Policy brief
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Weather shocks and health in Dar es Salaam

In brief

- Climate change is making extreme weather events more frequent around the world. Evidence suggests that extreme weather can affect health. Urban residents in developing countries are particularly vulnerable to weather shocks due to poor sanitation and infrastructure.
- Research suggests that extreme weather can impact health in two ways: (1) Direct mechanisms, that is by increasing the chance that urban residents come into contact with pathogens, for example through stagnant water; (2) Indirect mechanisms, as extreme weather can reduce residents' ability to work, lowering their income, thus increasing the risk of negative health outcomes.
- Analysis of a unique high-frequency dataset of weekly cholera cases and accumulated rain for wards in Dar es Salaam shows that there is an association between weather and cholera cases in the city.
- The analysis finds strong evidence that extreme rainfall increases weekly cholera incidence. The effect is larger in wards that are more prone to flooding, have higher shares of informal housing and unpaved roads.
- This provides further evidence that policy makers should invest in making cities resilient, by (1) investing in urban infrastructure such as roads and informal housing; (2) introducing urban WASH interventions; and (3) considering social safety nets, which help undercut some of the indirect mechanisms through which extreme weather impacts health.

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Challenges of weather shocks in a rapidly urbanising world

Climate change will have a significant impact on the lives of the poor in the years ahead as extreme weather events such as floods, heavy precipitation and droughts are expected to become more frequent. As cities in sub-Saharan Africa (SSA) continue to urbanise at an unprecedented pace, the question of how their urban dwellers are impacted by extreme weather such as heavy rain fall is becoming increasingly relevant. The World Bank (2016) estimates that climate change could push up to 77 million more urban residents into poverty by 2030. While city dwellers may seem better prepared against weather extremes than their rural counterparts, rapid urbanisation has often resulted in poor infrastructure, limited public service provision, and informality, which leaves residents vulnerable to weather variability.

This policy brief discusses the results and policy implications of research looking at the effect of rainfall and flooding on cholera incidence in Dar es Salaam. This question is examined in the context of a cholera outbreak in Dar es Salaam in 2015 and 2016, during which almost five thousand cases were recorded. Looking at health outcomes is important as contagion is one "downside of density" (Glaeser & Sims 2015) in urban areas. Poor health and disease not only lower productivity in the short-term, they also hinder long-term economic growth (Well 2007).

Figure 1: Flooding due to heavy rain in Dar es Salaam

Image credit: Daniel Hayduk/Stringer/Getty

Background: Dar es Salaam and cholera

Dar es Salaam is one of the largest and fasted growing cities in eastern Africa, with a population well over 4.4 million. As such, it faces many challenges. The rapid pace of urbansation has resulted in large infrastructure deficits. Close to 70% of Dar es Salaam's residents live in informal settlements without adequate access to clean water, proper drainage system and waste collection. Only 37% of the solid waste is properly collected, and only 50% of residents have access to improved sanitation (World Bank 2017). Dar es Salaam's geography and coastal location make it vulnerable to climatic hazards. In particular, floods are a significant economic and health risk, exposing residents to hazards like vector-borne diseases such as malaria and cholera that thrive in stagnant water.

Cholera is an acute diarrhoeal infection caused by the ingestion of food or water contaminated with the bacterium vibrio cholera. It can affect both children and adults and can kill within hours if left untreated. According to the WHO, roughly 1.3 to 4.0 million cases are recorded worldwide every year. Cholera has been endemic in Tanzania since the 1970s and Dar es Salaam has historically been the most affected region. During the 2015-2016 outbreak, more than one fifth of the nationally recorded 24,000 cases occurred in Dar es Salaam.

How can weather shocks affect health in urban areas?

Extreme weather can affect human health in two ways (Burgess et al. 2017).

