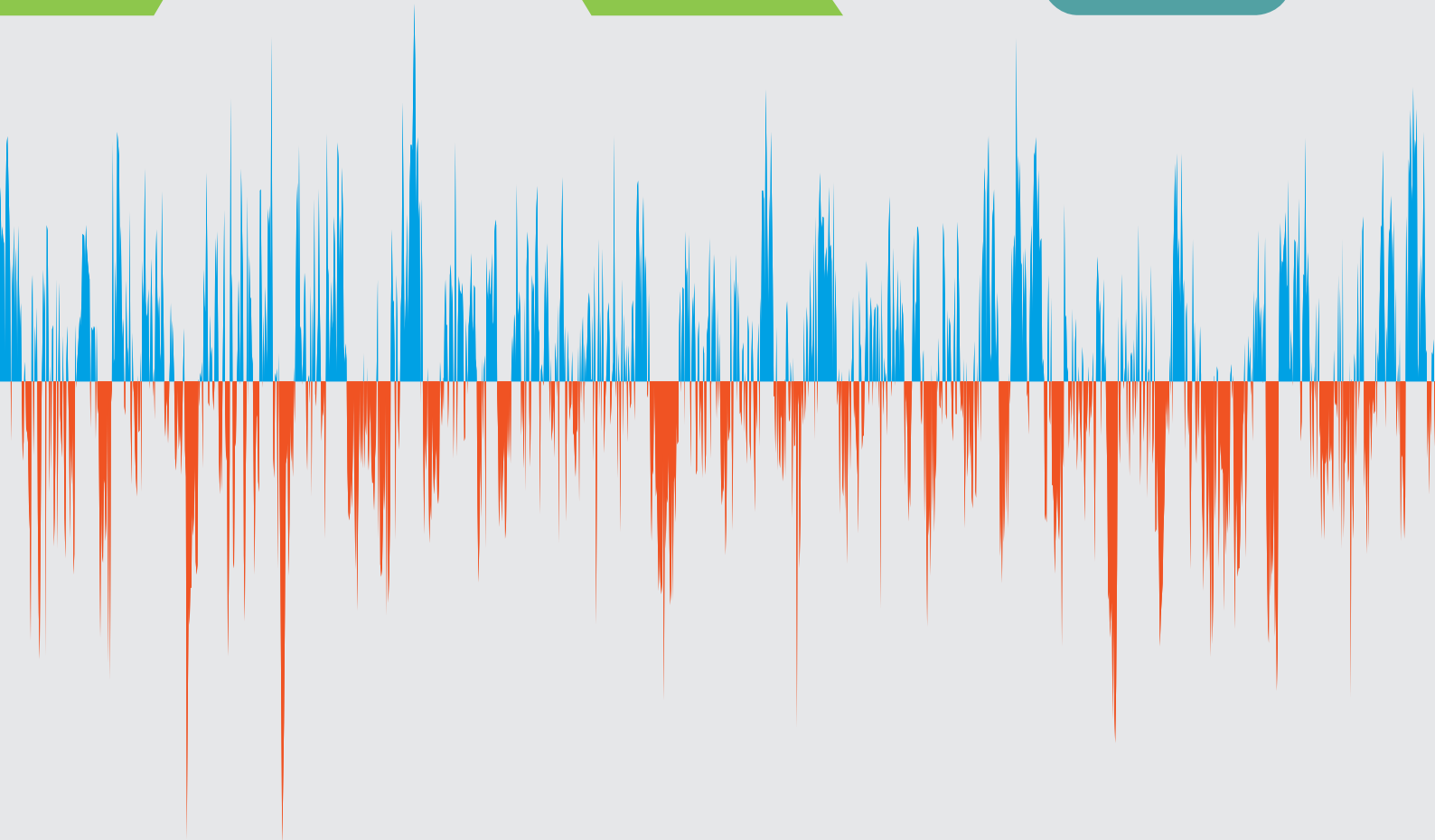
Nexus Brief, Nr. 2, December 2016

Climate Change & Environment

The El Niño phenomenon and related impacts



Key Messages

El Niño events are natural variations of the circulation pattern in and over the Pacific Ocean, with strong impacts on the meteorological conditions on a global level. El Niño events cause intense rainfall over Ecuador and Peru, whereas at the same time unusually dry conditions prevail in Australia and Indonesia. In Eastern and southern Africa, El Niño induces droughts, while Central America and the Caribbean experience wet conditions.

