSci** *(10 mins + Q&A)* 2) Challenges and opportunities in Japan's health and public health systems, **Dr Joji SUGAWARA,** Health and Global Policy Institute *(10 mins + Q&A)* 3) Challenges and opportunities in the UK's health and public health systems, **Professor Sir Gregor Smith,** Chief Medical Officer for Scotland *(10 mins + Q&A)*
11:15–11:45	**Refreshment break**
11:45–13:00	**Session 2: Case studies: examples of actions to increase resilience of health systems** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** 1) Heat and health resilience in Japan, **Professor Masahiro HASHIZUME,** The University of Tokyo *(10 mins + Q&A)*

	2) Mental health and health resilience, **Dr Ramita Thawonmas,** Nagasaki University *(10 mins + Q&A)* 3) Disaster nursing and resilient health systems, **Professor Sakiko KANBARA,** Kobe City College of Nursing *(10 mins + Q&A)* 4) Adverse weather and health in England: preparing, responding and lessons learned, **Ross Thompson,** UK Health Security Agency *(10 mins + Q&A)*
13:00–14:00	**Lunch**
14:00–15:15	**Session 3: Case studies: examples of actions to increase resilience of health systems** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** 5) A human rights-based approach to health in the context of climate change, **Professor Yasushi KATSUMA,** Waseda University *(10 mins + Q&A)* 6) Lessons learned from the Resilient Health Systems project, **Dr Ibidun Fakoya,** King's College London *(10 mins + Q&A)* 7) Building resilient healthcare: a case-based complexity approach to policymaking and evaluation for smarter decision making, **Professor Brian Castellani,** Durham University *(10 mins + Q&A)* 8) Working with the healthcare industry to decarbonise, **Professor Sunhee SUK,** Nagasaki University *(10 mins + Q&A)*
15:15–15:35	**Refreshment break**
15:35–17:00	**Session 4: Breakout group discussions** This session will reflect on what we heard from the morning presentations and discuss: Question 1) Reflecting on presentations so far, what are the other main challenges to resilient health and public health systems in Japan and the UK? Question 2) What are the key evidence gaps around health system resilience? Taking into account question 1 and case study presentations: Question 3) Where are the common evidence gaps between Japan and the UK? Participants will feed back discussions in plenary.
17:00–17:30	**Session 4: Feedback in plenary and summary of day** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** A presenter from each group will be asked to summarise their group's discussions *(4 mins).* After every group has fed back there will be time to reflect on this and ask questions *(10 mins).*
17:30–19:30	**Networking reception and dinner**

09:30–09:45	**Welcome to Day Two** Workshop co-chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi**
09:45–10:30	**Session 5: Case studies: examples of actions to increase resilience of health systems** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** 1) The Lancet PRIME Commission on developing grassroot indicators for pandemic preparedness and response, **Professor Helena Legido-Quigley,** Imperial College London *(10 mins + Q&A)* 2) Importance of maternal and child health for resilient health systems, **Professor Takeo FUJIWARA,** Institute of Science Tokyo *(10 mins + Q&A)* 3) Delivering a net zero health service, Overview and practical actions in research and innovation, **Dr Fanny Burrows,** Greener NHS, NHS England *(10 mins + Q&A)*
10:30–11:15	**Session 6: Breakout group discussions** Participants will reflect on presentations and discussions so far to discuss: Question 4) What are the opportunities for collaboration between the UK and Japan on resilience of health systems?
11:15–11:45	**Refreshment break**
11:45–12:45	**Session 6: Breakout group discussions continued** Question 5) How can we ensure actions to improve health system resilience help reduce health inequalities in Japan and the UK? In preparation for plenary discussion, participants will discuss in their small groups: Question 6) What are the future challenges for the science and technology community in the health sector, considering planetary health? Question 7) What are the key priorities going forward to ensure health systems are resilient to future threats? Who are the main players to address these? Including: research, funding and policy priorities
12:45–13:40	**Lunch**
13:40–14:10	**Session 7: Feedback in plenary** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** A presenter from each group will be asked to summarise their group's discussions for questions 4 and 5 *(4 mins).* After every group has fed back there will be time to reflect on this and ask questions *(10 mins).*

