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The costs of climate change adaptation in middle-income countries

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Question

- *What evidence is there that middle-income countries need to invest more than they currently do in climate change adaptation?*
- *What are the main likely human and economic costs if middle-income countries fail to do so considering how poor and vulnerable groups are affected?*

Contents

1. Summary

While potential costs and tracked spending on adaptation to climate change in middle-income countries (MICs) are difficult to measure, there is wide agreement that current spending on adaption is highly inadequate (Buchner et al, 2019; PCC, 2018; UNEP, 2016; Yeo, 2019). Climate finance has been increasing, both from domestic sources and through international transfers, but spending on climate change mitigation through renewable energy, energy efficiency and sustainable transport makes up the vast majority of investments (Buchner et al., 2019; Yeo, 2019). Given that MICs are predicted to be among the most vulnerable to future climate shocks and also to high poverty rates (Shepherd et al, 2013), it will be critical to fill this financing gap in order to address these vulnerabilities. There is great interest in leveraging public finance to increase private sector investments in adaptation in MICs but, so far, private investment in adaptation investment has been minimal (Buchner et al, 2019; Yeo, 2019).

This report begins with a summary of available estimates of climate adaption finance needs and tracked spending in MICs. Due to data and standardisation limitations, it is not possible to accurately measure total costs for adaptation in MICs, therefore this report goes on to briefly explore some of the potential human and economic costs of failing to invest. Evidence limitations also means that it is not possible to determine the most effective adaptation finance modalities for MICs, therefore this report concludes with a short overview of cross-cutting themes that are widely discussed in the literature with some support from empirical evidence.

Overall, evidence on the costs of adaptation and tracked spending across possible sources of funding is minimal. This is a well-known challenge, with ongoing debate as to how to resolve the issue going forwards. Initiatives to address evidence gaps on finance for adaptation include the OECD's tracking of climate finance flows under the Development Assistance Committee (DAC) and The Climate Policy Initiative's regular Global 'Landscape of Climate Finance' Report. Empirical evidence is particularly lacking on the effectiveness of different finance modalities for adaptation. No comprehensive studies were identified for this report, only early summary evidence of ongoing climate funds such as the Adaptation Fund established under the Kyoto Protocol (see: Manuamorn et al., 2020).

Despite these limitations, three cross-cutting themes have been identified that are either partly supported by empirical evidence or are widely supported by leading institutions or climate finance experts. These are:

- International public finance for adaptation through bilateral or multilateral institutions is more effective when accompanied by complimentary non-financial support such as research, training and supportive trade policy.
- Although many look to the private sector as being key to filling the adaptation finance gap, so far very little private finance has been mobilised for climate adaptation. It may be that the profit motives of the private sector are incompatible with adaptation's focus on cost savings.
- There is emerging evidence that decentralised spending to support local adaptation programming can provide good value for money. Empowering local communities to engage directly in climate adaptation programming is considered to be an effective way to address specific adaptation needs and to ensure the inclusion of marginalised groups who are disproportionately impacted by climate change.

2. Estimated costs of climate finance in MICs

Estimating Total Costs

The estimated total costs of adaptation in low- and middle income countries (LICs and MICs) range between USD 140 billion to USD 300 billion by 2030, and between USD 280 billion and USD 500 billion by 2050 (UNEP, 2016, p.xii). No systematic country-level estimates are available to distinguish climate adaptation costs between MICs and LICs. One estimate that allows disaggregation by region comes from a 2010 World Bank synthesis report drawing on national databases and sub-national data. Of the USD 70-100 billion per year that the report estimates will be required globally to adapt to a global temperature change of 2°C, costs are predicted to be highest in East Asia and the Pacific (USD 25.7 billion), followed by Latin America and the Caribbean (USD 21.3 billion) and sub-Saharan Africa and South Asia (both estimated at USD 17.1 billion) (World Bank, 2010, p.xix[1]).

