

# A SIGN OF THINGS TO COME?

## EXAMINING FOUR MAJOR CLIMATE-RELATED DISASTERS, 2010–2013, AND THEIR IMPACTS ON FOOD SECURITY

A preliminary study for Oxfam's GROW Campaign

CHRISTOPHER COGLAN,<sup>1</sup> MALIHA MUZAMMIL,<sup>1</sup> JOHN INGRAM,<sup>1</sup> JOOST VERVOORT,<sup>1,2</sup> FRIEDERIKE OTTO<sup>1</sup>, AND RACHEL JAMES<sup>1</sup>

<sup>1</sup> ENVIRONMENTAL CHANGE INSTITUTE, UNIVERSITY OF OXFORD

<sup>2</sup> CLIMATE CHANGE, AGRICULTURE AND FOOD SECURITY (CCAFS)

**This report analyses impacts of four extreme weather events (a heat wave in Russia, flooding in Pakistan, drought in East Africa, and a typhoon in the Philippines) on food security. For each case, the nature of the extreme weather is characterized, and its impact on vulnerable people is assessed by considering when and why threats emerge, and the role of governance in the state and non-state responses to the emergency. Scenarios of the plausible impacts of increased extreme weather severity on food security and other socioeconomic parameters are presented for each case.**

Related Oxfam-commissioned research includes [Climate Shocks, Food and Nutrition Security: Evidence from the Young Lives cohort study](#)

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# EXECUTIVE SUMMARY

From 2010 to 2013 the world experienced a number of extreme weather events, several of which were notable for their intensity, duration, and impacts on livelihoods and food security. This report focuses on four case studies – a heat wave in Russia, flooding in Pakistan, drought in East Africa, and a typhoon in the Philippines – that represent a range of extreme weather. It analyses the impact of these extreme weather events on food security, by considering when and why threats emerge. This involves characterization of the weather events, examination of the vulnerable groups affected, and analysis of livelihoods and the role of governance and capital.

In addition to their immediate impacts in the directly affected regions, this study demonstrates that weather events can be associated with impacts in other parts of the world. For example, the Russian heat wave, which occurred as a result of an atmospheric blocking high-pressure system, had both domestic and international effects: first, it dramatically reduced the wheat harvest in many parts of Russia, undermining resilience of farmers and reducing the national food supply; then, due to Russia banning wheat exports, world wheat prices increased, reducing poor people's access to food and, according to some analyses, contributing to the unrest in several of the states involved in the Arab Spring, which were dependent on Russian imports.<sup>1</sup> In the same year, Pakistan experienced higher monsoon rains, linked to the high pressure over Russia. This led to severe damage to crops, livestock, and markets in Punjab, and to extended flooding in Sindh, where the greatest impacts on health, housing, and infrastructure were experienced.

This study also identifies cases in which extreme weather events exacerbated existing unfavourable conditions, and events in which poor preparation resulted in greater harm. For example, in East Africa the failure of the long rains in early 2011 was catastrophic because the region had already experienced drier-than-average conditions the previous year, and there had been a limited response to early warnings among the region's governments. This combination of extreme weather and poor preparation and response affected the livelihoods of millions of people in Kenya, Ethiopia and Somalia, and compounded the flow of refugees associated with armed conflict in Somalia.

In the case of Typhoon Haiyan, a powerful tropical cyclone that hit the Philippines in November 2013, the level of destruction was exacerbated by existing damage from earlier storms. The scale of destruction made the regeneration of farmers' livelihoods, in particular those growing rice and coconuts, an urgent issue. In response, the government demanded far more urgent and decisive action on climate change from the global community at the UN Climate talks in Poland – Yeb Sano, leading the Philippines delegation, had just learned that Haiyan had obliterated his hometown.

The findings of this report elucidate the complicated relationship between weather events and food security. The report also considers the relevance of climate change. On a global level, climate change is expected to increase the magnitude and frequency of heatwaves and heavy rainfall events, due to rising global temperatures and the ability of warmer air to hold more water vapour. However, it will never be possible to say that any specific event, including the four events analysed in this report, would not have happened without climate change. What scientists can do is estimate whether climate change increased the risk of an event. Initial evidence suggests that the Russian heat wave and the East African drought were made more likely because of climate change; but it is not yet possible to assess the climate change signal in the case of the floods in Pakistan and Typhoon Haiyan.

Given the risk that extreme weather events might increase in frequency and magnitude in future, but uncertainty in the exact trajectory of future climate, it is valuable to consider hypothetical scenarios for larger or more frequent events, and how these might impact food security. In this report, explorative scenario analysis demonstrates the potential for adaptive capacities to be overwhelmed and vulnerable communities to be driven to extremes.

It has become apparent that the weakness or strength of governance at various levels can either intensify or mitigate the impacts of extreme weather events. This report highlights just some such governance failings in each case study, and suggests that changes in the risk of extreme events associated with climate change could put even more pressure on decision makers. It is imperative that a cultural shift encompassing governments, NGOs and society at large occurs, so that the reduction of risk for vulnerable groups is given consideration beyond immediate post-disaster response.

# SECTION 1: INTRODUCTION

## 1.1 PROJECT BRIEF

This report considers how extreme weather events affect the food security of vulnerable groups. It builds on Oxfam's briefing paper 'Growing Disruption: Climate change, food and the fight against hunger',<sup>2</sup> which discusses how climate change (including changes in extreme weather events) might alter the conditions that commonly reduce the availability, access, utilization, and stability of food supplies for people living in poverty.

In this report, case studies are used to examine the effect of specific extreme weather events on vulnerable groups' food security, working within the same food-systems approach. This approach covers access, availability and utilization, and stability. In addition to seeking a better understanding of the interaction between recent extreme weather and food security for each case study, the report considers the potential influence of climate change and the possible implications for food security if the frequency or magnitude of extreme weather events were to increase.

The report draws on a wide range of academic and other literature. It has been prepared in close consultation with climate scientists, food systems researchers, and scenarios experts from the University of Oxford's Environmental Change Institute (ECI) and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

## 1.2 REPORT STRUCTURE

The remainder of this section provides an introduction to the topic, and an explanation of the methodology used for the second section of the report.

The second, and most substantial, section analyses the interaction between extreme weather and food security for each case study.

The third section considers the relevance of climate change to this issue, including a summary of the current scientific understanding of the influence of human emissions on extreme weather. Building upon this, some hypothetical climate scenarios are provided.

The final section discusses the implications of the findings.

## 1.3 NATURE OF VULNERABILITY TO WEATHER EXTREMES

Extreme weather causes social and economic damage, and directly and rapidly affects people, property and structures.<sup>3</sup> Vulnerability to extreme weather is exacerbated when the components of vulnerability – such as livelihood strength and resilience, wellbeing, self-protection, social protection, and governance – are weak.<sup>4</sup> The economic, social, and environmental factors of vulnerability are also interrelated, i.e. economically vulnerable communities are more likely to be socially vulnerable.<sup>5</sup>

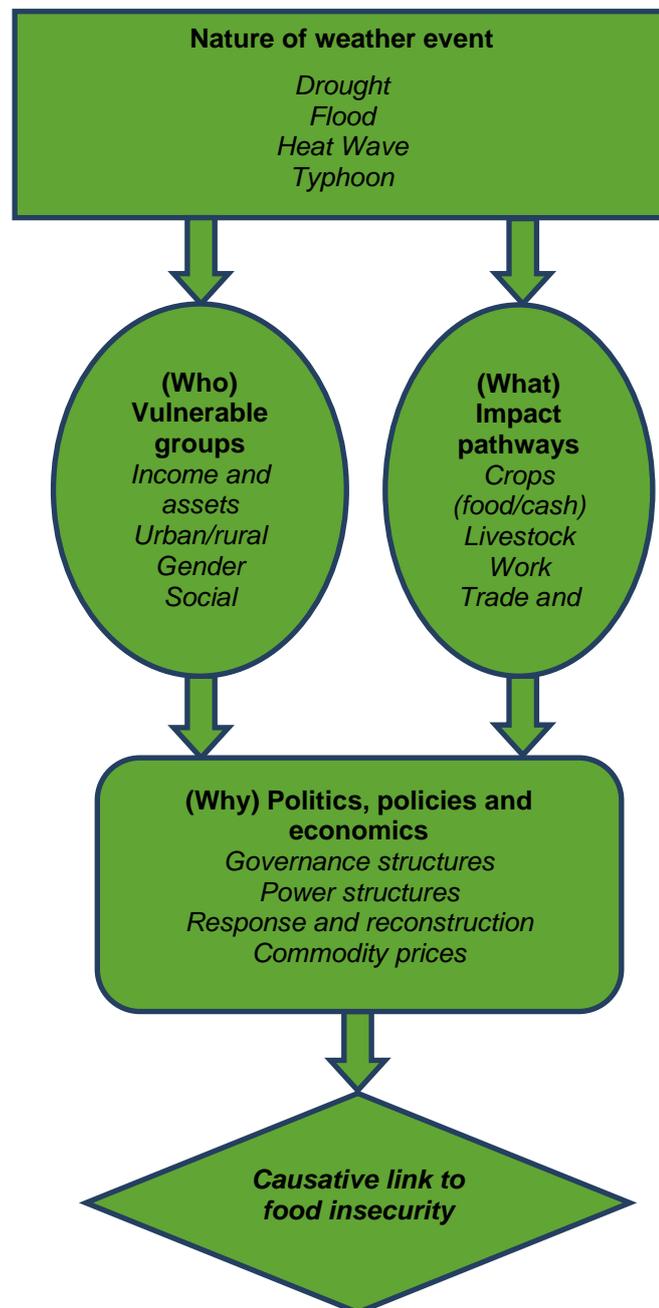
# 1.4 METHODOLOGY FOR CASE STUDY ANALYSIS

Four recent case studies were selected to represent different types of extreme weather event: a heat wave, a flooding event, a drought, and a typhoon. For each case study, a literature review was undertaken alongside consultation with project partners. The information gathered was used to:

1. describe the nature of the weather event;
2. identify the vulnerable groups affected;
3. determine the impact of the event on livelihoods;
4. examine the response of governments and economies.

This information was then used to make an assessment of the relationship between the weather event and food security. This framework is illustrated in Figure 1.

**Figure 1: Case study narrative development**



### 1.3.1 Describing the nature of an extreme weather event

In order to understand the impacts of a weather event, it is important to first understand its physical characteristics. This could include meteorological anomalies in temperature, rainfall, and wind speed, and hydrological conditions such as flood plain inundation or soil moisture deficits. Potentially important characteristics include the event's magnitude, spatial extent, and duration.

It is also useful to understand the event in the context of past variability: how often does an event of this nature occur? How different is it from normal conditions? Finally, it may be helpful to analyse the physical processes that led to the extreme event. For example, winter flooding in the UK is often the result of low-pressure systems from the Atlantic linked to the jet stream, but in spring it may be a consequence of snowmelt.

