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Weather Forecasting

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Even if we do not know the exact cause nor the real extent, we are experiencing climatic changes that may be contributing to extreme weather events. In the United States, rising ocean temperatures contributed to the destructive power of hurricanes Katrina and Sandy, while in Europe, increased rain-fall led to recent flooding in the UK, France, and Italy. Although it is impossible to say that climate change actually caused any of these events, computer models indicate that we should see more extreme weather in the future.

This has raised questions concern-ing how casualties and property damage brought about by these types of catastrophic events might be prevented. Of course, methods for reducing climate changes by reducing the emission of greenhouse gases and the human activities that cause the global temperature increases dominate the conversation. The beneficial effects of these countermeasures, however, require a long time to materialize and are not directly related to instrumentation and measurement (I&M).

Weather forecasting and emergency management, on the other hand, have the potential to make a more immediate impact. These are more closely related to the I&M field and even now help to prevent casualties and mitigate damages caused by catastrophic weather events. Despite this, events like those mentioned above have spawned criticism that foreseeable improvements in emergency management and weather forecasting could have saved lives and property already lost.

This has given rise to a debate concerning the liability of those responsible for emergency management as well as weather forecasting. Those coming under closest scrutiny are, of course, emergency managers and responders. They are the primary target of most criticism, yet they base their decisions, at least in part, on information provided by weather forecasters. This leads to a more interesting question: Can weather forecasters be liable for wrong or inaccurate forecasts?

This is a hard question to answer because there is little precedent available. Although useful weather forecasting began as early as the 19th Century, the guesswork still involved was such that nobody could reasonably consider holding a meteorologist liable for an inaccurate forecast prior to the latter half of the twentieth century [1]. Beginning in the 1950s, however, the accuracy of forecasting advanced rapidly with the introduction of new mathematical models, computers, and satellites [2]. Accompanying this were improvements in the accuracy of meteorological instruments and expansion of Earth-based networks of observational weather stations. Together, all of these advances give meteorologists real-time knowledge of the weather conditions around the globe and permit them to make far more accurate weather predictions. For example, where general weather patterns are concerned, seven-day forecasts are now as accurate as five-day forecasts were 20-25 years ago, while five-day forecasts are as accurate as two to three day forecasts were two decades ago.

The importance of having reliable weather forecasts available is apparent. Not only do they help us order our daily lives, but they are relied upon for maritime, aeronautical, and agricultural purposes. Critically, though, weather forecasts must be understood and exploited in time-dependent terms of probability. In the United Kingdom, forecasts of temperature within a 24-hour period are accurate to within +/- 2 °C, 85 to 90 percent of the time [3]. However, sun and rain forecasts have to be exploited over shorter intervals, because they are approximately 75% accurate over any three-hour period. The result is that for general weather conditions, such as temperature, rain, or sun, weather forecasting is considered statistically reliable for a period of about one to three days.

The forecasting of more specific severe weather events, such as tornados, hurricanes, and blizzards, is considerably less advanced. Given the extreme complexity of the phenomena in question, hyper-accurate forecasting of these events is not routinely possible. Nonetheless, advances have led to a greater understanding of the conditions that lead to these types of events as well as improved our ability to make predictions about each event's behavior, such as the path of a hurricane.

Metrologically speaking, every weather forecast is dependent upon a vast number of measured results. These results, once entered into models, give output that must be interpreted by forecasters and decision makers. For the output to be useful and forecasts to be trustworthy, measurements must be made and reported competently. This requires trained people

and the correct care and use of all employed measurement instruments. Critically, since weather forecasts are in in terms of probability, consideration of the range and likelihood of values attributable to the quantities measured for the best predictions are important. This means that the uncertainty associated with each measured value must be properly determined and incorporated into the estimate of a weather model's reliability. Given the multitude of measurements and variables involved, and the sensitive dependence between many of those variables, even small uncertainties in measured results can have a significant impact on the reliability of a forecast.

When considering the question of liability, the importance of the uncertainty associated with weather forecasting is not lost upon the courts. According to one U.S. court ruling:

> *Weather predictions cannot be given the character of established facts. Even with today's techniques, the general public questions the reliability of the daily weather forecasts, not because of any doubt that reasonable methods are used in making such determinations, but because of the vagaries of the weather. So, a forecast that turns out to be an erroneous forecast, standing alone, should not be considered as any evidence of fault…* [4].

Moreover, whether or not the entity providing forecasts is a government agency may be critical to the analysis. In the United States, most suits against government bodies for inaccurate weather forecasting have been defeated under the doctrine of sovereign immunity or federal statute [5]. If it were otherwise, it is feared that weather forecasting by public agencies would be made impossible by the inherent uncertainty associated with it and the magnitude of the liability that would otherwise attach. According to another U. S. court,

> *…as a matter of public policy, […] to open the National Weather Service to lawsuits for alleged negligent weather forecasts would ultimately destroy the National Weather Service and its efficacy. The highly unpredictable business of forecasting the weather under such circumstances would result in forecasts that were either so general or so broad as to become useless…* [6], [7].

