



# Building a climate-resilient **polio-free** world

Technical brief

**POLIO** GLOBAL  
ERADICATION  
INITIATIVE



BILL & MELINDA  
GATES foundation



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# | Acronyms and abbreviations

<b>CO2</b>	Carbon dioxide
<b>GHG</b>	Greenhouse gas
<b>GPEI</b>	Global Polio Eradication Initiative
<b>SDD</b>	Solar direct-drive
<b>UNICEF</b>	United Nations Children's Fund
<b>WASH</b>	Water, sanitation and hygiene
<b>WHO</b>	World Health Organization

# Executive summary

**The climate crisis unfolding today risks reversing centuries of progress for humanity.** Though actions needed to mitigate and adapt to the climate crisis are much broader than the polio eradication effort, the Global Polio Eradication Initiative (GPEI) recognizes the urgent need to take stock of its role and responsibility to help address this planetary emergency. As the Intergovernmental Panel on Climate Change's 2023 report states,<sup>1</sup> "There is a rapidly closing window of opportunity to secure a liveable and sustainable future for all." **Everyone has a role to play, and the GPEI is no different.**

**This technical brief serves as a starting point**, presenting areas for GPEI stakeholders to explore to both deliver a polio-free world and ensure a climate-resilient future. It is not intended to be a final guidebook but is meant to inspire reflection, further investigation and action by the programme. Specifically, this brief:

- explains why building a climate-resilient GPEI is a vital step towards ensuring a safer, healthier future for all;
- explores how the GPEI is impacted by and contributes to the climate crisis throughout its life cycle – from vaccine production to delivery and disposal; and
- outlines critical areas for the GPEI to explore to reduce its carbon footprint (mitigation) and protect polio staff, activities and the communities it serves from the effects of a hotter world (adaptation).

<sup>1</sup> IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001 <https://www.ipcc.ch/report/sixth-assessment-report-cycle/>



Volunteers distribute supplies to people impacted by Typhoon Odette in the Philippines. © Chynna Dorado/Rotary International

## Health and the climate crisis

The climate crisis is one of the biggest health threats facing humanity today (1). Between 2030 and 2050, rising temperatures are expected to cause an estimated quarter-million deaths each year from malnutrition, malaria, diarrhoea, dengue and heat stress alone (2). Extreme weather events (e.g. heatwaves, floods and storms) have become more common and severe while typical weather patterns (e.g. average temperatures and rainfall) continue to drastically change, disrupting global systems and local health services. Around the world, the poorest and most marginalized communities, particularly children (3), bear the brunt of the climate crisis, exacerbating existing health inequities (4).

While the health impacts of the climate crisis are vast, the health sector itself has a vital role to play in reducing harmful greenhouse gas (GHG) emissions. The health sector, particularly in the world's wealthiest economies, is estimated to represent 4.4% of global GHG emissions; if the sector were a country, it would be the fifth-largest emitter on the planet (5). Health systems must also adapt to the impacts of a hotter world, as extreme weather events and changes in typical weather patterns threaten the capacity of the workforce and health infrastructure to protect communities.

Promoting climate resiliency in the health sector – the process of adapting to the realities of a hotter world while implementing measures to mitigate GHG emissions – is paramount to protect the health of people and the planet. Building climate-resilient health systems, and more resilient communities, will also help advance the goals of key international environmental agreements, including the 2015 Paris Agreement (6), as well as help attain the 2030 Sustainable Development Goals (7) and the Immunization Agenda 2030 (8), all of which are directly and indirectly related to safeguarding human health and well-being.

“The climate crisis is a health crisis: the same unsustainable choices that are killing our planet are killing people. We need transformative solutions to wean the world off its addiction to fossil fuels, to reimagine economies and societies focused on well-being and to safeguard the health of the planet on which human health depends.”

– Dr Tedros Adhanom Ghebreyesus,  
WHO Director-General





A health worker administers polio vaccine (nOPV2) drops to a child in an IDP camp in Somalia. © Ismail Taxta/Getty Images

## The climate crisis and polio eradication

The climate crisis and its threat to health cannot be ignored in the pursuit of a polio-free world. Like other immunization programmes, extreme weather events and changes in typical weather patterns will increasingly impact the Global Polio Eradication Initiative (GPEI) staff and activities – from the production and procurement of polio vaccines and supplies to the implementation of campaigns – as well as threaten the health of the communities it serves.

Over the last 35 years, the GPEI has helped reduce the global polio burden over 99.9% (9), thanks to the tireless efforts of frontline workers, communities, local governments and global partners. Recent trends in polio-affected countries, like the shrinking genetic diversity of the virus and increasingly geographically confined outbreaks, suggest that, in most places, the virus is on its last legs. The world has a historic opportunity to stop virus transmission for good, but the GPEI must build on its history of innovating in the face of adversity to protect its staff, activities and the communities it serves from the realities of a hotter world.

