



Food and Agriculture
Organization of the
United Nations

The impact of disasters on agriculture and food security



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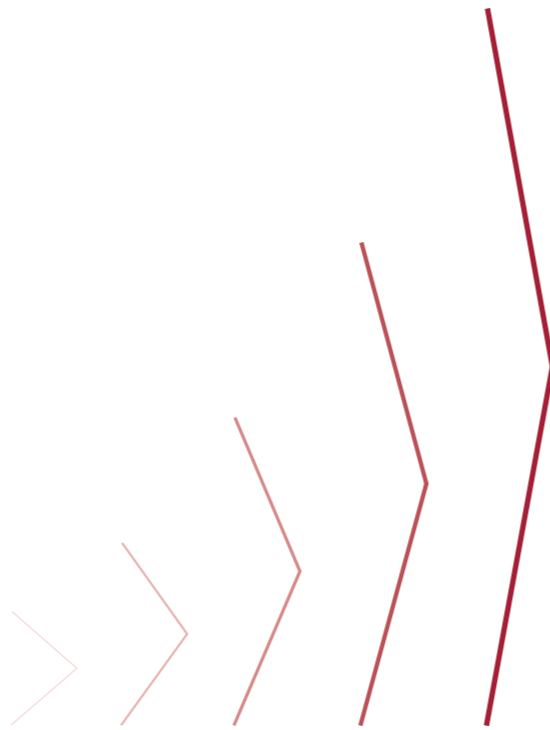
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In developing countries the agriculture sector absorbs about 22 percent of the total damage and losses caused by natural hazards



Disasters
jeopardize
agricultural
production and
development and
often have **cascading
negative effects**
across national
economies





The number of climate-induced disasters has increased significantly over the last decade

Of all natural hazards, floods, droughts and tropical storms affect the agriculture sector most showing the severe impact of climate-related disasters

More than 80 percent of the damage and losses caused by drought is to agriculture, especially livestock and crop production

The fisheries subsector is most affected by tsunamis and storms, while most of the economic impact on forestry is caused by floods and storms

The study aims to help fill the current knowledge gap on the nature and magnitude of impacts of disasters triggered by natural hazards on the agriculture sector and its subsectors (crops, livestock, fisheries and forestry) in developing countries. Quantifying the full extent of sector damage and losses is fundamental to better understand people's vulnerabilities and risks and inform appropriate risk reduction measures and investments. The study demonstrates that natural hazards regularly impact heavily on agriculture and hamper the eradication of hunger and achievement of sustainable development

Foreword

As the frequency and severity of disasters triggered by natural hazards have continued to rise over the last three decades, so too has their economic cost. Worldwide, in the decade from 2003 to 2013, these disasters cost some USD 1.5 trillion in economic damage. In the last few years, according to the 2015 Report of the Secretary-General on the Implementation of the International Strategy for Disaster Reduction, “Economic losses [from natural hazard-induced disasters] have reached an average of USD 250 billion to USD 300 billion a year”.

Yet, we know comparatively little about the full impact of such disasters on agriculture and its subsectors (crops, livestock, fisheries and forestry). This study was thus undertaken by the Food and Agriculture Organization of the United Nations (FAO) to begin filling information gaps about the nature and magnitude of disaster impacts on the agriculture sector in developing countries.

The study shows that at a conservative estimate, 22 percent of the damage and losses caused by such disasters in developing countries between 2003 and 2013 fell on the agriculture sector – rising to 25 percent when just climate-related disasters are taken into account.

In many of the countries most vulnerable to natural hazard-induced disasters, agriculture is the main source of livelihoods and food security, and a key driver of economic growth. Of all natural hazards, floods, droughts and storms affect the agriculture sector the most, showing the severe impact of climate-related disasters on the sector. These disasters thus undermine efforts to eradicate hunger and food insecurity, and build sustainable, prosperous futures.

This year alone, small-scale farmers, fishers, pastoralists and forest- and tree-dependent people – from Myanmar to Guatemala and from Vanuatu to Malawi – have seen their livelihoods eroded or erased by cyclones, droughts, floods and earthquakes.

For FAO, enhancing the resilience of agriculture-based livelihoods in the face of disasters is at the core of our commitment to tackle hunger, food insecurity and extreme poverty worldwide.

In 2015, the international community has committed to two major agendas that recognize resilience as fundamental to their achievement: the Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction 2015–2030, while a Universal Climate Change Agreement is expected before the end of the year.

However, without accurate, up-to-date information on disaster impacts at the sector level, we cannot effectively measure our progress in meeting the targets set.

Sector-specific data on damage and losses are also essential for effective policy and practice. National strategies for disaster risk reduction and climate change adaptation that support resilience must address the types of disasters with the greatest impact on the agriculture sector. Ultimately, this will contribute to national efforts to achieve sustainable agricultural development, reduce hunger and poverty, and meet the targets set under relevant international commitments.

We hope that this study will ignite national, regional and global efforts to develop comprehensive data collection and monitoring systems, thereby informing effective policies and actions to build resilient livelihoods and help eradicate hunger, food insecurity and malnutrition.

José Graziano da Silva
Director-General



Acknowledgements

This report on the impact of disasters on agriculture and food security is the outcome of extensive cross-departmental collaboration within the framework of the efforts of the Food and Agriculture Organization of the United Nations (FAO) to enhance the resilience of agriculture-based livelihoods to disasters.

Produced under the overall leadership of Dominique Burgeon, Strategic Programme Leader – Resilience, the study forms a critical part of the Organization’s work under Strategic Objective 5: “Increase the resilience of livelihoods to threats and crises”. Significant technical inputs and advice were provided by various divisions and departments within FAO, including the Technical Cooperation Department, Economic and Social Development Department, Agriculture and Consumer Protection Department, Fisheries and Aquaculture Department, Forestry Department and the Climate, Energy and Tenure Division. In addition, FAO country offices provided invaluable support in gathering national-level data where available.

The study and report were coordinated and supervised by Stephan Baas, with Monica Trujillo as coordinating lead author. Niccolò Lombardi was a contributing author. Lucia Palombi and Tamara van’t Wout contributed to the research, data collection and analysis and the drafting of case studies.

Technical guidance on the statistical methods and analysis presented in Chapter II was provided by Shukri Ahmed and Piero Conforti.

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Editorial, graphic and design work was coordinated by Anne De Lannoy.

Acronyms

DES	Dietary energy supply
EM-DAT CRED	International Disaster Database – Centre for Research on the Epidemiology of Disasters
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GFDRR	Global Facility for Disaster Reduction and Recovery
IFRC	International Federation of Red Cross and Red Crescent Societies
IMF	International Monetary Fund
IUCN	International Union for Conservation of Nature
OECD	Organisation for Economic Co-operation and Development
ODI	Overseas Development Institute
PDNA	Post-disaster needs assessment
SDG	Sustainable Development Goal
UNISDR	United Nations Office for Disaster Risk Reduction

Executive Summary

Between 2003 and 2013, disasters triggered by natural hazards caused USD 1.5 trillion in economic damage¹ worldwide. In developing countries alone, these disasters cost about USD 550 billion in estimated damage and affected 2 billion people². Such disasters often undermine national economic growth and development goals, as well as agriculture sector growth and sustainable sector development. However, there is no clear understanding of the economic impact of disasters on the agriculture sector³.

To protect development investments in the agriculture sector and strengthen the sector's resilience to disasters, a clear understanding is needed of the particular way the sector is affected by disasters. However, globally available statistics on damage or losses do not disaggregate the impact on individual sectors. This is largely because the data is not collected and reported in a systematic way by sector at the national or subnational levels. Thus, the full impact of disasters on the agriculture sector is not well understood. Disasters do not affect all people and sectors in the same way or to the same extent, and these differences have important policy implications.

Effective policy and practice requires sector-specific damage and loss data for the agriculture sector. National strategies on disaster risk reduction and climate change adaptation that support resilience and sustainable agricultural development must address the types of disasters with the greatest impact on the sector, such as climate-related disasters. Governments must design measures specific to the crop, livestock, fisheries and forestry subsectors, and be enabled to adopt more systematic strategies that counteract the impact of disasters on sector growth and development and thus national food security. Ultimately, this will contribute to national efforts to achieve sustainable agricultural development, reduce hunger and poverty, and meet the targets set under relevant international commitments.

The Food and Agriculture Organization of the United Nations (FAO) carried out the present study to help fill existing knowledge gaps about the nature and magnitude of disaster impacts triggered by natural hazards on the agriculture sector and subsectors (crops, livestock, fisheries and forestry) in developing countries. The study seeks to provide systematized data, analysis and information, while increasing awareness about the urgent need to enhance national and international commitment and budget allocations to risk reduction for the sector, including improving data collection and monitoring systems on sector-specific damage and losses.

The ultimate goal is to inform the implementation and monitoring of the three key international agendas of 2015, which recognize resilience as a fundamental ingredient for their achievement: the Sustainable Development Goals (SDGs), specifically Goal 2; the Sendai Framework for Disaster Risk Reduction 2015–2030; and the Universal Climate Change Agreement that is expected under the United Nations Framework Convention on Climate Change.

¹ Based on data from the International Disaster Database – Centre for Research on the Epidemiology of Disasters (EM-DAT CRED).

² The term “disaster” refers to all those caused by natural hazards as reported in EM-DAT CRED, as well as the data on damage and populations affected.

³ Although this study focuses only on disasters triggered by natural hazards, the importance of human-induced disasters and their impact on agriculture is recognized. Disasters such as conflicts and environmental contamination, among others, can have strong repercussions for the agriculture sector and its subsectors.

The breadth and scope of disaster impact on the agriculture sector

The study begins by presenting the breadth and scope of the impact of disasters triggered by natural hazards on the agriculture sector. Damage and losses to the agriculture sector caused by 78 disasters are presented based on needs assessments conducted in developing countries in Africa, Asia and the Pacific, and Latin America and the Caribbean between 2003 and 2013.

The findings reveal that disasters can cause considerable damage to physical agricultural assets such as standing crops, irrigation systems, livestock shelters and veterinary services, aquaculture equipment or hatcheries; post-production infrastructure such as facilities for storage, processing, marketing and transport, buildings and equipment of farm schools and cooperatives; as well as sector ministries and their departments. Losses are also high – for example, the decline in output from crop, livestock, fisheries and aquaculture, and forestry production – with considerable economic losses to farmers and often having a domino effect on the food value chain, agro-industries, imports and exports and sector growth.

The study found that in developing countries, the agriculture sector absorbs an average of 22 percent of the total damage and losses caused by disasters triggered by natural hazards. The remaining damage and losses are to other sectors, i.e. housing, health, education, transport and communication, electricity, water and sanitation, commerce, industry, tourism and the environment, among others. **This rises to 25 percent when considering just climate-related disasters, such as droughts, floods, hurricanes, typhoons and cyclones⁴.**

The relationship between drought and agriculture is particularly important, as 84 percent of the damage and losses caused by droughts is to the agriculture sector, while the remaining impact is typically on sectors such as health and nutrition, energy, water and sanitation, among others⁵.

When examining the wider impact of disasters, the study shows that beyond production losses, **medium- and large-scale disasters can have a significant impact across the food value chain, with negative consequences on trade flows of agricultural commodities, sector growth, food and non-food agro-industries, and ultimately national economies.** For example, crop production losses caused by the 2010 floods in Pakistan directly affected cotton ginning, rice processing and flour and sugar milling, while cotton and rice imports surged. Agriculture absorbed 50 percent of the USD 10 billion in total damage and losses, and sector growth dropped from 3.5 percent to 0.2 percent between 2009 and 2010, as did national gross domestic product (GDP) from 2.8 percent to 1.6 percent between the same years.

At the same time, **disaster impact on agriculture has a direct effect on livelihoods and food security.** Disasters can cause unemployment and/or a decline in wages and therefore income among farmers and farm labourers. They lower the availability of food commodities in local markets, leading to food inflation. These pressures reduce households' purchasing capacity, restrict access to food, deplete savings and can force the sale of vital productive assets and erode livelihoods. Ultimately, the quantity and quality of food consumption are reduced and food insecurity and malnutrition increase, particularly among the most vulnerable households. For instance, the 2010 floods in Pakistan affected 4.5 million workers, two-thirds of whom were employed in agriculture, and over 70 percent of farmers lost more than half of their expected income.

⁴ In this study, climate-related disasters include drought, floods and storms such as hurricanes, typhoons and cyclones.

⁵ The findings on drought are based on three needs assessments available on drought between 2003 and 2013 (out of the 78 assessments reviewed), which assessed the impact of drought in Djibouti, Kenya and Uganda. (See Chapters I and III.)

Over time, damage and losses to the agriculture sector accumulate as a result of recurring disasters, adding up in their sector economic impact and constraining agricultural growth and development. For example, the Philippines was affected by 75 disasters between 2006 and 2013, primarily floods and typhoons/tropical storms, causing USD 3.8 billion in damage and losses to the sector over eight years. This translates into an average of USD 477 million in economic losses to the agriculture sector every year, equivalent to about one-quarter of the total annual national budget allocated to the sector in 2014⁶.

Analysis of ten years of data on production losses, changes in trade flows and agriculture sector growth

A statistical analysis using FAO agricultural databases helped to quantify crop and livestock production losses, as well as changes in trade flows and the performance of agriculture value added associated with 140 medium- and large-scale disasters (affecting at least 250 000 people) that occurred in 67 developing countries between 2003 and 2013⁷.

The assessment found that **approximately USD 80 billion was lost as a result of declines in crop and livestock production after these disasters.**

This corresponds to 333 million tonnes of cereals, pulses, meat, milk and other commodities. **These losses are equivalent to, on average, 7 percent of national per capita dietary energy supply (DES) after each disaster⁸.** This is already significant at the national level, but is likely higher at subnational level, where losses in calories may increase household food insecurity unless relevant measures are taken to compensate and fill the gap in DES.

These findings are considered conservative as the analysis focused on medium- and large-scale disasters, and on selected agricultural commodities. Including the thousands of so-called “silent disasters” that mainly hit agriculture, as well as other small-scale disasters and additional crop, livestock, fisheries and aquaculture, and forestry commodities would likely increase the reported production losses.

The disasters analysed were closely correlated with rises in food imports and drops in food exports. Increases in imports amounted⁹, in relative terms, to 28 percent of their projected value, while decreases in exports represented about 6 percent of the projected value of exports. Higher import expenditures and lower export revenues can negatively affect the national balance of payment.

The analysis also revealed significant negative trends in agriculture value-added growth for 55 percent of the disasters considered¹⁰. **After each disaster there is an average loss of 2.6 percent of national agricultural value-added growth¹¹ in the countries affected, with a much more significant impact likely at subnational levels.**

⁶ The Philippine's 2014 budget for the agriculture sector was approximately USD 1.8 billion.

⁷ Medium- and large-scale disasters were selected for the analysis, defined as those affecting 250 000 people or more, as these are likely to have an impact on agricultural production at the national level and can be analysed using national statistics.

⁸ See Annex 5 for details on the methodology.

⁹ The data on trade flows is based on the analysis of medium- and large-scale disasters that occurred between 2003 and 2011 in developing countries.

¹⁰ Negative performance is intended as a value of agriculture value-added growth rate lower than the 2003–2013 linear trend value in the year of disaster.

¹¹ Agriculture value added is the net output of the agriculture sector and subsectors after adding all outputs and subtracting intermediate inputs. Agriculture value-added growth is the annual percentage change of agriculture value added.

The impact of drought on agriculture in sub-Saharan Africa

An in-depth analysis was conducted on droughts in sub-Saharan Africa since 1980 to better understand trends and magnitude of drought impact and specific consequences in the region. This extensive analysis was prioritized owing to the high and increasing frequency of droughts in the region as a result of climate change, and the importance of the agriculture sector to economic growth and food security in the region. Agriculture contributes, on average, to 25 percent of GDP in sub-Saharan Africa, rising to 50 percent when the agribusiness sector is included. In addition, over 60 percent of the population lives in rural areas and the sector employs about 60 percent of the workforce¹².

Between 1980 and 2014, over 363 million people in sub-Saharan Africa were affected by droughts. **When considered by subregion, the results show that droughts affect more people in eastern Africa with 203 million people affected**, followed by southern Africa with 86 million and western Africa with 74 million. Ethiopia and Kenya together accounted for 30 percent of the total number of people affected, with nearly 61 million and 48 million, respectively (see Annex 4).

The study found that sub-Saharan African countries suffered about USD 31 billion in crop and livestock production losses after the droughts that occurred between 1991 and 2013, with the highest losses – USD 19 billion – experienced in eastern Africa. In southern Africa, losses amounted to over USD 10 billion and USD 2.5 billion in western Africa¹³.

After the droughts that occurred between 1991 and 2011 in the region, food imports increased by USD 6 billion and exports of the same commodities fell by nearly USD 2 billion¹⁴. **Sub-Saharan African countries lost an average of 3.5 percent of agriculture value-added growth after each drought** – a figure that is likely to be more acute at the subnational level.

The impact of drought on agriculture in sub-Saharan Africa often has a major cascading effect on national economies. For example, in Kenya between 2008 and 2011 drought caused crop production losses as well as losses in the food processing industry, particularly grain milling and coffee and tea processing. During the same four-year period, the agriculture sector experienced damage and losses of almost USD 11 billion and sector growth fell to -5 percent in 2008 and -2.3 percent in 2009.

Need to improve information systems on disaster impact for the agriculture sector

In order to design well-informed risk reduction strategies and investments within the agriculture sector, several challenges must be addressed to improve the information systems and statistics available on the impact of disasters on the sector. This requires:

- Addressing and overcoming the significant data gaps at the global, regional, national and subnational levels in order to gain a full understanding of the magnitude and diversity of disaster impact on agriculture, its subsectors and related natural resources and ecosystem services, and to better inform resilient and sustainable sectoral development planning, implementation and funding.

- Improving global and regional databases and information systems based on national data. The methodology for assessing impact should be improved to better capture the full extent of disaster impact on agriculture, its subsectors, the food value chain, food security, the environment and natural resources associated with the sector, and national economies. This precision is critical for formulating well-tailored policies and investments in the sector.
- Better recording and standardizing data collection and establishing regular monitoring and reporting at the country level, including at the subnational level. This also requires advising on and strengthening the capacity to do so, which is critical for disaster risk management and agriculture sector risk management.
- Systematically using damage and loss information at the global and national levels to monitor and measure progress towards the resilience goals and targets of the SDGs, the Sendai Framework and the expected Universal Climate Change Agreement.

In order to meet these challenges and as part of the Organization's commitment to resilience and the three global agendas, FAO will support efforts to improve monitoring and reporting of disaster impact on the agriculture sector by assisting Member Nations to collect and report relevant data. FAO will also improve the methodology applied to measuring, at the global level, the impact of disasters on the agriculture sector; for example, by enhancing statistical analysis and increasing the number of countries, disasters and commodities analysed.

Recommendations to strengthen the resilience of the agriculture sector

In order to reduce the impact of disasters on agriculture, especially in view of climate change and the increasing frequency and magnitude of climate-related disasters, it is necessary to ensure that:

- Disaster risk reduction for resilience building becomes an essential component of all humanitarian and development funding for the agriculture sector¹⁵, as well as a priority for government and private sector investment in agriculture. This is particularly important in countries where disasters cause heavy losses to the sector and national economies.
- Disaster risk reduction and management (a backbone of resilience) is systematically embedded into agriculture sector development plans and investments, particularly in disaster-prone countries where agriculture is an important source of livelihoods, food security and nutrition, as well as a key driver of economic growth.
- Humanitarian aid to agriculture more consistently reflects the impact of disasters on the sector. Disaster risk reduction and management strategies should be integrated into post-disaster recovery efforts in the agriculture sector to ensure that investments made in disaster response and recovery also build resilience to future shocks.
- National governments and the international community establish targets for financing disaster risk reduction in the agriculture sector in order to prevent and mitigate the significant impact of disasters.

¹² Deutsche Bank, 2014, Agricultural value chains in sub-Saharan Africa – From a development challenge to a business opportunity.

¹³ Central Africa is not included as no country in the subregion experienced droughts affecting more than 250 000 people between 1991 and 2013.

¹⁴ The findings reflect droughts that took place between 1991 and 2011, as data was unavailable for more recent years. Commodities included in the analysis were cereals, pulses, milk and meat.

¹⁵ Overseas Development Institute. 2014. Dare to prepare: taking risk seriously. Financing emergency preparedness; from fighting crisis to managing risk.

Worldwide, the average annual number of disasters that occurred between 2003 and 2013 was twice the average annual number of disasters that occurred in the 1980s

Economic losses have reached an average of USD 250 billion to USD 300 billion a year, severely affecting stable economic growth in low- and middle-income countries and eroding development gains in vulnerable communities.
Source: 2015 Report of the Secretary-General on the Implementation of the International Strategy for Disaster Reduction

The study reviewed 78 post-disaster needs assessments of disaster events in 48 countries, and conducted a statistical analysis of 140 medium- and large-scale disasters in 67 countries

Introduction

Data on disaster damage and losses in the agriculture sector are not systematically collected or reported

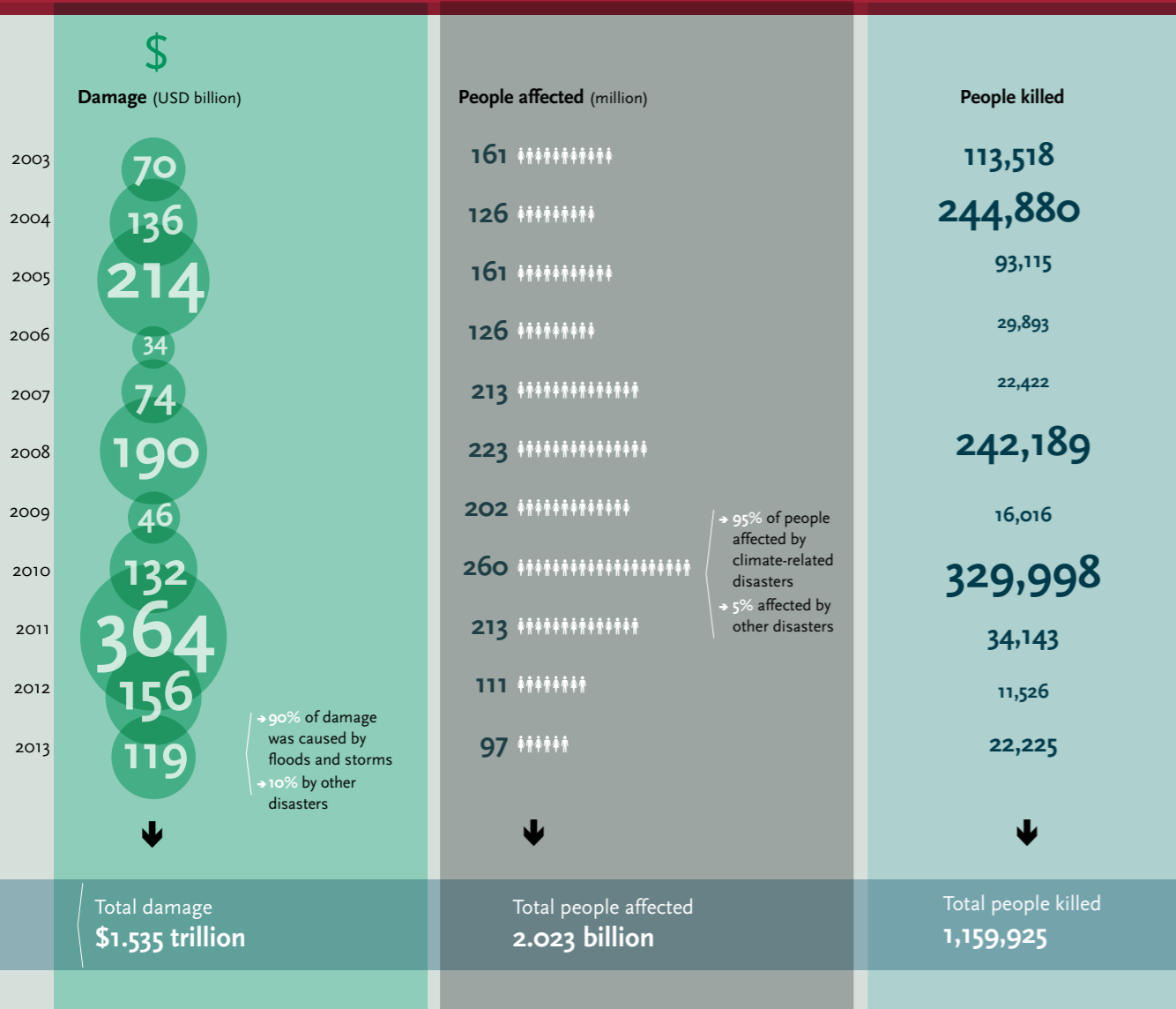
Background

Between 2003 and 2013, disasters caused by natural hazards caused USD 1.5 trillion in damages worldwide (Figure 1). In developing countries alone, estimated damages from these disasters amounted to about USD 550 billion and affected 2 billion people¹⁶. Such disasters undermine national economic growth and development goals, as well as the growth and sustainable development of the agriculture sector. Despite this, there is as of yet no clear understanding of the extent and nature of the economic impact of disasters on the agriculture sector and its subsectors. This study thus seeks to fill this critical information gap¹⁷.

