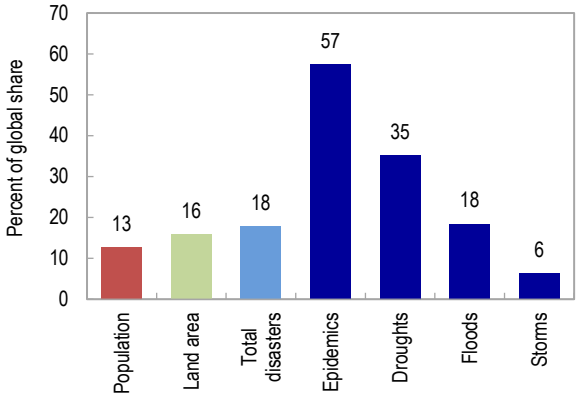
3. Enhancing Resilience to Natural Disasters in Sub-Saharan Africa

The 2014–15 Ebola epidemic in West Africa and the 2016 droughts induced by El Niño in parts of Eastern and Southern Africa have brought to the fore the economic and social costs posed by natural disasters in sub-Saharan Africa. Policymakers have struggled to manage the impact of these crises, which have had adverse effects on macroeconomic performance. The significant international spillovers and scale of humanitarian relief needs drive home the point that these challenges are a concern of global as well as regional scale.

In this context, this chapter analyzes the economic and social implications of natural disasters for sub-Saharan Africa and assesses policy responses.[1] Natural disasters are defined as events of natural causes that lead to damage, dislocation, or loss of life. These events can be weather-related (flood, drought, storm), geophysical (earthquake, volcano), or biological (epidemic). Sub-Saharan Africa is impacted disproportionately by certain types of natural disasters compared with other regions; in particular, it is far more prone to droughts and epidemics (Figure 3.1). However, the region's relative exposure to disasters overall appears to be broadly in line with its share of global population and land area.

Our analysis finds that the impact of natural disasters in sub-Saharan Africa is magnified by structural factors that limit countries' capacity to respond adequately and develop resilience over time. In particular, the impact of weather-related disasters is amplified by, for example, a heavy reliance on rain-fed agriculture in output and employment. Moreover, with 40 percent of the world's poor living in sub-Saharan Africa, natural disasters have a substantial social impact, leading to strong increases in food insecurity, poverty, and inequality. The combined effect of the natural disasters and structural factors results in a large part of sub-Saharan African countries being considered among the most vulnerable to natural disasters in the world (World Risk Report 2016; Figure 3.2).[2]

Figure 3.1. Sub-Saharan Africa: Share in Selected Indicators, 2014



Sources: Incidence of Natural Disasters database, EM–DAT; World Bank, World Development Indicators; and IMF staff calculations.

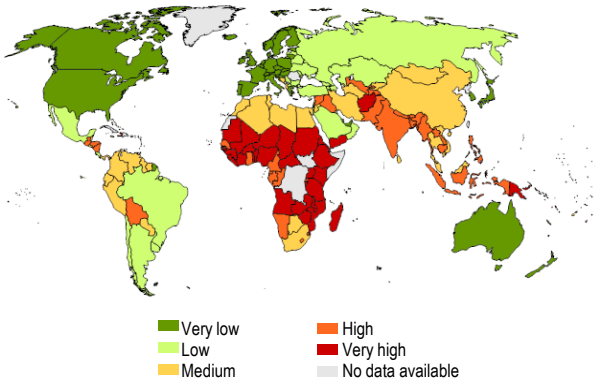
Climate change will compound these challenges with more extreme weather events, as well as rising temperatures and sea levels (IPCC 2012). Agriculture is expected to suffer from declining yields and reduced arable land, while hydropower generation could also be disrupted. Rising sea levels and environmental degradation will likely generate significant relocation costs and hamper tourism. The region's challenges will intensify with a population projected to double by 2050, accompanied by accelerating urbanization (IMF 2015a).

This chapter was prepared by a team led by Marshall Mills and Vimal Thakoor under the guidance of David Owen. The main authors are Mounir Bari, Marlon Francisco, Ermal Hitaj, Tobias Rasmussen, and Arina Viseth, with contributions from Luisa Charry, Kerstin Gerling, Farayi Gwenhamo, Mumtaz Hussain, Yun Liu, Fan Yang, and Mustafa Yenice.

[1] The chapter relies on the EM–DAT disaster database (http://www.emdat.be), including for the definitions of events. The database includes all disasters meeting one of the following criteria: 10 people killed, 100 people affected (injured, homeless, or requiring immediate assistance such as food, water, sanitation, and medical assistance), a declaration of a state of emergency, or a call for international assistance.

[2] The World Risk Index measures the vulnerability of a country to natural disasters as a function of its susceptibility (public infrastructure, housing conditions, nutrition, poverty, economic capacity, and income distribution), its coping capacities (governance and perception of corruption, disaster preparedness, early warning systems, medical services, and social networks), and its adaptive capacities (education and research, gender equity, environmental status, ecosystem protection, and adaptation strategies and investments).

Figure 3.2. Sub-Saharan Africa: Vulnerability to Natural Disasters



Sources: United Nations University Institute for Environment and Human Security, World Risk Report 2016.

Given the economic and social ramifications, building resilience to natural disasters and climate change is receiving increasing attention and plays a central role in the Sustainable Development Goals (SDGs). In particular, the goals include making infrastructure and cities more resilient to natural disasters and combating the impact of climate change.[3]

The chapter starts by surveying the types of disasters affecting the region before turning to the structural factors that magnify their impact. It then assesses the economic and social impacts by combining several approaches (stylized facts, event studies, and empirical estimates). The implications of climate change for resilience are then examined, including potential impacts of rising temperatures. The chapter concludes by looking at policies that countries with varying capacities and vulnerabilities can put in place to enhance resilience.[4]

The main findings are as follows:

- Natural disasters in sub-Saharan Africa tend to have an uneven impact on macroeconomic conditions in the short run. On average, the impact on short-term growth is mixed, except for the clear adverse effect of droughts in small states. The overall impact on fiscal positions points to increased current spending and a deterioration in the fiscal balance. There is also a substantial negative impact on external balances, as well as a small impact on financial sector soundness. These results reflect the uneven impact of the disasters, initial conditions, and policy responses, the latter often offsetting to a large extent the negative impact on growth performance in the short run. Natural disasters can easily spill over beyond borders, as highlighted by the 2014 Ebola crisis.
- In contrast, there is a clear negative effect on long-term growth and social indicators in sub-Saharan Africa, particularly from major disasters. This impact largely reflects the damage to infrastructure and human capital.
- Climate change will increase vulnerabilities, with potentially severe effects on growth and social indicators without effective adaptation. Rising temperatures and rainfall volatility are expected to increase the frequency and severity of droughts and floods, thereby impairing agricultural productivity. Growth in the region has historically been sensitive to increases in temperature.
- To protect against the negative impact of natural disasters, in the near term, resource-constrained economies in sub-Saharan Africa should begin by implementing cost-effective adaptation measures to reduce risk. Indeed, while they should pursue "first-best" solutions in the long-run that aim to transfer risk and build buffers, most countries have limited resources and capacity to pursue these solutions effectively in the short run.
- The international community can help develop risk reduction and transfer mechanisms for sub-Saharan Africa, as well as provide support to cope with disasters' effects. Development partners can better coordinate disaster relief efforts to make them more rapid and better targeted. The IMF has been increasingly adapting its lending and advice to help respond to natural disasters.

[3] More generally, countering the effects of natural disasters and climate change feature prominently in targets for numerous SDGs, including building the resilience of the poor to climate-related events and other disasters; ending a number of epidemics common in Africa; strengthening public health capacity; and strengthening resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

[4] It complements work underway through the IMF's "Small States Resilience to Natural Disasters and Climate Change: Role of the IMF" (IMF 2016c forthcoming), which focuses at this stage on small states.

NATURAL DISASTERS IN SUB-SAHARAN AFRICA

This section surveys natural disasters in sub-Saharan Africa, looking at the frequency, location, type, and proportion of the population affected.

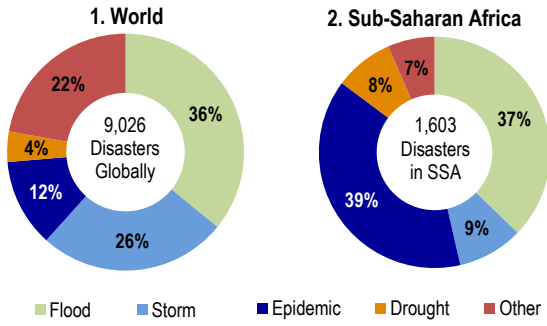
Sub-Saharan Africa experienced 1,603 reported disasters, about 18 percent of the global total (Figure 3.3). Epidemics and floods accounted for the bulk of disasters, at 39 percent and 37 percent, respectively.[5] Droughts accounted for 8 percent of disasters, twice the share globally.

Countries across sub-Saharan Africa exhibit different levels of vulnerability to droughts, epidemics, floods, and storms. Figure 3.4 shows the frequency with which countries were affected by droughts and epidemics and the share of population affected. The human cost varies, but there is a strong correlation between frequency and population affected in most cases.

- **Droughts** are more frequent in the Sahel region and eastern and southern Africa. About a dozen countries reported six or more droughts since 1990, with Ethiopia, Kenya, and Mozambique experiencing frequent droughts. Droughts are strongly correlated with El Niño. Reflecting the high frequency of droughts, the Sahel region and eastern and southern Africa have the highest percentage of population affected. While not affected as frequently, Lesotho and Swaziland have a high share of population impacted. Epidemics tend to be concentrated around the equator. Ten countries reported more than one epidemic a year. The most common of these are transmitted by mosquitoes or are waterborne.
- **Floods** occur throughout the continent, with nine countries averaging more than one event per year. Countries with the highest human cost are evenly dispersed throughout the continent.
- **Storms** are more common in the southeastern part of the continent, reflecting the prevalence of tropical cyclones in that part of the Indian Ocean. Seven countries reported six or more storms.

