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# **Flood Recovery and Resilience in Pakistan**

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## Introduction

*"We've never seen this much water in our lives," Abdul explains, "My uncle is 84 and even he hasn't witnessed this sort of flooding in this area." – BBC, 2021<sup>1</sup>*

In 2022, many parts of the world experienced record numbers of severe flooding events due to increased rainfall. These events have resulted in immediate and lasting impacts on lives, health, and health systems as well as many additional impacts on economics, education, and security across the world. Of all natural disasters, flooding is the most common cause of loss of life and property. A recent insurance document reporting the cost of natural disasters in 2022 found that of the 29 natural global disasters that caused damage over US\$1 billion, six of these disasters were floods.<sup>2</sup> Unfortunately, the impact of flooding is expected to grow for a variety of reasons: urbanization will lead to increasingly concentrated population centers in coastal regions, and changing climates will precipitate unexpected weather patterns, warmer air facilitating more rainfall in some regions, and higher sea levels.<sup>3</sup> Models show that 1.81 billion individuals, or 23% of the world's population, are already susceptible to flood depths greater than 0.15 meters due to a 1-in-100-year flood event, and that 4 in 10 of those at-risk live on less than US\$5.50 a day.<sup>4</sup>

The uncalculated human cost innate to these monetary amounts are difficult to fathom, as floods devastate societies across sectors. Immediate loss of life occurs due to drowning in fast-moving water or from injury from deadly debris, particularly during flashfloods. Access to evacuation routes, critical services, and lifesaving assistance diminishes as floodwaters damage infrastructure, thereby diminishing response systems' ability to access affected areas and provide emergency transportation. Disruptions to law enforcement, supply chains, and healthcare pose challenges to both immediate needs and longer-term societal recovery.

Flooding also represents short- and medium-term health risks. For example, waterborne diseases such as diarrhea, cholera, typhoid fever, and leptospirosis typically increase as households lose access to safe sanitation, water shortages allay hygiene behaviors, and latrines overflow. A study in Bangladesh found that the number of cholera cases increased by 14% when rainfall increased by 10mm above the rainfall threshold due to increased wastewater contamination leading to environment-to-person transmission.<sup>5</sup> Another health risk comes in the form of vector-borne diseases, such as dengue fever and malaria, both as results of expanded mosquito breeding environments. In 2019, Bangladesh experienced its worst dengue outbreak to date with over 100,000 cases and 179 deaths, following severe monsoon flooding.<sup>6</sup> Drinking contaminated water can also lead to typhoid fever, cholera, and hepatitis A, as was the case in the Philippines following heavy rainfall and flooding events.<sup>7</sup>

Floods also have health justice implications; several studies show that poor households are disproportionately exposed to the risks of flooding since they often congregate in particularly low-lying, densely populated areas in coastal urban centers. The highly localized nature of flooding risk and response, itself an effect of poor land-use planning and infrastructure neglect, can manifest in persistent, multi-generational poverty, as seen in Mumbai, Dhaka, Caracas, or Rio de Janeiro.<sup>4,8</sup>

Global trends have set populations on a deadly collision course with nature, and innovative solutions to flooding preparedness and resilience are sorely needed to abate flood-related morbidity and mortality.

# Case Prompt

*“Even as we respond to the emergency in Pakistan, we must remember that unless we address the existential threat of climate change, we will be responding to emergencies like this and worse more often.”*

~ Dr. Tedros Adhanom Ghebreyesus<sup>9</sup>

## *Background*

In June 2022, unexpectedly prolific monsoon rains unleashed a torrential downpour on Pakistan. The effects were amplified by excessive snowmelt from an uncharacteristically warm spring, including May temperatures that exceeded 117°F in Jacobabad and Sibi.<sup>10,11</sup> Areas bordering high-volume lakes and rivers, as well as the highly populated coastline, placed vulnerable communities into the path of surging water.<sup>12</sup>

Over the next three months, the ensuing floods killed about 1,700 people, with 20% of these mortalities attributable to flooding-related indirect causes such as diseases and malnutrition.<sup>2</sup> Economic losses are estimated to exceed US\$30 billion. Approximately 3.1 million individuals were displaced, and 300,000 homes were destroyed.<sup>13</sup> An estimated 500,000 people are currently sheltered in camps. Nine hundred health facilities were also immediately damaged, leaving millions of citizens without access to health care and medical treatment.<sup>14</sup>

Several health interventions targeting ongoing communicable disease challenges in Pakistan have also been disrupted. Resulting disaster-related health problems include acute watery diarrhea, dengue fever, malaria, polio, COVID-19, and measles. Cases of infectious disease are especially high in camps, where water and sanitation facilities are limited.<sup>15</sup> It's estimated that this past year, environmental and climatic risks were responsible for 23% of the total burden of disease in the region.<sup>16</sup> In response, the WHO has set up 19 stabilization centers around the country, primarily to address severe acute malnutrition among children.<sup>17</sup>

Of these public health issues, the increased incidence of waterborne diseases is most concerning due to its health impact and its direct link to flood-related resilience. Heavy precipitation and flooding overwhelm water infrastructure and lead to contamination of common water sources, introducing pollutants and pathogens. Numerous studies suggest a significant, dramatic increase in transmission of all types of diarrheal diseases due to heavy rainfall events and subsequent flooding.<sup>18</sup> Models indicate continually increasing risk of water-borne pathogens as effects of climate change continue. As an example, the incidence of *E. coli* and other waterborne pathogens is predicted to increase as monthly average temperature increases and rainfall patterns shift.<sup>19</sup>

Even before the flooding of 2022, Pakistan had one of the greatest burdens of enteric disease in the world, with an annual incidence of 493.5 cases per 100,000 people.<sup>20,21</sup> Since July 2022, an estimated half a million individuals in Pakistan have reported waterborne diseases such as acute diarrhea, skin and eye infections, and typhoid.<sup>16</sup> It is believed that these infections result from people coming into contact with stagnant, contaminated water. The incidence of diarrheal diseases, particularly among children, has only been exacerbated by low vaccination rates and high rates of malnutrition.<sup>22</sup> The main water-borne threats in Pakistan include hepatitis and diarrheal diseases such as cholera, typhoid, salmonellosis, and giardiasis.<sup>20</sup>

Sindh, one of the most heavily affected regions by the 2022 floods, is also one of the most affected by diarrheal diseases. In 2021, Sindh province had the highest diarrheal disease incidence in the country, with the majority of cases occurring in children under 5.<sup>23</sup> Typhoid morbidity and mortality rates in Sindh province are approximately three times greater than Pakistan nationally, including a higher incidence of XDR typhoid strains that are extensively resistant to antibiotics.<sup>24,25</sup>

## Team Instructions

In light of the health challenges Pakistan continues to face and will face in the future, USAID is seeking contractor assistance in their ongoing work as a supportive partner to the Pakistani Ministry of National Health Services, Regulations and Coordination (NHSRC), and National Disaster Management Authority (NDMA) for flood recovery and resilience-building. They have issued a Request for Proposal (RFP) for a cooperative agreement of US\$1.5 million over three years. The goal of the agreement is to involve new, innovative partners in developing community-level solutions for Sindh Province. You will take on the role of a social impact company, a small NGO, or an academic institute and submit a bid for the award detailing a locally implementable intervention to address waterborne diseases which resulted from serious flooding.