Over the last three decades, there has been a rising trend in the occurrence of disasters worldwide and related economic damage (Figure 2). This is particularly noteworthy in relation to climatological events such as droughts, hydrological events like floods and meteorological events such as storms.

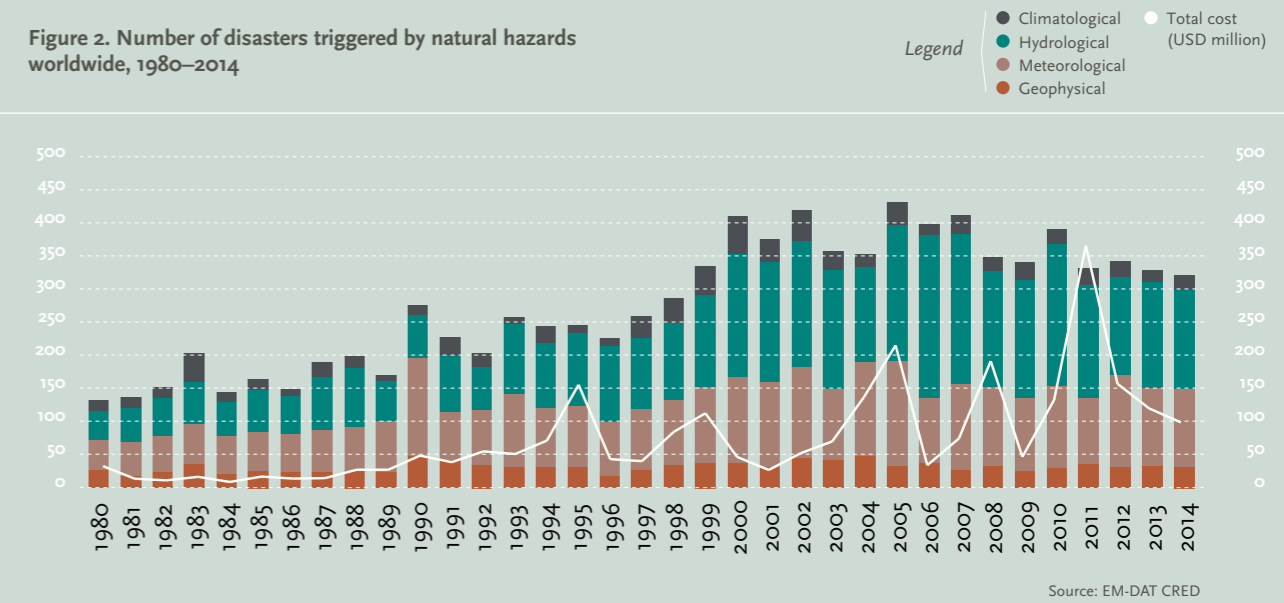
- ¹⁶ The term “disaster” refers to all those caused by natural hazards as reported in EM-DAT CRED, as well as the data on damages. The economic damages reported in this database are considered an underestimate given that such information is only available for 36 percent of disasters reported.
- ¹⁷ Although this study focuses only on disasters triggered by natural hazards, the importance of human-induced disasters and their impact on agriculture is recognized. Disasters such as conflicts and environmental contamination, among others, may have strong repercussions on the agriculture sector.

Figure 1. The impact of disasters between 2003 and 2013



Source: EM-DAT CRED

Figure 2. Number of disasters triggered by natural hazards worldwide, 1980–2014



The increase in weather-related events is of significant concern to the agriculture sector given the sector's dependence on climate. As will be demonstrated throughout this report, these types of hazards pose the greatest threat to the sector. The urgent need to strengthen the resilience of food systems is clear given the increasing frequency and severity of climate-related disasters, coupled with the rising demand for food linked to population growth. This is particularly crucial in countries where disasters are frequent and where the agriculture sector contributes significantly to employment, poverty reduction and food security, as well as being a key driver of national economic growth.

A clear understanding of the particular way in which the agriculture sector is affected by disasters is crucial to protect development investments and strengthen the sector's resilience to disasters. Yet, the economic impact of disasters on the agriculture sector is not known at the global or regional levels. **Globally available statistics on damage or losses do not disaggregate the impact on individual sectors.**

This is largely because the impact of disasters is not collected and reported in a systematic way by sector at the national or subnational levels. In the aftermath of disasters, many countries conduct needs assessments involving sectoral ministries in order to inform the humanitarian response. In some cases, assessments are conducted as a joint effort between governments and the international community, for example post-disaster needs assessments (PDNAs). Such assessments evaluate the impact of disasters across all relevant sectors; however, the assessment results and data collected are not systematically included in national disaster loss databases.

Needs assessments do not share a common method for assessing the impact of disasters. Some use livelihood or food economy approaches to assess the impact of a disaster on the agriculture sector, while others assess the economic impact or focus on the physical damage to crops and livestock. The varying forms of analysis applied produce a different perspective of the disaster impact on the sector. The end result is that the full consequences of disasters on the agriculture sector are not well understood at the global, regional, national or subnational levels.

Disasters do not affect all people and sectors in the same way, or to the same extent, all people and sectors in the same way or to the same extent Disasters do not affect all people and sectors in the same way, or to the same extent, and these differences have important policy implications. For example, as this study illustrates, specific types of hazards cause more agricultural losses than others, the agriculture subsectors are affected differently by disasters, and the nature of disaster impact on the sector differs by region and country. It is therefore necessary to understand the breadth and scope of disaster impact on agriculture and livelihoods, such as the extent to which disasters increase the level of food insecurity or arrest sector economic growth.

Effective policy and practice requires sector-specific damage and loss data for the agriculture sector. National strategies for disaster risk reduction and climate change adaptation that support resilience and sustainable agricultural development must be informed by the particular nature of disaster impact on the sector, addressing hazards that cause the greatest losses such as climate-related disasters; designing measures specific to the crop, livestock, fisheries and aquaculture, and forestry subsectors; and adopting more systemic strategies that counteract the impact of disasters on sector growth and development and on national food security. Ultimately, this will support government efforts to achieve sustainable agricultural development, reduce hunger and poverty and meet their targets under relevant international commitments.

Purpose, approach and methods of the study

Specific objective and purpose of the study

The Food and Agriculture Organization of the United Nations (FAO) undertook this study with the specific objective of helping to fill the existing knowledge gap about the nature and magnitude of the impacts of disasters triggered by natural hazards on the agriculture sector and its subsectors (crops, livestock, fisheries and forestry) in developing countries. Through the study, FAO seeks to provide systematized data, analysis and information, as well as increase awareness about the urgent need to enhance national and international commitment and budget allocations to risk reduction for the sector, including improving data collection and monitoring systems for damage and losses to agriculture.

Ultimately, the study should inform the implementation and monitoring of the three main international agendas to be adopted in 2015, which recognize resilience as fundamental to their achievement The ultimate goal of the study is to inform the implementation and monitoring of the three main international agendas to be adopted in 2015, which recognize resilience as fundamental to their achievement: (i) the Sustainable Development Goals (SDGs), specifically Goal 2; (ii) the Sendai Framework for Disaster Risk Reduction 2015–2030; and (iii) the Universal Climate Change Agreement that is expected under the United Nations Framework Convention on Climate Change, including the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (Loss and Damage Mechanism).

Concepts used to define the impact of disasters on the agriculture sector

For the purpose of this study, the impact of disasters on agriculture is considered in a holistic manner to capture damage and losses to the sector, the resulting wider economic impact, and the effect on livelihoods, food security and nutrition.

Damage and losses:

“**Damage**” refers to the total or partial destruction of physical assets and infrastructure in disaster-affected areas, expressed as replacement or repair costs. In the agriculture sector, damage is considered in relation to standing crops, irrigation systems, livestock shelters and veterinary services, aquaculture equipment or hatcheries, farm equipment and machinery, and post-production infrastructure such as storage, processing, marketing and transport facilities, among others.

“**Losses**” refer to the changes in economic flows arising from the disaster. In agriculture, losses may include, among others, the decline in output in crop, livestock, fisheries and aquaculture, and forestry production; increased costs of farm inputs such as fertilizers, seeds, livestock feed, veterinary care and other inputs; lower revenues and higher operational costs in the provision of services; and the unexpected expenditures to meet humanitarian and recovery needs in the sector¹⁸.

The wider impact on economy, food security and nutrition: The study also considers losses across the food value chain, and the consequent impact on agriculture value added or sector growth on trade flows and on national economic growth. The wider impact considers losses in food and non-food agro-industries that result from agricultural production losses. In addition, the resulting wider impacts on rural and agriculture-based livelihoods and food security are considered. For example, employment and income losses among farm labourers, reduced food supply, restricted access to food, reduced quantity and quality of food consumed, and increases in malnutrition among affected populations.

Key terminology specific to this report

The agriculture sector: this includes the crop, livestock, fisheries and forestry subsectors, and is so intended when used throughout the report unless otherwise specified.

Disasters: the analysis undertaken and presented throughout this report focused on disasters caused by natural hazards, i.e. droughts, floods, hurricanes, typhoons, cyclones, earthquakes, tsunamis and volcanic eruptions. Therefore, the term “disasters” in this report refers to these types of hazards, unless indicated otherwise.

Climate-related disasters: in this report, these refer specifically to droughts, floods, hurricanes, typhoons and cyclones.

Resilience: this is understood as the ability to prevent disasters and crises, and to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner. This includes protecting, restoring and improving food and agricultural systems under threats that impact food security and nutrition, agriculture, and/or food safety and public health.

¹⁸ For the most part, this report applies the definition of damage and losses used in the methodology of two needs assessment guidelines: (i) United Nations, Global Facility for Disaster Reduction and Recovery (GFDRR) and European Commission. 2013. Post-Disaster Needs Assessments Volume A and B Guidelines; and (ii) GFDRR. 2010. Damage, Loss and Needs Assessment: Guidance Notes Volume 1.

Approach and methods used in the study

Given the lack of globally available data on the economic impact of disasters on the agriculture sector in developing countries, the study combined several methods to fill the information gap. In particular, the study sought to shed some light on the nature and characteristics of disaster impact on agriculture and its subsectors, quantify losses, holistically assess the broader impact on the sector and report at a wider scale, covering developing countries. The following is a brief overview of the approach and methodology used.

Review and analysis of damage and losses to the agriculture sector caused by disasters over the past decade in developing countries: The analysis is based on a sample of 78 needs assessments undertaken in the aftermath of disasters¹⁹ that occurred between 2003 and 2013 in 48 countries in Africa, Asia and the Pacific, and Latin America and the Caribbean. (The list of countries and disasters analysed is provided in Annex 3.) The sample includes small-, medium- and large-scale disasters²⁰, covering different types of natural hazards across all developing regions. As such, it is a representative sample that provides an evidence-based analysis of global trends. This method made it possible to identify the combined damage and losses that affect the sector, the share of damage and losses to agriculture compared with other affected sectors, the types of hazards that have had the most significant economic impact on agriculture and the differences in this impact across the agriculture subsectors.

The study covers 15 small island developing states including 11 in the Caribbean, 2 in Africa and 2 in Asia and the Pacific

Statistical analysis to quantify crop and livestock production losses observed after the occurrence of disasters over the past decade, as well as changes in trade flows and agriculture value-added growth: This was done to fill information gaps in statistics currently available at the global level. The statistical analysis covers 140 disasters that affected 250 000 people or more and that took place between 2003 and 2013 in Asia, Latin America and the Caribbean, the Near East and sub-Saharan Africa. (The list of countries analysed is provided in Annex 2.) The analysis used national and international statistics on disasters, production, imports and exports (trade flows), and agriculture value-added growth, based on data in FAOSTAT and the World Bank World Development Indicators. The findings represent a first effort to provide approximate figures on some of the key losses associated with disasters in the agriculture sector. The analysis prioritized developing countries and focused on a selected number of agricultural commodities. (A more detailed description of the methodology used is provided in Annex 5.)

In-depth review and analysis of specific disaster events, including drought in sub-Saharan Africa, based on a comprehensive set of data and information sources, to develop case material and present a holistic picture of disaster impact on the agriculture sector: The analysis of detailed data from many sources made it possible to develop case studies that demonstrate the wide impact that disasters have on the sector, including the impact of production losses across the value chain, on sector value-added growth, imports and exports, balance of payments and overall national economies, as well as on food security and nutrition.

¹⁹ The needs assessments reviewed include both PDNAs and damage and loss assessments, as well as others that may use different titles or names.

²⁰ Of the 78 disasters reviewed, 41 affected more than 250 000 people, while 15 affected between 50 000 and 250 000 people, and 22 affected less than 50 000 people.

Study outline

The findings of the study are presented in four sections, as outlined below.

Chapter I: The scope of disaster impact on agriculture

This chapter presents the breadth and scope of disaster impact on the agriculture sector. In particular, the chapter focuses on (i) key global trends related to damage and losses to the agriculture sector, based on a sample of 78 disaster events that occurred over the past decade (2003–2013) in developing countries; (ii) an analysis of disaster impact on the agricultural subsectors (crops, livestock, fisheries and forestry) and natural resources; and (iii) an analysis of the wider impact of disasters, for example across the agriculture value chain, on agro-industries, national economies and livelihoods, based on statistical analyses and in-depth case studies. The chapter also illustrates the cumulative damages and losses caused by recurring disasters in specific countries.

Chapter II: Quantifying production losses, changes in trade flows and sector growth after disasters over the past decade

This chapter focuses on a quantitative measurement of the losses associated with 140 disasters that occurred over the past decade in developing countries based on FAO's statistical analysis. The findings of the analysis presented include: (i) quantification of the monetary value of crop and livestock production losses; (ii) observed changes in agricultural imports and exports; and (iii) trends in the performance of agriculture value-added growth. The results are presented for all developing regions and compared across regions and by type of hazard.

Chapter III: Drought in sub-Saharan Africa – an in-depth analysis of the impact on agriculture

Given the severe impact of drought on agriculture, this chapter is dedicated to an in-depth analysis of how droughts have affected sub-Saharan Africa from 1980 to 2013. The analysis looks at drought trends in terms of their geo-spatial and temporal distribution by subregion and decade, quantifying the crop and livestock production losses associated with droughts and illustrating the wider impact of droughts on the food value chain, trade flows, agriculture sector growth, national GDP and other national economic indicators, as well as on food security and nutrition.

Chapter IV: Core findings, conclusions and the way forward

The final chapter presents the core findings and main conclusions, including the implications of the study's findings for disaster risk reduction and management as well as development planning in agriculture. The chapter also provides recommendations to support global, regional and national efforts to strengthen the resilience of the agriculture sector and livelihoods.

Indirect losses experienced by the agriculture sector in the seasons after a disaster are twice as high as the direct damage to agricultural assets

Almost three-quarters of recorded post-disaster damage and losses to agriculture were to the crops and livestock subsectors

Twenty-five percent of the economic impact caused by climate-related disasters falls on the agriculture sector

Chapter I

The scope of disaster impact on agriculture

The impact of different types of hazards on agriculture subsectors varies substantially, which requires context-specific disaster risk reduction and management

This chapter presents the breadth and scope of disaster impact on the agriculture sector. Key global trends for damage and losses to the agriculture sector are presented, followed by a discussion of the nature of disaster impact on agriculture subsectors (crops, livestock, fisheries and forestry) and natural resources, with trends in damage and losses for each. The wider impact of disasters is then presented across the value chain, on agro-industries, national economies, livelihoods and food security, as well as the cumulative damage and losses caused by recurring disasters.

1.1 Global trends in damage and losses to the agriculture sector

Overall damage and losses to agriculture

FAO analysed the damage and losses to the agriculture sector caused by 78 disaster events that occurred between 2003 and 2013 in developing countries in Africa, Asia and the Pacific, and Latin America and the Caribbean. These included small-, medium- and large-scale disasters, 13 of which occurred in Africa, 27 in Asia and the Pacific, 37 in Latin America and the Caribbean, and one in Eastern Europe. (See Annex 3 for a full list of the countries and disasters analysed.)

The data analysed is based on information reported in needs assessments, which are typically undertaken in the immediate aftermath of disasters as a collaborative effort between governments and the international community to assess the impact of a disaster on all major affected sectors²¹. The study calculated the damage and losses to the agriculture sector as reported in these needs assessments²². In the assessments, damage refers to the total or partial destruction of physical assets and infrastructure in the affected areas in terms of their monetary value expressed as replacement costs. Losses refer to the changes in economic flows arising from the disaster and that continue until economic recovery is achieved²³.

Together, the 78 disasters cost USD 30 billion in damage and losses to the agriculture sector

Together, the 78 disasters cost USD 30 billion in damage and losses to agriculture and its subsectors, out of a total of USD 140 billion in combined damage and losses across all sectors. The attached map shows the ten disasters causing the greatest damage and losses to the agriculture sector out of the 78 reviewed between 2003 and 2013.

Disasters have an impact across a range of sectors depending on their magnitude, geographic location and other characteristics. The reviewed needs assessments typically evaluated the damage and losses to productive sectors such as agriculture, livelihoods, commerce and industry, commerce and trade, and tourism; to social sectors such as housing, education, health, culture and nutrition; and to infrastructure such as water and sanitation, energy and electricity, transport and telecommunications²⁴.

The damage and losses calculated for the agriculture sector were analysed in relation to the damage and losses to all sectors combined, expressed in terms of the percentage share of the total. The findings indicate that in terms of direct physical damage alone, roughly 14 percent was to the agriculture sector while the remaining damage was to other sectors.

²¹ The needs assessments reviewed include both PDNAs and damage and loss assessments, as well as others that may use different titles or names.
²² The damage and losses to the agriculture sector reported in this chapter include the impact on crops, livestock, fisheries, forestry, irrigation and other areas such as sector infrastructure, which are calculated under different 'sectors' within the needs assessments reviewed.
²³ For further information on the methodology used to assess damage and losses, refer to: (i) European Commission, World Bank and United Nations. 2013. PDNAs Volume A and B Guidelines and (ii) GFDRR. 2010. Damage, Loss and Needs Assessment: Guidance Notes Volume 1.
²⁴ For further information on sectoral classifications see European Commission, World Bank and United Nations. 2013. PDNA: Volume A Guidelines; and World Bank. 2010. Damage, Loss and Needs Assessment Guidance Notes.

This direct damage to agriculture typically includes the partial or total destruction of vital agricultural infrastructure and assets, including standing crops; farm tools and equipment; irrigation systems; livestock shelters and veterinary services; fishing boats and equipment; landing sites; aquaculture equipment and hatcheries; post-production infrastructure such as storage, processing, marketing and transport facilities; buildings and equipment of farm schools and cooperatives, and sector ministries and their departments, among others.

Of all the indirect losses these disasters caused, nearly 30 percent was to the agriculture sector alone. In other words, the greatest economic impact of disasters to the agriculture sector stems from losses, while the physical damage is comparatively smaller given the relatively lower monetary value of agricultural assets when compared with infrastructure such as housing or roads. The losses to the agriculture sector may include a decline in output in crop, livestock, fisheries and aquaculture, and forestry production; increased cost of production from higher outlays on farm inputs such as fertilizers, seeds, livestock feed and veterinary care, among others; lower revenues and higher operational costs in the provision of services; and unexpected expenditures to meet humanitarian and recovery needs in the sector.

When damage and losses are combined, **the agriculture sector absorbs an average of 22 percent of the total impact of natural hazards – a figure much higher than previously reported²⁵**. The remaining damage and losses are to other sectors such as housing, health, education, transport and communication, electricity, water and sanitation, commerce, industry, tourism, and the environment, among others. When considering only climate-related disasters – such as floods, droughts, hurricanes, typhoons and cyclones (excluding geological hazards such as earthquakes, tsunamis and volcanic eruptions) – the percentage share of the total damage and losses affecting agriculture rises. **Twenty-five percent of the economic impact caused by climate-related disasters falls on the agriculture sector.**

²⁵ In the 2013 Global Assessment Report, the monetary value of disaster impact was calculated based on physical impact indicators reported in 45 national disaster loss databases. Physical impact indicators included houses damaged and destroyed, hospitals damaged, education centres damaged, damages in roads, crop hectares damaged and livestock units lost. According to the estimated figures, agriculture (crops and livestock) absorbed about 13 percent of the total monetary value of disaster impact. See United Nations Office for Disaster Risk Reduction (UNISDR) 2013.

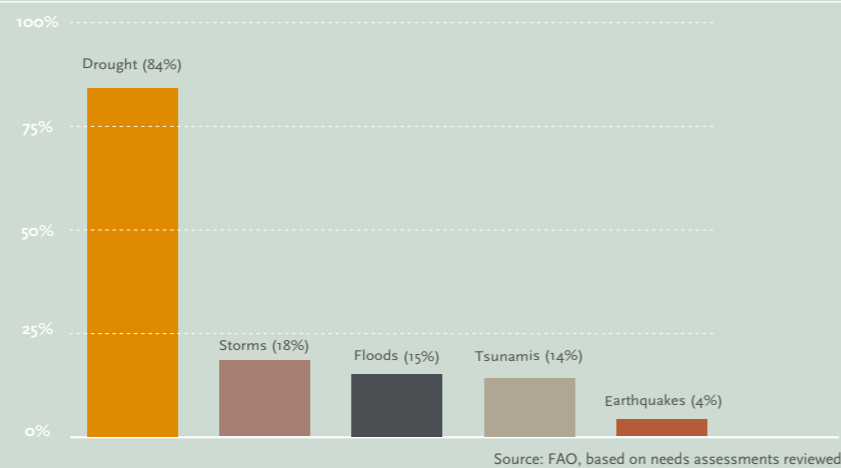
Damage and losses to agriculture as share of total damage and losses to all sectors



However, the percentage share of damage and losses to the agriculture sector varies significantly among the disasters analysed, influenced by the type of disaster, their magnitude or specific geographic location (rural versus urban), among other factors. For example, in Kenya, 85 percent of all damage and losses caused by drought between 2008 and 2011 were to the agriculture sector. In Pakistan, the sector suffered roughly 50 percent of the total economic impact of the 2010 floods, while tropical storm O3B which struck Yemen in 2008 inflicted 63 percent of its impact on the agriculture sector, and the Indonesian tsunami in 2004 almost 20 percent.

The data was analysed by type of disaster to determine which caused the greatest damage and losses to agriculture, expressed as the percentage share of total damage and losses to all sectors combined. As illustrated in **Figure 3, the findings show that of all natural hazards, the relationship between drought and agriculture is particularly important as 84 percent of the damage and losses caused by droughts is to agriculture**, while the remaining impact is typically to sectors such as health and nutrition, energy, water and sanitation, among others. This figure is an estimate based on three needs

Figure 3. Damage and losses to the agriculture sector by type of hazard (percentage share of all sectors combined)



assessments available on droughts – in Djibouti (2008–2011), Kenya (2008–2011) and Uganda (2010–2011). Given the significant impact of drought on agriculture, and the limited data available, Chapter III presents an in-depth analysis of drought in sub-Saharan Africa, showing strong evidence that supports this estimate. Hurricanes, cyclones, typhoons and floods also have a considerable impact on the agriculture sector, while geological disasters have a comparatively lower economic impact. These findings reveal that a significant proportion of the overall economic impact of disasters falls on the agriculture sector when compared with the total impact on all sectors combined. This is especially true in the case of climate-related disasters, particularly droughts. Yet, there are strong indications that damage and losses to agriculture are considerably higher than reported. For example, the data does not include the damage and losses to agriculture-based small and medium enterprises or on-farm unemployment and the consequent income loss caused by disasters. Such data is typically grouped under a separate “livelihoods” sector in the assessments analysed.

