The Pacific island countries (PICs) are among the most susceptible to natural disasters in the world. The combination of location and small size heightens their vulnerability to earthquakes and weather-related extremes such as cyclones, tsunamis, hurricanes, and floods. And climate change poses risks to the very survival of some Pacific islands.

This is the first IMF study to quantify the impact of natural disasters on Pacific island economies using a cross-country approach. Previous IMF analyses have been conducted on a country-by-country basis. After a disaster occurs, the IMF typically assesses the impact of the event on the macroeconomic framework and debt sustainability (using a debt sustainability analysis) jointly with the World Bank Group and in
collaboration with the Asian Development Bank (ADB).

Assessing the prospective fiscal costs and growth impact of natural disasters is vital to evaluate the long-term economic prospects of PICs. Mainstreaming estimates within the macro framework before an event occurs can help enhance countries’ disaster risk management and thus their ability to cope with such events. It can also help tailor better IMF policy advice. Integrating such prospective costs into the debt sustainability analysis could determine ex ante the magnitude of the need for fiscal and financial buffers and other sources of financing. It can also determine the fiscal space available for building infrastructure to address natural disasters and climate change. The chapter also presents a multipillar strategy that involves national, regional, and multilateral responses, including the engagement of the IMF. This integrated framework can provide a more strategic and less ad hoc framework for strengthening the resilience of PICs to natural disasters and climate change both before and after events.

Stylized Facts for the Pacific Islands

PICs, on average, have been more heavily affected by natural disasters relative to other small states, and the evidence for this holds across a large range of metrics:

- **Occurrence**—During the last four decades, PICs have suffered more natural disasters than small states in other regions. PICs have experienced about 2,400 tropical cyclones in the last 60 years (World Bank 2013), and their occurrence has increased over time in line with global trends (Figures 5.1 and 5.2).

- **Probability of a natural disaster**—Based on historical frequency, the probability of a natural disaster averages more than 20 percent a year across the small Pacific states and Papua New Guinea. Given that PICs are geographically dispersed, natural disasters do not hit all countries at once, although they may hit more than one country, as Cyclone Pam did in March 2015, inflicting heavy damage on Vanuatu and Tuvalu. The joint probability of the occurrence of natural disasters in more than one PIC is generally below 5 percent, with a maximum of 12 percent for Fiji and Papua New Guinea (Figures 5.3 and 5.4).

- **World Risk Index**—According to the World Risk Index, a composite measure of a country’s exposure to natural hazards and of its ability to cope with them, the Pacific islands have the highest risk of suffering a disaster. Among the 171 countries covered by the index, six Pacific islands rank among the 16 countries with the highest risk of experiencing a natural disaster, topped by Vanuatu (Figures 5.5 and 5.6).

- **Damage and losses**—Annual damage and losses, a better measure of the vulnerability of countries to natural disasters, averaged 2.3 percent of GDP in the PICs during 1980–2014, higher than in peers and non–small states. For example, even though disasters are more frequent in Papua New Guinea and Fiji, damage and losses seem to be far higher in Samoa and Vanuatu. This suggests that the intensity of natural disasters and resilience to these events vary across countries. Cross-country studies (Raddatz 2009; Cavallo and Noy 2010) show that the economic effects of natural disasters depend on a range of variables, including income level, stage of development, country size, disaster type, and disaster severity. Moreover, natural disasters generally hit less-developed economies harder than developed economies. Developed economies are more highly exposed to wealth losses, whereas large and diversified economies can better absorb shocks (Auffret 2003). Damage and losses are in fact lower in Papua New Guinea, which is not a small state, than in other PICs, even though disaster occurrence is the highest in the region. And damages and losses are also lower in Fiji, a middle-income country. Lack of diversification also heightens vulnerability to natural disasters and other shocks (Figures 5.7 and 5.8).

Figure 5.1 Average Number of Natural Disasters Each Year

Figure 5.2 Pacific Island Countries: Average Number of Natural Disasters Each Year

Figure 5.3 Probability of Occurrence of Natural Disasters during 1970–2014

Figure 5.4 Pacific Island Countries: Joint Probability of Occurrence of a Natural Disaster during 1970–2014

Figure 5.5 Natural Disaster Risks: World Risk Index, 2014
Climate change poses risks to the survival of some Pacific islands. Low-lying atolls such as Kiribati, Marshall Islands, and Tuvalu are the most vulnerable to rising sea levels. But climate change also threatens agricultural income in higher islands such as Papua New Guinea and the Solomon Islands, especially by increasing water salinity in rural areas. Sea levels are already rising, and recent studies (ADB 2013; IPCC 2013) suggest they will rise further, between 1.0 and 1.7 meters in some cases. For example, a rise of 50 centimeters would lead to a loss of 80 percent of the land in the Majuro Atoll of the Marshall Islands, and the habitability of other islands would be threatened well before lands are lost.

The interaction of climate change and natural disasters affects the Pacific islands to varying degrees. Rising temperatures are widely predicted to increase the frequency of, and risks associated with, natural disasters. Higher-elevation islands would also be hit hard, given their concentrations of population, socioeconomic activity, and infrastructure in coastal zones.

Macroeconomic Impact of Natural Disasters

Framing the Issue

Natural disasters and climate change pose macro-critical challenges to PICs, with varying degrees of severity (Figures 5.9 and 5.10). As well as their devastating human cost, natural disasters and climate change destroy or damage infrastructure and other capital, creating considerable macroeconomic volatility.

Natural disasters contribute to the higher revenue volatility experienced by PICs, relative both to other small states and to non–small states. Disasters can damage growth prospects and contribute to the low potential growth rates of PICs, and they typically worsen fiscal positions. In Chapter 10 of this volume the authors show that a natural disaster that affects 1 percent of the population in the Pacific islands causes a drop in real revenue of 0.4 percentage point, double that in other small states where the revenue drop is 0.2 percentage point. Natural disasters often expand public debt by triggering more borrowing, owing to lower revenues or increased spending, thereby intensifying balance of payments pressures.

