Science and Policy Knowledge Series

Integration of Disaster Risk Reduction and Climate Change Adaptation into Sustainable Development

Advisory Note

December 2015

El Niño 2015/2016

IMPACT OUTLOOK AND POLICY IMPLICATIONS

1. Key Messages

- The 2015-2016 El Niño is likely to be one of the strongest El Niño events since 1997-1998.
- Unlike the 1997-1998 El Niño that followed a neutral year in 1996-1997, the 2015-2016 El Niño is following several months of a mild El Niño in 2014. El Niño is currently at its strongest phase so far and is intensifying.
- The observed impacts from July to October 2015 confirmed its influence on weather patterns, resulting in drought conditions with intermittent “very severe” category cyclones over the Asia and Pacific region.
- As indicated in previous El Niño Advisory Notes prepared by ESCAP and RIMES, the impact of the 2015-2016 El Niño could be even more severe in certain locations such as the uplands of Cambodia, central and southern India, eastern Indonesia, central and southern Philippines, central and northeast Thailand, Papua New Guinea and other Pacific island countries.
- In the Pacific region alone, it is estimated that 4.7 million people are facing El Niño induced drought.
- The Pacific island countries are most likely to face severe risks from the ongoing 2015-2016 El Niño. The most vulnerable sectors are agriculture, freshwater resources, reef ecosystems, fisheries, public health systems and infrastructure.

- El Niño will likely continue to cause significant drought during the period from November 2015 to April 2016, spanning southern parts of Sumatra, Java and eastern parts of Indonesia, central and southern parts of the Philippines and Timor-Leste. Most parts of Mongolia could experience a severe winter associated drought (or *dzud*) leading to inadequate pasture or fodder for the livestock. Many Pacific island countries are likely to experience drought as well as intermittent cyclones.

- Sri Lanka and southern India could continue to experience higher than normal rainfall as per the winter SASCOF outlook issued by WMO and this could cause further flooding, particularly urban flooding, in certain locations. In India, severe floods have already been reported in several parts of Tamil Nadu during November and December 2015, inundating most areas of Chennai.

- Though no two El Niño's impacts are identical, past El Niño associated risk patterns could provide guidance to anticipate and manage future El Niño associated risks. Climate change is also likely to increase El Niño risk, and therefore long term development strategies need to factor in these risks.

- Regional cooperation is critical to ensure better understanding of El Niño associated risks. Sharing and exchanging risk information among stakeholders and creating appropriate enabling mechanisms to act on risk information would help address and better prepare for the impacts of El Niño. Many strategies for this are highlighted in ESCAP's recently published Asia-Pacific Disaster Report 2015.

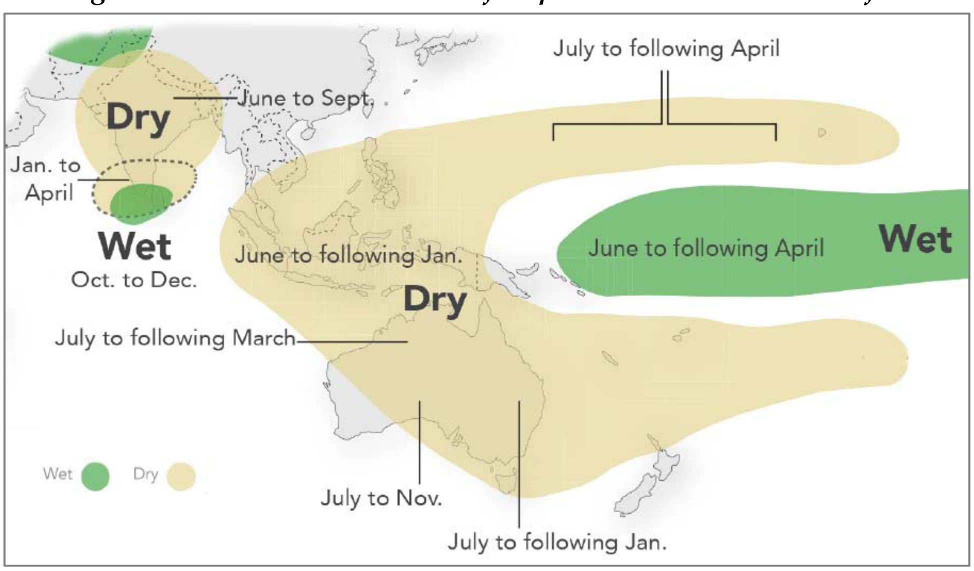
2. Introduction

The El Niño Southern Oscillation (ENSO) cycle is a periodic climatic phenomenon that refers to a warming of the Central and Eastern Pacific, affecting the atmosphere and weather patterns. The effects of El Niño depend strongly on location and season. The main threat comes from reduced rainfall and drought in some regions, but El Niño can also cause heavy rainfall and flooding in others, making it a complex phenomenon.

As forecasted in the previous two El Niño Advisory Notes prepared by ESCAP and RIMES, El Niño which set in around late 2014 has had significant impacts across many countries and sectors of Asia and the Pacific (ESCAP and RIMES, 2014a and 2014b). Climatologists are predicting that the 2015-2016 El Niño event is likely to be one of the strongest since 1997-1998 and may persist until the second quarter of 2016 (FAO, 2015). This is particularly alarming considering the potential effects in Asia-Pacific. The 1997-1998 El Niño alone caused 23,000 fatalities from natural disasters, increased poverty rates by approximately 15 per cent in many countries and cost governments up to USD 45 billion due to severe droughts, storms and other effects (World Bank, 2015).

El Niño conditions are known to shift rainfall patterns across the Asia-Pacific region. These differ from one El Niño event to the next, but the strongest shifts remain consistent in terms of location and season as illustrated in Figure 1, allowing some forewarning for preparedness and adaptation.

Figure 1: Historical El Niño rainfall patterns in the Asia-Pacific.



Source: FAO, 2015.

The strongest effects on precipitation are generally felt in South-East Asia and the Western Pacific Ocean, especially in the dry season between August and November (KNMI, 2015). In the Central and Southern islands of the Pacific and some areas of South-East Asia, where there is a strong reliance on agriculture, the reduced wet season rainfall could have significant impacts.