El Niño events have happened regularly over the past thousands of years. The first major El Niño event of the 21st century took place in 2015/2016, and faded out in May 2016. It is unclear whether or not El Niño variations in general will intensify in the future with a warmer climate, but it is expected that El Niño-induced rainfall will intensify due to increased moisture availability.

El Niño events always have strong impacts on society. While direct meteorological consequences fade out after 12 to 18 months, secondary and tertiary impacts on food security and agricultural production extend into the following months and years, with cascading effects on livelihoods, health, water, sanitation, education and other sectors. The 2015/2016 El Niño affected over 60 million people globally.

El Niño impacts and consequences often affect poor and vulnerable regions, people and communities. The immediate financial needs run to several billion US dollars. The political conflicts in Syria, South Sudan, Yemen and elsewhere in combination with the 2015/2016 El Niño event and related climatic extremes are putting an unprecedented level of strain on the worldwide humanitarian aid system in 2016.

For the coming decades, in the course of continued climate change, an increase in extreme events is expected, independently of future El Niño events. It is therefore essential to shift from a reactive system with a focus on post-event aid and relief, towards a system of prevention, preparedness and adaptation, aiming at increasing the preparedness, responsiveness and resilience of potentially affected populations and societies.

Efficient monitoring and early warning systems are of key importance for the reduction of the impacts of El Niño–Southern Oscillation (ENSO) variations. A main challenge is the establishment of effective communication of information available from operational El Niño monitoring and warning systems to targeted recipients.

International policy documents provide an appropriate framework for the planning and implementation of actions for combating climate change and climatic extremes. The main task for involved actors, such as development and cooperation agencies, is to find suitable measures and feasible actions that are aligned with these global political frameworks on the one hand, and specifically tailored to the local conditions and needs on the other hand.

Context

Why this nexus brief

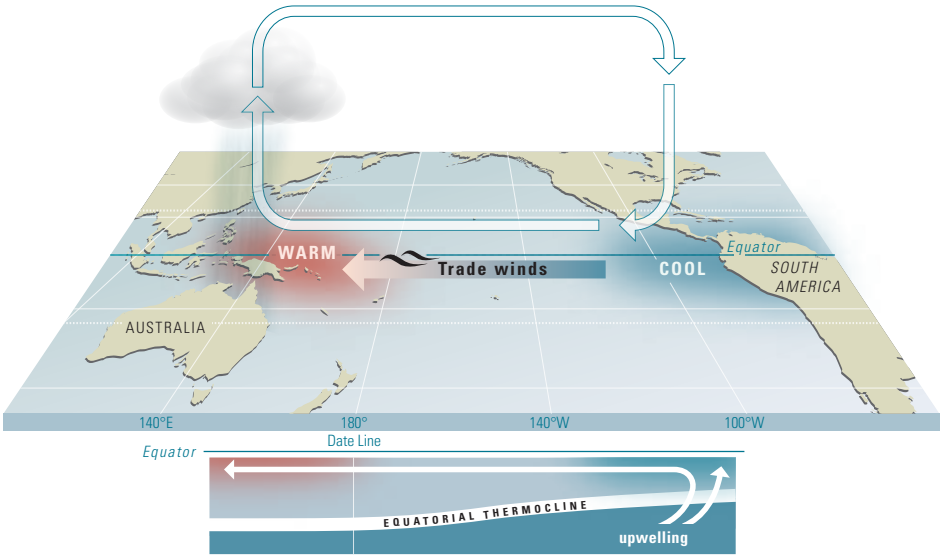
This nexus brief focuses on the phenomenon of the El Niño–Southern Oscillation (ENSO) and in particular on the 2015/2016 El Niño event, which faded out in May 2016, but has impacts and effects on environmental and societal systems that will extend well into 2017.