In addition, disaster impact on subsectors such as fisheries and forestry is not always reported in the assessments²⁶. More systematic assessments and analyses of disaster impact across sectors are needed to provide guidance for the mainstreaming of

²⁶ For example, damage and losses are not reported for the fisheries subsector in 38 percent of the assessments reviewed, and 60 percent in the case of the forestry subsector. Although in some cases this is likely because the subsectors were not affected, in others it is not.

disaster risk reduction into development policies and strategies. The large share of drought impact absorbed by agriculture, for example, called for the development of national drought management policies in affected countries.

Regular assessment of damage and losses caused by drought would provide invaluable support to policy-makers for the mainstreaming of drought management principles and actions into agricultural development plans.

Disasters that have a significant impact on agriculture will typically slow down sector growth, as well as national GDP in countries where the sector drives economic growth. Yet these losses are not usually calculated in assessments and are therefore not reflected in the data reported above. Finally, the findings do not reflect losses in agro-industries that result directly from agricultural production losses, such as in the food processing and textile industries which directly depend on agricultural inputs²⁷. Section 1.3 provides an overview of the wider impact of disasters on agriculture, based on other sources of data and information.

1.2 Impact of disasters on the agriculture subsectors and natural resources

Impact of disasters on crops, livestock, fisheries and forestry

A closer analysis was undertaken of the damage and losses caused by the 78 disasters, with respect to each subsector: crops, livestock, fisheries and forestry²⁸. The findings show that within the agriculture sector, the crop subsector absorbs over 42 percent of the total damage and losses caused by disasters, while the livestock subsector sustains nearly 34 percent of the total economic impact within agriculture²⁹. Fisheries absorb about 5.5 percent and forestry roughly 2.3 percent of the impact. However, the impact of natural hazards on these two subsectors was not always reported in the assessments analysed, so these findings likely underestimate the actual economic impact of disasters on fisheries and forestry.

At the same time, different types of disasters have a differentiated impact on each subsector, as illustrated in **Figure 4**, depending on their exposure and vulnerability or their relative importance to national or local economies and livelihoods.

For example, crops tend to be most affected by floods and storms; together they account for an estimated 93 percent of the economic impact on the subsector. Livestock is overwhelmingly affected by droughts, causing nearly 86 percent of all damage and losses to the subsector.

One study found that nine major droughts in selected African countries between 1981 and 2000 resulted in average livestock loss of 40 percent, with a range of 22–90 percent³⁰. In Kenya, the livestock subsector was most severely affected during the 2008–2011 drought, which caused USD 9 billion in damage and losses during this period. The drought depleted pastures and water, especially in the arid and semi-arid land areas, resulting in the deterioration of livestock body condition and reduced immunity. This triggered massive migration of livestock to other regions with better water sources, and the congregation of migrating herds led to increased and widespread disease outbreaks in most parts of Kenya. Livestock mortality from starvation and disease affected 9 percent of livestock, while disease incidence reached more than 40 percent of herds in the affected districts.

²⁷ Losses to agriculture-dependent industries are not disaggregated in the needs assessments reviewed and could therefore not be calculated into the damage and losses to the agriculture sector.

²⁸ The 78 disasters analysed correspond to those reviewed in the previous section, and referenced in Annex 3. The data reported for the “agriculture sector” combines damage and losses to crops, livestock, fisheries, forestry and irrigation although these are reported under different “sectors” in the assessments.

²⁹ These findings should be considered in view of the under-reporting on the fisheries and forestry subsectors in the assessments analysed.

³⁰ United Nations Environment Programme. 2009. The Environmental Food Crisis: the Environment’s Role in Averting Future Food Crises.

This has changed livestock composition and usage, and depressed livestock productivity. Livestock migration and reduced productivity caused food insecurity, loss of earnings, separation of families, school dropouts, environmental degradation and resource-based conflicts. In addition, high food prices deteriorated the purchasing capacity of households and the terms of trade for pastoralists (50–60 percent below the five-year average). In arid and semi-arid land districts, pastoralists reported critical rates of acute malnutrition in children (global acute malnutrition >20 percent), falling within the World Health Organization emergency threshold. In 2011, some 3.7 million people were food insecure – 1.8 million in marginal agricultural areas and 1.9 million in pastoral areas.

The fisheries subsector is most affected by tsunamis and storms such as hurricanes and cyclones, while most of the economic impact to forestry is caused by floods and storms

The fisheries subsector is most affected by tsunamis and storms such as hurricanes and cyclones, while most of the economic impact to forestry is caused by floods and storms (excluding wild fires). Of the 78 disasters reviewed, the 2004 tsunami affecting India and Indonesia had the greatest economic impact on fisheries, causing over USD 500 million in damage and losses to the subsector in each country. Fisheries also tend to suffer more in small island developing states. In the Maldives, 70 percent of the economic impact of the 2004 tsunami in the agriculture sector was to fisheries, which

had an enormous impact on livelihoods and the national economy³¹. The subsector (fisheries and fish processing) contributed over 9 percent to national GDP in 2004 and was the second major source of foreign exchange after tourism. One-third of the annual catch is typically consumed domestically, while fish accounted for almost half of the country's exports. The sector employed 11 percent of the labour force and about 20 percent of the total population relies on fisheries as their main income-earning activity. Fisheries infrastructure and assets were destroyed or damaged, including fishery island harbours and safe anchorage, boat sheds, fishing vessels, cottage and commercial fish processors and other assets. Within the fisheries subsector, pole and line tuna harvesting and small-scale fish processing were most affected by the tsunami.

In the case of forestry, biomass fires have a significant impact, burning annually between 3 and 4.5 million km² globally – an area equivalent to India and Pakistan combined – with negative consequences for the multiple services that forests provide to local ecosystems and the natural capital on which agriculture depends. Cyclone Nargis which struck Myanmar in 2008 caused almost USD 55 million in damage and losses to the forestry subsector. The cyclone also impacted other subsectors. About 2.4 million people were affected, mainly in the country's Ayeyarwady River Delta where 50–60 percent of families are engaged in agriculture and between 20 and 30 percent are landless, relying on fishing and agricultural labour. The cyclone affected paddy crops and plantation crops, and caused the loss of 50 percent of buffaloes and 20 percent of cattle in the worst-affected townships. Over half of small rice mills and two-thirds of larger rice mills in the affected areas were damaged. Commercial intensive aquaculture was affected by the damage to fisheries infrastructure, while heavy damage to both onshore production facilities and fishing boats affected the production of dried fish and shrimp, and fish paste. As a result, the cyclone had a critical impact on livelihoods, employment and income, particularly in the informal sector, such as seasonal jobs in agriculture, community works, small-scale fishing, rice mills, fish processing, salt production, wood cutting, and other resource-based economic activities.

Cyclone Nargis, which struck Myanmar in 2008, had the greatest economic impact on forestry of all the agriculture subsectors

Smallholder farmers lost income-earning opportunities, as did those involved in small-scale inshore and offshore fishing, landless poor dependent on wage labour in agriculture and skilled workers previously employed in a wide range of small and medium manufacturing and processing enterprises.

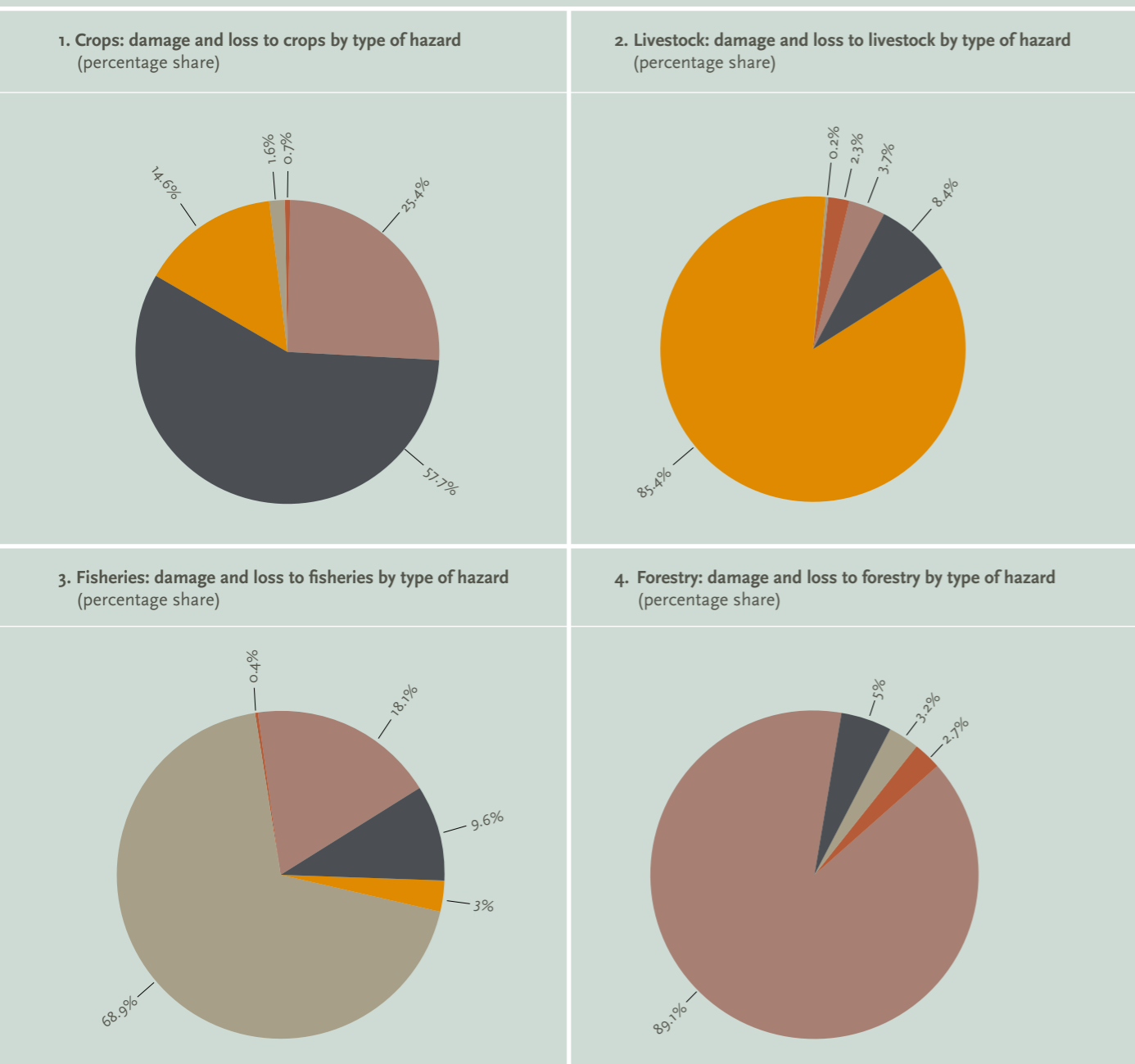
These findings show how the agriculture subsectors can be affected differently by disasters. Understanding these differences is critical to the formulation of policy and practices at national, subnational and community levels. Measures to strengthen the resilience of marine fisheries, for example, need to consider tsunamis and storms which tend to cause the greatest impact, whereas inland fisheries must consider the impact of floods and droughts. Wild fires and drought (often combined) are important hazards affecting forestry, which require special attention in risk reduction policies and planning.

Furthermore, disaggregated subsectoral data on disaster impact is needed to support the implementation of innovative risk management tools, such as weather risk insurance schemes for agriculture and rural livelihoods. Systematic and coherent data availability will facilitate the design of insurance schemes which would help to further diversify risk mitigation strategies.

Another consideration is the potential contribution that the subsectors can make in post-disaster situations, depending on the relative impact on each. For instance, capture fisheries can be restored relatively quickly after a disaster (provided that no serious damage has been caused to the aquatic environment) and may be able to provide alternative livelihoods to affected populations during the recovery phase. Assessments of disaster impact on each of the subsectors will vary at country and subnational levels, and

Figure 4. Damage and losses to agriculture subsectors by type of hazard

Source: FAO, based on needs assessments (see Annex 3).



Legend: Storms Floods Drought Tsunamis Earthquakes

³¹ Republic of the Maldives, World Bank, Asian Development Bank, United Nations. 2005. Joint Needs Assessment.

investments to reduce risk and build resilience in these subsectors should be informed by the particular nature of disaster impact on that subsector.

Yet, forestry and fisheries tend to be under-reported in needs assessments and the impact of disasters on these must be better assessed and understood.

The direct damage and indirect losses of floods to the subsectors is illustrated in more detail in the case study on the 2007 floods in the Tabasco region of Mexico.

Case study | The 2007 floods in Tabasco, Mexico: the impact on the agriculture sector and subsectors

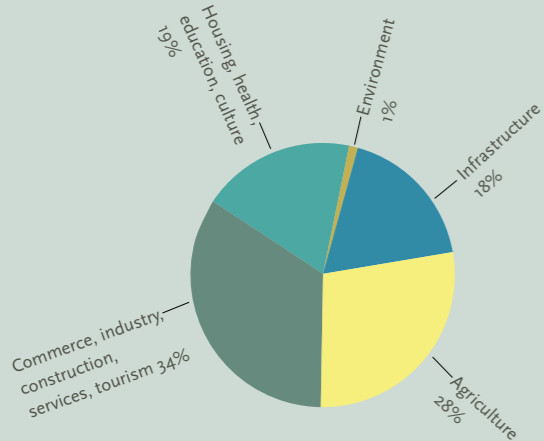
In September and October 2007, Mexico was struck by heavy rainfall causing serious flooding. The impact was especially severe in the state of Tabasco with 60% of its surface flooded and 1.5 million of its population affected (75% of the state's population).

The floods caused roughly USD 3 billion in damage and losses in Tabasco, equivalent to over 29% of the state's GDP.

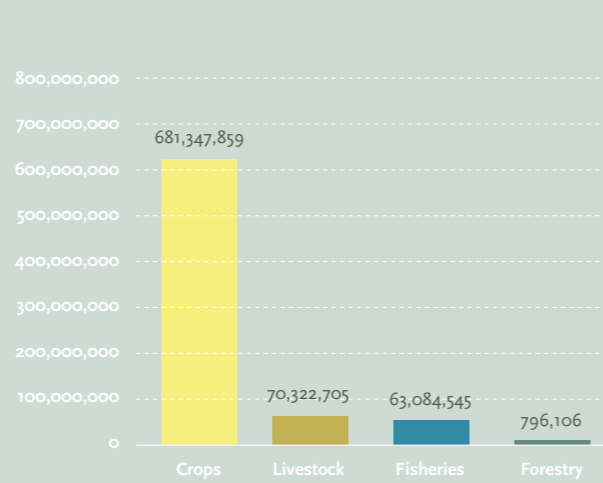
About 28% of the total economic impact was on the agriculture sector.

The damage and losses caused by the floods on all sectors, on agriculture and on its subsectors

Percentage share of damage and losses by sector (2007 floods in Tabasco, Mexico)



Damage and losses by agriculture subsector (USD) (2007 Floods in Tabasco, Mexico)



The impact of floods

Crops

The floods damaged or destroyed a total of 93,319 ha and 1.6 million tonnes of crops, including maize, rice, cacao, sugar cane and plantain, among others.

Maize production was reduced by 40–80%. Maize losses were a serious impact on household food security since 85% of maize production is for consumption and is a basic staple among the local population, particularly for poor households.

The floods destroyed 383,000 tonnes of plantains, damaging or destroying roughly 65% of the area planted. About 97% of the cacao planted was damaged or destroyed.

About 80% of the area planted with sugar cane was destroyed or damaged, causing the loss of 27,000 jobs.

Livestock

The floods affected about 32% of grazing pastures, roughly about 504,000 ha, and killed over 21,000 heads of livestock, resulting in a significant reduction in meat and milk production. In addition, 14,562 poultry and over 2,000 pigs perished or were consumed by the affected population, causing a collapse in household backyard production.

Fisheries

The floods destroyed fishing and aquaculture infrastructure and facilities, such as fish farms, oyster banks, fish feed and fish reproduction facilities. There were losses in fish and aquaculture production of robalo, tilapia, carp, shrimp, oyster and other crustaceans and fish species. Over 477,000 tonnes of fish were lost.

Forestry

The floods affected over 1,000 ha of forests, and about 366 ha had to be reforested with over 244,000 plants. In addition, 687 ha of eucalyptus and 1.3 million nursery plants were damaged.

Impact of disasters on natural resources and ecosystem services

Disasters also damage or destroy natural resources and ecosystem services that sustain agriculture. Land, water and biological diversity form the natural resource base of agriculture, essential to rural livelihoods and sustainable agricultural development. For example, forests and tree-based agricultural systems contribute to the livelihoods of an estimated 1 billion people globally³². Wild foods are important for food security and nutrition, while trees and forests are vital in the provision of ecosystem services to agriculture. Marine, coastal and inland areas also support a rich assortment of aquatic biodiversity. The planet already faces multiple pressures, including on fragile soils, water supplies, competing demands for land, overfishing and other pressures, and the impact of disasters further erodes this vital resource base for agriculture and livelihoods.

Disasters contribute to ecosystem degradation and loss, including increased soil erosion, declining rangeland quality, salinization of soils, deforestation and biodiversity loss. Increasing environmental degradation reduces the availability of goods and services to local communities, shrinks economic opportunities and livelihood options, and ultimately contributes to greater food insecurity and hunger. It further drives increasing numbers of people to use marginal lands and fragile environments³³.

Yet, the impact of disasters on natural resources and the environment is not always evaluated in needs assessments and remains a largely under-assessed sector, in terms of direct and indirect economic losses. However, some trends can be observed from the 78 disasters reviewed, which show that 43 of these disasters affected natural resources and the environment, causing over USD 2.3 billion in damage and losses³⁴.

In 2007, Hurricane Felix in Nicaragua caused a total of USD 552 million in damage and losses to natural resources and the environment, in addition to USD 57 million in damage and losses to the agriculture sector. Tropical Storm Agatha and the volcanic eruption of Pacaya in 2010 in Guatemala also had a considerable impact on the sector, causing USD 260 million in damage and losses.

At the same time, the deforestation caused by disasters and their degradation of land, catchments and watersheds, depletion of reefs and coastal ecosystems such as corals and mangroves, reduce nature's defense capacity against future hazards³⁵. Forests serve as shelterbelts and windbreaks, and protect against landslides, floods and avalanches³⁶. Trees stabilize riverbanks and mitigate soil erosion, while woodlots provide fuel wood, timber and fodder. Forests are estimated to save between USD 2 billion and USD 3.5 billion per year equivalent in disaster damage restoration of key forest ecosystems³⁷.

Of the 78 disasters covered in PDNAs, 43 caused a total of over USD 2.3 billion in damage and losses to natural resources and the environment

³² Center for International Forestry Research. 2013. Food Security and Nutrition: the Role of Forests.

³³ FAO. 2013. Resilient livelihoods. Disaster Risk Reduction for Food and Nutrition Security; UNISDR, 2004, Living with Risk: a Global Review of Disaster Reduction Initiatives.

³⁴ The damage and losses reported to natural resources and the environment also includes forestry.

³⁵ FAO. 2013. Resilient livelihoods. Disaster Risk Reduction for Food and Nutrition Security; UNISDR, 2004, Living with Risk: a Global Review of Disaster Reduction Initiatives.

³⁶ D. Burgeon, T. Hofer, P. van Lierop and S. Wabbes. 2015. Trees and forests – lifelines for resilience. FAO, Unasylva 66 (1-2), pp. 86–89.

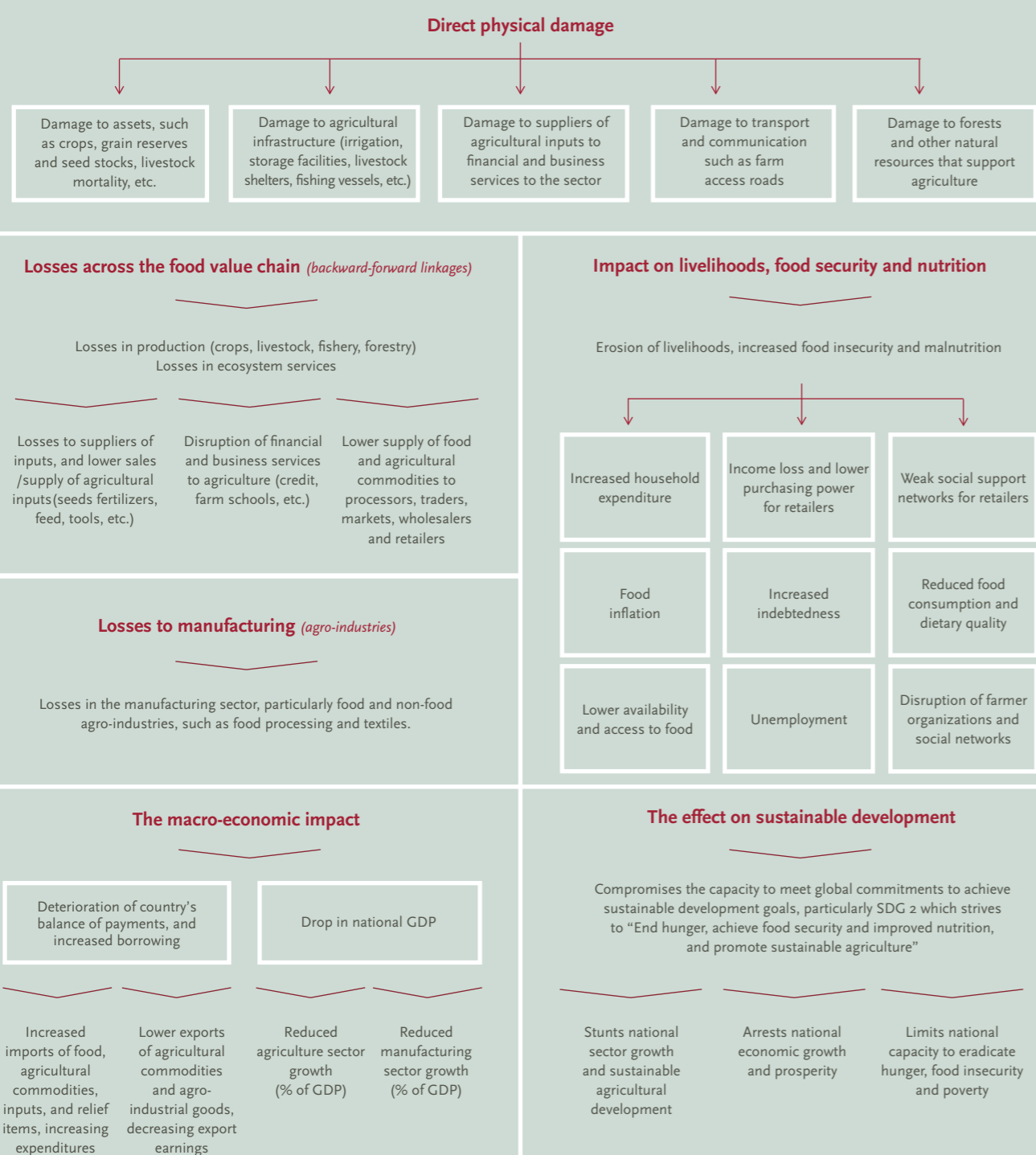
³⁷ International Union for the Conservation of Nature (IUCN), UNISDR. 2009. Environmental Guidance Note for Disaster Risk Reduction: Healthy Ecosystems for Human Security. 2009. IUCN, UNISDR.

1.3 Wider and cumulative impact of disasters

Assessments of the impact of disasters on the agriculture sector apply different approaches and methodologies. Some focus on the economic impact, such as the needs assessments reviewed in the previous sections which evaluate damage and losses. However, these do not assess the cascading and wider impact that disasters have on the food value chain, agro-industries and sector growth, or capture the implications for livelihoods and food security. Some assessments do follow a livelihoods approach or focus on food security³⁸. These and other types of assessments represent different analytical lenses through which we can measure impact, yielding

³⁸ For example, the methodologies proposed in the joint FAO/International Labour Organization Livelihood Assessment Toolkit, or the Emergency Food Security Assessment Handbook by the World Food Programme.

Figure 5: The impact of disasters on the agriculture sector and its wider potential consequences



different results. The approaches and findings they produce are complementary; together they present a holistic picture of disaster impact on agriculture and its broader consequences.

