Editors: G. Latini & C.A. Brebbia

AIR POLLUTION IX

WIT PRESS

Environmental litigation – air pollution models and modelers in court

P. Zannetti
EnviroComp Consulting, Inc. Fremont, California, USA

Abstract

Environmental litigation has been steadily increasing over the last two decades. This phenomenon is particularly noticeable in the United States (US). However, this trend is also affecting European countries and courts that deal with international issues.

The parties and their attorneys involved in litigation need expert witnesses such as scientists, engineers, medical doctors, etc., in order to comprehend various cases, and to help define litigation strategy, thus producing accurate and convincing written reports as well as expert testimony to judges and juries.

This paper exhibits a series of informal considerations and reflections of the role of scientists within this process, which is based upon experience in both Europe and the US.

1 Introduction

Statistics across the board indicate that the US is a legally aware society. Percentage wise, US attorneys outnumber attorneys in all other countries. American courts routinely discuss cases that would be dismissed in most Western countries, and American attorneys often take pro-bono cases without any down payment from the plaintiff or defendant. In many plaintiff cases, compensation is contingent on results of the case and attorneys collect if and only if their client wins.

These factors, in part, contribute to the commonality of litigation in general, and environmental litigation in particular, the end result of which can present positive and negative consequences. The bad news is that frivolous lawsuits tend

to waste money and resources that could be used otherwise. In addition, litigation costs are reflected in increased prices for products such as automobiles. The good news is that people who are convinced that they were injured or affected adversely by other people or corporations find it far easier (in the US) to obtain inexpensive legal representation in order to raise a particular case to the attention of judges, often achieving their goal of moral and monetary compensation from torts, such as toxic torts and air pollution.

Typically, during litigation, the plaintiff sues the defendant, but both parties usually acquire attorneys that will represent their interests in court. In many cases, both parties and their respective attorneys need expert witnesses such as: scientists, engineers, medical doctors, etc., who understand and are able to explain relevant technical matters, assist in the definition of litigation strategy, and produce accurate and convincing written reports for expert testimony to judges and juries. Generally, the number of experts needed is determined by the complexity of each case. The greater the potential liability (e.g., compensation for damages sought by the plaintiff), the greater is the level of effort required from expert witnesses on both sides.

2 A Case Example

Below is a typical litigation case involving expert witnesses along with a possible sequence of events.

A series of malfunctions and mechanical failures cause an accidental release from an industrial complex. The release is characterized by an intermittent plume emission with a high concentration of mercaptans. These chemicals are odorous substances characterized by an unpleasant smell detected at very low concentration. The accidental release lasts for a few hours and the chemicals are carried downwind to residential areas in proximity to the industrial complex in question.

Numerous people detect offensive odors in their communities over the next several hours. They make phone calls to the industrial complex, the local regulatory agencies, and to the media. A few people pay a visit to local clinics and hospitals. Several families evacuate their homes, albeit temporarily. After a few more hours, the emergency subsides, the emission rate of chemicals returns to normal, and the offensive odor has practically vanished.

But, in the days to follow, approximately 2,000 people in the residential area closest to the industrial complex, hire plaintiff attorneys to sue the industrial complex for odor nuisance, property trespassing, loss of property value, and adverse health effects. In a case such as this, compensation that could be awarded in a US court of law is US $20 million plus. At the same time as the lawsuit, the incident is investigated both by the industrial complex and the local environmental government agencies. Both groups prepare internal reports with discovery, evaluations, and recommendations.

After one year, the case is still quite active. The industrial complex has offered a compensation amount to a number of plaintiffs, but this settlement has been rejected by the plaintiff. At this junction, both parties realize that a trial by

jury is probable with the necessity for scientific experts. Both sides hire expert witnesses, such as chemical engineers (to characterize the release), plume modelers (to simulate the plume dispersion), toxicologists (to assess possible health effects), real estate experts (to assess the loss of property value), and others.