El Niño Southern Oscillation: Irregular periodic variations in the Pacific

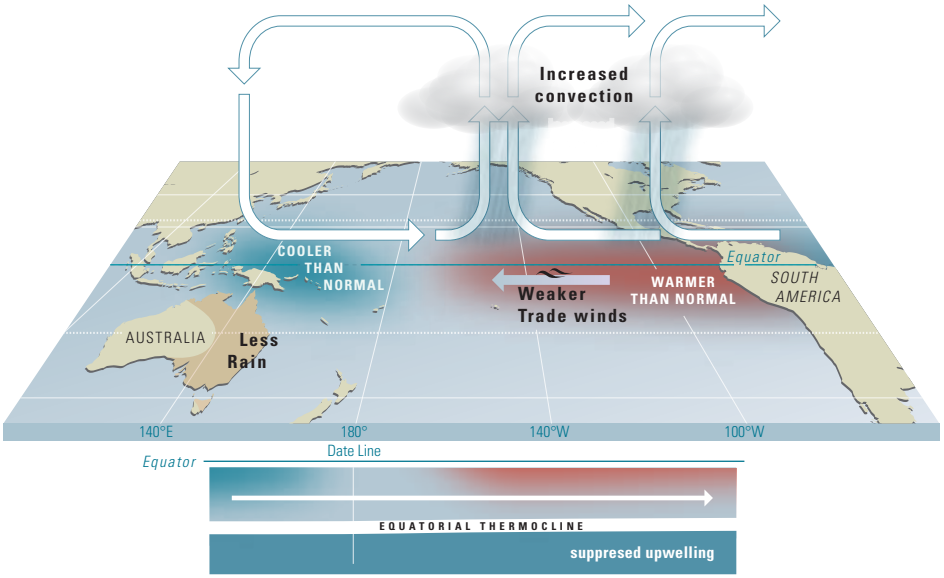
The normal circulation pattern in and over the Pacific Ocean is characterized by equatorial trade winds transporting cold water from the South American west coast towards the west and thus keeping sea surface temperatures cool. Consequently, warm surface waters are pushed towards the western Pacific, piling up in the western Pacific Ocean in Indonesia.

Figure 1: Understanding the El Niño / La Niña variations

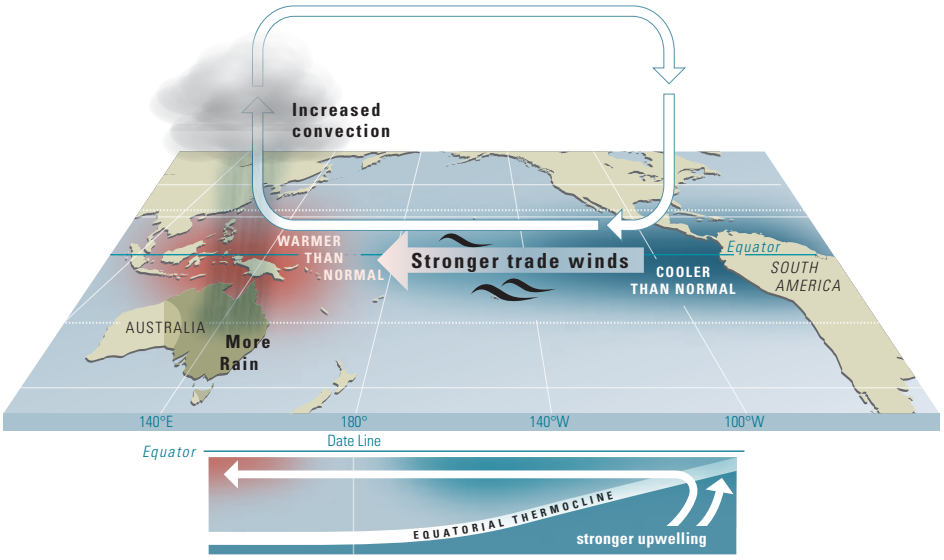
Schematic representation of relative ocean temperatures and atmospheric circulation in the tropical Pacific during normal conditions and El Niño and La Niña variations.



Neutral situation



El Niño episode



La Niña episode

This is the *neutral phase* of the El Niño Southern Oscillation (ENSO); about half of all years are within neutral ENSO phases. The name "El Niño" in Spanish means "the boy/the child", and was chosen because the warmest ocean temperatures in South America typically are observed around Christmas. Its counterpart, called "La Niña" (see below), means "the girl", and is characterized by inverse conditions.

During *El Niño variations*, this circulation pattern weakens, resulting in relaxing equatorial trade winds and a reduced transport of cold water from the eastern to the western Pacific. This leads to a reduction of the upwelling of cold, nutrient-rich water at the South American west coast and an eastward extension of warm surface waters from the western Pacific (Figure 1). Attached to this movement of warm waters towards the east are convective rainfall zones that move eastward as well. Reduced rainfall amounts in the western Pacific, including in Indonesia and northern Australia, and increased precipitation at the South American west coast are therefore direct meteorological consequences of El Niño variations of ENSO. However, via so-called teleconnections ENSO is also affecting the climate system beyond the Pacific region, and therefore has a strong impact on the meteorological conditions on a global level. El Niño events typically last between 12 and 18 months, starting in April and peaking in intensity between November and February.