Figure 5 summarizes the wider impact of disasters on the agriculture sector as a whole and its potential consequences, grouped into five core categories:

- Direct physical damage
- Losses across the food value chain (backward-forward linkages)
- Losses to manufacturing (agro-industries)
- Consequent macro-economic impact
- Impact on livelihoods, food security and nutrition
- Effect on sustainable development

This section presents an overview of the broader impact based on case studies.

The physical damage caused by disasters has a direct impact on agricultural production with negative consequences along the food value chain, including backward linkages – disrupting the flow of agricultural inputs such as seeds and fertilizers – and forward linkages with processing and distribution, markets and retailers. Disasters can destroy the infrastructure of input suppliers and post-harvest facilities. They can interrupt food supply, market access and trade. In medium- and large-scale disasters, high production losses can lead to increases in imports of food and agricultural commodities to compensate for lost production and meet domestic demand, increasing public expenditure. They can also reduce exports and revenues, with negative consequences for the balance of payment. When post-disaster production losses are significant and in countries where the sector makes an important contribution to economic growth, agriculture value-added or sector growth falls, as does national GDP.

In addition, the agriculture sector supplies vital resources to industry and stimulates the growth of some manufacturing subsectors. Therefore, agricultural production losses can reduce manufacturing/industrial output in sectors that depend on agriculture and raw materials. Agro-industries such as food processing are particularly vulnerable. In some cases, non-food agro-industries, such as the textile industry, can also be negatively affected by production losses. Such agro-industries (both food and non-food) will suffer from losses in production as well, with similar consequences for domestic supplies, exports, national revenues and ultimately manufacturing value added. The inter-dependence between agriculture and industry is important to the economies of least developed countries where agro-industrial sectors account for two-thirds of the manufacturing output. The share of agro-industrial sectors in total manufacturing value added is 70 percent in United Republic of Tanzania, 51 percent in Ethiopia, 35 percent in Kenya, 29 percent in Mexico and 20 percent in India³⁹.

Disasters cause direct and indirect losses – with serious repercussions on future harvests, agriculture-related manufacturing and industrial outputs

At the same time, disasters directly impact on agricultural livelihoods, food security and nutrition. Disasters can cause unemployment and/or a decline in wages and therefore income among farmers and farm labourers, and lower the availability of food commodities in local markets which typically produces food inflation. Such pressures reduce the purchasing capacity of households, restrict access to food, deplete savings, force the sale of vital productive assets, increase indebtedness and erode livelihoods.

Ultimately, the quantity and quality of food consumption is reduced, and food insecurity and malnutrition increases, particularly among the most vulnerable households. This impact is most felt at the local and household levels in disaster-affected areas.

³⁹ Data is for 2009, from the United Nations Industrial Development Organization. 2012. The structure and growth pattern of agro-industry of African countries.

The extent to which disasters erode livelihoods, produce food insecurity, cause disruptions along the food value chain, reduce manufacturing output and lower sector growth and national GDP varies depending on numerous factors beyond the study's scope.

Such factors include the nature, location and scale of the disaster; its timing in relation to the agricultural calendar; the size and composition of the agriculture sector; its relative importance to employment, income, manufacturing and national GDP; the vulnerability of the sector and affected populations to shocks; and the emergency policies or measures introduced by governments to mitigate the impact of disasters.

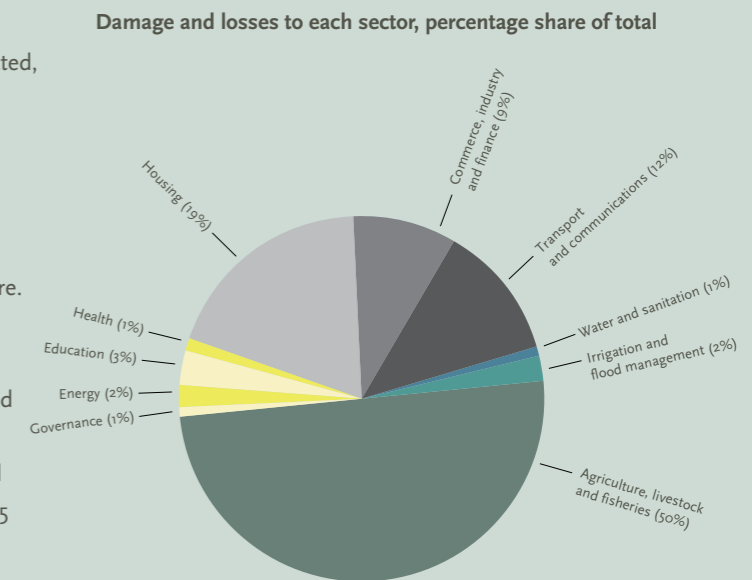
In sub-Saharan Africa, for example, droughts cause significant damage and losses to agriculture. In Uganda, the 2005–2007 drought and 2010–2011 rainfall deficits had far-reaching impacts on the national economy, causing production losses especially for the livestock subsector, reducing exports, affecting agro-industries and slowing the GDP growth rate. (See Section 3.2 for further detail on the effects of drought in Uganda.)

The following case study on floods in Pakistan is another example of how and to what extent the impact of disasters on agricultural production has a carry-over effect on the economy and food security.

Case study: The Pakistan floods in 2010 – the wider impact on agriculture, the value chain and the economy^a

Pakistan experienced extraordinary rainfall from July to September 2010, resulting in unprecedented floods affecting the entire length of the country and more than 20 million people – over one-tenth of the population.

Agriculture was the hardest hit sector. A large portion of Pakistan's most fertile land was affected, including the breadbasket province of Punjab. The sector contributes about 45% of total employment and was the basic source of livelihood for 80% of the affected population. About 4.5 million workers were affected, two-thirds of whom were employed in agriculture. Over 70 percent of farmers lost more than half of their expected income. The floods caused USD 10 billion in damage and losses – **USD 5 billion to the agriculture sector**. By contrast, just USD 200 million was allocated to the country's agriculture sector in the 2014/15 national budget^b.



About 2.4 million ha of unharvested crops were lost due to the floods, mainly cotton, rice, sugar cane and vegetables, as well as 1 million tonnes of food and seed stocks. This negatively affected cotton ginning, rice processing and flour and sugar milling. Rice production – the second largest staple food crop in Pakistan – fell to 7.2 million tonnes in 2010 from 10.3 million tonnes in 2009, and rice imports surged from 1,925 tonnes in 2010 to 21,052 tonnes in 2011.



Pakistan's foreign exchange reserves depend on exports, about 75% of which are from agriculture and textiles. The potentially negative impact of lost cotton production on the textile industry was offset by a surge in global cotton prices that provided unprecedented high export prices, induced production and increased earnings from textile exports.

Following the floods, agriculture sector growth dropped from 3.5% in 2009 to 0.2% in 2010 and 1.9% in 2011. National GDP fell from 2.8% in 2009 to 1.6% in 2010. In Pakistan, agriculture contributes about 24% of GDP. The graph below shows the strong correlation between agriculture and GDP growth.

The performance of agriculture added value and national GDP, 2006–2012



^a Source: FAO, based on Asian Development Bank, World Bank and United Nations. 2010. Pakistan Floods 2010: Preliminary Damage and Needs Assessment; Pakistan Congressional Research Service. 2010. Flooding in Pakistan: Overview and Issues for Congress; Government of Pakistan. 2011. Pakistan Economic Survey: 2010-2011. FAO. 2011. Pakistan floods: one year on; FAOSTAT.

^b Government of Pakistan, Federal Budget 2014/15. http://www.finance.gov.pk/budget/Budget_in_Brief_2014_15.pdf

PRE-PRODUCTION DAMAGE AND LOSSES

Crops absorbed nearly 90% of the damage and losses in agriculture.

Over 2 million ha of standing crops were lost, mainly cotton, rice, sugar cane and vegetables.

1 million tonnes of food and seed stocks were damaged.

Livestock: About 1.5 million animals and 10 million poultry were lost. Milk production declined.

Fisheries: Fish farms, fishponds, hatcheries, boats and gear were washed away or damaged.

Enterprises: Floods damaged micro-, small and medium enterprises, such as cotton ginning, rice processing, flour and sugar milling, silk and horticulture.

Agriculture infrastructure was damaged including machinery, warehouses, irrigation systems, animal health clinics, agriculture and livestock research and extension offices and government buildings and facilities.

Environment and ecosystem services: Floods damaged or destroyed trees, forests and forest lands, plantations, forest nurseries, mangroves, wetlands, wildlife resources and other natural assets that sustain agriculture and livelihoods.

POST-PRODUCTION LOSSES

Manufacturing/industry

Main industries affected were cotton ginning, rice processing, and flour and sugar milling.

Acute input shortages in the textile sector due to loss of 2–3 million bales of cotton. Textiles provide about one-third of manufacturing sector value added.

Loss to sugar cane crop would affect output of the sugar industry. Milk, meat, fruit, packaging and preparing units also affected.

Markets

Access to markets disrupted by damaged road and rail networks.

Disruptions and loss of stored food and agricultural inputs decreased the capacity of operators along the value chain (transporters, processors, wholesalers and retailers), raised transaction costs and reduced market functionality and the availability of food.

LOSSES TO THE WIDER NATIONAL ECONOMY

National GDP fell from 2.8% to 1.6% between 2009 and 2010.

Agriculture sector growth fell to 0.2% in 2010 from 3.5% in 2009.

Imports: Rice imports increased from 1,925 to 21,052 tonnes between 2010 and 2011, and cotton from 25 to 3,361 tonnes between 2009 and 2010.

Financial sector: Banking absorbed 93% of the USD 1 billion in loan losses. Largest share of loan losses was to the agriculture sector at 55%. Within the micro-finance sector, agriculture represented about 69% of all non-performing loans.

Fiscal deficit: Significant increase in federal and provincial government expenditures.

The widening fiscal deficit was largely financed through short-term borrowing.

Damage and losses: The floods caused over USD 5 billion in damage and loss to the agriculture sector, about 14% of the sector value added in 2009–2010.

Recovery cost: Estimates for agriculture sector post-disaster recovery ranged from USD 257 million to USD 1 billion.

FOOD AND NUTRITION INSECURITY

Shortfalls in domestic availability of food and agricultural commodities – over 60% of households lost much of their food grain stocks, 55% lost at least half their seed stocks.

Inflation: Food inflation surged to 20% by September 2010 from 12% in July.

Income loss: Over 70% of farmers lost more than 50% of their expected income.

Unemployment: 4.5 million workers were affected; two-thirds were employed in agriculture.

Food consumption: Dietary diversity was poor; almost one-third of the population had poor consumption intake and 19% were borderline.

Indebtedness: Farmers' debt doubled or tripled, forcing them to seek further loans to buy agricultural inputs and food. More than one-third of households were borrowing.

Poverty: Households whose livelihoods were most affected had the lowest income levels – of those whose income fell by 75% or more, 45% lived below the national poverty line.

Source: FAO, based on State Bank of Pakistan. 2011. The State of Pakistan's Economy: Annual Report 2010–2011; Pakistan Congressional Research Service. 2010. Flooding in Pakistan: Overview and Issues for Congress; FAO. 2011. Pakistan floods: one year on; Agriculture Cluster. 2010. Preliminary Rapid Damage Assessment in the Agriculture Sector for Flood-Affected Areas of Pakistan; FAO. 2010. Executive Brief: Pakistan Flooding; Asian Development Bank, World Bank and United Nations. 2010. Pakistan Floods 2010: Preliminary Damage and Needs Assessment; Arshad Ali, et al. Perspectives on the 2010 floods in Pakistan; World Food Programme. 2010. Pakistan Flood Impact Assessment.

Over the last decade, more than one-third of all developing countries have been affected by at least three medium- and large-scale disasters

In many countries, disasters are frequent events that over time incur a high economic cost in total damage and losses, as well as in repeated investments in recovery by governments and the international community. A significant number of developing countries experience recurring disasters. Over the last decade, more than one-third of all developing countries have been affected by at least three medium- and large-scale disasters. The most affected countries were Ethiopia, which faced six reported droughts⁴⁰, and India with six reported floods⁴¹. The cumulative impact of several disasters on the agriculture sector is illustrated by the examples from the Philippines, Pakistan and Mexico.

The study revealed the limited information available on the impact of disasters across the agricultural value chain and its effect on agro-industries, sector growth and development and national economies

This chapter illustrates the wider and complex nature of disaster impact on the agriculture sector, the severity of resulting damage and losses, and the high cumulative costs arising from frequent disasters in some countries. Chapter III provides additional examples of the wider impact of drought in the Horn of Africa (Djibouti, Kenya and Uganda) and southern Africa (South Africa and Zimbabwe). The agriculture sector's actual vulnerability to such shocks varies between countries. It is therefore critical to better understand these differences in terms of the broader impact of disasters on the sector. An important element in the findings of the study is the limited information available on the impact of disasters across the agricultural value chain and its consequences on agro-industries, sector growth, agricultural development and national economies.

One important element not typically considered in the analysis of disaster impact on the agriculture sector is the consequences on other sectors that are closely linked and depend on agriculture, such as food and non-food agro-industries. This needs to be better assessed and understood given that they account for the bulk of manufacturing output in many less-developed countries. Understanding the full ramifications of disasters is essential for countries to formulate well-designed and tailored strategies that can effectively buffer or mitigate the high cost to national economic growth.

The examples in this chapter highlight the need to adopt systemic risk reduction measures within the agriculture sector and its subsectors, as well as across interdependent sectors. In particular, disaster risk reduction principles and measures need to be embedded in national development plans for the agriculture sector. Similarly, longer-term and sector-specific strategies should guide post-disaster recovery efforts in agriculture in order to strengthen resilience and avoid recreating vulnerabilities and risks. This is particularly crucial in countries where the agriculture sector is repeatedly affected by recurring disasters.

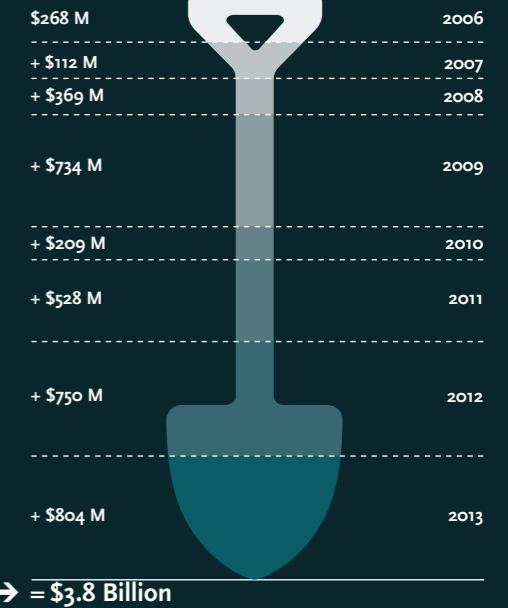
To measure at the aggregate global level the extent to which disasters have a wider impact, a statistical analysis was done of 140 disasters in 67 developing countries to determine how disasters are associated with changes in trade flows (imports and exports), and with the performance of agriculture value added (percent of GDP). The findings are presented in the next chapter.

40 Severe droughts occurred in Ethiopia in 2003, 2005, 2008, 2009, 2011 and 2012.

41 Major floods occurred in India in 2004, 2005, 2007, 2008, 2011 and 2013.

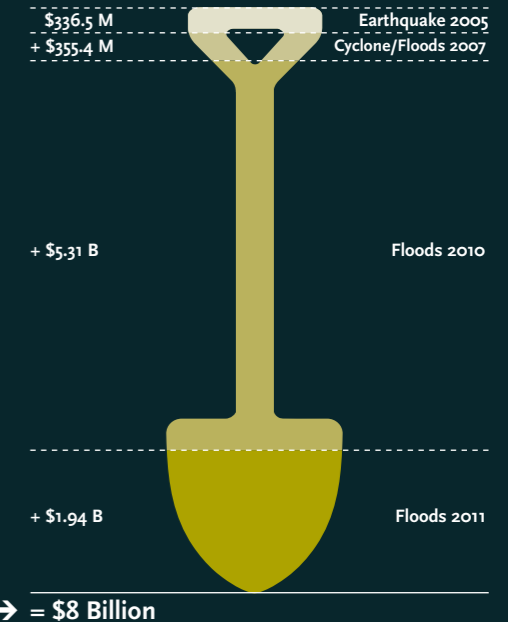
The Philippines 75 disasters US\$3.8 billion in accumulated damage and losses

Between 2006 and 2013, the Philippines was struck by 75 disasters – mostly typhoons, tropical storms and floods – which caused accumulated damage and losses of some **USD 3.8 billion to the country's agriculture sector**. In other words, the country's agriculture sector absorbed an average of USD 477 million in damage and losses each year – about one-quarter of the national budget allocated to the sector in 2014.



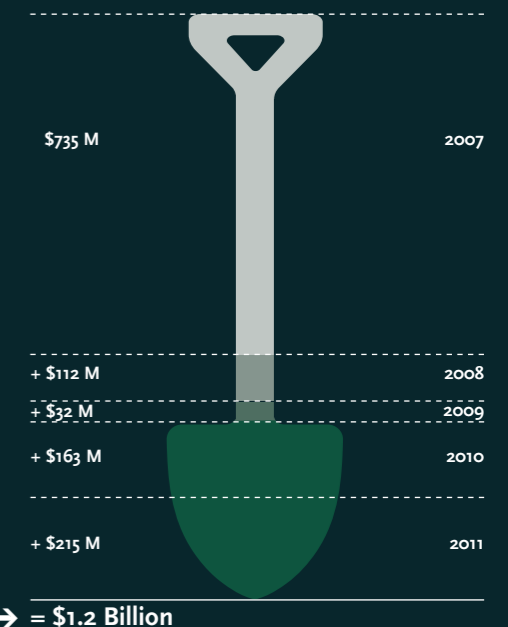
Pakistan 2005 earthquake a cyclone combined with floods in 2007 floods in 2010 and in 2011 US\$8 billion in accumulated damage and losses

The agriculture sector was affected by all four consecutive disasters, which together caused nearly **US\$8 billion in accumulated damage and losses**. This is four times what the government of Pakistan spent on the agriculture sector between 2008 and 2011.



Tabasco, Mexico 5 flood events between 2007 and 2011 US\$1.2 billion in accumulated damage and losses

By 2011 the state's agriculture sector had sustained a total of over **US\$1.2 billion in accumulated damage and losses as a result of the five consecutive floods**. This is a large loss for Tabasco, as it represents more than twice the state's agriculture GDP in 2012.



Between 2003 and 2013, crop and livestock production losses after medium- and large-scale disasters in developing countries amounted to more than USD 80 billion

In developing countries, 83 percent of crop and livestock production losses occurred after floods and droughts

Asia suffered the largest share of total production losses, followed by Africa

Chapter II

Quantifying production losses, changes in trade flows and sector growth after disasters over the past decade

Data on damage and losses in the agriculture sector are not systematically collected or reported worldwide. This chapter is an attempt to quantify crop and livestock production losses associated with disasters over the past decade in developing countries

One of the most direct impacts of disasters on agriculture is reduced agricultural production and productivity. This causes direct economic losses to farmers, which cascades across the value chain, affecting overall sectoral and economic growth. Several studies and needs assessments quantify the impact of disasters on agricultural production at the country level, often using primary data on damage to crops. Others demonstrate that disasters negatively affect imports and exports of agricultural commodities, and agriculture value added⁴². However, the full extent of disaster impact on agricultural production, trade and value added at the regional and global levels is not available or is very limited in scope. This is mainly due to the fact that primary data on damage and losses to agriculture is not being systematically reported at the country level or collected worldwide⁴³.

The statistical analysis covered 140 medium- and large-scale disasters that affected 67 developing countries

FAO has sought to fill this gap by quantifying changes in agricultural production and economic flows associated with disasters. A statistical analysis was performed to quantify: (i) crop and livestock production losses; (ii) changes in trade flows; and (iii) reduced sector growth. The analysis covered 140 medium- and large-scale disasters (affecting at least 250 000 people) that occurred between 2003 and 2013 in 67 developing countries in Asia⁴⁴, Latin America and the Caribbean, the Near East⁴⁵ and sub-Saharan Africa. (Annex 2 provides a list of countries considered in this analysis.)

The following method was applied:

- **Calculating production losses:** crop and livestock production losses (in terms of cereals, pulses, key livestock commodities⁴⁶ and other commodities⁴⁷) were calculated as decreases in yields (for crops) and production quantities (for livestock commodities) after the disasters compared with linear trend (1980–2013) projections.
- **Calculating changes in trade flows:** changes in the performance of imports were calculated as increases in the value of imports in the year of and year following a disaster compared with linear trend (1980–2011) projections. Changes in exports were calculated as decreases in the value of exports in the year of and year following a disaster compared with the linear trend⁴⁸. The analysis focused on cereals, pulses, fresh milk and meat.
- **Calculating changes in agriculture value added:** the analysis compared decreases in the rate of agriculture value-added growth during the year when disasters occurred and the subsequent year with the linear trend (2003–2013) projections.

42 See for example: World Bank. 2014. Análisis de riesgo del sector agropecuario en Paraguay. Identificación, priorización, estrategia y plan de acción; Israel and Briones. 2013. Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines. ERIA Discussion Paper Series; Cavallo and Noy. 2010. The Economics of Natural Disasters. A survey. Inter-American Development Bank; Loayzia et al. 2009. Natural Disasters and Growth Going beyond the Averages. World Bank; Sivakumar. 2005. Impacts of Natural Disasters in Agriculture, Rangeland and Forestry: An Overview. In: Sivakumar, Motha and Das (eds.). Natural Disasters and Extreme Events in Agriculture. Springer Hiderberg. pp.1–2.

43 The Disaster Inventory System database provides access to national data on disaster damage from 86 countries and territories. For agriculture, however, this database only reports two indicators: (1) the amount of cultivated or pastoral land affected (in hectares); and (2) the number of four-legged animals lost. Reported data are not disaggregated by type of crop or animal, and no distinction is made between partially or totally affected crop/pastoral land. Moreover, agricultural damage is reported only in 12 percent of all disasters included in Disaster Inventory System, and 22 countries do not report any agricultural damage between 2003 and 2013. Additional efforts should be made to collect primary data on agricultural damage at a detailed level.

44 Central Asia, eastern Asia (excluding China and Japan), southern Asia, southeastern Asia and the Pacific.

45 A subset of western Asian countries.

46 Cattle meat, goat meat, pig meat, sheep meat, cow milk, goat milk, sheep milk.

47 Other commodities were selected at country level and include any crop commodity (both staple and cash crop) other than cereals and pulses included in the FAOSTAT list of top 10 commodities by production quantity and production value in 2012. In the case of drought in Africa, “other commodities” refer to any crop commodity other than cereals and pulses that was mentioned in official assessments as being affected by drought. Examples of crops included under this category are: coffee, fruits, roots and tubers (e.g. potatoes, cassava), sugar cane, tobacco, vegetables, among others.

48 Changes in import and export flows were analysed using aggregated data at country level from FAOSTAT.

Annex 5 provides further details on the methodology used. The findings are presented according to different perspectives, including the distribution of losses by geographic region, by type of disaster and by type of commodity.

2.1 Crop and livestock production losses after disasters over the past decade

Quantifying crop and livestock production losses

The 67 countries analysed together faced a total of USD 80 billion in crop and livestock production losses

An analysis of crop and livestock production trends reveals significant losses associated with the medium- and large-scale disasters reviewed. The 67 countries analysed together faced a total of USD 80 billion in crop and livestock production losses after the 140 medium- to large-scale disasters assessed between 2003 and 2013, or an average of USD 7.3 billion per year. These losses were suffered by countries that derive a substantial share of GDP from the agriculture sector (an average of 21 percent between 2003 and 2013), and where agriculture contributes an average of 30 percent of total employment.

Most crop and livestock production losses occurred after floods and droughts, which together account for 83 percent of total losses. This provides further evidence that climate-related disasters have a considerable impact on agriculture, as presented in Chapter I. Addressing the underlying risks associated with droughts and floods in developing countries is therefore crucial to strengthen the resilience of agriculture and protect associated livelihoods from shocks.

Floods and droughts account for 83% of total crop and livestock production losses, showing the severe impact of climate-related disasters on the agriculture sector

The regional distribution of losses provides additional insights as to the extent of production losses associated with disasters on a geographic basis and in relation to the main types of disasters. While absolute losses are important to understand the overall reduction in crop and livestock production, meaningful cross-regional comparison is possible only in relative terms when considering losses in relation to the overall size and value of agricultural production in each region.