Experts on both sides move to collect available data and information in order to study the incident. In particular, they will need to perform plume model simulations and plot concentration outputs over a computerized map of the region to understand the actual plume impact during the incident and to identify the areas where concentration levels of concern were possibly exceeded. Both sides geocode the 2,000 plaintiff locations in order to plot them as dots in a computerized map. (Geocoding is the process of calculating the latitude and longitude of a location originally expressed with a street address. In the US, special geocoding software allows the performance of this task in a relatively easy fashion. Therefore, starting from a list of addresses, one can automatically calculate the exact GIS locations.) After which, geographic information systems (GIS) are used to identify and visualize those plaintiffs that are inside pre-defined concentration contour lines.

The experts set out to prepare technical reports and declarations, which are given to their clients and also provided to the opposing party. Experts may also be asked to prepare additional reports in order to comment on and criticize the technical work presented by the opposing team of experts. Experts are interrogated by opposing attorneys--a deposition process in which the expert, under oath, must accurately answer. All questions and answers posed during the deposition are recorded and may later be used during the trial.

Clearly, at the deposition stage, the litigation process is fully active and the experts play a critical role. During the litigation phase, minor mistakes, which in a purely scientific context would be small or irrelevant, may become the source of great concern as the opposing side endeavors to discredit the data and opinions compiled by a given expert.

Finally, if a settlement is not reached, the case will go to trial. Experts will be asked again to testify, only this time in front of a judge and often a jury. At this stage, an expert witness may be required to prepare graphs, charts, drawings, illustrations and in some cases, computer animations. Good visualization material is essential to ensure that the members of the jury, mostly non-technical people, understand the issues in layman's terms.

The case discussed above is just an example, bearing in mind that each case may present a different evolution, but the example offers a general idea of the processes involved. These processes require extensive interactions between scientists (and engineers, medical doctors, etc.) and attorneys, as discussed below.

3 Scientists and Attorneys – Not an Easy Marriage

Scientists and attorneys arrive from two different worlds and diverse educations, but this is not necessarily a cause for concern. Often, diverse people work

extremely well together, and it is a fact, in today's highly specialized domain, that specialists who work side by side are often from distinct backgrounds.

The problems that attorneys and scientists face when collaborating originate mostly from a lack of a full knowledge and understanding of an individual's role as well as cultural background. Unfortunately, in the author's opinion, scientists tend more to misunderstand the business of attorneys rather than the reverse.

In any given legal case, an attorney is hired by a client to represent either the plaintiff or defendant. The attorney strives to win each case for each client. An attorney will hire a scientist in order to clarify an area of expertise to win the case or to at least obtain a favorable settlement. Although the end result of a scientific examination cannot be anticipated, the attorney is hopeful that the scientist will perform a thorough and accurate technical analysis that includes a convincing approach, reasonable budget, and achievable goals with results that are favorable to the client.

A scientist needs to understand that he is hired by an attorney representing a client which, ultimately, is the beneficial party. However, the scientist is NOT hired by the beneficial party and is not "representing" that side. The scientist is providing a technical opinion on the scientific matters of the case – period. The scientist is NOT an advocate – no matter what his personal feelings are about the case.

When a scientist is hired by a client (an attorney or a law firm), there is a duty to perform the best possible job for the client. In order to fulfill the contract, the regulations are customary. First, according to law, the truth must be revealed under oath. Second, the needs of the client must be understood and the focus must be on the technical investigation on key issues at hand. Third, the scientist must be professional at all times, avoiding technical efforts on marginal issues (such as research projects on a grant scale) and keeping the client informed at all times. Forth, the scientist should be aware of the litigation process and be willing to discuss and agree with the client about documentation, files, communications and confidentiality issues. In short, the scientist must follow some direction imposed by the client who is the legal expert. The scientist does not need to understand every complicated legal issue and, when in doubt, should ask the client for direction.

As part of the consultant/client relationship, there is no argument that the personal integrity of the scientist must be maintained at all times. A client needs open communication with the scientist in order to interpret early on in the litigation process whether or not the opposing team has a viable case. Of course, the best case scenario is for the scientific results to be favorable to the beneficial party, but even when results prove unfavorable to the beneficial party, there should be some room for a good consultant to provide useful data. If the results are unfavorable, it is advantageous for the client to have this information in advance, rather than discovering the unfavorable results in the middle of a trial from the opposing experts. Moreover, mitigating circumstances could be discovered and scientifically proven. Also, the level of confidence of the results presented by the opposing team can be investigated and challenged.

