

El Niño: How to Prepare for Disaster

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El Niño is a common but irregular alteration in air and sea movements in the tropical Pacific, which has major effects on the weather and on the marine environment along the west coast of South America and further afield. El Niño is part of the larger El Niño Southern Oscillation (ENSO). El Niño conditions typically last for 12–18 months before a return to average or cooler conditions, and result in changes in convective activity and cloud formation which have far reaching consequences for global weather patterns. Although El Niño can affect a large proportion of the world's population (1), media interest only began relatively recently, as a result of the impacts and perceived impacts of the so-called 'El Niño of the Century' in 1982–3. The societal effects of El Niño-related weather patterns, the growing attempts to forecast El Niño and the implications of predictions for society raise many interesting questions concerning the links between science and society. In particular, it brings to light the pertinent

cut off, affecting ecosystems and devastating the fishing industry (2). The 1972–73 El Niño, for example, along with overfishing, had a catastrophic effect on the previously massive Peruvian anchovy fishery (2). Increased rainfall in

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northern Peru and southern Ecuador also causes flooding, damaging infrastructure and leaving hundreds dead and thousands homeless, while El Niño brings drought conditions to other parts of the region (3).

Across the world, El Niño can cause changes in weather patterns, so called 'teleconnections', which can cause floods, or droughts and fires, and affect crops (4) and vector-borne diseases (5). It is also important to consider that because we live in a global economy, the effects of El Niño may spread economically, as well as climatically. Kenya, for example, exports coffee, and although it is not always strongly affected directly by El Niño, "many international competitors of Kenyan coffee growers, such as those in Brazil, Ethiopia, or Indonesia are more clearly affected by El Niños that can reduce their production of coffee in the international marketplace. Kenya's economy could reap the profits lost by the other nations." (6) Similarly, the decline in palm oil production in Philippines could increase the price of other sources, such as Malaysia and West Africa (6). Predictions could thus be extremely valuable in helping nations to plan for future production and export patterns, even if they are not significantly affected by the changes in weather patterns.

Extreme weather events can be devastating to a nation's people and their economies. Communities that understand and plan accordingly can potentially save lives, and protect their infrastructure and economies from potential devastation. If scientists manage to link conditions months before with the resulting hazard, there can be a shift towards prevention and mitigation, rather than relying on reaction. What is difficult

about El Niño is its extreme complexity: its effects are not guaranteed, but mainly just statistical correlations. In particular, while in some areas of the world the teleconnections observed are consistent and reliable, there are other areas where they appear to be rather uncertain, and the suggested link may not really exist, but may simply result from coincidental observations or misperceptions.

The strong El Niños of recent times, and rising awareness in society,

What is El Niño?

In a 'normal' year, winds blowing off the west coast of South America push the seawater away, drawing cold water up from the depths to the surface. The cold water, also rich in nutrients, cools the air above it, which sinks and keeps hold of its water. In an El Niño year, the cool water is cut off, and warm water spills back across the upper layers of the ocean, depriving the ecosystems of nutrients. The rising air above the warm water releases its water, resulting in increased rainfall. Changes in the global patterns of winds and currents can effect smaller changes thousands of miles away.

matter of whether limited funds should be focused on scientific research to predict the occurrence of a complex event.

Long before scientists started investigating El Niño, people living on the west coast of South America recognised its impacts on fish and bird populations. Nutrient supplies are reduced as the water welling up from the deep sea is



All's calm, but for how long?

have provided the impetus for increased funding to try to predict El Niño. There are now many scientists working on El Niño, as part of many government and non-governmental organisations (e.g. 7).

Nowadays, satellites, buoys, ships and numerical computer models help us to understand El Niño, while previously, researchers had to rely on ships to record information about ocean currents, surface winds, and sea surface temperatures, leaving large gaps in data coverage. For example, the Tropical Atmosphere Ocean (TAO) array of 70 buoys was completed in 1994 (8). Increasing computer power is allowing many more factors to be included in models. Current claims for advance warning of the onset of an El Niño range from 4–12 months.



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The 1986 El Niño was predicted months in advance by computer models at the Lamont-Doherty Earth Observatory of Columbia University (8). However, the same model failed to predict the 1997–8 El Niño—clearly it is still problematic to devise a reliable model of the system (9). Climatic systems are often chaotic, making them hard to predict with physical models. To further complicate matters, the baseline against which El Niño events are measured may be shifting as a result

desired benefits associated with their use.

Can the costs incurred because of a bad seasonal forecast balance out the hypothetical value of a larger number of good forecasts? To assess the true value to society of an El Niño forecast system, one must include the costs of missed forecasts in the overall calculation of the benefits. For example, the value of action taken as a result of incorrect predictions should be counted in the benefit-cost analysis, along with the value of the damage caused by a muted response to a future, correct prediction, although this may be hard to quantify without hindsight.

El Niño has many consequences, both globally and locally. If the

links between cause and probable effects are unlocked, it may increase the accuracy of our predictions. Although we may be unable to counteract the onset of El Niño or many of its impacts, there is a real hope that we can understand and forecast the ENSO cycle with ever greater accuracy, and improve planning for fisheries, agriculture and health, so as to lessen the adverse effects. An economy that might otherwise be devastated may be able to avoid catastrophe with enough advance warning. Our current ability to predict El Niño remains severely limited, such that mistakes in prediction may have serious consequences. Contingency plans are at present a parallel option to continued research, because they cover a wider range of eventualities, even though they lack specificity and forewarning, which may be vital. Nonetheless, money should continue to go into research to understand the system and make predictions, as this does not detract from the funding available for current disaster contingency planning.

Incorrect predictions can undermine the credibility of scientists

of global warming (10).

When predictions turn out to be wrong, actions based on them can be counter-productive. In Australia, as a result of forecasted impacts, the government reduced projections of agricultural output and national economic projections. Farmers used these forecasts to alter their production activity (at personal financial losses). However, in the midst of drought, 3 weeks of favourable rain arrived, and farmers missed out on potential production (11), even though the Australian government later increased its economic projections for the agricultural sector following these rains. As another example, in 1982–3, a high visibility forecast projecting very high corn yields in Illinois was published in *Science* (12) and publicised in American newspapers. Unfortunately, it turned out to be very wrong, as weather conditions during the El Niño instead reduced yields by about 50% (11).

Predictions can only be used cautiously for disaster planning until the links are more scientifically quantified. Because forecasts are just probability statements of how likely things are to occur, the more dependent we become on them, the more care must be taken with their use. The public can come to expect too much from predictions, and incorrect predictions can then undermine the credibility of scientists (13). Forecasts come with unspecified risks and

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