In Asia, for example, production losses amounted to roughly USD 48 billion, corresponding to about 60 percent of total losses in all developing regions. The most significant losses in Asia were experienced after floods, which are associated with 77 percent of the region’s losses. Although Asia suffered the largest absolute amount of production losses, it was the least affected region when losses are placed in relation to the projected value of production⁴⁹ (Figure 6). When considered at country level, the findings show that India was the most affected by crop and livestock production losses after repeated floods between 2004 and 2013. Other particularly affected Asian countries include the Philippines (e.g. 2012 Bopha and 2013 Haiyan Typhoons), Pakistan (e.g. 2010 floods), Cambodia (e.g. 2005 drought) and Thailand (e.g. 2008 drought).

In Africa, absolute losses amounted to more than USD 14 billion, corresponding to about 6 percent of the projected value of production – more than double that of Asia. Losses in Africa are primarily felt after droughts, when 90 percent of the region’s losses occurred. Sharp declines in yields are observed in most countries during droughts, likely leading to losses in output and revenues. Such losses pose a serious challenge to food availability, rural livelihoods and the overall economy, particularly given the significant contribution of agriculture to food security and the economies of sub-Saharan Africa (see Chapter III for a comprehensive analysis of drought impact in sub-Saharan Africa).

49 Projected value of production is calculated as the total value that would have been produced in the analysed countries in case yields and production quantities had followed linear trends.

Latin American and Caribbean countries experienced about USD 11 billion in production losses, mainly after floods (55 percent of total losses in the region) and to a lesser degree after droughts and storms. In relative terms, regional losses corresponded to 3 percent of the projected value of production – lower than Africa but higher than Asia. The most affected country, also due to the large size of its agricultural production, was Brazil, which suffered major losses after the 2009 floods in the northeast. Other countries significantly affected included Colombia, after floods in 2007, 2010 and 2011; Mexico, following Hurricane Emily in 2005, the 2007 floods (Tabasco) and the 2011 drought; and Paraguay, after the 2011–2012 drought.

Only three major disasters occurred in the Near East during the period, causing USD 7 billion in production losses in the affected countries. These losses amounted to 7 percent of the projected value of production, making the Near East countries the most affected in relative terms. Most losses occurred after the 2008 drought in Syria.

Quantifying losses in calories

The total production losses reported above correspond to 333 million tonnes of cereals, pulses, meat, milk and other commodities⁵⁰. The most affected commodities were cereals, which account for more than one-third of total losses. Such significant losses in cereal production raise concerns about the consequences for food security in developing countries, which account for more than 60 percent of world cereal consumption and derive more than half of their dietary energy supply (DES) from cereals, roots and tubers⁵¹.

The most affected commodities were cereals, which account for more than one-third of total losses

In order to provide a measure of the amount of calories lost after disasters, losses were converted from physical quantities into calories using regional food composition tables. DES, which estimates the per capita amount of energy in food available for human consumption, expressed in kcal per capita per day, was used as a basis for comparison. Based on these figures, losses after each disaster correspond, on average, to nearly 7 percent of per capita DES in the countries analysed. This figure (calculated at national level) indicates the share of loss expressed in calories that was no longer available from domestic production for human consumption, with possible negative impacts on national or subnational food security.

While the findings presented above provide an estimation of the potential impact of disasters on food availability, it should be noted that crop and livestock losses do not necessarily translate into an equivalent loss of per capita energy supply. As illustrated later in this section, production shortfalls are usually compensated by an increase in commercial imports and food aid; therefore, the overall impact on DES after disasters may be lower. The presence of stocks and/or the increase in supply of non-affected commodities can play an important role in compensating energy supply losses resulting from declines in production.

Quantifying losses by agricultural commodity group

The 333 million tonnes of crop and livestock commodities lost after disasters were converted into monetary value and analysed by region in order to better understand the regional distribution of losses by commodity group (Figure 7). The analysis shows that there are largely differing declines in production per commodity group and region.

50 Total losses correspond to 139 million tonnes of cereals; 12 million tonnes of pulses; 5 million tonnes of meat (including cattle, goat, pig and sheep meat), 20 million tonnes of milk (including cow, goat and sheep milk), and 157 million tonnes of other commodities (e.g. coffee, tobacco, sugar cane and selected fruits, vegetables, roots and tubers).

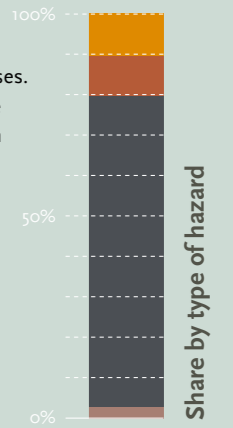
51 FAO. 2015. Share of dietary energy supply derived from cereals, roots and tubers. Based on FAO Food Security Indicators.

Figure 6. Losses after 140 medium- to large-scale disasters affecting more than 250,000 people alone

ASIA

USD **48 billion**
in crop and livestock losses 2003–2013
↓
2% of the projected value of production

Floods were associated with 77% of the region's losses. While the region experienced the largest absolute production losses, it was least affected in relation to the projected value of production. India was most affected by losses after recurrent floods from 2004 to 2013, while the Philippines (e.g. 2012 Bopha and 2013 Haiyan Typhoons), Pakistan (e.g. 2010 floods), Cambodia (e.g. 2005 drought) and Thailand (e.g. 2008 drought) were also hard-hit

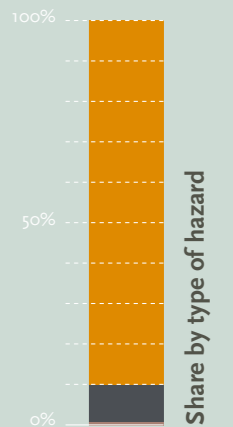


Source: FAO, based on FAOSTAT

AFRICA

USD **14 billion**
in crop and livestock losses 2003–2013
↓
6% of the projected value of production

Some 90% of the region's losses occurred after droughts, when most countries experienced sharp declines in yields, likely leading to losses in output and revenue. Droughts severely challenge food availability, rural livelihoods and overall economies, particularly given agriculture's critical contribution to food security and economies in sub-Saharan Africa

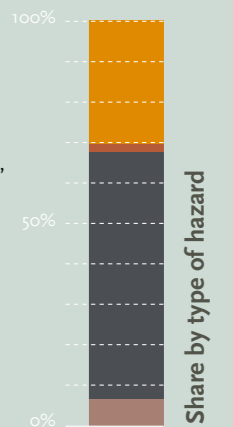


Source: FAO, based on FAOSTAT

LATIN AMERICA AND THE CARIBBEAN

USD **11 billion**
in crop and livestock losses 2003–2013
↓
3% of the projected value of production

Most losses occurred after floods (55%) followed by droughts and storms. Brazil was most affected, also due to the large size of its agricultural production, following 2009 floods in the north of the country. Other seriously affected countries included Colombia (2007, 2010 and 2011 floods), Mexico (2005 Hurricane Emily, 2007 Tabasco floods and 2011 drought) and Paraguay (2011–12 drought)

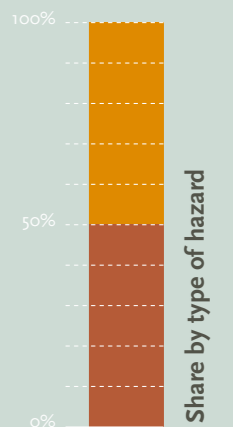


Source: FAO, based on FAOSTAT

NEAR EAST

USD **7 billion**
in crop and livestock losses 2003–2013
↓
7% of the projected value of production

The Near East was the most affected region in relative terms, with most losses occurring after the 2008 drought in Syria



Source: FAO, based on FAOSTAT

Legend: Storms Floods Drought Earthquakes

Cereals correspond to about 50% of crop losses in Africa

Figure 7 shows for instance that cereals (especially maize, millet, sorghum and wheat) are the most affected crops in Africa, corresponding to about 50 percent of total production losses in the region. Latin American and Caribbean countries mainly experienced losses in cash crops such as coffee, sugar cane and tropical fruits, as well as staple crops like cassava and potatoes. Cereals, especially rice, maize and wheat, were the most affected commodities in Asia, followed by livestock and tropical fruits, particularly bananas and mangoes, and cassava. Near East countries experienced the majority of losses to cash crops.

In some cases, post-disaster falls in cereal production occurred in countries that face food security challenges and derive high shares of food energy intake from cereals. In Ethiopia, for example, maize yields dropped by 26 percent following the 2003 drought. Major cereal producers and exporters have also suffered significant losses from disasters. India alone accounted for more than one-third of total cereal losses in all the analysed countries. Cash crop production also declined in top exporting countries in Latin America. In Brazil, coffee yields declined by up to 10 percent after the 2007 drought, impacting international prices⁵².

The analysis shows that significant declines in crop and livestock production are associated with disasters in developing countries. Yet, the reported figures are likely to be underestimated as the analysis focused on medium- and large-scale disasters and on a selected number of commodities. It is likely that losses also occurred in other commodities.

In addition, the findings show that losses differ in terms of affected commodity groups and type of disaster across regions and countries. Such differences should be taken into consideration in development plans for the agriculture sector for integrating measures and targets that reduce risks and improve the resilience of the sector. For this reason, the collection, systematic reporting and in-depth analysis of data on the impact of disasters on agriculture are essential to support context-specific planning for risk reduction and should become a central priority of national governments and the international community.

⁵² <http://www.ibtimes.com/droughts-brazil-west-africa-us-are-hurting-commodities-experts-say-its-only-temporary-1562843>

Disaster risk reduction measures should pay specific attention to crops that contribute most to food security and nutrition

In Africa, for example, the sharp decline in key staple cereal crops such as maize, millet and sorghum after disasters (especially drought) represents a major challenge for food security and nutrition. Disaster risk reduction measures should consider the types of crops most affected in each region and country, with specific attention to crops that provide the largest contribution to food security and nutrition, as well as to rural livelihoods.

Disaggregated data on the impact of disasters on agricultural commodities is needed to support decision-makers and relevant stakeholders in selecting appropriate crop varieties and other farming practices and agricultural technologies that build resilience.

2.2 Changes in agricultural trade flows after disasters

Declines in agricultural production after disasters can trigger changes in agricultural trade flows, which in turn can increase import expenditures and reduce export revenues. Section 1.3 presented the wider impact of disasters on macro-economic flows, including on agricultural trade. A broader analysis was conducted of 116 disasters affecting 59 developing countries between 2003 and 2011 to determine the extent to which changes in agricultural imports and exports are associated with disasters in developing regions⁵³.

The findings reveal that food imports increased by USD 33 billion following disasters over the period considered, corresponding to 28 percent of the projected value of imports⁵⁴. Imports include both commercial food imports and food aid shipments.

Figure 8 shows the rise in agricultural commodity imports by region. Together, Asian and Latin American and Caribbean countries account for a large majority of increases in imports associated with disasters. Such a tendency may be considered an indirect effect of losses to domestic production and consequent rise in demand for imported food. In the case of Africa, however, the findings show that increases in agricultural imports after disasters are proportionally lower than losses in domestic production. In the United Republic of Tanzania, while cereal production losses amounted to about 850 000 tonnes following the 2006 drought, cereal imports grew by about 350 000 tonnes, thereby compensating less than half of losses, with likely negative consequences on food availability.

⁵³ The sample size of countries and disasters is smaller than in Section 2.2 due to data on agricultural trade being available only until 2011 at the time of writing.
⁵⁴ The figure on increases in imports is likely to be higher when considering food aid shipments of all types of commodities. Furthermore, limited data availability prevented a detailed analysis of food aid shipments allocated to disasters triggered by natural hazards.

Figure 7. Regional production losses by commodity group associated with disasters between 2003 and 2013

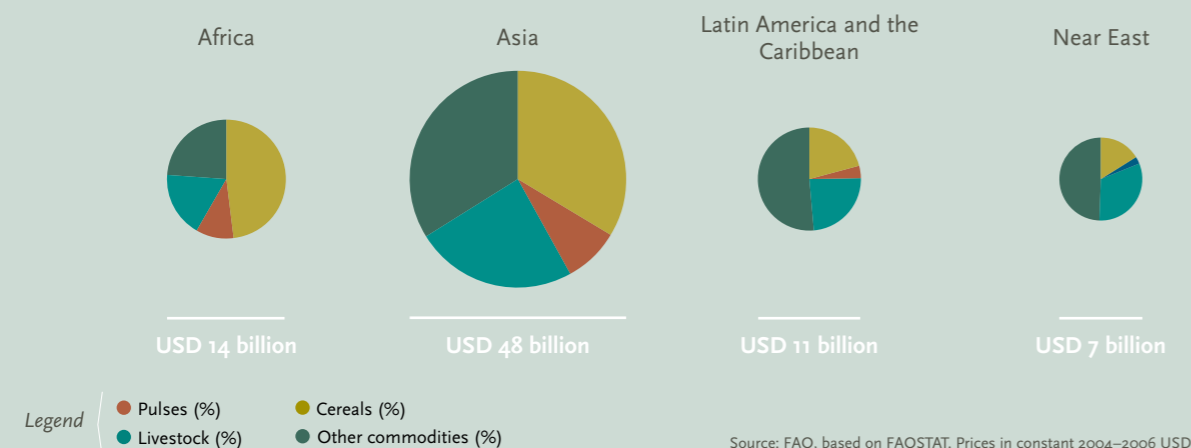


Figure 8. Decreases in exports and increases in imports after disasters analysed between 2003 and 2011 by region (in USD billion)



In order to compare more consistently across regional markets, increases in imports were measured as a share of the projected value of imports. The results show that regional differences are minor. For each region, increases in imports after disasters were between 25 and 30 percent higher than projected values.

Decreases in exports of cereals, pulses, milk and meat amounted to nearly USD 7 billion – about a 6% drop in the projected value of exports

Decreases in exports of cereals, pulses, milk and meat amounted to nearly USD 7 billion – about a 6 percent drop in the projected value of exports. Almost two-thirds of total declines occurred in Asian countries, representing USD 4.4 billion, mainly due to the larger size of Asian export markets. One reason for the reduction in exports after disasters may be the diversion in tradable agricultural commodities towards domestic markets to meet domestic food demand. Also, the impact of disasters on agricultural production has likely had an indirect negative effect on the amount (and value) of exported agricultural commodities.

When compared with projected exports, the analysis shows that the Near East is the most affected region in relative terms, losing 42 percent of projected exports after disasters. Almost all decreases in exports in the region occurred after the 2008 drought in Syria. In Africa, decreases in exports correspond to 26 percent of projected exports, while the share is considerably lower in Asia (6 percent) and Latin America and the Caribbean (2 percent). We can thus conclude that losses in export revenues may have a relatively stronger negative impact on the balance of trade in African and Near East countries compared with Asian, Latin American and Caribbean countries.

Overall, the analysis reveals that significant changes in agricultural trade flows occurred after medium- and large-scale disasters in developing countries. A positive statistical correlation is found between disasters and trade flows. For example, increased imports of cereals, pulses, meat or milk were observed after 95 percent of the disasters analysed, while decreased exports of the same commodities occurred after 89 percent of the disasters. A positive relationship was also found between production losses and falling exports, as reductions in exported commodities were greater after disasters that caused the greatest production losses. Changes in trade flows would likely be more significant if other commodities were considered, such as cash crops which contribute significantly to export revenues in many developing countries. Further analysis of agricultural trade dynamics within countries may reveal even more drastic changes in imports and exports of food products in the affected regions.

2.3 Changes in sector growth associated with disasters over the past decade

Production losses can reduce agricultural value added or sector growth, with consequences for national GDP in countries where the sector is a key driver of economic growth

Ultimately, production losses can reduce agriculture value added or sector growth, with consequences for national GDP in countries where the sector is a key driver of economic growth.

Several examples and case studies were presented in Chapter I in order to illustrate the impact of disasters on agriculture sector growth. In this section, a broader assessment was undertaken of 125 disasters that affected 60 developing countries between 2003 and 2013 in order to determine the extent to which agriculture sector growth declined after disasters⁵⁵. Decreases in the rate of agriculture value-added growth during the year when disasters occurred and the subsequent year were compared with the linear trend projection (2003–2013). Annexes 3 and 5 provide further details on the countries and disasters included in this analysis, as well as on the methodology used.

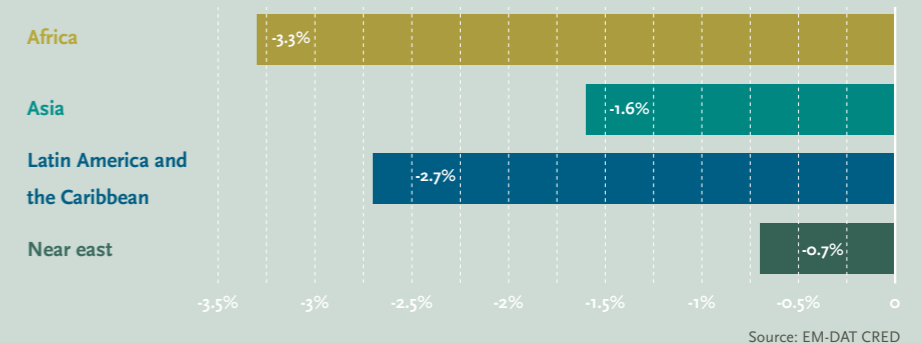
⁵⁵ Disasters that occurred in Chad, the Gambia, Israel, Kenya, Myanmar, Peru and the Syrian Arab Republic were excluded from the analysis due to lack of data on agriculture GDP growth.

The results show significant drops in agriculture value-added growth after disasters. In 55 percent of the events analysed, a decline in agriculture value-added growth in the year of disasters was observed⁵⁶. In the year after the disaster, sector growth was negatively affected by 83 percent of all the disasters analysed. On average, each disaster eroded 2.6 percent of sectoral growth.

The decline in sector growth was particularly remarkable after some severe droughts. For example, agriculture value-added growth in Zimbabwe declined by an average of about 18 percent in 2007 and 2008 following a drought. A significant drop in sector growth was also observed after the 2012 drought in Paraguay, with agriculture value-added growth declining by an average of 16 percent in 2012 and 2013 compared with projected growth. The poorer performance of agriculture compared with linear growth trends suggests the sector is highly vulnerable to the disruptive effects of disasters, especially in the short term.

Figure 9 shows that Africa was most affected in terms of average decline in agriculture value added, losing 3.3 percent of agriculture growth after each disaster. This highlights the susceptibility of African countries to changes in agriculture sector growth after disasters. Given agriculture's significant contribution to total GDP in the African countries analysed (about 25 percent on average), such losses in sector growth can negatively affect the entire national economy, as illustrated in Chapter I.

Figure 9. Average share of agriculture value-added growth lost after disasters between 2003 and 2013, by region



Overall, it is clear that agriculture growth declines significantly after disasters in developing countries. The findings represent observed trends and not a causal relationship given the complex and dynamic interplay of domestic and international factors that can influence agriculture growth during the years when disasters occur. However, there is a strong correlation between falling sector growth and disasters, illustrated by the negative trend in agriculture GDP growth observed in 55 percent of the disasters analysed.

⁵⁶ Negative performance is intended as a value of agriculture GDP growth rate lower than the linear trend value in the year of disaster.



Agriculture is highly susceptible to climate variability and change. If no risk reduction and adaptation measures are put in place, enhanced exposure to drought will further compromise food security in sub-Saharan Africa

Over 360 million people in sub-Saharan Africa were affected by droughts between 1980 and 2013

Total crop and livestock losses after droughts, between 1991 and 2013, cost more than USD 30 billion

Chapter III

Drought in sub-Saharan Africa
– an in-depth analysis of
the impact on agriculture

Drought is one of the least-assessed natural hazards, despite its considerable impact on the agriculture sector. In sub-Saharan Africa, where the sector contributes an average of 25 percent of GDP, agriculture must take the lead in managing risks associated with drought

An in-depth analysis was carried out to better understand the consequences of droughts in sub-Saharan Africa, given their frequency and considerable impact on agriculture, livelihoods and food security and nutrition in the region.

Sub-Saharan Africa has not yet met the targets set at the World Food Summit of halving the number of undernourished people by 2015, nor the Millennium Development Goal target of halving the proportion of undernourished people by 2015. In fact, the number of undernourished people in the region rose from 182 million in 1990–1992 to 227 million in 2012–2014⁵⁷.

Agriculture is vital to food security, poverty reduction and economic growth in many countries of sub-Saharan Africa. Over 60 percent of the region's population is rural and lives largely off agriculture, while the sector employs about 60 percent of the workforce. Smallholder farmers account for about three-quarters of the region's poor population, with smallholder farming comprising 80 percent of all farms. **In sub-Saharan Africa, agriculture contributes an average of 25 percent of GDP, and as much as 50 percent when the agribusiness sector is included⁵⁸.** Agriculture's considerable contribution to employment, as well as to African economies makes the sector a critical engine of economic growth and welfare.

However, agriculture is especially susceptible to climate variability and change, and frequent droughts in the region limit the sector's potential. The analysis presented in this section was undertaken to better understand the consequences of drought in the region. Given its significant impact, ensuring drought-resilient food production systems in sub-Saharan Africa is fundamental to sustainable agriculture and national economic development.

57 FAO, 2014. The State of Food Insecurity in the World.

58 Deutsche Bank, 2014. Agricultural value chains in sub-Saharan Africa. From a development challenge to a business opportunity.

3.1 Brief overview of trends in drought and food insecurity in sub-Saharan Africa (1980–2014)

The term “drought” may refer to meteorological drought (precipitation well below average), hydrological drought (low river flows and water levels in rivers, lakes and groundwater), agricultural drought (low soil moisture) and environmental drought (a combination of the above)⁵⁹. However, a lack of data meant that this study could not analyse drought events according to the above classification. At global level, the EM-DAT CRED database is the only publicly available database that documents drought events reported by countries. Therefore, the droughts reported in this database were used for the analysis presented in this chapter. Annex 4 shows the years when droughts were reported in sub-Saharan Africa between 1980 and 2014⁶⁰.

FAO analysed the geo-spatial and temporal distribution of droughts in sub-Saharan Africa between 1980 and 2014 in relation to the populations affected. **During this period, droughts affected over 363 million people in the region, of whom 203 million were in eastern Africa**, followed by southern Africa with 86 million, western Africa with 74 million and central Africa with less than 1 million⁶¹. Five countries accounted for nearly half of all drought-affected populations in the region since 1980: Ethiopia, Kenya, Malawi, the Niger and South Africa, totalling 171 million people.

The number of people affected by drought in sub-Saharan Africa is growing, from 82–90 million in the 1980s and 1990s to 132 million in the 2000s

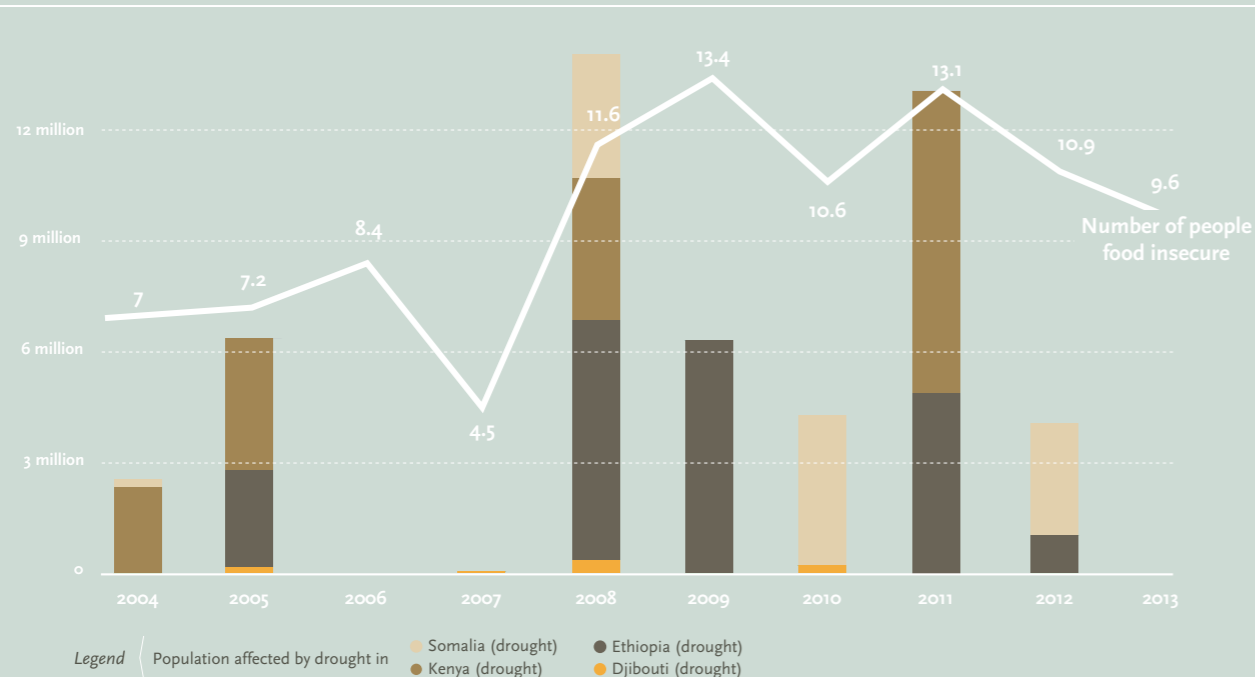
Comparing the four decades in terms of the number of people affected by drought, some 132 million people were affected in the 2000s compared with roughly 82–90 million people in the 1980s and 1990s, respectively. In terms of the current decade, as of 2014 drought has already affected 59 million people in Africa, indicating a worsening trend.

