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This column is written for those interested in learning about the world of Data for Good, where statistical analysis is dedicated to good causes that benefit our lives, our communities, and our world. If you would like to know more or have ideas for articles, contact David Corliss at *davidjcorliss@peace-work.org*.

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STAT*tr@k* is a column in *Amstat News* and a website covering ideas, people, and career paths shaping the future of statistics and data science. To read more articles like this one, visit the website at *http://stattrak.amstat.org*. If you have suggestions for future articles, or would like to submit an article, please email Megan Murphy, *Amstat News* managing editor, at *megan@amstat.org*

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STAT*tr@k*

Breaking Down the Impossible: How Applied Statistics Can Guide Humanitarian Response

Adam Barone, ASA Senior Editor (Contract)



Adam Barone has been recognized seven times for excellence in journalism by the New England Press Association, New Hampshire Press Association, and Hoosier State Press Association. He's covered a diverse range of topics, including technology, business, social issues, and sports.

Bring water to the Sahel, a vast region of Africa facing an ongoing water crisis. This was the challenge handed to one team of graduate engineering students last spring in MFE634 at Syracuse University, Jorge Romeu's Productivity and Quality Engineering class. The problem is different for every team—usually three or four per class—but the mission is the same: Use quality engineering principles, many of which draw on applied statistics, to tackle a humanitarian crisis.

The exercise offers a practical window into how statistical skills can apply to complex problems well beyond the scope of industry and classroom settings—a quality Romeu says makes the course much more engaging for students. "They are extremely motivated to do their work," he says, "much more than if they were just sitting there passively like a sack of potatoes ingesting all of the theory I give them."

The challenge comes in learning to apply those theories in environments where root causes are undefined, information is incomplete, and the stakes are human lives.

Plenty of people want to make the world a better place. What statistics and data science bring to that ambition is a disciplined way to decide what to do first, what evidence to trust, and how much confidence to place in a proposed solution. In humanitarian crises, this way of thinking can turn an overwhelming problem into a sequence of measurable decisions.

"Statistics is the heart of the tools we have because everything is uncertain and everything is constantly changing," says Romeu. "You have a devastated city. You have to reconstruct it. You have to bring in people. How do you bring them in? Where do you put them? Once they are there, all the equipment uses gasoline. Where do you get the electricity from? Where do these workers sleep? They have to eat. It's a very complex operation, and everything is based on estimations and consumption rates. All of that is just statistics."

In Romeu's view, many humanitarian crises can be understood as systems that have fallen out of balance—where needs have emerged faster than resources can respond. The statistical challenge is to estimate those flows well enough to restore that balance.

Romeu's decision to frame these classroom projects around humanitarian crises grew from his broader philosophy of professional purpose. Engineers and statisticians may be trained to solve technical problems, he says, but that knowledge need not remain confined to industry or the classroom. "We obtain a qualification, but we live in society," Romeu says. "We could use some of our knowledge to help society solve their problems."

In the Sahel, the problems are ongoing and myriad. A combination of prolonged drought, floods, rapid population growth, and inadequate infrastructure are converging to limit access to safe drinking water, while straining agriculture, sanitation, and regional economies.

For Romeu, these challenges are precisely where quality engineering becomes useful. It's a framework for turning one overwhelming problem into a series of smaller ones that can be measured and addressed systematically.

Without that framework, relief efforts can become reactive—built from experience, subject-matter expertise, and immediate necessity as conditions unfold. Those capacities remain essential, but statistical thinking can help direct resources where they are most likely to improve outcomes.

"It's applied statistics, and you have a lot of logistics," Romeu says. "You need to analyze the reliability of the different components. You need to compare different types of solutions and find out which is the most efficient—the one that provides the best solution with the lowest cost because you only have so much money."

In the classroom, this approach becomes a sequence of questions whose applicability extends far beyond the confines of academia. Can the available data be trusted? Where is the system most vulnerable? Which factors most influence the outcome? What happens if a critical component fails? And how will anyone know whether an intervention actually improved the problem?