### 1.3.2 Defining vulnerable groups

Many factors may influence how vulnerable people are to extreme weather, and can also help with the identification of groups vulnerable to food insecurity. Those factors considered in this study include:

1. Income and assets: wealth and ownership of assets, e.g. arable land, may lead to people being affected very differently by an extreme event, and will likely influence their ability to recover.
2. Gender: women may not have the same access to or control over disaster response as men and they also carry the burden of having the largest burden of care for children and elderly. Women, children and the elderly may be more vulnerable to extreme weather.
3. Social divisions: race, religion, the marginalization of groups such as pastoralists, and caste issues may influence who is affected during a crisis, and who receives support before, during and after disasters and into recovery.

Figure 2. Who is vulnerable and why?



Source: 'UNDP Human Development Report (2014), Sustaining Human Progress: reducing vulnerabilities and building resilience', <http://hdr.undp.org/en/content/human-development-report-2014>

### **1.3.3. Assessing impact pathways**

To assess the impact of extreme weather on livelihood potential and food security, the following basic factors were considered in this study:

1. Crops: were there changes in the yield of cash or food crops? Did the amount of cultivated land decrease?
2. Livestock: how have livestock populations been impacted?
3. Work: how has a weather event impacted livelihood strategies? Has there been a movement of labour out of the region or to particular sectors or industries?
4. Trade and markets: how have the dynamics of imported or exported goods changed?

### **1.3.4. Evaluating politics, policies and economies**

Evaluating politics, policies, and economics is fundamental to understanding responses to extreme weather, and how they relate to impacts on food security. Therefore, the following factors were considered:

1. Loss and damage: what kinds of losses (i.e. permanent or irreparable negative impacts) and damage (i.e. recoverable negative impacts) were recorded, including to homes, infrastructure or freshwater sources?
2. Commodity prices: how volatile are local cash and food (crop/livestock) commodity prices? How dependent are local markets on global markets? Have any measures been put in place to limit impacts in times of disasters?
3. Power structures: what is the distribution of resources throughout the affected regions and across segments of society?
4. Response and reconstruction: are there effective weather response capacities? Do governments and communities have the organizational capacity to provide information and/or education to prevent avoidable loss and damage? Is there a long-term commitment to reconstruction efforts following an event that takes into account the needs of all affected citizens?

# SECTION 2: CASE STUDIES

Using the methodology outlined in Section 1.4, the interaction between extreme weather and food security will now be explored for each of four case studies: the heat wave in Russia in 2010, the 2010 flooding in Pakistan, the East African drought of 2010/2011, and Typhoon Haiyan in the Philippines in 2013.

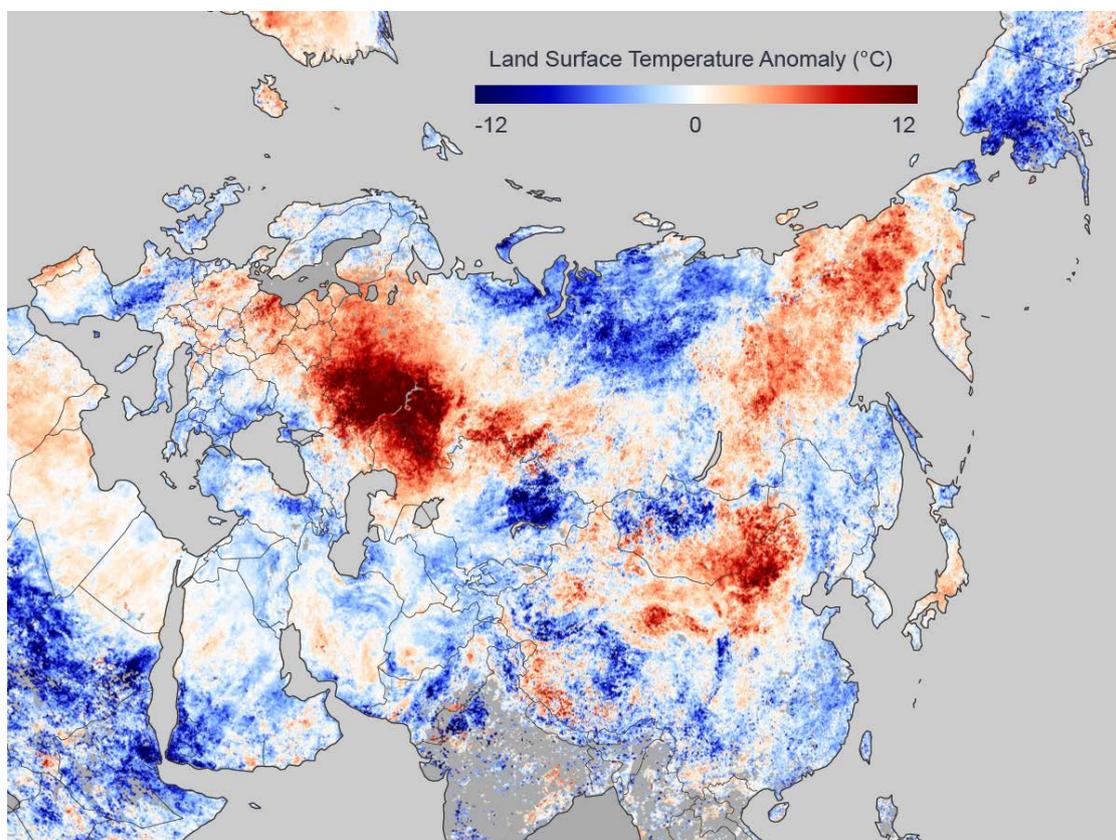
## 2.1 RUSSIA'S 2010 HEAT WAVE

### 2.1.1. Description

During the summer of 2010, an extreme heat wave occurred over much of Eastern Europe, with the largest anomalies in western Russia. The average daily maximum temperature for Moscow in July is approximately 23°C; in 2010, a maximum temperature of 38.2°C was recorded,<sup>6</sup> and western Russia experienced its warmest July since records began in 1880.<sup>7</sup> Unprecedented temperature anomalies were measured over an area of more than 2 million km<sup>2</sup>. The heat wave lasted from the beginning of July until mid-August. The very dry conditions that preceded it created an environment in which wild fires could easily break out and spread.<sup>8</sup>

The high temperatures and drought conditions were caused by a persistent area of high pressure—a 'blocking high' or 'blocking anticyclone' centred over Western Russia.<sup>9</sup> These systems are associated with high pollution levels, as the supply of clean air is restricted, and industrial pollution can be trapped locally. Combined with smoke from forest and peat fires, heavy smog was generated.

**Figure 3: Modis satellite temperature image from NASA, 9 August 2010**



Source: NASA Earth Observatory image by Jesse Allen, based on MODIS land surface temperature data available through the NASA Earth Observations website. Caption by Michon Scott.

## 2.1.2. Significance

The heat wave, drought and wild fires had a significant impact on crop yields, which posed both domestic and international challenges. Some 13.3 million acres of crops were destroyed by drought and fire, which represented close to 17 percent of the total crop area of the country, and affected close to 25,000 farms.<sup>10</sup> Of Russia's grain-producing regions, Volga experienced a harvest decline of 70 percent, while the Central region suffered a 54 percent decline. There was a countrywide decline of 33 percent in the overall wheat harvest.<sup>11,12</sup> (It should be noted that some districts matched or exceeded their grain harvests from the year before, with the Southern and North Caucasus districts producing 99 percent and 109 percent of their yields, respectively.<sup>13</sup>) This decline in crop production led to domestic food price increases, and many members of society entered into poverty. The Russian government's response was to ban wheat exports. This had global implications, as Russia was the world's fourth-largest wheat exporter, accounting for roughly 14 percent of the global wheat trade.<sup>14,15</sup> The resultant rise in international grain prices may have influenced the political instability in North Africa and the Middle East during the Arab Spring.

## 2.1.3. Narrative

### 2.1.3.1. The vulnerable close to home

The heat wave had a substantial impact on Russia's poorest and most vulnerable citizens. It was associated with close to 56,000 deaths<sup>16</sup> from heat and air pollution, of which an estimated 11,000 were in Moscow.<sup>17</sup> In addition, the loss of a third of annual domestic wheat production led to dramatic increases in food prices, including for staples such as bread and buckwheat, as well as animal feed, which had subsequent impacts on the price of dairy products. Panic buying aggravated the situation.<sup>18,19</sup> Between July 2010 and March 2011, the average price of a subsistence basket of food rose by 20–30 percent in most regions of Russia. This rise in food prices at a time when incomes remained steady led to an increase in poverty. Women were the hardest hit due to their role in providing food for their families as they have the largest burden in feeding children and the elderly. Farmers, traders and others working in the agricultural industry also faced particularly difficult circumstances. The export ban dented Russia's reputation as a supplier.<sup>20</sup>

### The Russian government's response

The decline in crop yields posed a significant challenge to the Russian government, which responded by banning wheat exports in August 2010. This ban was in keeping with existing food security policies;<sup>21</sup> in the wake of the food price spike of 2007–2008, the government established the 'Doctrine on Food Security' in 2010 to limit food exports.<sup>22</sup> These policies were inspired by economic nationalism, but the export ban failed to reduce domestic food prices in the aftermath of the crisis. Although there was enough locally produced supply to cover domestic consumption, prices continued to rise, with flour increasing by 18 percent and bread by 10 percent between July and December 2010.<sup>23</sup> This may have been partly due to hoarding by grain speculators and profiteers, who withheld grain and broke contracts, in anticipation of future price increases and opportunities for price-gouging.<sup>24</sup>

The Russian government also reworked some of its long-term agricultural policies. A programme was introduced to protect the animal husbandry sector, 'On Measures for Accelerating the Development of Animal Husbandry as a Policy Priority for Attaining Food Security in Russia' in 2010 and 2011, which aimed to maintain domestic production and reduce meat imports. The government pursued this with incentives to stimulate and strengthen dairy and meat producers. In effect, what was beginning to take shape was a transfer of wealth in the country from crop to livestock producers.<sup>25</sup> Even during the export ban, the Russian government stated that it would not permit a reduction in the number of cattle and poultry.<sup>26</sup>

The Russian government seemed to subsequently be taking heed of the potential ongoing threat to farms from future climate anomalies, and discussed various long-term solutions, such as increasing land-use efficiency and irrigation. Protecting the production capacity and financial solvency of farms and producers was also heavily discussed.<sup>27</sup> A proposed solution was to improve the insurance system, in order to avoid a repeat of large post-event rebuilding costs to the state. It was decided that federal funds were no longer to be used to deal with the effects of extreme weather events. This measure had the potential to make a substantial difference during future events, since only 20 percent of the crops destroyed in 2010 were covered by private insurance.<sup>28</sup> However, in the subsequent 2012 drought, it was found that many Russian farmers still did not have insurance, largely due to a lack of trust in insurance organizations, so this strategy has not yet been adopted by many Russians.<sup>29</sup>