Heatwaves, floods, droughts and storms can expose polio workforces to new occupational hazards, disrupt and damage GPEI operations, and worsen water, sanitation and hygiene (WASH) conditions in affected communities. Poor WASH increases the likelihood of

ingesting faecal-contaminated water, food or drinks, the most common route of poliovirus transmission (10). It is also an underlying cause of malnutrition, which weakens children's immune systems, making them even more susceptible to diseases like polio.

These weather events, coupled with longer-term changes in typical weather patterns, also impact the availability of food, water and other resources, which can trigger increased population movements and, in some cases, conflict. This can heighten the risk of people encountering and spreading the virus in polio-affected areas and beyond while making it harder to reach every child with the polio vaccine. In addition, poliovirus transmission is highest during the hottest parts of the year, so longer periods of higher temperatures could extend these high transmission seasons.

Countries at high risk for polio are already disproportionately experiencing the impacts of the climate crisis. In 2021, Pakistan and Afghanistan, the last two remaining endemic countries for wild polio, ranked eighth and 17th in the world for countries most affected by extreme weather events from 2000 to 2019. Mozambique, another country deemed vital to stopping virus transmission globally as it battles concurrent wild polio and variant poliovirus outbreaks, ranked fifth (11). In other places

facing persistent variant poliovirus outbreaks, like Yemen, rising temperatures and severe droughts have led to a vicious cycle of malnutrition and disease (12).

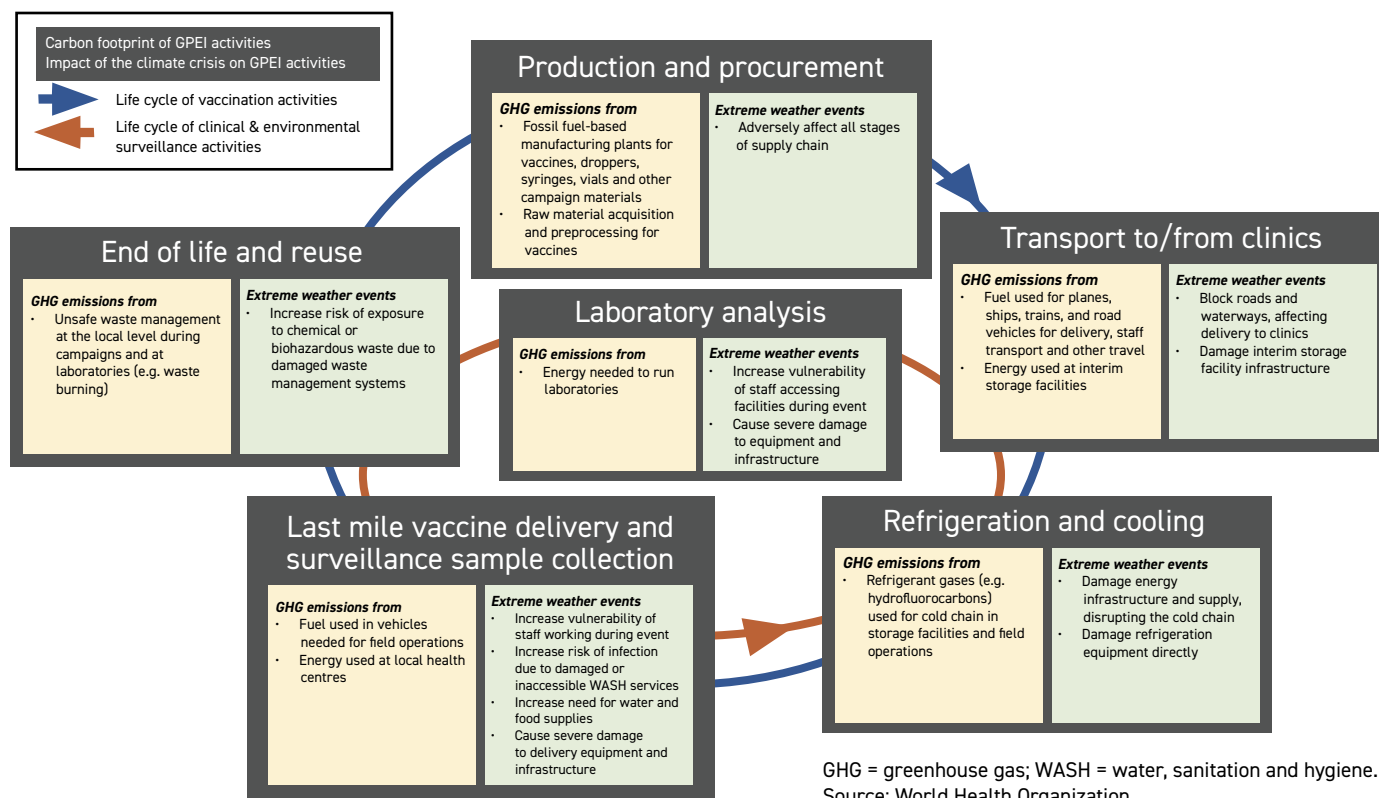
At the same time, GPEI activities generate GHG emissions – from carbon dioxide (CO<sub>2</sub>) to refrigerant gases like hydrofluorocarbons – and thus contribute to rising global temperatures (see Fig. 1). Of all GPEI activities, the life cycle of producing, transporting, delivering and disposing of polio vaccines and supplies likely accounts for the largest proportion of the GPEI's overall carbon footprint. In April 2023, the United Nations Children's Fund (UNICEF), the organization responsible for procuring polio vaccines for the GPEI, estimated the carbon<sup>2</sup> emissions for delivering its immunization programme globally.