Table 5.1 Most Recent Natural Disasters: Damages and Losses

<table>
<thead>
<tr>
<th>Country</th>
<th>Millions of U.S. Dollars</th>
<th>Percent of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiji</td>
<td>940 (2016)</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>108.8 (2012)</td>
<td>2.6</td>
</tr>
<tr>
<td>Micronesia</td>
<td>8.5 (2015)</td>
<td>3.0</td>
</tr>
<tr>
<td>Palau</td>
<td>1.2 (2013)</td>
<td>0.5</td>
</tr>
<tr>
<td>Samoa</td>
<td>210 (2012)</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>152.1 (2009)</td>
<td>25.0</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>100 (2014)</td>
<td>9.0</td>
</tr>
<tr>
<td>Tonga</td>
<td>45.4 (2014)</td>
<td>10.0</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>11.9 (2015)</td>
<td>33.6</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>20 (2014)</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>467 (2015)</td>
<td>61.0</td>
</tr>
<tr>
<td>PICs mean</td>
<td>187.7</td>
<td>20.1</td>
</tr>
<tr>
<td>PICs median</td>
<td>104.4</td>
<td>20.0</td>
</tr>
</tbody>
</table>

Sources: Country authorities; Emergency Events Database (EM-DAT); and IMF staff estimates. Note: PICs = Pacific island countries.

Figure 5.9 GDP Volatility and Intensity of Natural Disasters, 1990–2013
Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Intensity = \([\text{number of deaths} + 0.33 \times \text{number of people affected}] / \text{population}\) * 100.

Figure 5.10 Revenue Volatility and Intensity of Natural Disasters, 1990–2013

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Intensity = \([\text{number of deaths} + 0.33 \times \text{number of people affected}] / \text{population}\) * 100.

Recent Empirical Analyses

The literature reveals that the economic impact depends on the type of disaster and its magnitude, despite the stimulus of rehabilitation activity. Fomby, Ikeda, and Loayza (2013) find negative effects on growth from droughts and storms and no statistically significant effect on aggregate GDP growth from earthquakes. Raddatz (2009) finds small countries are hurt more by windstorms, but helped by moderate floods; the latter result seems to derive from higher electricity-generating capacity given more plentiful water supply. Acevedo (2014) finds negative effects from both storms and floods in Caribbean countries. Loayza and others (2009) find that although small disasters may have a positive effect in the short term (owing to reconstruction boosting growth, for example), the short-term effect of large disasters on growth is always negative.

Some international organizations have estimated the cost of natural disasters and climate change in terms of reduced economic growth. According to the World Bank (2014), natural disasters in the PICs cause damage, every year on average, of nearly 2 percent of GDP (about US$248 million). For climate change, the ADB estimates economic costs for the Pacific islands of 2.2 to 3.5 percent of GDP annually, which could rise as high as 12.7 percent by the end of the century (ADB 2013). The ADB also estimates that preparing for the effects of climate change may cost between 1½ and 2½ percent of GDP a year.²

Estimating the Macro-Fiscal Impact of Natural Disasters

As noted at the start of this chapter, this is the first cross-country IMF study assessing the impact of natural disasters on growth in the Pacific islands as a group. We use the Emergency Events Database (EM-DAT) maintained by the Centre for Research on the Epidemiology of Disasters, and the following three methodologies: (1) a panel vector autoregression model to estimate the short-term impact on growth and on the fiscal balance and its components (revenue and expenditure), (2) a panel autoregressive distributed lag model to estimate the long-term effect on GDP growth, and (3) an event analysis to study growth and fiscal performance during and after natural disasters.

Vector Autoregression Model

We use annual panel data for five countries (Fiji, Samoa, the Solomon Islands, Tonga, Vanuatu) for 1970–2013 to measure the impact of natural disasters on fiscal aggregates and growth. The panel is unbalanced because a long time series for these countries is unavailable owing to data weaknesses and because many of them became independent in the late 1970s.

The model specification includes the following variables: real GDP growth, total government spending as a percent of GDP, tax revenue as a percent of GDP, the overall fiscal balance as a percent of GDP, and a measure of natural disaster intensity. Following Fomby, Ikeda, and Loayza (2013), the disaster intensity is proxied by the share of the fatalities and of the overall affected population and defined as:

$$I = \frac{\text{number of deaths} + 0.33 \times \text{number of people affected}}{\text{population}} \times 100$$

The identification strategy assumes that natural-disaster damage affects real GDP growth and fiscal variables in the current period, while natural disasters are exogenous.² This assumption is implemented with a Choleski decomposition. The vector autoregression is described by the equations below, with the lag structure set to one in order to minimize the number of parameters estimated:

$$\begin{align*}
\Delta y_t &= \alpha_i + \beta_i \Delta y_{t-1} + \sum_{j=1}^{5} \gamma_{ij} \Delta y_{t-j} + \epsilon_t \\
\epsilon_t &\sim \text{i.i.d. normal} \\
\end{align*}$$

where

$$i = \{\text{Fiji, Samoa, the Solomon Islands, Tonga, Vanuatu}\}.$$  

The estimation results show that natural disasters reduce short-term growth. The effects of a natural disaster with an intensity affecting 1 percent of the population are shown in the impulse responses plotted in Figure 5.11. The shock causes growth to contract by about 0.5 percentage point in the year of the disaster. A natural disaster that causes damage and losses equal to 1 percent of GDP causes an average drop in GDP of 0.7 percentage point in the year of the disaster. This is equal to an annual drop on average of 2.1 percent for all the Pacific islands, based on historical data on damage and losses (Figure 5.12).