### **2.1.3.2. International shockwaves**

The wheat export ban had a major effect on people beyond Russia's borders. The Russian export ban was the central catalyst in the 60–80 percent increase in global wheat prices between July and September 2010.<sup>30</sup> By April 2011, wheat prices were 85 percent higher on international markets than the year before, at \$364 per tonne.<sup>31</sup> The effects of this were widespread. Among Russia's neighbours, wheat is a staple food of particular importance to the poor segments of the population, and prices rose in many cases: Kyrgyzstan (54 percent), Tajikistan (37 percent), Mongolia (33 percent), and Azerbaijan (24 percent).<sup>32</sup> Pakistan, Russia's fourth-largest customer, experienced a 16 percent increase in the price of wheat. During this time, Pakistan also experienced a 1.6 percent increase in people living in poverty.<sup>33</sup>

Egypt was the world's largest wheat importer<sup>34</sup> and Russia's biggest customer, importing 50 percent of its grain from the latter.<sup>35</sup> While the Egyptian government was committed to maintaining the price of the cheapest bread, in order to minimize the impact of price increases on poor households,<sup>36</sup> this was an extremely expensive policy measure, amounting to 8 percent of the country's total GDP in 2011.<sup>37</sup> This could not be sustained, and higher wheat prices affected the cost and availability of bread in Egypt, and subsequently influenced citizen protests. Bread took on symbolic importance in protests, as evidenced by the widespread slogan 'bread and dignity'.<sup>38</sup> As such, it has been suggested that higher wheat prices indirectly contributed to the Egyptian revolution.<sup>39</sup>

Among the countries affected by the Arab Spring, it is interesting to note that Egypt ranked first, Syria fifth, Yemen ninth, and Tunisia tenth as destinations for Russian wheat exports in 2009.<sup>40</sup> Price increases for a staple such as bread has the potential to cause huge impacts at the household level in many nations in the Middle East and North Africa due to these populations' dependence on wheat, and because food constitutes a large proportion of household spending. Globally in 2010, in terms of wheat imports per capita and per cent of income spent on food, respectively, Libya ranked second (37.2 percent of income), Algeria fifth (43.7 percent), Tunisia sixth (35.6 percent), Yemen seventh (45 percent), and Egypt eighth (38.8 percent).<sup>41</sup>

### **2.1.4. Conclusion**

The unprecedented heat wave of 2010 was intense and unexpected, and was associated with drought, wild fires, and increased pollution levels. It dramatically affected farmers and the domestic wheat harvest, and many from poorer segments of the Russian population entered poverty. The decision of the government to institute a wheat export ban greatly affected world wheat prices, and played a factor in encouraging unrest in Arab Spring nations dependent on Russian wheat imports.

## 2.2 PAKISTAN'S 2010 FLOODS

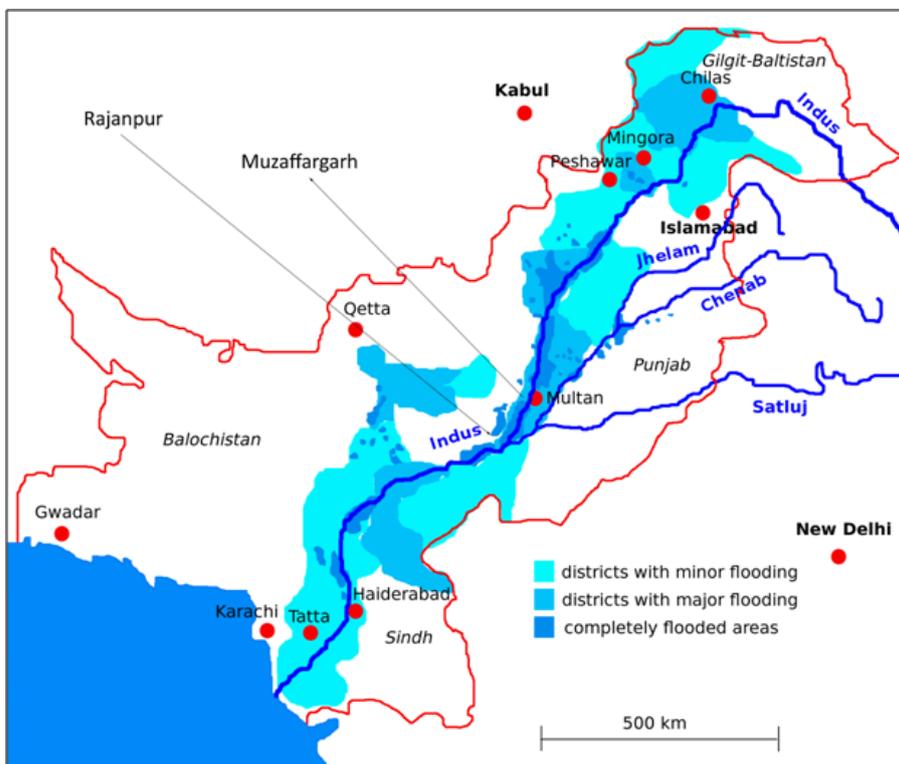
### 2.2.1. Description

During July and August 2010, Pakistan experienced higher-than-normal monsoon rainfall, particularly in the upper part of the Indus river system, which drains the western Himalayas. The monsoon's onset was about 10 days earlier than normal, and was followed by a series of monsoon surges. Some areas received more than four times their usual monthly rainfall in just three days.<sup>42,43,44</sup> These rainfall anomalies led to large-scale inundation in the Indus river basin, propagating from Khyber Pakhtunkhwa south through Punjab, Balochistan, and Sindh.<sup>45,46</sup> In early August, the flooding was associated with widespread landslides in these regions of the country.<sup>47</sup>

The unusual intensity of the monsoon appears to have been linked to the Russian heat wave. At the same time as there was very high pressure over western Russia, low pressure was observed to the east, including over Pakistan. As the monsoon is driven by pressure differences, this acted to bring the monsoon further north than usual. In addition, interactions between the monsoon and disturbances associated with the large-scale circulation pattern led to unusually heavy rainfall.<sup>48</sup>

The El Niño Southern Oscillation (ENSO) may also have had an indirect role on the rainfall anomalies in Pakistan. ENSO is a naturally occurring mode of climate variability, oscillating between 'El Niño', 'La Niña' and 'neutral conditions'. It originates in the tropical Pacific, but has an important influence on global climate. 2010 marked the beginning of a weak La Niña, which is associated with warm anomalies and easterly wind anomalies in the western Pacific. This reduced the transport of moisture from southern Asia towards the Pacific, and therefore contributed to wetter conditions over Pakistan.<sup>49</sup>

**Figure 4: Map showing extent of flooding on 26 August 2010 and locations of Rajanpur and Muzaffargarh Districts**



Source: Walsh, M. and R. Fuentes-Nieva (2014) 'Information Flows Faster than Water: How livelihoods were saved in Pakistan's 2010 floods', Oxford: Oxfam GB.

## 2.2.2. Significance

The 2010 floods were one of the worst disasters in Pakistan's history.<sup>50</sup> The floods were associated with approximately 2,000 fatalities. Roughly 2 million homes were destroyed or damaged, and 21 million people were forced to flee their homes.<sup>51</sup> The flooding negatively impacted food security on a national scale, and threatened the long-term nutritional needs of nearly 8 million people. Food consumption scores indicate that roughly a third of people in affected areas experienced poor levels of dietary diversity and food intake.<sup>52</sup> While certainly national in scope – an estimated 20 percent of the country's landmass was underwater – the impacts of the event were spatially variable, determined by local conditions including socio-economic factors.<sup>53</sup> This can be particularly illustrated by examining the provinces of Sindh and Punjab.

One of the most significant features of this event was the duration. In 2010, the flooding lasted for several weeks in many places, and for several months in Sindh.<sup>54</sup> Since 2010, Pakistan has suffered from a further three years of less publicized floods.

## 2.2.3. Narrative

### 2.2.3.1. Income, prices and asset impacts

According to the Asian Development Bank and the World Bank, Pakistan suffered an estimated financial loss of \$9.7bn, with significant damage to homes, farms, transport and communications, water supply, power, and sanitation. Some Pakistani sources have speculated that the direct and indirect losses were closer to \$43bn.<sup>55</sup> Wheat and rice prices increased by 80 percent in 2010<sup>56</sup> and the average person was spending 65 percent of their income on food.<sup>57</sup> At the national level, the country lost an estimated 2 million hectares of crops, and 40 percent of its livestock – tens of thousands of animals.<sup>58</sup> Pakistan had been an important exporter of wheat and rice, but struggled to regain its market position after the floods, as other countries stepped in to fill its orders.<sup>59</sup>

The impacts were not equally distributed. Those displaced or who lost physical assets in the floods were disproportionately landless tenants and farmers: 70 percent of this segment of the population lost at least 50 percent of their expected income.<sup>60</sup> Some 60 percent of Pakistan's citizens lost their primary livelihood (i.e. more than 50 percent of income) across all but one province.<sup>61</sup> While economically vulnerable households were hit the hardest across the board, social divisions played a significant role at the provincial level. The impact of the floods was particularly severe for women. In flood-affected areas, 53 percent of women were found to be severely food insecure compared to 43 percent of the overall population. Standing crops were badly affected which provide an important source of livelihoods for women in cotton picking, and rice and sugarcane harvesting. Livestock losses were less compared to crops as the owners were able to take many of their animals along with them in Punjab and Sindh. However, poultry birds (an important source of income for women) were completely lost.

In addition, women across the country who found themselves displaced had more limited access to public sanitation facilities. In the camps separate toilet and washing facilities were often not available, resulting in increased health risks.<sup>62</sup> In Sindh, women who were due to receive agricultural support packages under the state land distribution package had this aid suspended, as they were not deemed to be a priority.<sup>63</sup> Additionally, religion and caste played a role in the distribution of aid, and some political parties distributed assistance based on member affiliation in Sindh.<sup>64</sup>

### 2.2.3.2. A tale of two provinces

In Punjab province in central-north Pakistan flooding was catastrophic but the water washed downstream fairly rapidly compared to Sindh in the south where the flooding lasted much longer. In Punjab, about 12,400 km<sup>2</sup> of cropland was flooded, while 9,200 km<sup>2</sup> was flooded in Sindh.<sup>65</sup> Of all Pakistan's provinces, Punjab had the highest total area of destroyed cotton and sugarcane; the largest area of destroyed rice and wheat was in Sindh, where 5,106 km<sup>2</sup> of Pakistan's 8,762 km<sup>2</sup> of flooded rice crop area was located.<sup>66</sup>

While 42 percent of homes were destroyed or damaged across the country, the highest proportion was in Sindh: out of the 1,910,000 homes affected, about 876,000 (roughly 46 percent) were in this province.<sup>67</sup> Punjab suffered significant short-term effects due to extensive damage to both crops and markets. During the flooding, the non-functioning of local food markets directly affected 47 percent of households there - the largest such impact in all Pakistan's provinces.<sup>68</sup>

In Sindh, the dramatic price spikes and the delayed planting of winter crops resulted in even greater impact. The percentage of households with 'poor food consumption' increased from 13 to 76 percent in Sindh, and from 10 percent to 45 percent in Punjab. After the floods many households coped by shifting to less preferred foods, purchasing food on credit, borrowing, limiting portion size, reducing the number of meals and even going entire days without eating. In many households women ate less than men.<sup>69</sup>