La Niña variations are the counterparts of El Niño events. By an intensification of the normal circulation pattern – i.e., stronger westward trade winds – a higher contrast of cold surface waters in the eastern and warm surface waters in the western Pacific develops (Figure 1). The effects of La Niña events are often the reverse of El Niño: Heavy precipitation in the western Pacific region coincide with drought conditions in western South America during La Niña events, which typically last at least five months.

Direct consequences and impacts of El Niño

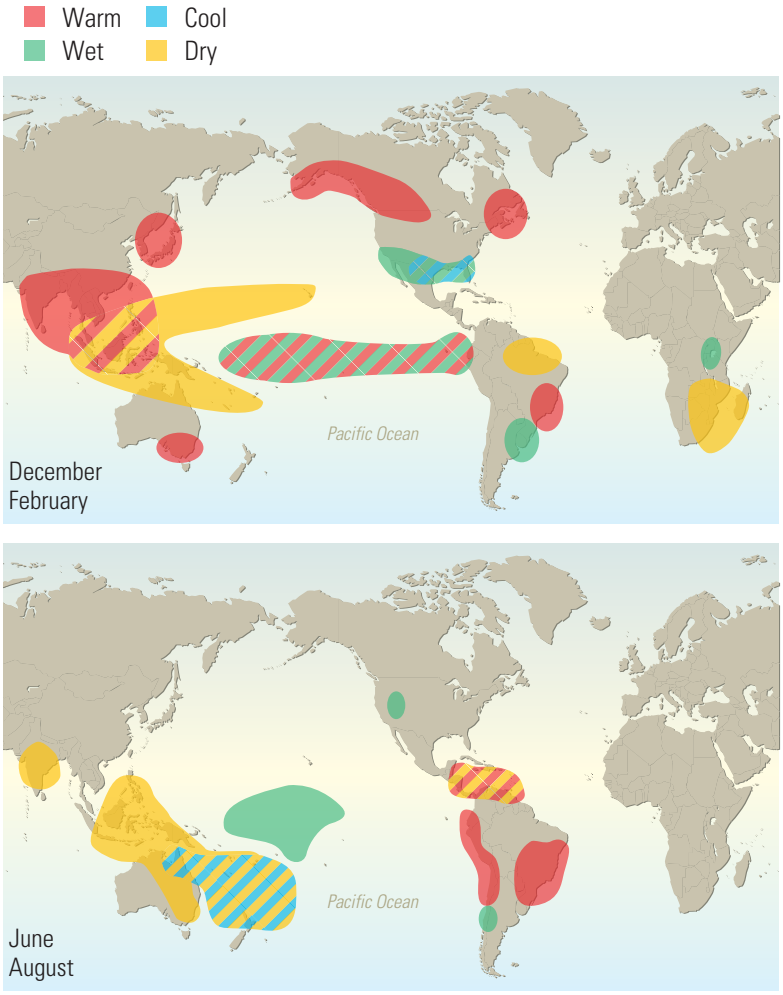
During normal ENSO conditions, warm sea surface waters in the western Pacific cause low pressure conditions with convection and rainfall in Australia and Indonesia. Falling winds build up a high-pressure system over Ecuador and Peru, with dry conditions. At their coasts, the westward trade winds cause upwelling of the cold Humboldt current, which transports cold water from Antarctica along the South American west coast towards the equator, supplies the eastern tropical Pacific with cold, nutrient-rich waters, and causes a significant increase in fish stocks.

El Niño variations of ENSO can cause droughts and heatwaves in Australia and Indonesia, whereas intense rainfall in Ecuador and Peru during the normally dry period drastically increases the risk for major flooding and landslides. Within the ocean, the warm surface waters prevent upwelling of the cold and nutrient-rich water, eventually resulting in reduced fish stocks in the fishery zones of coastal South America.

Besides these impacts in and around the Pacific Ocean, ENSO has other, far-reaching impacts on seasonal precipitation and temperature patterns in many areas of the globe via teleconnections. Figure 2 shows typical meteorological impacts of El Niño events for December to February (top) and June-August (bottom).

Figure 2: El Niño regional impacts

El Niño global impacts for winter (December – February) and for summer (June – August).



Source: US National Oceanic and Atmospheric Administration.

Facts & Figures

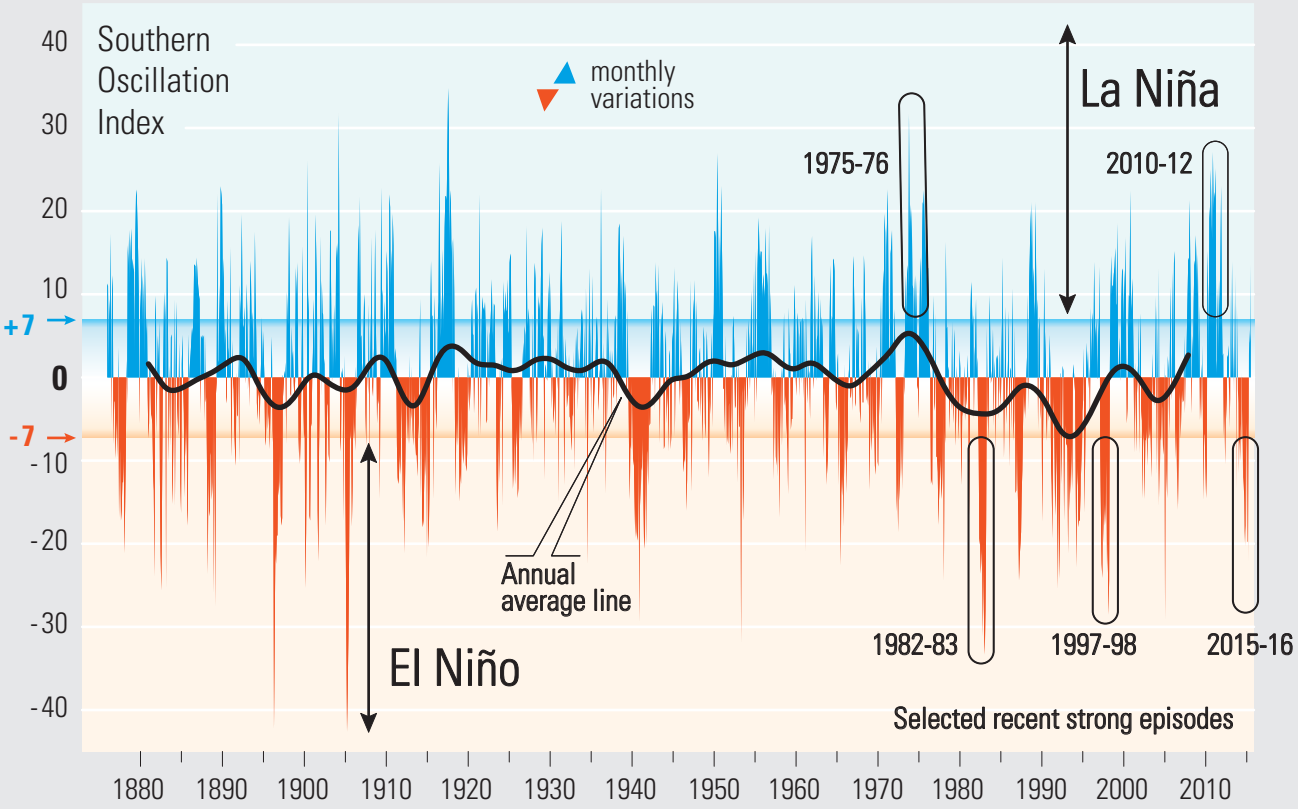
El Niño in the past

El Niño events have happened regularly over the past probably thousands of years, as indicated by records in old coral species. Since 1880, major El Niño events were recorded in the years 1891, 1925/1926, 1972/1973, 1982/1983, 1997/1998, and now recently in 2015/2016 (Figure 3).

El Niño events always have had strong impacts on society, often affecting poor and vulnerable people and communities. According to the UN Office for the Coordination of Humanitarian Affairs (OCHA), the strong 1997/1998 El Niño caused around 21,000 casualties and damage to infrastructure of 36 billion US dollars worldwide, including secondary effects.

Figure 3: The Southern Oscillation Index long-term variations

Plot of the Southern Oscillation Index (SOI) derived from pressure measurements at Tahiti and Darwin. Values lower than -7 (excursions in red) indicate El Niño episodes. Values greater than +7 (excursions in blue) are typical of a La Niña episode.



Data source: Australian Bureau of Meteorology, 2016. Original vector file: Wikimedia (Creative Commons Attribution-Share Alike 3.0 Unported license).