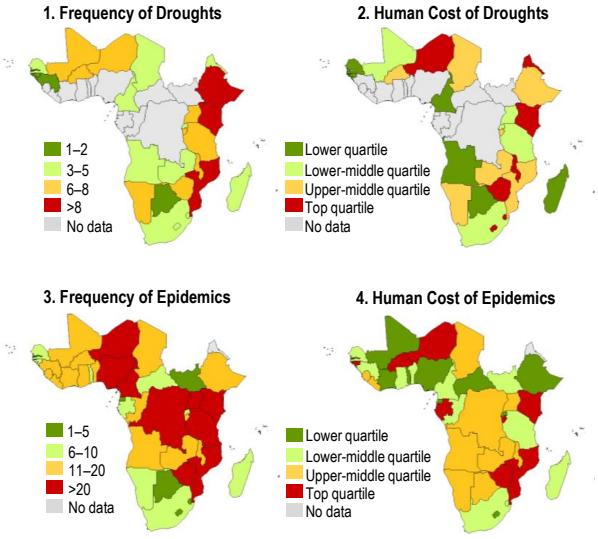
Some countries are affected by multiple disasters. For instance, Mozambique stands out as being vulnerable to all four types of disasters. Kenya shows high vulnerability to both frequency and human cost of droughts and epidemics. Comoros and Seychelles have historically been impacted by both storms and epidemics. Different disasters are more often correlated in sub-Saharan Africa

Figure 3.3. World and Sub-Saharan Africa: Frequency of Disasters, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

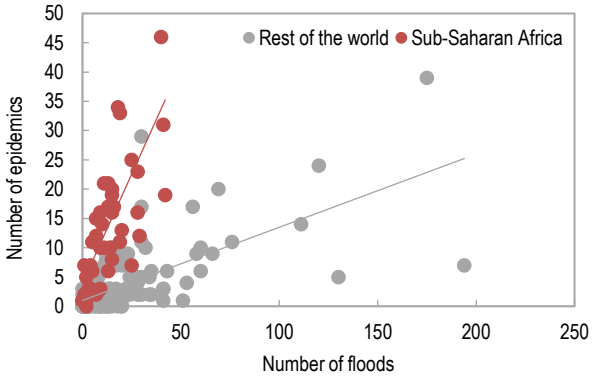
Figure 3.4. Sub-Saharan Africa: Frequency and Human Cost of Droughts and Epidemics, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

[5] This chapter focuses on natural disasters starting from 1990 in light of considerations on the comparability of the data. The chapter relies on the number of people affected as the primary measure of severity of a disaster.

Figure 3.5. Sub-Saharan Africa: Floods and Epidemics by Country, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

than elsewhere. For example, there is a stronger correlation between floods and epidemics in sub-Saharan Africa relative to the rest of the world (Figure 3.5).

The impact of disasters can be amplified in the presence of structural weaknesses. We look at the ones most relevant for sub-Saharan Africa in the next section.

STRUCTURAL FACTORS AFFECTING THE IMPACT OF NATURAL DISASTERS

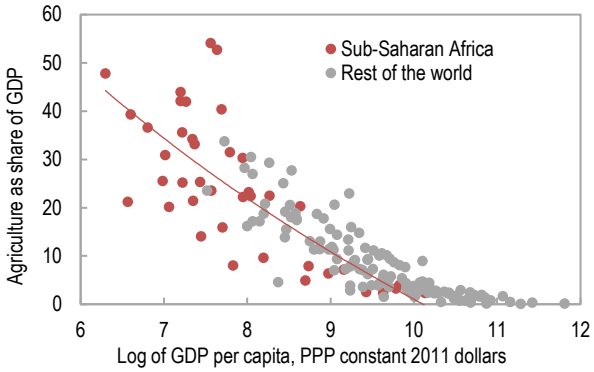
The impact of natural disasters is determined by the interaction between their severity, frequency, and duration on the one hand and the country's initial conditions on the other (such as for example the size of land area and population exposed, as well as the extent to which a country is prepared and able to cope with disasters). The postdisaster response also plays a major role in determining the net impact.

Indeed, the type of disaster interacts with structural factors to determine the magnitude of the impact. Floods and storms tend to be short lived but cause significant immediate damage to output as well as physical and human capital. In contrast, epidemics and droughts tend to last longer; while the damage to physical capital tends to be mitigated, the impact is felt in terms of lost output and human capital over time. Droughts result in reduced food supplies, possibly leading to malnutrition and poverty (with long-lasting implications), as well as disruptions in hydroelectric power generation.

Sub-Saharan Africa exhibits structural characteristics that exacerbate vulnerabilities, in four main areas:

- **Weak adaptation capacity**—Sub-Saharan African countries have shown limited financial and institutional capacity for effective adaptation to reduce exposure and vulnerability. As a result, many are among the most exposed and vulnerable in the world (see Figure 3.2). Noy (2009) finds that higher literacy rate, better institutions, higher per capita income, higher degree of openness to trade, and higher levels of government spending all increase the ability of governments and the private sector to mobilize resources for reconstruction and contain the spillovers on the macro economy. Economic diversification and fiscal space to conduct counter-cyclical policy can also impact the response and overall economic cost.
- **High share of rain-fed agriculture in GDP**—A large share of agriculture in GDP (Figure 3.6) and employment adds to vulnerability, as do other weather-sensitive activities, such as herding and fishing. Sub-Saharan Africa has the highest share of rain-fed agriculture globally at 95 percent (Figure 3.7). These vulnerabilities contribute to short term income losses and increased food insecurity.

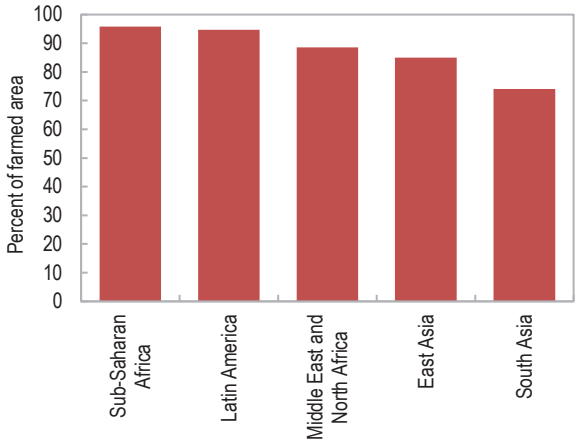
Figure 3.6. Sub-Saharan Africa: Share of Agriculture and GDP per Capita, 2014



Sources: World Bank, World Development Indicators; and IMF staff calculations.

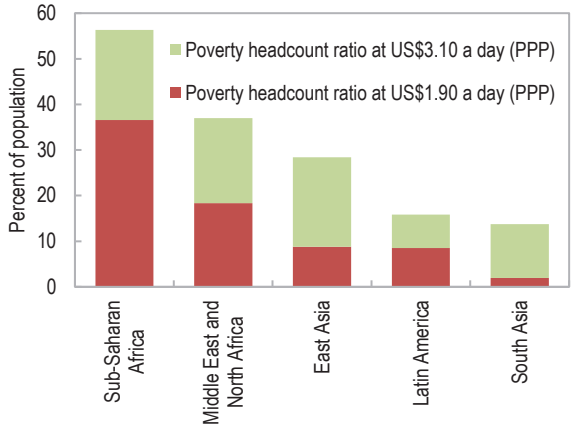
Note: PPP = purchasing power parity.

Figure 3.7. Selected Regions: Percent of Rain-fed Farmed Area, Average 2005–13



Sources: United Nations, Food and Agriculture Organization statistics database; and IMF staff calculations.

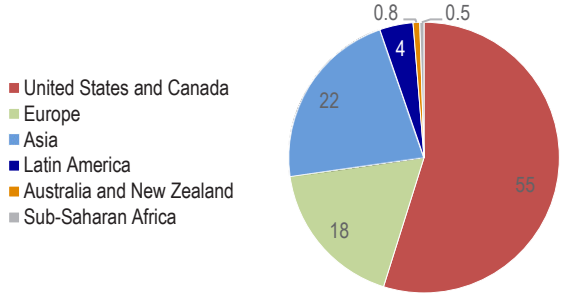
Figure 3.8. Selected Regions: Poverty Headcount Ratios, 2012



Sources: World Bank, World Development Indicators; and IMF staff calculations.

Note: PPP = purchasing power parity.

Figure 3.9. Selected Regions: Agricultural Insurance Premium, 2011
(Percent of total)



Source: Swiss Re. 2013.

- **High levels of absolute poverty**—Sub-Saharan Africa has the world's largest shares of population living under US$1.90 and US$3.10 a day (Figure 3.8). These segments tend to be among the most vulnerable, as a small shock can often result in an increase in the number of people living below the poverty line and unable to meet their basic needs.
- **Limited financial sector development**—Low levels of access to credit and especially insurance, both domestically and for sovereigns, reduce the scope both for risk transfer and for financing for postdisaster relief and reconstruction. Agricultural insurance coverage in sub-Saharan Africa is lagging compared with other regions, with only 0.5 percent of the total agricultural insurance premiums in the world paid in the region (Figure 3.9). The trend also applies to private insurance. In more developed economies, private sector insurance can significantly offset the macroeconomic impact of even severe disasters (Goetz, von Dahlen, and Saxena 2012).

Put together, these vulnerabilities exacerbate the impact of natural disasters in sub-Saharan Africa relative to other regions. The next section looks at the economic and social costs of these disasters.

THE ECONOMIC AND SOCIAL IMPACTS OF NATURAL DISASTERS

To develop policy responses to these vulnerabilities, it is important to identify the economic and social impacts of natural disasters. In this section, we examine the channels for these impacts and their magnitude by sector, looking at both the near-term macroeconomic effects as well as longer-term impacts on growth and social indicators. Notwithstanding some challenges in disentangling complex effects, we find that the near-term macroeconomic effects tend to be mixed, depending on the types of disasters and sectors affected—often they are not substantial overall. On the other hand, the effects on long-term growth and social indicators are more evident and substantial.

Channels of Impact

To examine the economic and social impacts of natural disasters, we start by identifying the channels of transmission:

- First, damage to capital—both physical and human—and disruption to economic activities are likely to adversely impact output and growth in both the short and long term. This negative impact can however be offset to some degree in the near term by policy responses, for example, increased activity for reconstruction. In the longer run, the quantity and quality of both infrastructure and human capital will suffer.
- Second, reduced export capacity and increased import demand can weaken external balances. Damage to production capacity and infrastructure reduces exports, while reconstruction needs and production shortfalls lead to a higher demand for imports. Evidence points to agricultural exports being the most vulnerable to droughts, floods, and storms.
- Third, lower tax revenue and increased public spending needs can worsen fiscal indicators, as the tax base weakens and relief efforts and reconstruction increase spending needs. However, lags in effects (for example, corporate taxes levied on previous years' profits) and expenditure switching—both from current to capital items and from planned capital spending to reconstruction—can mitigate or obscure these effects.
- Fourth, losses at enterprises and households can worsen financial sector indicators.
- Finally, the poor tend to be disproportionately impacted as they tend to live in vulnerable areas and have fewer resources to cope with disasters. Falls in agricultural production can lead to reduced employment opportunities. This can aggravate food insecurity, poverty, and inequality, thereby reducing human capital accumulation and growth potential in the long term.