### 2.2.3.3. The government response

The scale of the floods of 2010 was quite unprecedented in Pakistan's history and arguably beyond the capacity of any government to respond to adequately. Furthermore, the floods happened at a time when the country's disaster management structure had only just completed a major re-organization. In the new structure the Government of Pakistan's National Disaster Management Authority worked with provincial and district level management authorities through a decentralized system. The aim of this structure is to enable more rapid and appropriate responses driven by local needs and improve local accountability. However, the scale of the disaster and the fledgling nature of the new structure meant that the floods had very different impacts in different regions. Most interventions were led by provincial governments and the national army.<sup>70</sup>

While some observers generally praised the efforts of the governments and, in particular, the army, others have evaluated the response as insufficient.<sup>71</sup> Food aid, for example, was mostly disbursed in camps, shelters and makeshift communities, and as such did not reach all who were in need.<sup>72</sup> Delays in aid provision contributed to many farmers missing the winter planting season.<sup>73</sup> In northern areas, the response was quicker and more organized, largely due to the fact that people in these areas had gained experience from a major earthquake in 2005, and had therefore developed disaster-management capacities. Whilst flooding in the southern provinces of Sindh and Punjab happens every year, the sheer scale of the flooding and its duration in situations of highly unequal political, social and economic power meant that disaster response was often inadequate.<sup>74</sup>

Coercive landlords were able to take advantage of this situation. Across the country, flood-affected people were forced to hand over cash assistance received from the government or NGOs. In addition, landlords used the washing away of land borders and the loss of ownership deeds as an opportunity to attempt to take over poor farmers' land.<sup>75</sup> Oxfam Country Director Arif Jabber Khan observed: "Pakistan's flood protection programmes resulted in the construction of embankments and other larger structures that protected the landholdings of large farmers and at the same time, made millions vulnerable to more extreme conditions than they were used to. Additionally, during extreme events, decisions on breaches to protect large infrastructure (barrages for example) are made on political grounds and I saw it myself from the air, that the land of large farmers was protected while small farmers' land was deliberately

flooded". A commission of inquiry by the Supreme Court of Pakistan found that the major breaches that occurred happened because of infrastructure failure, stemming from failure to maintain infrastructure, rather than deliberate decisions. However, the commission did not consider causes of breaches to secondary infrastructure and the testimony of many flood-affected people asserts that in these cases, deliberate decisions were often taken to flood land used by poor people rather than by the rich.<sup>76</sup>

## **2.2.4. Conclusion**

In 2010, Pakistan experienced much higher-than-average monsoon rains, leading to large-scale and prolonged flooding. This weather event had severe impacts on several parts of the country, but not all were equally affected. In Sindh, the flooding lasted longer and large volumes of standing water resulted in more direct negative health and nutritional outcomes, and damage to housing and infrastructure, while the damage to crops, livestock and markets was more severe in Punjab. The performance of the country's emergency response teams was also geographically differentiated, with northern areas proving more effective at dealing with the flooding than southern areas. The central government was heavily criticized for not acting more decisively in the crisis.

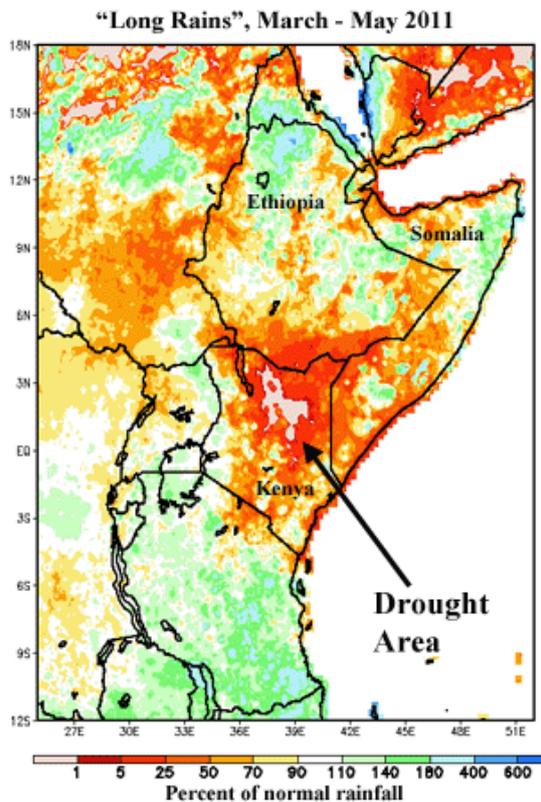
## **2.3 EAST AFRICA'S 2010–11 DROUGHT**

### **2.3.1. Description**

In 2011 there was a severe drought in a large area of the Greater Horn of Africa, affecting parts of Ethiopia, Kenya and Somalia and also Djibouti. The region has two main rainfall seasons, known in Kenya as the 'short rains' (October–November/December), and the 'long rains' (March–May/June).<sup>77</sup> The 2011 drought was associated with the successive failure of both the 2010 short rains and the 2011 long rains.<sup>78</sup>

East Africa is naturally a dry region, which experiences high variability in rainfall from year to year, due to a variety of influences including ENSO and the Indian Ocean. A combination of different factors contributed to the situation in 2011, not all of which are fully understood. The failure of the short rains has been linked to La Niña,<sup>79</sup> which is usually associated with drier conditions during this season. The long rains are less well understood (see section 3).

Figure 5: Percent of normal precipitation in East Africa, 2011



Source: NOAA Climate Prediction Center via Dr. J. Masters (2011), 'Deadliest weather disaster of 2011: the East African Drought', 20 December, <http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=2005>

### 2.3.2. Significance

The 2011 drought was severe but it was not unexpected. In summer 2010, the Famine Early Warning Systems Network (FEWS NET) issued an alert for key pastoral areas of Ethiopia, Somalia and northern Kenya,<sup>80</sup> knowing that a La Niña year was forecasted and this might weaken the short rains, that there was a risk the long rains could also fail, and that people were already vulnerable on the ground due to high food prices and previous droughts. Despite the warning, the drought had devastating effects. It delayed the region's main cropping season.<sup>81</sup> The number of people in the Horn of Africa in need of food assistance in July of 2011 stood at 17.5 million, which was double the figure in January.<sup>82</sup> The drought compounded the crisis that already existed in South Central Somalia which was racked by conflict and where there was no effective central government. Elsewhere the worst-affected areas were those already suffering from decades of entrenched poverty in communities on the fringe of their respective societies.<sup>83</sup> In Somalia alone the UN estimated that no less than 258,000 'excess deaths' were attributable to the emergency<sup>84</sup> with half of deaths being of children under five years of age.

## 2.3.3. Narrative

### 2.3.3.1. Food prices

Food prices reached record levels in parts of Kenya, Ethiopia, and Somalia, and each country had a particular crop that became a symbol of the crisis. In Addis Ababa, Ethiopia, wholesale wheat prices reached a record of 8,500 birr per tonne, representing an 85 percent increase from the previous year. In Nairobi, Kenya, maize prices reached a record high of \$450 per tonne, representing a 55 percent increase from the previous year.<sup>85</sup> This was directly linked to the near-total crop failure in some areas of the country, with national maize output predicted to be roughly 15 percent below average after the drought.<sup>86</sup> Food availability decreased nationwide. With a decline in purchasing power occurring from month to month, there was a disincentive for traders to bring in unaffordable food. Government cash grants were limited, so relief agencies provided some.<sup>87</sup> In Mogadishu, Somalia, maize and red sorghum were traded at \$660 and \$670 per tonne, constituting a 106 percent and a 180 percent increase, respectively, from pre-disaster prices.<sup>88</sup> In Somalia, locally produced and imported food tended to be available, but only at high prices.<sup>89</sup>

Livestock was also seriously affected, with the Food and Agriculture Organization of the United Nations (FAO) estimating mortality rates of 60 percent of Ethiopia's cattle, 40 percent of sheep and 25–30 percent of goats.<sup>90</sup> In the Oromia and Somali regions, livestock market statistics showed steadily declining body condition among cattle being sold, and hundreds of thousands of animals dying between February and July.<sup>91</sup> This problem was not limited to Ethiopia. In July 2011, the market for livestock across northern Kenya had almost completely collapsed, with the price of a cow dropping from \$220 to \$30.<sup>92</sup> The FAO estimated that up to 60 percent of Kenya's cattle had died.<sup>93</sup> As a result of losing their livestock many pastoralists lost their livelihoods, have been unable to rebuild their herds and have become highly vulnerable to further droughts.

### 2.3.3.2. A humanitarian and refugee crisis

Children were disproportionately impacted by the drought. As mentioned earlier, more than half of all deaths may have occurred among children under five. In addition, roughly one million children under the age of five were treated for malnutrition.<sup>94</sup> In Kenya, an estimated 508,000 children saw their education disrupted in drought-prone areas of the north and northeast,<sup>95</sup> and there were accounts of girls aged 13–15 being sold in exchange for livestock, and of older women walking long distances in search of food and water, often resorting to binding their stomachs to stave off hunger.<sup>96</sup>

A combination of two failed rainy seasons and years of internal violence and conflict resulted in some areas of Somalia entering famine.<sup>97</sup> According to UN estimates, the rate of malnutrition increased in southern and central Somalia from 16.4 percent before the event to 36.4 percent in 2011.<sup>98</sup> In those regions, armed conflict was already impacting children, households and communities.<sup>99</sup> According to analysis of deaths among Somalis both within southern and central Somalia and also in the refugee camps in Ethiopia and Kenya, "There is consensus that the humanitarian response to the famine was mostly late and insufficient, and that limited access to most of the affected population, resulting from widespread insecurity and operating restrictions imposed on several relief agencies, was a major constraint".<sup>100</sup>

In July 2011, an estimated 1.5 million people—20 percent of the total population—were displaced within Somalia, which played a role in destabilisation across the region.<sup>101</sup> Some Somalis fled to drought-affected regions of Kenya and Ethiopia, such that a further 600,000 refugees were estimated to be located there.<sup>102</sup> The conditions in refugee camps were extremely difficult; malnutrition rates in Kenya's Dadaab camp and Ethiopia's Dollo Ado camp were 37 percent and 33 percent, respectively.<sup>103</sup> In Kenya, political insecurity compounded the problem, and challenged humanitarian operations in Dadaab, preventing access to about 463,000 refugees for weeks at a time.<sup>104</sup>

### 2.3.3.3. National failures and space for regional solutions

Regional early warning systems predicted the impending drought in Ethiopia, Somalia, Djibouti and northern Kenya through the Food Security and Nutrition Working Group for East Africa, which then set up a La Niña task force to deal with impacts associated with the phenomenon. A series of alerts and warnings were issued. However, as Jan Egeland, UN Emergency Relief Coordinator (2003–2006) observed: "The greatest tragedy is that the world saw this disaster coming but did not prevent it. Across Ethiopia, Kenya, Djibouti and Somalia this crisis has played out very differently, but common to all of them was a slow response to early warnings. Early signs of an oncoming food crisis were clear many months before the emergency reached its peak. Yet it was not until the situation had reached crisis point that the international system started to respond at scale".