You will be given 10 minutes to present your proposal to a panel of judges representing USAID program officers and Pakistani public health officials. An additional 5-minute question-and-answer session will follow. Proposals will be assessed according to seven criteria:

- **Feasibility**. The intervention should be realistic, cost-effective, operationally viable, and likely to demonstrate measurable impact within three years.
- **Applicability**. The intervention should demonstrate an awareness and alignment with national and funder priorities, including those of USAID, NHSRC, NDMA and provincial authorities.
- **Local Relevance**. In addition to addressing national priorities, the intervention should demonstrate a clear awareness of community priorities, outlining levels of engagement, contextual awareness, and cultural sensitivity.
- **Evidence Base**. Teams should support their proposals with high quality evidence from their own research, which should relate directly to the feasibility and relevance of the proposed intervention.
- **Multidisciplinary**. The intervention should engage multiple sectors and stakeholders to address the environmental, societal, and development facets of the problem.
- **Integration**. Teams should prioritize one primary goal to address the immediate needs of stakeholders, but also delineate at least one secondary goal in their proposal that anticipates longer-term needs.
- **Adaptability**. The intervention should demonstrate post-implementation flexibility in order to adapt to future emergencies or unforeseen circumstances. In addition, both near- and long-term prospects for project resilience should demonstrate systemic improvements and persistent impact.

A successful proposal will include a detailed and well-researched project plan that spans the full funding timeline, an outline of how funds will be used, and a description of specific metrics that will be used to measure progress and impact. Presentations should communicate how the project addresses critical community needs at the *local level* and partners' priorities at the *national level*. Additional aspects may be considered, such as tools to manage stakeholder relationships or a public relations strategy.

# Supporting Information

## Country Profile

### *Geography and Demography*

Pakistan is an 800,000 square-kilometer country in South Asia that stretches from the Arabian Sea in the south to the Karakoram Mountains in the north. Pakistan is divided into four provinces, roughly corresponding to the major resident ethnolinguistic group, with Sindh in the south, Punjab in the east, and Baluchistan in the high desert west.<sup>26</sup> One diverse province – Khyber Pakhtunkhwa (KPK) – is home to most of the nation’s Pashto-speakers, and includes the former Federally Administered Tribal Areas along the Afghan border (unified with KPK in 2018), the western portion of the Jammu & Kashmir region, and the remote and mountainous Gilgit Baltistan to the far north.<sup>27</sup>

The Indus River Valley is Pakistan’s key geographic feature, tracing the length of the country from the edge of the Tibetan Plateau to a vast, 16 square-kilometer wetland delta in the country’s southern Sindh Province.<sup>26</sup> In June through September, the Indus swells with snowmelt from the Western Himalaya and can become several miles wide in places along low-lying plains of the Punjab and Sindh regions – occasionally bursting its banks.<sup>28</sup>

Most of Pakistan’s population of 243 million – the fifth largest in the world<sup>29</sup> – live near the Indus, one of its tributaries, or in regions artificially irrigated by the world’s largest system of agricultural canals.<sup>30</sup> Karachi is the country’s largest city, situated on the southern Sindh coastline at the mouth of the Indus with a population of over 17.2 million.<sup>31</sup>

Pakistan is a very young country, with a median age of 22, more than 55% of its population under 25, and more than 90% under 55.<sup>32</sup> Almost a third of Pakistanis are currently between the ages of 18 and 32 – the largest such age cohort in the nation’s history<sup>33</sup> – with more than 17% of the total population under the age of 5 in 2018. Pakistan is roughly two-thirds urban and one-third rural, with nearly half the urban population residing in slums.<sup>34</sup>

English and Urdu are Pakistan’s official languages, but Pashto, Balochi, Sindhi and Punjabi are also widely spoken, and more than 60 other languages are reported as mother tongues. Ethnically, 44.7% of Pakistanis identify as Punjabi, 15.4% as Pashtun, 14.1% as Sindhi, 8.4% as Saraiki, 7.6% as Muhajirs, and 3.6% as Baluch. Pakistanis are predominantly (96.5%) Muslim, about 85-90% Shia and 10-15% Sunni. A small minority of Hindus and Christians comprise the remaining religious affiliations.<sup>32</sup>

### *Sindh Province*

An estimated 47-62 million people live in Sindh Province,<sup>35</sup> which comprises 18 percent of the total land area. Most Sindh residents live along the last few miles of the Indus River course, and roughly a third live in the provincial capital of Karachi at its mouth. A major global megacity, Karachi is the nation’s largest metropolitan area, its only seaport, and its main economic hub.<sup>26</sup> Sindh has lower unemployment rates than the rest of Pakistan and produces the majority of national income tax revenue. Despite an arid climate, agricultural industries employ a large portion of Sindh residents.<sup>26</sup>

Despite being more urbanized than the rest of Pakistan, Sindh is still half rural. A traditional feudal system persists in some rural areas, characterized by bonded labor, subsistence village economies, and political power tied to landownership concentrated among a minority of individuals – indeed, a large number of seats in the

Sindh provincial assembly are occupied by “landlords.”<sup>26</sup> This feudal or *wadero* system has been implicated in the region’s continued struggles with poverty, poor primary school enrollment and literacy rates (especially among females), and challenges related to social and public health development.<sup>36</sup>

Sindh’s identity as a distinct political entity predates the formation of Pakistan, and has deep roots in ethnicity, language, and history. Tensions exist between Sindh and the Punjab, with reasons ranging from water rights to Punjabis’ historical majority control over the government and military.<sup>37</sup> Though demographic data is limited, about half of Sindh’s residents are estimated to be ethnic Sindhi. Another large portion of the population identify as Mohajir, and both Sindhi and Mohajir ethnopolitical factions have claimed to outnumber one another as Pakistan’s largest ethnic minority and Sindh’s ethnic majority.<sup>35</sup> Politically-motivated violence and targeted organized crime between different ethnic factions in Sindh has been severe, resulting in major military interventions in Karachi in the 1990s and persistent political instability. The security situation in Karachi in the mid-2010s got so bad that federal immunization efforts were interrupted as paramilitary forces again engaged in antiterror operations.<sup>26</sup>

### *Politics and Economics*

Pakistan’s 2022 GDP was projected to be US\$376.5 billion.<sup>38</sup> This puts the Pakistani economy in the top quarter globally.<sup>39</sup> However, Pakistan’s 2021 per-capita gross national income (GNI) was US\$1,470.<sup>40</sup> This means Pakistan ranks among the bottom quartile for income globally, well below the US\$4,095 threshold for World Bank classification as a Lower Middle-Income Country.<sup>41</sup> It is estimated that about one fifth of Pakistanis live below the national poverty line,<sup>42</sup> with more than a third of surviving on US\$3.20 per day or less, and three-quarters on US\$5.50 per day or less.<sup>43</sup>

Pakistan operates under a federal parliamentary system, partially inherited from its time under colonial rule as part of the British Raj. Pakistan’s government and constitution are heavily influenced by religion, combining both Islamic Shari’ah and more secular Western legal traditions.<sup>44</sup> Mandate to govern in Pakistan is largely influenced by support from the country’s powerful, well-funded, US-aligned and nuclear-armed military.<sup>45</sup> The current government is controlled by the Pakistan Muslim League-Nawaz (PML-N), a conservative religious party led by prime minister Shehbaz Sharif. Sharif’s predecessor, Imran Khan of the populist Pakistan Tehreek-e-Insaf (PTI) party, was ousted in April 2022.<sup>45</sup> The resultant political unrest culminated in an assassination attempt on Khan while he was leading a march to call for snap national elections on November 3, 2022, pushing tensions in the country to new heights garnering international attention.<sup>47, 48</sup>