Assessing the Impact

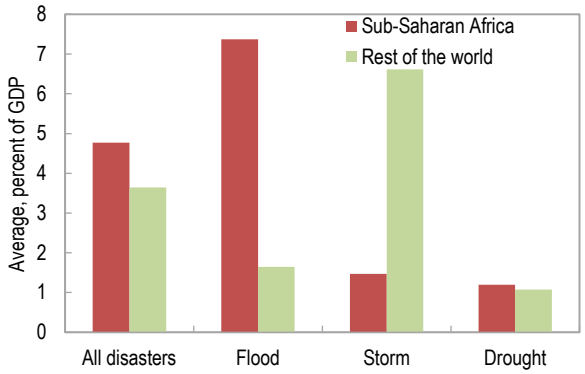
It can be challenging to quantify the impact of disasters, since it can be mixed in some cases, obscured by other factors, or offset by responses. Moreover, while the macroeconomic data used for analysis in low-income countries tend to be reported on an annual basis, natural disasters tend to be more localized and have widely varying durations—days for storms and floods and sometimes months for droughts and epidemics. For this reason, we use a combination of methods to analyze the short-term and long-term effects. First, we use event studies to identify stylized facts on the evolution of some important economic and social variables following disasters. The event analysis is focused on the major disasters (top 20 percent of disasters, based on the percentage of population affected). We also conduct case studies of major disasters, the 2014–15 Ebola epidemic and the drought in southern Africa that started in 2014 (Boxes 3.1 and 3.2). Second, to better control for other contemporaneous factors, we complement the event studies with empirical estimates using different methodologies adapted to the questions being asked. Since the impact can vary according to the types of disasters, where data allows, we look at the four most common ones separately: droughts, epidemics, floods, and storms which account for nearly 90 percent of all disasters in the region.

Short-Term Macroeconomic Effects

Significant damage reported

The economic costs of the top 20 percent of disasters in sub-Saharan Africa show significant costs, particularly relative to other regions (Figure 3.10). The average reported economic costs are higher in sub-Saharan Africa, except for storms. Similarly, except for storms, the average number of people reported to have been affected is broadly the same or higher in sub-Saharan Africa (Figure 3.11). Storms typically cause more damage in more affluent countries, where valuable assets are concentrated on coasts and around rivers. Major droughts affect 35 percent of a country's population on average, while the proportion of the population in sub-Saharan Africa impacted by epidemics is nearly twice as high as elsewhere.

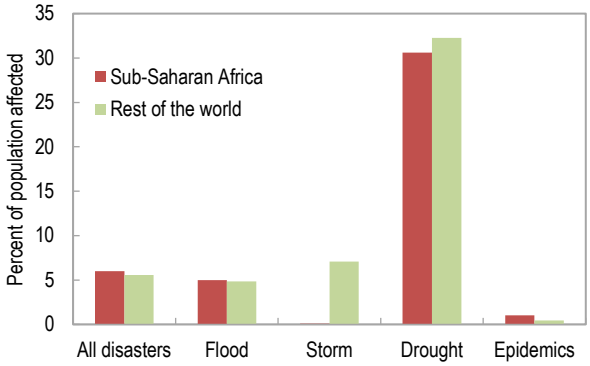
Figure 3.10. Sub-Saharan Africa: Average Economic Cost of Selected Disasters,[1] 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

Figure 3.11. Average Human Cost of Selected Disasters,[1] 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

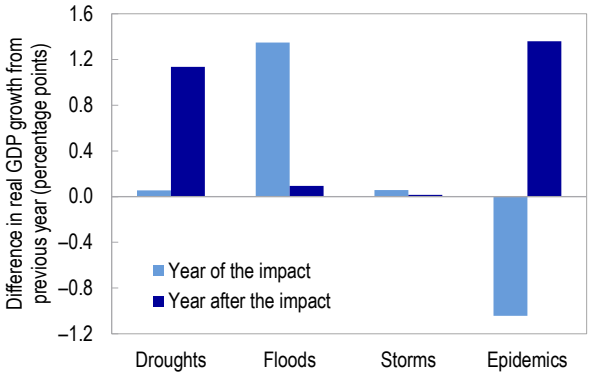
[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

Muted near-term growth impact

The near-term growth impact of natural disasters is mixed in sub-Saharan Africa. This could be explained in part by policy measures that offset the negative impact and a small positive impact of some disasters in net terms.

- Event analysis—Figure 3.12 shows the mixed evolution of GDP growth during and after major (top 20 percent) disasters over the period 1990–2014. Only epidemics are associated with a marked slowdown in growth compared with the year directly preceding the event, and this is reversed in the following year. There is little overall measured impact on GDP during the year of a drought, and an acceleration in the following year (perhaps due to the rebound in the agricultural sector or higher aid flows). The impact of storms on growth is marginal in both years. Floods are associated with higher growth (possibly reflecting the benefits of associated rainfall). One of the reasons the event analysis does not yield conclusive results could have to do with the fact that the approach does not control for other factors.

Figure 3.12. Sub-Saharan Africa: Event Analysis, Impact of Selected Disasters[1] on Real GDP Growth, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

- Empirical analysis—To overcome this deficiency, an empirical approach relating growth in GDP per capita to various natural disasters is undertaken controlling for commonly used growth determinants.[6] To account for potential spillovers of the growth impact, we look at both the impact in the year of the disaster and the following year. The results (summarized in Table 3.1) are mixed and at times counterintuitive. Small states in sub-Saharan Africa tend to be more vulnerable, with droughts associated with a contraction of about 0.4 percentage point in income per capita growth. In low-income countries, there is a positive impact in the

[6] We extend the model by Barro (2003) by including natural disasters as a determinant of growth. Using yearly data for a panel of 136 countries during the period 1984–2014, we apply the three-stage least squares method to assess the short-term effect of disasters on growth. The other variables in the model include initial GDP, trade openness, life expectancy, fertility, public consumption, public investment, educational attainment, quality of institutions, and inflation.

Table 3.1. Selected Groups: Econometric Estimates, Average Impact of Selected Disasters on Income per Capita Growth in the Short Term, 1990–2014

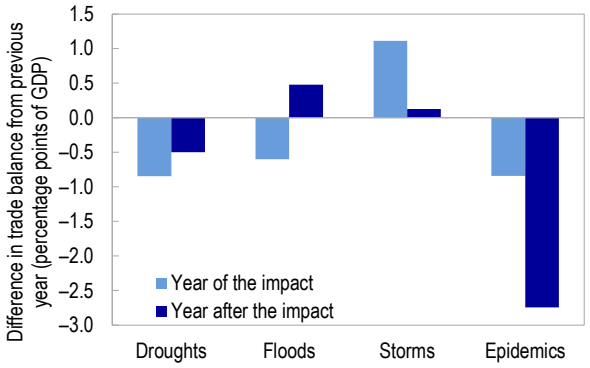
	Overall	SSA		SSA LIC		Small State		Small State SSA	
		Overall	Interaction	Overall	Interaction	Overall	Interaction	Overall	Interaction
Drought									
Year of impact	0.048	0.000	0.068	–0.045	0.159*	0.071	–0.23	0.064	–0.366***
Year after impact	–0.011	–0.094	0.114	–0.084	0.124	0.013	–0.250*	0.006	–0.404*
Epidemic									
Year of impact	0.040	0.105*	–0.1	0.144***	–0.197***	0.042	–0.084	0.042	–0.084
Year after impact	0.038	0.079	–0.064	0.112**	–0.148**	0.036	0.049	0.036	0.049
Flood									
Year of impact	0.044*	0.059**	–0.047	0.063**	–0.078	0.046*	–0.055	0.045*	–0.065
Year after impact	0.033	0.036	–0.01	0.041	–0.033	0.034	–0.118	0.033	…
Storm									
Year of impact	–0.015	–0.021	0.045	–0.027	0.104	–0.01	–0.074	–0.009	–0.195
Year after impact	0.002	–0.003	0.033	0.001	0.002	0.001	0.013	–0.002	0.239

Source: IMF staff calculations.

Note: LIC = low-income country; SSA = sub-Saharan Africa.*** p<0.01, ** p<0.05, *p<0.1.

year of the disaster. Floods on the other hand tend to have a marginally positive impact on growth. This could be due to the fact that floods tend to benefit rain-fed agriculture in the surrounding areas. While epidemics lead to an overall marginal but positive impact in sub-Saharan Africa, there is a negative impact in low-income countries. Storms do not seem to have a significant impact in the short-term. The positive impact of disasters could reflect the stimulus that follows some of these disasters.

Figure 3.13. Sub-Saharan Africa: Event Analysis, Impact of Selected Disasters[1] on Trade Balance, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

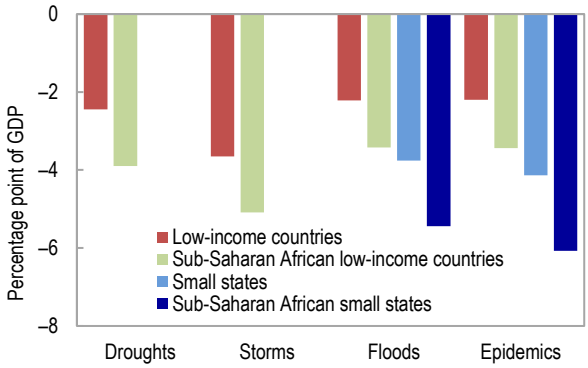
Weaker external balances

Conversely, there are clear indications of a marked deterioration in external balances following most types of disasters, which can contribute to external vulnerabilities.

- Event analysis points to a sustained and substantial deterioration in the trade balance associated with droughts and epidemics (Figure 3.13). The trade balance weakens the year of a flood and recovers the next year. Storms are associated with an improvement in the trade balance.
- The empirical results looking at the current account and controlling for other factors[7] also support the finding that external balances are substantially weakened by disasters in sub-Saharan Africa. The current account is more severely impacted in low-income countries, small states, and especially small states in sub-Saharan Africa, relative to other regions (Figure 3.14).