Trends in the Horn of Africa show high levels of food insecurity on an annual basis, as illustrated in **Figure 11**. For example, every year an average of 9.6 million people faced food insecurity and required humanitarian assistance in the Horn of Africa alone. Drought is just one of several types of shocks that produce food insecurity in the region. As shown in **Figure 11** peaks of food insecurity in the Horn of Africa occurred in years when several million people were affected by drought in the subregion, indicating a strong correlation between drought and food insecurity. In many cases, there is a complex interaction of crises that may combine with drought to produce food insecurity, such as soaring and volatile food prices, livestock and plant pests and disease, resource-based competition, internal conflict and civil insecurity. These are among other important drivers of production loss and food insecurity, which can coincide with drought in a given year.

Figure 10. Total population (millions) affected by drought in sub-Saharan Africa (1980–2013) by subregion



Figure 11. Population facing food insecurity/in need of humanitarian assistance in the Horn of Africa and population affected by drought in Djibouti, Ethiopia, Kenya and Somalia by year (millions)



Source: Data on food insecure people in the Horn of Africa is based on national and international assessment reports, Flash Appeals and United Nations and partners' Consolidated Appeals. Information on drought-affected people is based on data from EM-DAT CRED. Note: data on food insecure people in the Horn of Africa refers to Djibouti, Ethiopia, Kenya and Somalia.

3.2 Damage and losses to agriculture due to drought

As much as 84% of the economic impact of drought falls on agriculture

Droughts cause significant damage and losses to agriculture. Drought in Kenya (2008–2011), Djibouti (2008–2011) and Uganda (2010–2011) cost a total of USD 11.4 billion in damage and losses to the three countries' agriculture sectors and a total of USD 13.6 billion to all sectors combined.

59 Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: Synthesis Report (Fourth Assessment Report -AR4).

60 It is important to note that the EM-DAT CRED has limitations that should be considered; namely that it records only disaster events that meet one of four criteria: (i) Ten or more people reported killed, (ii) 100 or more people reported affected, (iii) declaration of a state of emergency, and (iv) call for international assistance. The database therefore does not necessarily capture all drought events. Another limitation is that the type of drought is not reported in the database, nor its duration. Ideally, more specific information would enable a more precise analysis of drought impact, for example the crop season or calendar associated with a given drought.

61 Based on EM-DAT CRED. The number of people affected reported in EM-DAT CRED database refers to the sum of injured, homeless and people requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.

This suggests that on average as much as 84 percent of the economic impact of drought falls on agriculture. The remaining impact is typically on sectors such as health and nutrition, energy, water and sanitation, among others. The specific wider impact caused by these droughts on food security and the economy is presented in the next section.

In Uganda, the drought in 2005–2007 and rainfall deficits during 2010–2011 had a significant impact on agriculture, with far-reaching consequences at the national level.

Agriculture accounts for about 21 percent of GDP in the country, 66 percent of total employment and 46 percent of export earnings. Manufacturing accounts for about 20 percent of GDP and 40 percent of this is attributed to agro-industries, mainly food processing. The 2005–2007 drought negatively affected food and cash crop production and productivity. Cattle and other animal stocks were also affected, resulting in lower availability of meat and milk products into 2008. Production losses impacted food availability, raised market prices of foodstuffs and increased malnutrition rates among the population in the affected areas. Production losses also resulted in lower exports of traditional cash crops such as sugar, coffee and tobacco, which had an adverse impact on producers' earnings. The losses in primary production had a subsequent negative effect on manufacturing and trade.

Traders had a lower quantity of agriculture and livestock goods to sell. GDP grew at slower rates than expected during 2005–2008, by a combined 3 percent rate during and after the drought. The total value of losses, adjusted for inflation and expressed in 2010 terms, was estimated to be USD 380 million⁶².

Livestock production in Uganda's Karamoja region absorbed most of the impact of the 2010–2011 rainfall deficits

In 2010–2011, Uganda once again faced rainfall deficits, lowering production and exports of similar cash crops, which led to further losses in the country's agro-industry sector, particularly sugar, coffee, tea, tobacco and grains processing. Livestock, especially cattle, was affected by water and feed scarcity and disease, which resulted in production losses in meat and milk. Most of the impact on livestock was in Karamoja region, one of the most important areas for livestock production in Uganda and where most livestock owners and pastoralists have very low per capita incomes. Commerce was indirectly affected by the lower quantity of agricultural goods sold and by increases in prices of these goods due to scarcity and speculation. The losses sustained in food processing had a negative impact on Uganda's exports and balance of payments in both 2010 and 2011. Overall, 77 percent of the total USD 907 million in damage and losses caused by the drought fell on the agriculture sector, which in part explains the large cascading effect it had on the national economy. The total damage and losses were equivalent to 7.5 percent of the country's GDP in 2010. Isolated from other factors, the rainfall deficits had an estimated impact of 3.5 percent on GDP growth for 2010 and 2011 combined⁶³.

3.3 Wider impact of drought

Chapter I illustrated how and to what extent the impact of disasters on agricultural production affects livelihoods and food security, and has a cascading effect across the food and agriculture value chain and on manufacturing, which resonates on national economies. A similar analysis of the wider impact of drought indicates a much more significant impact in sub-Saharan Africa compared with other types of disasters.

⁶² Government of Uganda. 2012. The 2010–2011 Integrated Rainfall Variability Impacts, Needs Assessment and Drought Risk Management Strategy.

⁶³ Government of Uganda. 2012. The 2010–2011 Integrated Rainfall Variability Impacts, Needs Assessment and Drought Risk Management Strategy. Note: where required, the exchange rate used was: UGX 2 450 per USD 1.

This can be seen in the Horn of Africa, where drought and rainfall deficits affected various areas between 2008 and 2011. The severe drought crisis that gripped the region by 2011 brought food insecurity to 15.5 million people who needed humanitarian assistance, and as many as 2.3 million children were acutely malnourished, while over 560 000 were suffering from acute malnutrition⁶⁴.

In Djibouti, the severe drought crisis of 2011 affected half of the rural population and caused a 25% decline in food consumption

In Djibouti, the drought affected over 120 000 people – 50 percent of the rural population and 15 percent of the total population⁶⁵. Agricultural production and livestock losses led to severe food insecurity in rural areas.

The drought caused a 25 percent decline in food consumption (equal to a 20 percent loss in kcal per household) and a 50 percent decrease in the consumption of goods and services such as education and health. The drought caused an estimated USD 209 million in total damage and losses between 2008 and 2011.

Crop and livestock losses amounted to 41 percent of the sector's GDP, which produced a GDP average yearly deflection of 3.9 percent over the period. The country's current account balance increased annually by 2.7 percent of GDP between 2008 and 2011⁶⁶.

In Kenya, the drought caused nearly USD 11 billion in damage and losses to agriculture, equal to 85 percent of the total economic impact. Losses were felt in the food processing industry, leading to lower exports, and sector growth fell to -5 percent in 2008 and -2.3 percent in 2009, with negative consequences for national GDP⁶⁷.

The 1991/92 drought in southern Africa affected 72% of the population resulting in a six times higher than normal volume of food imports

The 1991/92 drought affecting southern Africa further illustrates the complexity and far-reaching effect of droughts on agriculture, food security and national economies. Many parts of southern Africa received less than 75 percent of their average rainfall and 70 percent of the crops failed, affecting ten countries in the Southern African Development Community. A total of 86 million people were affected, about 72 percent of the population, 20 million of whom were at serious risk of starvation⁶⁸. Although the region was a net exporter of food, southern Africa imported 11.6 million tonnes of food between April 1992 and June 1993 – six times higher than the normal volume of imports in the subregion⁶⁹.

In South Africa, the drought resulted in the loss of 49 000 agricultural jobs and 20 000 formal jobs in non-agricultural sectors. Maize imports were required until 1995, while maize export earnings fell, with further declines in other agricultural exports and in exports from related sectors. Agricultural GDP declined by 27 percent and national GDP by 2.4 percent. In the manufacturing sector, output declined by 3.3 percent. Consumer expenditure fell by 0.9 percent and gross domestic savings by 8.4 percent⁷⁰.

⁶⁴ FAO Global Information and Early Warning Systems. 2011. Crop Prospects and Food Situation.

⁶⁵ This is said to be a conservative estimate and the affected population may have been as high as 245 000 people, see for example PDNA at a Glance.

⁶⁶ Republic of Djibouti, World Bank, United Nations and European Union. 2011. Evaluation des Dommages, Pertes et Besoins Suite à la Sécheresse en République de Djibouti.

⁶⁷ Republic of Kenya with technical support from the European Union, United Nations and World Bank. 2012.

⁶⁸ Buckland, R., Eele, G., and Mugwara, R. 2000. *Humanitarian crisis and natural disasters: A SADC perspective*. In: Clay, E. and Stokke, O. (eds) *Food aid and human security*. European Association of Development Research. London: Frank Cass publishers.

⁶⁹ International Federation of Red Cross and Red Crescent Societies (IFRC), World Disasters Report 1994; The Stern Review: the Economics of Climate Change; Benson C and Clay E., 1994, The impact of drought on sub-Saharan African economies: a preliminary examination, Overseas Development Institute (ODI) Working Paper 77; International Monetary Fund (IMF). 2003. Fund Assistance for Countries Facing Exogenous Shocks; Glantz, M.H., et al. 1997. Food security in southern Africa: assessing the use and value of ENSO information; Kinsey, B. 1998. Coping with Drought in Zimbabwe: Survey Evidence on Responses of Rural Households to Risk.

⁷⁰ IFRC, World Disasters Report 1994; The Stern Review: the Economics of Climate Change; Benson C and Clay E., 1994, The impact of drought on sub-Saharan African economies: a preliminary examination, ODI Working Paper 77; IMF. 2003. Fund Assistance for Countries Facing Exogenous Shocks; Glantz M.H., et al. 1997. Food security in southern Africa: assessing the use and value of ENSO information; Kinsey, B. 1998. Coping with Drought in Zimbabwe: Survey Evidence on Responses of Rural Households to Risk.

UGANDA | The sector-wide and economic impact of the 2010–2011 rainfall deficit

Electricity
Rainfall deficits raised the costs of electricity generation for Uganda. Compared to 2009, the share of hydropower generation decreased by 2% in 2010 and by nearly 4% in 2011. At the same time, bagasse electricity generation at sugar mills declined by 10% in 2010 and by a further 40% in 2011 due to lack of sugar cane availability

Commerce/trade
The losses sustained in the processing of sugar, coffee, and tea and tobacco had a negative impact on Uganda's exports and balance of payments in 2010–2011. The commerce or trade sector was indirectly affected by lower quantity of agricultural goods sold, and increases in prices of the same goods. Lower sales in the sector were estimated at USD 16 million in 2010 and 2011. It was further estimated that gains were obtained by the traders due to the higher unit prices of those products in the two years. Total losses for the commerce sector were thus estimated as USD 69.4 million in 2010–2011. Commerce sustained 7% of all damage and losses

Total damage and losses, and GDP
The estimated impact of the rainfall deficit, isolated from other factors, was 1.8% in 2010 and 1.7% in 2011, or a combined figure of 3.5% of GDP growth for the two years
The value of damage and losses in 2010–2011 was estimated at USD 1.2 billion, which is equivalent to 7.5% of the country's GDP in 2010

Agricultural production
Damage and losses in the agriculture sector was USD 907 million, accounting for 77% of total damage and losses across all economic sectors. Within the sector livestock sustained 52% of the impact and crops 48%

Agro-industry
Agro-industry losses were USD 113.5 million in value as a result of primary production losses in the agriculture sector, causing further production or processing losses, particularly sugar, coffee, tea, tobacco and grains processing. Agro-industry sustained 10% of total damage and losses

Imports/exports
The lower production of cash crops resulted in lower amounts of exports, particularly sugar, coffee, tea and tobacco. In addition, higher fuel imports were needed to produce more electricity using thermal power plants as a substitute for hydroelectric production

Deficit and balance of payments
It was estimated that the current government deficit in 2010 would have been 7.5% lower and the expected surplus for 2011 would have been 7.1% higher if the rainfall deficit had not occurred due to lower tax revenues arising from production losses and higher expenditures on relief. It was estimated that if the rainfall deficit had not occurred, Uganda would have experienced a 2.5% improvement in its balance of payments in 2010 and a similar positive impact in 2011



Food shortages

Expenditures
The provision of food assistance by the government cost USD 6.9 million

The recovery from the drought was estimated to cost USD 173 million

Prices
Uganda faced higher-than-normal prices of basic food products, caused by food scarcity and indirectly by speculation from traders. Food crops inflation increased to 29%, up from 1.5% in January 2011

Food insecurity
As a result of the drought, 669 000 people faced food insecurity in the country

Poverty
The most severe effects of the rainfall deficits occurred in districts with the lowest human development conditions, which suggests that poverty may have been aggravated by the rainfall deficits

In Uganda, agriculture accounts for about 21% of GDP, 46% of export earnings and 66% of total employment. Coffee is the most important export crop. Manufacturing accounts for about 20% of GDP, and 40% of this is attributed to agro-industry, mainly food processing.

Source: FAO, based on Government of Uganda, 2012, the 2010–2011 Integrated Rainfall Variability Impacts, Needs Assessment and Drought Risk Management Strategy. Note: Exchange rate used: 2,450 shillings per USD.

The 1991/92 drought also had a significant impact in Zimbabwe. Production losses in maize, cotton and sugar cane negatively affected agroprocessing and textiles, causing manufacturing output to fall by 9 percent by the end of 1992 and a 6 percent reduction in foreign currency receipts from manufactured exports. Agriculture sector growth in Zimbabwe fell by 23 percent in real terms in 1992 and the country's real GDP by 9 percent. The current account deficit doubled from 6 to 12 percent of GDP in the same period, and the increase was financed mainly with higher borrowing. The country received external debt relief, increasing external debt as a percentage of GDP from 36 percent in 1991 to 60 percent in 1992, and to 75 percent by 1995⁷¹.

By 1992, 5.6 million people (half the population) had registered for drought relief and 1.5 million children under eight years of age received supplementary feeding. Both child malnutrition and the number of children with low birth weight worsened. Employment was relatively stable, but real wages declined by 23 percent in 1992, and 42 percent in agriculture⁷².

- 71 IFRC, World Disasters Report 1994; The Stern Review: the Economics of Climate Change; Benson C and Clay E., 1994, The impact of drought on Sub-Saharan African economies: a preliminary examination, ODI Working Paper 77; IMF. 2003. Fund Assistance for Countries Facing Exogenous Shocks; Glantz M.H., et al. 1997. Food security in southern Africa: assessing the use and value of ENSO information; Kinsey, B. 1998. Coping with Drought in Zimbabwe: Survey Evidence on Responses of Rural Households to Risk.
- 72 IMF. 2003. Fund Assistance for Countries Facing Exogenous Shocks; Benson, C. and Clay, E. 1994. The impact of drought on sub-Saharan African economies: a preliminary examination, ODI Working Paper 77; Glantz, M.H., et al. 1997. Food security in southern Africa: assessing the use and value of ENSO information; Kinsey, B. 1998. Coping with Drought in Zimbabwe: Survey Evidence on Responses of Rural Households to Risk.

Figure 12. Cereal, pulse and livestock production losses after droughts in sub-Saharan Africa, by subregion (USD billion)

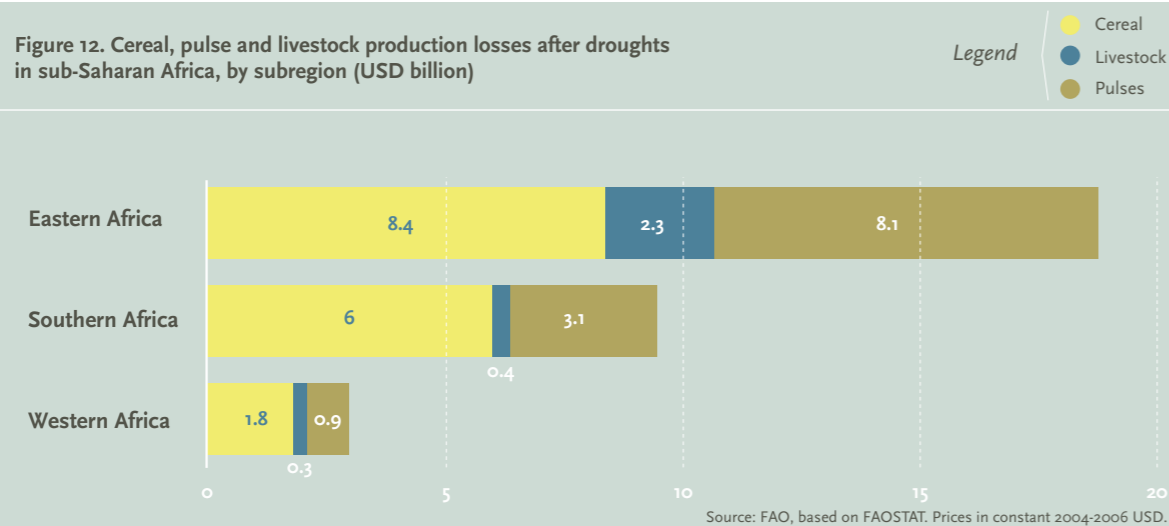
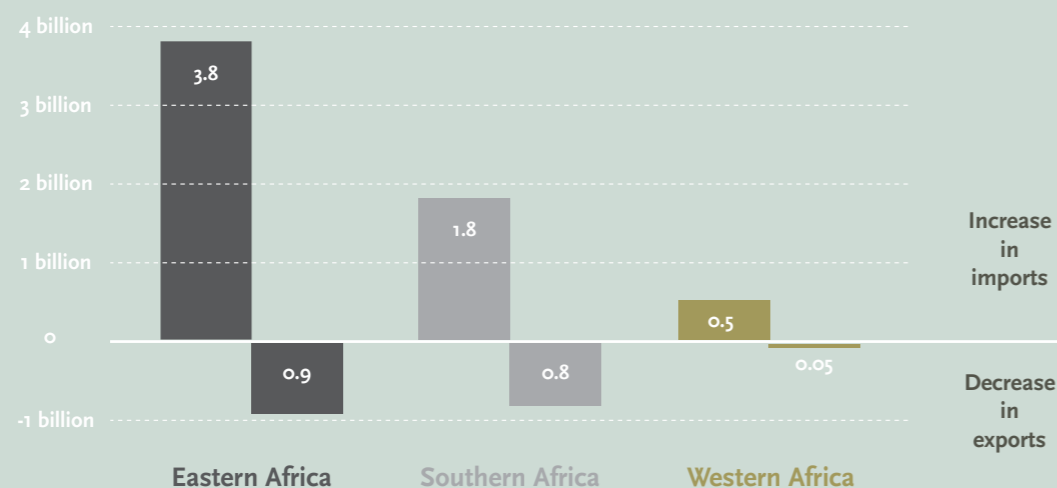


Figure 13. Changes in trade flows after droughts in sub-Saharan Africa, by subregion (USD billion)



3.4 Quantifying losses after droughts in sub-Saharan Africa (1991–2013)

The study assessed the level of production losses associated with drought in sub-Saharan Africa between 1991 and 2013, providing longer-term trends across the subregions. The method described in Chapter II was applied here, focusing on medium- and large-scale drought events that affected 250 000 people or more during the period⁷³. The study focused on cereals, pulses and key livestock commodities⁷⁴, analysing productivity and production time series at the country level.

The findings reported refer to the production losses associated with droughts. In some countries and years, other factors may have also influenced the performance of production including soaring food prices, plant and animal pests and diseases, conflict and internal insecurity, among other potential drivers.

Crop and livestock production losses due to drought in sub-Saharan Africa (1991–2013)

Total crop and livestock production losses after droughts were equivalent to about USD 31 billion between 1991 and 2013 in sub-Saharan Africa, of which more than half, or USD 16 billion, were cereal losses. As shown in **Figure 12, eastern Africa was the most affected by production losses, which reached about USD 19 billion**, followed by southern and western Africa.

In order to analyse these figures in relative terms, total losses were compared with the projected value of production, i.e. the value of commodities that would have been produced had yields and production quantities followed linear trends. The results show that cereals and pulses were the most affected commodity groups, with production dropping by 8 percent and 22 percent, respectively. This was followed by livestock commodities, which faced a 7 percent decline in production after the droughts.

In physical terms, production losses were equal to 76 million tonnes of cereals, pulses and livestock commodities. These losses were converted into calorie losses in order to provide a measure of drought impacts on DES. Losses in calories are expressed as the average share of DES per capita lost after each drought.

On average, 8 percent of per capita DES was lost after each drought in sub-Saharan Africa between 1991 and 2013. Southern Africa was the most affected subregion, followed by western and eastern Africa.

Impact of drought on agricultural trade flows and sector growth

The performance of trade flows in relation to drought in sub-Saharan Africa was also analysed to determine changes in imports and exports⁷⁵. The analysis applied the method described in Chapter II and considered the following commodities: cereals, pulses, fresh milk and meat. The indicators used for the analysis were: (i) annual value of imports; and (ii) annual value of exports, aggregated by commodity group. The analysis of trade flows focuses on droughts that took place between 1991 and 2011, while the analysis of sector growth focuses on droughts that took place between 2003 and 2013, given the lack of data.

73 The time span of the analysis (1991–2013) was based on producer price data in FAOSTAT, which is not available for the 1980s. Therefore the analysis includes 27 sub-Saharan African countries reported as having droughts during the period, including: Angola, Burkina Faso, Burundi, Chad, Djibouti, Eritrea, Ethiopia, Gambia, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, the Niger, Rwanda, Senegal, Somalia, South Africa, the Sudan, Swaziland, the United Republic of Tanzania, Uganda, Zambia and Zimbabwe.

74 In addition to cereals, pulses and livestock commodities, the assessment focused on staple and cash crops specifically mentioned in country assessments (e.g. PDNAs, Crop and Food Security Assessment Missions and Emergency Food Security Assessments) as being affected by drought.

75 Data on trade flows was not available for 2012 and 2013 at the time of writing.

The findings show that food imports increased and food exports decreased after droughts in sub-Saharan Africa. The total value of imports of cereals, pulses, milk and meat increased by USD 6 billion, corresponding to more than 9 percent of the total value of agricultural imports in the countries analysed. The total value of exports for the same commodity groups decreased by almost USD 2 billion, corresponding to 2.5 percent of the total value of agricultural exports.

Changes in trade flows by subregion (Figure 13) revealed that eastern Africa was the most affected by both increases in imports and decreases in exports, followed by southern and western Africa. Major changes occurred, especially in eastern African countries, after droughts between 2008 and 2011, as well as in Zimbabwe (after droughts in 1991 and 2010) and South Africa (after droughts in 1995 and 2004).

When the performance of sector growth was examined in relation to droughts in sub-Saharan Africa over the decade 2003 to 2013, the results show that affected countries have lost an average of 3.5 percent of agriculture value-added growth after each drought. Africa was most affected in terms of average decline in agriculture value added, losing 3.3 percent of agriculture growth after each disaster. As shown in Figure 14, Western and Southern African countries were the most affected, losing 4.1 percent of agriculture growth on average after each disaster. The drop in sector growth was very high in countries like Angola, which lost about 17 percent of sector growth on average in 2012 and 2013 after the 2012 drought, Namibia, where sector growth declined by 12 percent after the 2013 drought compared with projections, and Senegal, which lost 9 percent of sector growth on average in 2003 and 2004 following the 2003 drought.

