commentary
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Who benefits from climate forecasts?

The effective and equitable dissemination of climate forecasts is as important and challenging as their accuracy. During El Nino 1997-98, Peruvian fisheries showed the need to understand forecast use and all parties' interests.

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El Nino often dominates world news about climate because of its widespread and frequently disastrous impacts. Our ability to predict El Nino is limited, but resources are committed to improving and communicating seasonal-to-interannual forecasts. Better forecasts will not necessarily help all, or even any, groups within an affected society, however. Attention must be focused on how to disseminate forecasts for maximum benefit.

A first issue is to study the use and non-use of forecasts in places affected by El Nino. This can help in designing dissemination strategies that address constraints on benefits such as limited access to forecasts and the distortion of forecast information. A second issue is to consider whose welfare counts as a 'benefit' among groups such as labor, industry, and consumers; different regions; and the present and future. Although such choices are not made easier by analysis, they can be clarified by the delineation of different groups and their goals. These responsibilities may not belong to climate researchers themselves, but seem imperative for public agencies which fund such work and for those who promote dissemination of forecasts.

Although El Nino was named by fishermen and described scientifically in Peru as early as 1892, it took the strong 1972-73 event and the collapse of the Peruvian anchovy fishery to draw attention to the potential impact of El Nino. And it was not until the 1982-83 event, which contributed to at least $13 billion of damage and 1,500 deaths, that El Nino's global nature was realized. Together with the growing belief that, given adequate data, forecasting was possible, these dramatic events stimulated the implementation of the Tropical Ocean-Global Atmosphere program in 1985, and led to predictive models. Most researchers felt that such predictions were unreliable. But, after Mark Cane and Steve Zebiak successfully forecast an El Nino event in 1986, other groups began to release experimental forecasts to the public.

There were some successes. The Ethiopian government's advice to its farmers, after a forecast of drought in 1986-87, reduced the amount of food relief required. In northeast Brazil, a warning of drought in late 1991 prompted the state of Ceara to assist farmers to mitigate the effect on grain production, drinking water shortage and employment.

However, not all the news was good. In this Brazilian case, forecast credibility was questioned when the media spread early official forecasts but perhaps over-represented their certainty, and later official forecast updates were not spread. In Zimbabwe, a late 1997 forecast suggesting a more severe drought than occurred contributed to a reduction in planting and output. In Australia in 1997-98, a 'meteorological drought' (drop in rainfall) was correctly forecast, but the rains that fell came at a crucial time for crops, so that the 'agricultural drought' (drop in production) was less severe. Thus, those anticipating an El Nino as bad as the 1982-83 event lost out (for other examples, see M. H. Glantz, *Currents of Change: El Nino's impact on climate and society*. Cambridge University Press, 1996).

Today, El Nino forecasts are routinely disseminated, and climate institutions are expected to combine cutting-edge science with societal benefits. For example, the recently-created International Research Institute for Climate Prediction, based at Columbia University in New York and the University of California at San Diego, has a mandate to improve forecasts and their applications, and is working with actual and potential 'end-users' of climate information.

Peruvian fisheries

Despite advance forecasts, Peru was severely affected by the extreme 1997-98 El Nino. Forecasts became widely available in March 1997 but, like many forecasts to follow, they underestimated the event's magnitude. Despite sizeable and relatively early disaster-prevention efforts, rain and floods affected thousands, crop yields fell, and infrastructure was destroyed. The total fish catch fell steeply.

Commercial fishing had boomed from the mid-1950s until the early 1970s, when heavy fishing and the 1972-73 El Nino contributed to the collapse of the anchovy fishery. Only by the 1990s did catches recover. Today the sector represents more than 4% of the country's gross national product and in 1997 generated more than $1 billion in foreign exchange earnings. It can be divided into artisanal and industrial groups, which fish different species using different methods, and are subject to different regulations.

The artisanal group consists of about 50,000 small-scale producers who fish or dive from small boats. Their catch is sold or consumed locally, or exported. Historically, they have been self-employed, with low socioeconomic status and limited political influence. The industrial group employs more than 20,000 people, mainly in fishing fleets, fishmeal plants or canneries. Many more work in building and repairing ships, engines and nets. Fishermen's union power has disappeared as labor protection laws have weakened. Large firms have diversified into canned fish, agriculture, mining and other industries. They wield considerable influence at all levels of government. Because it has significant loans outstanding to fishing companies, the financial sector has considerable influence on the fishing sector.

During the 1997-98 El Nino, people responded both to the changing ocean environment and to a series of forecasts of the event's duration and magnitude. Industrial firms closed plants and canneries, moved fishing fleets south, and kept vessels idle. Illegal fishing increased, including industrial boats pursuing fish into the zone reserved for artisanal fishing, which increased tension between the groups. Artisanal fishermen shifted to tropical species catchable only during El Nino conditions, but their revenues were limited by drops in market prices and climate-related interruptions of transport to markets.

Two other key groups, and potential forecast users, are the government and the financial sector. The Minister of Fisheries banned anchovy fishing relatively early, in April 1997. The ban was based on unusually high catches near shore and forecasts of a strong El Nino (but it was lifted after just a few days, reportedly due to industry pressure). For the rest of 1997 and well into 1998 catches plummeted. By September 1998, unemployment in Chimbote, the largest Peruvian fishing port, was so severe that food was distributed to thousands of fishermen and their families. The fishermen's welfare organization cut its employees' salaries and could not pay full benefits. In the financial sector, banks slashed lending based on climate forecasts, and re-financed many existing loans in anticipation of poor catches. Domestic effects on fishing families included increased criminality and reduced spending on basic education.

Outside the Net

The dominant medium for dissemination of probabilistic El Nino information in 1997-98 was the Internet, in English. The web is convenient, cheap and egalitarian, as it is widely available and easy to update. But although anyone in Peru with Internet access could view an El Nino website, in practice many (including artisanal fishermen and industrial employees) neither have access to a computer nor understand English. Also many Peruvians have little formal training regarding probabilistic information. Thus, climate forecasters unwittingly disadvantaged some groups in Peru compared with local competitors.

Second- or third-hand information can come through broadcast and print media. However, journalists often do not understand El Nino or probabilities, and 'simplify' the information. More effort is needed to target affected groups (perhaps via radio), and to make forecast information more useful, for example through public education or training of journalists.

Conflicting incentives

The Peruvian government has access to various forecasts of some skill, but scientists' limited ability to translate general predictions into coastal predictions for management of fish stocks leaves room for interpretation. As interpreters of forecasts, oceanographic and meteorological agencies often become advisors on decisions such as whether to declare a state of emergency. An emergency could freeze interest payments, helping companies desperate for debt relief. But in this event companies that wanted loans or to sell bonds did not favor such a declaration. Given the latitude for interpretation, politics affects both agencies' interpretations and whether governments listen to them. Such decisions can come down to relative influence. In 1997-98, different fishing companies tried to convince decision makers of the 'right' view to adopt of the intensity and duration of the El Nino event, and of its implications for fish stocks.

Institutions are made up of individuals. Individuals with access to climate information can demand payment to reveal it, blocking transmission. And it is rumored that large fishing companies use tactics including job offers to distort official press releases. Even if incorrect, such beliefs undermine trust in official climate information.

Competition between institutions puts pressure on their employees to produce answers—now. In response, employees may remove caveats from press releases, injecting false certainty. With the media, they may rush to publicize sensationalized information. An article about a possible end to the El Nino event, in Peru's leading newspaper in late 1997, relied on the interpretation of a single satellite image, and conveyed unwarranted certainty. Media coverage of climate-related press releases also frequently draws its own conclusions on how mortality, crop yields or fish stocks will be affected.

Understanding the uses of forecasts could lead to better dissemination strategies. But possible conflicts may arise here too, since the pursuit of disseminators' interests (perhaps scientific progress or funding) may not maximize aid to those affected by El Nino. For example, some forecasters place all their latest data directly on the Internet (see, for instance, http://nic.fb4.noaa.gov/products/predictions/experimental/bulletin/index.html). However, the distribution of multiple, conflicting forecasts leads to confusion. Thus, for information to be of most use to those affected, it could be preferable to have passwords on websites for researchers, and a unified dissemination process, including quality control, for public climate information.

Better for everyone?

Stands are being taken on this controversial issue. For Peru, groups including the United Nations Food and Agriculture Organization and the World Bank have stressed the benefits of "responsible fishing", and advocated "sustainability". Other groups in Peru might disagree, as this could conflict with the fishing industry's focus on profit. From a sustainability viewpoint, one might define benefits as higher fish stocks. In that case, forecasts will not necessarily help. It may be obvious to supporters of sustainability that forecasts should trigger restrictions on fishing when stocks are under climate-related stress. However, forecasts were used by companies to anticipate fish migration patterns—private use of El Nino forecasts contributed to increased fishing effort. Given a goal of sustainability, then, a better understanding of how locals use forecasts may suggest coupling their dissemination with tighter fishing regulations.

Others advocate equity within society, and the protection of workers during El Nino-related shocks to the fishing sector—obviously not a universal view. Again, the dissemination of forecasts will not necessarily yield benefits so defined, such as higher wages or employment. In the Peruvian case, when forecasts suggested low future profits, some fishing companies accelerated their seasonal downsizing.

The desire of forecasters and forecast providers for research progress and accessible climate information has contributed to an explosion of El Nino information. These goals are laudable and may even be widely accepted. However, unlimited dissemination may cause confusion. In the example we have discussed here, multiple, often conflicting forecasts in Peru have reduced the effectiveness of predictions. A research clearinghouse might alleviate this problem.

Finally, meetings intended to produce consensus regional forecasts and communication between concerned citizens took place in Peru, sponsored in part by forecast providers. This is commendable, as is encouraging local groups to organize these forums. But particular local groups may have their own interests at heart. In Peru, some key agencies were excluded from full participation in a forum of this type.

General principles

The dissemination of seasonal-to-interannual climate forecasts can bring great benefits. However, to realize and maximize these, we must study the use of forecasts to help anticipate use patterns and increase the effectiveness of forecast dissemination. While politically challenging, it is also essential to make explicit whose 'benefits' count.

Although we have mainly discussed the Peruvian fishing sector during the 1997-98 El Nino, the lessons apply to the dissemination of El Nino forecasts to other regions and to economic sectors such as agriculture, disaster prevention and water management. They also apply to research choices made by climate scientists about the kinds of expertise and products to develop and provide.

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