In addition to a political crisis, Pakistan is currently facing economic struggles. For years, the country has battled a foreign debt crisis resulting from import/export imbalances, low economic growth, and double-digit inflation.<sup>48–50</sup> The COVID-19 pandemic dealt a major blow to national exports and a resultant 10 percent GDP loss in 2020.<sup>51</sup> A 2019 US\$7 million bailout plan negotiated with the International Monetary Fund has been plagued by stalled funds and unpopular terms (including a revocation of fuel and electricity subsidies), presenting an international controversy that flared again in January 2023.<sup>52–54</sup> In January 2023, with national liabilities topping US\$100 billion and international aid lacking, Pakistan at last raised nearly US\$10 billion in foreign pledges out of a US\$16.3 billion estimate of needed funds – most is expected to be in the form of even more loans.<sup>55,56,57</sup> Pakistan’s economic situation has come to represent, in the wake of COP27, the international community’s reckoning with what many consider a slow and “broken” system of international aid that traps emerging economies in a cycle of crisis, debt, and poor economic self-determination – a cycle which is worsening as climate change-related disasters intensify and multiply.<sup>58</sup>

## *Environment and Natural Disasters*

According to the World Bank, Pakistan faces some of the highest levels of disaster risk in the world, ranking 18<sup>th</sup> out of 191 countries on the 2019 INFORM Risk Index.<sup>59,60</sup> Much of that vulnerability is a result of the country's exposure to severe floods. Prior to the current crisis, Pakistan's worst flooding event in recent history occurred in the middle of 2010, killing 1,700 people, affecting 20 percent of the country's total land area, and impacting more than 20 million people.<sup>61</sup> The result was so bad that it prompted the formation of the National and Provincial Disaster Management Authorities.<sup>62</sup> While the last 12 years have seen the highest human costs from flooding, Pakistan is no stranger to such events; the Pakistan Federal Flood Commission has recorded 16 super riverine floods between 1950 and 2010, and one every year since 2010.<sup>63</sup>

As Pakistan ranked 8<sup>th</sup> in the world for long-term climate vulnerability on the 2021 Global Climate Risk Index, flooding there has an interplay with climate and environmental factors.<sup>13</sup> A *Scientific American* report blamed deforestation and land-use changes for partial exacerbation of the 2010 floods.<sup>61</sup> Currently only about 5 percent of Pakistan is forested (well below the global average), which presents a problem during extreme rainfall events because well-structured forests can stabilize soils and help to maintain riverbank integrity.<sup>64</sup> Pakistan has one of the highest deforestation rates in Asia according to the UN Food and Agriculture Organization, which has resulted in an 80 percent tree cover loss since independence in 1947.<sup>61</sup>

Pakistan also has more glacial ice than any other country outside the polar regions,<sup>13</sup> which can pose a problem as global temperatures rise. Pakistan has seen a 0.3 degree C rise in average temperatures per decade between 1986 and 2015, which is higher than the global average and has resulted in severe heatwaves – April and May 2022 saw long periods above 40 degrees in parts of the country, and Jacobabad (considered the “hottest city on earth”) topped out at 51 degrees.<sup>65</sup> While glacial melt plays a role in upstream river flows, the main problem lies in warmer air holding more moisture – as a result, Pakistan had seen 3 times its average annual rainfall by September 2022,<sup>65</sup> with Sindh recording 8.3 times its normal precipitation.<sup>66</sup> Climate scientists predict that shifting monsoon patterns could worsen the country's susceptibility to storms and severe rainfall in the near future.<sup>13</sup>

Pakistan also has a history of social and governance factors exacerbating the effects of climate-related disasters. Pakistan ranked 176<sup>th</sup> out of 180 countries on the 2022 Yale Environmental Performance Index, which is indicative of a lack of political will and limited government capacity to address the effects of climate change.<sup>61</sup> In the aftermath of the 2010 floods, people at home and abroad viewed the then-president's decision to continue with a European tour as emblematic of Pakistani leaderships' unwillingness or inability to respond effectively, while police protection failed to prevent sectarian violence and service denial to members of minority communities across the country.<sup>13,64</sup> The Center for Strategic and International Studies attributes much of Pakistan's limited flood resilience to corruption, poor water resource and infrastructure management, and weak regulatory enforcement. Low-quality construction has continued in 2010 flood areas despite ostensible legal restrictions, and illegal logging has continued at an alarming rate despite paramilitary interventions. The ongoing leadership crisis is the latest manifestation of the political conflicts that have long obstructed federal and provincial agency collaboration for disaster response.<sup>64</sup>

## *Health Policy and Healthcare System*

Pakistan does not have a national-level health agency in the same way that most federally administered nations do. The former Ministry of Health was dissolved in 2011 with the 18<sup>th</sup> amendment to the constitution, with most health-related responsibilities subsequently devolved to provincial authorities. The MoH was

replaced by the Ministry of National Health Service Regulation and Coordination (NHSRC) in 2012, which conducts oversight and regulatory roles rather than service delivery.<sup>43</sup>

The population of Pakistan are served by 1,167 hospitals, 5,695 dispensaries, and 5,464 Basic Health Units (BHU). Additionally, 675 Rural Health Centers (RHC) serve more remote areas, with 733 Maternal Child Health Centers (MCHC) – which are often simply the homes of community health workers<sup>67</sup> – serving lower-resource areas.<sup>34</sup> Healthcare facility access is relatively strong in the country, as nearly all urban residents and roughly 92 percent of individuals in rural areas can reach a healthcare provider.<sup>68</sup> However, facility access is not the only factor in overall care accessibility or quality: a 2018 Lancet report ranked Pakistan 154<sup>th</sup> out of 195 countries by Health Access and Quality (HAQ) Index,<sup>69</sup> and its 2022 HAQ score of 32.4 out of 100 – the lowest in South Asia – is comparable to several low-income nations in Sub-Saharan Africa.<sup>70</sup> Evidence suggests Pakistan’s healthcare access and quality problems likely stem from shortfalls in:

- *Affordability.* Even though the country has a public system of providers offering care free of charge, private sector facilities run by for-profit companies and NGOs control an increasingly large portion of the market, including roughly 80 percent of all primary care services. Indeed, 70 percent of all healthcare spending in Pakistan is done in the private sector, nearly 60 percent of which is out-of-pocket spending by patients (the WHO-recommended figure for OOP expense as a portion of total national healthcare spending is 15-25%).<sup>71</sup> More than half of Pakistanis are at risk for catastrophic medical costs from surgical care, which is well above both the South Asia regional average of 36% and the lower-middle income country average of 32%.<sup>43</sup> An estimated 20 of all impoverished households were driven below the poverty line by medical expenses.<sup>72</sup>
- *Infrastructure.* Even where community health worker presence is strong, referral uptake is poor in part due to material deficits in public facilities’ ability to provide organized, quality care.<sup>73</sup> A 2018 assessment by UNICEF found that, particularly in Sindh, major upgrades to computerization were needed, especially regarding health information systems and logistics management for drugs and medical supplies. Difficulties regarding substandard quality assurance were identified involving the national Drug Regulatory Authority and similar provincial agencies. The report also called for critical upgrades to warehouse capacity and staff technical knowledge, as well as dispensary capabilities for RHCs conducting high volumes of outpatient services.<sup>74</sup>
- *Workforce capacity.* Data on the health workforce in Pakistan is scarce, but estimates for the patient-to-population ratio range from about 1 in 800 to 1 in 1,000.<sup>75,76</sup> The NHSRC has a 2030 target of 1.11 physicians and 3.34 nurses and midwives per 1,000 Pakistanis in order to attain WHO-defined Universal Health Coverage (UHC) for 75 percent of the population. However, despite the country’s capacity to graduate tens of thousands of health professionals per year through its 107 medical schools, authorities anticipate high attrition rates and a persistent shortage of 780,000 critical healthcare workers.<sup>33</sup> Pakistan’s health workforce, especially in the public sector, is plagued by emigration due to burnout, limited resources, hostility towards health workers, and social pressures burdening female professionals.<sup>68</sup>
- *Government investment.* Health has been persistently underinvested and underprioritized by Pakistani regimes for years,<sup>77,78</sup> in stark contrast to the government’s extraordinary spending on debt service and the military.<sup>43</sup> Total healthcare spending in Pakistan was roughly 3 percent of GDP in 2018, only about 30 percent of which was direct government expenditure.<sup>79</sup> This translates to government health spending comprising only 4 percent of all government spending, and only 1 percent of GDP. This is substantially less than both the South Asia regional average and the lower-middle income country average,<sup>43</sup> and is well below the 5 percent WHO recommendation.<sup>71</sup> Spending increases in Sindh have consistently lagged behind the nation as a whole and all other provinces.<sup>43</sup>