The examples of Ethiopia and Kenya illustrate the relationship between droughts, agriculture sector growth and national GDP. In Kenya, between 1980 and 2013, agriculture growth fluctuated throughout the period but showed negative peaks in years when droughts occurred and/or the subsequent year. As shown in Figure 15, the drop in sector growth coincided with most drought years with the exception of 1994. Agriculture is important to Kenya's national economy, contributing an average of about 30 percent of GDP during the period. This is clearly reflected in the strong relationship between agriculture GDP and national GDP performance.

In Ethiopia, there was also a negative trend in agriculture growth following droughts, especially the droughts reported in 1983, 1987, 1997/98 and 2003. The greatest drop in growth occurred in 1984/85 following the 1983 drought. Drought was reported during five years between 2004 and 2012.

This period witnessed a gradual slowdown in agriculture growth, although less severe than during previous droughts. The impact of droughts on Ethiopia's agriculture has a direct negative effect on the performance of the country's GDP. As reflected in Figure 16, there is a strong correlation between agriculture growth and GDP growth. This is understandable given the importance of the sector in Ethiopia, where it contributed between 40 and 58 percent of the country's GDP from 1980 to 2012.

Droughts jeopardize agricultural production in sub-Saharan Africa, with severe consequences for food security and nutrition, and for national economies that are largely based on the agriculture sector. The findings of this in-depth analysis call for further mainstreaming of drought risk management in the development plans of drought-affected countries in the region. Governments in sub-Saharan Africa have already started building the institutional and policy frameworks necessary to address disaster risks in a comprehensive way. The African Risk Capacity, for example, was established as a Specialized Agency of the African Union to "help Member States improve their capacities to better plan, prepare and respond to extreme weather events

and natural disasters, therefore protecting the food security of their vulnerable populations"⁷⁶.

These encouraging initiatives would further benefit from more comprehensive analysis of drought impact on the sector, food value chain, manufacturing and national economies, as well as systematic monitoring and reporting of the impact of droughts in sub-Saharan Africa is needed to ensure that context-specific, evidence-based measures are taken to enhance the resilience of agriculture in the face of recurring and progressively increasing drought events.

76 www.africanriskcapacity.org

Figure 14. Average annual share of agriculture value-added growth lost after droughts in sub-Saharan Africa, by subregion

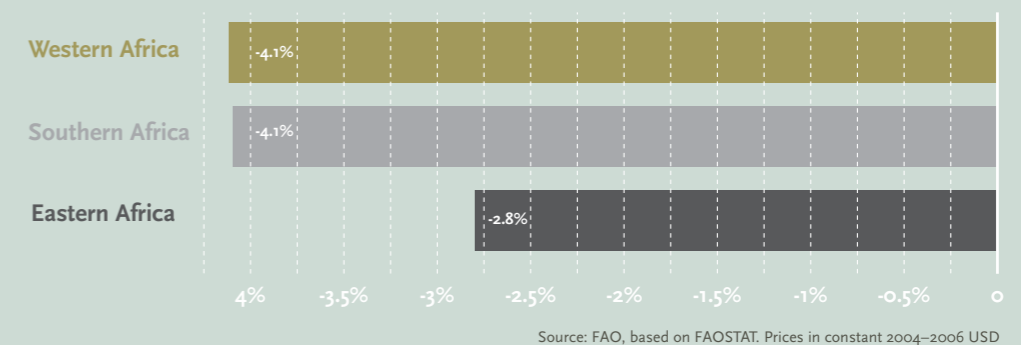


Figure 15. Kenya – GDP growth and agriculture value-added growth in relation to major droughts

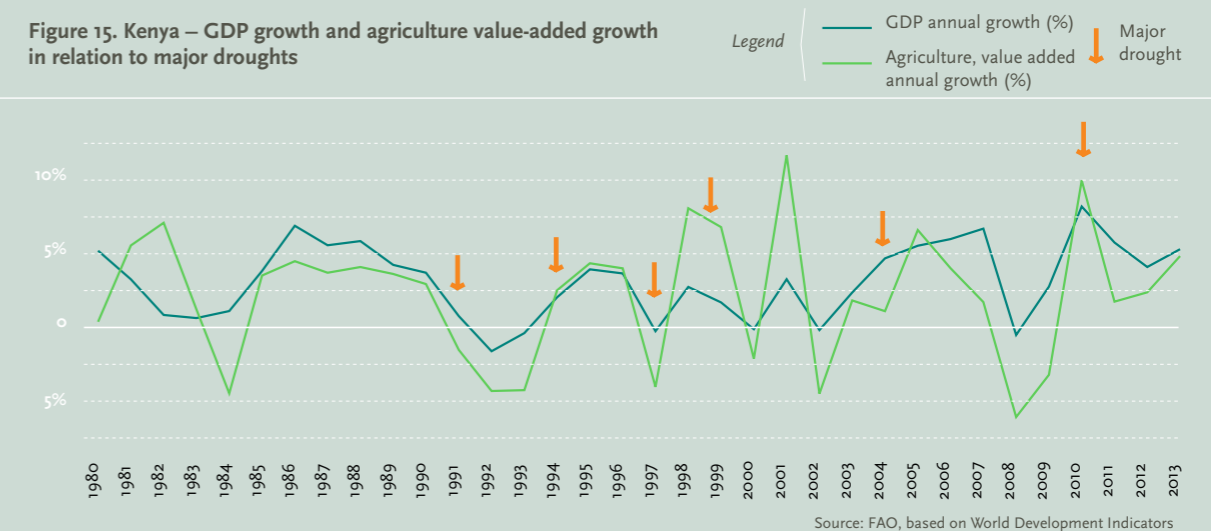
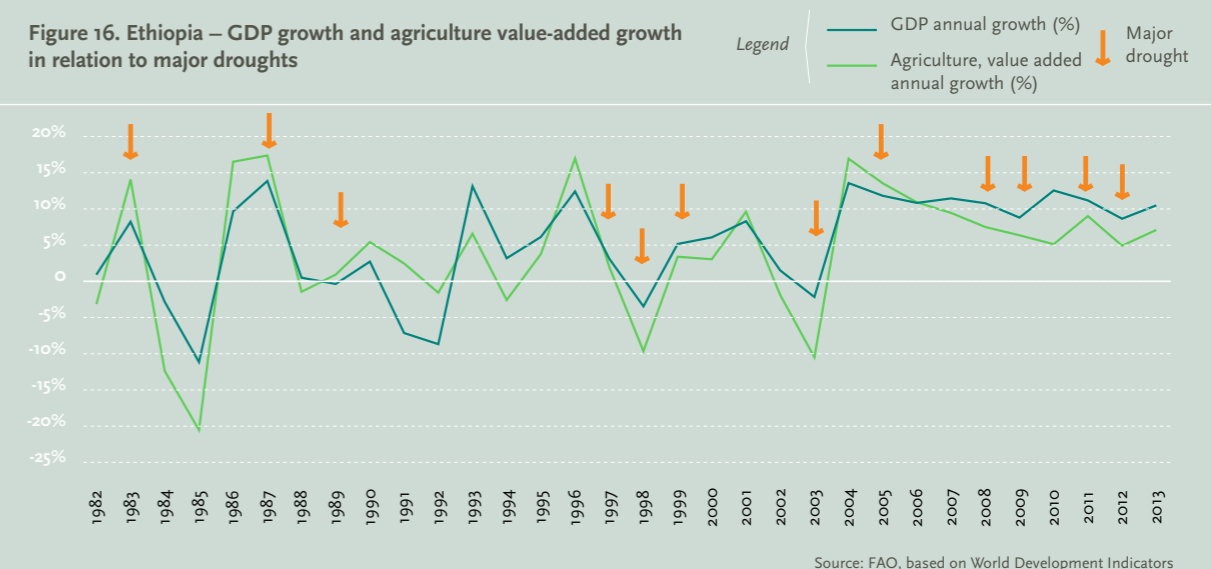


Figure 16. Ethiopia – GDP growth and agriculture value-added growth in relation to major droughts





The new 2015 international commitments recognize the large impact of disasters and call for urgent action

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Achieving food security and the eradication of hunger in developing countries is compromised when disasters reduce the availability of food, cause unemployment and income loss, inflate food prices and restrict people's access to food

It is necessary to anchor resilience and risk reduction in agriculture development plans and investments in order to reduce damage and losses and build resilience in food production systems

Chapter IV

Core findings, conclusions and the way forward

Damage and losses on agriculture due to disasters need to be better recorded at the country level in national disaster loss databases

4.1 Summary of core findings

Despite existing data gaps, the study applied various approaches and methodologies to assess disaster impact on agriculture in developing countries. The findings provide new insights into trends in damage and losses, approximations of quantified losses over the past decade and the wider implications for livelihoods and national economies. The study sheds further light on “what is at stake” when it comes to the real cost of disasters to agriculture.

Some of the study’s key findings include:

- The economic impact of disasters on agriculture is not yet well enough understood or reported. Limited statistics are available at the global, regional and national levels, while a lack of reporting at the country level further limits the availability of data. This is particularly the case for the fisheries, forestry and natural resources subsectors.
- For the agriculture sector in particular, indirect losses (i.e. post-disaster production losses and changes in economic flows) are on average higher than direct damage (i.e. destruction of physical agricultural assets and infrastructure) caused by disasters.
- Different types of disasters have significantly differing effects on the agriculture sector and its subsectors, and across countries and regions, which requires tailored risk reduction interventions in terms of policy, planning and financial investments in prevention and sustainable post-disaster recovery responses.
- One-quarter of the economic impact of climate-related disasters directly affects the agriculture sector. In the case of droughts, as much as 84 percent of resulting damage and losses are to the sector.
- At least USD 80 billion in crop and livestock production has been lost in developing countries over the past decade after disasters.
- These production losses correspond to 333 million tonnes of cereals, pulses, meat, milk and other commodities, which has direct implications for food security in developing countries. The production losses correspond to an average 7 percent loss in DES available per capita in the countries affected.
- When disasters affect the agriculture sector, they can have far-reaching negative consequences beyond physical damage; they: (i) lower production and productivity; (ii) decrease exports of agricultural commodities and increase food imports, causing an disequilibrium in the balance of trade and in the balance of payments in affected countries; and (iii) arrest agriculture sector growth and the sustainable development of the sector. In addition, production losses can directly impact on manufacturing such as on agro-industries that depend on agricultural commodities and raw materials. This wider impact can derail sector growth and resonate across national economies.
- More than one-third of all developing countries have been affected by at least three medium- or large-scale disasters between 2003 and 2013. Recurrent disasters continually cause damage and losses to agriculture, undermining sustainable agriculture, growth and food security.
- Achieving sustainable agricultural development and food security is at serious risk in countries with recurrent disasters and where the agriculture sector drives economic growth and prosperity, employing and feeding the majority of the vulnerable populations affected.

4.2 Financial resource flows to the agriculture sector and to disaster risk reduction

Reviewing these core findings calls for an analysis of the financial resource flows to the agriculture sector, in relation to government expenditure, official development assistance and humanitarian aid⁷⁷. There are several reports and datasets that examine financial flows to agriculture and, separately, financial flows to disaster risk reduction.

Despite trends in rising human and economic losses, growth in funding for disasters has been moderate over the last two decades

They indicate that despite trends in rising human and economic losses, growth in funding for disasters has been moderate over the last two decades. Based on data from the Disaster Aid Tracking database, which includes ex-ante and ex-post disaster-related development and humanitarian aid from public and private donors, ODI reported that the share allocated to disaster risk reduction across all sectors was particularly low between 1991 and 2010, corresponding to an average of 0.4 percent of total development assistance⁷⁸.

However, there is no comprehensive study on the links between disaster impact on agriculture and investments made in risk reduction within the sector.

In the absence of this, the following is a summary of financial resource flows under different funding streams⁷⁹ to the agriculture sector and disaster risk reduction and management in the context of natural hazards.

Humanitarian aid

Between 2003 and 2013, roughly USD 121 billion was spent on humanitarian assistance for all types of disasters and crises⁸⁰. About 3.4 percent was directed to the agriculture sector, averaging about USD 374 million annually⁸¹.

Just 3.4% of the estimated USD 121 billion spent on humanitarian aid between 2003 and 2013 was directed to the agriculture sector

In the same period, about USD 20 billion was allocated to all sectors for humanitarian assistance after disasters triggered by natural hazards – about USD 1.8 billion per year⁸². Alone the estimated crop and livestock production losses recorded after the 140 analysed disasters triggered by natural hazards in developing countries amounted to USD 80 billion or more than USD 7 billion per year over the same period⁸³.

Official development assistance

Only 4.2 percent of total official development assistance was spent on agriculture between 2003 and 2012 – less than half of the United Nations target of 10 percent. On average, the sector received less than USD 6 billion per year between 2003 and 2012⁸⁴. Development funding represents an essential resource flow for enhancing resilience to drive the sustainable development of agriculture. The gap between allocation and targets over the last decade calls for increased funding to agricultural risk-sensitive development, especially given the increasing impact of disasters, particularly those related to climate.

77 Private sector investments represent an essential contribution to agricultural development. For the purpose of this report, however, the analysis of financial flows focused only on government spending, official development assistance and humanitarian aid.

78 ODI. 2015. *Financing for disaster risk reduction. Ten things to know.*

79 When comparing financial flows to agriculture with disaster damage and losses to agriculture, it must be noted that the former includes the provision of agricultural inputs for crops that are expected to generate value added throughout the different phases of production. Also, agriculture may benefit indirectly from resources allocated to other sectors. For example, funds allocated to the health sector may bring benefits to populations depending on agriculture, which translate into benefits for the agriculture sector.

80 Data based on the United Nations Office for the Coordination of Humanitarian Assistance Financial Tracking Service. Data refers to all crises.

81 Data based on Financial Tracking Service. Data refers to all crises.

82 Data based on Financial Tracking Service. Data refers to natural hazards only.

83 Estimated crop and livestock production losses are likely to be conservative as the analysis focused on selected commodities affected by medium- and large-scale disasters. Furthermore, fisheries and forestry production losses after disasters are not included in the estimation of production losses.

84 Data based on the Organisation for Economic Co-operation and Development (OECD) Creditor Reporting System. Official development assistance is from all donors to all developing countries in constant 2012 prices.

In African countries, agriculture represented just 3–6% of government spending despite the severe damage and losses caused by disasters to the sector

Government expenditure

Although, globally, government spending on agriculture increased from 1980 to 2007, agricultural expenditure as a share of total public expenditure has shown the opposite trend in all regions except Europe and Central Asia⁸⁵. In African countries, despite the severe damage and losses caused by drought to agriculture and wider impact on national economies, agriculture's share of government spending was about 3–6 percent (2003 to 2007), lower than the 10 percent (except in the 1980s) target to which African governments agreed in 2003 when signing the Maputo Declaration⁸⁶. Much higher investments should be expected in countries where agriculture is a vital source of livelihoods, income, employment and food, a key driver of economic prosperity, and where disasters stunt sector and national economic growth, and consequently arrest progress in eliminating hunger, food insecurity and poverty.

As illustrated in this study, **disasters exact a heavy toll on the agriculture sector in developing countries, as they often affect agricultural production with cascading negative consequences for national economies**. At the same time, the above-mentioned trends suggest that the sector received a relatively low share of total resource flows over the analysed period. However, further analysis is needed to make a meaningful comparison between resource flows to agriculture and the impact of disasters on the sector.

Enhanced coherence between humanitarian, development and government investment is needed to effectively enhance the resilience of agriculture

Enhanced coherence and synergies between humanitarian, development and government investment are needed to effectively enhance the resilience of agriculture and address the underlying drivers of risks affecting farmers, pastoralists, fishers and forest- and tree-dependent people, eventually preventing and/or mitigating the damage and losses caused by disasters to agriculture. Further work is needed to quantify the cost-benefit ratio of investing in disaster risk reduction in agriculture compared with: (i) other kinds of agriculture sector investments; and (ii) post-disaster support to the sector. There is some evidence to suggest that investing in disaster risk reduction in agriculture is more cost-effective in terms of reducing the impact of natural hazards than other kinds of investments⁸⁷; however, the evidence base for this must be strengthened in order to present a convincing case.

4.3 Conclusions, recommendations and the way forward

While this study helps to fill information gaps regarding the impact of disasters on agriculture, two core challenges need to be addressed: (i) improving information systems at the global, national and local levels; and (ii) further strengthening resilience through higher investments in agriculture.

Improving information systems on disaster impact for agriculture

- Address and overcome the still significant data gaps at the global, regional, national and subnational levels in order to gain a full and coherent understanding of the magnitude and diversity of disaster impact on agriculture and its subsectors, and to better inform resilient and sustainable sectoral development planning, implementation and funding and the development of innovative risk insurance schemes for agriculture and rural livelihoods.
- Improve global and regional databases and information systems based on national data. The methodology for assessing impact on the sector should be improved to better capture the full extent of disaster impact on agriculture, its subsectors, the food value chain, food security, environment/natural resources/ ecosystem services associated with the sector, and national economies. This precision is necessary for the formulation of well-tailored policies and investments in the sector.
- Better record and standardize data collection, monitoring and reporting at the country level, including at the subnational level. Similarly, advise on the capacity available to do so, which must be strengthened for general disaster risk management and agriculture sector risk management. This can be achieved through collaboration among relevant national institutions such as Ministries of Agriculture, Forestry and Fisheries and their departments, National Emergency Management Agencies and National Bureau of Statistics.
- At the global and national levels, systematically use damage and loss information to monitor and measure progress in achieving the resilience goals and targets of the SDGs, the Sendai Framework for Disaster Risk Reduction 2015–2030, and the Universal Climate Change Agreement that is expected under the United Nations Framework Convention on Climate Change.

85 Based on the Statistics for Public Expenditure for Economic Development database from the International Food Policy Research Institute, which covers 67 countries – 13 of these are high-income non-OECD countries and 54 are classified as low- or middle-income countries.

86 African Union. 2003. Maputo Declaration on Agriculture and Food Security in Africa.

87 ODI and World Bank, 2015. Unlocking the triple dividend of resilience. Why investing in disaster risk management pays off; Kelman. 2012. Disaster Mitigation is Cost-Effective. World Development Report: Background Paper; Vorhies. 2012. The Economics of Investing in Disaster Risk Reduction. Working paper based on a review of the current literature commissioned by UNISDR. Geneva: Secretariat to the United Nations International Strategy for Disaster Reduction.

Strengthening resilience through higher investments in agriculture

- Disaster risk reduction and management (the backbone of resilience) must be systematically embedded into agriculture sectoral and subsectoral development plans and investments, particularly in countries facing recurrent disasters and where agriculture is a critical source of livelihoods, food security and nutrition, as well as a key driver of economic growth.
- Increased financial resources should be directed to the agriculture sector in developing countries from national governments, the private sector and development assistance in a manner that is more consistent with the sector's crucial role in eradicating hunger and achieving food security, sustainable agricultural development and economic growth.
- Humanitarian aid to the agriculture sector should better reflect the impact of disasters on the sector. Disaster risk reduction and management strategies should be fully integrated into post-disaster recovery efforts in the sector to ensure that investments in disaster response and recovery also build resilience to future shocks rather than recreating the risks faced by the sector.
- National governments and the international community should establish targets for financing disaster risk reduction in the agriculture sector in order to prevent and mitigate the impact of disasters.

The explicit inclusion of resilience in the 2015 SDGs is a critical move that is expected to provide a major push along the path to resilient and sustainable agriculture

The Sendai Framework is expected to galvanize and reinforce efforts to mainstream risk reduction across the agriculture sector

The way forward

It is promising that three key international commitments at the top of the global agenda in 2015 recognize the significant impact of disasters and the vital importance of resilience. In particular, the explicit inclusion of resilience in the 2015 SDGs is expected to provide a major push along the path to resilient and sustainable agriculture. Two Goals in particular are of relevance to the agriculture sector: Goal 2 which strives to “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture” and is supported by target 2.4 which seeks, by 2030, to “ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality”; and Goal 13 on combating climate change and its impacts, with its target 13.1 which seeks to “strengthen resilience and adaptive capacity to climate-related hazards and disasters in all countries”⁸⁸. This is a critical goal and target for the agriculture sector given its extreme vulnerability to climate variability and change.

Another milestone is the recently agreed Sendai Framework for Disaster Risk Reduction 2015–2030, the successor to the 2005 Hyogo Framework for Action, which is the primary global instrument for disaster risk reduction. The Sendai Framework has renewed international commitment and reflects an enhanced framework that builds on lessons learned and good practices worldwide. Furthermore, it is expected to galvanize and reinforce efforts to mainstream risk reduction across the agriculture sector, particularly in view of its core outcome: “the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries”.

Finally, the Universal Climate Change Agreement that is emerging under the United Nations Framework Convention on Climate Change is also expected to further progress on resilience, in particular through SDG Goal 13 on combating climate change and its impacts, and its related target 13.1. A parallel initiative is the Warsaw International Mechanism for Loss and Damage – the main vehicle for addressing loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change.

For all three global commitments, monitoring the achievement of agreed targets on resilience as they relate to agriculture depends on the availability of data at the country and global levels on the impact of disasters on the sector. In order to meet this challenge and close the information gap, and as part of FAO's corporate commitment to resilience and the three global agendas, the Organization will help improve monitoring and reporting of disaster impact on the agriculture sector by supporting Member Nations to collect and report relevant data and by enhancing the methodology applied to measure, at the global level, the impact of disasters on the agriculture sector; for example, by improving statistical analysis and increasing the number of countries, disasters and commodities analysed.

⁸⁸ In addition to the two goals mentioned, resilience is included in other SDGs, including: Goal 1: End poverty in all its forms everywhere; Goal 6: Ensure availability and sustainable management of water and sanitation for all; Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all; Goal 12: Ensure sustainable consumption and production patterns; Goal 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development; and Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. See also FAO. 2015. *FAO and the 17 Sustainable Development Goals*.

《 ANNEXES

Annex 1. Glossary

Adaptation: The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. (UNISDR, 2009)

Damage: The total or partial destruction of physical assets and infrastructure in the disaster-affected areas, in terms of their monetary value expressed as the replacement cost. (EC, World Bank, UN, 2013)

Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. (UNISDR, 2009)

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. (UNISDR, 2009)

Drought: The term drought may refer to meteorological drought (precipitation well below average), hydrological drought (low river flows and water levels in rivers, lakes and groundwater), agricultural drought (low soil moisture), and environmental drought (a combination of the above). (IPCC, 2007)

Food security and nutrition: A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Hazard: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. (UNISDR, 2009)

Losses: Changes in economic flows arising from the disaster which continue until the achievement of full economic recovery and reconstruction. Typical losses for the agriculture sector include the decline in production of agriculture, livestock, fisheries/aquaculture and forestry and possible higher costs of production in them and lower revenues and higher operational costs in the provision of services. (EC, World Bank, UN, 2013)

Natural hazard: Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. (UNISDR 2009)

Resilience: For FAO, “resilience to shocks” is the ability to prevent and mitigate disasters and crises as well as to anticipate, absorb, accommodate or recover and adapt from them in a timely, efficient and sustainable manner. This includes protecting, restoring and improving livelihoods systems in the face of threats that impact agriculture, food and nutrition (and related public health). (FAO, 2013)

Risk: The combination of the probability of an event and its negative consequences. (UNISDR, 2009)

Sustainable development: The concept of sustainable development was introduced in the World Conservation Strategy (IUCN 1980) and had its roots in the concept of a sustainable society and in the management of renewable resources. Adopted by the WCED in 1987 and by the Rio Conference in 1992 as a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. sustainable development integrates the political, social, economic and environmental dimensions. (IPCC, 2007)

Annex 2. List of countries included in the quantitative analysis of production losses and changes in economic flows after disasters (Chapter II).

The following list includes all countries considered in the analysis of crop and livestock production losses, changes in trade flows and changes in agriculture value-added growth after disasters (Chapter II of this report).

Out of these, 67 countries were included in the analysis as they experienced at least one medium-to-large scale disaster affecting 250 000 people or more between 2003 and 2013 (based on data from EM-DAT CRED).

The selected countries are highlighted in bold.