3. El Niño impacts in Asia

3.1 Observed El Niño impacts and risk patterns in Asia

The mild El Niño conditions during the second half of 2014 have matured to strong El Niño conditions since mid-2015. During the 2014 summer monsoon season (June to September), significant drought conditions were observed over Cambodia, India and Thailand. Certain areas of these countries have been experiencing drought conditions for the second year in succession due to lower than normal rainfall during the 2015 summer monsoon season. Emerging drought conditions during June to October 2015 have also been reported over Indonesia and Timor-Leste. In fact, in parts of Cambodia, the Lao People's Democratic Republic and Viet Nam, farmers have been leaving fields and rice paddies unplanted due to excessively dry and hot conditions. In China's Liaoning province, the lowest rainfall levels since 1951 left more than 230,000 people short of drinking water in July (World Bank, 2015). The details of El Niño risk patterns and observed impacts in past El Niño events, and over 2014 and 2015 where noticeable, are listed below for several countries:

- **Cambodia:** Both drier and wetter rainfall conditions have previously been observed during El Niño years (Thomas et al., 2012). In 2014, 116,129 ha (5 per cent) of cultivated land was affected and 20,289 ha (0.79 per cent) was damaged. In 2015, the onset of rains was delayed until mid-July, affecting 77,419 ha of cultivated land (HRF, 2015).

- **India:** In general, El Niño results in suppressed rainfall conditions during the June to September months, though for some El Niño years there may be no impact on rainfall (Krishna Kumar et al., 2006). Food grain production is highly vulnerable to ENSO events, resulting in significant falls in crop production (especially rice) during El Niño periods (Krishna Kumar et al., 2004). In 2014, seasonal rainfall was around 12 per cent less than normal, which affected food grain production by 10 million tons (RIMES, 2015). In 2015, seasonal rainfall was around 14 per cent lower than normal, with water levels in reservoirs down by 30 per cent. Around 40 per cent of all districts were declared as drought affected (RIMES, 2015). By comparison, and demonstrating the complexity of El Niño, the southern part of India around the peninsular often experiences increased rainfall conditions during October to December during El Niño events (Yadav, 2012, Kumar et al.,2009), which can create a favorable crop production environment but also flooding in certain pockets of southern India.

- **Indonesia**: In general, El Niño conditions result in rainfall being reduced or the onset of the wet season being delayed. In the past, the effect of El-Niño has been particularly strong in regions heavily influenced by the monsoon system (central region) and weak in regions influenced by the equatorial system (the western region) (Boer, 2001). The south and southeast regions of Indonesia, comprising of South Sumatra, South Kalimantan, Java, Bali and Nusa Tengara, are relatively more sensitive to ENSO. Drought-like conditions have led to forest fires, crop production loss (especially in Java where 55 per cent of rice is grown) and water scarcity during previous El Niño events (Naylor et al., 2001). During the current El Niño period, forest fires have been severe, affecting 2 million hectares of land along with 45 million people and 250,000 hectares of crop area in 2015 (RIMES, 2015).

- **Philippines:** The monthly rainfall received in most parts of the country has been reduced by more than 50 per cent during the peak periods of strong El Niño events in the past, but these strong events have also suppressed tropical cyclone activity, though not during weak-to-moderate events (Reyes and David, 2006). Impacts of El Niño events have also previously been seen on crop production (rice) and water availability for domestic consumption, irrigation and hydropower (de Guzman, 2015). In the second quarter of 2015, paddy crops were down by 7 per cent in upland areas and the overall production has been projected to be 500,000 tons, much lower than normal. The Philippines Government plans to import around 800,000 tons of rice to ensure food security in the country (RIMES, 2015).

- **Sri Lanka:** El Niño typically leads to wetter conditions during October to December and drier conditions during January to March and July to August (Zubair and Ropelwski, 2006). Often, an El Niño brings favorable agriculture crop production during the Maha season and negligible impacts on water resources during January to March months.

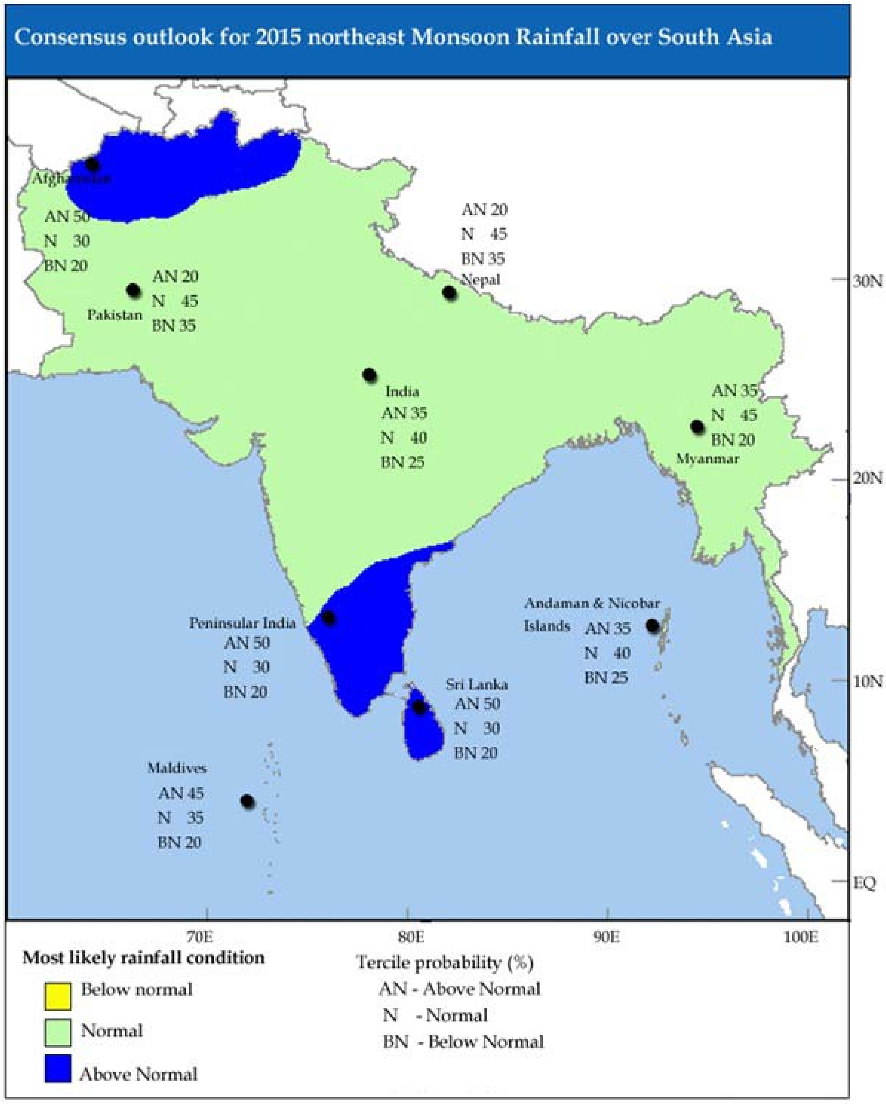
- **Thailand:** Summer season rainfall in 2014 was reduced by 20 per cent in 2014 and reservoir water levels fell by 30-40 per cent, resulting in a loss of around 800,000 million tons of rice in 2014 (RIMES, 2015). A second consecutive year of drought has been seen in 2015, which resulted in insufficient replenishment of key reservoirs. Reservoir levels in late September 2015 were critically low, 40 to 50 per cent less than 2014's drought affected levels (RIMES, 2015).