Technical work as the one described above should be performed with the goal to objectively frame the problem, and not to confuse the issues. The correct scientific manner involves informing the jury of the results along with a degree of reliability.

When collaborating, scientists and attorneys may often encounter communication problems resulting in frustration. For example, during a deposition when questioned by the opposition, a scientist may discover - - that his client did not disclose all the available information involved with the case. It may be an honest mistake in which the attorney simply forgot to provide some data or information, or it might be a deliberate litigation strategy in which the attorney was convinced that specific information was useless or counterproductive to his case. While a scientist by his own nature and education, wants to know the entirety of a given case, an attorney, for strategic purposes or in order to minimize expenses, may well decide to limit the role of an expert witness to a narrow field and therefore, would not provide information in the range that was outside that given domain.

Due to these various wave lengths, attorneys are often frustrated when scientists are not clear about their aim. This frustration escalates if the scientist regards the budget as a research grant, conducting parallel efforts and investigations without specific authorization. Particularly disturbing is the situation in which an expert witness prepares written statements without previous discussion and authorization. Another grave mistake that creates a negative situation for the attorney is an expert witness who, under the pressure of cross-examination, reveals weaknesses and doubts not discussed in advance with the client. Rightly so, attorneys do not relish surprises, especially during deposition or at trial.

4 The Role of Simulation Models

In the past, experts hired for litigation cases were required to provide opinions and subsequently support those doctrines with published citations, professional experience, and simple "pen-and-paper" calculations. Presently, all technical fields are much more complex and therefore, computers now play a very important role in all aspects of science. In particular, techniques that involve computer simulation are used in virtually all technical fields.

For example, in air pollution, computer simulation models have been used in the US since the early 1970s as "regulatory tools", i.e., official tools recommended by regulatory agencies to simulate the concentration impact of emissions of chemicals into the atmosphere. The most common application of air pollution models is made for "permit applications" or "implementation plans", i.e., to simulate future emission scenarios and assure that future emissions will not cause exceedances in the ambient concentrations of pollutants. (An exceedance is a measured or simulated ambient concentration of a chemical greater than a pre-defined level of concern, e.g., a national air quality standard.) In the US, a permit for a new industrial emission can only be obtained by running

a regulatory model and thus convincing the local regulatory agencies that future concentration impacts will be within acceptable levels.

But the same "regulatory" models, or similar tools, can also be used to simulate the past, e.g., to simulate an accidental release from an industrial facility. Accidental releases in the US are often litigated in court whereas experts are hired in order to perform a reconstruction of the incidents. Today, these experts commonly use simulation models to estimate the concentration impact in the neighboring areas downwind from the release.

The use of computer simulation models is clearly necessary in accidental release cases (as well as in many other environmental litigation cases, e.g., groundwater contamination). However, the use of computer models complicates the litigation strategy for attorneys. In fact, in the past, when experts were using "pen-and-paper" formulas, it was difficult but not impossible for an attorney to understand the full nature and substance of these calculations and thereby cross-examine the expert witness with precise and pointed questions. But now, with computer models performing thousands, and often millions, of numerical calculations, an attorney cannot master the numerical details. In his cross-examination, the attorney will focus instead on: 1) understanding and evaluating the input data and assumptions used to run the model; 2) verifying that the model is peer-reviewed and accepted by the scientific community; and 3) making sure that the results of the models are not in contradiction with basic, elementary scientific assumptions. The formidable task for attorneys on both sides is to understand as much as possible about modeling techniques and to be able to present or criticize the results of those models in court.

For the modeler, a litigation case is a unique experience where his area of expertise is presented to and judged by the legal community who have limited or no scientific background. Working in a litigation environment, the modeler must anticipate possible criticism of his investigation. Questions can vary from typical criticism that a scientist may face while presenting a paper at a scientific conference to a more challenging arena. In fact, within the litigation environment, a technical analysis can be approached from any given angle, oftentimes in an unexpected and unprecedented manner. It is well to bear in mind that among scientists, all disagreements and differences are eventually resolved under the general guidance called the scientific method. It may take years, even generations sometimes, to set the record straight, but there is no doubt that, eventually, science overcomes junk science. However, in litigation cases, the confrontation that transpires between the plaintiff and defendant will be decided by a judge and (often) a jury, their decision based solely on the opinions and materials presented at trial. Therefore, the configuration in which opinions are presented may be as important as the data themselves. It is therefore crucial that an expert witness approach the jury with an understandable language that presents itself as knowledgeable, honest, and credible.