Figure 5.11 Response of Growth and Fiscal Aggregates to a Natural Disaster with Intensity Equivalent to 1 Percent of the Population Affected

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Figure 5.12 Pacific Island Countries: Short-Term Impact of Natural Disasters on GDP Growth

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.
Natural disasters also worsen the fiscal positions of PICs. For damage and losses equal to 1 percent of GDP, GDP growth drops by 0.7 percentage point.

These results are robust to an alternative definition of disaster intensity (Figure 5.13). This includes damage and losses in percent of GDP as the disaster variable instead of disaster intensity. The results are broadly similar; the main difference is that GDP growth returns to the predisaster trend faster than in the first specification and that spending consistently picks up in the year after the disaster, with possible delays in reconstruction activity. It also takes longer for the fiscal balance to return to the preshock trend.

The results are also robust to global shocks and different lag specifications. Estimations that include two and three lags present analogous impulse responses, in terms of the sign of the responses. Including real world GDP growth and changes in oil prices as measures of global shocks affects the estimations minimally.

Figure 5.13 Response of Growth and Fiscal Aggregates to 1 Percent of GDP Damage Shock

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Autoregressive Distributed Lag Model

We estimate the impact of natural disasters on long-term growth using a panel autoregressive distributed lag model with fixed effects. We use annual panel data for five countries (Fiji, Papua New Guinea, Samoa, Tonga, Vanuatu) for 1970–2014. The dependent variable is real GDP (in log). The explanatory variables are population, capital stocks (both in log), and damage and losses (in percent of GDP). The capital stock series is constructed applying the perpetual inventory method.

The econometric result shows that for damage and losses equal to 1 percent of GDP, growth in PICs falls on average by 0.3 percentage point over 10 years (Figure 5.14 and Annex 5.1). This means that during 1980–2014 trend growth was 0.7 percentage point lower than it would have been without natural disasters. The actual average growth for the PICs during the same period averaged 2.6 percent; without natural disasters, the average would have been 3.3 percent (Figures 5.15 and 5.16).

Figure 5.14 Pacific Island Countries: Long-Term Impact of Natural Disasters on Trend GDP

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Note: Trend GDP is calculated as a 10-year moving average of real GDP.

Figure 5.15 Pacific Island Countries: Long-Term Impact of Natural Disasters on Trend Growth

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

Note: According to the panel autoregressive distributed lag model, for every incident of damage and losses equivalent to 1 percent of GDP, GDP growth drops by 0.3 percent over 10 years. Given historical data on damages and losses, the average GDP growth drop during 1980–2014 was 0.7 percentage point.

Figure 5.16 Pacific Island Countries: Long-Term Impact of Natural Disasters on Trend Growth

Sources: Emergency Events Database (EM-DAT); and IMF staff estimates.

The long-term impact of natural disasters on GDP growth is substantial. Assume that before a disaster, GDP grows at 3 percent. The 10-year growth on a cumulative basis would then be 34 percent. After a disaster, with damage and losses equal to 60 percent of GDP, growth falls by 18 percentage points (that is, 60 multiplied by 0.3), resulting in a 10-year growth loss of 16 percent on a cumulative basis (Table 5.2).

Table 5.2 Illustration of Long-Term Impact of Natural Disasters on GDP Growth

<table>
<thead>
<tr>
<th></th>
<th>Before Natural Disaster</th>
<th>After Natural Disaster</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual GDP growth (in percent)</td>
<td>3.0</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Cumulative GDP growth over 10 years (in percent)</td>
<td>34.0</td>
<td>16.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>

Source: Authors' calculations. Note: Assumes damage and losses of 60 percent of GDP. The number 18 is equivalent to 0.3%60. See Annex Table 5.1 for the coefficient on damage and losses. Since real GDP is in log while damage and losses are expressed in percent of GDP, the coefficient 0.003 is multiplied by 100. Calculated as \( (1 + \text{annual growth rate})^{10} \).

Source: Authors' calculations. Note: Assumes damage and losses of 60 percent of GDP. The number 18 is equivalent to 0.3%60. See Annex Table 5.1 for the coefficient on damage and losses. Since real GDP is in log while damage and losses are expressed in percent of GDP, the coefficient 0.003 is multiplied by 100. Calculated as \( (1 + \text{annual growth rate})^{10} \).
Event Analysis

Using an event analysis, we study growth performance during and after natural disasters. We define a natural disaster episode as one that results in damage and losses of at least 10 percent of GDP. In contrast to the other two econometric models, event analysis focuses on the relationship between growth performance and natural disaster shocks before, during, and after an episode. While event analysis does not attempt to determine the direction of causality, it represents a useful complement to econometric models because it allows us to uncover the nonlinear dynamics of economic relationships that are likely to be missed by standard econometric specifications.

A main finding is that a loss in output relative to the predisaster GDP growth trend persists after two years, with the fiscal balance remaining as negative as in the year of the disaster. While not a conclusive determinant of the growth effects of natural disasters, these events were probably dominant factors affecting the economies at the time. On average growth was zero in the year of the disaster. While growth rebounds fairly quickly (on average two years after the disaster), it is below the growth rate prior to the disaster. The still-large fiscal balance deterioration is consistent with the results of the vector autoregression and may reflect infrastructure rehabilitation and rebuilding (Figures 5.17 and 5.18).

Figure 5.17 Event Analysis: Real GDP Growth before and after Natural Disasters

Sources: Centre for Research on the Epidemiology of Disasters, International Disaster Database; and IMF staff estimates.

Note: Based on natural disasters with damage and losses larger than 10 percent of GDP during 1970–2013. Average of two years before and average of two years after. The median damage of these natural disasters was 26 percent of GDP.