This analysis found that the burning of waste for disposal accounted for 28% of annual emissions, the transportation of vaccines and supplies accounted for 27%, the operation of cold chain equipment for 25%, and the production of vaccines, cold chain equipment and supplies for 20% (13).

As one of the largest global health partnerships, the GPEI is in a unique position to improve its climate resiliency by further collaborating with cross-sector partners, national and local authorities, and the communities it serves. While the programme can take steps to mitigate and adapt to the climate crisis, it does not operate in a vacuum, and supporting broader health systems and communities to become more climate resilient is key to ensuring safe, healthy societies around the world.

**Fig. 1 The GPEI life cycle**

How the GPEI contributes to and is impacted by the climate crisis across its life cycle



<sup>2</sup>“Carbon” in this document refers to CO<sub>2</sub> equivalent, or the amount of CO<sub>2</sub> plus all other greenhouse gases including methane, nitrous oxide, etc., that significantly contribute to rising global temperatures.



Health workers return to truck after administering polio vaccines in Somalia. © WHO/EMRO

## Climate crisis mitigation activities

This section outlines areas for the GPEI to explore to help **mitigate** the impact of its activities on the climate crisis while still delivering life-saving vaccines and conducting critical surveillance efforts. In select settings, the programme has collaborated with local authorities and already made strides in reducing GHG emissions. While known strategies should be replicated and expanded today, further mapping of the current level of emissions associated with each stage of the programme's life cycle is needed to determine what larger-scale, systematic changes should be prioritized to reduce the GPEI's carbon footprint.

### Production and procurement

The production and procurement of GPEI immunization campaign materials – from vaccine vials to marker pens – are likely to significantly contribute to the programme's carbon footprint. Currently, the programme does not require suppliers to meet criteria related to their climate impact, as it relies on a small number of suppliers, many of which are in low-income countries. Such requirements must be proposed gradually and mindfully to avoid causing serious disruptions to the global supply chain and thus eradication efforts.

In 2018, UNICEF introduced the Sustainable Procurement Procedure (14), making strides towards ensuring a stable supply of vaccines while reducing the process's impact on the planet. Shortly after, UNICEF conducted a baseline sustainability assessment of all its vaccine suppliers, including those that produce the oral polio vaccine and the inactivated polio vaccine. Nearly half of the suppliers reported monitoring CO2 emissions and 39% planned to convert to renewable energy. In 2023, UNICEF followed up on this work by reviewing supplier standards and identifying ways to ensure more sustainable procurement practices across its portfolio. While this assessment is still under way, the programme can consider several other mitigation best practices, including the following:

“All parties must supercharge efforts to close the emissions gap and accelerate the transition from fossil fuels to renewable energy.... Let us show succeeding generations that when they needed us to fight for their future, we did.”  
– Catherine Russell,  
UNICEF Executive Director

- **ensure all partners comply with their respective sustainable procurement policies** for the production and procurement of vaccines and other campaign materials;
- **limit the use of plastic products and packaging** in GPEI procurement where possible:
  - reduce single-use materials in favour of recyclable plastics or other materials (e.g. biodegradable paper, cardboard or plant-based products), and
  - require the use of more sustainable plastics (e.g. bioplastics over polypropylene) when alternative materials are not available (15);
- **procure locally as much as possible** and work with national authorities to help build local development and manufacturing capacities (weigh the decision based on local sustainability standards, modes of transport available and other factors, to realize climate benefits);
- **ensure the GPEI-funded product design includes an exploration of smaller, less carbon-intensive products** that deliver the same function (e.g. more compact vials that reduce the number of shipping containers needed for transport); and
- **identify and implement tools that can measure the annual carbon impact of GPEI production and procurement activities.**



Vaccinators on motorbike to deliver vaccines during a polio campaign. © UNICEF/Nigeria

## GPEI operations from transport, refrigeration, last-mile activities to labs

Fossil fuels used to transport vaccines, stool and sewage samples and staff by way of ships, trucks, cars, motorbikes and aeroplanes contribute to the programme's carbon footprint. Infrastructure, including vaccine storage facilities and equipment, as well as surveillance laboratories also use fossil fuels to operate. Along the cold chain, commonly used refrigeration equipment can emit hydrofluorocarbons, a GHG that can be nearly 2000 times more potent than CO<sub>2</sub> (16). Ways to diminish the use of fossil fuels include the following:

- **shift from fossil fuel to alternative energy sources for key delivery** activities and transport where possible (e.g. solar-powered vaccine refrigerators and laboratories, electric-powered vehicles);
- **ensure the use of alternative refrigerant technology** with low global warming power for GPEI-funded cold chain activities to reduce hydrofluorocarbon emissions (17);
- **bundle shipments from suppliers to recipient countries** when possible to avoid excessive trips;
- **conduct multi-antigen campaigns** delivering more services with fewer vehicles and resources; and
- **reduce air travel for personnel** by encouraging the use of video and teleconference, as feasible, and prioritize efficient routing (e.g. direct flights) when air travel is necessary.