Slow and inadequate reactions to the warnings caused delays and large-scale responses by governments and international agencies only occurred after malnutrition rates in parts of the region exceeded emergency thresholds.<sup>105</sup>

However, the situation varied to a considerable extent between countries:

- In Ethiopia, early action took place across several sectors. It was built upon the state-sponsored Productive Safety Net Programme and investment in new health posts which enabled huge increases in access to nutrition responses,<sup>106</sup> and pre-positioned food supplies greatly assisted authorities once drought conditions became severe.<sup>107</sup>
- In Kenya, the national capacity for response was reduced by political distractions associated with a new constitution and corruption allegations directed at government and donor-funded projects in the drylands.<sup>108</sup> An Oxfam analysis found that: "In Kenya, too much weight is given to the food aid system (as opposed to the national early warning system), which is unwieldy and unable to respond quickly to an emerging crisis; assessments are only carried out twice a year and by the time the reports are produced, the figures of those needing aid are already several months out of date."<sup>109</sup>
- The lack of an effective government in central and southern Somalia, access restrictions and the unwillingness of donors to invest led to famine and a refugee outflow. A National Drought Emergency Relief Committee was hastily formed. This committee made a national disaster appeal to raise funds and supply food and water to affected citizens.<sup>110</sup>

### 2.3.4. Conclusion

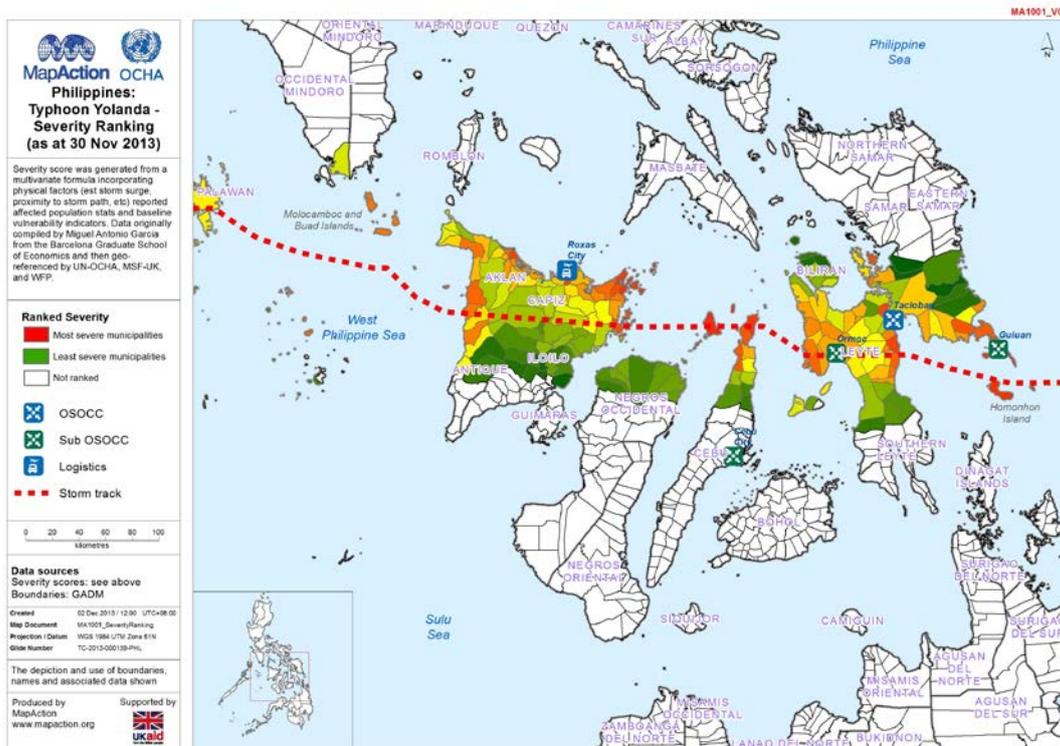
The impact of two consecutive poor rainy seasons in 2010 and 2011 – on top of a general drying trend across much of the region over several decades – was devastating for East Africa. The coincidence of conflict and a lack of central government control in Somalia created a refugee crisis that spread into Kenya and Ethiopia. The arrival of tens of thousands of people put huge pressure on the large refugee camps, which already held hundreds of thousands. The majority of people impacted in this crisis were the most vulnerable members of their societies, in particular children, women, and pastoralists. The responses to predictions and warnings of drought were poor, compounded by wider governance issues.

# 2.4 TYPHOON HAIYAN IN THE PHILIPPINES, 2013

## 2.4.1. Description

Typhoon Haiyan, known as Typhoon Yolanda in the Philippines, developed in the tropical Pacific in early November 2013 and tracked westwards. It made landfall in the Philippines on 7 November, hitting regions 6, 7 and 8 including the provinces of Guiuan, Eastern Samar; Tolosa, Leyte Province; Daanbantayan and Bantayan Island, Cebu Province; Concepcion, Iloilo Province (Panay Island); and Palawan Island.<sup>111</sup> In total nine regions comprising 44 provinces were affected.

Figure 6: Typhoon Yolanda - Severity Ranking as at 30 Nov 2013



Source: MapAction (2013), <http://www.mapaction.org/component/mapcat/mapdetail/3165.html>

When it reached the Philippines, Haiyan was an exceptionally strong cyclone, classified as the highest category (5) on the Saffir–Simpson hurricane scale.<sup>112</sup> Cyclones are low-pressure systems, and the central pressure of this storm was extremely low, estimated at 895 mb. The winds were particularly strong, with sustained speeds near 195mph when averaged over a minute, making it probably the strongest tropical cyclone ever recorded to make landfall.<sup>113</sup> The high wind speed was combined with storm surges, which caused waves as high as 15m.<sup>114</sup>

## 2.4.2. Significance

The devastation resulting from this typhoon was partly a result of its unusual intensity. However, as the third in a series of storms that struck the country in less than 12 months, it also compounded existing damage.<sup>115</sup> Losses and damages associated with the cyclone are still being recorded, but it is predicted that the total sum could reach \$23bn. The human costs are also significant, with 11.3 million people affected across nine regions,<sup>116</sup> and 4.1 million displaced.<sup>117</sup> The impact on key infrastructure, fishing and essential crops required for livelihoods, especially rice, has raised the possibility of a significant food security tragedy for the Philippines' most vulnerable people.

## 2.4.3. Narrative

### 2.4.3.1. Overwhelming livelihood and property damage

Haiyan hit the poorest provinces in the country. The typhoon resulted in an estimated 5.9 million workers losing their livelihoods, as income sources were destroyed, lost or disrupted.<sup>118</sup> The typhoon also damaged roughly 1.1 million houses, and destroyed another 550,000.<sup>119</sup> There was widespread damage to rural infrastructure, including irrigation systems,<sup>120</sup> and an estimated 600,000 hectares of agricultural land were destroyed.<sup>121</sup> Destruction of roads and blockages from fallen trees hampered assistance to more remote areas. State infrastructure suffered great damage, including destruction of citizens' records.

The Philippine Department of Agriculture estimated that about 150,000 farming households and some 50,000 fishing households (accounting for roughly 400,000 people) were directly affected by the typhoon.<sup>122</sup> Including indirect impacts of the disaster, over one million farmer and fishing households will require direct assistance with their livelihoods.<sup>123</sup>

Fishing communities – the poorest sector of society – suffered particularly badly from the destruction of physical assets, with 65 percent losing their productive assets and 28,000, mainly small-scale, fishing boats destroyed.<sup>124</sup>

Important crops, including coconuts and rice, suffered extensive damage. In the hardest hit part of the country, region 8, comprising the provinces of Leyte, Samar and Biliran, 33 million coconut trees were destroyed, effectively eliminating the livelihoods of the coconut farmers for the next six to nine years.<sup>125</sup> Coconut growers are the poorest sector of the agricultural workforce. Nationally the production of coconuts and sugar dropped dramatically, such that the Philippines were unable to meet self-sufficiency targets and export quotas.<sup>126</sup>

As the typhoon struck between two farming seasons, it severely affected ready-to-harvest, harvested and newly planted rice, in addition to destruction of seeds and tools.<sup>127</sup> A total of 67,000 hectares of rice crops were destroyed, which reduced production by 131,600 tonnes. This is serious for food security, as rice provides half of the Philippines' food energy requirements. The Eastern Visayas region lost one third of its rice stocks.

The expected production shortfalls, accompanied by rising imports and limited government rice reserves, left millions of households vulnerable to food insecurity from a period of sustained high prices. The threat was moderated because the government implemented immediate measures to ensure that the price increase was regulated. The poorest people in the country spend 30 percent of their income on rice; in the six months directly following the typhoon, the worst-affected communities were predicted to experience income drops of 25 percent.<sup>128</sup>

### **2.4.3.3. Ineffective governance and the impact on the most vulnerable**

The Philippines is used to dealing with typhoons. The country experiences an average of 20 typhoons per year, and along with floods, landslides, droughts, volcanic eruptions, earthquakes and tsunamis this makes it one of the most disaster-prone countries in the world.<sup>129</sup> In fact Typhoon Haiyan hit whilst the government was three weeks into disaster responses elsewhere - to a 7.2 magnitude earthquake in Bohol and dealing with internal displacement due to conflict in Zamboanga. In the case of Typhoon Haiyan, the storm did not deviate from a direct route and regular timely and accurate warnings were issued by the Philippines Meteorological Department. It is estimated that disaster preparedness and speedy evacuations helped save at least 800,000 lives.

However, the colossal destructive power of the typhoon was unlike any previously witnessed. Furthermore, although the meteorological service was putting out frequent alerts to communities to warn them about a pending 'storm surge' up to 7m high, communities did not necessarily understand that storm surge meant a huge wave like a miniature tsunami that inflicted enormous damage to coastal communities even some distance inland. The perceived threat of stronger typhoons, and storm surges enhanced by sea-level rise, were behind calls by the government of the Philippines for the world to combat climate change in the aftermath of the typhoon.<sup>130</sup>

Assessments suggested that approximately 5.6 million people required emergency food assistance and support to prevent food insecurity in the short and long term, or the restoration of their agricultural and fishing livelihoods in the long term.<sup>131</sup> If livelihoods are not quickly restored, those affected will need to live on food aid until the next potential growing season in October 2014.<sup>132</sup> It is concerning that only 17 percent of all emergency response and restoration activities currently aim to restore livelihoods.<sup>133</sup>

Domestic institutional barriers hinder the coordination of relief and early recovery efforts as well as effectiveness of long-term responses. Government inefficiencies need to be tackled, in order to deal with negative pressure on vulnerable groups, such as women and children. As of June 2014 there was need for food aid for 145,000 children, micronutrient supplementation for an additional 100,000, and treatment for acute malnutrition for a further 27,000. Unfortunately, the deficit of skilled workers in the field is hampering the scale-up of such nutrition activities.<sup>134</sup> In addition, the distribution of assistance to affected farmers in more remote areas, such as highlands, has been either limited or absent,<sup>135</sup> and some members of minority indigenous communities have reported discrimination in the delivery of assistance.<sup>136</sup>

## **2.4.4. Conclusion**

The frequency and intensity of typhoons in the Philippines, and the devastation caused by Typhoon Haiyan, has potential implications for food security if reconstruction efforts are not extensive and effective. The regeneration of livelihoods for farmers, especially considering the role of rice in providing for the poor, is essential, as is the restoration of fisheries. Social protection systems and longer-term preparedness measures should be implemented by domestic actors and international partners as key elements to strengthen resilience.