Syracuse graduate engineering management student Emma Klein confronted those questions as part of the Sahel team in Romeu's spring 2026 class. Her group began by identifying possible causes of the region's issues. But before drawing conclusions from any of it, they had to answer a more fundamental question: Could they trust the measurements?

Klein's primary assignment involved Gage R&R, a measurement-system analysis used to determine how much of the observed variation came from the process itself and how much came from the measurement system. When the team's initial Gage R&R analysis showed excessive variability, they revisited the data rather than build conclusions on questionable foundations.

"With the measurement system analysis, the numbers we were given didn't give good results," Klein said. "They had high variability. And in the case of the Gage R&R, it was unfavorable for the processing if we couldn't trust the data we were given from the sampling tool. So, after we determined that the data was insufficient, we were able to go back and use a second dataset that Professor Romeu provided, run the test again, and compare the before and after to find the differences between the datasets."

In a humanitarian setting, that distinction is consequential. If the measurement system is adding more noise than the process itself, the team may be fixing the wrong problem, misallocating scarce resources, or mistaking random variation for improvement.

Learning by Doing

Knowing which statistical tools to use is one thing. Applying them in a real-world context is another. Integrating those capabilities, Romeu believes, can elevate professional practice in a wide range of statistically oriented fields—like quality engineering.

Romeu says his teaching method draws heavily from educational philosopher John Dewey's concept of learning by doing: "You don't regurgitate a definition, you apply it. Then you see the problems in applying it. So, in all my courses, even in my applied statistics course—which was a prerequisite for this class—I always use the approach of learning by doing."

Romeu's approach teaches students to recognize what information matters, when an analysis isn't working, and when assumptions must be questioned—skills that translate to most problem-solving scenarios that involve applied statistics.

Learning this way can be uncomfortable, but Romeu supports his students by ensuring they have the statistical foundation to begin pulling apart the problems he gives them.

Making an Impossible Problem Smaller

The Sahel exercise gradually turned one enormous instruction—bring water to the region—into a series of smaller engineering questions. What was driving the gap between water supply and demand? Where could groundwater be accessed? How reliably could it be pumped and treated? How could extraction be monitored to avoid exhausting the source? Where were the likely failure points?

Different quality engineering methods addressed different parts of that system. Root-cause analysis helped organize the sources of problems. Measurement-system analysis tested whether the data was trustworthy. Designed experiments explored factors affecting performance. Statistical process control and reliability analysis offered ways to monitor the system and anticipate failure.

The students ultimately proposed a conceptual decentralized system involving groundwater extraction, solar-powered pumps, filtration, elevated storage, and local distribution. The point wasn't to claim they had "solved" a global crisis from a classroom in Upstate New York. It was to learn how to turn a seemingly impossible challenge into a series of questions, measurements, decisions, and feedback.

"By breaking the problem down and focusing on one system at a time, I think it really helped and made the project more manageable," Klein says.

Beyond the Classroom

Over the years, Romeu has built projects around hurricanes, earthquakes, volcanic disasters, mining accidents, war zones, and large-scale reconstruction.

Though MFE634 projects don't lead directly to action in crisis zones, Romeu has spent years applying his quality engineering methods to make an impact in the field. He leads the Quality, Reliability and Continuous Improvement Institute, a public-service initiative he created through the Juarez-Lincoln-Marti International Education Project to make practical resources in applied statistics, reliability, and quality engineering freely available to relief workers on the ground. The institute serves as a repository for tutorials, papers, and teaching materials, including work developed in his courses.

But Romeu is also clear about the limits of the framework. Some of the hardest problems aren't statistical at all. In crisis settings, stakeholders may withhold information, provide false data, or actively obstruct relief efforts. And no model can compensate for distorted evidence or evidence that never reaches the analyst.

For Klein, the exercise ultimately changed the meaning of the calculations. The models and measurements led to pumps, water supplies, infrastructure, and failure rates—but behind each of those variables were people. "4.2 million people were forced to flee. Those are huge numbers. It really puts everything into context that what we're dealing with is someone's life," she says. ■

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