## End of life and reuse

Health services like immunization campaigns produce medical waste, including syringes, empty vaccine vials and pen markers for polio campaigns. In settings without effective medical waste management systems, waste is often burned, causing dioxin and CO<sub>2</sub> emissions (18). The GPEI works to promote and comply with national regulations for sound medical waste management to ensure waste products from campaigns are disposed of safely. While national and local authorities largely drive these processes, the GPEI can take several steps to mitigate its impact when disposing of materials, primarily by reducing the amount of waste produced at earlier stages of the life cycle. Measures include the following:

- **encourage and support national and local partners to develop systems to safely collect and reuse products when possible** (e.g. disinfect and sterilize vaccine vials for reuse) and sort waste for recycling;
- **encourage national and local partners to use sustainable waste disposal and treatment technologies** (e.g. switch from incineration to microwaving or steaming); and
- **include sustainable waste disposal and treatment systems** in the design of any GPEI-funded construction.



A health worker carries megaphones and ice packs to be used during a polio vaccination campaign at the national vaccine store in Monrovia, Liberia ©Arete / Benson Ibeabuchi / UNICEF Liberia



A solar fridge in Democratic Republic of the Congo. © Gavi/Thomas Nicolon

## Climate resilience in action 1

# The use of solar power in the fight to end polio

Nearly 1 billion people worldwide<sup>3</sup> access health care facilities that do not have regular or consistent power. Unreliable energy disrupts routine and emergency care – from interrupting diagnostic tests to preventing vaccines from staying cold. As heatwaves, floods and other extreme weather events become more common, energy disruptions are expected to increase due to events like power outages and heat stress on existing infrastructure. To address these challenges in the last mile of polio eradication and reduce its carbon footprint, the GPEI and partners have turned to solar power, a more affordable, reliable and climate-resilient energy source to power polio vaccination and surveillance activities.

## Solar-powered vaccine refrigerators

For decades,<sup>4</sup> refrigerators powered by fossil fuels like kerosene or petrol were essential to maintaining vaccines at just the right temperature. Yet, these refrigerators that would emit GHGs, were relatively expensive to operate and were vulnerable to disruptions in the national energy supply. Now, the GPEI and its partners significantly rely on solar power, specifically, solar direct-drive (SDD) vaccine refrigerators.<sup>5</sup> SDD refrigerators can run for days without power if needed, not only making them more dependable but also extending the programme's reach in some of the most difficult yet critical areas to end polio.

In the Democratic Republic of the Congo, a country the size of western Europe with difficult terrain and longstanding security challenges, millions of children have missed out on polio and other life-saving vaccines, in part because vaccines could not be kept cold on the trip to reach them. In 2016, just 16% of health centres in the country had a working refrigerator. Between 2018 and 2021, Gavi and its partners helped address this gap by delivering over 5500 new solar-powered fridges in the country.<sup>6</sup>

On the remote islands of Lake Chad,<sup>7</sup> the introduction of solar-powered refrigerators means that parents and health workers can simply go to the community centre on the island, rather than travelling long distances by boat to receive or administer polio vaccines. Meanwhile, in Somalia, a country that experiences frequent interruptions in power supply, all vaccine refrigerators from the regional storage points down to the community-level administration are now SDD refrigerators.

## Solar-powered surveillance

During surveillance, stool and environmental samples travel through the vaccine cold chain in reverse – from the field site or clinic to the regional and global laboratories – for testing. In January 2021, an insurgency in Borno state, Nigeria showed the world just how vital reliable, climate-resilient energy for surveillance is. The insurgency resulted in over 10 months of power outages, including at the University of Maiduguri Teaching Hospital, which houses one of only two national polio laboratories in Nigeria. This meant that samples from the 10 most vulnerable states for polio transmission in northern Nigeria could not be tested.

To help the lab get back on track as quickly as possible and prevent future power issues, the WHO provided 48 solar panels. As a result, throughout most of 2021, more than 10 000 stool samples of children with acute flaccid paralysis and over 500 environmental samples were analysed by the laboratory, an essential step to finding and stopping the virus.<sup>8</sup>

In the face of the climate crisis and its many knock-on effects, including extreme weather events and even more persistent conflicts, health programmes like the GPEI must continue to integrate renewable energy at every turn. From powering refrigerators to entire laboratories, solar-power technology has become a key energy source to help reduce the GPEI's GHG emissions and ensure a polio-free future.