Moreover, a modeler, with the assistance of his client, needs to understand and anticipate any possible criticism and be prepared for that criticism with gusto. A modeler must be aware that all his previous modeling work and publications may be examined by the opposing attorneys for the purpose of

identifying authentic or apparent contradictions that may be used to discredit the work or, at least, inject doubts on the reliability of results.

Since the beginning, a modeling task in a litigation case presents important choices that the expert witness needs to make. First of all, does the case warrant the need for a complex computer model? Should perhaps a simple model be chosen? Which model will be easier to explain to a jury?

So, which model should be used? In one case, for example, the expert may use a computer model developed and recommended by the US Environmental Protection Agency (EPA). In another scenario, the expert might use a "research prototype" code developed at a University or a National Laboratory. In yet another case, the expert might utilize a model recently developed, or even a model (or a set of calculations) expressly developed for the case at hand.

Bear in mind that each choice has advantages and disadvantages. Clearly, models that are widely used by other scientists and recommended by regulatory agencies can be perceived as more reliable than others. However, in litigation, an expert witness has ample latitude in selecting the tools that are most appropriate for the case. If the use of a particular model can be convincingly justified as the most appropriate, then it may redeem itself. Whatever tool is chosen, the expert witness must be able to persuasively present it as reliable, peer-reviewed science. In all cases, the expert witness must feel comfortable in the ability to justify the choice to a non-technical audience under cross-examination.

Eventually, a modeler must provide copy of all documentation, papers, calculations, and computer files to the opposing attorneys. It is during this phase that often an expert on the opposing side will be asked to review all evidence and most likely be required to re-run some or all of the computer simulations. Therefore, all litigation procedures must be performed with the knowledge of this disputatious process. It is for this reason that comments, approximations, corrections, assumptions that in a pure scientific environment would be acceptable, may become problematic in a litigation environment, where, for example, a minor, irrelevant error could be used to discredit the entire modeling endeavor.

A modeling expert must realize that modeling runs are extremely complex and can be criticized and misrepresented by the opposition. Moreover, every model run requires a choice of suitable input parameters. These inputs can be generally defined within a certain range of variability, so the choice of actual numbers in each range is critical.

For example, when considering accidental releases of chemicals, an expert first needs to estimate the actual emission rate, expressed, for example, in grams per second. An exact estimate may be impossible but, in general, a credible range of values can be found (e.g., between 5 and 10 grams per second). Which value, then, should the expert use? The "average" value of 7.5 grams per second could be a reasonable choice. On the other hand, this may be criticized as an underestimation of the actual release. The maximum value of 10 grams per second may also be a good choice - a "conservative" choice - in the sense that this value would represent the highest possible rate and, therefore, the "worst-

case" scenario. However, it may be criticized as extreme and inappropriately high.

An expert may decide to perform simulation modeling using "ranges" of values, to cover all possibilities. But, with this approach, results are not expressed in numbers but by range of numbers with probabilistic distributions - a concept not easy to explain to non-technical people.

An expert also needs to be extremely cautious during presentation of the modeling results. In scientific papers for scientific audiences, graphs and figures are typically used to visualize and clarify assumptions and results. For example, a scientist may plot concentration contour lines to visualize the area of impact of a plume using arbitrary contour values, just to depict the shape of the plume. In litigation, instead, a scientist should be careful in selecting contour values and be ready to justify why certain values were selected instead of others.

Again, visualization of model results is extremely important, especially when presenting results to a jury. But, the expert witness must realize that each and every dot and line in a plot could be challenged by the opposing attorneys.

5 Some Practical Suggestions

Working as a litigation expert can be an extremely interesting and professionally rewarding experience for a scientist. As an expert witness, the scientist is under oath and must reveal the truth. In addition, while both parties (plaintiffs and defendants) are legally represented in court by their respective attorneys, the expert witness does not have legal representation. The client for the expert witness is an attorney but is not the attorney for the expert witness.