Figure 5.18 Event Analysis: Fiscal balance before and after Natural Disasters

Sources: Center for Research on Epidemiology for Disasters, International Disaster Database; and IMF staff estimates.

Note: Based on natural disasters with damage and losses larger than 10 percent of GDP during 1970–2013. Average of two years before and average of two years after. The median damage of these natural disasters was 26 percent of GDP.

Increasing Macro-Fiscal Resilience by Enhancing Disaster Risk Management: A Multipillar Framework

Policies that support strong fundamentals can foster resilience. Some PICs have rebuilt or made progress in rebuilding fiscal buffers since the global financial crisis. But more than half still have less-comfortable buffers (higher debt, lower fiscal balances and reserves) than before the crisis. Enhancing resilience to natural disasters and climate change demands a multipillar strategy at the national, regional, and multilateral levels, and it also requires enhancing countries’ risk-management capacity (Figure 5.19). The key pillars of disaster risk management before the event include (Laframboise and Loko 2012):

Figure 5.19 Multipillar Framework: Strengthening Resilience before and after Disasters

Note: DSAs = debt sustainability analyses; PFM = public financial management. Green shows the role of the IMF.

- Identifying and undertaking risk assessment. At the national level, building resilience before an event entails identifying risks and explicitly integrating these risks into the fiscal frameworks and budget planning.
- Providing self-insurance by building policy buffers to enhance resilience to shocks (lower debt, higher fiscal balances and reserves).
- Reducing risks by enhancing preparedness, including by investing in “smart” infrastructure that can better cope with climate change and natural hazards and by enhancing debt-management capacity.
- Transferring risk through private or sovereign insurance and through multilateral risk sharing (that is, international safety net):
  - Insurance is provided through the Pacific Catastrophe Risk Insurance Pilot for the Pacific islands, a joint initiative between the Secretariat of the Pacific Community, the World Bank Group, and the ADB, with financial support from the government of Japan and the Global Facility for Disaster Reduction and Recovery. This very innovative scheme, covering Marshall Islands, Samoa, the Solomon Islands, Tonga, and Vanuatu, was launched in January 2013 and concluded its first phase in October 2014. The pilot began its second phase in November 2014 and is expected to be concluded in October 2015. The scheme offers immediate funding in the wake of severe natural disasters (World Bank 2013) to currently participating countries: the Cook Islands, Marshall Islands, Samoa, Tonga, and Vanuatu. The government of Japan provided an additional US$1 million to fund premium subsidies for four of the participating countries (the Cook Islands is self-funding). The pilot uses “parametric triggers” such as cyclone intensity or earthquake magnitude to determine payouts. In January 2014 Tonga became the first country to benefit from a payout under the pilot of US$1.3 million, and Vanuatu received US$1.9 million after Cyclone Pam. Damages and losses were US$45.4 million in Tonga and US$467 million in Vanuatu.
Coping with natural disasters coupled with ensuring a resilient recovery is the main pillar of disaster risk management after an event. The main actions at the national level include emergency response and reconstruction efforts. A sound reconstruction program should consist of measures to reduce risks, such as resettlement away from coastlines, where feasible, and infrastructure investment. Reconstruction can provide an opportunity to accelerate broader growth-enhancing structural reforms.

Donor financing will remain important in enhancing resilience to cope with natural disasters and climate change as the PICs are too small and the costs too high to be fully internalized by building buffers. Moreover, building buffers also has an opportunity cost. Participation in insurance mechanisms is very promising, but so far the disbursement has been limited. However, increased global resources are being made available for climate change finance under the United Nations Framework Convention on Climate Change, with a new target of raising US$100 billion a year by 2020 to cover rising climate change costs. But access to global funding for the PICs is challenging because of capacity constraints, so bilateral funding remains critical. Moreover, the complexity of numerous financing instruments can add to the overall donor coordination challenge (Annex 5.2). Donor funding is a necessary part of resilience for small Pacific island states. Donor coordination should also be strengthened among multilateral institutions, donors, national authorities, and civil society, especially given the limited administrative capacity of these countries.

The Role of the IMF

The IMF is increasingly incorporating macro-critical challenges posed by natural disasters and climate change into its work. The IMF has been looking at how to help countries respond through policy advice (surveillance), financial support, and technical assistance and training to build capacity (IMF 2012). The IMF recently published a staff guidance note on small states that recognizes the importance of natural disaster management and climate change (IMF 2014d). Among other policy messages, the note emphasizes the need to enhance resilience to shocks and climate change. It incorporates several of the lessons cited in this chapter, including the potential for recovery programs to pursue growth-enhancing reforms. The guidance note recognizes the complex nature of climate-change-financing arrangements and the problems posed by lack of capacity in accessing climate change resources. As such, in their consideration of fiscal space in the surveillance context, the IMF staff is advised to be sensitive to the long-term implications of climate change for the public investment needs of small states and to be ready to consider how these might be financed.

Surveillance

The 2013 IMF Board paper on small states (IMF 2013a) indicates that fostering resilience before the event requires:

- Integrating natural disaster risks into macro frameworks to determine the magnitude of the buffers (or self-insurance) needed and of the required outside insurance.
- Ensuring sufficient flexibility to help redeploy spending rapidly.
- Ensuring sufficient policy space (external reserves and low debt) to help mitigate potential balance of payments shortfalls.

After the event, an efficient response—that is, in the area of resilience—requires greater transparency to ensure the effective use of disaster assistance, strengthening coordination among development partners and authorities, and pursuing growth-enhancing structural reforms.