[7] We extend the model by Chinn and Prasad (2003) by including natural disasters as a determinant of the current account. We apply a simple ordinary least squares and use a panel of 177 countries during the period 1990–2014. The other variables in the model include: the government fiscal balance, real effect exchange rate, broad money, direct investment, and international reserves, as well as a dummy if a country is resource rich.

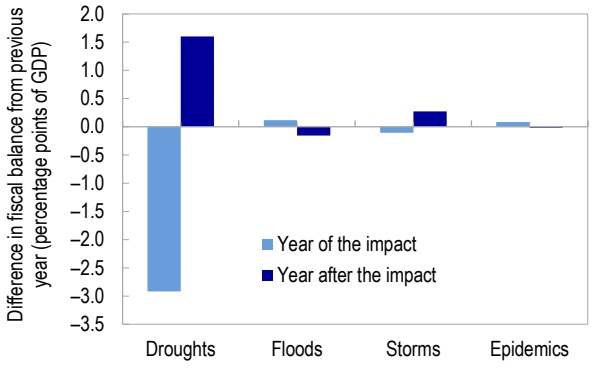
Figure 3.14. Sub-Saharan Africa: Econometric Estimates, Impact of Selected Disasters[1] on Current Account Balance



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

Note: Only statistically significiant results are shown.
[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

Figure 3.15. Sub-Saharan Africa: Event Analysis, Impact of Selected Disasters[1] on the Fiscal Balance Excluding Grants, 1990–2014



Sources: Incidence of Natural Disasters database, EM–DAT; and IMF staff calculations.

[1] Selected disasters are those in the top 20 percent most damaging disasters in terms of human lives affected.

Weaker fiscal positions in some cases

Disasters do not tend to be associated with clear impacts on fiscal variables on average. As noted above, some effects may occur with lags (such as revenue or reconstruction), be obscured by expenditure switching, or be offset by external budget support (in the form of grants and/or financing). Often, these immediate policy responses can come at the expense of rapid recovery (such as delayed reconstruction) or long-term development (such as cutting previously planned capital spending). This is broadly consistent with findings by Gerling, Moreno, and Toffano (forthcoming).

- The event analysis points to a significant deterioration in the fiscal balance in the year of a disaster only in the case of droughts, followed by a partial recovery (Figure 3.15). Other effects are marginal.
- The empirical analysis[8] that tries to control for other factors yields few statistically significant results regarding the impact. Depending on the model specification, current expenditures tend to increase by 0.2 percent of GDP and the primary balance deteriorates by 0.7 percent of GDP following disasters. There was no discernible impact on debt dynamics, although this could be due to official debt relief in many of the sub-Saharan African countries during the period under consideration.

Heightened financial sector fragility

Financial sector soundness tends to deteriorate moderately in the sub-Saharan African countries following a disaster, as nonperforming loans (NPLs) tend to increase.

The event analysis point to an increase in NPLs in sub-Saharan African countries affected by disasters, in contrast to all other country groups, where NPLs tend to decline (Figure 3.16).

- The empirical results confirm that natural disasters contribute to a deterioration in NPLs across all disaster types for the region.[9] The deterioration in NPLs is highest for storms,

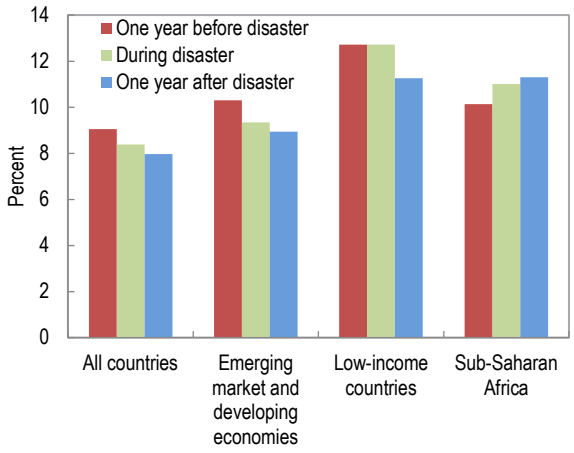
[8] We use a modified version of Cabezon and others 2015 to assess the impact of natural disasters on key fiscal variables. We estimate a panel VAR covering 45 countries over the period 1990–2014. The basic specification controls for the primary fiscal balance, tax revenue, government current expenditure, real GDP growth, and the intensity of natural disasters. An alternative specification controls for the primary fiscal balance, the C-efficiency ratio of value-added tax revenue to consumption, divided by the standard tax rate government total expenditure, real GDP growth, and the intensity of natural disasters

[9] We extend the model by Ebeke, Loko, and Viseth (2014) by including natural disasters as a determinant of NPLs. We apply a fractional logit model to assess the impact of natural disasters using a sample that covers 176 countries during the 1997–2014 period. The other variables in the model include real GDP growth, GDP per capita, trade openness, and a measure of governance.

followed by droughts, epidemics, and floods, with the increase varying between 0.1 and 1 percentage point (Figure 3.17).

These results suggest that the lower financial development and associated credit constraints in sub-Saharan Africa increase vulnerabilities to disasters. Additionally, the limited availability of insurance and firms' difficulty in accessing credit can also hamper the ability of firms to restore their operations and sustain debt service after disasters.

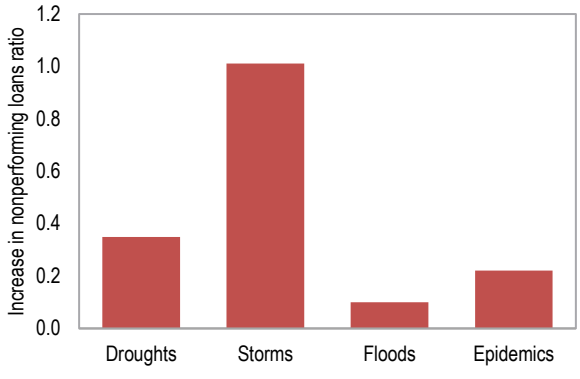
Figure 3.16. Selected Groups: Event Analysis, Impact of Natural Disasters on Nonperforming Loans



Sources: World Bank, Global Financial Development database; and IMF staff calculations.

Note: Disaster episode is defined as one that occurred between 1997 and 2014 and that resulted in more than 0.5 percent of GDP in damage.

Figure 3.17. Sub-Saharan Africa: Econometric Estimates, Impact of Natural Disasters on Nonperforming Loans



Sources: World Bank, Global Financial Development database; and IMF staff calculations.

Long-Term Effects

Disasters appear to have substantial longer-term impacts on growth and social indictors, despite the muted effects in the near term. These negative long-term impacts could reflect the effects over time of both the disasters and the responses to cope with them.

Disasters do appear to affect longer term development through repeated damage to physical and human capital. This damage reduces the overall level and efficiency of capital, hence lowering potential growth.

- To assess this impact, the first econometric approach[10] looks at the types of disasters and finds a persistent adverse impact on growth from droughts (between –0.4 percent of GDP overall and –0.5 percent of GDP for the severe disasters in sub-Saharan Africa) and storms (about –0.2 percent of GDP). The results are summarized in Table 3.2.
- The second approach focuses on selected sub-Saharan African countries and finds that natural disasters lower real GDP by about 0.9 percent in the long term. In addition,

Table 3.2. Sub-Saharan Africa: Econometric Estimates, Average Impact of Selected Disasters on Real GDP Growth,
(Average Real GDP Change over a 10-year Period (percent), 1990–2014)

		Droughts	Storms	Floods	Epidemics
Overall		–0.361*	–0.197**	–0.081	–0.076
Sub-Saharan Africa	Overall	–0.222	–0.160*	–0.109	–0.219
	Interaction	–0.257	–0.445	0.124	0.188
Sub-Saharan African low-income countries	Overall	–0.222	–0.160*	–0.109	–0.187
	Interaction	–0.257	–0.445	0.124	0.155
Top 20 percent	Overall	–0.441**	–0.204**	–0.108	–0.071
	Interaction	0.440	0.057	0.196	–0.027
Top 20 percent and sub-Saharan Africa	Overall	–0.441**	–0.183**	–0.080	–0.082
	Interaction	0.440	–0.524	–0.018	0.076

Source: IMF staff calculations.

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

[10] We use the same model as for the short-term growth impact (Barro 2003). We use 10-year panel data covering 95 countries during the 1984–2014 period. The other explanatory variables remain unchanged (see footnote 6).

damage to physical infrastructure and reduced human capital also compound the impact. Annex 3.1 provides additional details.

Social Costs

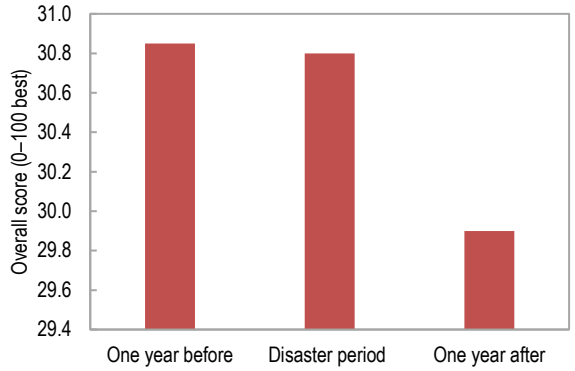
To assess the social impact of disasters, we examine trends in food security, poverty, and inequality and find that disasters are associated with deterioration in most cases.

- The event analysis suggests that natural disasters worsen social conditions across all dimensions. There is a marked decline in the availability, affordability, and quality of food following a disaster, resulting in a marked decline in food security (Figure 3.18); these trends disproportionately affect the poor, who spend a higher share of income on food. Both poverty and inequality also tend to be higher in countries that are impacted by disasters (Figure 3.19).
- The empirical analysis[11] points to significant increases in poverty following all four types of disasters, ranging from a 0.2 to a 0.5 percent increase (see Mills and others, forthcoming; Figure 3.20). The increase is often stronger for sub-Saharan countries or low-income countries than elsewhere.

A number of factors explain the substantial deterioration in social conditions following a disaster, especially in sub-Saharan Africa and low-income countries. The lack of effective social safety nets can increase the vulnerability of poor households hit by reduced subsistence production and wages. In addition, the poor tend to settle in the most vulnerable areas, which also tend to suffer from weak housing standards (World Bank 2003). In addition, credit constraints and limited insurance limit options to cope with disasters' impact (IMF 2003). These social pressures arising from natural disasters can in turn contribute to the incentives for migration, leading to regional and global spillovers.

