Father-son team develops smart strategies for protection again natural disasters

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(Phys.org)—Do costly seawalls provide a false sense of security in efforts to control nature? Would it be better to focus on far less expensive warning systems and improved evacuation procedures that can save many lives?

Seth Stein, a Northwestern University geologist, has teamed up with his father, Jerome Stein, an economist at Brown University, to develop new strategies to defend society against natural disasters like Hurricane Sandy as well as the effects of climate change.

The approach, which considers costs and benefits while looking for the best solution, is based on a mathematical technique called optimization.

The research is published in the October issue of the Geological Society of America journal *GSA Today*. The article is titled "Rebuilding Tohoku: a joint geophysical and economic framework for hazard mitigation."

"We're playing a high-stakes game against nature and often losing," said Seth Stein, the William Deering Professor of Geological Sciences in the Weinberg College of Arts and Sciences at Northwestern.

"Just in the past few years, both the Japanese tsunami and Hurricane Katrina did more than $100 billion in damage, despite expensive protection measures that were in place. Hurricane Sandy is likely to cost at least $20 billion," he said. "The question is how to do better. For

example, should New York spend billions of dollars on a barrier to prevent flooding like the city saw this week?"

Both the U.S. and Japanese governments decided to rebuild the defenses that failed essentially to the level they were before, only better. These decisions have been questioned, Seth Stein said. Critics argue that coastal defenses in Louisiana and surroundings should be built not just to withstand a hurricane like Katrina, but much more powerful ones that are known to occur there.

The New York Times noted in discussing Japan's decision to rebuild the tsunami defenses: "Some critics have long argued that the construction of seawalls was a mistaken, hubristic effort to control nature as well as the kind of wasteful public works project that successive Japanese governments used to reward politically connected companies in flush times and to try to kick-start a stagnant economy."

The problem, explains Jerome Stein, is that the decisions on how to protect against these hazards are made politically without careful consideration of alternatives. "There are complicated choices that have to be made, given that we don't know when a similar event will happen," he said. "We need ways to consider a range of options, each of which has different costs and benefits, and help communities involved make the most informed choices."

The mathematical model the Steins have developed lets communities balance the costs and benefits of different strategies.

"We start from the losses that would occur if nothing was done to protect against future disasters and then calculate how much less they would be for increasing amounts of protection," said Jerome Stein, a professor emeritus of economics.

"That reduction is the benefit of more protection, but the increased protection also costs more," he said. "When you add the cost and benefit, you get a U-shaped curve with a minimum at the level of protection that is the best choice. More protection reduces losses, but the cost involved is more than that reduction. Less protection costs less, but produces higher losses. The bottom of the curve is the sweet spot."

Although global warming results largely from human actions, many of its effects are expected to appear as natural disasters like coastal flooding, severe weather or droughts. The Steins' mathematical optimization model could be applied to these situations, too.

"Nations around the world have to decide both how to reduce emissions of carbon dioxide that cause warming and how to adapt to the effects of warming," Seth Stein said. "Choosing policies to address these large-scale problems is a much more complicated version of addressing a specific hazard in a limited area, so considering costs and benefits and looking for good solutions is even more crucial."

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