## Community and Population Health

In addition to care access and quality issues, Pakistan faces a number of public health challenges:

- Having increased from 62 to 67 between 2000 and 2018, life expectancy at birth still remains below 70 as of 2021.<sup>43,72</sup>
- Infant mortality remains the 17<sup>th</sup> highest out of 227 countries and territories as of 2022, at 62 per 1,000 live births.<sup>72,80</sup> Maternal mortality rates are some of the highest in Asia.<sup>54</sup>
- Insufficient clean water and clean cooking infrastructure.<sup>72</sup>
- Child non- and under-vaccinated populations rank among the largest in the world. In addition to access and health literacy disparities, hesitancy issues stem from misinformation and religious and cultural norms (though religion can also play an important role in uptake).<sup>54,81</sup>
- Diarrhea and pneumonia persist as leading causes of child morbidity and mortality.<sup>80</sup>
- Large disparities in child mortality persist according to income level and region, with northern Baluchistan and rural northeast Sindh having some of the worst levels.<sup>33,82</sup>
- Despite record lows in 2018, between 2009 and 2019 malnutrition ranked as the number one risk factor for combined death and disability. Stunting, wasting, and underweight rates remain above low-income country averages.<sup>43,82</sup> Even before flooding began in 2022, severe acute malnutrition (SAM) rates were already at emergency levels in parts of Sindh.<sup>16</sup>

Despite these challenges, Pakistan has made some important gains in population health in recent years thanks in large part to its wide range of provincial public health programs. The Sindh Department of Health alone has divisions addressing maternal and child health, hepatitis elimination, safe blood transfusion, and blindness, with dedicated infectious disease control programs each for tuberculosis, malaria, HIV/AIDS, and dengue. Sindh also has collaborating centers with the Expanded Programme on Immunisation (EPI) and the World Food Program, and a public-private partnership for primary healthcare improvement with the People's Primary Healthcare Initiative (PPHI). Recent years have also seen the Sindh Department of Health expand its digital tools, including the Health Information System, healthcare automation efforts, geographic information capabilities, HIV screening, and supply chain management.<sup>83</sup>

At the national level, Pakistan has the world's largest polio surveillance and response network;<sup>84</sup> uses innovative vertically integrated approaches to nutrition, reproductive, and maternal/child health;<sup>74</sup> and has consistently improved coverage rates for all vaccine preventable diseases to above 80 percent as of 2021.<sup>85</sup> In 2022, Pakistan expanded its successful Sehat Sahulat Program pilot in KPK to the Punjab, offering every household a healthcare card worth PKR1 million (roughly US\$5,600) usable at both public and private facilities. Though political, economic and humanitarian challenges remain, nationwide program rollout is now underway with tens of millions of families enrolled and millions of hospital visits covered.<sup>72,86</sup>

Many of these public health gains would not be possible without the critical role that community health workers play in Pakistan, particularly in rural and low-income areas. Pakistan is notable for its Lady Health Worker (LHW) Program, originating in 1951 as a women-centric initiative to address poor maternal and child health outcomes in underserved areas.<sup>87</sup> Since then, LHW roles and responsibilities have grown to include hygiene promotion, vaccinations, community tuberculosis control, polio surveillance, HIV/AIDS education, family planning, COVID-19 management and more. LHWs report to provincial health departments throughout the country, usually operating out of their own homes.<sup>67</sup> The program is largely credited with the two-thirds reduction in neonatal and maternal mortality seen in Pakistan between 1947 and 2016, but continues to struggle with poor referral uptake and trust, low staffing, extreme workloads, low wages, limited professional growth opportunities, and sociocultural marginalization of both female providers and patients.<sup>67,73,78</sup> Despite a

goal of 100-150 thousand LHWs, the workforce stayed around 90,000 between 2008 and 2017 at a ratio of about one LHW per 2,300 Pakistanis.<sup>33,67</sup>

In addition to its allopathic health workforce, Pakistan has a robust alternative medicine community. As of 2017, there were more than 60,000 registered traditional medicine physicians (*hakims*), more than 140 alternative medicine schools, and more than 150,000 practitioners offering care according to traditional systems of knowledge such as *ayurveda* and *unani tibb*.<sup>33</sup>

## Biology and Epidemiology of Waterborne Diseases

Waterborne diseases result from exposure to contaminated water sources. Routes of transmission include ingestion, breathing in droplets of contaminated water, and living in proximity to livestock, wildlife, or other sources of contamination. Safe drinking water, sanitation, and hygiene (summarized as WaSH) are limited in many low-income settings. The WHO estimates that the majority of the burden of waterborne diseases, 842,000 deaths per year, is attributable to a lack of WaSH resources.<sup>88</sup> In Pakistan, WaSH-related illnesses were the 6th most common cause of death and disability in 2019.<sup>82,89</sup>

As flooding devastated WaSH infrastructure in Pakistan, a corresponding increase in skin infections, gastroenteritis, and acute diarrheal illnesses has occurred. Between July and October 2022, 700,000 cases of diarrhea and 770,000 cases of skin diseases were reported in Pakistan.<sup>66,90</sup> As of January 2023, an estimated 4 million children are living in close proximity to contaminated water sources following the floods.<sup>91</sup> Particularly concerning are waterborne pathogens of epidemic potential, including cholera and typhoid, as well as dysentery. By the end of September 2022, at least 10,000 cases of dysentery were reported in Sindh province, with an additional 137,000 cases of general diarrheal illness.<sup>92-95</sup> Dysentery is a serious condition in which a diarrheal infection leads to intestinal inflammation and bloody diarrhea, which can be caused by multiple pathogens including *V. cholera*, *E. coli*, *Salmonella*, and *Shigella*. Viral gastroenteritis, most commonly caused by rotavirus, and acute viral hepatitis, caused by Hepatitis A and E commonly affect put children at risk in endemic areas. While pathogens like dengue and malaria are not waterborne, their prevalence also increases after flooding events due to breeding habitat expansion for the mosquito vectors.<sup>96</sup>

