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# RESILIENCE TO SHOCKS

## RESILIENCE TO SHOCKS

The world has been subject to a series of shocks – from economic crises in rich countries, to natural disasters in developing countries, along with floods or droughts in key food producing regions. In a complex global economy, these crises have become increasingly interrelated. If the countries of Asia and the Pacific are to become more resilient to these regular, overlapping shocks, they will need to address them in a more comprehensive and systemic manner.

In early 2011, the people of Dhamuirhat, a rural community in Bangladesh, were taken by surprise by high food prices. The shop prices of key items such as rice, flour, soybean oil and chicken were 30 per cent higher than a couple of months earlier. As one agricultural worker said: “I am often afraid to ask the price.”<sup>1</sup>

The people of Dhamuirhat did not know that these high prices had their origins in distant places. In the Russian Federation, for example, in June 2010, an abnormal heat wave had hit the wheat fields, causing fires and leading to the worst drought in nearly 40 years. Added to this were historically severe floods in Pakistan. These and other events were restricting global food supplies.

News of such shortages was transmitted instantly to the trading floor of the Chicago Mercantile Exchange where buyers and sellers match orders and haggle over futures and options contracts for agricultural commodities. Tight global supply coupled with financialization of commodity markets drove prices up. By February 2011, the global prices of wheat and other cereals had soared to record highs – which were soon reflected in local markets around the world. This was the beginning of a ‘new normal’ of high food prices.

This would have been difficult enough to cope with on its own. But people were already under pressure from another shock: the 2008 global financial crisis. The collapse of the American investment bank Lehman Brothers in September 2008 had eventually triggered a freeze in the global financial system. In Asia and the Pacific, this was felt primarily through a dramatic decline in trade. Within a couple of months, Asia-Pacific exports had collapsed – threatening the jobs of millions of workers.

“Why should something that happens ten thousand miles away affect me?” asked a female worker in the India state of Karnataka, as jobs started to disappear in early 2009. She had lost her employment in a small-scale business exporting handmade dolls.<sup>2</sup>

In an increasingly globalized economy, natural disasters can also be linked to employment in more oblique ways. In the Compostela Valley in the southern island of Mindanao in the Philippines, for example, small-scale gold miners had benefited from the high price of gold – an attractive alternative investment in times of uncertainty. Between 2008 and 2012, the price more than doubled. This, combined with the discovery of rich deposits, had lured thousands

of poor migrants from other islands to try their luck in the mountainous and landslide-prone sites in the Compostela Valley. That all came to an end at 4:45 am on 4 December 2012, when Typhoon Pablo made landfall in Mindanao.<sup>3</sup> The effect was catastrophic. But here too survivors would have found it hard to link that destruction with the global economic crisis.

All these crises are the result of shocks applied to complex interlinked systems. And globalization is binding these systems ever more closely together – and demanding that countries move aggressively towards comprehensive risk management. One of the most pressing development challenges is to build resilience to such combined crises (Box I-1).

## BOX I-1

### Resilience within the United Nations development agenda

The crucial need to build resilience was recognized in the Hyogo Framework for Action 2005–2015 (HFA): Building the Resilience of Nations and Communities to Disasters. This was adopted at the United Nations World Conference on Disaster Reduction in Kobe, Japan, in 2005 – only days after the 2004 Indian Ocean earthquake.<sup>4</sup> The HFA was subsequently endorsed by the General Assembly in its resolution 60/195 on the International Strategy for Disaster Reduction.

The ESCAP Commission in 2008 requested the Executive Secretary to continue to assist member countries in building their capacity to make appropriate policy responses that mitigate the impact of the economic crises, restore growth and avoid future global shocks – in resolution 65/1 on the implementation of the Bali Outcome Document in addressing the food, fuel and financial crises. Subsequently, a report of the Secretary-General emphasized that reducing disaster and other social and economic risks would be crucial for accelerating progress towards the Millennium Development Goals.<sup>5</sup>

The Fourth United Nations Conference on the Least Developed Countries, in adopting the Programme of Action for the Least Developed Countries for the Decade 2011–2020, identified ‘multiple crises and other emerging challenges’ as one of the eight interlinked priority areas for the sustainable development of the least developed countries.<sup>6</sup>

In 2012, the Secretary-General’s High-Level Panel on Global Sustainability brought out the report ‘Resilient People, Resilient Planet – A Future Worth Choosing’. It outlines a vision towards sustainable development through inclusive economic growth, environmental development and social equity. It also emphasizes a strategy for empowering people to make sustainable choices during a period of global volatility and uncertainty.

Some contemporary thoughts on resilience have been captured in the Rio+20 outcome document, ‘The Future We Want’, which emphasizes the need for building resilience in several economic, social and environmental spheres. In particular, the outcome document calls for “disaster risk reduction and the building of resilience to disasters to be addressed with a renewed sense of urgency in the context of sustainable development and poverty eradication, and as appropriate, to be integrated into policies, plans, programmes and budgets at all levels and considered within relevant future frameworks.” And it further invites “governments at all levels, as well as relevant subregional, regional and international organizations, to commit to adequate, timely and predictable resources for disaster risk reduction in order to enhance the resilience of cities and communities to disasters, according to their own circumstances and capacities.”<sup>7</sup>

Why have they not done so already? There are many reasons – some of which are common to many human activities. One is that human beings are not very good at assessing risks, relying more on immediate instinctive responses rather than rational analysis (Box I-2). And generally policymakers are more accustomed to breaking down complex issues into supposedly distinct parts than dealing with a systemic whole.

## BOX I-2

### Policymaker blind spots

Most policymakers agree that prevention is better than cure. Faced with multiple and increasingly frequent shocks, why do they not then invest more in risk prevention and preparedness? There are many factors at play. Some will be linked to immediate political problems and budget pressures. But research on behavioural economics, notably the work of Nobel Prize winner Daniel Kahneman, suggests that when it comes to evaluating risks there are basic limitations in the human mind.<sup>8</sup>

People are, for example, likely to be more concerned about an event that has recently happened. Thus, immediately after an earthquake, they will take more anti-earthquake precautions by building up emergency food supplies, but then become steadily less diligent as the memory fades – though clearly the risk is unchanged. On the other hand, people overestimate the probability of unlikely events and underestimate the probability of relatively common risks. One US study found, for example, that tornados were thought to kill more people than asthma – which actually causes 20 times more deaths.

Then there is myopic behaviour – simple short-sightedness. Thus people tend to postpone buying insurance or building up savings for old age. And when taking decisions they seldom give sufficient weight to the needs of future generations.<sup>9</sup>

Individual decisions are also easily swayed by the ways in which issues are framed. A patient who is asked whether they want to risk surgery is likely to be encouraged by the statement “the one-month survival rate is 90 per cent” but discouraged by the statement “there is 10 per cent mortality in the first month”, though they both say the same thing.

And in general people tend to underestimate the extent of their ignorance and the uncertainty of the world in which they live. They thus assume they understand what happened in the past, and are overconfident in their ability to predict the future.

Policymakers in particular are likely to fall victim to the wisdom of hindsight. They know they will be blamed for decisions that work out badly, but get little credit for successful outcomes. As a result they tend to be reluctant to take risks, or are likely to underestimate them. They are thus likely to produce plans and forecasts that are unrealistically close to best-case scenarios, overestimating benefits and underestimating costs.

How can these constraints be overcome? First, policymakers need to be conscious of the potential illusions of the human mind and their consequent decision-making blind spots. Second, they need to know more about risks and how to measure them. For this purpose they can take advantage of more sophisticated decision-making methodologies. For example, for assessing the likely outcomes of risky projects they might use ‘reference class forecasting’ – using large databases that have information on both plans and outcomes of hundreds of similar projects all over the world.<sup>10</sup>

For low-probability, high-impact catastrophes which are difficult to assess using the traditional cost-benefit analysis they might instead use scenario analysis.<sup>11</sup> This will consider future events based on a range of alternative outcomes and favour solutions that are flexible, adaptive and hence can be used to safeguard from multiple shocks. Integrating risk-based methodologies into cost-benefit analysis can enable policymakers to quantify the consequences of climate change disasters and risks.

When taking decisions it is also crucial to involve those that may be most affected. As they experience these risks directly, they may be in a better position to understand them – and have fewer cognitive illusions.

## DEFINING RESILIENCE

Resilience is usually associated with recovering from shocks. The form that this resilience takes will depend on the system that suffers

the shock and the functions that need to recover. However, a common element of the different definitions is the idea that recovery in a changing environment requires the capacity to withstand, absorb and adapt to shocks (Box I-3).

### BOX I-3

#### Definitions of resilience

"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions." <sup>12</sup>

"A measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables." <sup>13</sup>

"The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self organization and the capacity to adapt to stress and change." <sup>14</sup>

"The ability to absorb disturbances, to be changed and then to re-organize and still have the same identity (retain the same basic structure and ways of functioning). It includes the ability to learn from the disturbance." <sup>15</sup>

"The ability of people, households, communities, countries, and systems to mitigate, adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth." <sup>16</sup>

"The ability to deal with change and continue to develop." <sup>17</sup>

"Disaster resilience is the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses – such as earthquakes, drought or violent conflict – without compromising their long-term prospects." <sup>18</sup>

"The working definition of a resilient country (...) is (...) one that has the capability to 1) adapt to changing contexts, 2) withstand sudden shocks and 3) recover to a desired equilibrium, either the previous one or a new one, while preserving the continuity of its operations." <sup>19</sup>

This report concerns resilience of countries to multiple crises. Ultimately, what matters, however, is the effect of such shocks on people’s lives – both in current and future generations. Therefore, the working definition of resilience in this report is:

*The capacity of countries to withstand, adapt to, and recover from natural disasters and major economic crises – so that their people can continue to lead the kind of life they value.*

Building resilience to a wide range of potential shocks is a complex task involving a large number of interconnected systems: economic, social and environmental. It demands that people, organizations and institutions develop the ability to reconfigure and redesign their systems to be able to cope with multiple shocks (Figure I-1). Although there are a number of measures of exposure and vulnerability to either economic crises or natural disasters, there are only a few tentative measures of resilience. One suggestion on how such a measure of the combined effects of these shocks is shown in Appendix 1.

## PREDICTABLE AND UNPREDICTABLE SHOCKS

If countries are to be resilient to multiple shocks they need to deal with them as they arise. In some cases the risks are predictable and the forms of mitigation and response are fairly well developed. Bangladesh, for example, is regularly exposed to floods and cyclones and, as a result, has invested in disaster risk reduction – in flood monitoring, for example, and forecasting and early warning systems, all of which have proved effective in the aftermath of the two most recent cyclones Sidr in 2007 and Alia in 2009.<sup>20</sup>

Other recent shocks in the region have been more surprising and unexpected. Of the natural disasters, earthquakes are less common, especially when combined with tsunamis. Economic crises too are less predictable. For example, the collapse of Lehman Brothers, one of the biggest United States investment banks, which helped trigger the 2008 global financial crisis, would have been considered highly improbable.

FIGURE I-1

### What is resilience?

Resilience is the ability to		
Quickly bounce back and restore a stable equilibrium after stresses, ensuring reduced risks and disturbances from shocks.	Mitigate disruption and reconfigure from shocks so as to maintain a functioning system.	Reorganize and transform in order to respond to crises, absorb their impact and maintain the system’s core purpose.
Objects	Systems	Complex systems

Source: ESCAP based on Breen and Anderies, 2011.