Solar panels on the roof of a healthcare clinic in Sierra Leone. © Gavi, the Vaccine Alliance

<sup>3</sup> Energizing health: accelerating electricity access in health-care facilities. Geneva: World Health Organization, World Bank, Sustainable Energy for All and International Renewable Energy Agency; 2023 (<https://www.who.int/publications/i/item/9789240066960>, accessed 5 January 2024).

<sup>4</sup> Using the sun to keep vaccines cool. New York: United Nations Children's Fund (UNICEF); 2015 (<https://www.unicef.org/innovation/stories/using-sun-keep-vaccines-cool>, accessed 8 January 2024).

<sup>5</sup> Solar direct-drive vaccine refrigerators and freezers. Geneva: World Health Organization; 2017 (<https://apps.who.int/iris/bitstream/handle/10665/254715/WHO-IVB-17.01-eng.pdf;sequence=1>, accessed 8 January 2024).

<sup>6</sup> DRC's solar revolution. Gavi, the Vaccine Alliance; 2018 (<https://www.gavi.org/vaccineswork/drcs-solar-revolution>, accessed 8 January 2024).

<sup>7</sup> Protecting against polio in Lake Chad. Geneva: World Health Organization; 2018 (<https://polioeradication.org/news-post/protecting-against-polio-in-lake-chad>, accessed 8 January 2024).

<sup>8</sup> WHO delivers solar panels to accredited polio laboratory in Borno state. Geneva: World Health Organization; 2021 (<https://www.afro.who.int/news/who-delivers-solar-panels-accredited-polio-laboratory-borno-state>, accessed 5 January 2024).



Health worker and community member cross river to deliver vaccines in Pakistan. © Rotary International

## Climate crisis adaptation activities

This section outlines areas for the GPEI to explore to help **adapt** its operations to be better prepared for and respond to extreme weather events. These suggestions would help protect frontline health workers and essential infrastructure, ensuring vaccination and surveillance activities can continue safely and successfully. When implementing any measure to address challenges posed by the climate crisis, it is also crucial to be mindful of how these actions might affect the overall carbon emissions associated with the programme.

“ We are in a race against time to adapt to a rapidly changing climate. Adaptation must not be the forgotten component of climate action.”

– António Guterres,  
UN Secretary-General

### Production, procurement and transport

As with all global supply chains, extreme weather events can threaten the infrastructure and complex transport networks that are key to manufacturing and delivering goods around the world. The programme and its partners should consider some longer-term steps in response to these challenges, including the following:

- **shorten supply chains by procuring locally** where feasible and working with national authorities to help build local development and manufacturing capacities (weigh the decision based on local sustainability standards, modes of transport available and other factors, to realize climate benefits); and
- **incentivize national authorities to build and maintain climate-resilient infrastructure** to safeguard the production of key products used in GPEI activities.

### Refrigeration and cooling

The climate crisis can threaten global energy supply – from heatwaves causing blackouts to tropical storms wiping out physical energy infrastructure. For polio immunization campaigns and surveillance efforts, consistent energy is vital to ensuring a reliable cold chain to deliver life-saving tools. Measures include the following:

- **lower the dependency on grid supplied energy** for facilities, including refrigerators and cooling systems, by continuing the rollout of solar, wind and other renewable energy sources;
- **explore the use of new vaccine delivery strategies (e.g. the controlled temperature chain) (19) and technologies (e.g. microarray patches) (20)** that reduce reliance on traditional cold chain infrastructure; and
- **train health workers managing the cold chain** on how to prepare for, respond to and recover from extreme weather events.



## Last-mile vaccine delivery and surveillance sample collection, and end of life and reuse

Close collaboration with both frontline workers and the communities they serve is critical for climate adaptation at the local level – where vaccines and other goods travel the last mile from the health facility to the child, and surveillance efforts collect stool and sewage samples. In accordance with existing global guidance documents (21), the programme can implement many activities with national and local authorities to better adapt to more frequent extreme weather events and changing weather patterns.

To ensure these strategies reach and support both women and men equally, it is key to take gender norms and roles into account when exploring each suggestion. The programme can do this by ensuring women's participation in all stages of the decision-making process, as well as collecting and analysing gender-disaggregated data to quickly identify and address any discrepancies in benefits. Measures include the following:

### Foster resilient communities and health care workforces:

- **review local climate vulnerability and adaptation assessments in consequential geographies** to understand near- and long-term climate risks and how they impact the workforce and communities they serve;
- **create clear contingency plans** to guide polio campaign operations in the face of extreme weather events (e.g. how to access and leave facilities during storms or floods, or plan house-to-house vaccination campaigns during a heatwave);
- **train the polio workforce**, particularly frontline workers and supervisors, on how to prepare for, respond to and recover from extreme weather events;
- **provide reliable access to personal protective equipment** to ensure the safety of staff working during and after extreme weather events, such as masks, gloves, goggles, gowns, hand sanitizer, soap and water, and cleaning supplies;
- **ensure women are included** at all stages of decision-making, from risk assessment to implementing adaptation solutions; and
- **explore providing educational and behaviour change interventions** alongside polio campaigns to raise awareness about the localized risks of the climate crisis.