The wide variability in global and regional estimated costs of climate adaptation is due to a number of data and standardisation limitations (IPCC, 2018; Micale et al., 2018; UNEP, 2016; UNFCC, 2007). Some of the difficulties in estimating accurate costs for climate adaptation include:

- The use of different projected global temperature changes to estimate the impacts of climate change;
- The inclusion of different human and economic impacts to estimate costs;
- Different assumptions about the relationship between climate change and human and economic outcomes and about countries' adaptive capacities to manage them;
- Different assumptions about the economic value of these outcomes;
- Whether estimates should include the compounding effect of failing to address current climate adaptation needs.

A lack of clarity on the complex relationship between climate change and human, and economic outcomes appears to be the leading challenge for estimating the costs of adaptation. The range of possible impacts is vast, with different priorities, assumptions and availability of data leading to different calculations of adaptation costs.

> "Studies with greater coverage will produce higher estimates, as they include a larger number of impacts. Comprehensive studies at the national level… identify several hundred potential risks and opportunities from climate change. Nonetheless, most quantitative studies focus on a subset of the most important of these, mainly due to the complexity associated with quantifying and monetising impacts."
>
> (UNEP, 2016, p.14)

Few estimates offer disaggregated costs by sector, however adaptation costs for infrastructure, particularly in urban areas, are expected to pose some of the highest costs for adaptation (World Bank, 2010). Infrastructure that may be impacted includes: public

[1] These estimates reflect gross costs (not including gains) in the report's 'wet scenario' where costs are estimated to be higher than in the 'dry scenario'.

buildings, railways, roads, and drainage. The World Bank's 2010 report estimates urban infrastructure will make up just over half of all infrastructure costs and that these are likely to be highest in East Asia and the Pacific (p. xx).

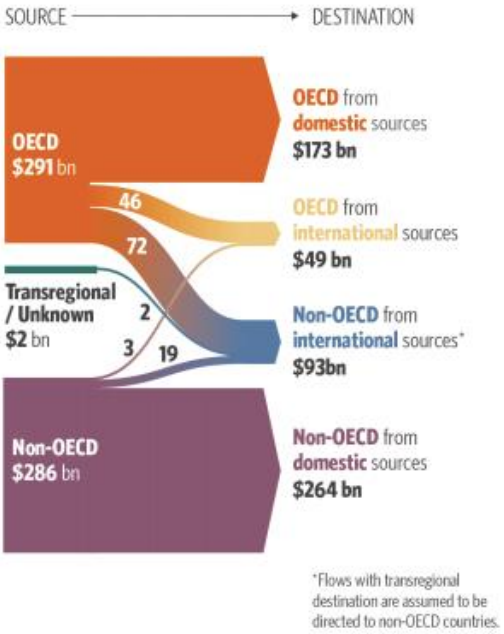
Trends in adaptation finance

Finance committed to climate change adaptation makes up a very small proportion of total climate finance spending. Buchner et al. (2019) estimate that finance for adaption made up just 5% of total climate finance flows in 2017/2018 and a further 2.1% was estimated to be of 'dual benefit' for both adaptation and mitigation. The vast majority of climate finance (93%) has been allocated to climate mitigation. Buchner et al. (2019) also note that the proportion of climate finance dedicated to adaptation has not changed from 2015/2016, but that 'dual benefit' flows have increased from 1.2% over the two-year period.

"**Adaptation finance gained momentum in 2017/2018, increasing 35% to an annual average of USD 30 billion from USD 22 billion in 2015/2016**" (Buchner et al, 2019, p.21). While this recent increase is indicative of a positive shift in adaptation finance, the current value of investments remains far short of estimated adaptation costs and existing finance commitments (UNEP, 2018). As with total costs, estimates of tracked spending on climate adaptation vary widely due to the same definitional constraints noted above. Distinguishing spending on adaption from spending on mitigation and broader development programming present further definitional challenges (Buchner et al., 2019, p.21).