Moreover, one event that in isolation might not seem catastrophic can nevertheless provoke multiple and interrelated shocks. This makes it hard to envisage all the possible scenarios and assess potential responses. For example, natural disasters such as the 2010 floods in Pakistan and droughts in the Russian Federation triggered complex crises, which were transmitted by the financial and trade systems. The damage can then be amplified by the interactions of fallible and sometimes confused agents.

In other cases, a complex crisis has emerged because the natural disaster is on such a scale that it causes a cascade of system failures. This happened following the earthquake in Japan in 2011, followed by a 10-metre high tsunami that hit north-eastern Japan and damaged the Fukushima power plant, triggering a third crisis, a nuclear accident. Even when countries have prepared for individual crises, they may find it difficult to cope with multiple overlapping events.

When the result is a large systemic crisis, one of the main challenges is to anticipate how all participants of the system are likely to act. This is true even in market systems: in principle with information conveyed by prices, markets should be self-correcting; in practice markets are often highly imperfect. As a result, as argued by Joseph Stiglitz following the 2008 global financial crisis: “(...)even if banks perfectly assessed their own risk, there would be no assurance that the system as a whole was stable.”<sup>21</sup>

It is particularly difficult to address shocks that cross-cut multiple geographical, temporal and jurisdictional scales (Figure I-2). This presents three challenges:

1. Recognizing potential interactions – as between the price of gold and increased exposure of miners to disasters.



2. Dealing with different levels of interactions – as with natural disasters triggering sudden price moves in commodity markets.

3. Addressing different perceptions and values – as with climate change when different countries have different interests and views.<sup>22</sup>

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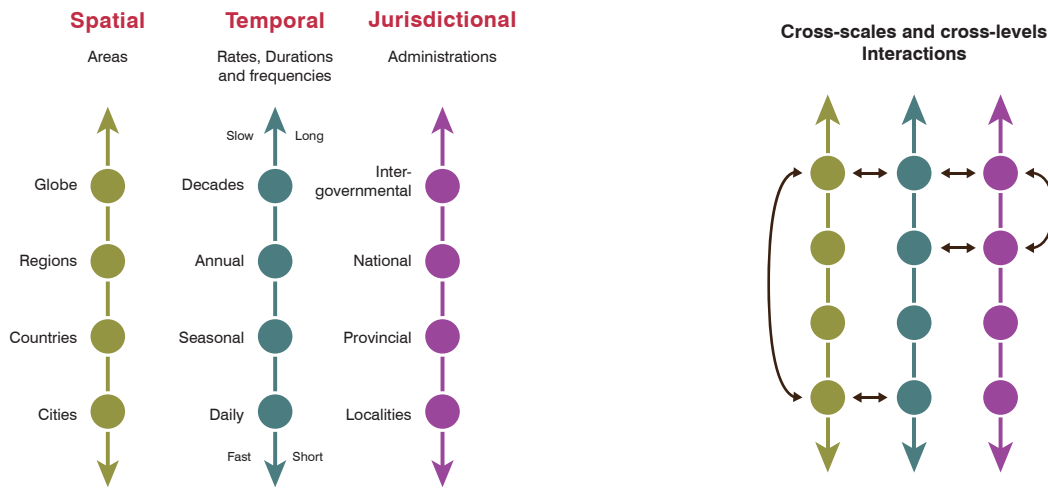
## WHY RESILIENCE IS IMPORTANT

Resilience is crucial because Asia and the Pacific is regularly suffering simultaneous, multiple shocks, particularly economic crises and natural disasters.



FIGURE I-2

Different scales and levels



Source: ESCAP based on Cash and others, 2001.

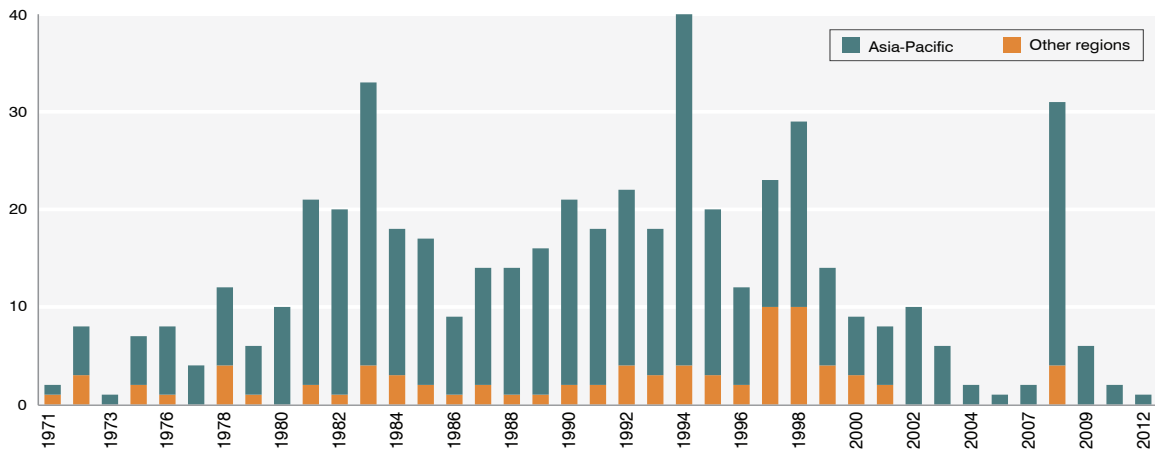
Contagion from financial crisis

The Asia-Pacific region has been affected in recent years by a number of financial crises. However, most of these have originated outside

Asia and the Pacific. Indeed over the past 40 years only one crisis in four started in the region; and none in the five years preceding the 2008 global financial crisis (Figure I-3).

FIGURE I-3

Number of financial crises starting in a given year, 1971-2012



Source: ESCAP based on data from Laeven and Valencia, 2012.

Note: Financial crises include systemic banking crises, currency crises, and sovereign debt crises.

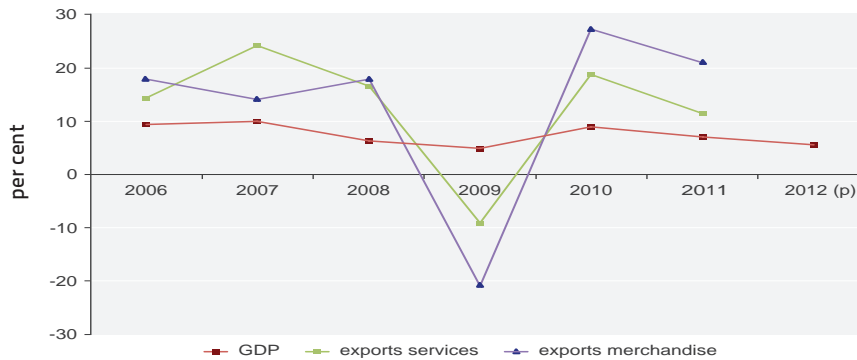
The most severe external event was the global economic crisis in 2008. The region's emerging economies felt the first round of this through falling exports – which in some cases reduced growth by more than one quarter. Nevertheless, by 2010 the developing countries of the region had managed a V-shaped recovery – though this tailed off as a result of spillovers from the euro zone debt crisis and the uncertain economic outlook in the United States. In 2012, growth in developing Asia was only 5.7 per cent, the lowest rate for a decade (Figure I-4).<sup>23</sup>

### *Financial integration increases risk of cross-border transmission of shocks*

The contagion from the 2008 crisis illustrated the extent to which financial systems are integrated. Such integration increases the potential risks of cross-border transmission of shocks caused by sudden stops of capital flows. The impact of volatility will depend, however, on a range of factors, including GDP growth, the degree of trade openness and the stock market capitalization.

FIGURE I-4

### Growth of GDP and exports of developing Asia-Pacific economies, 2006-2012



Sources: ESCAP, 2012c and 2012d ESCAP annual core indicators online database. Available from: [www.unescap.org/stat/data/index](http://www.unescap.org/stat/data/index) (accessed November 2012).

FIGURE I-5

### Capital inflows to selected Asia-Pacific economies, 2005-2011



Source: ESCAP based on IMF International Financial Statistics. Available from <http://www.imf.org/external/data.htm> (accessed January 2013).

Note: Selected Asia-Pacific economies include: Australia; Bangladesh; Hong Kong, China; Georgia; India; Indonesia; Japan; Kazakhstan; Malaysia; Pakistan; Philippines; Russian Federation; Singapore; Thailand and Turkey.

Emerging Asian economies account for over 70 per cent of the total portfolio investment inflows in emerging markets.<sup>24</sup> Asian emerging markets attract a significant share of shorter term and more volatile investment. This is illustrated in Figure I-5 which shows a sharp drop in portfolio flows during the 2008 financial crisis.

### *Interconnected financial markets create the potential for systemic failures*

Financial systems based on a large number of competing banks should in principle be buffered against shocks: if one bank fails, others can take over the released demand and continue to supply the market with credit. But much will depend on the structure, or “topology” of the banking network.<sup>25</sup> If these banks are closely interconnected they may be susceptible to financial contagion.<sup>26</sup> The United States for example, has a few hub banks, while most banks deal only with a few other banks.<sup>27</sup> Such networks are more robust to random failures.<sup>28</sup> If a non-hub bank fails at random, this will have only a small effect on the system as a whole.

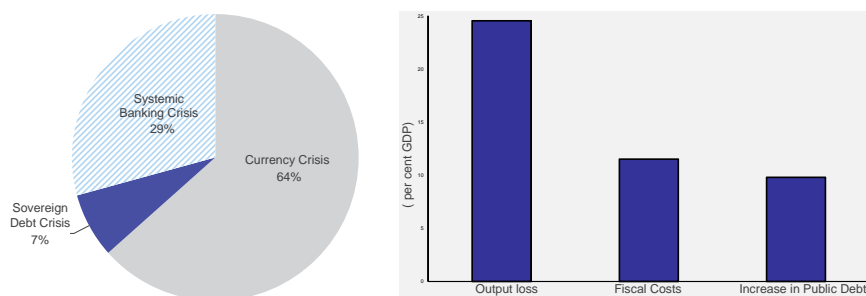
These networks are, however, still vulnerable to failures of hub banks, or to targeted attacks.

And they may also suffer contagion from other networks.<sup>29</sup> For example, political and social networks can spread rumours that lead to herd behaviour in networks that otherwise might have been unaffected. Indeed the risks of economic and financial shocks increase when people believe they are likely to happen – self-fulfilling prophecies. For example, investors around the world now believe global shocks are all too plausible and may want to reduce their risk exposure at the same time. Since 2007, these ‘risk-off’ episodes have become more frequent.<sup>30</sup> Analysing a single network may thus miss a broader systemic risk.

Systemic banking crises can result in major losses and fiscal distress. In the developed countries these usually take the form of large losses in output and increases in public debt. Developing countries, on the other hand, which have weak institutional capacity and limited access to global markets, tend to experience higher fiscal costs associated with financial sector restructuring. Over the past four decades, Asia-Pacific economies have experienced 24 episodes of systemic banking crises. On average, these have resulted in losses amounting to a quarter of the country’s GDP, and 10 per cent increases in both fiscal costs and public debt (Figure I- 6).

FIGURE I-6

### Share and average relative costs from systemic banking crises in Asia and the Pacific, 1970-2011



Source: ESCAP based on Laeven and Valencia, 2012.