The first are direct mechanisms. In the case considered here, heavy rainfall can increase surface runoff from point sources (pit-latrines, waste dump site) which may cause increased contamination of water sources. Stagnation and slow flowing of waterways may lead to increased exposure to pathogens. Heavy rainfall and flooding have all been associated with a higher likelihood of exposure to the cholera vibrio (Osei et al. 2010). Poor infrastructure amplifies the likelihood of flooding thus increasing the impact of rainfall through direct mechanisms.

The second channel are indirect mechanisms. Extreme weather may negatively impact income which then has a negative impact on health. For instance, flooding and heavy rainfall may significantly affect work-places and accessibility to jobs particularly if road infrastructure is poor. Lower incomes can then lead to the reduced consumption of healthier goods such as clean water and fresh food, and thus increase the risk of exposure to the bacteria and illness. Behavioural changes during periods of weather shocks may also increase the probability of contagion (WHO).

Empirical setting and data: Causal estimates

This analysis is based on a high-frequency panel dataset containing weekly information on cholera incidence and accumulated precipitation for all wards of Dar es Salaam from the first week of March 2015 to the first week of September 2016. It covers positive cholera cases in Dar es Salaam for the last cholera outbreak. Ward features were also included in the analysis (including data from the work of NGO Dar Ramani Huria). This detailed data enables us to accurately test the impact of rainfall on cholera occurrence. In particular, observing the same ward over time while the rate of rain varies, allows us to isolate the impact of rain and flooding on cholera, removing potential unobserved factors contributing to cholera incidence at the ward-level.

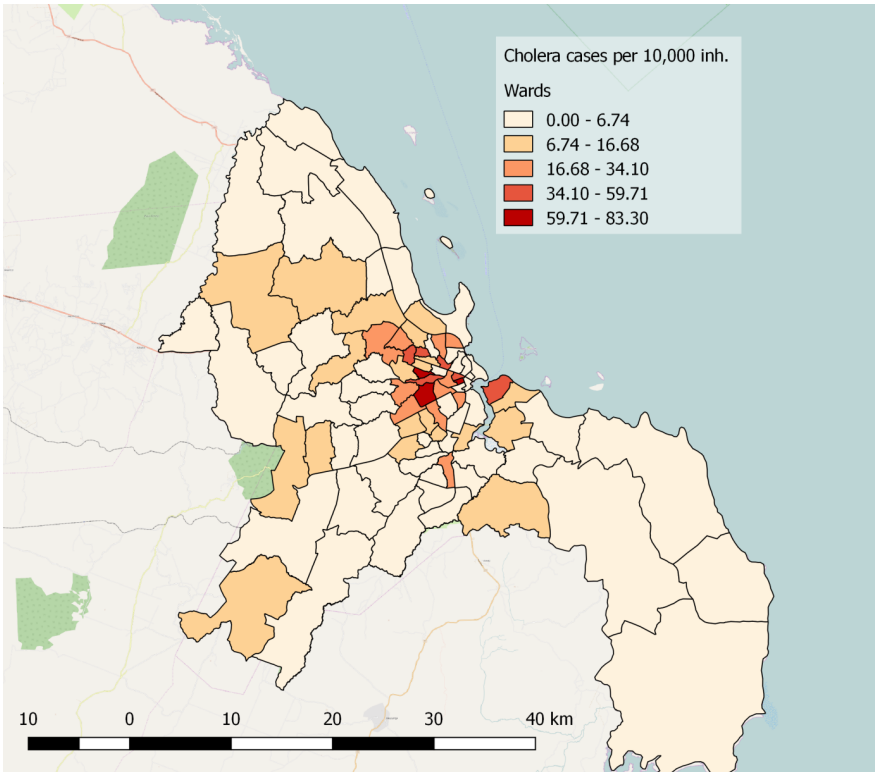
Main findings: Cholera, rainfall, floods & infrastructure

There are four key findings in this study:

1. Heavy rainfall has a strong positive effect on weekly cholera occurrence within wards of Dar es Salaam. On average, a 10 mm increase in total weekly rain leads to an increase of up to 3.5% of weekly recorded cholera cases. Extreme rainfall has an even larger impact: a single additional week of heavy rainfall[1], increases the number of effective cholera cases by up to 20.3% relative to a week with very light rain. The impact of heavy rain is even higher in wards with a higher risk of flooding.
2. Weekly rainfall has a larger positive impact on cholera cases in wards with larger shares of informal housing and a higher density of footways (i.e. informal roads). Informal settlements are usually located in flood-prone areas. They suffer from poor quality infrastructure and deprived water and sanitation conditions. Vulnerable populations residing in these wards are also more likely to suffer from negative income shocks during extreme weather events.
3. The impact of rain on cholera is relatively localised, as there are little to no spillovers from rainfall in one ward to cholera cases in neighbouring wards. Only when considering the relative elevation there is a small effect. Rain in a lower elevation ward has a small impact on cholera cases in neighbouring wards. This could be explained by water source contamination.
4. 10 mm of cumulated rainfall increases the number of cholera cases immediately, and for up to 5 weeks. That is, six-week cumulated rainfall increases current cholera incidence in a ward by up to 12%, and six-week cumulated extreme rainfall by 37% more than the same period with light rain. Though rainfall has a higher impact in the immediate week.

1. Defined as total weekly rainfall falling above the 75th percentile of the total rainfall distribution.

Figure 2: Total Cholera cases per 10,000 inhabitants during 2015-16 Outbreak



Building resilience to tackle epidemics: Policy lessons

The evidence reported here suggests that rainfall, particularly heavy rainfall, is linked with negative health outcomes, with a stronger effect in informal areas with limited infrastructure. Consequently, we believe that investing in making cities more resilient is important in order to reduce the risk of negative health effects from extreme weather.

Urban resilience has many definitions. Generally, a resilient city has the ability to manage and withstand a wide range of shocks and stresses which may occur (World Bank 2016). In particular as urban poverty is increasing, urban resilience is key for reducing the risks arising from infectious diseases. In 2014, the African Development Bank estimated that Dar-es-Salaam was expected to grow by 85% by 2025. This rapid growth will put additional pressure on the urban and land use planning system, and remedial measures are key to ensure that the city is resilient to extreme weather. The following interventions should be considered.

1. Investing in resilient infrastructure

Cities in developing countries need to address infrastructure gaps to contain the risk of recurrent epidemic outbreaks in fragile environments.

Policies should consider not only improving the quality of local infrastructures such as the pavement of informal roads, but address the problem of informal housing. Investing in resilient housing (including retrofitting when possible), as well as the proper servicing of informal areas (with sewerages connections), is central. The World Bank finds that reconstructing after a disaster costs 4 times more than prevention costs (Triveno 2017). Addressing regulatory gaps, for instance by regulating illegal waste dumping, together with its proper enforcement, is also important.

2. Water & sanitation

A large empirical literature in public health has shown that water and sanitation (WASH) interventions reduce the risk of cholera contagion and other water borne diseases. There are available climate-resilient WASH interventions that prevent environmental shocks from translating into significant health hazards (WHO 2009).

3. Social safety nets

Considering the indirect mechanisms through which weather shocks can impact health is also important. Governments can reduce adverse shocks by supporting households with subsidised health goods or direct transfers in periods of outbreaks. There is a greater role to be played for social safety nets in urban areas (Gentilini 2015). J-PAL Urban Service Initiative, for instance, aims at identifying and rigorously evaluating innovative methods to improve the welfare of the urban poor.

Achieving resilient cities requires a complete approach that incorporates the different channels through which weather hazards impact urban residents, particularly poor urban dwellers. Financing constraints remain a major limitation. These investments are expensive for cities in the developing world that struggle to raise resources even to fund the ongoing provision of public services. More and better evidence concerning large-scale policy interventions in urban areas are needed so that authorities can properly decide areas to prioritise. Further empirical understanding on how to increase resilience and prevent contagion of treatable diseases in developing cities will be crucial if these are to become engines of growth.

Further reading

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