## 2.5 CASE STUDY SUMMARY MATRIX

	<b>Governance structures</b>	<b>Power structures</b>	<b>Response and reconstruction</b>	<b>Commodity prices</b>	<b>Impact on vulnerable groups</b>
<b>Russia heat wave</b>	The Russian government responded to the crisis by banning wheat exports.	Hoarding of food supplies and price gouging by speculators compounded the crisis. The informal sector often filled a void.	The government began transferring wealth from grain to livestock producers. It also encouraged private insurance to avoid rebuilding costs in the future.	Global wheat prices rose dramatically, up 85 percent year-on-year in April 2011. Possible link to political upheaval in the Middle East. Domestic price rises for subsistence goods resulted in poverty increases.	Domestically, increase in poverty was felt by agricultural workers and women. Internationally, among Arab Spring nations, Egypt's hungry protestors may have suffered the greatest impact.
<b>Pakistan flood</b>	The newly established decentralized disaster management system was not ready for an event of such magnitude but equally Pakistan's central government did not take a lead role.	Some coercive landlords took advantage of smallholders and other flood-affected people. Alongside neglect of infrastructure, some flooding was the result of deliberate breaches by wealthy landowners.	The response was largely determined by geographic location. The south experienced poorer emergency response than the north.	There was an 80 percent increase in wheat and rice prices in 2010.	Those affected by the flood were disproportionately landless tenants and farmers. 70 percent lost at least 50 percent of their income. In addition, 53 percent of women were found to be food insecure, compared with 43 percent of the total population.
<b>East Africa drought</b>	Ethiopia was best prepared, with pre-positioned state-sponsored safety nets. Kenya experienced political distractions. Somalia had no effective governance structures, responded too late, and entered famine.	Across the region a six-month delay in the large-scale international and domestic aid effort due to a general culture of risk aversion and in central/southern Somalia, wariness of the political situation and risks posed by armed groups.	Regional early warning signs were not heeded as required. Significant pressure on large refugee camps in Kenya and Ethiopia.	Food prices reached record levels in several markets. Each country had a symbol of the crisis: wheat in Ethiopia, maize in Kenya, and red sorghum in Somalia.	Children under five years of age were disproportionately affected, accounting for over half of all deaths in Somalia. Women and pastoralists were also impacted. There was huge swelling in already cramped refugee camps.

<p><b>Philippines typhoon</b></p>	<p>Central government issued warnings and local governments are prepared for typhoons but not on this scale, and storm surges were new and not understood. A lack of support for the resumption of government services. Insufficient human resources hampered nutritional goals.</p>	<p>Distribution of assistance to affected farmers in more remote areas either limited or absent. Loss of citizen's records and documents. Resettlement of fishing communities inland risks depriving them of livelihoods.</p>	<p>Only 17 percent of total (international + national) recovery projects aim to restore livelihoods. The government made an urgent plea to the international community to combat climate change in response.</p>	<p>Extensive damage to two consecutive farming seasons led to higher rice prices.</p>	<p>Farming and fishing communities. Women, children and some ethnic minorities faced discrimination with aid distribution.</p>
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# SECTION 3: RELEVANCE OF CLIMATE CHANGE

The four case studies analysed in Section 2 illustrate how extreme weather events can lead to widespread disturbances in food security. This section will consider how climate change might complicate this situation, by asking:

- How has the frequency and magnitude of such extreme weather events changed in the recent past and how might it change in future?
- Has climate change altered the risk of these extreme events occurring?
- If there are more intense extreme weather events more often, how might this affect food security?

First, we will discuss the association between human greenhouse gas emissions and extreme events, including a summary of the evidence about the potential role of climate change in each of the four extreme weather events focused on in this report. Then, we will consider illustrative scenario analyses of potential future risks including the potential implications of such changes for food security.

All extreme events have unique causes, in the sense that a combination of natural variability and external climate drivers lead to a specific event. Therefore it is not possible to say exactly how climate change will affect specific events such as heat waves in Russia, flooding in Pakistan, droughts in East Africa, or typhoons in the Philippines. However, it is possible to say how the likelihood of the types of events we understand and can model reliably – heat waves, floods, certain droughts – have changed due to climate change. But because of the fact that specific extreme events are caused by multiple local factors, as detailed in Section 2, statements attributing changes in the risk of an event to climate change have to be done on a case-by-case basis. On a global scale it can furthermore be said that the magnitude and frequency of heat waves and extreme precipitation events will increase, simply because of the increasing global temperatures and the ability of warmer air to hold more water vapour. However, as the global atmospheric circulation is expected to change as well only the increased risk of heat waves can be transferred from global to local and regional scales.

Against this background the scenarios explored at the end of this section are purely illustrative and cannot be assessed with respect to their likelihood of occurring in the future. However, from a climate scientific point of view all scenarios are plausible.

## 3.1. THE LINK BETWEEN EXTREME WEATHER EVENTS AND CLIMATE CHANGE

The influence of greenhouse gases on the climate system is unequivocal. We know that global temperatures rose during the 20th century due to human emissions, and are very likely to rise in future.<sup>137</sup> Understanding the influence of greenhouse gases and global warming on extreme weather events is more difficult. This is partly because extreme events are, by definition, rare, and so data are limited, and partly because of natural variability in the climate system. Extreme weather has always occurred, and natural variability will continue to influence weather in future. However, scientists expect that emissions from fossil fuels will alter the frequency and intensity of extreme weather events, and there is an increasing amount of evidence to support this.

There are two related areas of enquiry that can help us to understand the link between weather and climate change:

1. Trends in extreme events, about which we can draw some conclusions from basic physics, historical observations, and model experiments exploring future climate scenarios;
2. While it will never be possible to confidently state that an event would not have occurred without human-induced climate change, 'probabilistic event attribution studies' (PEA), that consider whether and to what extent climate change altered the magnitude of and the risk of such an event occurring, can be conducted for certain types of extreme event.

In a seminal 2004 paper, Stott et al. developed a method of PEA, and showed that climate change doubled the risk of the record-breaking 2003 European heat wave.<sup>138</sup> Since this time, improvements to climate models and the methodology have allowed for the demonstration of links – positive or negative, or the absence thereof – between some specific extreme events and anthropogenic climate change.

While climate models have greatly improved in recent years, with the increase in spatial resolution making the representation of extreme weather much better, their capability to simulate such events varies. Robust attribution statements can be made for heat waves and extreme precipitation events, and, to a certain degree, droughts. The influence of climate change on individual hurricanes and typhoons is, however, not analyzable with current research tools.

While it is possible to attribute individual extreme events, within the above-mentioned constraints, studies need to be made for each single event because each event results from a specific set of conditions. For example, for flooding in the UK, PEA studies have suggested that climate change increased the risk of flooding in autumn 2000, but decreased the risk of flooding in Spring 2001.<sup>139</sup> To date, studies have only been done for a small number of extreme events on an ad hoc basis, and therefore for many extreme weather events we cannot yet make statements about whether climate change had an influence on that specific event.

In the following sections, we will consider evidence that might shed light on the association between climate change and each of the weather events discussed in Section 2.

### 3.1.1. Russia's 2010 heat wave

There is strong evidence that anthropogenic greenhouse gases are causing average temperatures to rise globally and regionally.<sup>140</sup> Changes in heat waves—defined as spells of days with temperatures above a threshold determined from historical climatology—have been linked to climate change.<sup>141</sup> According to the most recent assessment report from the IPCC, it is likely that human influence has substantially increased the probability of heat waves in some locations, and made it very likely that heat waves will occur more often and last longer in future.<sup>142</sup>

Several studies have investigated the role of climate change in the 2010 Russian heat wave. Dole et al.<sup>143</sup> suggest that it was 'mainly natural in origin', while Rahmstorf and Coumou<sup>144</sup> found that human-induced climate change made its occurrence more likely. They show that observed warming in western Russia is more than twice the global mean warming and estimate that this warming trend has increased the number of records expected in the past decade five-fold. Otto et al.<sup>145</sup> demonstrated that these results are not contradictory: the magnitude of the heat wave was no different from what would be expected from natural variability, but climate change did indeed increase the probability of it occurring.

### 3.1.2. Pakistan's 2010 floods

Flooding can have a variety of causes, both man-made and natural. On many occasions flooding results from river basin management as well as weather events; therefore, it is too simple a question to ask whether flooding will become more frequent and widespread. The 2010 flooding in Pakistan was associated with very heavy rainfall and the extension of monsoon rainfall further north than on average. These combined with inefficient water management and unsustainable land use to bring disaster.

Abdul Majid Khan, Oxfam's Programme Manager for Disaster Risk Reduction and Climate Change in Pakistan, observed: "It's true we're managing our water resources poorly, and have been for 40 years; that's not changed. But what has changed is the pattern and timing of the rains. We have very extensive rains, especially in areas where we didn't really have monsoons before; and the rains have been coming later every year now for four or five years. Farmers can't grow crops - either crops don't mature because the rains are late or in other areas people are about to pick the crops when the rain starts and batters them down. And that's why we're getting these floods year on year."<sup>146</sup>

What happened in Pakistan in 2010 raises the question of whether we should expect changes in rainfall events because of climate change.

In general, an increase in heavy rainfall is expected in a warmer atmosphere.<sup>147</sup> This is because, as temperatures rise, the atmosphere can hold more water vapour, which increases the likelihood of heavy rainfall events. In keeping with this theory, an increase in heavy rainfall has been observed globally as the hydrological cycle intensifies.<sup>148</sup> Therefore we are seeing, and can confidently expect, more heavy rainfall events globally because of climate change.

In general, in Pakistan wet months have been becoming wetter and dry months drier from 1991 onwards compared to the previous 30-year period with wetter summers and drier winters.<sup>149</sup> Broadly, mean rainfall has increased in the North and declined in the South since 1960<sup>150</sup> and the number of heavy rainfall events has increased.<sup>151</sup> However, how climate change will affect rainfall events in any particular location is another question. The controls on rainfall are often very complicated. The extremely heavy rainfall leading to Pakistan's flooding in 2010 was associated with large-scale low pressure systems linked to the Russian heat wave and La Niña. It is as yet very difficult to say how climate change might affect the dynamics of these large scale processes.