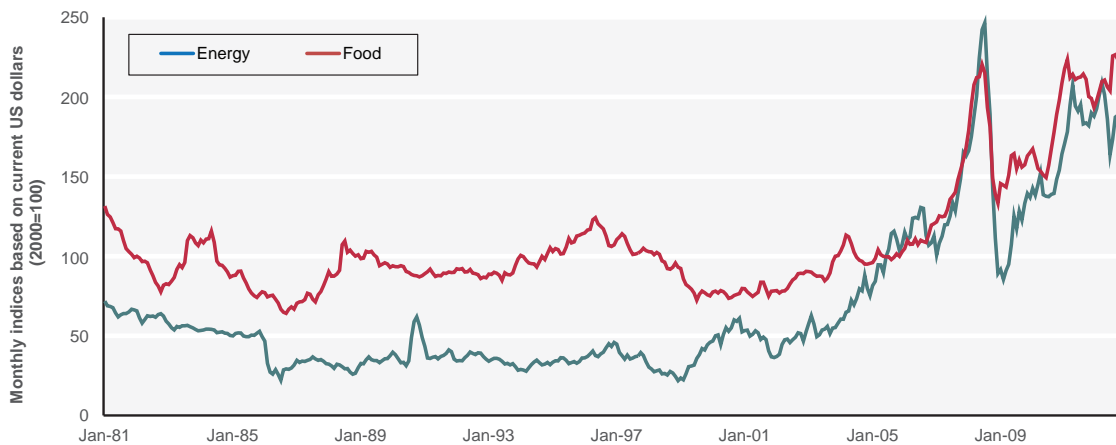
### High and volatile commodity prices

Tight global supply coupled with financial speculation has led to high and volatile commodity prices (Figure I-7). In addition, some food commodity prices have recently been coupled with energy prices (Figure I-8). This is understandable since high fuel prices drive up

the costs of production and transportation, as well as the prices of agricultural inputs such as fertilizers. But it may also be that speculative investments have shifted some commodity prices away from the fundamentals.<sup>31</sup> This is suggested by the extent of co-movements among those commodities for which there are futures markets; those without futures markets seem unrelated.

FIGURE I-7

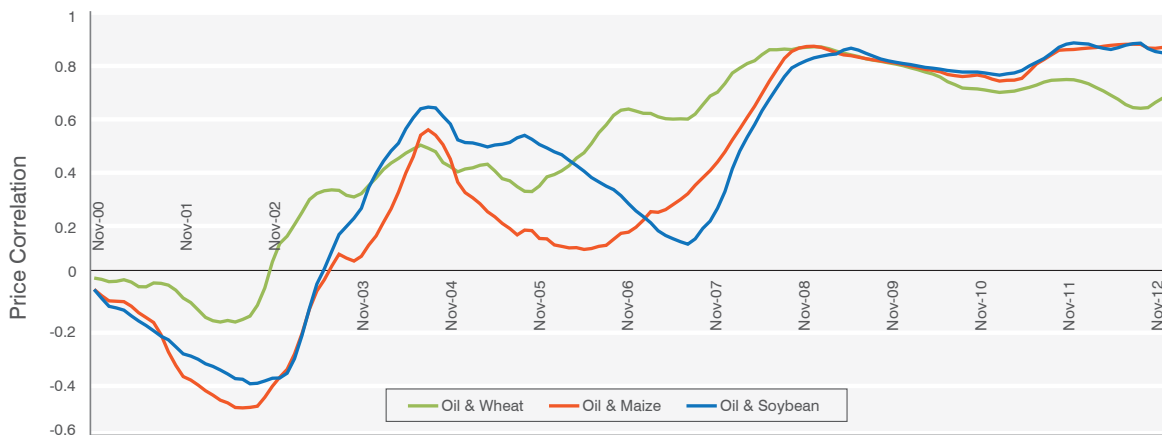
#### High and volatile prices of commodities, 1981-2012



Source: Based on data from World Bank Commodity Markets available from <http://go.worldbank.org/4ROCCIEQ50> (accessed January 2013)

FIGURE I-8

#### Prices of commodities have become more correlated, 2000-2012



Source: Based on data from World Bank Commodity Markets, available from <http://go.worldbank.org/4ROCCIEQ50> (accessed January 2013)

High prices of food and fuel threaten food security, increase inflation and slow the rate of poverty reduction. In countries that are net importers, high prices of food and fuel can also put pressure on the exchange rate, leading to higher prices for other imports. Some local food producers may gain, but high food prices generally hurt the poor who are net buyers of food thus have less to spend on other priorities including health and education (Box I-4). In 2010, across Asia and the Pacific the combination of high prices of food and oil is thought to have prevented some 15.6 million people escaping from poverty and pushed another 3.7 million below the poverty line.<sup>32</sup>

Sudden price moves can also cause a deterioration in the terms of trade, with high output losses.<sup>33</sup> For example, in the aftermath of the 2008 global financial crisis, commodity exporters in North and Central Asia suffered

from sharp drops in oil and mineral prices resulting in a decline in output.<sup>34</sup> In 2008, the plunge of oil prices helped trigger banking crises in Kazakhstan and the Russian Federation and a currency crisis in Turkmenistan. The least developed countries are particularly vulnerable to declining terms of trade and external demand shocks. Between 2007 and 2009, in countries such as Bhutan and Lao People's Democratic Republic, GDP growth was reduced by more than 10 percentage points.<sup>35</sup>

*Increased interconnection of trade, while promoting economic growth, makes the region vulnerable to external shocks*

Another hallmark of the current wave of globalization is the increasing movement of goods and services across borders. In the past 10 years, world trade has almost tripled,<sup>37</sup> and the majority of this growth was driven by the emergence of developing countries. This higher

#### Box I-4

##### Disasters triggering high commodity prices

In Pakistan in 2010, the monsoon rains caused massive floods which killed nearly two thousand people, affected more than 20 million and made at least 7.8 million people food insecure. There was also serious economic damage. Agriculture accounts for 21 per cent of Pakistan's GDP, 45 per cent of employment and 60 per cent of exports. This disaster resulted in a loss of 7.5 million tons of sugarcane, 2.5 million tons of rice, 0.7 million tons of cotton and 0.3 million tons of maize.<sup>36</sup>

The floods also damaged infrastructure, destroyed storage facilities, roads and constrained food access for many communities – in a country where almost 20 per cent of the total population were already undernourished. The wheat price increased about 10 per cent in the three months following the disaster. According to the World Food Programme, between July and August 2010, the wheat price increased 82 per cent in one local market in the Khyber Pakhtunkhwa mountainous area. The floods impacted livelihoods and income-generating opportunities for the poor including farmers and unskilled labourers.

The floods reduced food production and generated rises in international prices. Between July and December 2010 the rice price increased from 465.8 to 563.8 rupees, and between 2009 and 2010 reduced rice exports from 13 to 9 per cent.

Sources: Pakistan, NDMA 2010; FAO, 2011b; WFP, 2010a.

value of trade was also more interconnected. Between 1993 and 2010, the number of countries that were responsible for the top 75 per cent in value of all the world's bilateral trade increased from 53 to 74 (Figure I-9). Over the same period, the average number of bilateral trade relations within that group increased from six to eight. Previously the main hubs, which had trade links with many other countries, were the United States, Japan, Germany, the United Kingdom and France. But by 2010 these had been joined by other countries in Europe and emerging countries such as China, India, Malaysia, the Republic of Korea and Singapore.

Exporters that have more trading partners should be less exposed to any crisis in export

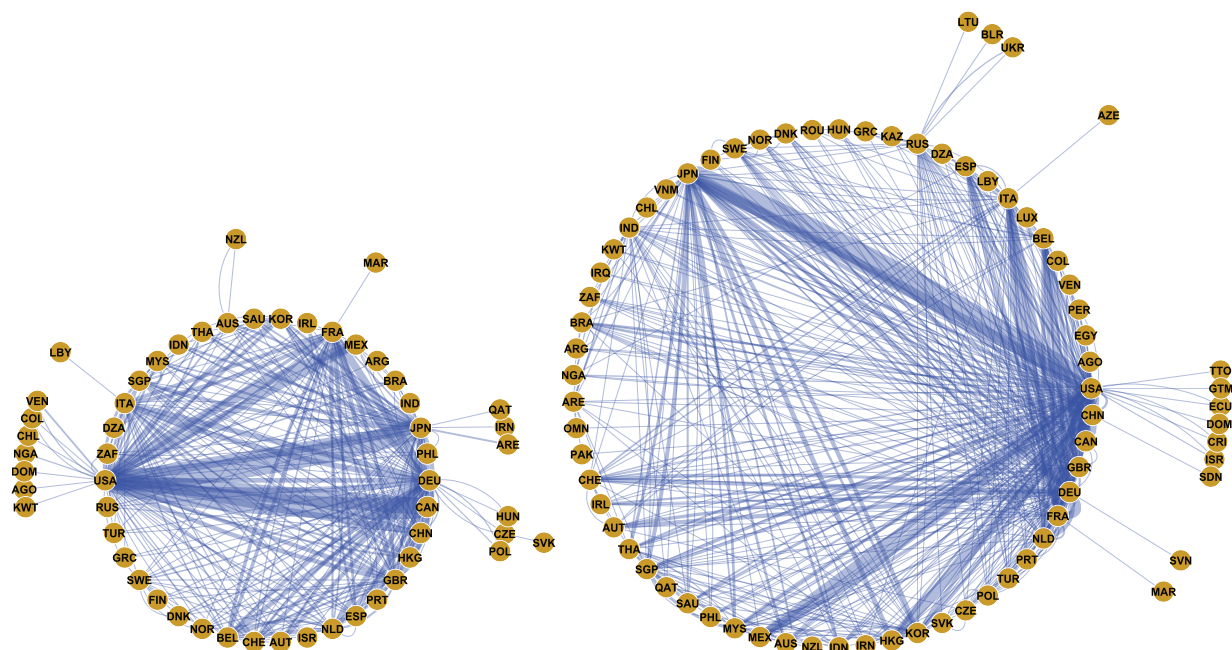
demand. But they will have less protection if the economic cycles of their trading partners are correlated.<sup>38</sup> This is currently the case as a result of low economic growth and export demand in the main trading hubs in the West. Increasing the number of trade partners has thus not necessarily reduced exposure to demand shocks.

### *Disasters disrupt supply chains*

Not only are countries trading with more partners, they are integrating their production networks. Nowadays, a high proportion of trade in Asia and the Pacific is in intermediate goods used in global supply chains for the production of final capital and consumption goods. Between 2002 and 2010, the total trade in

Figure I-9

Higher bilateral trade-value partners participating in 75 per cent of global trade

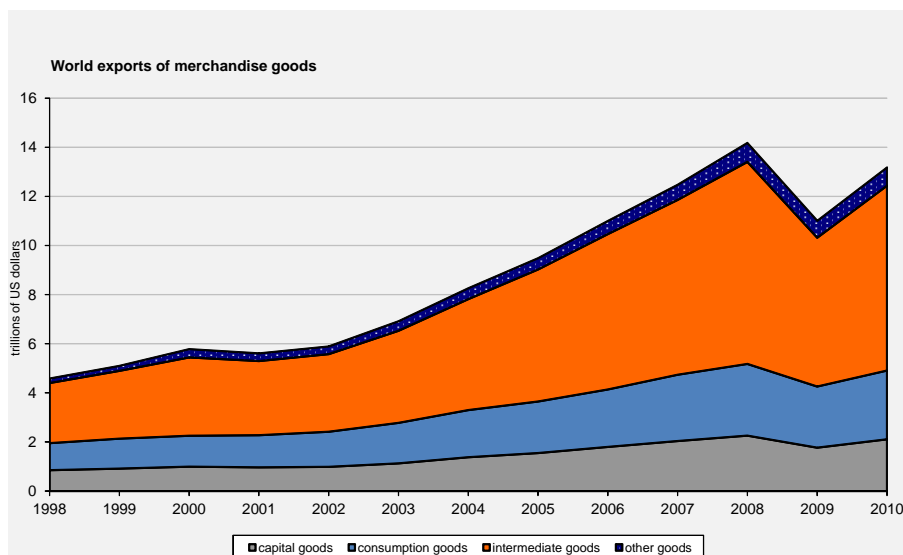


Source: ESCAP based on COMTRADE. Available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012).