Most climate finance remains in the country of origin (figure 1). Buchner et al. (2019) identify a "domestic preference" for investments, with 76% of tracked climate finance being invested in the country in which the finance is sourced. They also show that climate finance is balanced between investments in OECD and non-OECD countries. While the authors conclude that this indicates a "balanced awareness between developed and developing countries regarding the need to scale up climate investments", it is important to note that the impacts of climate change are expected to be greater in LICs and MICs (see figure 2).

Figure 1: Climate Finance flows by OECD status of source and destination (USD, 2017/2018 average)

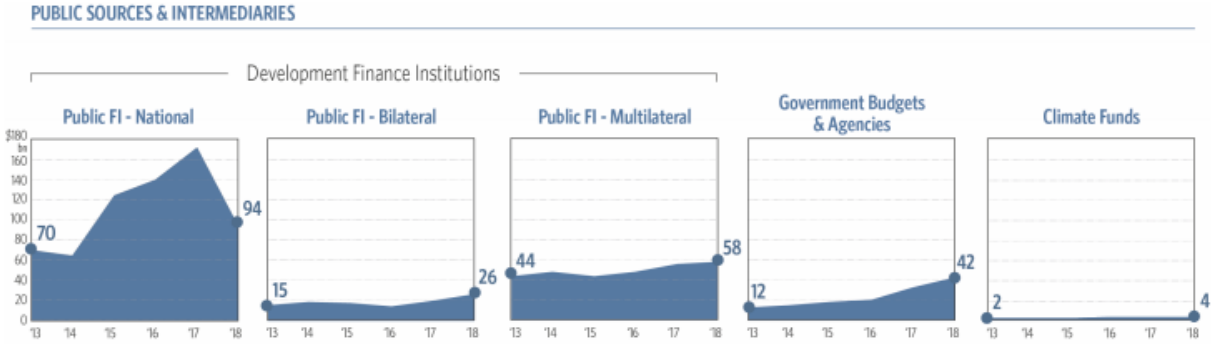


Source: Buchner et al (2019, p 24), licensed under Creative Common License, https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/2019-Global-Landscape-of-Climate-Finance.pdf

See: Figure 2: Predicted climate variability by GDP per capita and geographic region, Economist (2018), referring to data from Bathiany, Dakos, Scheffer & Lention (2018), https://www.economist.com/graphic-detail/2018/05/09/climate-change-will-affect-developing-countries-more-than-rich-ones

Nearly all investment in adaptation comes from public spending and the majority (79%) comes from national development finance institutions (Buchner et al., 2019, p.21). Figure 3 shows a breakdown of tracked climate finance by type of public institution. Public finance for adaptation has been concentrated in a small number of sectors, with the water sector making up the largest share of investments (Buchner et al, 2019). Latest estimates show a balancing out of investment across sectors however, with 32% spent on water and wastewater management, 24% on agriculture and land use, and 22% spent on disaster risk management (Buchner et al., 2019, p.22). Increases in investments have been particularly strong for adaptation in the agricultural, forestry and land use sector (Buchner et al., 2019).

Figure 3: Public source and intermediaries of climate finance (USD billion)



Source: Buchner et al. (2019, p.11), licensed under Creative Common License, https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/2019-Global-Landscape-of-Climate-Finance.pdf

Overseas Development Assistance (ODA), bilateral development finance and multilateral development finance are leading sources of international investment in adaption in LICs and MICs (Buchner et al., 2019; UNEP, 2016). While two thirds of ODA has been in the form of grants, the majority of international finance through bilateral and multilateral development finance institutions has been through low-cost or market-rate loans (see Table 1).