**Table 1. Waterborne pathogen risks in Pakistan following 2022 floods.**

	Clinical Significance	Situation in Pakistan
<b>Cholera (<i>V. cholerae</i>)</b>	<ul style="list-style-type: none"> <li>Bacterial pathogen of epidemic potential.<sup>97</sup></li> <li>Presents as profuse watery diarrhea, vomiting, thirst, leg cramps, restlessness, dehydration.<sup>98</sup></li> <li>In non-endemic areas, symptoms can be particularly severe and may be fatal, especially in young children, due to extremely rapid fluid loss.<sup>99</sup></li> <li>Diarrhea produced by infected patients contains large amounts of infectious bacteria that contaminates surfaces, water supplies, or transmits from person to person. Caretaking of infected patients, including children, carries risk of infection. Reinfection is likely.</li> <li>Oral vaccine (two doses) approved for anyone over 2 years of age, providing protection for 2-3 years. Vaccine efficacy is 80-85% in 1<sup>st</sup> year after vaccination, but quickly declines.<sup>99</sup></li> </ul>	<ul style="list-style-type: none"> <li>Although cholera is endemic in Pakistan, cases have rapidly increased since the start of the flooding events in May 2022. Between January 15 and May 27, 2022, Sindh province reported 234 confirmed cholera cases, in addition to over 50 reported cases in other provinces during this time period.<sup>100</sup> In Karachi, 129 confirmed cases occurred between January 15 and April 27, 2022.<sup>101</sup></li> <li>Globally, cholera cases are surging in multiple countries so vaccine supplies are limited and acquiring vaccines for mass vaccination campaigns is challenging.<sup>102</sup></li> <li>Over 10 separate cholera outbreaks have been reported in flooded areas or areas where displaced persons from flooded regions have gathered.<sup>103</sup></li> </ul>
<b>Typhoid (<i>Salmonella</i> Typhi and Paratyphi)</b>	<ul style="list-style-type: none"> <li>Presents as fever, stomach pain, rash, headache. Without treatment, cases can result in shock or death.<sup>104</sup></li> <li>Ingested via contaminated food or water.</li> <li>Common in areas with lack of access to clean, potable water or substandard sewer systems, including systems overwhelmed by storms or high water levels.<sup>104</sup></li> <li>Typhoid vaccines available as live, oral vaccine or intramuscular, inactivated vaccine for anyone over 2 years old. Efficacy estimates range between 50 – 80%, so vaccinated individuals remain susceptible in the event of mass transmission or typhoid outbreak.<sup>105</sup></li> </ul>	<ul style="list-style-type: none"> <li>Pakistan has highest typhoid incidence in South Asia (approximately 493.5 cases per 100,000 in 2018).<sup>106</sup> Typhoid burden and mortality are higher in Sindh province than Pakistan as a whole (Table 2).<sup>25</sup></li> <li>XDR Typhoid (extensively drug resistant) is the predominant strain in Pakistan, particularly in Sindh province, since 2019.<sup>24</sup> Case estimates exceed 15,000 between 2016 and 2022. This strain is resistant to almost all antibiotics, but is currently treatable with limited, strong antibiotics.</li> <li>Typhoid vaccination is included in Pakistan’s national immunization program, but vaccination coverage among adults (outside scope of the program) remains relatively low.<sup>34</sup> Production of oral (live) typhoid vaccine was halted in December 2020 due to COVID-19 pandemic, so supplies and distribution have been limited. A vaccination drive was recently launched in 22 districts most affected by flooding or displacement.<sup>107</sup></li> </ul>
<b><i>E. coli</i> (ETEC, EHEC)</b>	<ul style="list-style-type: none"> <li>Presents as watery or bloody diarrhea, abdominal cramping and pain, fever, nausea, headache, bloating. EHEC may develop into hemolytic uremic syndrome (HUS), a severe complication that includes kidney damage, anemia, and thrombocytopenia. Most common in children and can lead to permanent kidney damage even after recovery.<sup>108</sup></li> <li>Transmitted by food or water contaminated with feces from an infected human or animal, or direct contact with an infected person or animal. Cattle are the primary animal reservoirs.</li> </ul>	<ul style="list-style-type: none"> <li>Before the recent flooding, multidrug resistant strains of <i>E. coli</i> were found to contaminate water supplies in urban areas of Pakistan.<sup>109</sup></li> <li>During previous flooding events in Pakistan, <i>E. coli</i> infections increased, especially in children. During floods in 2010-2011, <i>E. coli</i> incidence quadrupled, although sporadic cases of EHEC/ETEC continue during non-disaster time periods.<sup>110</sup></li> </ul>

<b>Shigella</b>	<ul style="list-style-type: none"> <li>● Bacterial diarrheal infection, predominantly caused by <i>S. dysenteriae</i> and <i>S. boydii</i> strains of Shigella bacteria.<sup>111</sup></li> <li>● Presents as bloody diarrhea, fever, abdominal pain, urge for bowel movement even when bowels are empty</li> <li>● One of the highest risks of transmission of any bacterial diarrheal illness. Shigella spreads very easily from person to person due to the very low infectious dose.<sup>111</sup></li> <li>● Transmitted through touching or contact with contaminated material like surfaces, food, drinking water, fecal matter, etc.</li> </ul>	<ul style="list-style-type: none"> <li>● Before current flooding, <i>Shigella</i> was detected in water supplies and food products in urban areas of Pakistan, with higher prevalence during warmer months. <i>S. flexneri</i> is the most common strain of Shigella in Pakistan.<sup>112</sup></li> <li>● Multidrug resistance of <i>Shigella</i> has been detected in Pakistan since 1996, including in pediatric <i>Shigella</i> cases. As of 2006, the majority of <i>Shigella</i> strains were resistant to commonly used antibiotic regimens.<sup>113</sup></li> </ul>
<b>Rotavirus</b>	<ul style="list-style-type: none"> <li>● Leading cause of acute gastroenteritis worldwide, causing life-threatening viral diarrheal illnesses in young children.<sup>114</sup></li> <li>● Presents as profuse watery diarrhea, vomiting, abdominal cramping, fever, fatigue, dehydration. More rarely causes convulsions, encephalitis, or encephalopathy.</li> <li>● Fecal-oral transmission or indirectly through contaminated hands, surfaces, food, water sources, etc.</li> <li>● Two multivalent, live attenuated vaccines are approved for use by WHO. Both vaccines require at least 2 doses, spaced several weeks apart. Vaccination efficacy differs between high- and low-income countries, potentially resulting from malnutrition, coinfection with other enteric pathogens, repeated exposure, environmental enteric dysfunction (EED), etc.<sup>115</sup> Vaccine efficacy in high-income countries is &gt;90%, while in low-income countries is approximately 44%.<sup>116</sup></li> </ul>	<ul style="list-style-type: none"> <li>● Although Pakistan-specific efficacy data is not available, in Bangladesh vaccine efficacy against severe diarrheal illness was approximately 74%. Vaccine failure was associated with EED, found in 80% of infants in an urban area and associated with approximately 24% of vaccine failure.<sup>117</sup></li> <li>● Malnutrition and vitamin deficiencies, hypothesized to reduce vaccine efficacy, are prevalent in Pakistan. Sindh province has a higher burden than Pakistan as a whole (Table 2).<sup>25</sup></li> <li>● Even after vaccination, approximately 22% of acute gastroenteritis in children in Pakistan was caused by rotavirus. Infections were most common in the winter, spring, and fall and least common in the summer.<sup>118</sup></li> <li>● Before current flooding, rotavirus was detected in wastewater and water sources of urban areas in Pakistan. The strains detected matched those of children hospitalized with rotavirus, suggesting wastewater runoff or lack of water treatment as the cause.<sup>119</sup> Wastewater overflow during the current floods has led to more infections, although cases are underreported.<sup>120</sup></li> </ul>
<b>Acute Viral Hepatitis (Hepatitis A and E)</b>	<ul style="list-style-type: none"> <li>● Presents with fever, headache, nausea, vomiting, diarrhea, abdominal pain, dark urine, jaundice, and joint pain.<sup>121</sup></li> <li>● Transmitted through close contact with an infected person or ingestion of contaminated food or water.</li> <li>● Vaccination is available for Hepatitis A for individuals over 12 months of age. Vaccination efficacy is &gt;90% after one dose and is an effective form of prevention in endemic and non-endemic areas.<sup>122</sup></li> </ul>	<ul style="list-style-type: none"> <li>● Hepatitis A is endemic in Pakistan and accounts for 50-60% of acute viral hepatitis cases in children. By age 14, &gt;95% of people living in Pakistan have been exposed to Hepatitis A. High mortality rates have been observed in pregnant women and children who subsequently develop liver failure.<sup>123-125</sup></li> <li>● Multiple previous epidemics of Hepatitis E in Pakistan have resulted from water sources contaminated with sewage runoff, lack of proper water treatment, and overcrowding conditions.<sup>96,126,127</sup></li> <li>● Cases of Hepatitis A and E are believed to be surging in displaced persons camps.<sup>128,129</sup> National vaccine stockpiles have been mobilized to provide Sindh Province with at least 100,000 Hepatitis A vaccines since flooding began.<sup>130</sup></li> </ul>