Note: Each small circle represents a country that is part of the group responsible for the top 75 per cent in value of all the world's bilateral trade. The links between nodes represent bilateral trade, and the thicker the link the higher the value traded.

FIGURE I-10

## Increasing share of trade in intermediate goods, 1998-2010



Source: ESCAP based on Basu and others 2013 and COMTRADE. Available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012).

intermediate goods in current terms increased from about \$3.2 trillion to more than \$7.5 trillion. This increasing integration of trade in parts and components has helped boost output, but can also make the system more vulnerable to disasters: when one node collapses, the entire supply chain succumbs (Figure I-10).

Natural disasters have indeed been disrupting production and supply chains. In March 2011, following the earthquake, Japanese automobile production fell by 47.7 per cent and electrical component production by 8.3 per cent. The effects were soon felt elsewhere. Between April and May 2011, the production of automobiles and electrical goods slowed significantly in Thailand, the Philippines, Malaysia and Indonesia. There were similar effects following the 2011 floods in Thailand which disrupted production not only in Thailand but also in other countries, notably Japan where electrical component production fell

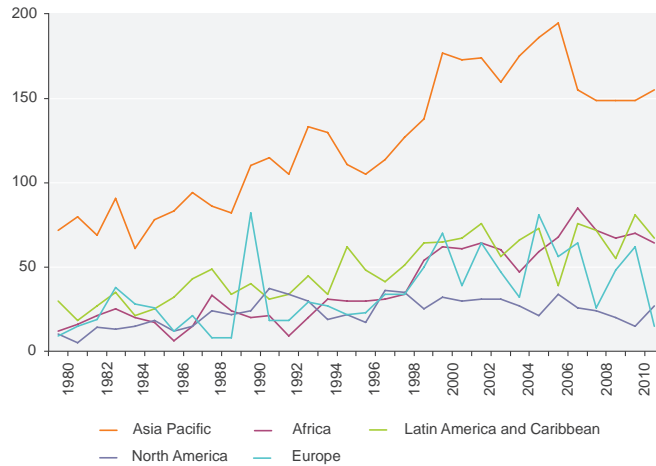
3.7 per cent in the fourth quarter of 2011. Thailand's flooding also reduced the region's agricultural production.<sup>39</sup>

### *Asia and the Pacific is the world most disaster-prone region*

Over the past three decades, the incidence of natural disasters has increased globally but the sharpest increase has been in Asia and the Pacific (Figure I-11).<sup>40</sup> In the past decade, a person living in Asia and the Pacific was almost twice as likely to be affected by a natural disaster as a person living in Africa; almost six times more likely than someone in Latin America and the Caribbean, and almost 30 times more likely than a person living in North America or Europe. In total, during that period, around 2.5 million people in Asia and the Pacific were affected by disasters and almost 800,000 were killed (Figure I-12).

FIGURE I-11

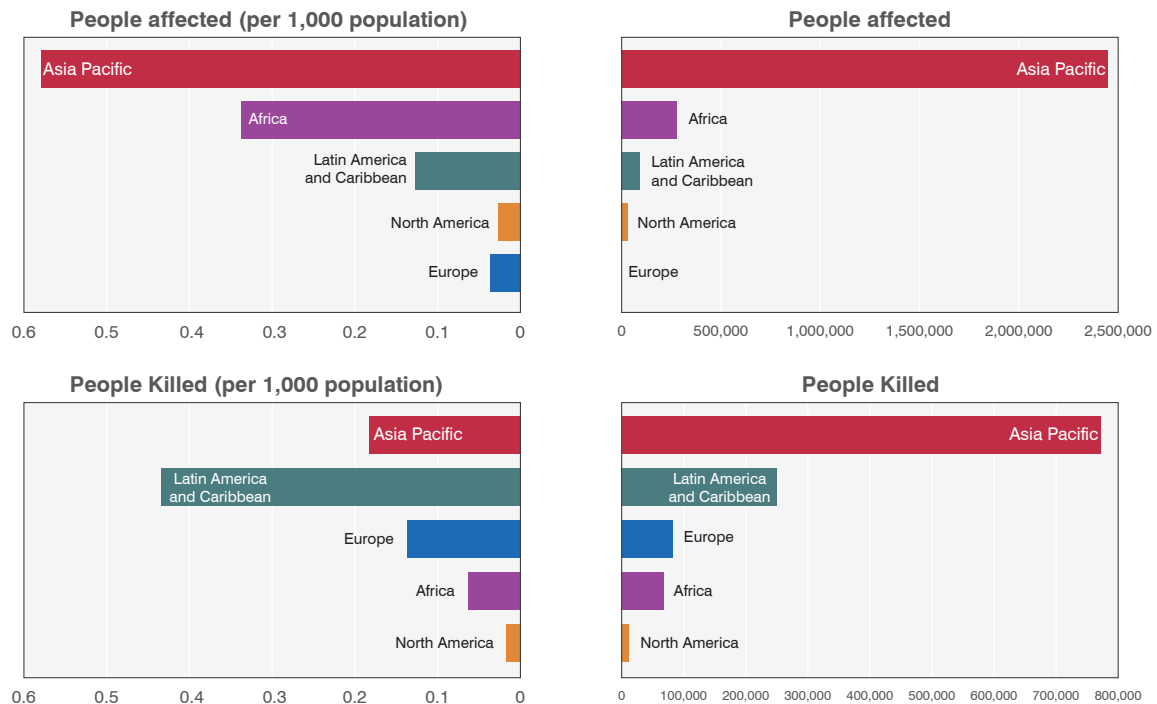
The number of reported natural disasters has increased, particularly in Asia and the Pacific, 1980-2011



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from <http://www.emdat.be/> (accessed November 2012).

FIGURE I-12

Risks of being killed or being affected by natural disasters, 2000-2012



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from <http://www.emdat.be/> (accessed November 2012).



*Losses and damage have been rising*

At the same time disasters have been causing greater economic damage. And over the past 20 years the pattern of losses has been dominated by the increasing frequency of large events (Figure I-13). In absolute terms, disasters may cause greater economic damage in richer countries that have more developed infrastructure.

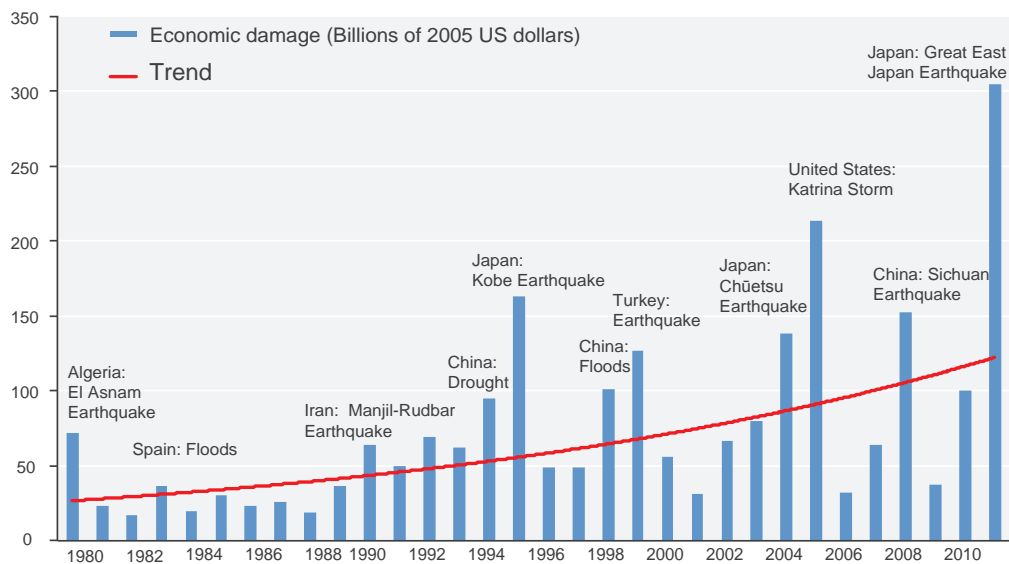
But in relative terms the low-income countries are much harder hit. <sup>41</sup> In Asia and the Pacific, in the past five years, the average annual impact

of disasters as a percentage of GDP was almost twice as high in low-income countries as in lower middle-income countries, and more than 10 times higher than in upper middle-income and high-income countries (Figure I-14).

The impact can be particularly severe in small island countries, in many cases causing damage and losses that represent multiples of the country’s total annual output (Figure I-15).

FIGURE I-13

Global economic losses and damage are on the rise, 1980-2010

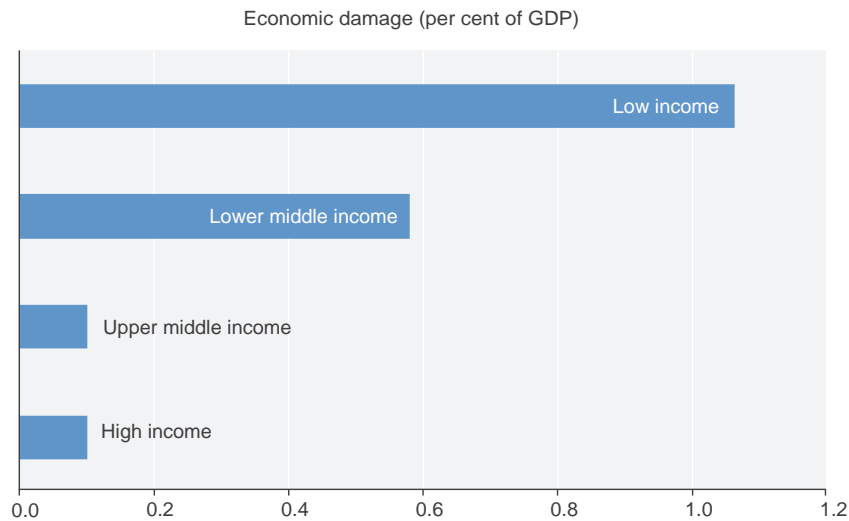


Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from <http://www.emdat.be/> (accessed November 2012).

Notes: Labels in the figure show major disasters that contributed to high damage and loss in selected years.