### Advocate for climate-resilient GPEI-funded infrastructure:

- **support local authorities in building climate-resilient facilities** using materials, construction and design approaches as well as siting criteria that are responsive to climate risks (e.g. roof structures that can withstand strong winds);
- **ensure access to climate-resilient WASH (22)** to protect staff, ensure the quality of vaccines in clinics and secure biosafety in laboratories (e.g. incorporate rainwater harvesting systems in facilities to provide consistent clean water supplies during droughts or floods); and
- **create backup waste storage sites**, safe from extreme weather events like flooding or sea-level rises.



A polio worker marking a child's finger during the first polio campaign after the floods. © WHO/Pakistan

## Climate resilience in action 2

# Pakistan after the floods

Pakistan, one of the last two endemic countries for wild polio, is closer than ever to ending this devastating disease for good. Many experts, however, say Pakistan is among the countries most vulnerable to the climate crisis. As the world becomes hotter, more frequent and severe heatwaves, intense droughts and devastating floods threaten the incredible progress that has been made against polio.

From May to October 2022, a historic heatwave was followed by heavy monsoon rains and melting Himalayan glaciers, causing the worst flooding in Pakistan's history; almost one third of the country was under water at its peak. One in seven people in the country were affected by these floods and close to 8 million people were displaced, including thousands of polio workers themselves.<sup>9</sup>

Critical infrastructure in the country was also damaged, from roads and bridges to health and sanitation systems. Such devastation following floods and storms leads to wastewater overflow, compromising safe drinking water and spreading pathogens like cholera and polio.<sup>10</sup> This increases the risk of people encountering these life-threatening diseases while making it even harder to reach every child with the necessary vaccines to protect them.

In response to this climate emergency,<sup>11</sup> the programme activated extreme weather contingency plans to resume immunization activities for polio and other vaccine-preventable diseases as soon as possible. This included adjusting campaign schedules and strategies, such as conducting vaccinations at health camps, at transit points and in settlements for displaced persons. In some cases, this meant wading through deep water to reach children with life-saving vaccines. Despite the extraordinary circumstances, the programme managed to reach nearly 32 million children in the country during its August 2022 campaign.

<sup>9</sup> Pakistan – Floods. Washington (DC): United States Agency for International Development (USAID); 2022 ([https://www.usaid.gov/sites/default/files/2022-12/2022-09-30\\_USG\\_Pakistan\\_Floods\\_Fact\\_Sheet\\_8.pdf](https://www.usaid.gov/sites/default/files/2022-12/2022-09-30_USG_Pakistan_Floods_Fact_Sheet_8.pdf), accessed 8 January 2024).

<sup>10</sup> Over half of infectious diseases made worse by climate change. Gavi, the Vaccine Alliance; 2022 (<https://www.gavi.org/vaccineswork/over-half-infectious-diseases-made-worse-climate-change>, accessed 8 January 2024).

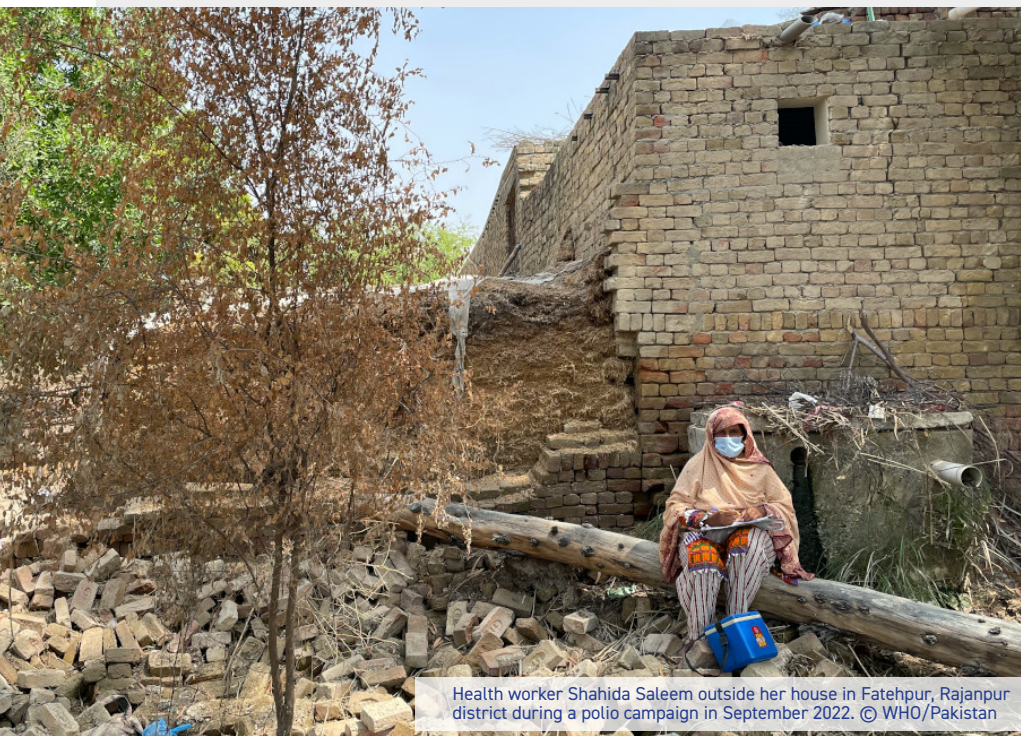
<sup>11</sup> Pakistan polio infrastructure continues support to flood relief, while intensifying eradication efforts. Geneva: World Health Organization; 2022 (<https://polioeradication.org/news-post/pakistan-polio-infrastructure-continues-support-to-flood-relief-while-intensifying-efforts-to-eradicate-polio>, accessed 5 January 2024).