El Niño and Climate Change

The ENSO and El Niño events are phenomena of natural climate variability with global impacts, but are not directly related to climate change. The influence of climate change on the frequency and intensity of El Niño events is uncertain. According to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), there is little consensus within the relevant scientific studies on whether the observed changes in ENSO frequency and intensity during the last decades are due to climate change or natural variability. Simulations with General Circulation Models strengthen the hypothesis that the frequency of El Niño and La Niña events might rather depend on natural climate variability than on anthropogenic climate change. Therefore, as stated by the IPCC in AR5, confidence that El Niño events in general will intensify in the future with a warmer climate is also low. Nevertheless, there is high confidence that ENSO will remain the dominant mode of inter-annual climatic variability throughout the 21st century and also that ENSO-induced rainfall variability will intensify due to changes in moisture availability (Christensen et al., 2013). Independently of ENSO, more frequent extreme events such as droughts and intense precipitation are expected in the course of ongoing climate change, with similar effects for affected populations and impacts on the humanitarian aid system.

El Niño and global temperatures

On a global scale, mainly via teleconnections, El Niño events lead to higher average land and ocean temperatures. 15 out of the 16 highest monthly global land and ocean average temperatures ever recorded since 1880 have occurred between February 2015 and July 2016, which coincides with the El Niño 2015/2016 period. The temperatures recorded for the first seven months of 2016 clearly outbalance the record heatwave in 2015, with January to April 2016 being in the top 5 positive temperature anomalies from the 20th century average (NOAA, 2016). This is a combined effect of climate change and El Niño, highlighting the difficulty of separating the influence of climate variability phenomena, such as ENSO and climate change.

Humanitarian impact of the 2015/2016 El Niño

The 2015/2016 El Niño event had strong humanitarian impacts, affecting over 60 million people globally. While the direct meteorological consequences of El Niño, such as droughts and heavy rainfall as well as related natural disasters are fading out since spring 2016, impacts on food security and agricultural production, with cascading effects on livelihoods, health, water, sanitation, education and other sectors, are likely to continue throughout 2016, and might extend well into 2017.

Heavy precipitation and flooding in the eastern Pacific (South America)

Increased ocean surface temperatures during El Niño variations increase the potential for an intensity of tropical cyclones. The combination of El Niño and other environmental parameters favourable for the development of intense storms led the 2015 hurricane season to set a number of records, in particular in the eastern North Pacific (Collins et al., 2016). Hurricane Patricia, which made landfall in Mexico on 24 October 2015, was reportedly the most intense tropical cyclone in the western hemisphere on record.

In December 2015, severe flooding occurred in Paraguay due to intense precipitation, with 130,000 persons having been forced to leave their homes.

Later, during the first months of 2016, heavy rainfall and related landslides in Peru and Ecuador caused severe damage, including the loss of health infrastructure, which will have long-term impacts on the availability of health services.

Droughts and wildfires in the western Pacific (Indonesia, and East and South Africa)

On the other side of the Pacific Ocean, the dry conditions due to El Niño caused wildfires in Indonesia, in many places among the worst on record. As a consequence, dense haze covered many parts of Indonesia and neighbouring countries, with significant repercussions for health.

Further north, in Vietnam, more than 83 per cent of the country has been affected by drought. A strong intrusion of saltwater due to the reduced rainfall amounts has been observed in the Mekong Delta, affecting groundwater. As of March 2016, 2 million people needed urgent access to freshwater and 430,000 ha of crops had been damaged (ECHO, 2016a; OCHA, 2016a, 2016b).

Food insecurity

Food insecurity, besides shortages of drinking water, is one of the most common, severe and long-lasting consequences of droughts. Droughts related to the 2015/2016 El Niño event had severe impacts, first of all in Eastern and Southern Africa. In Ethiopia, 2015 spring rains failed, and El Niño affected the patterns of the 2015 summer rains, resulting in the worst drought in 50 years for some regions (OCHA 2016c; ECHO, 2016b). Food insecurity entails secondary effects such as malnutrition, reduced cattle-breeding due to fodder shortages, and increased vulnerability to soil degradation caused by possible subsequent intense rainfall events. In Sudan, 4.6 million people are experiencing food insecurity due to El Niño effects, exacerbating the critical food security conditions due to an already below-average agricultural production in 2015 (FAO 2016c; WFP 2016). It is expected that these conditions will lead to rising staple food prices and to further deterioration of already poor pasture conditions. These aspects are likely to continue and possibly worsen the existing political conflict in the region.

Guatemala, Honduras and El Salvador are experiencing the worst drought in decades. The 2015 cereal harvest in Haiti was the lowest in 12 years with losses of up to 90 per cent (FAO, 2016a). As Central America and the Caribbean already experienced a bad agricultural season before the onset of the 2015/2016 El Niño, food insecurity will persist for a second consecutive year (ECLAC & FAO, 2016).