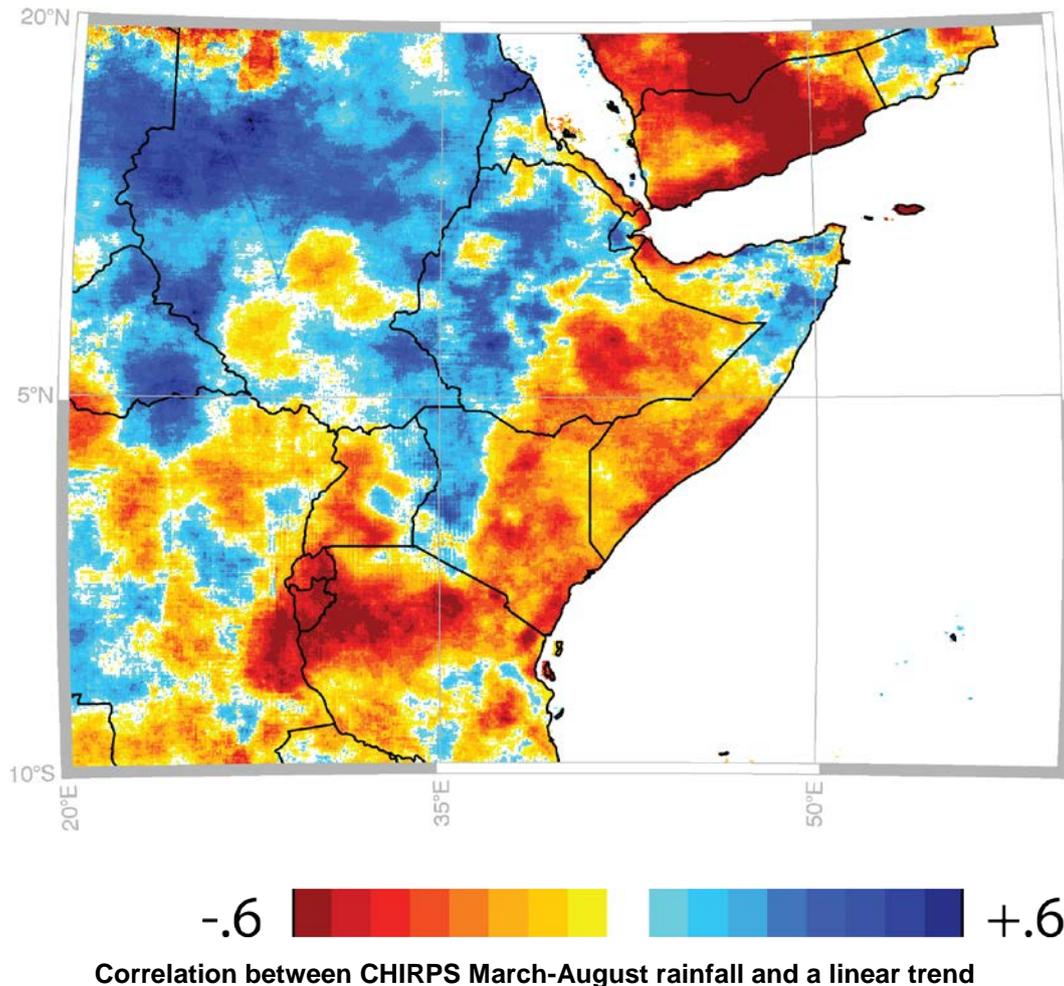
There has been one paper which considered the attribution of the 2010 floods.<sup>152</sup> The authors found that the model they employed was not able to provide reliable results for this event. Without further research using other models, and/or improvements in model ability, it will remain unclear whether climate change played a role in this specific case.

### **3.1.3. East Africa's 2010–11 drought**

Whether or not more droughts should be expected in the future is an even more challenging scientific question than for flooding. This is largely due to the difficulty of anticipating changes in rainfall and the crucial role of soil–atmosphere interactions, which is a challenge for contemporary climate models. Drought is a very difficult phenomenon to define or measure. There is not a scientific basis for the idea that there has been an observed trend in global-scale dryness or drought in the 20th century. However, there may have been some changes in dryness and drought at a regional scale; there is medium confidence that the duration and intensity of drought has increased in southern Europe, for example.<sup>153</sup>

For East Africa, there is evidence to suggest that there has been a recent and abrupt decline in rainfall and an increase in droughts over the last 20 to 30 years<sup>154, 155, 156, 157</sup> and there have been increasing problems for food security. These decreases in rainfall have been accompanied by significant increases in air temperatures.<sup>158</sup> Rainfall recession increasingly encroaches onto some densely populated and food surplus producing areas in the centre of Kenya.<sup>159</sup> Across East Africa there were poor rains in 2008, 2009, 2011 and 2012. In Somalia the short rains failed in 2013 and the long rains in 2014, leading to new warnings of rising acute food insecurity. Long season rainfall has declined across much of southern Ethiopia and Somalia, western Uganda, eastern Kenya, Rwanda, Burundi and northern Tanzania (see Figure 5). Scientists have found that this is linked to changes in the Pacific Ocean,<sup>160</sup> and warming of the Indian Ocean.<sup>161</sup> Large warming of the Indian Ocean has been observed over the 20th century<sup>162</sup> and further strong Indian Ocean warming is projected in future.<sup>163</sup> If this link proves to be a major driver, then this suggests droughts in East Africa will continue to occur and, indeed, become even more frequent. However, climate model projections for East Africa suggest conditions will generally become wetter. There seems to be an inconsistency between the trend observed in the recent past, generally drying, and the wetter futures in the climate models.

**Figure 7: March–August rainfall trends for East Africa**



Source: Climate Hazards Group Infrared Precipitation with Stations (CHIRPS) used for drought monitoring: U.S Geological Survey and University of Santa Barbara Climate Hazards Group (2014), available at 'The State of Rain', [http://www.usgs.gov/blogs/features/usgs\\_top\\_story/the-state-of-rain/](http://www.usgs.gov/blogs/features/usgs_top_story/the-state-of-rain/)

Lott et al.(2013) have conducted an attribution study to specifically investigate the East African drought in 2011.<sup>164</sup> As noted in section 2.3, the drought resulted from the failure of both the short rains in 2010 and the long rains in 2011. Lott et al. found that there is no evidence of human influence on the failure of the first rainy season, which was mainly associated with La Niña, a naturally occurring mode of variability with a strong influence on rainfall in East Africa. However, the study also tested the role of climate change in the long rains of 2011, finding that the probability of dry conditions had increased due to human influence.

Combining all these sources of evidence, it is as yet difficult to draw conclusions about links between climate change and drought in East Africa. There is evidence that the region has become drier over the last 30 years, and that that climate change increased the probability of dry conditions in East Africa in early 2011. Yet models suggest the region could become wetter. The influence of greenhouse gases on the different drivers of rainfall in this region and the interplay between these drivers demand further investigation to better understand future drought risk.

### **3.1.4. Typhoon Haiyan in the Philippines, 2013**

While some evidence indicates that storm intensity has increased over the last three decades,<sup>165</sup> reliable data are limited to the north Atlantic, where observations are most abundant. The evidence is not yet conclusive in other places, including the Pacific Ocean.<sup>166</sup>

There is also low confidence in any observed long-term (i.e. 40 years or more) increases in tropical cyclone activity (i.e. intensity, frequency, duration), after accounting for past changes in observing capabilities.

How underlying changes towards wetter and hotter conditions and more intense rainfall will affect the specific phenomenon of tropical cyclones or typhoons like Haiyan is still very difficult to answer. Earlier studies suggesting an increase in the magnitude of tropical storms on a global average due to higher temperatures in the tropical oceans<sup>167</sup> are now thought to have not incorporated crucial aspects of changes to circulation.<sup>168</sup> It is also not possible to conduct attribution studies on individual storms like Haiyan because the models used for attribution studies cannot simulate typhoons. More complex models, which are currently too expensive to run for attribution, show improved ability, and therefore this is expected to change.

Uncertainty in projections of tropical cyclones is also too high to draw any conclusions on future changes in risk. Heavy rainfall associated with tropical cyclones is, however, likely to increase with continued warming.<sup>169</sup> According to government meteorologists the intensity of rainfall has been increasing in most parts of the Philippines and there is a trend towards more extreme daily rainfall (1951–2008).<sup>170</sup> Furthermore, an ongoing rise in sea level is likely to heighten the destructiveness of tropical cyclones by increasing storm surge capacity so that sea water is carried further inland.

## 3.2 CONSIDERING THE IMPACTS OF HYPOTHETICAL CLIMATE SCENARIOS

The four case studies presented in this report provide different examples of the impacts of extreme weather events, and begins to indicate how their interactions with socioeconomic and governance conditions affect food security. Impacts are often exacerbated by poor governance, while extreme events, in turn, can further undermine governance structures and increase poverty and vulnerability, leading to further socioeconomic injustice.

As outlined in the previous section, climate change will change the intensity and/or frequency of some types of extreme weather events. Given uncertainties about future changes and the difficulty of predicting specific events, it is valuable to consider some simple, hypothetical and purely explorative scenarios from among many that can be considered plausible.<sup>171,172</sup> A consideration of the impacts of increased intensity and frequency of extreme events follows. It is important to note that these scenarios are not mutually exclusive or exhaustive.

### 3.2.1. Case study: Russia heat wave

#### 3.2.1.1. Scenario 1

- A more intense heat wave in Russia affects a larger geographical area, and more than 50 percent of wheat production is lost (cf. 'only' around 33 percent in the 2010 drought).

If health care conditions were the same, it is likely that more vulnerable people would die from this event. Wheat and bread prices could rise above the price range that a significantly larger group of poor Russians would be able to afford, which could have implications for political stability. There could also be greater impacts upon countries normally dependent on Russian wheat due to changes in supply and international prices. The Russian government might enact a longer-lasting export ban, leading to even higher food prices nationally and worldwide. This in turn could have an impact on countries that are currently already in political and security crises, especially those involved in the escalating consequences of the Arab Spring. The extreme price spike would also be affected by price speculations, which were already problematic in 2010.

### 3.2.1.2. Scenario 2

- Heat waves become more frequent occurrences.

The Russian government already responded to the 2010 heat wave by encouraging a shift toward livestock, but it is unclear whether this would be effective or rather overwhelmed by more frequent heat waves. Insurance systems have not been seen as reliable by farmers, and with heat waves becoming more frequent, premiums would increase. With a lack of viable safety nets and increasingly untenable conditions for wheat production, many farmers may have to move to other livelihood sources. Because of this, Russia's future as a global bread basket could become uncertain as temperatures rise under extreme climate scenarios, particularly from the 2030s onwards.<sup>173</sup> Global wheat prices would go up. Russia would need to import more wheat from neighbouring countries. Compensation may come from wheat growing areas extending further north with temperature changes, and adaptations may happen. But the long-term decline of food production in this region could have significant consequences for food security in Russia, as well as in politically unstable countries that have so far relied on it.

## 3.2.2. Case study: Pakistan floods

### 3.2.2.1. Scenario 1

- Pakistan suffers a flood of even greater duration than in 2010.

While responses in Punjab in 2010 were relatively quick and effective, aid efforts might be overwhelmed by more persistent flooding, as getting help to the stricken would be nearly impossible in conditions that remained extreme for longer. Longer floods could also destroy more infrastructure and resources, potentially resulting in more widespread migration, as the possibility to return and rebuild faded. Additionally, there would be a risk of greater social injustice from local leaders, who might force affected communities to hand over their aid funds. Potentially, a more decentralized relief response system could lead to people having a greater say in the use of relief resources and hold local leaders accountable. However, this reform would be challenging in politically unstable conditions, especially when trust in local leaders has been shaken by abuse of power during previous flooding.