The GPEI also committed to supporting more than 12,500 polio workers in the country who were impacted by the floods. Nasreen Faiz, a team member who took part in polio campaigns following the floods,<sup>12</sup> was among those affected. “One after the other, house after house was destroyed. ... My entire village was finished. The crops were gone, the homes were gone, the animals were dead,” she recounted. Shahida Saleem, another polio worker, evacuated her home for the floods and came back to find it severely damaged and her belongings under 3 feet of water.

The GPEI quickly secured funds to compensate those workers who suffered full or partial damage to their homes, like Nasreen and Shahida. As of April 2023, cheques worth 216 million Pakistani rupees (approximately US\$ 752,000) had been distributed to 10 500 polio workers. While no amount of money can offset the loss and havoc from these devastating floods, the GPEI worked to support the workforce as much as possible.

Additionally, the programme drew on its long history of supporting humanitarian crises to help address the impacts of this climate emergency on the communities it serves. It helped establish critical health camps in flood-affected districts to provide basic health services, from the administration of routine immunizations and treatment of diseases to the distribution of water purification tablets and the provision of nutrition services. To continue fighting polio and other infectious diseases, programme staff also actively conducted disease surveillance and collected and analysed data to help target outbreak response strategies in these high-risk settings.

Above all, working hand in hand with communities and local authorities, the polio programme was able to adapt its operations to ensure progress against polio in Pakistan was not lost and the polio workforce and affected communities were supported in the aftermath of this climate disaster. While the programme was able to successfully respond in this instance, it will face even more disruptions like this on the road to ending polio as the world becomes hotter. Lessons from its work in Pakistan following the floods will be essential to ensuring the fight against this devastating disease can continue amid future disruptions, and its staff and communities are protected along the way.



Health worker Shahida Saleem outside her house in Fatehpur, Rajanpur district during a polio campaign in September 2022. © WHO/Pakistan

**The GPEI must build on its history of innovating in the face of adversity to protect its staff, activities and the communities it serves from the realities of a hotter world.** The time is now for the GPEI and its partners – including donors, polio-affected country governments, suppliers and local health workforces – to come together to assess, prioritize and ensure climate resiliency at all levels of the polio eradication programme.

<sup>12</sup> After the floods: how the polio program came together to help flood-affected frontline workers. Geneva: World Health Organization; 2023 (<https://polioeradication.org/news-post/after-the-floods>, accessed 8 January 2024).