## Disaster Response and the International Community

### *Current Flood Situation*

According to the WHO, floods damaged or destroyed more than 1 million homes and more than 2,000 health facilities – roughly 10 percent of the country’s total. More than 33 million people were affected, over 600,000 of whom were internally displaced (at least 240,000 of whom live in Sindh).<sup>16,131</sup> EIP and polio campaigns were interrupted, and more than a quarter of all district disease surveillance and reporting systems were put offline. Tuberculosis and HIV/AIDS activities were also particularly disrupted.<sup>16,132</sup> 26 of the 84 “calamity hit” districts are in Sindh, which bore the brunt of road, bridge and rail damage and 88 percent of all home destruction.<sup>54,133</sup> 80 percent of Sindh’s total cropland was completely destroyed. By December 2022, more than 5 million people (mostly in Sindh and Baluchistan) were already experiencing emergency levels of food insecurity with an additional million expected to join them by March 2023.<sup>131,134</sup> Some estimates expect an eventual total population of severely food insecure people to top 8.5 million, coming at a time when Sindh’s rice harvest reached a 10-year low.<sup>135</sup>

According to the latest situation report from the UN Office for the Coordination of Humanitarian Affairs (OCHA) dated 6 January 2023, stagnant floodwaters remained in 12 Sindh districts,<sup>135</sup> raising concerns about longer-term water- and vector-borne disease problems even as similar issues subsided in most other parts of the country.<sup>54</sup> Sindh still had an estimated 89,000 displaced persons, and the NDMA prepared a National Contingency Plan as fears turned toward impending severe winter weather conditions. To date, millions of people have been reached with humanitarian assistance, but support from the health sector and water, sanitation, and hygiene have lagged behind targets (2.4 million out of 6.4 million and 1.8 million out of 3.4 million, respectively).<sup>135</sup>

### *Response Apparatus*

In response to the flooding, the prime minister established the National Flood Response and Coordination Center, tasked with building relief centers, distributing cash assistance, and supporting the NDMA in its efforts to mobilize domestic and global resources.<sup>61</sup> The Center was dissolved on December 5, 2022 and replaced with the Resilience, Recovery, Reconstruction and Rehabilitation Framework to oversee progress on the national Flood Response Plan (FRP) for September 2022 through May 2023 developed in collaboration with OCHA and targeted primarily at Sindh and parts of Balochistan,<sup>66</sup> The FRP includes 9 target areas grouped under three strategic objectives: acute needs (including lifesaving, livelihood assistance, and winterization), health (including communicable disease control, nutrition, and maternal and child health), and security (including safety, dignity, and self-determination for affected persons).<sup>136</sup>

On-the-ground activities are predominantly being handled by Pakistan-based NGOs including the Women Democratic Front, the Aga Khan Development Network, the Edhi Foundation, the Hidaya Foundation, and the Pakistan Red Crescent, while the World Bank has provided the majority of funding for major projects.<sup>64</sup> New World Bank involvement in the Sindh flood response totals nearly US\$1.7 billion, including the US\$500 million Sindh Flood Emergency Rehabilitation Project (SFERP) and the US\$200 million Sindh Integrated Health and Population Project (SIHPP). Uniting a coalition of multiple provincial agencies, SFERP aims to recover infrastructure and improve government response capacities,

while SIHPP intends to improve quality and access to reproductive, maternal/child, and adolescent health and nutritional services.<sup>137</sup>

Several other organizations are playing major roles in flood response, including OCHA, WHO, UNICEF, WFP, USAID, and IFRC. All international organizations are meant to partner directly with NDMA, which has oversight authority and wide latitude to requisition whatever government resources or manpower is needed for disaster response. In addition to NDMA activities, WHO and NHSRC are co-chairing regular Health Sector Coordination (HSC) meetings,<sup>16,138</sup> and WHO had as of December 2022 established ten emergency health centers reporting to three operational hubs in the Sindh districts of Sukkur, Naseerabad, and Hyderabad.<sup>139</sup>

PDMA's and district-level authorities also operate with relative autonomy and a broad mandate for action. Sindh PDMA's resources are centralized at three locations in Sukkur, Hyderabad, and Karachi.<sup>138</sup> The agency has launched a new Disaster Management Information System and aims to improve disaster-related GIS capability and web-based information management. Additionally, Sindh PDMA oversees the Sindh Resilience Project, with objectives to simultaneously mitigate ongoing flood damage while building long-term resilience through improved natural disaster response, domestic resource mobilization, health system durability, and technical support for project implementation. The Sindh Resilience Project also aims to add disaster preparedness upgrades to the new Sindh Integrated Emergency and Health Services, an innovative organization combining EMS with a free health hotline and other services developed in partnership with the World Bank.<sup>140,141</sup>

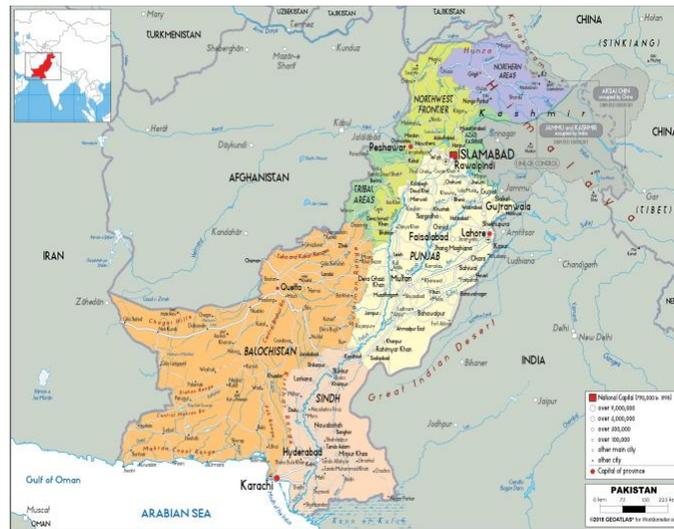
#### *USAID and Pakistan*

USAID work continues a 75-year-long health and development sector relationship between the US and Pakistan. Of note, the long-running Field Epidemiology Laboratory Training Program (FELTP) – now transferred to Pakistani control – was developed in partnership with USAID and other US agencies. FELTP was first on the scene during the COVID-19 pandemic, and has dramatically improved Pakistan's outbreak response and field epidemiology capabilities since 2006.<sup>142</sup> During a July 2022 bilateral Health Dialogue between the two countries, a potential extension of this relationship involving the establishment of a Pakistan CDC was discussed.<sup>143</sup>

USAID has contributed nearly US\$7.7 billion to Pakistan in the last ten years, with much of that funding aimed at improve private sector growth and infectious disease prevention, surveillance and response.<sup>144</sup> In October 2022, USAID announced US\$30 million in flood relief for Pakistan, bringing that year's donations to a total of US\$97 million (the largest of any single donor organization).<sup>145</sup> While USAID has no current ongoing projects related to health in Pakistan, they recently completed a 2020 District Health Survey and a Maternal and Child Health program.<sup>146</sup> In general, USAID's Pakistan program prioritizes peacebuilding, youth and female workforce opportunity development, national and provincial government stability and capacity, and global health security.<sup>144</sup>

# Tables and Figures

**Figure 1. Political map of Pakistan, showing Sindh, Balochistan, and Punjab Provinces with Khyber Pakhtunkhwa divided into its different regions.**