FIGURE I-14

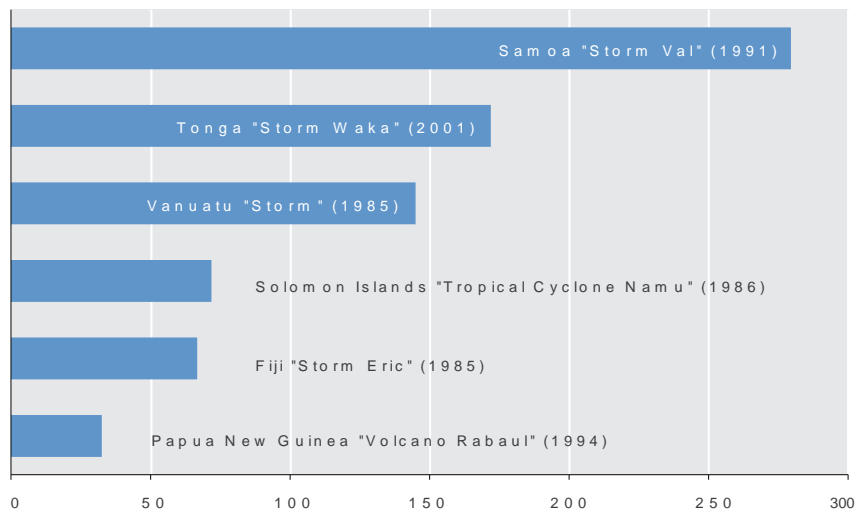
### Impact is higher in poorer countries: Asia-Pacific average annual impact by income classification, 2006-2010



Source: ESCAP based on data from EM-DAT: The OFDA/CRED International Disaster Database. Available from <http://www.emdat.be/> (accessed February 2013).

FIGURE I-15

### Small island countries, economic damage as a percentage of GDP



Source: ESCAP based on the World Bank's World Development Indicators available from <http://data.worldbank.org/data-catalog/world-development-indicators> (accessed January 2013) and EM-DAT: the OFDA/CRED International Disaster Database. Available from <http://www.emdat.be/> (accessed January 2013).

### *Shocks make growth volatile*

Developing economies, and the small ones in particular, are also vulnerable to natural and other disasters because of structural weaknesses. Often they do not have very diverse exports and can be highly dependent on primary commodities. They can also be quite remote and have high concentrations of poverty. As a result they have less capacity to absorb shocks and their economic growth is likely to be more volatile. This is evident in Samoa, for example which in 1990 was hit by major storm Val and in 2009 by a tsunami, both of which caused significant losses in output (Figure I-16).

growth in many least developed countries is still below the pre-crisis trend.<sup>43</sup> In low-income countries, droughts, floods, storms and extreme temperature events can lead to declines in real per capita GDP of around 2 per cent.<sup>44</sup>

A major disaster causes suffering and loss of life, but in a poor country it also damages the limited stock of capital goods and can lead to a long-term decline in productive capacity. As economic activity declines, fiscal revenues also shrink. The sudden and large demand for cash and foreign currency adds to the macroeconomic challenges. Likewise, financial and economic crises generate output losses that result in

FIGURE I-16

#### Samoa, real GDP growth percentage, 1983 – 2011



Source: ESCAP based on World Bank's World Development Indicators. Available from <http://data.worldbank.org/data-catalog/world-development-indicators> (accessed January 2013).

### *Large shocks can cause permanent economic loss*

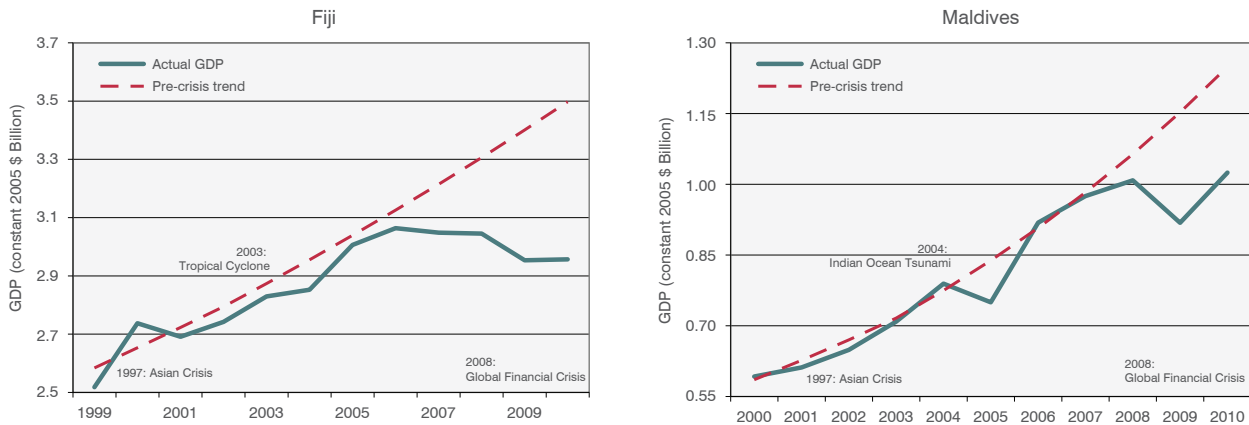
Severe shocks can also knock countries off their growth trajectories and lead to a permanent loss in output. For example, a banking crisis in developing and emerging economies may reduce total output by 4.5 per cent after eight years.<sup>42</sup> As a result of the 2008 crisis, GDP

economic slowdowns, create unemployment and threaten poverty reduction. All this distress can easily derail the economy and send it to a lower path of growth.

If a country suffers a series of shocks this can also have a cumulative effect, as illustrated by the 2003 cyclone Ami in Fiji and the 2004

FIGURE I-17

## Persistent losses caused by shocks



Source: ESCAP based on Annual core indicators online database. Available from [www.unescap.org/stat/data/statdb/DataExplorer.aspx](http://www.unescap.org/stat/data/statdb/DataExplorer.aspx) (accessed January 2013)

Note: For more details see Laeven and Valencia, 2012.

Indian Ocean tsunami in Maldives, both of which were coupled with the 2008 global financial crisis (Figure I-17).

In addition to the permanent losses in output, large shocks also affect the achievement of the Millennium Development Goals. In Pakistan, for example, the 2005 earthquake, the 2007 cyclone and the 2010 floods all affected net primary school enrolment. These events damaged education facilities – reducing the quantity and quality of education.<sup>45</sup>

## WHO IS MOST VULNERABLE TO MULTIPLE SHOCKS?

The countries most vulnerable to economic crises and natural disasters can be highlighted using two indices. The first is the ESCAP vulnerability index which assesses each country's exposure and capacity to cope with economic crises, and has been computed for 37 countries.<sup>46</sup> The second is the world risk index

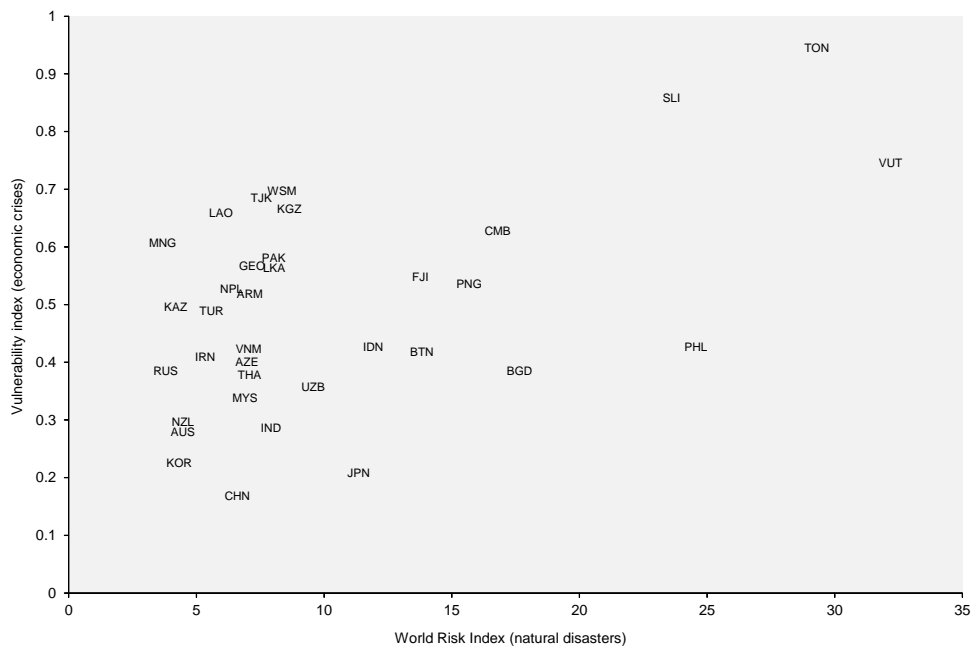
which assesses the risk to natural disasters using four indicators: exposure, susceptibility, coping and adaptive capacity.<sup>47</sup> Figure I-18 plots these two indices against each other. The countries most vulnerable to both types of shock lie in the top-right quadrant. These are the small island developing States including the Solomon Islands, Tonga and Vanuatu – which have populations concentrated in low-lying coastal areas and do not have very diverse economies.

As a proportion of GDP, the countries that lose most as a result of natural disasters are the developing countries, which globally lose 2 to 15 per cent of GDP annually.<sup>48</sup> Among these, the most vulnerable are the least developed countries, landlocked developing countries and small island developing States.

A similar trend emerges in the Asia-Pacific region where the most vulnerable are the least developed countries and small islands developing States. Bangladesh, Cambodia,

FIGURE I-18

## Mapping vulnerability to economic crises and natural disasters



Source: ESCAP, 2010; UNU, 2011.

Papua New Guinea, the Philippines, Solomon Islands, Tonga and Vanuatu are the most at risk to natural disasters due to their high exposure and susceptibility to damage. The landlocked developing countries such as Tajikistan, Kyrgyzstan, Mongolia and Lao People's Democratic Republic are the most susceptible to economic shocks; these countries, being relatively more dependent on primary products, suffer most from commodity market volatility.

However, not all are equally vulnerable. A hazard only becomes a disaster when it encounters exposed and vulnerable communities. Vulnerability is also determined therefore by social, economic and environmental factors as well as the capacity to respond. Countries such as Bangladesh, Japan, Indonesia and the Philippines, even though

at relatively higher risk have taken positive steps to mitigate the adverse effects.

The map of vulnerability in Asia-Pacific follows, to a great extent, the contours of the region's poverty map which shows the most vulnerable people to be those living in the most populous least developed countries.

### *From fragility to resilience*

For people living in fragile and conflict-affected States, the journey from fragility to resilience is often both long and arduous. One quarter of the people in the world still live in areas plagued by high levels of criminal and political violence. They are twice as likely to be undernourished and their children three times as likely to be out of school.<sup>49</sup> With the additional threats to lives and livelihoods of climate change, natural

disasters, and economic crises, establishing human security is the most fundamental requirement of development. While this issue is not taken up in this report, for fragile states, good governance, strong institutions, accountable management of natural, human and financial resources, and above all, enlightened leadership matter the most.

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## SYSTEMIC RESPONSES

In future, it is clear that many countries will need to build their resilience to adapt and thrive in an unpredictable and shock-prone environment. To achieve this they will need to make policy in a different way. Rather than dealing with problems in the economy, environment and society separately, they will have to be addressed as parts of an overall system.

In pursuing these policies, policymakers of the region face key challenges when dealing with multiple crises. Subsequent chapters of this consider how they might address them:

■ ***Chapter 2 – The macroeconomics of resilience***

Confronted with an already weakened macroeconomic environment as a result of an economic slowdown, policymakers face the dilemma of how to handle the added challenge of natural disasters using the limited number of macroeconomic instruments they have. This is particularly difficult in the least developed countries and in small and less diversified economies.

■ ***Chapter 3 – Building resilient communities***

Economic crises and disasters hurt poor and vulnerable people the most. It is important therefore to support the most vulnerable communities, so that they can learn from

past adversities and bounce back stronger and better-prepared for future shocks. This, however, requires a better understanding of the measures needed at national, provincial and local government levels to build community resilience.