- **Timor-Leste:** Decreased rainfall conditions are usually observed during the El Niño years, often leading to reduced groundwater availability, with knock-on effects in the agriculture sector.

3.2 El Niño 2015 -2016: Flooding in South Asia

A consensus outlook for the 2015 northeast monsoon season rainfall over South Asia was released on 14-15 October 2015 jointly by WMO, IMD/Government of India, RIMES and CIDA. The outlook highlighted that the prevailing strong El Niño conditions in the equatorial Pacific would affect substantially the 2015 Northeast monsoon season (October–December) particularly in the southern peninsular of India, Sri Lanka and the Maldives (Figure 2) (IMD, 2015a).

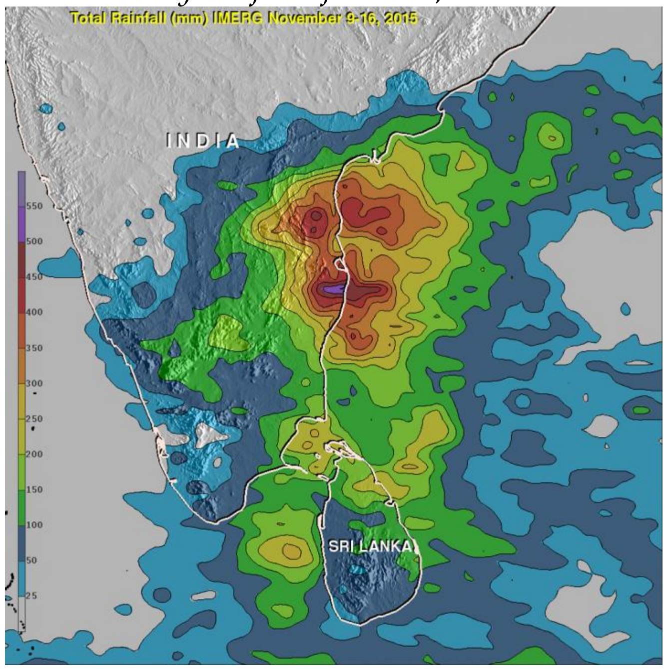
Figure 2: Consensus Outlook for Northeast Monsoon Rainfall in South Asia, 2015



Source: WMO, Indian Meteorological Department/Government of India, RIMES and CIDA – Winter South Asia Climate Outlook Forum, Chennai, India, 14-15 Oct 2015.

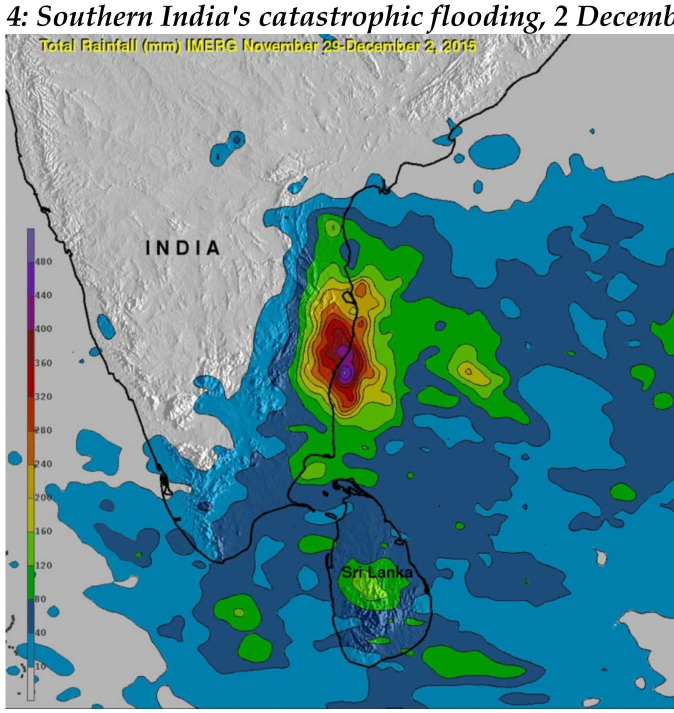
As predicted, the middle of November 2015 witnessed extreme rainfall that caused severe flooding in southeastern India and northern Sri Lanka. The city of Chennai in the state of Tamil Nadu was hit exceptionally hard, with numerous deaths recorded. Extreme heavy rainfall over southeastern India caused deadly flooding in mid-November. Figure 3 shows the rainfall data provided by The Global Precipitation Measurement satellite. Up to 550 mm (21.7 inches) of rain was recorded, which drenched India's southeastern coast in the state of Tamil Nadu and over 200 mm (7.9 inches) fell in large areas of southeastern India and northern Sri Lanka. Record-setting rainfall since November 2015 has generated severe floods, shown in Figure 4, resulting in the death of a large number of people. Reports indicated that the Chennai airport was water-logged and the runway was submerged. While there is no detailed scientific investigation into whether there is a direct link between the 2015-2016 El Niño and Chennai city flooding yet, the consensus that strong El Niño conditions has led to abnormal rainfall during the northeast monsoon season in South Asia indicates that El Niño had a part to play in the sequence of extreme weather events in India.

Figure 3: An analysis of rainfall data, 9-16 November 2015



Source: NASA/JAXA/Hal Pierce, 2015, available from: http://www.eurekalert.org/multimedia/pub/103517.php.

Figure 4: Southern India's catastrophic flooding, 2 December 2015



Source: NASA, 3 December 2015, available from: http://www.nasa.gov/image-feature/goddard/southern-indias-catastrophic-flooding-analyzed-by-nasas-imerg

3.3 Towards 2016: potential impacts in Asia

In Sri Lanka, during the Maha season (November to February), the effects of El Niño are likely to have no impact on paddy production, though heavy rains leading to floods are likely to affect coastal regions. The coconut production might fall in the following year (2017) because of poor rainfall during January to February 2016; however there is unlikely to be an impact on water resources in the country.