# References

1. COP26 special report on climate change and health: the health argument for climate action. Geneva: World Health Organization; 2021 (<https://www.who.int/publications/i/item/9789240036727>, accessed 19 January 2024).
2. Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s. Geneva: World Health Organization; 2014 (<https://www.who.int/publications/i/item/9789241507691>, accessed 9 February 2024)
3. The climate crisis is a child rights crisis: introducing the Children's Climate Risk Index. New York: United Nations Children's Fund (UNICEF); 2021 (<https://www.unicef.org/media/105376/file/UNICEF-climate-crisis-child-rights-crisis.pdf>, accessed 21 December 2023).
4. The global risks report 2023: 18th Edition. Geneva: World Economic Forum; 2023 ([https://www3.weforum.org/docs/WEF\\_Global\\_Risks\\_Report\\_2023.pdf](https://www3.weforum.org/docs/WEF_Global_Risks_Report_2023.pdf), accessed 21 December 2023).
5. Health care's climate footprint: how the health sector contributes to the global climate crisis and opportunities for action. Health Care Without Harm in collaboration with Arup; 2019 ([https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint\\_092319.pdf](https://noharm-global.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf), accessed 4 January 2024).
6. The Paris Agreement [website]. Bonn: United Nations Framework Convention on Climate Change (<https://unfccc.int/process-and-meetings/the-paris-agreement>, accessed 25 April 2023).
7. Transforming our world: the 2030 Agenda for Sustainable Development [website]. New York: United Nations; 2015 (<https://sdgs.un.org/2030agenda>, accessed 25 April 2023).
8. Immunization Agenda 2030 [website]. Geneva: World Health Organization; 2020 (<https://www.immunizationagenda2030.org>, accessed 15 June 2023).
9. World Health Organization Fact Sheet Poliomyelitis October 2023 <https://www.who.int/news-room/fact-sheets/detail/poliomyelitis>, retrieved 9 February 2024
10. Fine PE, Carneiro IA. Transmissibility and persistence of oral polio vaccine viruses: implications for the global poliomyelitis eradication initiative. *Am J Epidemiol.* 1999;150(10):1001–21 (<https://pubmed.ncbi.nlm.nih.gov/10568615>, accessed 5 January 2024).
11. Eckstein D, Künzel V, Schäfer L. Global climate risk index 2021: who suffers most from extreme weather events? Weather-related loss events in 2019 and 2000–2019. *Germanwatch eV*; 2021 (<https://www.germanwatch.org/en/19777>, accessed 2 May 2023).
12. Yemen situation report [website]. New York: United Nations Office for the Coordination of Humanitarian Affairs; 2022 (<https://reports.unocha.org/en/country/yemen>, accessed 16 June 2023).
13. Seidel M, Dhiman R, Mate N. Estimating carbon emissions for delivering immunization program globally [Presentation]. United Nations Children's Fund (UNICEF); 2023 (<https://www.technet-21.org/en/resources/presentation/estimating-carbon-emissions-for-delivering-immunization-program-globally>, accessed 5 January 2024).
14. UNICEF procedure on sustainable procurement [website]. New York: United Nations Children's Fund (UNICEF); 2018 (<https://www.unicef.org/supply/documents/sustainable-procurement-procedure>, accessed 21 December 2023).
15. Atiweh G, Mikhael A, Parrish CC, Banoub J, Le TA. Environmental impact of bioplastic use: a review. *Heliyon.* 2021;7(9):e07918 (<https://www.sciencedirect.com/science/article/pii/S2405844021020211>, accessed 5 January 2024).
16. The Montreal Protocol on substances that deplete the ozone layer [website]. Nairobi: United Nations Environment Programme (<https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol>, accessed 5 May 2023).
17. Mota-Babiloni A, Makhnatch P, Khodabandeh R. Recent investigations in HFCs substitution with lower GWP synthetic alternatives: focus on energetic performance and environmental impact. *Int J Refrig.* 2017;82:288–301 (<https://www.sciencedirect.com/science/article/abs/pii/S0140700717302608?via%3Dihub>, accessed 5 January 2024).
18. Arkenbout A. The hidden impacts of incineration residues. *Zero Waste Europe*; 2019 ([https://zerowasteurope.eu/wp-content/uploads/2019/11/zero\\_waste\\_europe\\_cs\\_the-hidden-impacts-of-incineration-residues\\_en-1.pdf](https://zerowasteurope.eu/wp-content/uploads/2019/11/zero_waste_europe_cs_the-hidden-impacts-of-incineration-residues_en-1.pdf), accessed 5 January 2024).
19. Mohamed SH, Hady OA, Kashef MT, Zedan H. Antivenoms, hepatitis B vaccine and oral polio vaccine can be considered for storage and handling outside the cold chain following the innovative 'controlled temperature chain' approach. *Biologicals.* 2022;78:27–35 (<https://pubmed.ncbi.nlm.nih.gov/35803876>, accessed 8 January 2024).
20. Peyraud N, Zehrunge D, Jarrahan C, Frivold C, Orubu T, Giersing B. Potential use of microarray patches for vaccine delivery in low- and middle-income countries. *Vaccine.* 2019;37(32):4427–34 (<https://pubmed.ncbi.nlm.nih.gov/31262587>, accessed 8 January 2024).
21. Quality criteria for health national adaptation plans [website]. Geneva: World Health Organization; 2021 (<https://www.who.int/publications/i/item/9789240018983>, accessed 8 January 2024).
22. Water, sanitation, hygiene, waste and electricity services in health care facilities: progress on the fundamentals. 2023 global report. Geneva: World Health Organization and the United Nations Children's Fund (UNICEF); 2023 (<https://iris.who.int/bitstream/handle/10665/368975/9789240075085-eng.pdf?sequence=1>, accessed 8 January 2024).

## Annex: Methodology

To grasp the connection between climate change and polio, the WHO team extensively scrutinized peer-reviewed scientific literature, reports and other pertinent sources. To guarantee the brief's practicality and applicability, the team engaged in interviews with seasoned polio programme managers. These first-hand perspectives from experts directly involved in polio eradication efforts shed light on the operational challenges presented by climate change, the most effective mitigation strategies and the practical needs of the programme managers. To maintain the credibility of the document, experts in polio eradication and climate change reviewed the content, methodology and recommendations outlined in the draft version. This peer review functioned as a quality control mechanism, ensuring that the brief is scientifically sound, methodologically rigorous and tailored to the specific requirements of polio eradication programmes.

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