[11] We build on Ravallion 1997 and Ravallion and Chen 1997 by including natural disasters as a determinant of poverty. We apply a fractional logit estimation method using a sample of 176 countries during the period 1997–2014. The other variables in the model include GDP per capita and the Gini coefficient.

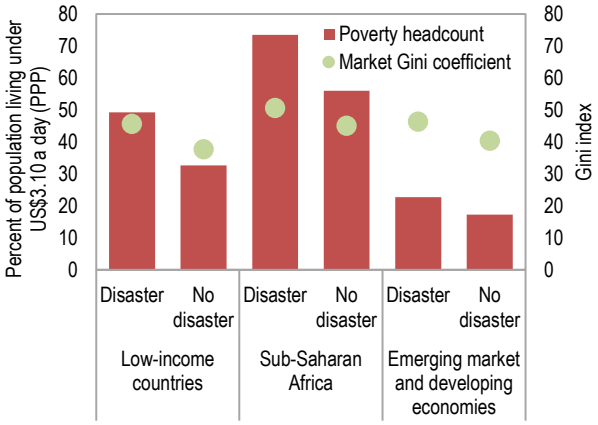
Figure 3.18. Sub-Saharan Africa: Event Analysis, Food Security Index, 2011–14



Source: Global Food Security Index database.

Note: Disaster period is defined as one during which any type of disaster (flood, drought, epidemic, storm) resulted in damage of more than 0.5 percent of GDP.

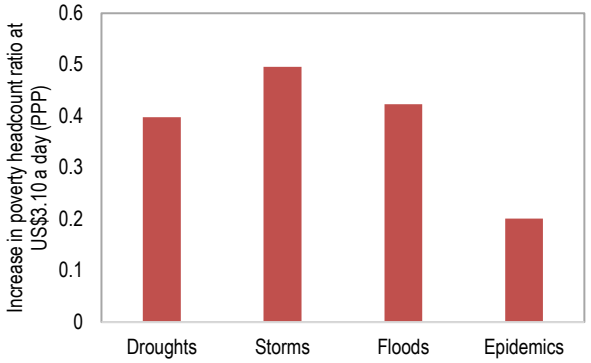
Figure 3.19. Selected Groups: Event Analysis, Poverty, and Inequality, 2011–13



Sources: Solt 2014; and World Bank, World Development Indicators.

Note: Disaster period is defined as one during which any type of disaster (flood, drought, epidemic, storm) resulted in damage of more than 0.5 percent of GDP. PPP = purchasing power parity.

Figure 3.20. Sub-Saharan Africa: Econometric Estimates, Impact of Natural Disaters on Poverty, 2011–13



Source: World Bank, World Development Indicators.

Note: PPP = purchasing power parity.

In sum, the results point to a muted impact for short-term growth and fiscal variables, although there are clear short-term impacts on the external and financial sectors that can contribute to vulnerability. We also find a slowdown in longer-term growth and a clear deterioration in social indicators.

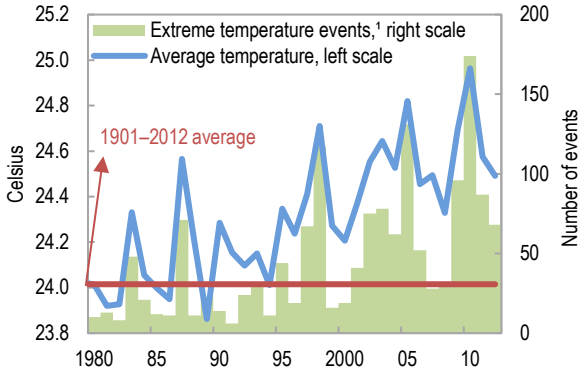
THE CHALLENGES POSED BY CLIMATE CHANGE

Climate change is expected to compound the difficulties posed by natural disasters. The region will suffer disproportionately from rising temperatures, as well as from more frequent and intense droughts and floods (IPCC 2012). At the same time, the region has among the lowest adaptive capacity to climate change (in addition to natural disasters). Sub-Saharan Africa has already seen average temperature increases of about ½ degree Celsius (°C) over the past few decades, broadly in line with the global pattern, although future increases are expected to be above average, particularly in the more arid regions (IPCC 2014). Climate change is already contributing to patterns of rising temperatures and below average rainfall, punctuated with more frequent episodes of extreme rainfall (Figures 3.21 and 3.22).

Climate change is likely to negatively affect sub-Saharan Africa in the following ways:

- **Reduced agricultural output due to rising temperatures and volatility in water supply**—Warming by 1.5°–2°C could lead to a 40–80 percent reduction in present maize, millet, and sorghum cropping areas in Africa (World Bank 2013a). Climate change will hit poor households disproportionately.
- **Increased water stress contributing to desertification and reduction in cropping areas**—All regions will face increased variability in rainfall, although some specific regions, such as East Africa, may see overall increases. Changing rainfall patterns will also heighten uncertainty about hydroelectric power generation, complicating a key challenge for the region.
- **Rising sea levels will cause erosion in coastal areas**—especially for small islands, and contribute to flooding and saltwater intrusion (World Bank 2013a).
- **Environmental degradation**—for example, coral bleaching resulting from El Niño—can in turn accentuate economic costs and increase vulnerability. For example, variations in the water composition of Lake Tanganyika observed recently could jeopardize fisheries, an important food source for the large surrounding population.

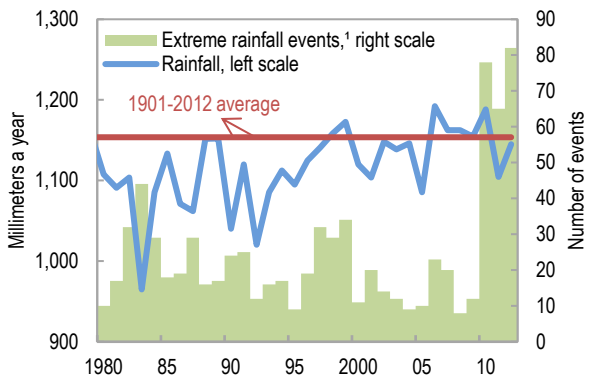
Figure 3.21. Sub-Saharan Africa: Temperature, 1980–2012



Sources: World Bank, Climate Change Knowledge Portal; and IMF staff calculations.

¹ Number of country-months where average temperature is more than 2 standard deviations away from the 1901–2012 average.

Figure 3.22. Sub-Saharan Africa: Rainfall, 1980–2012



Sources: Climate Change Knowledge Portal, World Bank; and IMF staff calculations.

¹ Number of country-months where total rainfall is more than 2 standard deviations away from the 1901–2012 average.

Table 3.3. Impact of Weather on Real GDP Growth[1]

	Dependent variable: Total GDP			Dependent variable: Agricultural GDP		
	(1)	(2)	(3)	(1)	(2)	(3)
Temperature						
Contemporaneous	–0.541 ***		–0.564 ***	–1.522 **		–1.324 *
	(0.186)		(0.190)	(0.691)		(0.687)
With three lags[2]		–0.461 ***			–0.559	
		(0.176)			(0.631)	
Extreme events			0.065			–0.461
			(0.112)			(0.403)
Rainfall						
Contemporaneous	0.006		0.006	0.081 **		0.081 **
	(0.007)		(0.007)	(0.033)		(0.032)
With three lags[2]		0.012			–0.013	
		(0.010)			(0.042)	
Extreme events			0.623			–0.214
			(1.614)			(5.027)
Number of observations	1,981	1,886	1,981	952	952	952
R^2	0.13	0.14	0.13	0.08	0.08	0.08

Source: IMF staff calculations.

Note: Panel regressions covering 43 sub-Saharan African countries during 1963–2012. Temperature (°C) and rainfall (cm) are first differences of annual averages based on monthly data, with Southern Hemisphere countries' years adjusted to end in June. Extreme events are number of months where the weather variable is more than 2 standard deviations away from the long-term country mean. All specifications include country and period fixed effects. Robust standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

[1] Dependent variable: 100 x Δlog (GDP in constant local currency prices).

[2] Average across all the coefficients.

- **Rising temperatures**—are expected to promote the spread of diseases, particularly to higher altitudes and more temperate regions (World Bank 2016b).
- **Fiscal costs and financial disruptions**—can also result from climate change (Farid and others 2016). The damage from climate change and the need to implement adaptation measures will weigh on the budget. The disruption and cost will be higher for cities in coastal areas. At the same time, changing weather patterns could disrupt traditional business models, lead to dislocation of economic activities, and result in stranded assets, such as roads, bridges, and dams.

The magnitude of the expected costs of climate change, while uncertain, is likely to be large. The impact will depend in large part on the extent of global warming and whether policy action can contain it at 1.5°–2°C. Studies generally place the relative costs for sub-Saharan Africa above the global average, reflecting its lower per capita incomes, higher initial temperatures, and a greater reliance on climate sensitive economic activity such as farming (Farid and others 2016).

Empirical estimates conducted for this study looked at the impact of rainfall and temperature on real GDP growth. The findings suggest that rising temperatures associated with climate change could reduce annual economic growth by about ½ percentage point (Table 3.3)[12]. The analysis did not find a significant impact historically of rainfall (on a national basis) on total GDP but it did point to some impact on agriculture. The regression results indicate that agricultural GDP is positively influenced by precipitation, with a 1 centimeter increase in rainfall leading to a 0.08 percent increase in sector-level growth. Moreover, the negative impact from higher temperature is also substantially larger for agricultural GDP than for total GDP, indicating its sensitivity to weather variations.

Having quantified the impact of natural disasters and the risk posed by climate change, the chapter next looks at policies countries could implement to cope with natural disasters and enhance their resilience.

[12] Dell, Jones, and Olken (2012) find a similar but higher impact of 1 percentage point, in low-income countries.

POLICY RESPONSES TO NATURAL DISASTERS AND CLIMATE CHANGE

Natural disasters have harmful economic and social effects, which are especially evident over the long-term. These effects depend on a number of factors: while some are deep rooted (such as poverty), or largerly beyond the control of country authorities (such as climate change), effective preparedness and policy responses can make a difference. Given the broad-ranging impact of disasters, an integrated multipillar strategy that emphasizes risk reduction, transfer, and retention is needed (IPCC 2012). Some approaches, including those involving international assistance, can span all three elements.