### 3.2.2.2. Scenario 2

- Floods become more frequent.

Pakistan suffered further floods in 2011, 2012 and 2013 – and as this report was being completed news bulletins reported severe flooding once again in September 2014 – so this scenario must be considered highly plausible. The capacity of the government to respond to such crises might be eroded, if they were less able to muster resources and support from the international community due to donor fatigue. In any case, the frequency of flooding could reduce opportunities for communities, government leaders and other sectors to improve preparedness for such disasters. Mass migrations would raise difficult questions about land rights, and might increase risks to vulnerable people such as women and children. In terms of agriculture, replacing the food previously supplied by stricken regions might prove challenging, while investment could depart from areas previously dominated by cash crops.

## 3.2.3. Case study: East Africa drought

### 3.2.3.1. Scenario 1

- A drought in East Africa covers an even wider area than the case study event.

The drought described in the case study already caused a total collapse of agricultural livelihoods in large areas. Further failure of crops and death of livestock could occur, affecting areas that thus far merely saw a relative loss of productivity. This in turn would mean that

refugees might have even fewer possibilities to sustain themselves elsewhere. The recent droughts saw minimal and delayed interventions from governments, even though early warning systems were in place and functional. Similarly, international aid was already struggling to provide sufficient water and other support, and a larger scale drought might leave more people without any aid. It is worth considering whether warnings of a larger-scale drought would prompt quicker and better action, based on learning from the drought described in the case study, or whether such a drought would still trigger a limited or no response.

### **3.2.3.2. Scenario 2**

- East Africa experiences droughts for a number of consecutive years

The climate of East Africa may well be becoming even more extreme, and some scientists suggest that the trend towards increasing drought is likely to continue in future.<sup>174</sup> Since there has been an increase in drought associated with Indian ocean warming (see section 3.1) Such a scenario is therefore plausible. As with Scenario 1, such a scenario would lead to further failure of crops and livestock, with areas possibly becoming permanently unsuitable for agriculture and even pastoralism. This would lead to more permanent refugees, with migration adding to long-term political instability. The international response to a long-term crisis of this nature is unsure. In this context it is disturbing to note that as this report was about to be published (September 2014), the UN warned that Somalis had once again suffered two failed rainy seasons resulting in poor harvests, water shortages and livestock deaths. Food prices were surging because of drought and conflict blocking roads and impeding trade routes and for the first time since 2011, more than one million people were in need of food aid.<sup>175</sup>

## **3.2.4. Case study: Philippines typhoon**

### **3.2.4.1. Scenario 1**

- A typhoon even stronger than Haiyan makes landfall in the Philippines and beyond.

By the time Haiyan reached Vietnam, it had been downgraded to a tropical storm. However, a stronger typhoon could potentially not only wreak greater devastation in the Philippines, but might continue onwards to cause destruction in mainland South-East Asia. The loss of more infrastructure over a wider area could have a negative impact on the availability and reach of aid. Further, the widespread destruction of infrastructure would likely reduce the ability of governments and international organizations to help. A more extreme typhoon would more generally pose a greater challenge in terms of funding and manpower both for the national government and international aid. Recovery would take longer, leaving vulnerable groups at risk for a longer period. If the typhoon severely affects multiple South-East Asian countries, international aid resources may be divided along political allegiances.

### **3.2.4.2. Scenario 2**

- Typhoons like Haiyan become frequent events.

The increase in disasters would likely lead to widespread displacement, severely affect attempts to rebuild rural livelihoods, and increase the scale and number of the social injustices that emerged during the Haiyan crisis, such as domestic violence and discrimination against certain social groups. More generally, there is a risk that remote areas could be left totally to their own devices, while the capacities and resources of global aid efforts might be exhausted by the accelerating cycle of destruction and reconstruction. This may lead to local communities becoming increasingly adaptive out of necessity, and local adaptation strategies could be supported by international programs, but it may also lead to a desertion of such remote areas. With increasingly frequent typhoons, strategic considerations of the leading global economic powers about influence in the Philippines and South-East Asia in general may impact the provision of aid resources.<sup>176</sup>

### **3.2.5. Conclusion**

Hypothetical scenarios based on increasing intensity and frequency of extreme weather events raise important questions about the possible future impacts of climate change. This is especially important in relation to their interactions with socioeconomic and governance conditions, the potential for adaptive capacities to be overwhelmed, and the circumstances in which vulnerable communities can be driven to extremes. Several scenarios presented here indicate strong consequences for political stability which could heavily exacerbate humanitarian crises. Therefore, strategies for climate change adaptation and coping with extreme weather events should be considered in the context of plausible, multi-dimensional scenarios, and involve multiple domains of decision making.

### 3.3. HYPOTHETICAL SCENARIOS SUMMARY MATRIX

	Nature of weather events	Vulnerable groups	Impact pathways	Governance and socio-economic dimension
<i>Russia</i>				
Scenario 1	More intense heat wave, affecting larger geographic area.	Farmers, poor Russians, poor individuals in import dependent countries.	Food price spike. Lost livelihoods for greater number of farmers.	Greater domestic and international instability.
Scenario 2	Heat waves become more frequent.		How would farmers cope with repeated losses in absence of trust in governments? Shifts to other commodities/livelihoods. Russia impracticable as a global bread basket.	Effects of a forced transition to other sources of food import on unstable countries previously dependent on Russian wheat.
<i>Pakistan</i>				
Scenario 1	A flood of greater duration.	Rural communities and small land owners, those dependent on regional food production and/or cash crops.	More infrastructure and resources destroyed. More migrations out of stricken areas.	Response capacities of government overwhelmed. Social injustice by local leaders more widespread.
Scenario 2	More frequent floods.		Repeated destruction of infrastructure and resources. Permanent migrations. Land rights lost.	Erosion of government's resources and the ability to mobilize international support. No chance for governments and communities to improve preparedness. How would recurring crises affect political stability?
<i>East Africa</i>				
Scenario 1	Larger-scale drought affecting a wider area.	Children under five years of age, women, pastoralists, refugees.	Further failure of crops and livestock, also in previously moderately affected areas. Educational failures. Fewer places to which refugees can flee.	More action or still no response from governments and other sectors.

<b>Scenario 2</b>	<b>Droughts for a number of consecutive years.</b>		<b>Areas become permanently unsuitable for agriculture and pastoralism. More permanent refugees.</b>	<b>Migration adding to long-term political instability? How would the global community respond to long-term crisis?</b>
<b>Philippines</b>				
<b>Scenario 1</b>	<b>More powerful typhoon.</b>	<b>Farming and fishing communities, women, children and some ethnic minorities.</b>	<b>Greater destruction in the Philippines, plus more damage on the South-East Asian mainland (shifting typhoon paths?).</b>	<b>A greater challenge in terms of funding and manpower.</b>
<b>Scenario 2</b>	<b>More frequent typhoons.</b>		<b>Attempts to rebuild rural livelihoods overwhelmed. Social injustices and discrimination to become endemic. Remote areas to be left to their own devices. Widespread displacement and land encroachment. Damage to ecosystems.</b>	<b>Exhaustion of national and global efforts and resources.</b>

# SECTION 4: POLICY RELEVANCE AND CONCLUDING REMARKS

Each of the case studies reflects the fact that extreme weather events have played an important role in the destabilization of both short- and long-term food security, with impacts on various aspects of life. In all cases, the impacts left citizens vulnerable and authorities unprepared. While direct measures such as emergency preparedness and the strengthening of response-related institutions would be helpful, this study identifies the need for a wider cultural shift in many countries facing both food security issues and extreme weather events. More attention to vulnerable groups and inequalities are required in these societies, going far beyond technical improvements to equipment or redirected funding. At the very heart of 'climate justice' is the promise that those who are most vulnerable will not bear the heaviest share of the burden when disasters inevitably strike.

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**Christopher Coghlan** is a doctoral student, teaching assistant and tutor in the School of Geography and the Environment at the University of Oxford. He is currently completing a thesis on global food systems across administrative scales. He works on Oxfam-commissioned research at the Environmental Change Institute (ECI) at the University of Oxford, and is the joint Scenarios and Policy Researcher for the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS).

**Maliha Muzammil** is joint Scenarios and Policy Researcher for the CGIAR Research Programme on CCAFS at the ECI. She is driving multi-stakeholder scenario development for the future of food security, livelihoods and environments for South Asia, working extensively with a wide range of regional actors. She is currently undertaking her PhD at SOAS, examining the opportunities and barriers for low carbon, climate resilient pathways in least developed countries using a political economy approach. She has worked on climate change adaptation, community-based adaptation, sustainable development and low carbon development.

**Dr John Ingram** trained in soil science and gained extensive experience in the 1980s working in East and Southern Africa and South Asia in agriculture, forestry and agroecology research. In 1991 he was recruited by the UK's Natural Environment Research Council (NERC) to organize, coordinate and synthesize agroecology research as part of the International Geosphere-Biosphere Programme. In 2001 he was appointed Executive Officer for the 10-year international project Global Environmental Change and Food Systems (GECAFS). On the close of GECAFS he was appointed NERC Food Security Leader, during which he represented NERC on the UK Global Food Security Programme. In May 2013 he joined the ECI to establish and lead a food systems research and training programme.

**Dr Joost Vervoort** is the Scenarios Officer for the CGIAR Research Programme on CCAFS. He drives multi-stakeholder scenario development for the future of food security, livelihoods and environments for East and West Africa, South and South-East Asia and Latin America. Working extensively with a wide range of regional actors he explores the long-term implications of multiple socio-economic scenarios combined with climate scenarios. The regional scenarios are used to guide policies, investments and institutional change at national and regional levels. Joost has a PhD in Production Ecology and Resource Conservation from Wageningen University and is scenarios work package leader on the TransMango project, funded by the European Commission (FP7), which focuses on plausible futures of the European food system in a global context.

**Dr Friederike Otto** is a physicist by training but gained a PhD in Philosophy of Science from the Free University Berlin. She was based at the Alfred Wegener Institute of Polar and Marine Research in Potsdam during her one-year diploma project working on atmospheric dynamics in global circulation models. While writing her PhD thesis she worked as a research assistant at the Potsdam Institute for Climate Impact Research (PIK) and came to Oxford as a post-doctoral researcher to work on the quantification of uncertainty in climate system modelling. She now works as a senior researcher at the ECI on the attribution of extreme weather and climate-related events to external drivers of the climate system. She is the scientific coordinator of the distributed-computing project [climateprediction.net](http://climateprediction.net) and leads a project to make the attribution of extreme events operational.

**Dr Rachel James** is a climate scientist focusing on changes in African rainfall systems. She is interested in the role of human influence on climate, and the application of climate models to better understand risks to water security, biodiversity, infrastructure, and food systems. She has a PhD from the University of Oxford and is a Research Fellow in Climate Modelling for Climate Services at the ECI, where she is promoting the use of climate science and climate models to provide useful information to decision makers. She is interested in the role of scientific information in climate policy, including the UNFCCC Mechanism for Loss and Damage.

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