Risk Mitigation Consulting Inc.

Intelligence and Analysis Division

WHITE PAPER SERIES

ENSO: Global Impacts of El Niño and La Niña

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INTENT

This white paper is designed to provide analysis of relevant, publicly available information on threat and hazard events/trends and their potential impacts to the interests of the United States, both at home and abroad. This product is not intended to be an all-encompassing assessment of the subject.

ENSO: Global Impacts of El Niño and La Niña

Introduction

Global weather patterns affect local weather, regional climates, and extreme weather events. Tracking these patterns can assist in preparing for floods, droughts, hurricanes, and high winds. Some of the largest and most impactful weather systems are created by ocean currents. These natural oscillations create weather systems, the most well-known of which is the El Niño Southern Oscillation (ENSO). ENSO has two parts: El Niño and La Niña. Since the patterns of ENSO tend to persist for several months, accurate long-range forecasts are possible for many regions. These forecasts can aid in assessing the potential hazards a region could face in the coming months. [1,2,5]

ENSO Cycle

The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific. El Niño and La Niña are opposite phases of the ENSO cycle. La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. It is commonly expected that La Niña will follow immediately on from an El Niño event, but this is not always the case. Typically, El Niño occurs more frequently than La Niña. El Niño and La Niña episodes typically last nine to 12 months, but some prolonged events may last for years. While their frequency can be quite irregular, El Niño and La Niña events occur most commonly every three to five years but can vary between two and seven years.[1,2]

The ENSO Alert System, status updates, and predictions are published approximately once a month by the National Oceanic and Atmospheric Administration (NOAA). As of 2 March 2020, the ENSO Alert System Status is Not Active. ENSO-neutral conditions are present, meaning neither El Niño nor La Niña patterns are currently present. In addition to examining the surface temperatures of seas and atmospheric circulation, NOAA updates the estimated likelihood that conditions will persist or change. For example, on 2 March 2020, it was assessed that ENSO-neutral is favored through Northern Hemisphere spring 2020 (~60% chance), continuing through summer 2020 (~50% chance).[7]

An El Niño is declared when the average temperature stays *more* than 0.5 degrees Celsius above the long-term average for a period of at least 5 consecutive overlapping 3-month seasons. A La Niña is declared when the average temperature stays *less* than 0.5 degrees Celsius above the long-term average for a period of at least 5 consecutive overlapping 3-month seasons.[3,7]

El Nino

The term El Niño refers to the large-scale ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. During an El Niño event, the surface waters in the central and eastern Pacific Ocean become significantly warmer than usual. Conditions for El Niño typically build up between June and December. El Niño usually alters the Pacific jet stream, extending it, strengthening it, and bringing wetter conditions to the western U.S. and Mexico. By changing the distribution of heat and wind across the Pacific,

El Niño alters rainfall patterns for months to seasons. As the warm ocean surface warms the atmosphere above it, moisture-rich air rises and develops into rain clouds. These warmer temperatures also change atmospheric pressures, leading to changes in global rainfall, wind patterns, and sea surface temperature.[1,2,3]

El Niño usually peaks between November and January, though the global effects are seen over the course of months. While the effects of El Niño are not necessarily guaranteed, there are trends that can be identified as typically occurring during this phase of the ENSO cycle. These effects are likely to develop over North America during the upcoming winter season. This includes warmer-than-average temperatures over western and central Canada, and over the western and northern United States. Due to stronger storm systems, wetter-than-average conditions are likely over portions of the U.S. Gulf Coast and Florida, while drier-than-average conditions can be expected in the Ohio Valley and the Pacific Northwest.[1,2,3]

The effects of both ENSO oscillations are global. Within the tropics, the eastward shift of thunderstorm activity from Indonesia into the central Pacific during warm episodes results in abnormally dry conditions over northern Australia, Indonesia and the Philippines in both seasons. Drier than normal conditions are observed over southeastern Africa and northern Brazil, during the northern winter season. During the northern summer season, Indian monsoon rainfall tends to be less than normal, especially in northwest India where crops are adversely affected. Wetter than normal conditions during warm episodes are observed along the west coast of tropical South America, the Gulf Coast, and southern Brazil to central Argentina. Also, during warm episodes extratropical storms and frontal systems follow paths that are significantly different from normal, resulting in persistent temperature and precipitation anomalies in many regions.[5]

La Nina

El Niño is frequently followed by a period of normal conditions in the equatorial Pacific Ocean. Sometimes, but not always, El Niño conditions give way to the other extreme of the ENSO cycle. This cold counterpart to El Niño is known as La Niña.