Health issues

In many African regions, El Niño-caused drought conditions were followed by unusually high rainfall amounts that come along with an increased risk for vector-borne diseases such as malaria, and outbreaks of other communicable diseases including measles and cholera. Cholera outbreaks were reported in Honduras and Nicaragua as well as in Tanzania, later spreading out further to Kenya, Chad and Somalia (WHO, 2016). In the latter countries, an additional nearly 90,000 people are affected by Rift Valley Fever (FAO, 2016b). High rates of malnutrition, exacerbated by food shortages, makes affected populations even more susceptible to these types of diseases.

Key issues

Key issue 1: Additional need for aid put on the global humanitarian system

The El Niño phenomenon has severe impacts in affected regions all around the world. By affecting tens of millions, requiring immediate financial assistance of several billion dollars, such events have tremendous effects on the humanitarian aid situation worldwide. Typically, ENSO variations affect the poorest of the poor, those directly depending on agricultural production in Eastern and Southern Africa, the Asia Pacific, Latin America and the Caribbean, i.e., the same regions severely affected by climate change. Impacts and consequences of ENSO variations not only coincide with other climatic and meteorological extremes, but also with civil and political conflicts, in many cases exacerbating the general situation and putting further stress on an already challenged aid system.

In mid-July 2016, the UN Special Envoy on El Niño and Climate stated that the total global funding request for humanitarian responses related to impacts of El Niño had risen to USD 6 billion including both government and UN plans, with a funding gap of over USD 4 billion at this time (OCHA, 2016d). Considering the looming secondary and tertiary effects of the direct consequences these figures are expected to increase further.

The global humanitarian system is already struggling to cope with the fallout from conflicts in Syria, South Sudan, Yemen and elsewhere. Phenomena like the 2015/2016 El Niño event cause extreme conditions in many parts of the world on a time horizon of up to several years, resulting in additional urgent needs for aid. This combination of political conflicts and climatic extremes is expected to put an unprecedented level of strain on the worldwide humanitarian aid in 2016.

Key issue 2: Secondary, long-term effects exacerbate direct impacts

ENSO variations not only have direct impacts, but often entail a series of impacts and chain reactions with often long-lasting consequences for the affected region. Although from a climatological point of view, El Niño conditions persist for 12 to 18 months, the secondary and tertiary effects, such as food insecurity, outbreaks of diseases, and damage to infrastructure persist for months to years longer. Such consequences of ENSO variations often result in an increased vulnerability of the affected populations and societies to possible further climatic extreme events in the short to mid term.

Key issue 3: Move from relief to adaptation and prevention

In view of future impacts and consequences of ENSO variations, efforts should be undertaken towards proactive and preventive measures, aiming at increasing the preparedness, responsiveness and resilience of affected populations and societies.

In relation to the 2015/2016 El Niño event, UN Secretary-General Ban Ki-moon warned that, "extreme weather events reverse development gains. For many of the poorest and most vulnerable, extreme weather events linked to climate change could put the achievements of the 2030 Agenda for Sustainable Development at risk." Although it is unclear whether or not future El Niño events will increase in frequency or intensity, in the course of continued climate change an increase in extreme events is expected, independent of future ENSO variations. It is therefore key to shift from a reactive system, focusing on post-event aid and relief to a system of prevention, preparedness and adaptation. Also, planning and anticipation for future El Niño events should be coordinated into a larger framework of preparedness for climatic extreme events as the expected impacts are akin and therefore require similar prevention, preparedness and adaptation measures.

Key issue 4: International policy frameworks provide a path toward effective management of El Niño related risks

In 2015, international collaboration efforts towards sustainable development, combating climate change and the reduction of disaster risk resulted in key agreements such as the Sendai Framework for Disaster Risk Reduction, the 2030 Agenda for Sustainable Development, and the Paris Agreement on Climate Change. Sustainable development is seriously challenged by impacts from extreme climatic events, in particular those affecting developing and least developed countries and populations mainly depending on the agricultural sector. The mentioned documents of the international policy agenda provide an appropriate framework for

the planning and implementation of related preventive actions, including early warning, capacity-building and climate change adaptation measures. They include as well the commitment of developed countries to mobilize financial resources and mechanisms in order to address the needs of developing countries in the context of meaningful mitigation and adaptation actions. The implementation of the Paris Agreement and the Sendai Framework are therefore of immediate priority in view of the observed and expected primary and secondary impacts of the 2015/2016 El Niño, but also regarding the preparation for future ENSO variations.