Africa	Angola, Benin , Botswana, Burkina Faso, Burundi , Cabo Verde, Cameroon, Central African Republic, Chad, Comoros , Congo, Côte d’Ivoire, Democratic Republic of the Congo, Djibouti , Equatorial Guinea, Eritrea, Ethiopia , Gabon, Gambia, Ghana , Guinea, Guinea-Bissau, Kenya, Lesotho , Liberia, Madagascar, Malawi, Mali, Mauritania , Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria , Réunion, Rwanda , Saint Helena, Sao Tome and Principe, Senegal , Seychelles, Sierra Leone, Somalia, South Africa , South Sudan, Sudan, Swaziland , Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe .
Asia and the Pacific	Afghanistan, Bangladesh , Bhutan, Brunei Darussalam, Cambodia, Democratic People’s Republic of Korea, India, Indonesia, Iran (Islamic Republic of) , Kazakhstan, Kyrgyzstan, Lao People’s Democratic Republic , Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines , Republic of Korea, Sri Lanka, Tajikistan, Thailand , Timor-Leste, Turkmenistan, Uzbekistan, Viet Nam .
Latin America and the Caribbean	Anguilla; Antigua and Barbuda; Argentina ; Aruba; Bahamas; Barbados; Belize; Bolivia (Plurinational State of) ; Bonaire; Sint Eustatius and Saba; Brazil ; British Virgin Islands; Cayman Islands; Chile, Colombia ; Costa Rica; Cuba ; Curaçao; Dominica; Dominican Republic; Ecuador, El Salvador ; Falkland Islands (Malvinas); French Guiana; Grenada; Guadeloupe; Guatemala, Guyana, Haiti, Honduras, Jamaica ; Martinique; Mexico ; Montserrat; Nicaragua; Panama; Paraguay, Peru ; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Martin (French Part); Saint Vincent and the Grenadines; Saint Barthélemy; Sint Maarten (partie néerlandaise); Suriname; Trinidad and Tobago; Turks and Caicos Islands; United States Virgin Islands; Uruguay; Venezuela (Bolivarian Republic of).
Near East	Iraq, Israel , Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Palestine, Syrian Arab Republic, Turkey , United Arab Emirates, Yemen.

Annex 3: List of countries and disasters covered by the 78 post-disaster needs assessments reviewed in the study (Chapter I)

The following list includes all countries and disasters covered by the PDNAs reviewed in Chapter I of the study. A PDNA is a government-led exercise with the support of relevant international organizations, for assessing economic damages and losses, and the recovery priorities in each sector after large-scale disasters.

Region	Countries	Number of disasters
Africa	13	13
Asia and the Pacific	15	27
Latin America and the Caribbean	19	37
Eastern Europe	1	1
Total	48 countries	78 disasters

Country	Type of disaster and name	Year	Country	Type of disaster and name	Year
Bahamas	Hurricanes Frances and Jeannes	2004	El Salvador	Tropical storm Stan and eruption of Llamatepec volcano	2005
Bangladesh	Cyclone	2007		Tropical storm Ida	2009
Belize	Hurricane Dean	2007		Tropical storm Agatha	2010
	Tropical Depression 16	2008	Fiji	Tropical cyclone Evan	2012
	Tropical storm Arthur	2008	Grenada	Hurricane Ivan	2004
Benin	Flood	2010	Guatemala	Tropical storm Stan	2005
Bhutan	Earthquake	2011		Tropical storm Agatha and volcano Pacay	2010
Bolivia	La Nina	2008		Tropical Depression 12E	2011
Burkina Faso	Flood	2009	Guyana	Floods	2005
Cambodia	Cyclone	2009		Floods	2006
	Floods	2013	Haiti	Hurricane Jeanne	2004
Cayman Islands	Hurricane Ivan	2004		Tropical storm Fay, Hurricanes Gustav, Hanna and Ike	2008
	Hurricane Paloma	2008		Earthquake	2010
Central African Republic	Flood	2009	India	Tsunami	2004
Colombia	Ola invernal	2010–2011		Flood, Bihar	2008
Djibouti	Drought	2008–2011	Indonesia	Tsunami	2004
Dominica	Hurricane Dean	2007		Earthquake	2006
Dominican Republic	Floods	2003		Floods, Aceh	2006
	Hurricane Jeanne	2004		Earthquake (West Sumatra)	2009
	Tropical storm Noel	2008			

Country	Type of disaster and name	Year	Country	Type of disaster and name	Year
Jamaica	Hurricane Ivan	2004	Pakistan	Cyclones and floods, Balochistan and Sindh	2007
	Tropical storm Gustav	2008		Flood	2011
Kenya	Drought	2008–2011		Flood, Sept	2012
				Flood	2010
Lao People's Democratic Republic	Typhoon	2011	Philippines	Cyclone, Ondoy and Pepeng	2009
	Cyclone (Ketsana 2009 and Flood, Kammuri 2008)	2009		Typhoon Haiyan	2013
Lesotho	Flood	2011	Saint Lucia	Hurricane Dean	2007
Madagascar	Cyclones: Fame, Ivan, Jokwe	2008		Floods	2013
Malawi	Flood	2012	Saint Vincent and Grenadines	Floods	2013
Maldives	Tsunami	2004	Samoa	Tsunami	2009
Mexico	Hurricane Stan	2005		Cyclone	2012
	Floods in Tabasco	2007	Senegal	Flood	2009
	Lluvias extremas in Tabasco	2008	Seychelles	Flood	2013
	Hurricane Wilma	2005	Sri Lanka	Tsunami	2004
	Hurricane Emily	2005	Suriname	Floods	2006
Moldova	Flood	2010	Thailand	Floods	2011
Myanmar	Cyclone, Nargis	2008	Togo	Flood	2010
Namibia	Flood	2009	Turks and Caicos islands	Tropical storm Hanna and Hurricane Ike	2008
Nicaragua	Hurricane Felix	2007	Uganda	Drought	2010–2011
Pakistan	Earthquake	2005	Yemen	Tropical storm 03B	2008

Annex 4. Droughts and population affected in Africa by subregion, by country, and by decade, 1980–2013 (Chapter III)

Northern Africa					Northern Africa				Total Pop Affected	
1980s		1990s		2000s		2010s				
Country	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected		
Algeria	1981	-		-	2005	105 000		-	380 000	
Morocco	1983, 1984	-	1999	275 000		-		-		
Tunisia	1988	-		-		-		-		
Total		-		275 000		105 000		-		
Western Africa					Western Africa				Total Pop Affected	
1980s		1990s		2000s		2010s				
Country	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected		
Benin	1983	2 100 000		-		-		-	74 542 255	
Burkina Faso	1980, 1988	1 450 000	1990, 1995, 1998	2 696 290	2001	-	2011, 2014	6 850 000		
Cabo Verde	1982	-	1992, 1998	10 000	2002	30 000		-		
Chad	1981	1 500 000	1993, 1997	656 000	2001, 2009	3 200 000	2012	1 600 000		
Côte d'Ivoire	1983	-		-		-		-		
Gambia	1980	500 000		-	2002	-	2012	428 000		
Ghana	1983	12 500 000		-		-		-		
Guinea	1981	-	1998	-		-		-		
Guinea Bissau	1982	-		-	2002, 2006	132 000		-		
Liberia	1983	-		-		-		-		
Mali	1980	1 500 000	1991	302 000	2001, 2005, 2006	1 025 000	2010, 2011	4 100 000		
Mauritania	1980	1 600 000	1993, 1997	467 907	2001	1 000 000	2010, 2011	1 538 000		
Niger	1980, 1988	4 500 000	1990, 1997	1 638 500	2001, 2005, 2009	14 484 558	2011	3 000 000		
Nigeria	1983	3 000 000		-		-		-		
Senegal	1982	1 200 000		-	2002	284 000	2011	850 000		
Togo	1983, 1989	400 000		-		-		-		
Total		30 250 000		5 770 697		20 155 558		18 366 000		
Eastern Africa					Eastern Africa					Total Pop Affected
1980s		1990s		2000s		2010s				
Country	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected		
Burundi		-	1999	650 000	2003, 2005, 2008, 2009	2 412 500	2011	-	203 022 254	
Djibouti	1980, 1983, 1988	255 000	1996	100 000	2001, 2005, 2007, 2008	632 750	2010	200 258		
Eritrea	1993, 1999	-		3 900 000	2008	1 700 000		-		
Ethiopia	1983, 1987, 1989	21 250 000	1997, 1998, 1999	5 886 200	2003, 2005, 2008, 2009	27 800 000	2011, 2012	5 805 679		
Kenya	1984	600 000	1991, 1994, 1997, 1999	28 500 000	2004, 2005, 2008	9 600 000	2011, 2014	9 650 000		
Rwanda	1984, 1989	480 000	1996, 1999	976 545	2003	1 000 000		-		
Somalia	1980, 1983, 1987, 1988	553 500		-	2000, 2004, 2005, 2008	4 700 000	2010, 2012, 2014	7 350 000		
Sudan	1980, 1983, 1987	11 850 000	1990, 1991, 1996	9 360 000	2000, 2009	6 300 000	2012	3 200 000		
United Republic of Tanzania	1984, 1988	2 010 000	1991, 1996	3 800 000	2003, 2004, 2006	5 854 000	2011	1 000 000		
Uganda	1987	600 000	1998, 1999	826 000	2002, 2005, 2008	2 355 000	2011	669 000		
Total		37 598 500		62 026 949		71 654 250		31 742 555		
Central Africa					Central Africa					Total Pop Affected
1980s		1990s		2000s		2010s				
Country	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected		
Cameroon		-	1990	186 900	2001, 2005	-		-	579 900	
Central African Republic	1983	-		-		-		-		
Congo	1983	-		-		-		-		
DR Congo	1984	300 000		-		-		-		
Sao Tome and Principe	1983	93 000		-		-		-		
Total		393 000		186 900		0		0		
Southern Africa					Southern Africa				Total Pop Affected	
1980s		1990s		2000s		2010s				
Country	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected	Year	Total Pop Affected		
Angola	1981, 1985, 1989	2 480 000	1997	-	2001, 2004	25 000	2012	1 833 900	86 269 729	
Botswana	1982	1 037 300	1992	100 000	2005	-		-		
Comoros	1981	-		-		-		-		
Lesotho	1983	500 000	1992	331 500	2002, 2007	975 000	2011	725 515		
Madagascar	1981, 1988	1 950 000		-	2000, 2002, 2005, 2008	1 565 290		-		
Malawi	1987	1 429 267	1990, 1992	9 800 000	2002, 2005, 2007	8 449 435	2012	1 900 000		
Mauritius		-	1999	-		-		-		
Mozambique	1981, 1987	4 758 000	1991, 1998	3 300 000	2001, 2002, 2003, 2005, 2007, 2008	3 239 500	2010	460 000		
Namibia	1982	-	1991, 1995, 1998	438 200	2001, 2002	345 000	2013	331 000		
South Africa	1980, 1982, 1986, 1988	2 170 000	1991, 1995	300 000	2004	15 000 000		-		
Swaziland	1983, 1984	-	1990	250 000	2001, 2007	1 380 000		-		
Zambia	1982, 1983	-	1991, 1995	2 973 204	2005	1 200 000		-		
Zimbabwe	1982	-	1991, 1998	5 055 000	2001, 2007	8 100 000	2010, 2013	3 867 618		
Total		14 324 567		22 547 904		40 279 225		9 118 033		

Annex 5. Methodology for the quantitative analysis of production losses and changes in economic flows after disasters (Chapter II)

A1. Selection of natural hazards

The identification of major natural hazards that occurred in developing countries between 2003 and 2013 was based on the data reported by the EM-DAT CRED. The database is compiled from various sources, including United Nations agencies, Non-governmental Organizations, insurance companies, research institutes and press agencies.

Five types of natural hazards reported in EM-DAT CRED were considered in the analysis based on their relevance for agriculture and likely impact on the sector. These include: (1) droughts; (2) floods; (3) storms (including tropical cyclones, typhoons and hurricanes); (4) earthquakes; and (5) volcanic eruptions. These disasters are defined by EM-DAT CRED as follows:

- Drought: An extended period of unusually low precipitation that produces a shortage of water for people, animals and plants.
- Flood: The overflow of water from a stream channel onto normally dry land in the floodplain (riverine flooding), higher-than-normal levels along the coast and in lakes or reservoirs (coastal flooding) as well as ponding of water at or near the point where the rain fell (flash floods).
- Storm: A tropical storm originates over tropical or subtropical waters and is characterized by a warm-core, non-frontal synoptic-scale cyclone with a low pressure center, spiral rain bands and strong winds. Depending on their location, tropical cyclones are referred to as hurricanes (Atlantic, Northeast Pacific), typhoons (Northwest Pacific), or cyclones (South Pacific and Indian Ocean).
- Earthquake: Sudden movement of a block of the Earth's crust along a geological fault and associated ground shaking.
- Volcanic Eruption: A type of volcanic event near an opening/vent in the Earth's surface including volcanic eruptions of lava, ash, hot vapor, gas, and pyroclastic material.

The selection of natural hazards was further narrowed to medium-to-large scale disasters that are likely to have an impact on national agricultural production figures. The total number of people affected as reported by EM-DAT CRED is used as a proxy indicator for the intensity of natural hazards. The disasters included in the analysis are limited to those having affected 250 000 people or more. For countries affected by more than one medium-to-large scale disaster, the selection was further narrowed to disasters with total population affected above the average¹.

The approach followed for the selection of natural hazards is subject to some key limitations, including:

- The inclusion of a disaster in the EM-DAT CRED requires compliance with a number of criteria, including: (1) Ten or more people reported killed; (2) Hundred or more people reported affected; (2) Declaration of a state of emergency; and (4) Call for international assistance. As a result, the list of disasters included in the database is likely to be incomplete.
- Small disasters are excluded from the analysis. Although the impact of small disasters on agriculture and food security is extremely relevant, the selection had to be limited to major disasters whose impacts on agriculture production are visible in national statistics. Additional research and data collection at subnational level should be conducted in order to capture the impact of smaller disasters.
- The minimum threshold of 250 000 people affected may have led to the exclusion of some disasters occurred in small countries, where total population affected was high in relative terms, but still below the absolute threshold.

¹ An exception was made for droughts, as all droughts affecting 250 000 people or more were included in the analysis.

A2. Assessment of agriculture production losses after natural hazards

The analysis of production losses is focused on four main categories of crop and livestock commodities, which were selected based on data availability and cross-country comparability criteria, as well as considering their relevance for food security, sectoral growth, rural income and farmers' livelihoods in the countries analysed. These include (1) cereals²; (2) pulses³; (3) key livestock commodities⁴; and (4) other commodities, including cash and staple crops selected at country level based on total production quantities and values, or specifically mentioned in country assessments as being impacted by disasters. The assessments reviewed for the identification of key affected commodities include, among others, PDNAs, Crop and Food Security Assessment Missions, Emergency Food Security Assessments.

The quantitative assessment of production losses was made by analysing yields and production time series at the country level, using data from FAOSTAT. As a first step, production losses were calculated in tonnes as follows:

- Cereals, pulses and other crop commodities losses were estimated by calculating decreases in crop yields in the year of disaster and in the subsequent year, compared with the long-term yield linear trend (1980–2013). The resulting yield losses were then multiplied by the area harvested in order to obtain lost production quantities (in tonnes) after each disaster and for each commodity.
- Livestock production losses (in tonnes) were estimated by calculating decreases in total production of each livestock commodity in the year of disaster and in the subsequent year, compared with long-term production linear trend (1980–2013).

Losses in tonnes were multiplied by producer prices in order to estimate the monetary value of production losses and hence to obtain an estimation of the economic impact on local producers. Results are presented as absolute monetary value of losses, and as percentage of the total expected production value (i.e. linear trend value) of the analysed commodities in the year of disaster and subsequent year.

Data on producer prices were extracted from FAOSTAT, which reports prices received by farmers for primary crops, live animals and livestock primary products as collected at the farm gate or at the first point of sale. Several data gaps are found in national producer prices time series. To overcome price data limitations, a regional producer price series was constructed for each commodity, as the average of prices available for the analysed countries in each region (weighted by GDP)⁵. Further, regional producer price series were converted from nominal to constant values (2004–2006, USD) using aggregated producer price indices. Aggregated regional constant price series served the triple purpose of (1) facilitating comparison across subregions, (2) facilitating comparison across decades, and (3) filling price data gaps at the country level.

Finally, production losses in tonnes were also converted into calories. The caloric content of crop and livestock commodities was derived from FAO Food Composition Tables for international and regional uses. These include:

- FAO Food Composition Table for International Use⁶;
- FAO Food Composition Table for Use in Africa⁷;
- FAO Food Composition Table for Use in East Asia⁸;
- INCAP's Food Composition Table for Use in Central America⁹;
- FAO Food Composition Table for the Near East¹⁰.

Calorie losses are reported as share of per capita DES at the national level. DES is a food security indicator calculated by FAO. It provides an indication of national average energy supply, expressed in calories per caput per day. Results are presented as the share of DES lost after each disaster at the regional level (average of national DES losses).

Importantly, the conversion of production losses into per capita DES should be used for comparative purposes only,

² Barley; fonio; maize; millet; oats; paddy rice; rye; sorghum; wheat; and other cereals not elsewhere specified.

³ Bambara beans; broad beans and horse beans; chickpeas; cowpeas; lentils; lupins; peas; pigeon peas; vetches; and other pulses not elsewhere specified.

⁴ Cattle meat; goat meat; pig meat; sheep meat; cow milk; goat milk; sheep milk.

⁵ For years when no price data are available, prices were derived using regional aggregated producer price indices for livestock, cereals and pulses. These indices were constructed as a weighted average of aggregated cereals, pulses and livestock producer price indices at the country level (based on data from FAOSTAT).

⁶ <http://www.fao.org/docrep/x5557e/x5557e00.htm>

⁷ <http://www.fao.org/docrep/003/x6877e/x6877e00.htm>

⁸ <http://www.fao.org/docrep/003/x6878e/x6878e00.htm>

⁹ http://www.incap.int/index.php/es/?option=com_docman&task=doc_details&gid=80&Itemid=268

¹⁰ <http://www.fao.org/docrep/003/x6879e/x6879e00.HTM>

as production losses after disasters do not necessarily translate into an equivalent loss of per capita energy supply. Indeed, production shortfalls may be compensated in several ways in order to reduce the negative impacts on food security, including, among others: (1) increases in commercial imports and food aid; (2) use of stocks; (3) increase in supply of non-affected commodities. The effectiveness of these measures would largely depend on the capacity of each country to respond to disaster impacts on agriculture, on a case-by-case basis.

This methodology is subject to some limitations that should be kept in mind when analysing results, including:

- Several data gaps are found in national producer price time series. Regional producer price series were constructed to overcome data limitations. However, regional series may hide important differences across national prices.
- The impact of disasters on agriculture production could not be separated from other possible drivers (e.g. conflicts, international price trends, public policies). Additional research is needed to isolate disasters' impacts as much as possible from other potential idiosyncratic factors that may have an influence on crop yields and livestock production.
- While the analysis focuses only on production losses, it is acknowledged that production of some commodities may have increased after disasters. For example, production of resistant crop varieties may have increased in the aftermath of disasters to substitute losses in affected crops. The analysis of substitution effects between agricultural commodities after disasters is outside the scope of this study.
- The analysis is limited to selected crop and livestock commodities, and it excludes disasters' impacts on fisheries and forestry production. Consequently, total production losses in the agriculture sector are likely to be higher than reported. Additional research should be conducted to cover all sectors and commodities.

A3. Assessment of changes in trade flows after natural hazards

The analysis of changes in agricultural trade flows after disasters focused on four commodities, including two crop commodities, namely cereals and pulses, and two livestock commodities, namely milk and meat.

The assessment aims to quantify increases in the monetary value of imports and decreases in the monetary value of exports of selected commodities after disasters. FAOSTAT data on the value of imports and exports by commodity (USD) was used to conduct the assessment. The value of exports is mostly reported as Freight on Board and calculated as the annual amount actually paid for the given commodity when sold for exportation to the compiling country. The value of imports is mostly reported as Cost Insurance and Freight and calculated as the annual amount actually paid for the given commodity when purchased for importation from the compiling country. Imports for re-export as well as food aid imports are comprised in total imports. The monetary value of imports and exports was deflated to ensure meaningful comparison across the time period analysed.

Increases in imports were calculated as increases in the monetary value of imports in the year of disaster and following year, compared to the long-term linear trend value (1980–2011). The reported figures correspond to the difference between the actual value of imports in disaster year and following year, and the linear trend value in those same years. When the linear trend value was higher than the actual import value, no increases in imports were accounted.

Similarly, decreases in exports were calculated as decreases in the monetary value of exports in the year of disaster and following year, compared to the long-term linear trend (1980–2011). Decreases in exports correspond to the difference between the linear trend value in disaster year and following year, and the actual value of exports in those same years. When the actual export value was higher than the linear trend value, no decreases in exports were accounted.

Results are presented as absolute monetary values of increases in imports and decreases in exports, and as the percentage of the total expected value of imports and value of exports (i.e. linear trend value) of the analysed commodities in the year of disaster and subsequent year.

Key limitations include:

- Since only a restricted number of agricultural commodities have been included in the analysis, results should be considered to be highly conservative. Additional research should be conducted on changes in trade flows of other agricultural commodities. In particular, research should be conducted on cash crop trade flows after disasters, considering their importance for export revenues in many developing countries.
- Food aid is mixed with agricultural commercial imports. Therefore, part of the increases in imports reported is attributable to post-disaster relief operations. While the cost of food aid is part of the economic impacts of disasters, it should be separated from the impact on national trade flows, and included in a separate analysis.
- The analysis is conducted exclusively at the national level. Therefore, considerations on post-disaster trade balance at subregional, regional or global level are outside the scope of the assessment. Additional research should be conducted to cover these aspects.
- Several concurring factors might determine the analysed changes in trade flows. In-depth research at the national level should be conducted in order to further explore the role played by disasters in the observed changes.
- Due to lack of data on import and export values, the time frame is only until 2011. Therefore, the sample of countries and disasters analysed is smaller than in the analysis of production losses.

A4. Assessment of changes in agriculture value-added growth after natural hazards

The assessment of changes in agriculture value-added growth after disasters was conducted using data from the World Bank's World Development Indicators. The indicators used for quantifying sectoral growth losses are:

- Agriculture, value added (annual growth in percentage), indicating the annual growth rate for agricultural value added based on constant local currency¹¹.
- Agriculture, value added (percentage of GDP), corresponding to the percentage contribution of agriculture value added to total GDP.
- GDP (constant 2005 USD), namely the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products¹².

Changes in agriculture value added annual growth after disasters were calculated as any decrease in actual growth rate in the year of disaster and following year, compared with the linear trend value (2003–2013) in the same years. Any drop in value added growth with respect to the linear trend value was accounted as a loss. In the case when value added growth rates in disaster years and subsequent years were found to be higher than the linear trend value, no losses were accounted.

Results are presented as average percentage losses in agriculture value added growth after each disaster. In cases when no losses occurred, disasters were assigned a zero value, and accounted in the average.

Key limitations include:

- World Bank data on agriculture value added and GDP is missing for some of the countries analysed. Therefore, the sample of countries and disasters analysed is smaller than in the analysis of production losses.
- The effect of disasters on agriculture growth was not separated from several other idiosyncratic factors that may have an influence on sectoral performance. Considering the complexity of macroeconomic dynamics within and across key economic sectors, quantifying the true impact of disasters on agriculture growth rates would be an extremely arduous task, especially for a global study. In-depth research should be conducted focusing on specific disasters and countries, in order to gain additional insights on the causal relationship between natural hazards and sector economic growth.

¹¹ Aggregates are based on constant 2005 USD. Agriculture corresponds to ISIC divisions 1–5 and includes forestry, hunting and fishing, as well as cultivation of crops and livestock production. See: <http://data.worldbank.org/indicator/NV.AGR.TOTL.KD.ZG>

¹² Data are in constant 2005 USD. Dollar figures for GDP are converted from domestic currencies using 2000 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used. See: <http://data.worldbank.org/indicator/NY.GDP.MKTP.KD?display=graph>

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http://www.desinventar.net/index_www.html

EMDAT-CRED database
<http://www.emdat.be/database>

FAOSTAT
<http://faostat.fao.org/>

World Bank World Development Indicators
<http://data.worldbank.org/data-catalog/world-development-indicators>

OECD Creditor Reporting System
<https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

Statistics of Public Expenditure for Economic Development (SPEED) database
<http://www.ifpri.org/blog/speed-public-expenditure-data-now-online>

OCHA Financial Tracking Service
<https://fts.unocha.org/>

www.fao.org/resilience

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