Higher than normal rainfall is likely to continue over the southern India and South Asia, including the Maldives and Sri Lanka during the winter period (December 2015 to February 2016), though lower rainfall is expected over the northern part of South Asia (India Meteorological Department, 2015b).

At the same time, the El Niño condition is likely to amplify the observed negative impacts of the 2014 winter season during November 2015 to April 2016 in Indonesia, the Philippines and Timor-Leste. Decreased rainfall conditions over the central and eastern regions in Indonesia are likely during the wet season which can lead to worsening of forest fires, crop production loss (rice, palm) and water scarcity in 2016 (WFP, 2015). Dry conditions will likely continue affecting most parts of the Philippines until April 2016. Drought or dry conditions are likely to affect 69 per cent of the country by the end of December 2015 and 85 per cent of the country by the end of March 2016 (PAGASA, 2015). This could aggravate crop production (rice) and water scarcity issues, for example, irrigation, hydropower generation and domestic water supply (de Guzman, 2015). Timor-Leste is also likely to experience adverse impacts on agriculture due to much lower rainfall.

4. El Niño impacts in the Pacific

4.1 El Niño Risk Patterns and observed impacts in Pacific islands

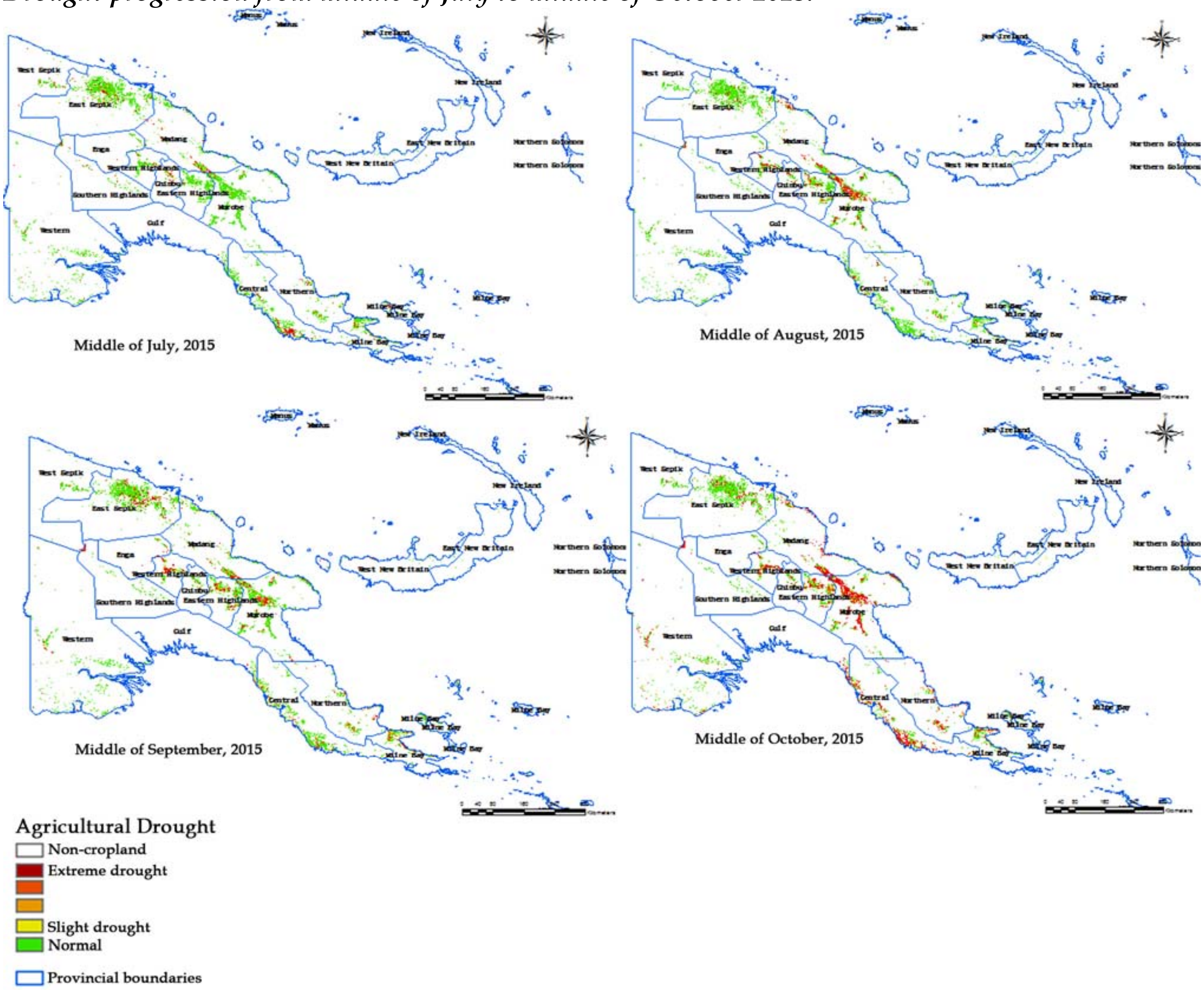
Pacific islands have different climatic conditions based on their geographical location and the influence of climate drivers, including El Niño. The Central and Southern islands experience dry seasons from May to October, with countries such as Papua New Guinea receiving much less rainfall (Box 1). The Northern islands, on the other hand, receive higher rainfall during May to October.

As discussed in the El Niño 2014/2015 Impact Outlook (ESCAP and RIMES, 2014b), generally El Niño is associated with suppressed rainfall in most Pacific island countries which can result in drought. El Niño conditions can also lead to increased frequency of tropical cyclones, abnormal sea level conditions and increased rainfall in other areas. As a result, water shortages, food insecurity and diseases such as cholera, dengue, and malaria, which threaten more than four million people in the Pacific region, are likely to be experienced (UNOCHA, 2015a). Many countries in the Pacific region are already experiencing drought, including Fiji, Papua New Guinea, Samoa, Tonga and Vanuatu. In Papua New Guinea, food shortages have been severe due to the worst drought in nearly two decades, coupled with frosts in the country's highlands, which have destroyed critical harvests (Yeager-Kozacek, 2015).

Box-1 Agricultural Drought Monitoring of Papua New Guinea in 2015

Papua New Guinea mainly plants sweet potato, sugarcane, palm oil, yams, taro, and other staple vegetables in the northwest, central and southern parts of the country, however, crop conditions are generally unfavorable and worsen during El Niño events. At present, the crop conditions are the worst in five years with more than 2.4 million people across Papua New Guinea affected by the drought that was exacerbated by the current El Niño event (Government of Papua New Guinea, 2015). From February to October in 2015, rainfall across the crop planting zones in Papua New Guinea was below average, particularly in the period of June to October, and in July and August. The entire of Papua New Guinea experienced above-average temperature conditions compared to the 14 year average, with a temperature deviation from normal of 2 to 3.2 degrees. All of this caused Papua New Guinea to experience persistent agricultural drought which is damaging crop yield, production of food supplies and exports.