Table 1: Adaptation finance sources and instruments

Sources	Main instrument (share of total)
Official Development Assistance	Grants (66%) and loans (32%)
Bilateral development finance institutions	Low-cost loans (80%)
Multilateral development finance institutions	Market-rate loans (84%)

Source: UNEP (2016, p. 25), https://unepdtu.org/publications/the-adaptation-finance-gap-report/

Private investors, which many argue are critical to meeting the costs of climate adaptation, make up a small proportion of tracked adaptation spending (Buchner et al., 2019). Private investors may include: corporations, households, commercial financial institutions (i.e. providers of private debt capital), institutional investors (i.e. insurance companies, asset management firms, pension funds, foundations, endowments), private equity, venture capital and infrastructure funds (Climate Policy Initiative, 2019). The same challenges for estimation discussed above apply with the added challenge that many private investors do so in response to immediate threats rather than explicitly linking investments to adaptation (UNEP, 2016). Section 4 explores some of the challenges in leveraging private finance for adaptation.

3. Overview of human and economic costs of failing to invest in climate adaptation

The following section explores a set of human and economic costs related to climate change that are highlighted in the literature as critical areas for investment in climate adaptation: poverty and livelihoods, food security, and health. This does not represent a comprehensive list of potential human and economic costs but is rather intended to provide a short introduction to some of the leading issues being confronted in MICs that will require investment for the purpose of climate adaptation. References to priority countries for the UK Cross-Government Prosperity Fund[2] are presented where possible.

Poverty and livelihoods

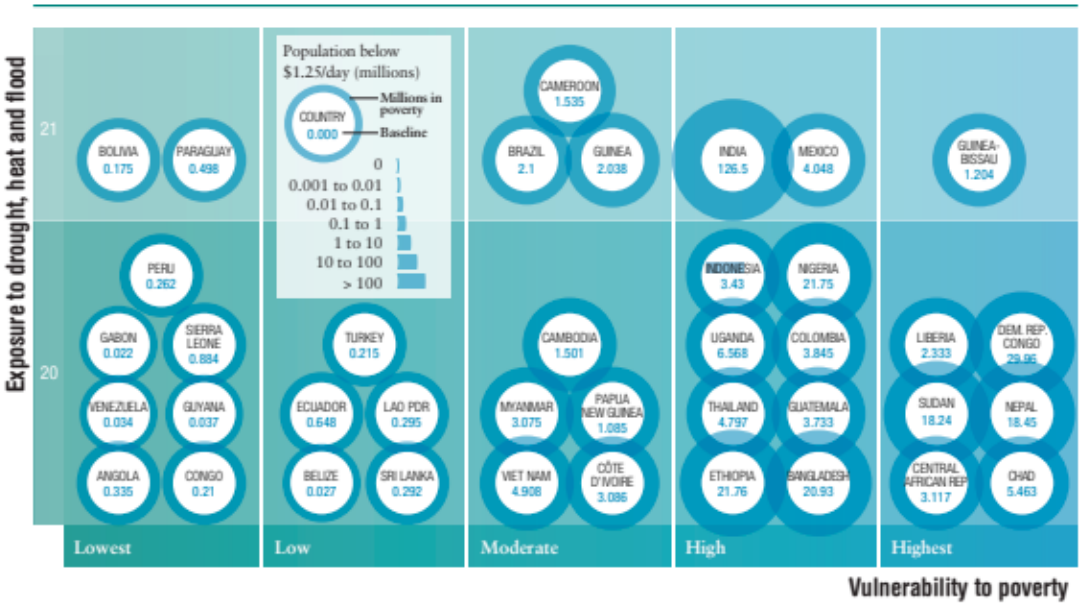
"Climate-related shocks and stresses, already a major obstacle to poverty reduction, will worsen with climate change" (IPCC, 2018, p.6). Examples of climate shocks and stresses that have had measurable impacts on poverty in MICs include:

- Excessive rainfall and monsoons in Thailand in 2011 led to severe livelihoods losses, particularly for the urban poor, tree crop farmers and agricultural labourers (World Bank, 2012).
- Disproportionate impacts on poor residents of recent water shortages in Cape Town, South Africa and Chennai, India that nearly led to 'Day Zero' (no municipal water access) (Trivedi & Chertock, 2019).
- Increased flooding in Bago city, Myanmar, has been shown to have a two-way relationship with poverty: poor people tend to live in flood-prone areas and flooding is found to exacerbate poverty (Kawasaki et al., 2020).