The costs of natural disasters and climate change are also included in the debt sustainability analysis and scenario analysis in the Article IV consultations. Kiribati’s recent Article IV reports (IMF 2011, 2014b) describe climate change vulnerabilities that have slowed Kiribati’s achievement of poverty reduction goals owing to the need to divert resources from development spending to building seawalls. Debt sustainability analyses on Kiribati have highlighted the fiscal risks arising from uncertain climate change costs and the importance of external assistance for concessional finance (IMF 2011). The 2014 Article IV Consultation Staff Report for Tonga (IMF 2014c) assessed the impact of Cyclone Ian, which hit the country in January 2014 provoking damages and losses of about 10 percent of GDP. The 2015 Article IV Consultation Staff Report for Samoa analyzed the impact of natural disasters on debt (IMF 2015b).

Financial Support

The IMF offers financing to meet a broad range of urgent balance of payments needs, including those arising from natural disasters. Although sometimes limited in magnitude, IMF financial support catalyzes external finance from other sources. IMF financing to support countries hit by natural disaster includes:

- The Rapid Credit Facility (RCF), which provides rapid financial support in a single, up-front payout for low-income countries facing urgent financing needs. Financial assistance under the RCF is provided as an outright disbursement to Poverty Reduction and Growth Trust (PRGT)-eligible members that face an urgent balance of payments need, and where a full-fledged economic program is either not necessary or not feasible. Financing under the RCF carries a zero interest rate through 2016 and has a grace period of 5½ years and a final maturity of 10 years. The Rapid Financing Instrument (RFI) is similar to the RCF and designed for situations where a full-fledged economic program is either not

Note: The text above is a natural representation of the document's content as provided. It does not include all historical references or technical details, focusing on the core narrative and key points relevant to the topic of natural disasters and their financial implications.
IMF policy advice on coping with natural disasters is also supported by technical assistance and training. For example, technical assistance on public financial management, which improves budget planning and enhances transparency of public funds, helps improve the foundation on which PICs seek natural disaster and climate change assistance. A sound public financial management system is essential to enhancing risk management related to these events by incorporating disaster risk into fiscal planning. The IMF also supports public financial management reform needed for climate change access through Public Expenditure and Financial Accountability assessments.

Public financial management reform and more transparent aid management policies enhance the effectiveness and quality of public expenditure, and so offer benefits that extend beyond climate change and natural disaster management. A Nauru case study by the Pacific Islands Forum Secretariat (2013a) offers several lessons on this, including the benefits of integrating climate change into national plans, policies, and budgets, and of tracking spending through budget systems. The study also cites the difficulties in quantifying the extent of external financing available for climate change and distinguishing this financing from existing development assistance. These challenges are likely to divert capacity from other aspects of core policy management.

The IMF also provides technical assistance to all members interested in adopting environmental tax reforms. Fiscal policies should take center stage in trying to get energy prices to reflect the harmful environmental side effects associated with energy use, notably climate change (de Mooij, Keen, and Parry 2012).

The Pacific Financial Technical Assistance Centre, in coordination with the World Bank’s Disaster Risk Financing and Insurance Program, held a regional workshop in March 2015 hosted by the Pacific Islands Forum Secretariat on incorporating natural disaster risks into the fiscal planning process. The workshop addressed such issues as special budgetary procedures for providing rapid access to emergency funding, the macroeconomic and fiscal impact of natural disasters, incorporating disaster risk into the fiscal planning process, and disaster risk financing.

Conclusions

Pacific island countries face severe challenges from natural disasters and climate change. These events have an impact on both potential growth and public finances.

A more strategic approach is needed to help countries deal with the increasing frequency and magnitude of these events. Explicit recognition of the costs of natural disasters and climate change in baseline macro frameworks and debt sustainability analyses is important, particularly given the risks that these events will become increasingly severe over time. While building policy buffers is especially relevant in the small states of the Pacific to enhance resilience before these events occur, these countries will need to continue to be supported by access to external assistance and insurance schemes. In addition to providing financing support, the IMF can also help by continuing to provide technical assistance and training to enhance

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- **Samoa** was hit by Tropical Cyclone Evan in December 2012, leading to loss of life and damage estimated at 30 percent of GDP. A request for a one-off disbursement of US$8.6 million under the RCF facility was approved by the IMF Board in May 2013 (IMF 2013b). In 2009, Samoa was hit by a tsunami whose damage and losses were estimated at 25 percent of GDP, and IMF financial assistance (equivalent to US$9.3 million) was also provided (IMF 2010).

- **Vanuatu**, in June 2015, received financial support from the IMF following the devastating cyclone of March 2015. The IMF Board approved a disbursement of about US$11.9 million under the RCF and disbursement of about US$11.9 million under the RFI (IMF 2015a). As in the case of Samoa, this financial assistance was intended to help Vanuatu cope with its immediate balance of payments needs and to catalyze critical donor support for the recovery.

- **Augmentation of an existing program**—When a country with an IMF-supported program is hit by a natural disaster, augmented financing under the existing program could be the usual channel for providing additional financial support.

- **IMF Catastrophe Containment and Relief (CCR) Trust**—This replaced the Post-Catastrophe Debt Relief Trust in February 2015. It allows the IMF to join international debt relief efforts when poor countries are hit by catastrophic natural disasters or public health disasters. The IMF can provide debt relief to free up resources to meet exceptional balance of payments needs created by the disaster, rather than having to assign those resources to debt service. The Catastrophe Containment and Relief Trust is available to 38 low-income countries eligible for concessional borrowing through the Poverty Reduction and Growth Trust that also have either income per capita below US$1,215 or, for small states, a population below 1.5 million and income per capita below US$2,430. Among the PICs, only the Solomon Islands meets these criteria. A country qualifies under the trust if it is hit by a disaster that directly affects at least one-third of the population and destroys more than a quarter of productive capacity. This is estimated by such early indications as destroyed structures and the impact on key economic sectors and public institutions, or by damage exceeding 100 percent of GDP.

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countries’ risk-management capacities, thereby continuing to also foster resilience before disasters occur.