14:10–14:55	**Session 8: Consensus building in plenary** Session chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi** Reflecting on presentations and breakout group discussions, participants will discuss the following questions in whole-group discussion: Question 6) What are the future challenges for the science and technology community, considering planetary health? Question 7) What are the key priorities going forward to ensure health systems are resilient to future threats? Who are the main players to address these? Including: Research, funding and policy priorities Participants will use Mentimeter to assist with consensus building.
14:55–15:10	**Conclusions from the workshop and outputs** Workshop co-chairs: **Professor Fumiko KASUGA** and **Professor Vittal Katikireddi**

Annexe 2: Participant list

Steering committee

Workshop co-chair – **Professor Fumiko Kasuga,** Nagasaki University

Workshop co-chair - **Professor Vittal Katikireddi FMedSci,** University of Glasgow

Professor Christl Donnelly CBE FMedSci, University of Oxford

Professor Masahiro HASHIZUME, The University of Tokyo

Professor Gesche Huebner, University of Exeter

Professor Masanari KIMURA, Nagasaki University

Professor Helena Legido-Quigley, Imperial College London

Associate Professor Lina Madaniyazi, Nagasaki University

Attendee list

Sammy Bishop, Greener NHS

Dr Fanny Burrows, Greener NHS

Professor Brian Castellani, Durham University

Alison Daykin, Department of Health and Social Care, UK Government

Dr Ibidun Fakoya, Kings College London

Dr Jacob Fry, National Institute for Environmental Sciences

Professor Takeo FUJIWARA, Tokyo Medical and Dental University

Martin Gadsden, Japan Agency for Medical Research and Development London

Dr Frederike Garbe, Public Health Scotland

Dr Julius Hafalla, London School of Hygiene & Tropical Medicine

Professor Shakoor Hajat, London School of Hygiene & Tropical Medicine

Assistant Professor Masato HONDA, Kanazawa University

Professor Sakiko KANBARA, Kobe City College of Nursing

Professor Yasushi KATSUMA, Waseda University

Andrew Mackenzie, Physiological Society

Professor Nicholas Mays, London School of Hygiene & Tropical Medicine

Professor Glenn McGregor, Durham University

Professor Martin McKee CBE FMedSci, London School of Hygiene & Tropical Medicine

Dr Ai MILOJEVIC, London School of Hygiene & Tropical Medicine

Associate Professor Tomoki NAKAYAMA, Nagasaki University

Katie Robertson, Department of Health and Social Care, UK Government

Dr Sarah Robertson, Public Health Scotland

Professor Sir Gregor Smith, Scottish Government

Professor Tom Solomon CBE FMedSci, Vice President, International

Dr Joji SUGAWARA, Health and Global Policy Institute

Associate Professor Sunhee SUK, Nagasaki University

Dr Ryo TAKAHASHI, Japan Embassy Health Attache

Dr Jun'ya TAKAKURA, National Institute for Environmental Studies

Associate Professor Ramita Thawonmas, Nagasaki University

Ross Thompson, UK Health Security Agency, UK Government

Hana Tomoi, London School of Hygiene & Tropical Medicine

Professor Masao UEKI, Nagasaki University

Jacopo Vanoli, London School of Hygiene & Tropical Medicine

Dr Lisa Wise, Welsh Government

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Dr Yumiko Myoken, Deputy Director

Polly Watson, International Programme Coordinator

Yui MIYAURA, International Programme Associate

Staff and Secretariat from the Academy of Medical Sciences

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Dr Anna Hands, FORUM Policy Manager

Alex Hulme, Head of International Policy

Annabel Miller, Senior International Policy Officer

Dr Amanda Zhu, Policy Intern

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