MICs are projected to be some of the most affected by climate variability while also maintaining high rates of poverty, which climate change is expected to exacerbate. A study by Shepherd et al. (2013) explores countries' combined vulnerability to future climate extremes such as droughts, extreme heat and floods and future vulnerability to poverty. MICs, including India, Mexico, Indonesia, Nigeria, Colombia, Thailand, Guatemala and Bangladesh, make up the majority of countries found to be in the 'high vulnerability' category based on their global assessment of combined future climate and poverty vulnerability (see figure 4).

[2] "The Prosperity Fund aims to support the inclusive economic growth needed to reduce poverty in partner countries. Through its primary purpose, the Fund's activities will contribute to achieving the UN Sustainable Development Goals". (GOV.UK, 2015).

Figure 4: Projected poverty levels in 2030 in countries with the highest exposure to droughts, extreme heat and floods



NOTE: The figure shows a set of countries with the highest exposure to the three hazards in 2030, plotted against their 'vulnerability to poverty', which is a measure of the risk they face of future poverty when presented with shocks, such as 'natural' disasters (see Chapter 2). The circles indicate projected poverty numbers for each of the countries in 2030 assuming a baseline projection. These countries differ from figure A as it features just the countries particularly exposed to the three hazards rather than the full list of five hazards included in figure A.

Source: Shepherd et al. (2013, p. ix), licensed under a Creative Commons Attribution-NonCommercial Licence (CC BY-NC 3.0), https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8633.pdf

The impacts of climate change are likely to be disproportionately felt by groups that already experience marginalisation, **further exacerbating poverty among these groups**. "People who are socially, economically, culturally, politically, institutionally, or otherwise marginalized are especially vulnerable to climate change and also to some adaptation and mitigation responses (IPCC, 2018, p.6).

Food security

A review of studies quantifying the impacts of climate change on food security found that undernourishment is predicted to rise by 5-26% in 2080, or between 5-10 million and 120-170 million people, as a result of climate change (Schmidhuber & Tubiello, 2007). Most models predict sub-Saharan Africa will account for a larger share of global food insecurity (up to 50%), though the authors note that this is only partly due to climate change, and more so the result of related social and economic development (Schmidhuber & Tubiello, 2007). One study by the FAO, modelling the impacts of climate change on crop yields with and without adaptation, found that some MICs could see significant yield losses if adaption is not achieved. The study found that crop yields could decrease by 38%-51% in Brazil, 28%-54% in Egypt, 38%-56% in India without adaptation measures (Fischer et al., 1996).

Climate change has already negatively impacted food security in many regions due to increasing temperatures, changing precipitation patterns and greater frequency of extreme events, particularly in Africa, Asia and South America (IPCC, 2019, p.439). These impacts are expected to worsen, with unpredictable crop production expected to affect rural households dependent on agriculture and increasing urban households' vulnerability to food

price shocks. (IPCC, 2019; Benzie & John, 2015). The World Bank (2010) study on estimated costs for adaptation found that LICs and MICs are predicted to have the largest negative impact on crop production, particularly South Asia, and that changing trade patterns as a result of climate change are expected to have a compounding effect on food security. Recent impacts of climate change on food security in MICs include:

- Prolonged drought in the Horn of Africa is currently threatening the food security of around 12 million people (ACAPS, 2019).
- The 2009 typhoon in the Philippines affected over 9.3 million people and is estimated to have led to USD 3.2 billion in losses and damages to the agricultural sector (Shepherd et al., 2013).
- Poor households that spend a high proportion of their income on food were highly impacted by the food price shock of 2007-2009 to which climate change was a contributing factor. The countries most impacted included poor net food importing countries as well as the urban poor in MICs (Compton et al., 2009).