Ideally, the policy mix will combine risk reduction through enhanced resilience, risk transfer through financial instruments, and a residual risk element retained for low-impact, high-frequency events (World Bank 2014; IMF 2016c forthcoming).

The risk management strategy should reflect a cost-benefit assessment looking at the expected impact of disasters and the payoff from the policies. The resource intensity of policies will differ, with some reflecting minor adjustments to existing frameworks and others creating significant resource needs. In light of resource and capacity constraints in the near term, many countries in sub-Saharan Africa will have to rely to a large degree on low-cost adaptation and risk retention, in which case a gradualist, cost-effective approach to implementing responses will likely be appropriate.[13] Nevertheless, it is urgent to integrate resilience into development strategies and launch implementation, since timely interventions can be both less costly and more effective.

This section looks at a combination of policies that can support risk management. The IMF is already directly involved in a number of these areas as part of its surveillance or financial programs or is working in close collaboration with other development partners as part of broader international efforts.

Risk Reduction

Risk reduction aims to mitigate the impact of disasters by integrating disaster planning into development strategies. Policies with general relevance include the following:

- **Assessing risks and information dissemination**—The first step in preparedness is adequate investment in risk identification and information dissemination. Early warning systems, including adequate weather and public health services and effective means of dissemination, can significantly enhance preparedness and reduce the impact on the population; one dollar invested in on early warning system yields an estimated $4 in reduced losses (World Bank 2016a). The operation of such systems in the region, while limited, is benefiting from technological improvements.
  - Information sharing among the countries affected by storms in the Indian Ocean allows for better forecasting of storm paths and facilitates any needed evacuations.
  - Rwanda is disseminating information on the expected timing of rainfall to farmers by mobile phone, which optimizes the planting of crops.
- **Making agriculture more resilient**—Enhancing the sector's resilience will help mitigate disasters' impact on income volatility, food insecurity, and poverty. Climate change is likely to further increase the benefits of resilience. Investment in water storage, irrigation, and increased agricultural productivity (for example, developing crops more resilient to water shortages) will support resilience. Box 3.4 elaborates on experiences in making agriculture more resilient in three sub-Saharan African countries.
  - The World Bank (2016a) estimates that interventions to enhance productivity in dryland households could lift many of them out of vulnerability to drought for US$160

[13] Box 3.3 looks at initiatives in Madagascar, a low-income, low-capacity country.

per household.[14] In Burkina Faso, large cisterns in sugarcane fields collect water that is distributed via efficient irrigation methods (IMF 2015c).

- **Promoting economic diversification—** Diversifying the economy toward manufacturing and services not related to agriculture will enhance resilience to weather-related disasters. Policies promoting diversification need to tackle the factors hindering the emergence of businesses that could drive noncommodity exports (IMF 2015b).
- **Adapting physical infrastructure—** Infrastructure development plans need to adapt to the growing risks from natural disasters and climate change, notwithstanding existing infrastructure gaps. Priority actions include strengthening building standards and planning ahead for the expected impact of climate change. Although resilient infrastructure usually costs more in the near term, it can pay off in the long run as it survives disasters. Adequate maintenance is also paramount for resilience. Policies implemented to enhance infrastructure resilience in the region include:
  - Improved construction standards resistant to storms in Madagascar, Malawi, and Mauritius (the first two focused on schools first), as well as the development of weather-resistant transport infrastructure in Madagascar and Mozambique (Ebinger and Vandycke 2015).
  - Reduced reliance on drought-prone hydropower generation and increased reliance on gas and geothermal energy in Kenya.
  - Risk-informed planning, as in São Tomé and Príncipe and Zambia; for example, by moving people from flood-prone to safer areas. Lesotho planned roads to reduce the impact of flooding (World Bank 2015a).
- **Strengthening financial infrastructure—** Resilient payments systems protect financial transactions after a natural disaster, helping minimize knock-on effects. Progress toward modern payment systems could also contribute to resilience by supporting postdisaster access to financing. Mobile banking could support a resilient payment system.

Risk Transfer

The transfer of risk, for compensation in the event of a disaster, can be considered at the level of households, businesses, or nations. For nations, risk transfer takes place through private or sovereign insurance and through regional or multilateral risk-sharing mechanisms.

- **Increasing access to financing and insurance for households and businesses**—This can help mitigate the financial stress, including for the most vulnerable. Progress in financial deepening and inclusion will support this adaptation. In Kenya, crop insurance via mobile phones has begun to broaden access, with assistance from the World Bank.
- **Improving international assistance and coordination**—Some low-income and fragile countries with limited policy space rely on international support to cope with natural disasters. Donors play an essential role in providing short-term relief in such instances. In light of concerns about the adequacy, allocation, and timeliness of post-disaster assistance (Clarke and Dercon 2016), donors should seek to strengthen coordination and preparedness to ensure timely responses following a natural disaster. The World Bank's catastrophe deferred drawdown option (CAT-DDO) provides rapid access to financing while also promoting risk reduction. Donors can also assist in maintaining debt sustainability after disasters, and several international initiatives have been designed to help countries in the face of disasters. For example, the "hurricane clause" in the restructuring of Grenada's debt represents an example of a state-contingent solution for an economy highly vulnerable to natural disasters.

[14] Predisaster interventions to boost resilience can be cost-effective. Dissemination of productivity-enhancing, resilient agricultural and herding techniques would cost about US$1 billion in the Sahel and the Horn of Africa, whereas humanitarian aid to the region totaled US$4 billion in 2013 (World Bank 2016a).

- **Providing cost-effective insurance**—Sovereign disaster risk insurance remains at an early stage of development but holds significant promise as a cost-effective tool, compared with current practices in ex-post discretionary financing. The African Union established the Africa Risk Capacity (ARC) in 2014, with donor support, to provide quick-disbursing aid in the event of severe drought; it disbursed US$26 million in 2015. To transfer the large risks of catastrophe insurance to global markets, it has been combined with index-linked securities, such as catastrophe bonds, or "cat bonds."

Risk Retention

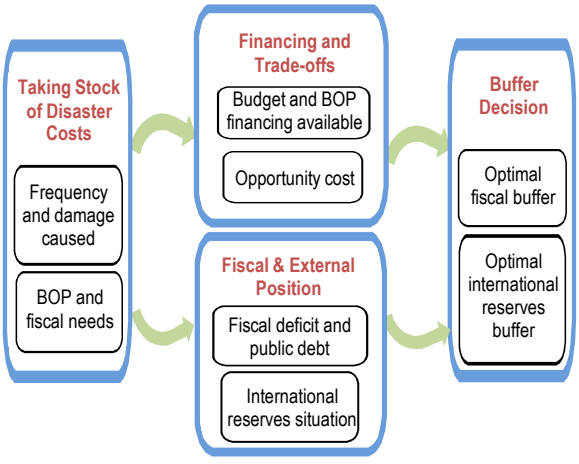
In principle, risk retention should be residual and targeted at high-frequency, low-impact events. At the same time, countries may have to retain a higher residual risk due to their limited capacity to reduce or transfer these risks. The primary policy responses to retained risk include the following:

- **Maintaining higher reserves and fiscal buffers**—A higher level of international reserves could help cushion potential balance of payments shortfalls, while higher fiscal buffers increase the resources available to cope with natural disasters (IMF 2016a, 2016c). The appropriate type and size of buffers would depend primarily on cost-benefit assessment, taking into account in particular the country's fiscal situation, the expected costs of natural disasters, and the ability to borrow—domestically or externally. Figure 3.23 highlights some of these considerations. For many sub-Saharan Africa countries with large infrastructure gaps and high opportunity costs, there are difficult trade-offs in maintaining policy buffers. Under these circumstances, it often makes sense to rely more on postdisaster external assistance. In some cases, increased remittances have provided resources after a disaster and supported preparedness (Mohapatra, Joseph, and Ratha 2012).
- **Strengthening social safety nets and public health systems**—Scalable and well-targeted safety nets enable the authorities to provide some protection to mitigate the social impact of the disasters, especially to the most vulnerable segments of the population. However, in a number of low-capacity countries, existing social safety nets are inadequate, limiting this response. Broadening access to primary health care is considered an adaptation priority, in light of the social impact of natural disasters and climate change (World Bank 2016b). Building health systems is a cost-effective response to the global spillover risks of pandemics (Commission on a Global Health Risk Framework for the Future 2016).
  - The Productive Safety Net Program (PSNP) in Ethiopia serves as an example of a public works program that has been scaled up during droughts and supports improved agricultural productivity by building community assets.
  - Rwanda has effectively extended universal primary health care, with increasing contributions, according to household income levels.

Postdisaster Response

Notwithstanding a country's level of preparedness, a timely and robust response after a disaster can mitigate the impact. Postdisaster measures should focus on protecting affected populations, restoring growth, and improving resilience. There are various options the authorities can consider:

Figure 3.23. Considerations in Determining the Size of Buffers



Source: IMF (2016b forthcoming).
Note: BOP = balance of payments.

- Scaling up social safety nets promptly, including food programs and emergency supplies, cushions the social impact.
- Expenditure flexibility and a responsive budget process can support disaster relief and infrastructure reconstruction. The budget can include contingency spending items that are only activated in the event of disasters (a form of fiscal buffer).
- Domestic financing of the recovery should be pursued provided it does not hamper or crowd out the efforts of the private sector. If domestic financing is not a viable option and external debt is high, the donor community should consider grants or debt rescheduling.
- There may be scope for an accommodative monetary policy where price and currency stability conditions allow. Furthermore, the monetary authority should ensure there is enough liquidity in the market to keep the payments system operational.
- To the extent that natural disasters have durable effects on trend growth and create significant balance of payments pressures, exchange rate flexibility can aid the adjustment process. The amount of foreign assistance will also determine the magnitude of the adjustment needed. At the same time, too rapid a depreciation can also have the unintended effects of exacerbating short-term balance-of-payments pressures, especially when there are large import needs related to reconstruction. To the extent that countries have sufficient external reserves, they could draw on these to smooth the pace of adjustment. Globally, exchange rate flexibility has also been associated with a faster recovery in output following disasters (Ramcharan 2007).