■ ***Chapter 4 – The land, water, energy nexus: avoiding catastrophic failure***

Building resilience involves using environmental resources as efficiently as possible. In particular this will mean diversifying economic activities so as to reduce dependence on individual environmental resources and limit the impacts on these systems in the event of an ecosystem failure. This will not be easy. Policymakers have to facilitate ecosystem conservation, regeneration and restoration while promoting sustained, inclusive and equitable economic growth.

■ ***Chapter 5 – Protecting critical sectors***

Some sectors are inherently vulnerable and can either cause a crisis or act as transmitters of a localized crisis to a larger system. For example, the financial sector is sensitive to shocks and prone to systemic crisis. It is also important to safeguard critical social infrastructure, such as schools, hospitals and community buildings, major supply roads, bridges, power, water systems and crucial communication lines, so that they do not fail during natural disasters. This will mean designing legal, regulatory, and governance structures that minimize their exposure and vulnerability.

■ ***Chapter 6 – Strengthening supply chains***

Integration into global value chains has enabled many Asia-Pacific economies to establish strong manufacturing bases and benefit from increased exports. However, this also increases

their vulnerability, directly and indirectly, to natural disasters. Policymakers also therefore need to devise mechanisms for boosting resilience throughout the chains.

■ *Chapter 7 – Mutual support through regional cooperation*

Countries are increasingly faced with economic crises and natural disasters that have cross-border impacts. They can benefit, therefore, from mutually reinforcing strategies to

build resilience, and share lessons, practical knowledge and experience across countries and subregions. The Asia-Pacific region has some regional cooperation mechanisms that deal with natural disasters and economic shocks. However, they are at different stages of development and, in most cases, they do not incorporate resilience. How to build on these mechanisms and fill up the gaps in regional cooperation is a key question for the governments of the region.



PHOTO CPA MEDIA

## APPENDIX

### MEASURING RESILIENCE

While there are a number of measures of exposure, vulnerability and risk to economic crises and disasters, thus far there have been fewer efforts to measure resilience to these combined shocks. This appendix makes an initial attempt to do so for each country based on characteristics of both the economy and the society. The focus is on the intrinsic resilience of countries to adapt to shocks, which is defined here as the resilience that emerges from intrinsic characteristics of the economy and the society that creates the environment for people to withstand, absorb and adapt to shocks. It considers therefore whether the economy can adapt to changed circumstances and self-organize to continue functioning at times of crises. And it considers whether people are sufficiently empowered to be better able to absorb and adapt to shocks. Another set of characteristics that might be used are those related to the environment, but it is not possible to investigate this at present due to a scarcity of relevant data.

***Resilient economies*** – This measure is based on the assumption that a country will be more resilient if it has a complex and diversified economy which will offer greater opportunities for recombining its productive capabilities to keep the economy functioning and generate productive jobs after a shock. To assess the complexity of its production structure this report uses a measure based on the characteristics of its exports (see technical annex).

***Resilient societies*** – People will be more resilient in more equitable societies that empower them to be better able to absorb and adapt to shocks. One way of measuring these is through levels of achievement in five Millennium Development Goals related to gender and children. The focus on women and children reflects their persistent vulnerability to shocks and the assumption that people will be in a stronger position to develop the capabilities needed to respond to disasters, if they live in societies that empower women and protect their children (see technical annex).

The result of this analysis is illustrated in Figure A-1. The vertical axis registers the economic component; the horizontal axis registers its social component. The figure is divided into four quadrants based on the global averages of each component. Countries in the upper-right quadrant are above the global average in both measures, so are more intrinsically resilient. In Asia and the Pacific these include Japan, Australia, and New Zealand, as well as emerging economies such as China, Malaysia, the Republic of Korea, and Thailand (Table A-1). They have diversified economies and are responsible for a large share of the region's total output. These countries also have relatively high achievement in the social indicators related to the inclusiveness of development. However, it should be noted that this is a national average and there is likely to be variation between regions in each economy: some regions may be better prepared to adapt to change and even benefit from it, while others may suffer dramatic loss and never recover.



FIGURE A-1

Intrinsic resilience, 2010

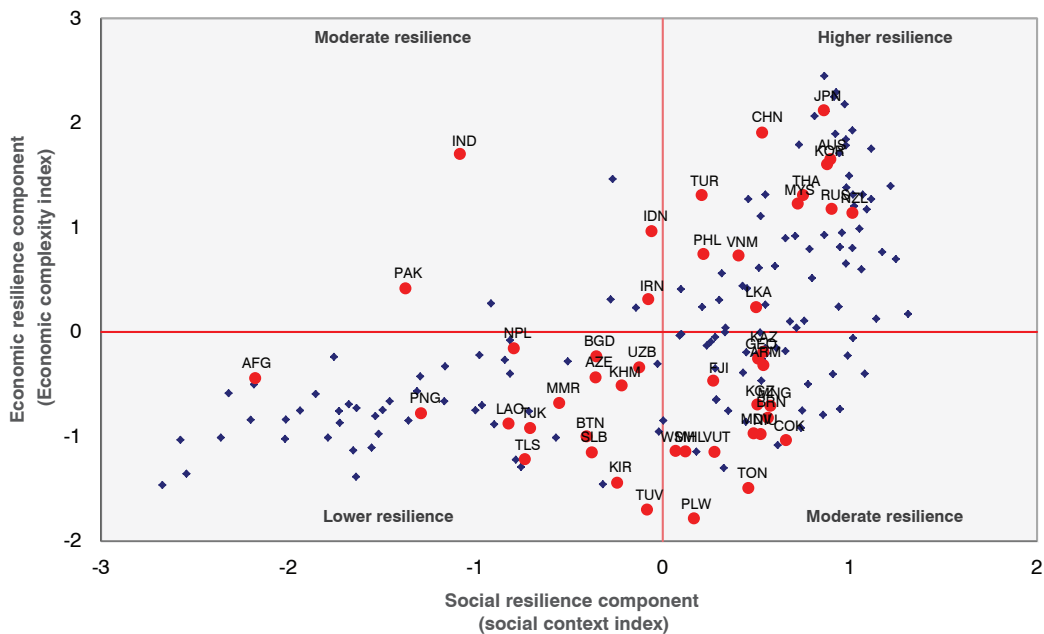


TABLE A-1

Intrinsic resilience of Asia-Pacific countries, 2010

<b>Higher</b>	
ENEA	China, Japan, Republic of Korea
NCA	Russian Federation
PAC	Australia, New Zealand
SEA	Malaysia, Philippines, Thailand, Viet Nam
SSWA	Sri Lanka, Turkey
<b>Moderate</b>	
<i>Higher social component</i>	
ENEA	Mongolia
NCA	Armenia, Georgia, Kazakhstan, Kyrgyzstan
PAC	Cook Islands, Fiji, Marshall Islands, Niue, Palau, Samoa, Tonga, Vanuatu
SEA	Brunei Darussalam
SSWA	Maldives
<i>Higher economic component</i>	
SEA	Indonesia
SSWA	India, Iran (Islamic Republic of), Pakistan
<b>Lower</b>	
NCA	Azerbaijan, Tajikistan, Uzbekistan
PAC	Kiribati, Papua New Guinea, Solomon Islands, Tuvalu
SEA	Cambodia, Lao People's Democratic Republic, Myanmar, Timor-Leste
SSWA	Afghanistan, Bangladesh, Bhutan, Nepal

Countries in the lower-left quadrant of the chart have a lower combined resilience. These include some of the region's least developed countries: Afghanistan, Bangladesh, Cambodia, Lao People's Democratic Republic, Nepal and Timor-Leste. Afghanistan, for example, despite progress in many social and economic indicators in recent years still has a low capacity to adapt to sudden and major shocks. Timor-Leste has also been involved in a difficult process of nation building and still has a relatively lower intrinsic resilience. In general, the economies that are least resilient are the smaller ones which are less diversified and have fewer productive capacities.

Countries in the upper-left quadrant have moderate resilience – with above-average economic resilience but below-average social resilience. These include Pakistan, and also India which, although it has made rapid economic progress, is still relatively unequal

when considering the welfare of women and children. On these measures, Indonesia and the Islamic Republic of Iran are borderline.

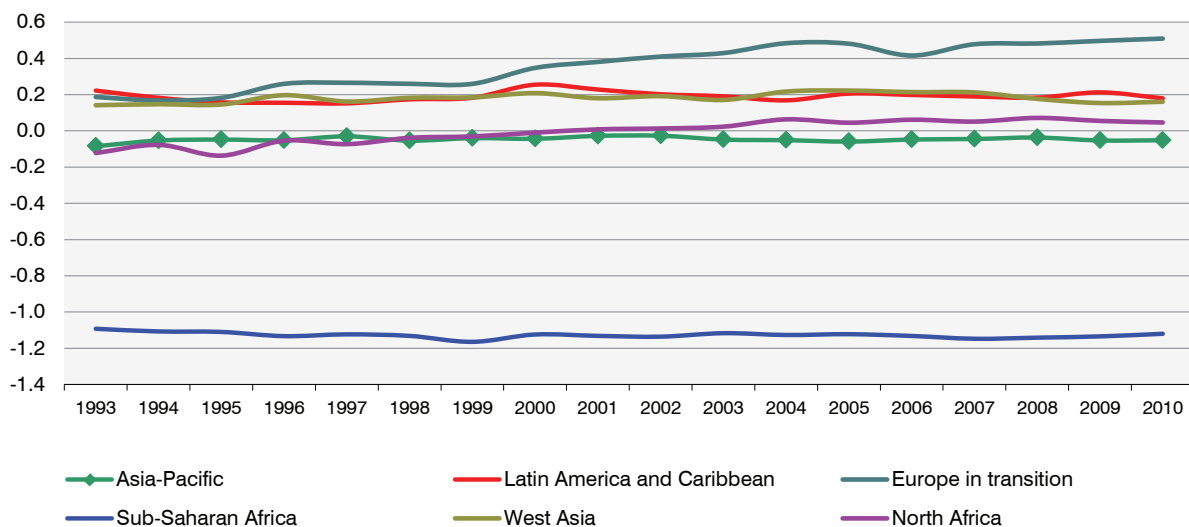
Countries in the lower-right quadrant also have moderate resilience, but in this case with above-average social resilience and below-average economic resilience. Most are small island countries; typically they have strong community links which bolster their intrinsic social resilience, but often have narrowly based economies making it too difficult for them to reorganize and adapt in case of a major shock – whether caused by an economic or natural disaster.

### *A composite index of resilience*

The economic and social components can be combined with equal weights to produce a composite index. The results for Asia and the Pacific as a whole are shown in Figure A-2. This shows the region's intrinsic resilience to be

FIGURE A-2

### Overall resilience index, selected global regions, 1993-2010



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/mdg/Default.aspx> (accessed November 2012).

Notes: In the graph, zero marks the global average. The standard deviation of the global distribution of the index of overall intrinsic resilience is equal to 1.

similar to the global average but lower than in Latin America and the Caribbean, West Asia or the transition countries in Europe. Moreover, the region has made scarcely any progress, and the gap with some other regions has widened.

The regional average hides differences in performance across and within Asia-Pacific subregions. This is illustrated in Figure A-3 which shows the resilience to be greatest in the East and North-East subregions. Resilience is lower in other subregions but has been rising, in North and Central Asia, for example, and particularly in South and South-West Asia. The Pacific, on the other hand, has become less resilient over the years, even when considering the relatively higher resilience of its developed countries, Australia and New Zealand.