Health

Climate change is predicted to cause an additional 250,000 deaths per year between 2030 and 2050 due to malnutrition, malaria, diarrhoea and heat stress (WHO, 2018). “The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion per year by 2030” (WHO, 2018). Adaptation costs are predicted to be highest in countries with weak health infrastructure, particularly in sub-Saharan Africa which is estimated to account for 80% of health sector adaptation costs by 2050 (World Bank, 2010, p.xii).

The impacts of climate change on health, both historical and projected, is one of the more advanced areas of research based on the scoping conducted for this report. Health implications from climate change in middle income countries include:

- A study on the health effects of climate change on children in Mexico found that diseases linked to climate change (diarrhoea and lower respiratory infections) are the leading cause of mortality among children aged 5-14 years old (Riojas-Rodríguez et al., 2018).
- An analysis of national mortality and temperature data in South Africa over 17 years found that temperature-related mortality (from cold or hot spells) accounts for 3.4% of deaths in in the country. (Chersich et al., 2018).
- An excess of 25,800-37,800 heat-related deaths per year have been predicted in Chinese cities between 2014-2060 (Chan et al., 2019).

4. Strategies to fill the adaptation funding gap

There are a range of direct financing and complimentary programming strategies that have been recommended in the literature to fill the climate adaptation financing gap, but the empirical evidence base to support these recommendations is very limited. The World Resource Institute (n.d.) notes that most adaption finance research is concerned with tracking flows to specific projects to monitor efforts to meet global adaptation funding targets, leaving research on adaptation financing modalities largely unexamined. This final section briefly

explores some cross-cutting themes that are discussed in the climate adaptation finance literature that speak to broad strategies to fill the adaptation funding gap: finance+ complimentary programming, leveraging private finance and decentralised spending for local impact.

Finance+ complimentary programming

The UNFCC (2007) include a useful list of complementary finance and programming strategies for donors to consider when assisting LICs and MICs to leverage additional finance and capacity to adapt to climate change:

- **Research**: funding domestic government research organisations, international research organisations, universities, or research-oriented NGOs to improve adaptation strategies;
- **Extension and training**: funding for rural training and extension programmes to disseminate adaptation options;
- **Transitional assistance**: identifying resources for creating job opportunities, supporting incomes, developing new infrastructure/institutions, relocating industry, providing temporary food aid, improving market functions and developing insurance;
- **Trade policy**: Governments may need to revise trade policies to adapt to new climate change conditions to allow imports and exports to mitigate lost production or to sell or dispose of surpluses;
- **Infrastructure development**: support public investment in new transport and municipal infrastructure, development of new lands, protection or improvements of existing lands, construction of irrigation and water control structures, protection of coastal resources, and incubation of new industries.

Leveraging private finance

It is estimated that there are around USD 23 trillion in opportunities for 'climate smart' investments in emerging markets up to 2030, however private investment in adaption has so far been minimal (Buchner et al., 2019; Ellis & Pillay, 2018) Ellie & Pillay (2018) argue that private financial interests and the nature of climate projects do not currently align:

> "The fundamental challenge is that the private sector is more likely to invest in mitigation than adaptation projects, as these typically have short-term quantifiable benefits attached to them. This is a big issue for unlocking private climate finance for much needed adaptation interventions in many developing countries, as the lack of simple revenue streams, and therefore returns, make these investments riskier."
>
> (Ellis & Pillay, 2018, p.4)

Widely cited barriers to private investment that need to be addressed include "poor legal, economic and regulatory frameworks, immature financial markets, and currency exchange risks, … the cost saving nature of adaptation investment, which contrasts with the revenue-creation of the private sector, or other social and cultural barriers." (UNEP, 2016, p.xiv).