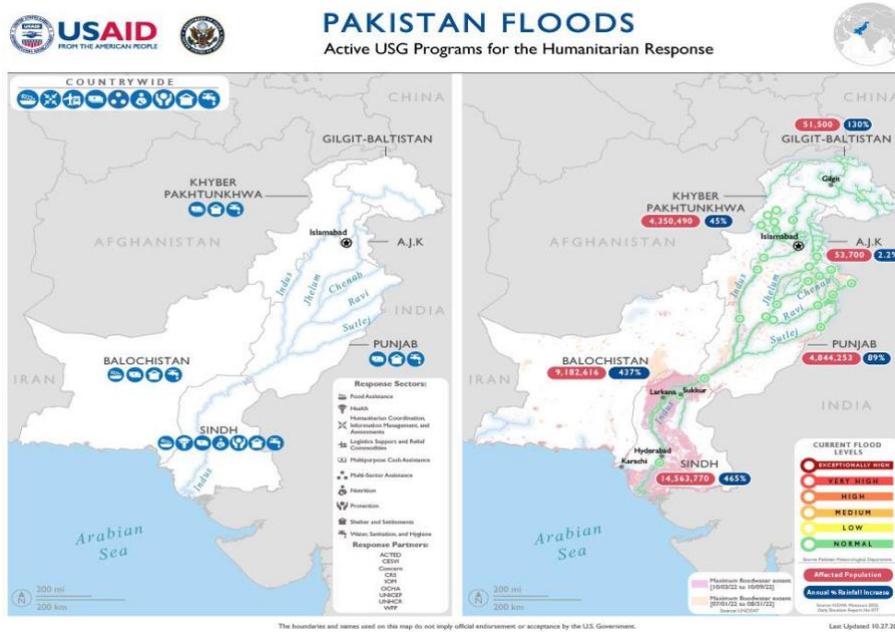
Source: Worldometer<sup>147</sup>

**Figure 2. Physical map of Pakistan, showing the Indus River Valley, the Himalayan Mountains, and the western high desert.**



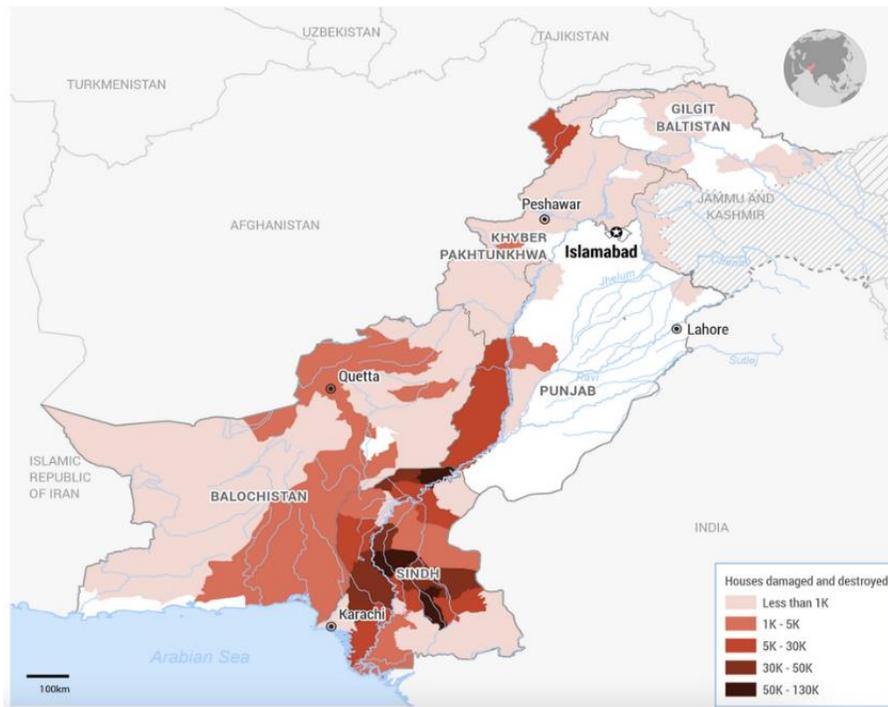
Source: Worldometer<sup>147</sup>

**Figure 3. Map displaying US government projects deployed to different flood-affected areas in Pakistan, current risk levels, and activity types.**