It is well to clarify that some scientists will not become worthy litigation experts for the same reasons that some attorneys will not be capable of mastering the art of advanced mathematics. Everyone has intrinsic limitations in one field or another, and nothing can be done to change this reality. For instance, there are scientists who possess the Nobel Prize that, if hired as litigation experts, would probably fail miserably under the grill of a well-prepared, aggressive cross-examination. Therefore, before a scientist becomes involved as a litigation expert, it is wise to question (and perhaps solicit the advice of his colleagues and friends) whether or not the task can be performed. In other words, is the risk worthwhile?

It is particularly risky for a scientist to be involved in litigation on rare occasions (e.g., every few years), as the extra skills that are required in this particular field may not be properly developed if the service is sporadic. Equally at stake is the scientist who only works on litigation cases. On the whole, the ideal situation is the scientist who has a full scientific workload who is often asked to provide a professional, independent assessment of technical issues related to litigation.

Consequently, a scientist involved in litigation must have the capacity to work well under rigid circumstances, extremely tough deadlines, and last minute requirements. Working with attorneys in the US may require concentrated periods with extended hours that include nights and weekends. During trials,

personal life, commitments and activities may be affected due to extremely hectic performance efforts. Additionally, a scientist who takes on the task of expert witness should be aware of the entire legal environment including aggressive attorneys whose jobs often entail the art of intimidating the expert witness on the stand.

That being said, a scientist should work closely with his client at all times in order to become aware of the client's fields of interest and budget limitations. At no time should a scientist make promises or commitments to a client about the results of his technical efforts. The scientist should work exclusively on the tasks required by the client in a timely fashion. Of course, a scientist can anticipate what he expects to discover and can certainly provide realistic cost and time estimates for the required scientific effort, but the scientist should not promise results before performance.

It is unwise for a scientist to work in litigation cases without a minimum understanding of the litigation process. There is nothing more valuable, for a scientist inexperienced in litigation, than good communication with experienced colleagues in the field of law. However, good publications can also assist a scientist with an understanding of a multitude of law-related issues, including rights, duties, and obligations.

One example is the book "Effective Expert Witnessing [1], which is quite comprehensive in explaining how to be an expert and give effective testimony. It includes case studies and other useful material (e.g., a directory of organizations). A shorter publication [2] on the same theme – "A Guide to Service as a Forensic Expert; Professional and Expert Witness" – is provided by ASFR-Professional Firms Practicing in the Geosciences and co-sponsored by the Association of Engineering Geologists. An additional book should be mentioned ("The Scientist and Engineer in Court" [3]), even though it is an older publication (1983). Also, some law firms distribute booklets with a set of recommendations and guidelines for experts.

In conclusion, a recent article on "The Expanding Use of Forensics in Environmental Science" [4] is worth mentioning, together with the 1999 book "Environmental Forensics" [5] for readers interested in advances in the scientific investigation of environmental crimes.

Disclaimer

This paper presents a series of preliminary and informal concepts on environmental litigation based on personal experience as an expert witness in Italy and in the United States. This paper does not intend to provide guidelines or recommendations. Plans are underway to expand, review, and refine these initial considerations via incoming innovative articles that address the same theme.

References

[1] Matson, J.V. *Effective Expert Witnessing*. CRC Press, Inc., Lewis Publishers. 1994.
[2] ASFR-Professional Firms Practicing in the Geosciences. *A Guide to Service as a Forensic Expert; Professional and Expert Witness*.
[3] Bradley, M.D. *The Scientist and Engineer in Court*. American Geophysical Union, Water Resources Monograph. 1983.
[4] Carpi, A. & J. Mital. The Expanding Use of Forensics in Environmental Science. *Environmental Science & Technology*, June 1, 2000, p 262A.
[5] Morrison, R.D. *Environmental Forensics*. CRC Press. 1999.

Economics policies: in

F. Becchis
Foundation for
and University

Abstract

The European di
council directive
sources of pollut
limits (EL); the
(Best Available
Entailing Excessi
focuses on a m
integrated standa
transfer pushing f

1 Introductio

1.1 The standard

As known, stand
theory, they shou
It seems a comm
models happen to
two main families

1.1.1 Environ

Environmental q
more than...). Th
individuals, vege
damages. Therefo
water, groundwa