The role of the IMF

The IMF assists in building resilience through policy advice, capacity building, and financing. In particular, the IMF's Rapid Credit Facility (RCF) and Rapid Finance Instrument (RFI) provide rapid assistance to countries with emergency balance of payments needs (Table 3.4). They are accessible under a number of specified circumstances and entail limited conditionality, albeit with a low access level compared with other IMF facilities. The presence of an IMF disbursement to a country can help lend credibility to the macroeconomic policy framework after a disaster, thereby catalyzing external assistance. Countries with ongoing IMF programs can also request augmentations, which has occurred in at least five cases since 2014, and the IMF has participated in postdisaster debt relief under the Catastrophe Containment and Relief

Table 3.4. IMF Postdisaster Assistance to Sub-Saharan African Countries, 2014–16[1]

			Purchases		
Country	Year	Event	Millions of SDRs	Percent of quota	Instrument used [2, 3]
Malawi	2016	Drought	34.7	25.0	Augmentation of ECF
The Gambia	2015	Ebola epidemic	7.8	25.0	RCF
Guinea	2015	Ebola epidemic	21.4	20.0	Debt relief under CCRT
Sierra Leone	2015	Ebola epidemic	20.7	20.0	Debt relief under CCRT
Liberia	2015	Ebola epidemic	25.8	20.0	Debt relief under CCRT
Guinea	2015	Ebola epidemic	45.1	42.1	Augmentation of ECF
Sierra Leone	2015	Ebola epidemic	51.9	50.0	Augmentation of ECF
Liberia	2015	Ebola epidemic	32.3	25.0	RCF
Guinea-Bissau	2014	Post conflict; food prices	3.6	25.0	RCF
Guinea	2014	Ebola epidemic	26.8	25.0	RCF
Liberia	2014	Ebola epidemic	32.3	25.0	Augmentation of ECF
Sierra Leone	2014	Ebola epidemic	25.9	25.0	Augmentation of ECF

Source: IMF staff calculations.

[1] Under 2009 LIC reform, RCF took over the role of subsidized emergency lending to LICs. Establishment of RFI in 2011 replaced previous policy on emergency lending on GRA terms.
[2] CCRT = Catastrophe Containment and Relief Trust; ECF = Extended Credit Facility; GRA = General Resource Account; LICs = low-income countries; RCF = Rapid Credit Facility; RFI = Rapid Finance Instrument.
[3] Following the devastating earthquake in Haiti in January 2010, the IMF had established a Post-Catastrophe Debt Relief (PCDR) Trust that allowed the IMF to join international debt relief efforts for very poor countries hit by the most catastrophic natural disasters. In February 2015, following the Ebola epidemic in Guinea, Liberia, and Sierra Leone, the IMF transformed the PCDR Trust to the CCR Trust to allow the IMF to provide grants for debt relief for the poorest and most vulnerable countries hit by catastrophic natural or public health disasters.

Trust (CCRT), which was successfully applied in the three West African countries (Guinea, Liberia, Sierra Leone) as they were battling the Ebola epidemics.

Climate Change Adaptation and Mitigation

Adapting to and mitigating climate change must be integrated into development planning and resilience building. Many of the policy responses to natural disasters are equally appropriate for the impact of climate change. Infrastructure design has to take into account changing rainfall patterns, rising sea levels, and more frequent and intense weather events. Other measures concern stronger soil and water conservation and better protection of natural barriers, such as rehabilitating mangrove swamps as buffers against ocean surges. Planning also needs to consider the risk of "stranded assets" (which could also become a factor in financial sector soundness). The sooner these factors are integrated, the lower the cost of adaptation. Although climate change is a slow-moving phenomenon, the policy responses are urgent.

Sub-Saharan African countries have made national commitments to control carbon emissions as part of a global effort to reduce CO_2. In many cases this will require new tax policy initiatives including in the direction of a carbon taxation (Box 3.5). Carbon taxation could facilitate domestic revenue mobilization for financing development, including resilience to disasters and climate change. In addition, the US$100 billion promised by advanced economies to developing economies in the context of COP21 could provide a source of financing for adaptation for low-income countries. The architecture of climate finance is complex and evolving rapidly, however, and low-capacity countries in sub-Saharan Africa will likely benefit from support by international financial institutions in mobilizing this assistance.

CONCLUSIONS

Sub-Saharan Africa is one of the world's most vulnerable regions to natural disasters, due in large part to low adaptive capacity. Climate change will add to this vulnerability. Natural disasters negatively affect economic and social indicators, especially over the longer term; while their short-term impact is often mixed, they can nevertheless contribute to vulnerability and pose challenges for macroeconomic management. It is thus imperative that building resilience is integrated into development strategies as quickly as possible. Countries need to decide what mix of policy responses best suits their development needs and capacity, including how to balance and implement the three main strategies of risk reduction, transfer, and retention. There are some broad policies that would apply to most countries and types of disasters in the region. Increasing investment in agriculture to make it more resilient is critical for food and economic security. Investing in the resilience of infrastructure to natural disasters and climate change is imperative, despite the higher upfront costs. More generally, ensuring better preparedness and spatial planning is a cost effective way to reduce losses. In particular, developing well-targeted social safety nets and building primary health care systems are cost-effective ways to combat the impact of disasters.

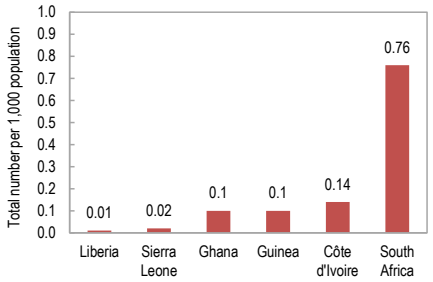
The impact of disasters is proportionately higher for low-income countries and poor households. To a large extent, this reflects an inability to adapt to and hedge against weather- and climate-related shocks. As such, increasing access to cost-effective financial instruments holds promise for transferring risks. It is important to increase the financial instruments in these areas and address issues regarding cost-effectiveness. That said, low-income countries and small states will have little alternative to retaining risk for some time. Mechanisms for quicker and better-targeted international disaster relief could also reduce the impact. While countries can self-insure by creating policy buffers, the opportunity cost is a significant consideration, particularly when the policy space is severely constrained, as in many countries in the region.

Box 3.1. Epidemics: Ebola—A Case Study in National Vulnerabilities, Global Costs

Starting in December 2013 in Guinea, the Ebola epidemic quickly spread to neighboring Sierra Leone and Liberia; by late 2014, it had spread to seven other countries (Italy, Mali, Nigeria, Senegal, Spain, United Kingdom, United States) and became a "Public Health Emergency of International Concern" according to the World Health Organization (WHO 2015). The outbreak infected 28,500 people and claimed more than 11,300 lives, almost entirely in the three western African countries, making it the deadliest Ebola outbreak on record. Deforestation related to population growth, changing land use, and climate change may have prompted transmission from wild animals to humans. Initial conditions in Guinea, Liberia, and Sierra Leone made these countries extremely vulnerable to the introduction of an unfamiliar disease. Poverty coupled with a legacy of protracted conflict and instability, weak health care systems (Figure 3.1.1), porous borders, and some cultural practices added to the challenge of containing the disease.

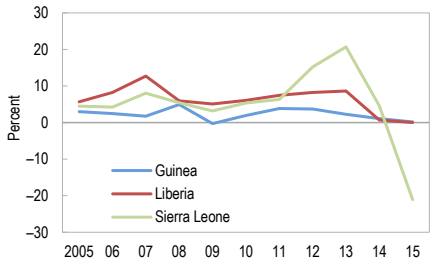
The economic and social impacts in the three most affected countries were severe. In addition to the deaths and infections, the shock was magnified by border closures, internal quarantines, school and government shutdowns, disruptions in international travel, significant reduction to domestic and cross-border trade, and negative effects on consumer and business confidence. Growth plummeted (up to 12 percent in Liberia, Figure 3.1.2), largely owing to the shock to the human capital stock and lower business and consumer confidence (World Bank 2015b; IMF 2016b forthcoming). The current account and fiscal balances deteriorated, to varying degrees (Figures 3.1.3 and 3.1.4). Inflation, unemployment, poverty, and food insecurity all increased. Two million people in Liberia and Sierra Leone needed food assistance (FAO 2015). The international community disbursed US$5.9 billion to fund the response and recovery efforts. About 25 percent of the funds were directly disbursed to government institutions, including from the IMF. Total IMF support to the most affected countries amounted to US$430 million, including US$100 million in debt relief through the Catastrophe Containment and Relief Trust.

Figure 3.1.1. Selected Sub-Saharan African Countries: Physicians per 1,000 people, 2010



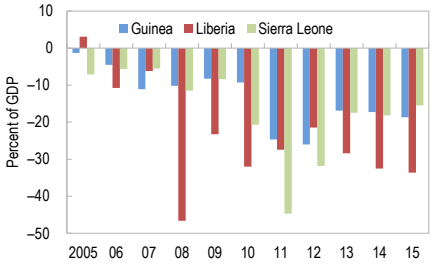
Source: World Health Organization.

Figure 3.1.2. Selected Sub-Saharan African Countries: Real GDP Growth



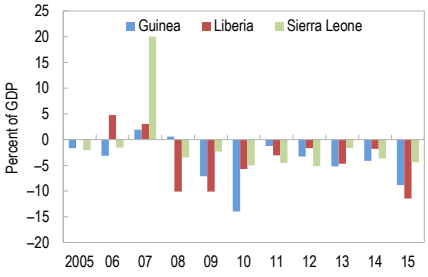
Source: IMF, World Economic Outlook database.

Figure 3.1.3. Selected Sub-Saharan African Countries: Current Account Balance



Source: IMF, World Economic Outlook database.

Figure 3.1.4. Selected Sub-Saharan African Countries: Overall Balance



Source: IMF, World Economic Outlook database.

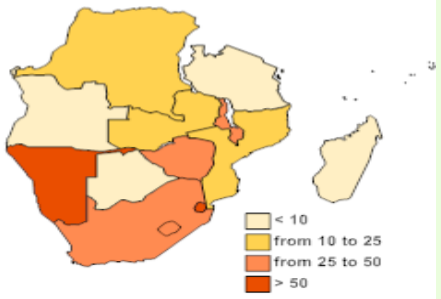
Box 3.2. Droughts: Case Study of the El Niño-induced Drought in Southern Africa

The harshest El Niño-induced drought since 1990 has affected more than 30 million people in southern Africa, threatening a regionwide food crisis. Food insecurity has increased, particularly among the rural population (Figure 3.2.1). Notwithstanding crop failures, the stock of cattle has been decimated, and households' disposable incomes have also been impacted due to diminished opportunities for casual labor. The World Food Program expects the number of people affected to increase to 40 million for 2016–17.