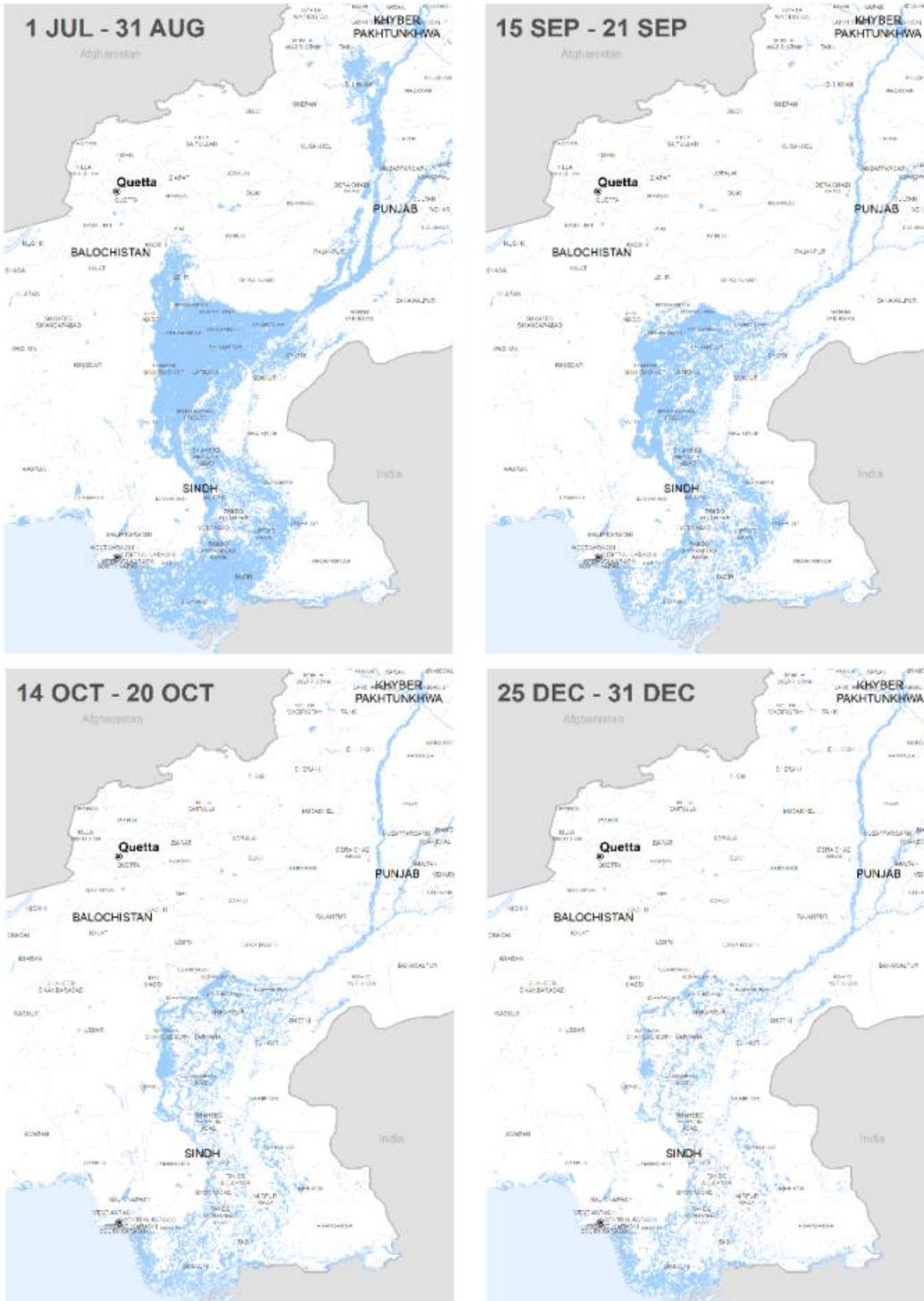
Source: USAID<sup>148</sup>

**Figure 4. Map displaying regional flood damage to homes in Pakistan by district, as of October 2022.**



Source: WHO<sup>139</sup>

**Figure 5. Map displaying flood water extent and recessions between July and December, 2022 in Sindh.**



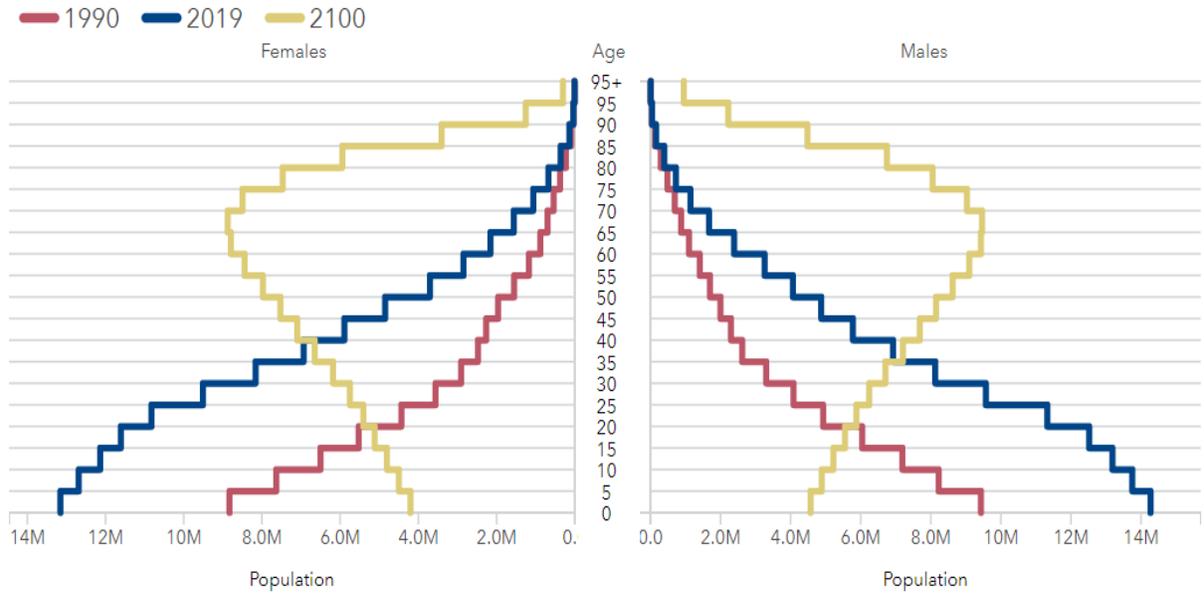
Source: UN OCHA<sup>135</sup>

**Table 2. Leading population health conditions for Pakistan and Sindh by percent total mortality, 2019.**

<b>Metric</b>	<b>Condition</b>	<b>National</b>	<b>Sindh Province</b>
<b>Disability-Adjusted Life Years (DALYs)</b>	<i>Neonatal Disorders</i>	24.3%	23.5%
	<i>Cardiovascular Diseases and Stroke</i>	10.5%	9.7%
	<i>Cancers</i>	6.7%	6.0%
	<i>Lower Respiratory Infections and TB</i>	9.0%	8.2%
	<i>Typhoid, Paratyphoid, Salmonella</i>	1.9%	4.5%
	<i>Diarrheal Diseases (Other)</i>	4.9%	4.4%
	<i>Malnutrition and Vitamin Deficiencies</i>	3.4%	3.9%
<b>Mortality Rate (overall)</b>	<i>Neonatal Disorders</i>	16.7%	16.9%
	<i>Cardiovascular Diseases and Stroke</i>	22.7%	21.5%
	<i>Cancers</i>	12.0%	11.4%
	<i>Lower Respiratory Infections and TB</i>	9.2%	8.4%
	<i>Typhoid, Paratyphoid, Salmonella</i>	1.6%	4.1%
	<i>Diarrheal Diseases (Other)</i>	5.1%	4.2%
	<i>Malnutrition and Vitamin Deficiencies</i>	0.97%	0.99%
<b>Mortality Rate (under 5 years of age)</b>	<i>Neonatal Disorders</i>	59.5%	59.2%
	<i>Lower Respiratory Infections and TB</i>	13.7%	13.5%
	<i>Typhoid, Paratyphoid, Salmonella</i>	1.0%	2.3%
	<i>Diarrheal Diseases (Other)</i>	7.7%	8.3%
	<i>Other Infectious Causes</i>	3.7%	6.4%
	<i>Malnutrition and Vitamin Deficiencies</i>	1.8%	1.2%

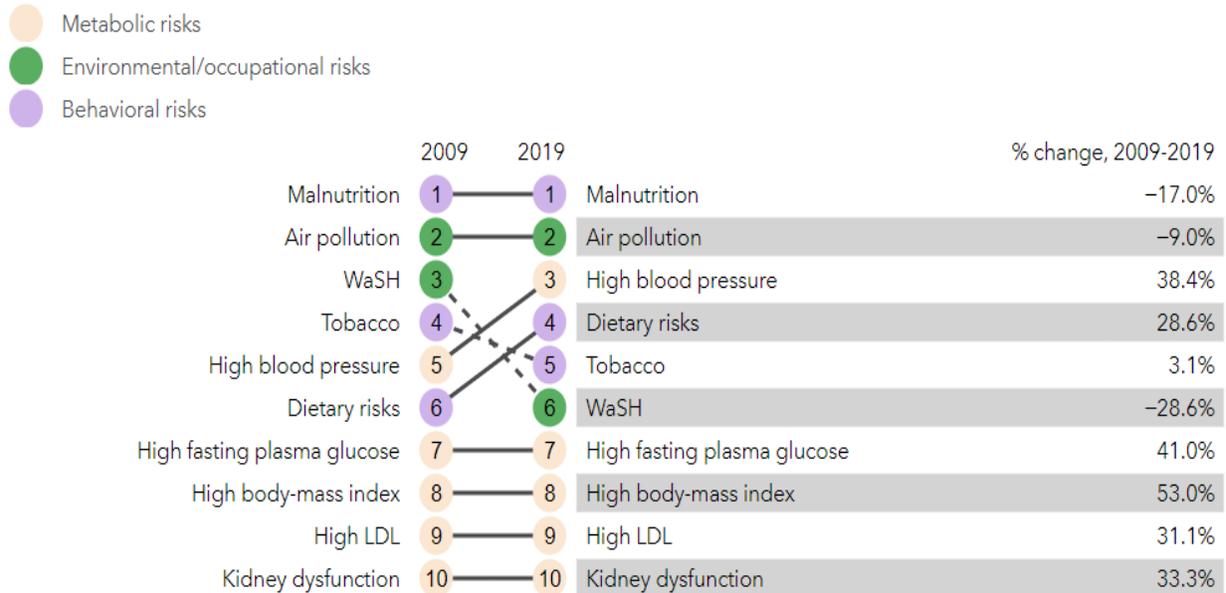
Source: Institute for Health Metrics and Evaluation<sup>25</sup>

Figure 6. Population age structure in Pakistan for males and females in 1990 and 2019, with projection to 2100.



Source: Institute for Health Metrics and Evaluation<sup>82,149</sup>

Figure 7: Top 10 risk factors contributing to total disability-adjusted life years lost in 2019 for Pakistan with percent change 2009-2019, all ages combined.



Source: Institute for Health Metrics and Evaluation<sup>82,89</sup>

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