While it is often suggested that private finance is needed to fill the adaptation funding gap, some emphasise the critical role of the public sector in managing climate adaptation to ensure inclusive and effective strategies are adopted. Buchner et al. (2019, p.6) suggest that:

> “governments have the unique opportunity to drive ambition and increase climate finance by explicitly adjusting the mandates of national institutions and of development banks… Public financial institutions must focus on the effectiveness and impact of climate investments in order to maximize value per dollar and ensure that public finance is used as a lever for transformative change.”

UNEP (2016, p.xii) also argue that:

> “dedicated climate funds help break down barriers to investment in adaptation projects in developing countries … by strengthening the capacities of local stakeholders, creating incentives for institutions and investors (for example, by offering concessional terms) and, ultimately, by taking on risks from which commercial financiers will typically shy away”.

Decentralised spending for local impact

The majority of adaptation finance is directed towards national-level initiatives. However, there is emerging evidence that decentralised finance can provide good value for money (Chan & Amerasinghe, n.d.; Manuamorn et al., 2020; Soanes et al., 2017). Soanes et al., (2017) estimate that only 10% of climate finance was directed to local projects between 2003 and 2016. They note that in contrast to overall climate finance trends, around half of these local projects were aimed at adaptation and half towards mitigation.

The participation of affected communities, particularly marginalised groups who will be disproportionately impacted by climate, is seen as an important factor for the effectiveness and sustainability of adaptation programmes (Soanes et al, 2017; UNEP, 2016). Local institutions are often more receptive to local adaptation needs that are likely to be rapidly changing as climate change advances. Their proximity to communities can also facilitate transparency and accountability of adaptation investments (Soanes et al., 2017).

5. References

ACAPS (2019). *Horn of Africa: Drought*. Thematic Report 22 July 2019. https://www.acaps.org/special-report/horn-africa-drought

Benzie, M. & John, A. (2015). *Reducing vulnerability to food price shocks in a changing climate*. Stockholm Environment Institute Discussion Brief. https://www.jstor.org/stable/resrep00394?seq=1#metadata_info_tab_contents

Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., Tolentino, R., Wetherbee, C. (2019). *Global Landscape of Climate Finance 2019*. Climate Policy Initiative: London. https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/2019-Global-Landscape-of-Climate-Finance.pdf

Chan, C. & Amerasinghe, N. (n.d.) *Deploying Adaptation Finance for Maximum Impact*. World Resource Institute. https://www.wri.org/news/deploying-adaptation-finance-maximum-impact

Chan, E., Ho, J., Hung, H., Liu, S., &Lam, H. (2019). Health impact of climate change in cities of middle-income countries: the case of China, *British Medical Bulletin*, 130 (1), 5–24.

Chersich M., Wright, C., Venter, F., Rees, H., Scorgie, F. & Erasmus, B. (2018). Impacts of Climate Change on Health and Wellbeing in South Africa. *International Journal of Environmental Research and Public Health*. 15(9), 1884.

Climate Policy Initiative (2019). *Global Landscape of Climate Finance 2019 – Methodology*. https://www.climatepolicyinitiative.org/wp-content/uploads/2019/11/GLCF-2019-Methodology-Document.pdf

Compton, J., Wiggins, S. & Keats, S. (2010). *Impact of the global food crisis on the poor: what is the evidence?* ODI: London. https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6371.pdf

Economist (2018). *Climate change will affect developing countries more than rich ones*. https://www.economist.com/graphic-detail/2018/05/09/climate-change-will-affect-developing-countries-more-than-rich-ones

Ellis, C. & Pillay, K. (2017*). Leveraging private sector finance for climate compatible development: Lessons from CDKN*. Climate and Development Knowledge Network: London. https://southsouthnorth.org/wp-content/uploads/2018/06/Working-Paper_Leveraging-private-climate-finance_final-web.pdf

Fischer, G., K. Frohberg, M.L. Parry, and C. Rosenzweig (1996): The Potential Effects of Climate Change on World Food Production and Security. In: F. Bazzaz, and W. Sombroek (Eds.): *Global Climate Change and Agricultural Production*. FAO: Rome.