The drought has reduced growth and boosted food inflation. Growth has suffered (Figure 3.2.2), due to both reduced agricultural product and lower hydroelectric power production. Zimbabwe is one of the worst-hit countries: the drought has cut crop production by an estimated 9.9 percent, and the Kariba Dam (which provides about 60 percent of peak electricity demand) risked a complete shutdown due to declining water levels. Electricity shortages have hampered energy-intensive mining and manufacturing activities in several countries.

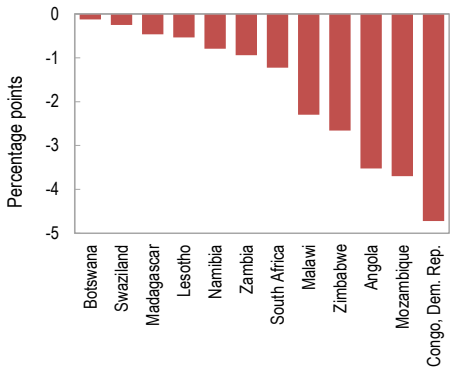
Needs for food and energy imports, as well as social protection, have pushed down fiscal and current account balances: costs range from 1 percent of GDP in Swaziland and Zambia to over 2 percent of GDP in Zimbabwe. While international partners have stepped up their support to some extent, significant financing needs remain. At the same time, many countries have also been hit by the decline in the prices of and demand for their commodity exports (for example, Madagascar, Mozambique, Zambia, Zimbabwe), which has also worsened their external positions.

Figure 3.2.1. Southern Africa: Rural Population Affected by Drought, 2016
(Percent of total rural population)



Source: Southern African Development Community Regional Humanitarian Appeal, June 2016.

Figure 3.2.2. Sub-Saharan Africa: Real GDP Growth, 2016: October 2016 versus October 2015 Projection



Source: IMF, World Economic Outlook database.

Box 3.3. Natural Disasters and Adaptation in Madagascar

Madagascar is among the countries most vulnerable to natural disasters in sub-Saharan Africa, owing to its high exposure to weather-related hazards combined with weak initial conditions related to low income, limited capacity, and a rapidly growing population. It accounts for over half of all reported deaths and economic damage due to storms in sub-Saharan Africa, totaling more than US$2 billion since 1967 (EM-DAT).

Despite low adaptive capacity, Madagascar is undertaking measures for disaster risk reduction and climate change adaptation, with the support of international partners, such as the Global Facility for Disaster Reduction and Recovery (GFDRR) managed by the World Bank. These measures include:

- Technical assistance to rice producers to increase resilience, notably through soil conservation, natural fertilizer production, and reforestation.
- Construction of resilient public facilities such as school and health centers. Between 2004 and 2006, 2,041 schools and 311 health centers were built to resist winds up to 250 kilometers an hour.
- The development of a regional risk information database aimed at assessing regional and national risk financing options, and the establishment of a technical center for disaster risk reduction.

Box 3.4. Contrasting Experiences in Enhancing Resilience to Droughts

Ethiopia, The Gambia, and Niger have taken a range of measures, with varying degrees of success to enhance their resilience to droughts. Two main factors explain the differing experiences: (1) the state of water management systems and other infrastructure; and (2) the effectiveness of the early warning systems and social safety nets.

Water management systems and other infrastructure

Ethiopia has taken steps to develop irrigation schemes of different scales in many parts of the country since the early 2000s. Smart investment in small-scale irrigation, rehabilitation of water catchments, and reforestation in the rural areas enhanced resilience. The size of the road networks to connect farmers to markets and emergency responders to villages doubled over the past decade. These measures have increased the resilience of the agricultural sector to droughts.

In The Gambia, efforts are underway through the government's Integrated Water Resources Management, but there remains considerable scope for better irrigation to support agriculture. In Niger, the potential for irrigation is limited, and its use is relatively low (World Bank 2013b). It is expected that the completion of Niger's Kandadji Dam in 2017 will boost irrigation, other agricultural activities, and hydroelectricity generation.

Early warning mechanisms and social safety nets

Early warning mechanisms are needed to communicate weather forecasts to farmers, enabling them to adapt and better plan their activities.

Ethiopia developed a program called the Livelihoods-Early Assessment-Protection (LEAP), which combines early assessment, early warning, contingency planning, and capacity building with contingency financing through the use of information technology systems. Ethiopia's early warning system also generates critical information useful for its social safety nets and food distribution in the aftermath of droughts. Generally, preexisting social protection systems that can be scaled up can contribute significantly to helping reduce the risk of exposure of poor households to droughts. Ethiopia's Productive Safety Net Program (PSNP) is useful in providing emergency food aid during droughts.

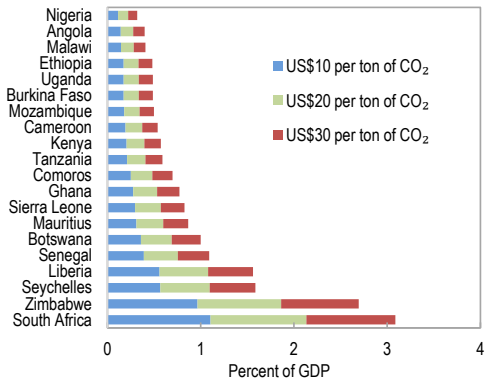
The Gambia and Niger have taken similar initiatives, but low human and infrastructure capacity for collection and monitoring of data on climate and climate change, and the limited development of alerts, have limited the effectiveness of early warning systems.

Box 3.5. Revenue Potential from Carbon Taxation

Carbon taxation involves levying charges on domestic use of coal, petroleum products, and natural gas in proportion to their carbon content. It is a straightforward extension of fuel taxes, which are well established in most sub-Saaharan African countries and among the easiest of taxes to administer.

Carbon taxes (or similar pricing instruments) are the most effective policies for reducing energy-related carbon dioxide (CO_2) emissions—as carbon taxes are reflected in higher prices for fossil fuels, electricity, and so on, this will encourage mitigation opportunities (for example, shifting to cleaner fuels, adoption of energy-saving technologies) across all sectors of the economy—though from a global perspective, mitigation action in large emitting countries is far more urgent (Farid and others 2016). The fiscal rationale for carbon taxes is, however, appealing in sub-Saharan African countries where revenues from broader tax instruments can be severely constrained by the high proportion of economic activity occurring in the informal sector.

Figure 3.5.1. Selected Sub-Saharan African Countries: Potential Revenue from Carbon Taxes, 2013 or Latest Available



Source: IMF staff calculations.

Note: The figure shows revenue that would have been raised had a carbon tax been in place in 2013 or latest year available, where each US$10 increase in the tax per ton of CO_2 is assumed to reduce emissions by 3.3 percent.

Carbon taxes can have significant revenue potential in sub-Saharan African countries, for example, if a US$20 per ton CO_2 tax had been in place in 2013 (or thereabouts) revenues would have exceeded 0.5 percent of GDP in about half of the countries illustrated in the Figure 3.5.1, and more than 1 percent of GDP in a quarter of them.[1] Revenue gains are obviously greater in emissions-intensive countries like South Africa, which use a lot of coal. And revenues are likely to grow over time given the high carbon prices (over US$50 per ton by 2030) that will be needed in many cases, if countries are to meet their emissions reductions pledges made for the 2015 Paris Agreement on climate change.[2]

However, it would be important to use these revenue sources productively, for example, to lower other burdensome taxes or fund public investments with high social value. Earmarking revenues for environmental spending (for example, on investments to improve resilience to climate change) might be problematic in this regard, as there is no relationship between the efficient amount of such spending and the revenues raised from carbon pricing consistent with mitigation objectives.

The author of this box is Ian Parry (IMF, Fiscal Affairs Department).

[1] For perspective, a US$20 per ton CO_2 tax in South Africa in 2014 would have raised fuel prices by approximately 4 percent for gasoline, 50 percent for coal, and 10 percent for natural gas

[2] See for example https://blog-imfdirect.imf.org/2016/04/21/countries-are-signing-up-for-sizeable-carbon-prices. Many countries, including some sub-Saharan African countries, have pledged to cut emissions by about 20–30 percent below business as usual levels by 2030.

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Annex 3.1. Long-Term Impact of Natural Disasters on GDP

To estimate the impact of natural disasters on long-term economic growth, we use an autoregressive distributed lag (ARDL) model. ARDL models are standard least squares regressions that can be used to examine long-term and cointegrating relationships between variables (Pesaran and Shin 1999). We estimate this model using panel data for 22 sub-Saharan African countries for the period 1985–2014.[1] The specification is the same as in Cabezon and others (2015) and is expressed as follows:

RGDP = f(capital stock, population, natural disaster)

The dependent variable is real GDP (in log) and the explanatory variables are population, capital stocks (both in logs) and natural disaster damage (in percent of population affected). The capital stock series is constructed by applying the perpetual inventory method to gross fixed capital formation data. Except for natural disasters (sourced from EM DAT), the other variables are from the IMF WEO database.

The results confirm the adverse long-term impact of natural disasters on economic growth. For natural disasters affecting more than 1 percent of the population, real GDP is lower by 0.92 percent in the long term.[2]

Annex Table 3.1.1. Panel Autoregressive Distributed Lag model, Fixed Effects

Real GDP	
Long–term	
Natural disaster	–0.0092 ***
Capital stock	0.52 *
Population	1.81 *
Short–term	
Error correction term	–0.05 *
Natural disaster	
First difference	1.02
Second difference	–0.05 **
Capital stock	
First difference	0.16 *
Second difference	0.08 *
Population	
First difference	0.77 *
Second difference	0.13
Constant	0.06 **

Source: IMF staff calculations.

Note: ***, **, and * denote statistical significance at 1, 5, and 10 percent levels of significance, respectively.

[1] The sample includes Botswana, Cameroon, Cabo Verde, Chad, Comoros, Democratic Republic of Congo, Ethiopia, The Gambia, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Niger, Senegal, Seychelles, South Africa, Swaziland, and Zimbabwe.

[2] The natural disaster variable is in percent of GDP, so the long run coefficient of –0.0092 is multiplied by 100 to get 0.92.