Drought progression from middle of July to middle of October 2015.



In July, agricultural drought occurred in some areas of Papua New Guinea, with low levels of rainfall and high temperatures experienced throughout the country. From mid-August, the drought conditions extended gradually, causing severe agricultural drought in the middle of the country (Morobe, Eastern Highlands, Madang, Western Highlands). From September to October, most of areas experienced severe agricultural drought, with a notable expansion towards the west and south provinces (such as Western, Central, Northern, Milne Bay). During November the drought conditions persisted and will likely continue into the first quarter of 2016.

Source: Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, 2015

However, the impact varies for different countries in the Pacific. For example, in Kiribati and Nauru, El Niño is associated with an increase in rainfall. Similarly, an analysis of the previous El Niño years show that, with the exception of Papua New Guinea that experienced fewer tropical cyclones, there has been an increase in the frequency of cyclones affecting the Central and Southern islands. The Marshall Islands have been exposed to a cyclone of greater intensity, while the exposure of a few countries such as Palau and Vanuatu remained the same. Different patterns of sea level rise have also been experienced due to El Niño. While most countries in the Pacific experience a below average sea level, the Cook Islands, Kiribati and Nauru have experienced a higher than average sea level during El Niño events.

4.2 *Impact of El Niño on different sectors in the Pacific*

The severe El Niño event of 1997-1998 resulted in drought that caused a failure of staple food crops, such as taro and yam, and forced people to depend on food aid and bush crops. The El Niño 2014/2015 Impact Outlook highlighted details of the impact of El Niño on different sectors of the economy, in particular agriculture, freshwater resources, reef ecosystems, fisheries, public health and infrastructure. One of the most significant impacts is on agriculture, which is a key component of the GDP for many Pacific countries. Reduced rainfall has been seen in many Pacific island countries during the wet season which has caused the loss of cash income for people dependent on agriculture. Table 1 lists some of the historical impacts of El Niño on various sensitive sectors in the Pacific along with recently observed impacts in 2015.

Table 1: Impact of El Niño on different sectors

Country	El Niño Risk Patterns	Historical impacts of El Niño on different sectors	Observed impacts in 2015 due to persisting El Niño
Federated States of Micronesia	Suppressed rainfall conditions are observed	**Agriculture**- Prolonged drought due to 1997/98 El Niño caused stress on staple crops, especially taro, and depleted food supplies (UN OCHA, 1998). **Water Resources-** Prolonged drought due to 1997/98 El Niño caused many areas to be without water, or on water rationing (UN OCHA, 1998).	None recorded yet.

Fiji	Suppressed rainfall conditions	**Agriculture-** The 1997-1998 drought caused 26 per cent decline in sugarcane production, and led to a decline in GDP of at least 1.3 per cent (World Bank, n.d.); losses of livestock amounted to around USD 7 million (McKenzie et al, 2005). During 2009, the western island received over 45 cm of rain in 24 hours that resulted to severe flooding of up to 3 to 5 meters, and severely damaged agriculture and infrastructure worth F$100 million (SPC, 2010). **Reef Ecosystems-** Coral bleaching cases reported due to warm sea surface temperatures in 1997-1998 (World Bank, n.d.); increases in sea level, sea surface temperatures changes, and alteration of the mixing layer thickness affect plankton productivity (Government of the Republic of Fiji, 2013)	Impacted indirectly by Cyclone Pam during March 2015. At least 30,000 people are currently affected by drought and the sugar cane crop is down by 25 per cent (FAO, 2015**).** The evolving El Niño event is already causing water shortages in many parts of Fiji, especially in the outer islands and remote rural areas where piped water is not accessible (UNOCHA, 2015c).
Kiribati	Increased rainfall events	**Fisheries**- Tuna catch increased by 10 per cent in 1997; however, the relationship to El Niño is not confirmed (Aaheim and Sygna, 2000).	Temperature will continue to increase, with more very hot days. More intense rainfall could be expected, relatively decreasing the likeliness of drought in the future but probably increasing the likeliness of floods/storms.
Marshall Islands	Suppressed rainfall conditions	**Agriculture-** Significant yield reduction in most crops during 1997-1998 (FAO, 2008). **Fisheries**- Decreased tuna catch during 2002-2003 event (FAO, 2008).	The country is bracing itself for the first El Niño related drought in almost two decades. Crisis is looming on a country that is heavily dependent on rain for drinking water (UNOCHA, 2015c). It is likely that unseasonal storm fronts and strong westerly winds could occur again, possibly affecting the fishing activities of Port Majuro (Johnson, 2015).
Niue		**Infrastructure**- Damage from high winds, storm surge, and intense rainfall from Cyclone Heta in 2004 was three times the country's GDP (Australian Bureau of Meteorology and CSIRO, 2011)	Indirect impacts due to cyclone Pam reported.
Palau	Suppressed rainfall conditions	**Water Resources**- Water shortage due to prolonged drought in 1997-1998 led to water rationing (Australian Bureau of Meteorology and CSIRO, 2011)	None recorded yet.
Papua New Guinea	Suppressed rainfall conditions	**Agriculture-** The 1997- 1998 drought severely affected subsistence farming, and significantly affected the production of coffee and cocoa. About 1 million people suffered from food insecurity due to failure of food crops. The Australian government provided AUD 30 million in food aid to areas affected by drought (SPC, n.d.). **Fisheries**- Increased tuna catch (Lehodey in Nicol et al., 2014).	An estimated 2.4 million people - about one-third of the country's population are affected by El Niño induced drought, frost and forest fires (FAO, 2015). Crop yields are declining and diseases are increasing (FAO, 2015). Food security is now a major concern with staple crops, such as sweet potato and other tubers, being stunted in size or completely destroyed by drought and frost (UNOCHA, 2015c)