During non-El Niño years, surface pressures tend to be low over the warm waters of the equatorial western Pacific as overlying warm moist air rises. Over the colder waters of the eastern equatorial Pacific, surface pressures tend to be higher as converging winds aloft contribute to the sinking of cool air. In the same way a ball rolls down a hill, air flows from high pressure in the east to low pressure in the west along this equatorial pressure gradient. This contrast in pressure is what drives the trade winds, the prevailing large-scale surface winds that blow from east to west. As winds blow along the surface of the equatorial waters, there is a net transport of ocean water in a westward direction. As this occurs, cold water rises along the coast of South America to replace the westward-moving surface water. This leads to colder than average temperatures in the east and warmer than average temperatures in the west.[1,4]

In the United States, the first three months of the year during a La Niña typically feature below normal precipitation in the Southwest, the central and southern sections of the Rockies and Great Plains, and Florida. Meanwhile, above average precipitation is more likely across the Pacific Northwest, in the northern Intermountain West, and over scattered sections of the north-central

states, Ohio Valley, and upper Southeast. La Niña features unusually cold weather in the Northwest and (to a lesser extent) northern California, the northern Intermountain West, and the north-central states. Farther south, above average temperatures are slightly favored in a broad area covering the southern Rockies and Great Plains, the Ohio Valley, the Southeast, and the mid-Atlantic states. There are generally more frequent instances of tornados in states already vulnerable to them. [1,4]

Globally, La Niña is characterized by wetter than normal conditions west of the equatorial central Pacific over northern Australia and Indonesia during the northern hemisphere winter, and over the Philippines during the northern hemisphere summer. Wetter than normal conditions are also observed over southeastern Africa and northern Brazil, during the northern hemisphere winter season. During the northern hemisphere summer season, the Indian monsoon rainfall tends to be greater than normal, especially in northwest India. Drier than normal conditions are observed along the west coast of tropical South America, the Gulf Coast and southern Brazil to central Argentina during their respective winter seasons. Conditions are also more favorable for hurricanes in the Caribbean and central Atlantic area. In the western Pacific, the formation of cyclones shifts westwards which increases the potential for landfall in those areas most vulnerable to their affects, and especially into continental Asia and China. [1,4]

Climate Change

Though ENSO is not caused by climate change, it often produces some of the hottest years on record because of the vast amount of heat that rises from Pacific waters into the overlying atmosphere. How El Niño and La Niña will change or affect climate change in the future is not currently clear. Very limited studies have been done on the future impacts of ENSO. Some recent research has suggested that the effects of the ENSO will worsen as the climate changes. A study from 2018 found that the increased wildfire danger in the Southwest United States associated with La Niña events would become more acute. Conversely, cooler and wetter weather in the same region, when associated with El Niño events, would likely become even cooler and even wetter in the future, enhancing flood risks. In short, when an El Niño or La Niña forms in the future, the study anticipates that climate change will amplify changes to temperature, precipitation and wildfire risk. However, more research is needed before climate change impacts to ENSO can be defined.[1,3]

Conclusion

ENSO is likely Earth's most influential natural climate pattern. Two sides of the same coin, El Niño and La Niña impact weather systems across the globe. Though there is variation in both the length and frequency of El Niño or La Niña, it is possible to relatively consistently predict the development of these systems. The impacts that result can be seen for months, most frequently affecting rainfall, floods, droughts, hurricanes, typhoons, high winds, extreme heat and cold, and tornados. Accounting for the oscillations of ENSO may assist in identifying an increase or decrease in the expected frequency or severity of these events.

Source List

1. Environmental Science. *El Niño and La Niña: Their Impact on the Environment.* https://www.environmentalscience.org/el-nino-la-nina-impact-environment
2. National Ocean Service. https://oceanservice.noaa.gov/facts/ninonina.html
3. Earth Observatory. NASA. *El Niño.* https://earthobservatory.nasa.gov/features/ElNino
4. Earth Observatory. NASA. *La Niña.* https://earthobservatory.nasa.gov/features/LaNina
5. National Weather Service. Climate Prediction Center. *El Niño/La Niña, Warm Episodes.* https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/impacts/warm_impacts.shtml
6. National Weather Service. Climate Prediction Center. *El Niño/La Niña, Cold Episodes.* https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/cold_impacts.shtml
7. NOAA. *ENSO: Recent Evolution, Current Status and Predictions.* https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf