

Our Affair with EL NIÑO

*How We Transformed an Enchanting Peruvian Current
into a Global Climate Catastrophe*

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PROLOGUE

Assessing Our Affair as it Approaches a Critical Juncture

“Don’t blame me; blame El Niño!” This slogan, which appears on bumper stickers and T-shirts, attests to the recognition and notoriety El Niño gained in 1997 when he apparently caused innumerable weather-related disasters worldwide. Although everybody now knows of him, he remains a mystery to many people. How did he acquire his name? How is he related to La Niña? If he has been with us for millennia, why did most of us first hear of him in 1997? What was special about that year? How are meteorologists able to anticipate El Niño months in advance when they are unable to predict the weather more than a few days hence? What is the secret of his versatility -- his ability to cause floods in California, droughts in Indonesia, mild winters in Canada, the disappearance of fish from the waters off Peru, and the appearance of unusual tropical fish off San Francisco?

These are some of the questions that reporters, journalists and producers of television documentaries asked me, as a presumed expert, during El Niño’s much-publicized visit in 1997. This book is my response, written after reflecting on the interviews, which I found both frustrating and rewarding. Frustrating because of the usual difficulties scientists encounter when they try to describe their work to nonscientists; rewarding because I came to realize how marvelously multifaceted El Niño is. Most scientists regard El Niño as simply a puzzle, a natural phenomenon that needs to be described and explained in terms of the laws that govern the motion of the ocean and atmosphere. That narrow perspective makes peripheral the economic and social impacts of El Niño, and also the cultural, historical and political factors that influence scientific research on El Niño. El Niño is so multifaceted that it can be of assistance with a very serious problem we face, bridging the gulf between the worlds of science and of human affairs.

Today we regard El Niño as a peril, a global climate hazard that adversely affects millions of people worldwide. Originally the term El Niño referred to a very different phenomenon, a modest, warm, seasonal current that appears along the shores of Ecuador

and Peru around Christmastime, and that was welcomed as a blessing. This remarkable change in our perception of El Niño occurred even though that natural phenomenon has remained essentially constant. We changed our views because of changes in our science, politics, economics, sociology and culture over the past few decades. It is as if we, passionate and capricious, have been having a turbulent affair with steadfast, aloof El Niño! Our relationship is rapidly approaching a critical juncture because constant El Niño is about to become fickle in response to activities of ours. We are provoking a response from him by rapidly changing the composition of the atmosphere. By increasing the atmospheric concentration of carbon dioxide we are inducing global climate changes that soon will include an altered El Niño.

The prospect of an altered El Niño is alarming because we are having more and more trouble coping with familiar El Niño. Our difficulties increase steadily because of a paradox: as we grow in wealth and in population, so does our vulnerability to natural hazards. (Insurance companies are concerned about a steep rise in claims related to damage inflicted by natural hazards, but there is no evidence of an increase in the number and intensity of severe storms, hurricanes, floods, earthquakes¹....) Scientists are trying to assist us by predicting some of these hazards, thus giving us time to prepare. They are able to do so because of remarkable technological developments and impressive scientific advances over the past few decades. For example, meteorologists have transformed weather prediction from an augury into a reliable source of important information, a splendid achievement that most people take for granted. Now scientists are turning their attention to the prediction of longer-term changes in atmospheric conditions. Their goal is to forecast whether next summer will be warmer and wetter than usual, and whether the following winter will be exceptionally mild or severe.

A first step towards the goal of long-term climate forecasts is the prediction of El Niño. That phenomenon is neither strictly oceanic, nor strictly atmospheric, but is attributable to interactions between the two media. It has therefore been necessary to merge the traditionally separate disciplines of meteorology and oceanography. A further requirement for predicting El Niño is the continuous monitoring of conditions at and below the ocean surface. Into the 1980's oceanographers were still gathering much of their data from solitary vessels while navigating by means of stars and sextants. (Asking for a "tall ship, and a star to steer her by" was not simply a romantic wish but a practical necessity.) Today satellites in space can pinpoint the position of a ship, and can serve as platforms from which we measure conditions at the ocean surface, globally within hours.

Instruments in space are unable to “see” below the ocean surface. To monitor subsurface conditions in the vast tropical Pacific Ocean oceanographers therefore started to maintain a large array of unattended instruments moored to the ocean floor. Scientists made such rapid progress that, although El Niño caught them by surprise in 1982, by 1997 they could anticipate the arrival of that phenomenon several months in advance. This was an impressive scientific achievement, but it had a most unfortunate blemish.

During the summer of 1997 scientists alerted Californians, on television and in newspapers, of a high probability for exceptionally heavy rains during the winter of 1997-1998 because of a very intense El Niño. Scientists also advised the people of Zimbabwe in Africa that rainfall there would probably be below normal. Californians did indeed experience floods, and were prepared, but Zimbabweans had normal rainfall and were unprepared. Because of the expectation that crops would be poor, and that farmers would be unable to pay back any loans, banks in Zimbabwe declined loans to farmers. The consequences were dire: crop production was 20% below normal in the impoverished country². The prediction of a drought in effect caused a drought.

The tragedy in Zimbabwe raises many questions. Why did the policymakers in Zimbabwe assign too much weight to the scientific predictions? Did they fail to appreciate the significance of a probabilistic forecast? Or did they cynically welcome the forecast of a mysterious phenomenon that threatens from the remote Pacific Ocean as an effective means for diverting attention from serious, local, political problems? What motivated scientists to make forecasts for Zimbabwe in 1997? Concern for the people of Zimbabwe was of course a major factor, but to what extent were the scientists responding to pressure from their sponsors to demonstrate that their results can be useful? During the Cold War scientists studying El Niño enjoyed remarkable freedom to do science mainly for the sake of understanding an intriguing natural phenomenon, but since the 1980's the sponsors of scientific research have insisted that the focus be on research with practical benefits. For science to flourish, scientists must have a skeptical attitude towards their own results, constantly questioning and testing apparent solutions to problems. They have to adopt a very different attitude when trying to persuade potential clients that their results are useful. How are scientists coping with this predicament? To what degree are such difficulties contributing to the poor communications between scientists and nonscientists?

Ignorance of the *1001 Things Everybody Should Know about Science*³ are usually cited as the reason for tensions and misunderstandings between scientists and nonscientists. If that were indeed the case then we could minimize the likelihood of disasters such as the one in Zimbabwe by insisting that policy-makers take courses in probability theory. However, the problem has another, more serious dimension. I learnt about its scope from teaching my undergraduate course on “Weather and Climate” (Geosciences 220 at Princeton University⁴.) The students in this course -- economists, historians, politicians, humanists, scientists, engineers, and a few older folks from the town -- have diverse backgrounds, but they all share a keen interest in weather and related phenomena. Their enthusiasm to learn about storms, fronts, hurricanes and tornadoes makes it relatively easy to introduce scientific concepts such as the adiabatic lapse rate and the Coriolis force. Few have trouble with these concepts, but many struggle with something far more fundamental: the profound differences between the worlds of science and of human affairs.

The scientific challenge of predicting El Niño, say, is very different from the challenge of mitigating the impact of an imminent El Niño. The methods and skills required to solve the problems encountered in the cold, uncompromising world of science have very limited applicability in the world of human affairs where compassion is a virtue, compromise a requisite. Each scientific problem has a well-defined solution that can be found by means of universal methods independent of race, gender or religion. A social problem, by contrast, has a multitude of solutions, each with advantages and disadvantages that are weighed differently in different cultures. So radical are the differences between the worlds of science and of human affairs that their demands are sometimes in conflict. A failure to appreciate these differences is one of the main reasons for misunderstandings between scientists and non-scientists.

The purpose of this book is to help improve communications between scientists and non-scientists by taking advantage of the interest everyone takes in El Niño. The book is a collection of essays that amount to nineteen ways of looking at this multifaceted phenomenon. Part I, which has four chapters, sets the stage, examines the origin of the name El Niño, relates how we transformed an enchanting current into a global menace, and explains, in chapter 4, why El Niño is a talented matchmaker, capable of integrating disparate communities.