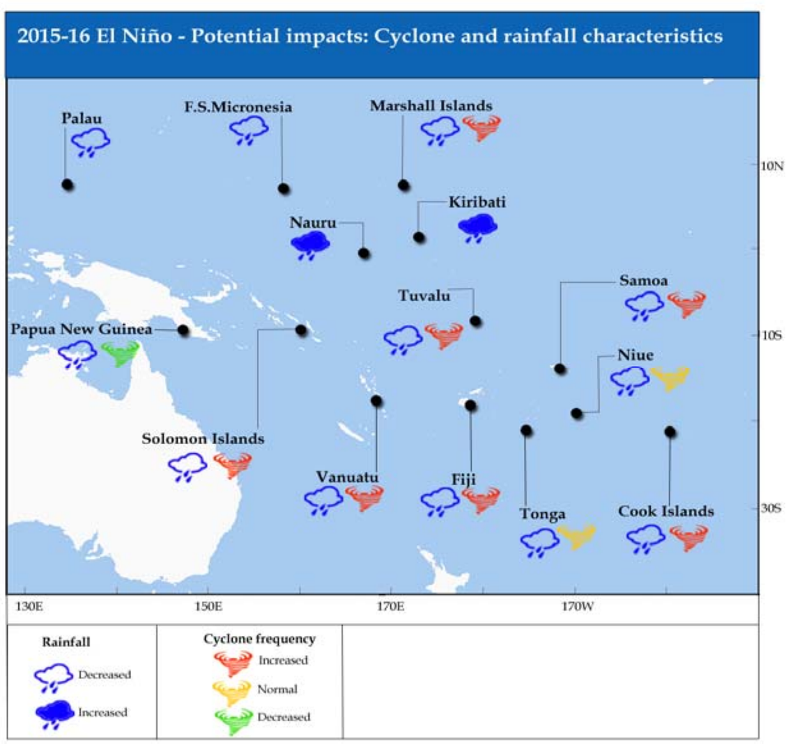
Samoa	Suppressed rainfall conditions	**Agriculture-** Drought-associated forest fires during the dry seasons of 1982-1983, 1997-1998, 2001-2002, and 2002-2003 (Australian Bureau of Meteorology and CSIRO, 2011). **Infrastructure-** Damage caused by tropical cyclones in 1990 and 1991 were estimated at four times the country's GDP; flooding due to tropical cyclones in 2008 and 2011 damaged transportation and water infrastructure severely (Australian Bureau of Meteorology and CSIRO, 2011).	None recorded yet.
Solomon Islands	Suppressed rainfall conditions	**Reef Ecosystem-** Coral bleaching cases reported due to warm SSTs in 1997-1998 (World Bank, n.d.) **Fisheries-** Increased tuna catch (Lehodey in Nicol et al., 2014).	Super cyclone associated heavy rainfall impacts reported in March 2015. An estimated 1500 houses were damaged. The emerging drought conditions have prompted authorities to call people to ration water (UNOCHA, 2015c).
Tonga	Suppressed rainfall conditions	**Agriculture**- Severe droughts in 1983, 1998, and 2006 caused stunted growth in sweet potatoes and coconuts; the livestock sector, particularly swine, were badly affected (Tonga, 2012) **Water Resources**- Prolonged droughts, such as in 1997-1998, significantly impacted shallow groundwater systems; seawater intrusion, due to storm surge associated with Hurricane Isaac in 1982, adversely affected freshwater lenses (The Kingdom of Tonga, 2012) **Reef Ecosystem**- Coral bleaching cases reported due to warm sea surface temperatures in 1997-1998 (World Bank, n.d.)	In Tonga, drought has been declared and further low rainfall is expected (FAO, 2015). Tonga has been experiencing drought conditions for eight months. Eua island, with about 7000 people, is affected the most from the drought.
Vanuatu	Suppressed rainfall conditions	**Water Resources**- Decreased rainfall and increases in evaporation associated with increased temperatures reduce the rate of groundwater recharge, affecting freshwater availability (FAO, 2008) **Reef Ecosystem**- Cyclone Ivy in 2003 caused considerable damage to coral reefs at Efate (FAO, 2008) **Fisheries**- Low fish catches during cyclone periods (FAO, 2008)	Cyclone Pam with wind speed of 270 km hit Vanuatu in March 2015. About 166,000 people were affected in varying degrees and 16 deaths were reported. 75,000 left in need of emergency shelter support and over 100,000 requiring supplies of clean drinking water (IFRC, 2015) In addition, 90 per cent of houses were destroyed in certain islands. Economic loss is estimated to be around USD 37 million in terms of loss of economic growth (Dornan, 2015). Communities are facing food and water shortages connected with an El Niño-induced drought (UN OCHA, 2015). Emergency food distribution has already begun in Vanuatu that has targeted around 90,000 people. (UNOCHA, 2015c)

4.3 Towards 2016: potential impacts in the Pacific

It is estimated that 4.7 million people in 11 Pacific countries are facing El Niño induced drought and dryness (UNOCHA, 2015b), which will have a significant impact on agriculture, particularly for countries where the sector contributes a significant amount to the GDP (between 10 per cent and 40 per cent) and employs a large proportion of their population (FAO, 2014).

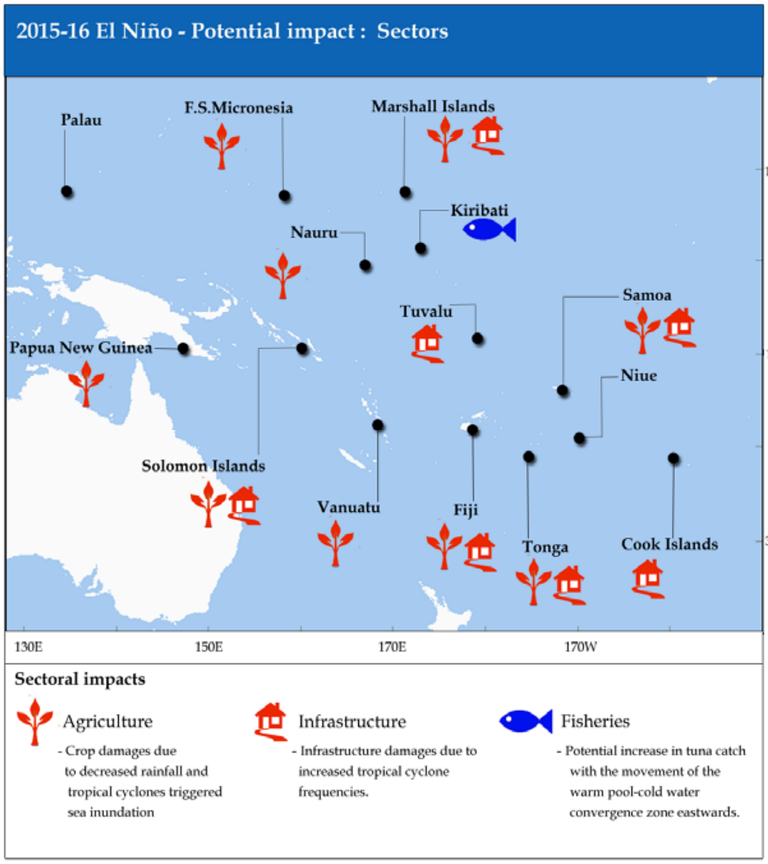
With the exception of Kiribati and Nauru, a reduction in wet season rainfall could threaten the water lenses which could lead to water scarcity. Studies suggest that Tonga may experience more dry weather over the next six months (RNZI, 2015). A reduction in water sources can also lead to health threats in the form of dengue outbreaks in many countries. Coral bleaching may threaten several countries due to an increase in the sea surface temperature, though islands such as Kiribati could expect an increased in tuna catch. Kiribati is likely to see continued increased temperatures with more very hot days, along with more intense rainfall, relatively decreasing the likeliness of drought in the future but possibly increasing the likeliness of floods/storms. In the Marshall Islands, unseasonal storm fronts and strong westerly winds are likely to occur again, possibly affecting the fishing activities of Port Majuro (Johnson, 2015). The potential increase in tropical cyclones in Fiji, the Cook Islands, Samoa, the Solomon Islands, Tuvalu and Vanuatu could be a potential threat to human settlements and infrastructure. The following maps (Figures 5 and 6) show the potential impact of the 2015-2016 El Niño on climate and different sectors.