Overall, the higher resilience is generally found in countries with higher per capita income. Resilience is also greater in countries that are more urbanized. Cities concentrate the largest share of the economic complexity of countries

and, in the aftermath of shocks, new connections are more likely to be established in the network of business and resources located in cities than in rural areas.

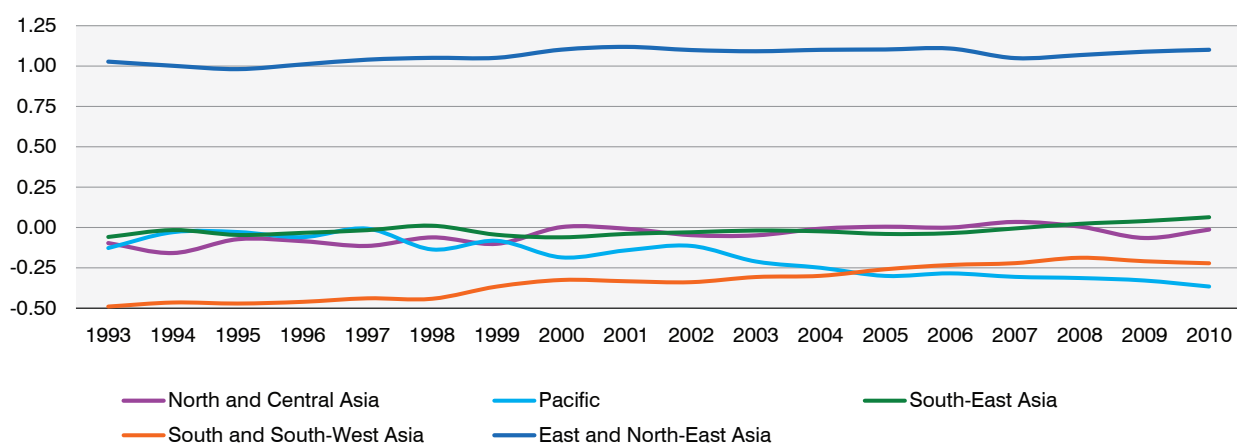
Higher resilience also goes hand in hand with better standards of governance – this would include better public services and a high quality civil service that is independent of political pressures. Also important is the quality of policy formulation and implementation, and the government’s commitment to such policies including those that promote private-sector development – which contributes to a dynamic economy that is more likely to self-organize and heal itself in the aftermath of a crisis.

### KNOWN RISKS AND VULNERABILITIES

The analysis of the relationship between resilience and the vulnerabilities associated to known risks provide important information about the challenges that countries face in dealing with more predictable crises.

FIGURE A-3

Index of intrinsic resilience, Asia-Pacific subregions ,1993-2010



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/mdg/Default.aspx> (accessed November 2012).

Notes: In the graph, zero marks the global average. The standard deviation of the global distribution of the index of overall intrinsic resilience is equal to 1.

This is illustrated in Figure A-4, which compares the resilience index with the economic vulnerability index (EVI). The EVI is a United Nations index which measures the risk of a country's economic development being affected by exogenous and unexpected shocks. The EVI is calculated by combining equally weighted indices of exposure, which include size, location, economic structure and environmental factors, and the effects of previous shocks, including trade shocks and natural disasters.<sup>50</sup>

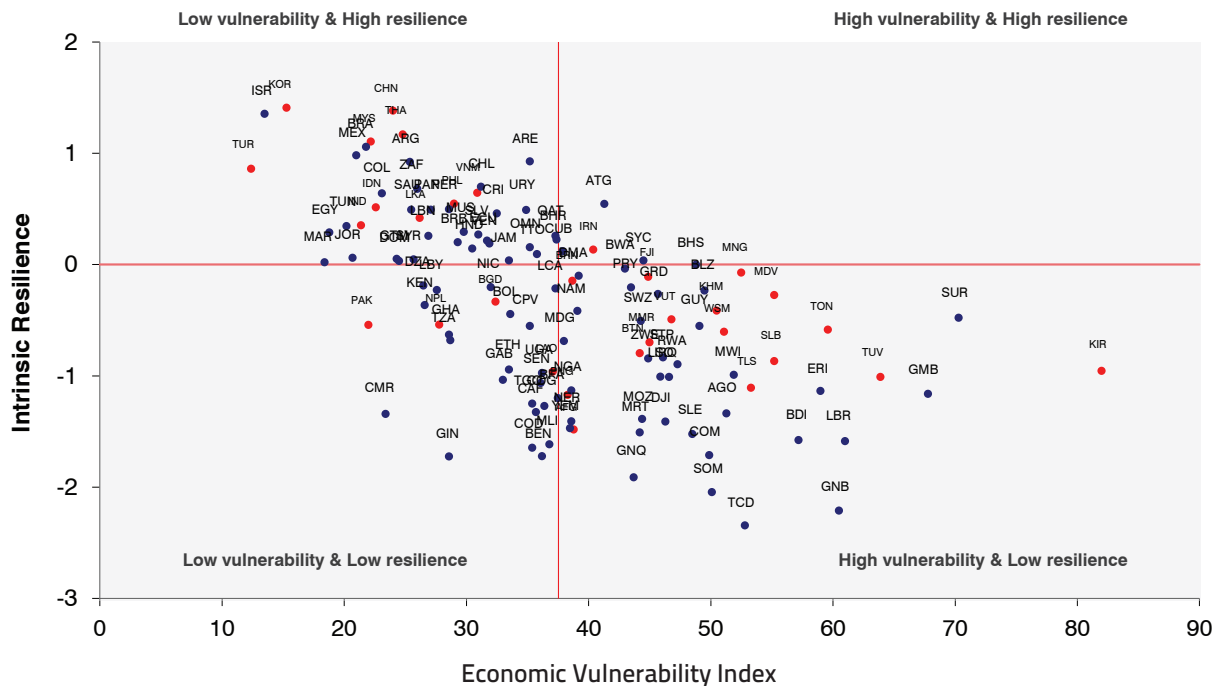
Figure A-4 shows that the intrinsic resilience index has an inverse association with the EVI: the higher the vulnerability, the lower the resilience. The red lines on the chart mark the global averages of the index of resilience and EVI. The countries in the top-left quadrant have

high resilience and lower values of economic vulnerability. People in these countries are less likely to be affected by crises, and more likely to adapt and recover from them. On the other hand, countries in the bottom-right quadrant have lower resilience and are more vulnerable to external shocks. This quadrant includes the least developed countries of the region, and the small island countries. Most at risk on this basis are Kiribati, Tonga and Tuvalu.

Similarly, countries can be classified according to their intrinsic resilience and the risks of natural disaster. The risk of disasters is estimated using the world risk index (WRI) developed by the United Nations University and the Alliance Development Works. The WRI has four components related to known disasters: exposure,

FIGURE A-4

### Association between intrinsic resilience and the economic vulnerability index



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/unsd/mdg/Default.aspx> (accessed November 2012).

susceptibility, coping capacities and adaptive capacities. The exposure component refers to the physical exposure to earthquakes, storms, floods and droughts. The susceptibility component includes indicators of public infrastructure, economic capacity, distribution of income, poverty, dependency ratios of youth and of elderly, and nutrition. The coping capacity element assesses the capacity of government and authorities, medical services and material coverage or insurances, while the adaptive capacity element covers education and research, gender equity, environmental status and investment.

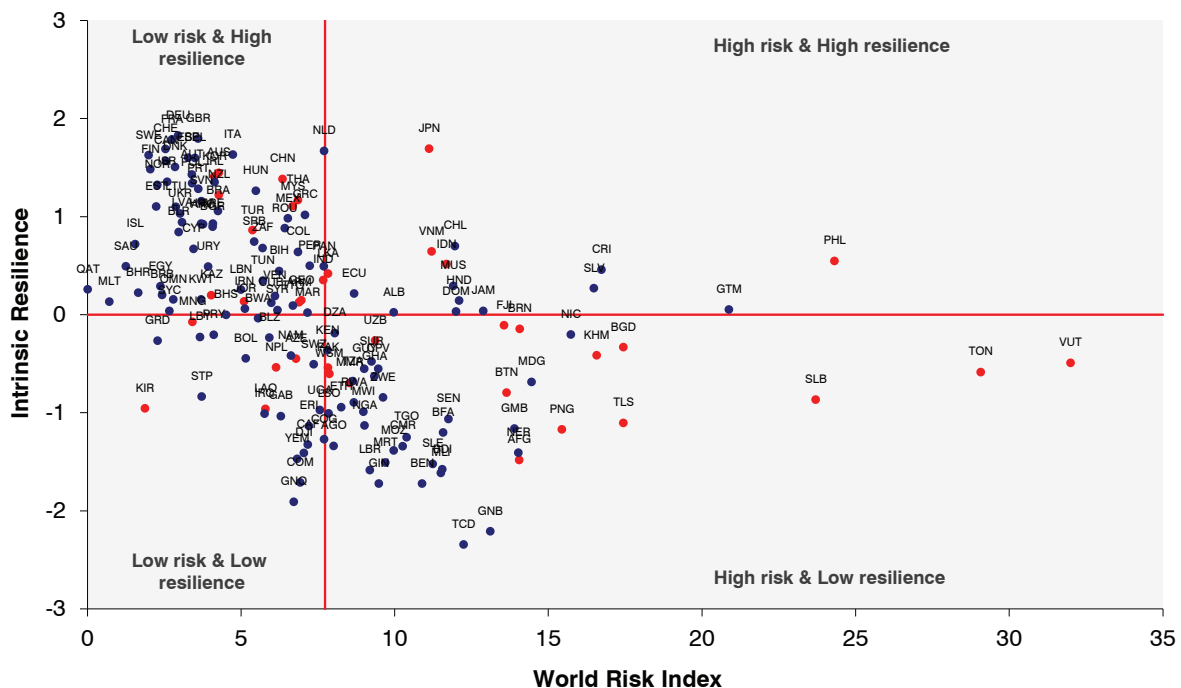
As indicated in Figure A-5, the intrinsic resilience index shows a less pronounced linkage with the WRI. The two red lines mark the

global averages of the index of resilience and the WRI. Globally, among the countries with high levels of resilience, Japan is the country that faces the higher risk of natural disasters. The resilience of those that face lower risk varies from low levels as in the case of Kiribati, Mongolia, Nepal, and Lao People’s Democratic Republic, to high resilience such as for Australia and the Republic of Korea. On the other hand, except for the Philippines, countries that face higher risk are associated with lower resilience.

The countries that are particularly at risk are Solomon Islands, Tonga and Vanuatu. These small island countries face many structural and geographical challenges in increasing resilience. Their small populations may create the conditions for more equitable societies but

FIGURE A-5

High risk countries are also less resilient



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/unsd/mdg/Default.aspx> (accessed November 2012).

limit the development of diverse economies that can adapt to shocks. The best way for these economies to safeguard their development is to take disaster risk reduction measures that reduce their exposure and sensitivity to natural disasters – to prevent hazards becoming disasters.

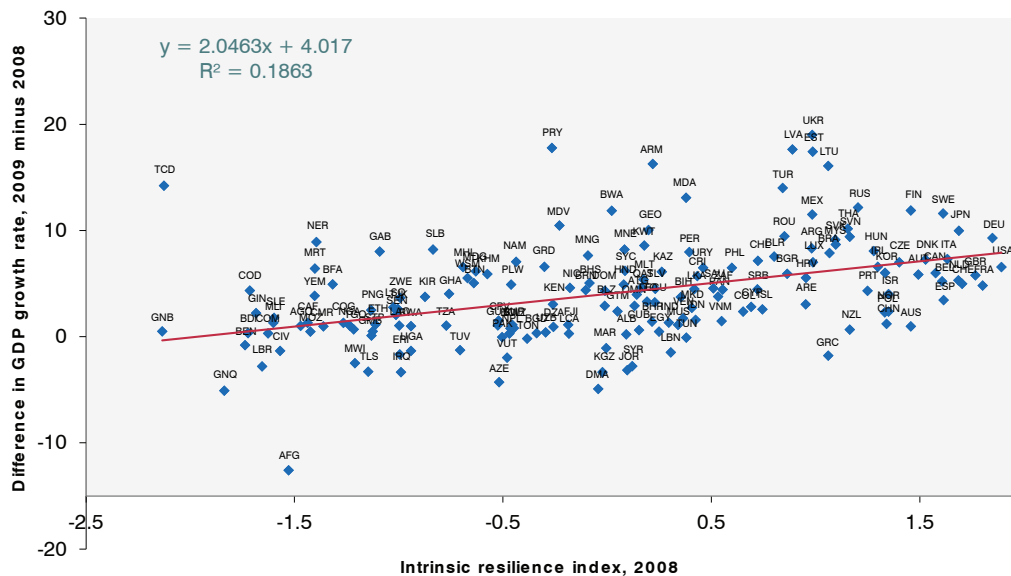
## RESILIENCE TO ECONOMIC CRISES

Countries in 2008 with higher scores on the intrinsic resilience index recovered best in 2009 after the global economic crisis (Figure A-6).

The association is statistically significant and the index alone explains 18 per cent of the variation of the differences between the 2008 and 2009 GDP growth rates of 171 economies. Similarly, Asia-Pacific countries in 1997 with higher scores for the intrinsic resilience index presented better economic performance in the midst of the 1997 Asian financial crisis (Figure A-7). Again, the association is statistically significant and the index alone explains 15 per cent of the variation of the differences between the 1997 and 1998 GDP growth rates of 42 economies of the region.

FIGURE A-6

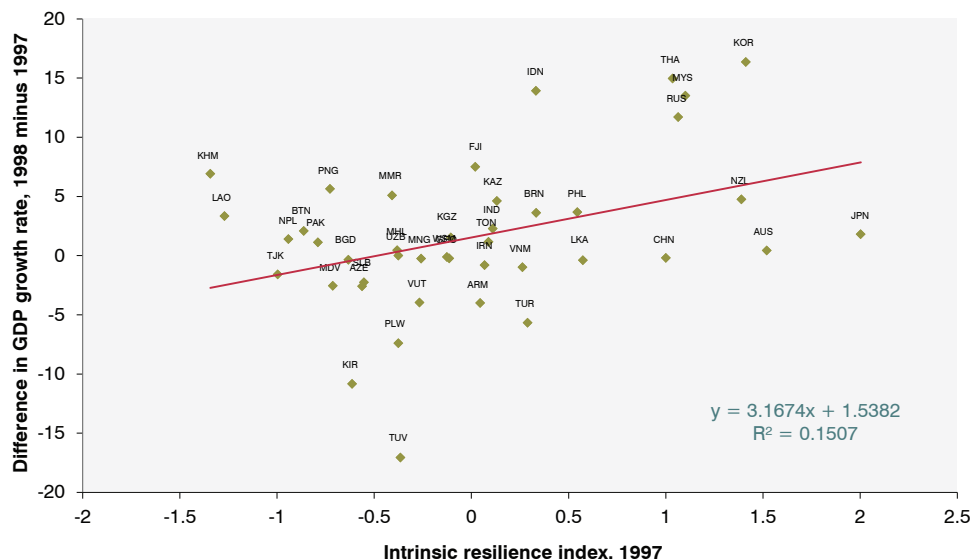
### Global economic crisis, 2008-2009



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/unsd/mdg/Default.aspx> (accessed November 2012) and the World Bank's World Development Indicators available from <http://data.worldbank.org/data-catalog/world-development-indicators> (accessed November 2012).

FIGURE A-7

## Asian financial crisis



Source: Based on data from COMTRADE available from <http://comtrade.un.org/db/default.aspx> (accessed November 2012) and MDG Indicators Database available from <http://mdgs.un.org/unsd/mdg/Default.aspx> (accessed November 2012) and the World Bank's World Development Indicators available from <http://data.worldbank.org/data-catalog/world-development-indicators> (accessed November 2012).

## TECHNICAL ANNEX

### ECONOMIC COMPLEXITY INDEX

The analysis presented in this Study applies the method of reflections proposed by Hidalgo and Hausmann<sup>51</sup> to quantify the set of productive capabilities available in a country's economy based on the structure of a bipartite network connecting countries to the products that they export. The method of reflections assumes that products require specific combinations of capabilities to be produced; countries have some capabilities but not others; and countries will produce goods as long as they have all the required capabilities.<sup>52</sup> This analysis infers the set of capabilities available in the countries by analysing the association and implied relationships that connect countries to products. The method uses trade data to infer the products that the country is able to produce.

Data is data from *United Nations COMTRADE* using SITC rev2 (5-digit level). The value traded is not used in the analysis, only the unit value is considered to further classify products by price range.

The method represents the network connecting countries to products using the adjacent matrix  $M_{cp}$ , where  $M_{cp}$  is 1 if the country produces the product and 0 otherwise. The method is defined as the recursive set of observables:

$$K_{c,N} = \frac{1}{K_{c,0}} \sum_p M_{cp} K_{p,N-1}$$

and

$$K_{p,N} = \frac{1}{K_{p,0}} \sum_c M_{cp} K_{c,N-1}$$

For  $N \geq 0$ , with  $K_{c,0}$  representing the number of products exported by country  $c$  and  $K_{p,0}$  representing the number of countries that export product  $p$ . The method of reflections thus produces, for each country  $c$ , a vector representing the complexity of productive structure of the country in terms of the diversification and ubiquity of its product-mix, which can be identified with an ordered list of  $N$  real numbers  $(K_{c,0}, K_{c,1}, K_{c,2}, \dots, K_{c,N})$ , where  $N$  is the number of iterations of the method of reflections. As the number  $N$  of iterations of the method increases, the higher order variables tend to converge to the same number. There is, therefore, a limit to the number of iterations that result in relevant values to produce the ranking. The value of such limit number ( $N_L$ ) depends on the structure of the network (i.e. the number of countries, products, and how they are connected). Since the method converges quickly, however, this report approximates the limit by  $K_{c,12}$ . The measure is normalized by subtracting its mean and dividing by the standard deviation.

## SOCIAL CONTEXT INDEX

This report creates a quantitative measure of intrinsic social resilience for each country by applying the method of reflections to information on the attainment of five Millennium

Development Goal (MDGs) indicators related to gender and children (Table A-2).

Similarly with the estimation of economic complexity, the method represents the network connecting countries to products using the adjacent matrix  $M_{cp}$ , where  $M_{cp}$  is 1 if the country produces the product and 0 otherwise. The assumption is that more challenging levels of attainment are less likely to be achieved by a larger number of countries, and that more socially equitable countries are more likely to reach a large number of goals. Data on each indicator is disaggregated by taking each percentage point in the level of attainment as a different MDG product. Missing values on the MDG dataset of a country between two reporting years were imputed using simple interpolation method and missing data in years before the earliest or after the latest data available were imputed by replacing them with the nearest available data/year for the country. For indicators such as infant and under-5 mortality, the scale is reversed to reflect the fact that the lower number represents the highest level of attainment. The measure is normalized by subtracting its mean and dividing by the standard deviation.

TABLE A-2

### List of MDG indicators considered to calculate the social resilience component

MDG	Indicator
Promote gender equality and empower women	Gender Parity Index in secondary level enrolment
	Share of women in wage employment in the non-agricultural sector
Reduce child mortality	Children under five mortality rate per 1,000 live births
	Infant mortality rate (0-1 year) per 1,000 live births
	Children 1 year old immunized against measles, percentage



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## ENDNOTES

- <sup>1</sup> Hossain and Green, 2011.
- <sup>2</sup> Narasimhan, 2009.
- <sup>3</sup> Philippines, NDRRMC, 2012.
- <sup>4</sup> United Nations, 2005a.
- <sup>5</sup> United Nations, 2010.
- <sup>6</sup> United Nations, 2011.
- <sup>7</sup> United Nations, 2012b.
- <sup>8</sup> Kahneman and others, 2011.
- <sup>9</sup> World Bank, 2012b.
- <sup>10</sup> Flyvbjerg, 2006.
- <sup>11</sup> Weitzman, 2009.
- <sup>12</sup> UNISDR Terminology on Disaster Risk Reduction.
- <sup>13</sup> Holling, 1973.
- <sup>14</sup> IPCC, 2007.
- <sup>15</sup> Resilience Alliance, further information from <http://www.resalliance.org/index.php/glossary>.
- <sup>16</sup> USAID, further information is available from <http://www.usaid.gov/resilience>
- <sup>17</sup> Stockholm Resilience Centre, further information is available from <http://www.stockholmresilience.org/21/research/what-is-resilience.html>.
- <sup>18</sup> UK DFID, 2011.
- <sup>19</sup> WEF, 2013.
- <sup>20</sup> For further information, refer to [www.usaid.gov/resilience](http://www.usaid.gov/resilience).
- <sup>21</sup> Stiglitz, 2009.
- <sup>22</sup> Cash and others, 2006.
- <sup>23</sup> ESCAP, 2012c and 2012d.
- <sup>24</sup> ADB, 2011b.
- <sup>25</sup> Fornanri and Stracca, 2012.
- <sup>26</sup> Grilli and others, 2012.
- <sup>27</sup> Soremaki and others, 2006.
- <sup>28</sup> Albert and others, 2000; Crucitti and others, 2004.
- <sup>29</sup> May and others, 2008.
- <sup>30</sup> De Bock and Carvalho Filho, 2013.
- <sup>31</sup> ESCAP, 2012c.
- <sup>32</sup> ESCAP, 2011b.
- <sup>33</sup> Becker and Mauro, 2006.
- <sup>34</sup> ESCAP, 2012c.
- <sup>35</sup> Bhattacharya and Dasgupta, 2012.
- <sup>36</sup> ADB and World Bank, 2010.
- <sup>37</sup> UNCTAD, 2013.
- <sup>38</sup> Jansen and others, 2009.
- <sup>39</sup> ESCAP, 2012c.
- <sup>40</sup> In this study natural disasters are droughts, floods, storms, extreme temperatures, and wildfires, as well as mass movements such as landslides, volcanoes, earthquakes and tsunamis.
- <sup>41</sup> Noy, 2009.
- <sup>42</sup> Furceri and Zdzienicka, 2012.
- <sup>43</sup> Bhattacharya and Dasgupta, 2012.
- <sup>44</sup> Raddatz, 2007; Hochrainer, 2009.
- <sup>45</sup> ESCAP and UNISDR, 2012.
- <sup>46</sup> ESCAP and others, 2010.
- <sup>47</sup> UNU, 2011.
- <sup>48</sup> UNISDR, 2011.
- <sup>49</sup> World Bank, 2011c.
- <sup>50</sup> Cariolle, Joel and Patrick Guilaumont, 2011.
- <sup>51</sup> Hidalgo and Hausmann, 2009.
- <sup>52</sup> Hausmann and Hidalgo, 2010.