The first step towards bridging a gulf is to become familiar with its characteristics, the topic of part II of this book. Chapter 5 explores the radically different ways in which we solve scientific and societal problems, and discusses how the different approaches can give rise to serious dilemmas. Some of these predicaments can inhibit the progress of science whose curiously undemocratic character is the topic of chapter 6. These matters merit the attention of scientists, and also of the sponsors of science, the public. At present the latter group is demanding that scientists engage in “out-reach” activities, and be involved in the policy aspects of environmental problems, for example. In principle this is laudable, but in practice it is fraught with dangers and can do harm in both the scientific and social spheres. This does not mean that scientists should confine their interests strictly to science. A physicist recently observed that scientists have as much interest in the history and philosophy of science as birds have in ornithology, but the story of our affair with El Niño indicates that such a lack of interest can be a serious liability.

The activities of scientists, and those of artists, poets and musicians have significant differences, but they also have striking parallels. A few are explored in Part III of this book. (Chapter 7 argues that an artist’s depiction of an elaborate panorama on canvas in oil has similarities with a scientist’s construction of a realistic computer model of weather and climate.)

Weather forecasting is a source of reliable information today, but the skill of meteorologists was far lower in the 1860’s when routine, daily predictions first became available. Were those forecasts, which had enormous uncertainties, of any value? What factors facilitated the subsequent advances in meteorology? What is required for similar advances in our understanding of, and ability to predict climate fluctuations such as El Niño? Part IV, a brief history of meteorology and oceanography, addresses these questions. It comes as no surprise that the continual testing of ideas and theories is of paramount importance to scientific progress. Weather prediction has advanced significantly because meteorologists are tested frequently – daily. Those who attempt to predict El Niño, a phenomenon that occurs every few years, have had little experience up to now but, in due course, will become more practiced. When we turn to global warming and related climate changes decades hence, we face a serious problem. The available instrumental records are far too short for stringent tests of models that are used for predictions, and will continue to be

inadequate for a considerable time to come. To test the models we are obliged to turn to the geological record of remarkably different climates in our planet's distant past. That record, the topic of chapter 16, gives a valuable context for the global warming we are starting to experience.

It will be a while before the forecasts of future climate changes, including global warming, are as reliable as weather predictions are today. We are therefore obliged to make policy decisions on the basis of uncertain and incomplete scientific information. How much scientific information do we need to start implementing effective policies? Part V of this book concerns a few specific environmental problems that permit considerable progress on the basis of a bare minimum of scientific information. The outstanding example is the way the government of India copes with poor monsoon rains that cause poor harvests. Such events used to contribute to horrendous famines that led to the deaths of millions of people. That no longer happens, not because of advances in the prediction of the monsoons, but mainly because of critical political changes that facilitated the implementation of effective policies. In the case of global warming, which the epilogue discusses, we must guard against the tendency to defer difficult political decisions on the grounds that the available scientific information is inadequate.

Our affair with El Niño is approaching a critical juncture because we are in the process of altering the composition of the atmosphere, and hence the climate of this planet. We acquired the technology to do so only recently, over the past century. We are very pleased with the considerable benefits that accompany this development – an enormous increase in our wealth and population -- but we are reluctant to accept that our technological prowess has also brought serious responsibilities. Because we are now geologic agents capable of interfering with the processes that make this a habitable planet, we have become custodians of planet Earth. The decisions we make today will affect not only our offspring for many generations to come, but will also affect all the other forms of life on this planet. In the conduct of our affairs we need to be wise and responsible stewards of our planet. How should we proceed?

The main message of this book is that the solutions to serious environmental problems will elude us unless we are all aware of, and respect the profound

differences between the worlds of science and of human affairs. Our biggest challenge is to give appropriate weight to the inevitably uncertain scientific information when making policy decisions. This is too serious a matter to be left to specialists such as scientists and economists. It is the joint responsibility of all of us because the policies we adopt reflect our values. For guidance we can draw on our wealth of experience in dealing with a variety of environmental problems in the past. We gained much of that experience during our affair with El Niño. Much can be learnt from him. We need to do so in a hurry, before we succeed in changing him.