Disaster Risk Reduction & Climate Change Adaptation in the Pacific. Copyright © UNISDR Asia and Pacific 2012. ISBN: 978 – 982 – 533 -001 -1 . 4. Implement, improve and maintain local monitoring frameworks for vulnerability and resilience tracking and reporting; and strengthen DRM and CCA monitoring capacities by participating in the progress review processes of the Hyogo and Madang frameworks for action and the Pacific Islands Framework for Action on Climate Change. Climate change has always happened on Earth, which is clearly seen in the geological record; it is the rapid rate and the magnitude of climate change occurring now that is of great concern worldwide. Greenhouse gases in the atmosphere absorb How do changes in climate and land use relate to one another? The link between land use and the climate is complex. First, land cover—as shaped by land use practices—affects the global concentration of greenhouse gases. In the Western United States, the availability of water has become a serious concern for many communities and rural areas. Near population centers, surface-water supplies are fully appropriated, and many communities are dependent upon ground water drawn from storage, which is an unsustainable strategy. Enhancing Macroeconomic Resilience to Natural Disasters and Climate Change in the Small States of the Pacific. 2015 - Asia and Pacific Department. In-text: (Cabezon et al., 2015). Your Bibliography: Cabezon, E., Hunter, L., Tumbarello, P., Washimi, K. and Wu, Y. (2015). Enhancing Macroeconomic Resilience to Natural Disasters and Climate Change in the Small States of the Pacific. 1st ed. [ebook] Asia and Pacific Department, pp.6-10. Available at: http://www.imf.org/external/pubs/ft/wp/2015/wp15125.pdf [Accessed Jun. 2015]. Magazine. Tabureguci, D. and Sharma, D. Preparedness is key in natural d...

Annex 5.1. Autoregressive Distributed Lag Model

The autoregressive distributed lag (ARDL) methodology is valid regardless of whether the regressors are exogenous or endogenous, and irrespective of whether the underlying variables are integrated of order 1 or zero, as shown in Annex Table 5.1.

**Annex Table 5.1.1 Fixed Effects Estimates of the Long-Term Effects Based on the ARDL Model**

<table>
<thead>
<tr>
<th>Dependent Variable: Real GDP (log)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock (log)</td>
<td>0.344***</td>
</tr>
<tr>
<td>Population (log)</td>
<td>0.628***</td>
</tr>
<tr>
<td>Damage and losses (percent of GDP)</td>
<td>−0.003**</td>
</tr>
<tr>
<td>F-statistics for cointegration</td>
<td>4.851***</td>
</tr>
<tr>
<td>Observations</td>
<td>225</td>
</tr>
<tr>
<td>Number of countries</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Authors’ compilation. Note: The lag length was selected using Schwarz’s Bayesian criterion. Estimation period: 1970–2014. *** p<0.01, ** p<0.05, * p<0.1.

Annex 5.2. Sources of International Financing to Cope with Natural Disasters and Climate Change

**Annex Table 5.2.1 Selected Programs and Funds**

<table>
<thead>
<tr>
<th>Institution</th>
<th>Programs/Funds</th>
<th>Purpose</th>
<th>Period</th>
<th>Amounts</th>
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</tr>
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</table>

Source: Authors’ compilation. Note: The lag length was selected using Schwarz’s Bayesian criterion. Estimation period: 1970–2014. *** p<0.01, ** p<0.05, * p<0.1.

Annex Table 5.2.1 Selected Programs and Funds
### Asian Development Bank (ADB)

#### Pacific Climate Change Program (PCCP)

- **Purpose**: Climate change
- **Period**: 2011–14
- **Amounts**: US$240 million

The ADB is delivering an integrated program to its Pacific Developing Member Countries (DMCs) to address both mitigation and adaptation to climate change, focusing on climate and disaster proofing of the investment portfolio and scaling up renewable energy. In the Pacific, the ADB has facilitated access to international climate financing primarily as cofinancing of investments. The ADB has set up dedicated climate facilities funded by its own resources and bilateral partners. Out of the ADB’s own funds, approximately US$172 million funded adaptation and mitigation costs of projects during 2011–14. In addition, the ADB mobilized about US$68 million from global funds from the Least Developed Country Fund (LDCF) and the Climate Investment Fund’s Pilot Program for Climate Resilience (PPCR).

<table>
<thead>
<tr>
<th>Institution</th>
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<th>Purpose</th>
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<th>Amounts</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADB</td>
<td>Asia Pacific Disaster Response Fund (APDRF)</td>
<td>Natural disasters</td>
<td></td>
<td>US$3 million per event</td>
<td>Incremental grant resources for developing member countries impacted by a major natural disaster, with quick-disbursing grants to assist ADB DMCs to restore life-saving services and augment aid provided by other donors. Since 2011, ADB has approved eight APDRF projects in the Pacific.</td>
</tr>
</tbody>
</table>
### ADB

**Programs/Funds**: Disaster Response Facility (DRF)

- **Purpose**: Natural disasters
- **Period**: Since 2011
- **Amounts**: US$26 million

The DRF supports emergency assistance, restoration, and rehabilitation and reconstruction needs. The assistance is provided in the form of grants or loans depending on a country’s status. In the case of a disaster, countries eligible for financing by the Asian Development Fund can get up to 100 percent of their annual performance-based allocation (PBA) or US$3 million per disaster, whichever is higher; a blend country can receive up to 3 percent of its annual PBA. Since 2011, the ADB has helped Pacific countries access US$26 million from the DRF through three projects (in Samoa, the Solomon Islands, and Tonga).

### European Union

**Programs/Funds**: African, Caribbean and Pacific (ACP)-EU Building Safety and Resilience in the Pacific

- **Purpose**: Disaster risk reduction and climate change adaptation
- **Period**: 2013–18
- **Amounts**: €20 million

Strengthen the capacity of PICs to address existing and emerging challenges with regard to the risks posed by natural hazards and related disasters, while maximizing synergies between disaster risk reduction (DRR) strategies and climate change adaptation (CCA).

**Programs/Funds**: ACP-EU Natural Disaster Risk Reduction Programme (NDRR)

- **Purpose**: Disaster risk reduction and climate change adaptation
- **Period**: 2011–20
- **Amounts**: Total: €80 million Indicative Pacific: €13.7 million

Address prevention, mitigation, and preparedness in response to natural hazards in ACP member states, focusing on mainstreaming disaster risk reduction, risk identification and assessment, early warning systems and communication on DRR, and risk transfer and integration of DRR into recovery.
<table>
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<tr>
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<th>Period</th>
<th>Amounts</th>
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</tr>
</thead>
<tbody>
<tr>
<td>European Union</td>
<td>Intra-ACP Global Climate Change Alliance (GCCA)</td>
<td>Climate change adaptation and mitigation</td>
<td>2012–16</td>
<td>€37 million</td>
<td>Indicative: Pacific €8.0 million. Integrated strategies, mainstreaming climate change in national development planning and budgeting, institutional and capacity strengthening, and fostering dialogue and exchange of experiences to address climate change in developing economies.</td>
</tr>
<tr>
<td>European Union/UNESCAP/ILO/UNDP</td>
<td>Enhancing the Capacity of Pacific Island Countries to Address the Impacts of Climate Change on Migration</td>
<td>Climate change and migration</td>
<td>Ends in 2016</td>
<td>€2.1 million</td>
<td>Capacity building on climate-change-induced migration financed through the European Initiative for Democracy and Human Rights (EIDHR).</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Index Insurance Facility (GIIF)</td>
<td>Disaster risk reduction</td>
<td>2008–16</td>
<td>€24.5 million (all ACP countries)</td>
<td>Reduce the vulnerability of the ACP population to external shocks/natural disasters through expansion of the use of index insurance as a risk management tool in ACP countries. GIIF seeks to introduce a new and more efficient approach (indexed or parametric insurance) for mitigating weather/catastrophic risks in developing economies.</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) South Pacific</td>
<td>Mainstreaming adaptation</td>
<td>2011–15</td>
<td>€10 million</td>
<td>Secretariat of the Pacific Community, Secretariat of the Pacific Regional Environment Programme: Overall development and poverty reduction, coastal zone management, health, infrastructure, and water and sanitation.</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) Papua New Guinea</td>
<td>UN-REDD–Forest</td>
<td>2013–17</td>
<td>€8.6 million</td>
<td>Contributes to the implementation of the national REDD readiness plan.</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) Samoa</td>
<td>Mainstreaming adaptation/disaster risk reduction</td>
<td>2012–15</td>
<td>€3.0 million</td>
<td>Contributes to the implementation of the national Water for Life Sector Plan – Water and sanitation.</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) The Solomon Islands</td>
<td>Mainstreaming adaptation</td>
<td>2011–14</td>
<td>€2.8 million</td>
<td>Overall development and poverty reduction. Contributes to the implementation of the Solomon Islands National Adaptation Programme of Action (NAPA) priorities and the National Disaster Risk Management Plan.</td>
</tr>
<tr>
<td>Institution</td>
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<td>Period</td>
<td>Amounts</td>
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</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) Timor-Leste</td>
<td>Mainstreaming adaptation</td>
<td>2013–18</td>
<td>€4.0 million</td>
<td>Overall development and poverty reduction, forests, agriculture, and natural resource management.</td>
</tr>
<tr>
<td>European Union</td>
<td>Global Climate Change Alliance (GCCA) Vanuatu</td>
<td>Mainstreaming adaptation/disaster risk reduction</td>
<td>2010–14</td>
<td>€3.2 million</td>
<td>Overall development and poverty reduction, agriculture, natural resource management, and water and sanitation. Contributes to the implementation of the measures identified in the NAPA.</td>
</tr>
<tr>
<td>European Union</td>
<td>Pro-Resilience Action</td>
<td>Building resilience in response to food crises</td>
<td>2014–20</td>
<td>Indicative €65 million a year (worldwide)</td>
<td>Supporting the poor and food insecure to react to crises by addressing the effects of the crises and strengthening their resilience. The action is worldwide, and Pacific small island developing states can access support if they are stricken by a food crisis. The program does not respond specifically to natural disasters. However, the program can be activated if a natural disaster has impacts in terms of food and nutrition security.</td>
</tr>
</tbody>
</table>
ACSE will help 15 Pacific island countries (PICs) adapt to adverse effects of climate change and enhance their energy security at national, provincial, and local/community levels. The objectives are: (1) create and/or strengthen national technical expertise on climate change adaptation and sustainable energy, (2) improve cost-effective and efficient energy systems to reduce fossil fuel dependency, and (3) improve communities’ adaptive capacity to cope with climate change challenges. Another aim of the ACSE program is to enhance sustainable livelihoods through the support of government institutional efforts and empowering communities to increase their self-reliance and their ability to cope with the effects of climate change through appropriate practices in agriculture and coastal fishery, by disseminating improved plant varieties that are resistant to saltwater, by securing their daily water supply, and by improving their access to energy, among other initiatives.
<table>
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<tr>
<td>United Nations</td>
<td>Adaptation Fund (AF)</td>
<td>To finance concrete adaptation projects and programs in developing-country parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.</td>
<td>Established 2001</td>
<td>The Adaptation Fund was established to finance concrete adaptation projects and programs in developing-country parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change. The Adaptation Fund is financed from the share of proceeds of the clean development mechanism (CDM) project activities and other sources of funding. The share of proceeds amounts to 2 percent of certified emission reductions (CERs) issued for a CDM project activity. The Adaptation Fund is supervised and managed by the Adaptation Fund Board (AFB). The AFB is composed of 16 members and 16 alternates and meets at least twice a year.</td>
<td></td>
</tr>
<tr>
<td>World Bank/United Nations</td>
<td>Global Facility for Disaster Reduction and Recovery (GFDRR)</td>
<td>To mainstream disaster risk reduction and climate change adaptation in country development strategies by supporting a country-led and country-managed implementation of the Hyogo Framework for Action (HFA).</td>
<td>Established For projects 2006</td>
<td>US$100,000 to US$1 million</td>
<td>GFDRR is a partnership of 35 countries and six international organizations committed to helping developing economies reduce their vulnerability to natural hazards and adapt to climate change. The partnership’s mission is to mainstream disaster risk reduction and climate change adaptation in country development strategies by supporting a country-led and country-managed implementation of the Hyogo Framework for Action (HFA).</td>
</tr>
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</table>
The IRM allows IDA countries to rapidly access up to 5 percent of their undisbursed IDA investment project balances following a crisis (natural disasters and economic shocks). Small states and countries with small undisbursed project balances will be able to access up to USD 5 million. The IRM complements longer-term emergency response tools available to IDA countries, such as the Crisis Response Window.

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<tbody>
<tr>
<td>World Bank Group, International Development Association (IDA)</td>
<td>Immediate Response Mechanism (IRM)</td>
<td>Natural disasters</td>
<td>Established December 2011</td>
<td>5 percent of undisbursed IDA project balances, or SDR 5 million.</td>
<td>The IRM allows IDA countries to rapidly access up to 5 percent of their undisbursed IDA investment project balances following a crisis (natural disasters and economic shocks). Small states and countries with small undisbursed project balances will be able to access up to USD 5 million. The IRM complements longer-term emergency response tools available to IDA countries, such as the Crisis Response Window.</td>
</tr>
<tr>
<td>World Bank Group, IDA</td>
<td>Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI)</td>
<td>Natural disasters</td>
<td>November 2012 to November 2014</td>
<td>USD 45 million in aggregate coverage</td>
<td>Participating countries select per-peril coverage and option of coverage attaching at loss levels of a severity of recurrence of 1 in 10, 15, or 20 years (or less frequent). Five PICs participated in the initial 2012–13 pilot, which had an aggregate limit of USD 45 million and an annual expected loss of USD 1 million. The scheme covers Marshall Islands, Samoa, the Solomon Islands, Tonga, Vanuatu, and the Cook Islands.</td>
</tr>
<tr>
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<tr>
<td>World Bank Group (Trustee)</td>
<td>Climate Investment Funds (CIF)</td>
<td>Climate change</td>
<td>Established 2008</td>
<td></td>
<td>The CIF provides funding to 48 developing and middle-income countries. Funding is from contributor countries, with co-funding sought from the private sector. The CIF fosters partnerships through a programmatic approach, whereby CIF countries, with support from the multilateral development banks, lead investment planning and implementation. The CIF has four funding windows: (1) the $5.5 billion Clean Technology Fund (CTF); (2) the $639 million Forest Investment Program (FIP); (3) the $1.3 billion Pilot Program for Climate Resilience (PPCR); and (4) the $551 million Scaling Up Renewable Energy in Low Income Countries Program (SREP).</td>
</tr>
<tr>
<td>World Bank Group IDA</td>
<td>Climate and disaster resilience</td>
<td>2011–15</td>
<td>US$150 million</td>
<td></td>
<td>The IDA-17 Replenishment requires Country Partnership Frameworks to incorporate climate and disaster risk considerations, and for all IDA operations to be screened for short- and long-term climate change and disaster risks, integrating resilience measures as appropriate. This includes both concessional credits and IDA grants that are used to support climate and disaster resilience.</td>
</tr>
<tr>
<td>World Bank Group</td>
<td>International Bank for Reconstruction and Development (IBRD)</td>
<td>Climate and disaster resilience</td>
<td>2011–15</td>
<td>US$15 million</td>
<td>The IBRD aims to reduce poverty in middle-income countries and creditworthy poorer countries by promoting sustainable development through loans, guarantees, risk-management products, and analytical and advisory services.</td>
</tr>
</tbody>
</table>
Total funding for 2010/11 and 2012/13 was A$599 million.

Support to developing countries to adapt to climate change, reduce their carbon emissions, and pursue cleaner development. Focus is on least developed countries and small island developing states. Efforts will build on work to reduce emissions from deforestation, pilot low emission development pathways, and engage in key international development and environment forums.

Japan will provide assistance to PICs that are battling rising sea levels and natural calamities as a result of global warming. Focus is on disaster risk reduction, climate change, environment, people-to-people exchanges, sustainable development, maritime issues and fisheries, and trade, investment, and tourism.

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</tr>
</thead>
<tbody>
<tr>
<td>Australian Department of Foreign Affairs and Trade (DFAT)</td>
<td>DFAT</td>
<td>Climate change</td>
<td>Total funding for 2010/11 and 2012/13 was A$599 million</td>
<td></td>
<td>Support to developing countries to adapt to climate change, reduce their carbon emissions, and pursue cleaner development. Focus is on least developed countries and small island developing states. Efforts will build on work to reduce emissions from deforestation, pilot low emission development pathways, and engage in key international development and environment forums.</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan’s Assistance Package for PICs at the 7th Pacific Islands Leaders Meeting (PALM7)</td>
<td>Climate change</td>
<td>2015–17</td>
<td>US$450 million</td>
<td>Japan will provide assistance to PICs that are battling rising sea levels and natural calamities as a result of global warming. Focus is on disaster risk reduction, climate change, environment, people-to-people exchanges, sustainable development, maritime issues and fisheries, and trade, investment, and tourism.</td>
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