Key issue 5: Establishing monitoring and early warning systems and improving effective communication

Monitoring and early warning, as also promoted by the Sendai Framework of Disaster Risk Reduction, are fundamentally important to reducing the impacts of ENSO variations and extreme events induced by climate change. This includes the setting up of new and the improvement of existing monitoring and warning systems, the establishment of civil defence and disaster response authorities and the building of disaster risk management capacities.

One of the main challenges is the establishment of effective communications adapted to the target recipients. Currently, adequate networks of geophysical measurements coupled with operational scientific models are able to monitor and predict the short- to mid-term development of ENSO.

In reality there is in many cases a lack of effective communication on the so-called last mile, i.e., the communication of ENSO status and alert levels from the responsible national and international organizations to the potentially affected population. Experiences from different regions in the world revealed that the most vulnerable part of the population was uninformed and therefore unprepared when hit by El Niño effects, despite the fact that alerts were transmitted. The challenges of such effective communication include on the one hand finding and establishing adequate and efficient means of communication, and on the other hand translating seasonal forecasts and risk data into risk-informed decision-making and actionable guidance so that different development sectors can take proactive measures. Systematic recording, evaluation and sharing of data related to disaster losses is furthermore required in order to draw conclusions and work towards future improvements.

Relevance for SDC

The Swiss Agency for Development and Cooperation (SDC) is active in a number of regions directly affected by ENSO variations, i.e., in many countries of Eastern and Southern Africa, South and South-East Asia as well as the Pacific Region, and also several countries in Latin America, including Nicaragua, Honduras, Haiti, Colombia, Peru and Bolivia.

In the short term and directly related to the impacts of the 2015/2016 El Niño, the main tasks of the international community are to mobilize the required financial resources and to ensure their efficient use in order to provide relief from the damage and adverse effects caused by this event. Apparently only a few El Niño-specific development and cooperation projects exist so far, but in the course of declaring an emergency, many governments allocate parts of their national budgets for the prevention, mitigation and relief of El Niño impacts. In most cases, these amounts may also be dedicated to organizations outside the government, and existing and operating projects and programmes can therefore hope to receive additional funding for unforeseen activities in the context of the 2015/2016 El Niño event.

In the long term, as outlined above, efforts must be undertaken to move from relief actions toward prevention and adaptation measures, addressing impacts and consequences of climatic extreme events in general, including ENSO variations. For SDC, this might involve a close collaboration between the Global and South Cooperation along with Humanitarian Aid.

International policy documents, such as the Sendai Framework for Disaster Risk Reduction, the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change, include the willingness and commitment of the international community to move in this direction and to provide the financial means. The main task for development and cooperation agencies, governments and other relevant actors involved in the process of climate change adaptation and prevention of climate-related disasters is to find suitable measures and feasible actions that are aligned with global political frameworks on the one hand, and specifically tailored to the local conditions and needs on the other hand, as illustrated by the examples in the text boxes.

Crop changes in sub-Saharan Africa as a reaction to the 2015/2016 El Niño

The Alliance for a Green Revolution in Africa (AGRA) supported local farmers in sub-Saharan African countries to change crops from traditional maize to more drought-tolerant maize varieties and to sweet potatoes or disease-resistant cassava varieties. This adaptation measure not only makes the crop less prone to drought-caused failures, but also yields higher crop rates, and, as in the case of sweet potatoes, addresses nutritional deficiencies widespread in the region by providing higher amounts of vitamin A.

In regions like sub-Saharan Africa, where roughly 70 per cent of the population works in mostly small-scale agriculture, such measures not only combat food insecurity, but at the same time support farmers escaping poverty. Eventually, such adaptation measures also contribute to the economic development of affected regions and countries (Kalibata, 2016).

ENSO-specific prevention and early warning in Vanuatu

An example of ENSO-specific prevention and early warning by SDC is the preparation of farmers on Vanuatu islands in the South Pacific Ocean, a region that was affected by a La Niña event in 2010-2012, causing flooding, waterlogged soils, washed out market roads and additional crop pests and diseases. In the framework of a joint project with GIZ, the German development agency, and in collaboration with the Ministry of Agriculture, local farmers were trained on how to construct simple backyard gardens with raised seed trays, elevated planting beds and polybags, organic pesticides, and off-season coverings and treatments. This was done in view of the increased probability of another La Niña event for late 2016 in this region, typically associated with above-normal rainfall.

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