While there is no precedent directly on this point, there are indications that the question might be answered differently by some European countries. In 2009, a magnitude 6.3 earthquake hit the city of L'Aquila in Central Italy. It is well known that earthquakes cannot be predicted. Nonetheless, seven members of the Italian National Committee for the Forecast and Prevention of Serious Risks (Italy's equivalent of the U. S.'s Federal Emergency Management Agency) were convicted of manslaughter for providing "superficial and ineffective" assessments of, and disclosing "inaccurate, incomplete, and contradictory" information about, the likelihood of an earthquake [8]. Although the Italian case involved criminal prosecution as opposed to civil liability, the principles applied are similar to those relied upon in those U. S. courts, which have found government liability for incorrect weather forecasts.

Neither statute nor the doctrine of sovereign immunity protects private sector weather forecasters [9]. Nonetheless, we did not find a single case where a private entity was held liable for an inaccurate forecast, which led to harm. As one court noted:

> *Because prediction of weather is precisely that—a prediction—a weather forecaster should not be subject to liability for an erroneous forecast. Predicting possible future events whose outcome is uncertain is not an exact science for which a broadcaster should be held liable* [10].

Despite this, given evolving notions of jurisprudence, the increasing dependence upon forecasts of greater accuracy and the growing market for private sector forecasting services, it would not be surprising if liability for faulty weather forecasting were found to attach in the future. A survey of the available case law gives rise to three general scenarios where liability might attach:

- A weather forecast was wrong because of technical mistakes in interpreting the measured data or in not maintaining the instruments relied upon (e.g., lack of proper periodic calibration). Either an event was not predicted, which caused injuries and property damage that could have been avoided, or a harmless event was predicted to be catastrophic, thus causing unjustified alarm and expense [11] – 13]. This set of circumstances should be of particular concern to metrologists working with weather forecasters [14].
- The weather forecast was technically correct, but the person in charge of the forecast did not correctly inform the decision maker about the predicted event or its potential seriousness so that either insufficient action was taken resulting in injuries and property damage that could have been avoided, or there was over-reaction that caused unjustified alarm and expense [15] – [18].
- The correct technical steps in the forecast evaluation were made; however, the weather forecast was wrong because of the complexity of the phenomena forecasted. Either there was no prediction of the event and this caused injuries and property damage that might have been avoided had the forecast been correct, or a harmless event was predicted to be catastrophic, thus causing unjustified alarm and expense [19].

While the idea of liability for incorrect weather forecasts may seem obtuse, American courts have found that such

liability may exist. Moreover, if Italian courts can find scientists criminally responsible for not having correctly informed the public about an event that was impossible to predict, then civil liability for incorrect forecasts of far more predictable severe weather events is not out of the realm of possibilities.

If courts do find that liability may attach to an incorrect weather forecast, the general standards and principles to be applied are likely to be those found in other areas of tort and contract law. For example, the duty to exercise reasonable care: a forecaster's duty of reasonable care would mean issuing forecasts "prepared according to the standards of a reasonably prudent meteorologist, including reporting facts about the current state of the weather accurately"… The focus at trial would be on whether the forecaster used "forecasting methods widely accepted and normally used by recognized forecasters for that purpose" [20].

Another point of interest arises in the area of recoverable damages. Although the most obvious impacts of inaccurate weather forecasting would be those related to preventable physical damage to persons and property, the economic effects associated with the response to *incorrect* predictions of severe, or even simply less than ideal, weather may be significant as well.

Consider locations or countries, such as Italy, where tourism is a major source of income. A forecast that predicts bad weather for a particular area is likely to result in tourists changing their travel plans and their money will no longer go into the local economy. If the forecast is correct, even though local merchants are still likely to be unhappy, it is doubtful that weather forecasters could be held legally responsible. On the other hand, if the weather turns out to be ideal, merchants, restaurateurs and hotel owners could then reasonably claim that they were deprived of income as a direct result of an erroneous belief that forecasters fostered in travelers.

This theory may soon be tested. In Italy, a syndicate of tourist operators is considering suing weather forecasters for economic losses caused by an incorrect forecast. Although there is no precedent directly on point, one can look at similar lawsuits brought by the tourism industry in other circumstances causing lost profits, such as those brought in the wake of the BP oil spill (Deepwater Horizon) in the Gulf of Mexico in 2010.

This field of law is still largely unexplored. Depending on how courts rule in the future, liability for incorrect weather forecasts could become a sword of Damocles dangling over the necks of meteorologists and the metrologists who assist them alike. Accordingly, care should be exercised when generating and communicating weather forecasts. Carelessness may have a steep price [9].

References

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