Figure 5: Potential 2015/2016 El Niño impact on cyclone and rainfall characteristics



Source: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, 2015.

Figure 6: Potential2015/2016 El Niño impact on different sectors



Source: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, 2015.

5. Policy Recommendations

As indicated in the previous El Niño 2014/2015 Impact Outlooks, El Niño tends to bring significant impacts to Asia-Pacific, particularly the negative impacts such as drought, flooding and cyclones. Though El Niño impacts vary between different regions and seasons, the risk patterns observed during the past could be used as a guide to take appropriate preventive risk reduction measures.

In terms of drought, ENSO forecasts can be very useful when planning for the agriculture sector. Countries that are at risk of El Niño induced drought could use predictions to help farmers adapt their farming practices before the main growing season in order to mitigate drought risk and impacts.

Furthermore, Box 2 highlights that climate change may amplify the risk of El Niño events, further emphasizing the need for policy measures and actions to factor in long term climate risk for El Niño, and climate change in general. What follows are some examples from the Asia-Pacific

Disaster Report 2015 of short to long term strategies that could be employed, particularly for building climate resilience in the agricultural sector:

Early warning and monitoring strategies (ESCAP 2015):

- strengthening seasonal forecasts for drought;
- strengthening knowledge networks for transferring information and alerts from government agencies to farmers;
- improved education of community and farmers; and
- developing El Niño contingency plans by governments.

Pre- or in-season mitigation, adaptation and response strategies:

- diversifying employment or income;
- livestock management through migration of stock or destocking;
- stockpiling through seedbanks, feedstocks and water at the household level;
- diversification of crops;
- changing to alternative crops needing less water or varieties that are drought-resistant;
- changing agricultural practices (e.g. no tillage); and
- improving water conservation and storage systems.

Long-term or seasonal adaptation strategies can include:

- improved planning and zoning to restrict agricultural practices in high risk areas, or encourage farming systems or crops suitable for the climate;
- rehabilitation of degraded land;
- improved education of community and farmers for long term management and adaptation;
- improving information for land management and drought planning;
- establishing financial risk management strategies during good seasons to support households during El Niño drought events; and
- utilizing intergovernmental platforms such as the WMO/ESCAP Panel on Tropical Cyclones and the ESCAP/WMO Typhoon Committee to undertake research and pilot projects to improve the understanding of tropical cyclones, related hazards and bringing about closer regional cooperation in early warning.

Already, countries of Asia-Pacific are acting to mitigate the effects of El Niño. In the Philippines, the Government is preparing a Roadmap to Address the Impact of El Niño (RAIN), focusing on lower food production, higher prices and lower farm income. Activities to help farmers cope with drought have also been implemented, such as cloud seeding, seed distribution, crop diversification and rotation, and water saving. Papua New Guinea has allocated USD 8.5 million to drought response. In Tonga, emergency water supplies are being distributed to the outer islands and water desalination services have been made available. Emergency water deliveries are also occurring in Fiji, especially on the outer islands, and Samoa has declared a meteorological drought and asked people to conserve water. The Government of Mongolia plans to allocate USD 5.3 million to support herders overcome the potentially harsh winter *dzud* ahead, and it is also trying export meat and live animals to China, the Russian Federation and Viet Nam, to reduce pressure on the likely limited fodder for livestock during the *dzud*. Alerts for possible flooding and landslides have been raised in Viet Nam, particularly for high-risk communities, and the Government of Myanmar has advised people living near rivers to leave their homes if water levels have risen beyond danger points (FAO, 2015). All of these national efforts are working towards preparing for or mitigating the impacts brought on by El Niño. However, many national efforts could be supported by regional cooperation initiatives.

Box-2 Climate change is exacerbating the intensity of the current El Niño event

With renewed emphasis on climate change stemming from the ongoing 2015 Paris Climate Conference (COP21), the World Bank restated their belief that climate change is likely to exacerbate the intensity of storms and flooding in some places and severe drought and water shortages in others.

Moreover, altered weather patterns brought on by of climate change increases the risk of El Niño events - especially for South-East Asian and the Pacific countries that are already vulnerable. Evidently, 2015 is already the hottest year ever recorded, increasing the El Niño effect caused by weakened trade winds that fail to push warmer Pacific Ocean waters to the west.

Building resilient and adaptable societies remains the best strategy against climate change. Learning from past experience, it is now possible to provide forecasts and data that help to better predict, prepare and respond to El Niño events leading to fewer deaths and economic losses from severe weather. It is important to continue investments in sustainable development and build resilience to the changing climate, instead of just focusing on the specific challenge of El Niño.