IPCC (2014). Summary for policymakers. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C., Barros, V., Dokken, D.,Mach, K., Mastrandrea, M., Bilir, T., Chatterjee, M., Ebi,K., Estrada, Y., Genova, R., Girma, B., Kissel, E., Levy, A., MacCracken, S., Mastrandrea, P. & White, L. (eds.)]. Cambridge

University Press: Cambridge & New York.
https://www.ipcc.ch/site/assets/uploads/2018/03/ar5_wgII_spm_en-1.pdf

GOV.UK (2015). *Guidance: Cross-Government Prosperity Fund*.
https://www.gov.uk/government/publications/cross-government-prosperity-fund-programme

Kawasaki, A., Kawamura, G., Zin, W. (2020). A local level relationship between floods and poverty: a case in Myanmar. *International Journal of Disaster Risk Reduction*. 42, 101348.

Manuarmorn, O., Biesbrosk, R. & Cenotari, V. (2020). What makes internationally-financed climate change adaptation projects focus on local communities? A configurational analysis of 30 Adaptation Fund projects. *Global Environmental Change*, 61, 102035.

Micale, V., Tonkonogy, B. & Mazza, F. (2018). *Understanding and Increasing Finance for Climate Adaptation in Developing Countries*. Climate Policy Initiative: London
https://www.international-climate-initiative.com/fileadmin/Dokumente/2019/20190225_Understanding-and-Increasing-Finance-for-Climate-Adaptation-in-Developing-Countries.pdf

Riojas-Rodríguez, H., Quezada-Jiménez, M.L., Zúñiga-Bello, P. & Hurtado-Díaz, M., 2018. Climate Change and Potential Health Effects in Mexican Children. *Annals of Global Health*, 84(2), 281–284.

Schmidhuber, J. & Tubiello, F. (2007). Global food security under climate change. *PNAS,* 104 (50), 19703-19708.

Shepherd, A., Mitchell, T., Lewis, K., Lenhardt, A., Jones, L., Scott, L. & Muir-Wood, R. (2013). *The geography of poverty, disasters and climate extremes in 2030*. ODI: London.
https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8633.pdf

Trivedi, A. & Chertock, M. (2019). *Responding to Day Zero Equitable: Water crisis lessons from Cape Town and Chennai*. World Resource Institute:
https://www.wri.org/blog/2019/10/responding-day-zero-equitably-water-crisis-lessons-cape-town-and-chennai

UNEP (2016). *The Adaptation Finance Gap Report 2016.* United Nations Environment Programme: Nairobi. https://unepdtu.org/publications/the-adaptation-finance-gap-report/

UNFCCC, (2007). *Investment and Financial Flows to Address Climate Change*. United Nations Framework Convention on Climate Change: Bonn.
https://unfccc.int/resource/docs/publications/financial_flows.pdf

WHO (2018). *Climate change and health: Key facts*. https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

World Bank (2010). *Economics of Adaptation to Climate Change: synthesis Report*. The World Bank: Washington D.C. https://openknowledge.worldbank.org/handle/10986/12750?show=full

World Bank (2012). *Thai Flood 2011: Rapid Assessment for Resilient Recovery and Reconstruction Planning*. The World Bank: Bangkok.
http://documents1.worldbank.org/curated/en/677841468335414861/pdf/698220WP0v10P106011020120Box370022B.pdf

World Resource Institute (n.d.). *Adaptation Finance and Accountability Initiative*. https://www.wri.org/our-work/project/adaptation-finance-accountability-initiative

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