Book Assails Unrealistic Mathematical Models

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Using equations to forecast the specific behavior of complex natural processes such as beach erosion and long-term nuclear waste storage creates a false sense of security, according to a new book by a retired Duke University geologist and his geologist daughter.

In a preface to "Useless Arithmetic: Why Environmental Scientists Can't Predict the Future," Orrin Pilkey and Linda Pilkey-Jarvis write that relying on such mathematical models has “done tangible damage to our society in many ways."

Among their examples, the pair charge that faulty mathematical models contributed to the collapse of a prime North American fishery. They say such models also are predicting unreachable margins of safety at a planned national U.S. high-level radioactive waste repository and have given coastal communities overly optimistic expectations about the endurance of beach nourishment projects.

"We make this point again and again: if your basic assumptions are wrong, it doesn't matter what the math does," said Pilkey, a retired professor at Duke's Nicholas School of the Environment and Earth Sciences.

"Since scientists now have computers on their desks that can do all kinds of sophisticated calculations, they have been saying 'give us enough money and we'll come up with a good model,' " he added. "And they have failed miserably. We scientists have to hang our heads in shame.

We should have, long ago, admitted our weaknesses."

The authors focus their criticisms on quantitative mathematical models, which they define as those attempting to make specific predictions about natural outcomes by answering the questions "when," "where" and "how much."

In the case of the now-collapsed Grand Banks cod fishery, the authors argue that Canadian scientists used unrealistic quantitative models of total allowable catch to determine harvesting levels. "According to these models, the Grand Banks should still be full of fish," they write.

In its assessments of the unfinished Yucca Mountain high-level nuclear waste site in Nevada, the U.S. government has used a "pyramid" of hundreds of quantitative mathematical models to predict the repository's long-term behavior, according to the authors. Those flawed models, they write, predict a questionable 10,000 years of certainty that natural processes will not cause the repository to leak radiation.

"Of all the examples of quantitative models that I looked at, the worst is the U.S. Army Corps of Engineers' modeling of the behavior of beaches," said Pilkey, who has also assailed those models in previous books on coastal development. "There is no truth in those models at all."

State and local governments use Corps models to guide engineering projects to "nourish" eroded beaches with imported sand. To receive federal funding, the government agencies must predict in advance the life span of the beach nourishment projects in order to ensure that the benefits outweigh the costs, and project supporters typically use modeling to make such predictions, the geologists write. But, they added, some of those beaches have been replenished more than 20 times since the early 1960s.

"Agencies that depend upon project approvals for their very survival (such as the U.S. Army Corps of Engineers) can and frequently do find ways to adjust models to come up with correct answers that will ensure project funding," the book adds.

While condemning quantitative modeling, the book is more supportive of qualitative models that predict only direction and magnitudes of natural phenomena while accepting the possibility of being "imprecise or wrong to some degree." As examples of good modeling, the authors cite hurricane-tracking forecasts and global climate models.

Pilkey, the James B. Duke Professor Emeritus of Geology at the Nicholas School, began Duke's Program for the Study of Developed Shorelines, which is now a joint program with Western Carolina University. An expert in the geology of deep ocean plains, he has also written numerous books on how ocean forces and human development jointly affect beaches.

Pilkey-Jarvis is a geologist and expert on oil spills for the state of Washington's ecology department.

Source: Duke University