Source: World Bank, 2015

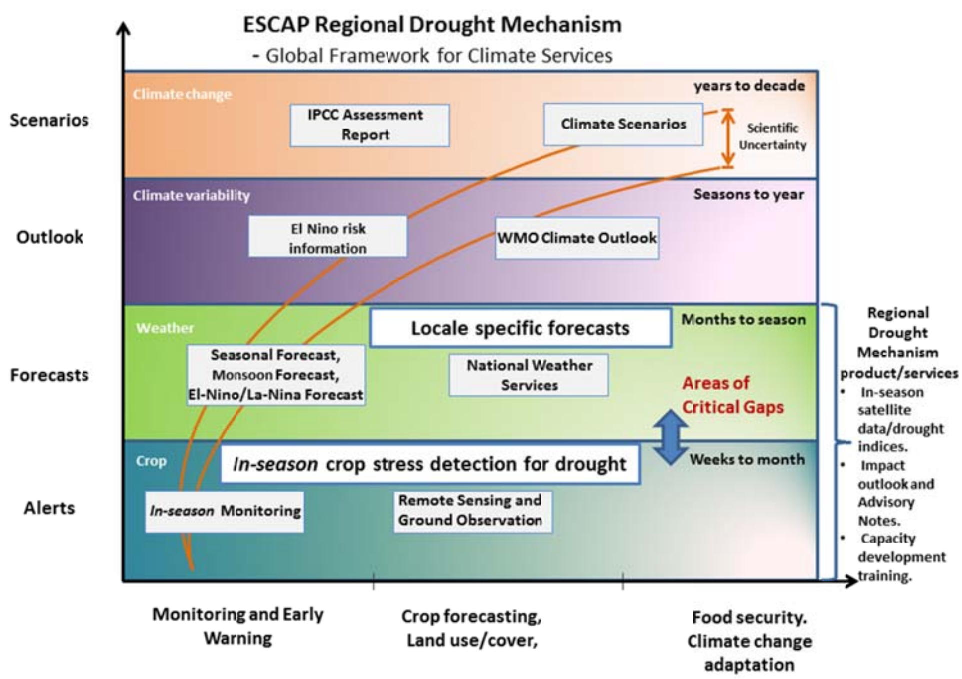
5.1 Regional Strategy for addressing shared vulnerabilities and El Niño associated disaster risk

As El Niño impacts many countries, sometimes simultaneously or in close succession, a regional strategy focusing on the sharing of information obtained from climate models, meteorological and hydrological observational networks, and earth observation satellite data, has to be developed that complements national risk management systems, particularly for the agriculture sector. Climate risk information associated with El Niño needs to be ‘actionable’, and location and sector-specific, but can be supported by regional efforts and knowledge. The information needs to be downscaled to the national and local levels, and contextualized for various climate-sensitive sectors. A regional cooperation mechanism for the delivery of climate risk information that is customized for applications at the national and local levels, supported by adequate capacity within climate-sensitive sectors, would greatly benefit many in the region.

Integrating climate risk information associated with El Niño and early warning systems can be strengthened with innovative technologies and user participation. The ESCAP Regional Drought Monitoring and Early Warning System (Regional Drought Mechanism) is an effort in this regard. The Mechanism takes advantage of data and imagery from the region's spacefaring countries, including China, India, Japan, Thailand and others, and shares it with other countries especially those prone to drought. This service complements the WMO's Global Framework for Climate Services by providing more detailed, localized forecasts and monitoring services that can be updated during the growing season.

In-season crop monitoring is a key information input for agricultural drought. However, it is complex to assess due to the diversity of agricultural land use and small land holdings in agrarian countries in Asia-Pacific. The Regional Drought Mechanism aims to address such complexity and gives a comprehensive near real-time drought monitoring and early warning system which can be seamlessly linked to long-term climate scenarios and with the seasonal climate outlooks (Figure 6).

Figure 6: ESCAP Regional Drought Mechanism – Global Framework of Climate Services



Source: ESCAP, Asia-Pacific Disaster Report, 2015.

Early warning systems can play a crucial role in mitigating the risk from many climate-related events such as drought, storms and cyclones. Both structural and non-structural measures can be used for reducing the extent and impact of cyclones. Structural measures seek to regulate the impact of El Niño associated storms and flood surges. Non-structural measures include El Niño forecasting and warning systems to reduce the effect of cyclones on loss of human lives and property. These multi-hazard early warning systems can be very cost effective and benefit greatly from regional cooperation (ESCAP, 2015). One estimate indicates a cost-benefit ratio of between 4 and 36; that is every dollar invested in early warning systems potentially generates $4 to $36 in benefits every year to countries in reduced losses, particularly for weather-sensitive sectors such as agriculture (Hallegatte, 2012, ESCAP, 2015). Yet, according to the WMO over 80 per cent of the world's 48 LDCs have only a basic early warning system, while just a handful of the 40 SIDS have an effective early warning system in place (WMO, 2015). To address these gaps, the Climate Risk Early Warning Systems (CREWS) initiative was launched at COP 21 in Paris on 2 December 2015, supported by the WMO, the UN Office for Disaster Risk Reduction (UNISDR) and the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR). This global initiative will complement regional and national actions to improve the quality of multi-hazard early warning systems, particularly in high risk and low capacity countries.

The ESCAP Trust Fund for Tsunami, Disaster and Climate Preparedness, through RIMES, has supported important platforms for risk communication, including Monsoon Forums in South-East and South Asia. Such platforms could be used to better address El Niño associated risks, particularly for upcoming monsoon seasons. For example, the consensus outlook for the 2015 northeast monsoon rainfall over South Asia was released on 14-17 October 2015, and highlighted the urban flood risks from October to December. Risk information such as this could help with flood mitigation and management if factored into timely flood preparedness measures. In the Pacific, such multistakeholder national forums need to be strengthened to facilitate user understanding of long-term risks, and harmonization of risk management strategies and development plans. Implementation of the Roadmap Towards a Post- 2015 Integrated Regional Strategy for Disaster Risk Management and Climate Change in the Pacific could put in place such mechanisms that enable countries to understand the complex climate risks, share and exchange risk information, and facilitate policy measures and implementation mechanisms for building resilience.

As highlighted in the Asia Pacific Disaster Report 2015, sustainable development cannot be achieved in the region without building resilience to disasters. The discussions at COP21 have noted that climate change will likely intensify the risk of El Niño events, and action for addressing climate change is needed to build long term resilience if the region is to achieve the Sustainable Development Goals (SDGs), adopted in 2015. Disasters are linked to almost all of these SDGs as they can significantly impact or undo development gains (ESCAP 2015).

Furthermore, El Niño brings to the forefront the transboundary nature of disasters, and that collective action is needed to better address these shared vulnerabilities and risks. A regional strategy will bring coherence between the various international agreements and thus ESCAP has embarked on the development of a strategic regional action plan that intends to facilitate the integration of vulnerability considerations into the regional economic cooperation and integration (RECI) efforts. This is to ensure that the gains from increasing economic cooperation are protected from increasingly larger and intense disasters that too often cross borders. Only by coming together in the spirit of cooperation can the Asia-Pacific region hope to become truly disaster resilient and achieve sustainable development in the future.

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