What is the environmental impact of hydraulic fracturing?

Pietro Bonetti and coauthors decided to study the role of disclosure rules for companies engaging in hydraulic fracturing, aka fracking. Their research has led to a novel way of assessing fracking's impact on surface water.

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Hydraulic fracturing, a technique used to stimulate oil and gas production from certain wells, burst onto the scene in the mid 2000's, increasing U.S. production of oil and natural gas to unforeseen levels, while raising questions about its impacts on nearby communities and on human health.

New evidence suggests that hydraulic fracturing, aka fracking, can affect the quality of nearby surface waters and that more data is needed to better understand the full extent of the impact.

That is according to a new paper by Pietro Bonetti of IESE, Christian Leuz of the University of Chicago Booth School of Business and Giovanna Michelon of the University of Bristol, which was published in *Science* in August 2021. The paper's summary reads: "First evidence that unconventional oil and gas development is related to increased salt concentrations in surface waters across several U.S. shales and watersheds." Here, *IESE Insight* asks Professor Bonetti to unpack that sentence and give some more context to this research. In this interview, we learn how fracking is related to the quality of nearby surface waters for several U.S. shales and why better water monitoring is key to fully understanding the impact on surface water.

How did this research come about?

Originally, the project was to study disclosure and transparency requirements — my main areas of research in the field of accounting — except in this case, the requirements pertained to fracking operations. Beginning in 2010, many U.S. states started to regulate hydraulic fracturing, obliging operators to disclose the substances used in their fracturing fluids. My coauthors and I decided to examine the consequences of the new state-level disclosure requirements on drilling activity and water quality.

But when we started to look into the data and review the scientific literature, we saw that the link between fracking and surface-water quality wasn't yet fully established. Some studies have found a link with groundwater contamination, but there were very few focusing on surface water. In fact, the U.S. Environmental Protection Agency (EPA) reviewed and synthesized the evidence concerning the impact of hydraulic fracturing on U.S. water resources and concluded in its 2016 report that there are instances of surface-water contamination related to local leaks and spills, but did not identify widespread or systematic contamination. However, we saw patterns in our data that were consistent with impact. So, our research team decided to put the disclosure paper on hold and explore the link between fracking and surface-water quality first.

How is this study different from others in the field?

The main innovation of our study is the large-sample, statistical approach. We borrowed from econometrics and built a geo-coded database that combines surface-water measurements with tens of thousands of hydraulic fracturing wells across hundreds of watersheds from 2006

to 2016. This large sample, combined with a statistical approach to the background chemical concentrations in many areas, made it easier to detect anomalous concentrations in surface waters that might go unnoticed in a smaller sample. With this approach, we examined anomalous changes in salt concentrations (bromide, chloride, barium, and strontium) associated with new wells in the same watersheds. Our statistical models explain more than 80% — and in many cases more than 90% — of the background variation in ion concentrations across watersheds over time, implying that we can reasonably estimate surface-water baselines and, hence, identify anomalous changes in salt concentration associated with new wells. While this approach does not identify the exact way in which unconventional oil and gas development affects surface water, it is very powerful for estimating the association between new fracking activities and nearby changes in surface-water quality.

What are the main findings?

We find that new hydraulic fracturing wells are associated with small increases in salt concentrations in nearby surface waters. Drilling down, so to speak, the largest impacts occur during the early phases of production, when wells generate large amounts of flowback and produce water. Additionally, we observe the largest associations when water monitoring stations are within 15 kilometers and downstream from a well. However, even the highest increases in observed salt concentrations remained *well* below what the EPA considers harmful. That said, most water measurements were taken in rivers or streams, so dilution must be taken into account and also the fact that the average well in our data was not particularly close to a monitoring station.

What does this last point imply?

Our estimated water impacts are indeed very small, well below EPA limits, and should therefore not set off any alarm bells. However, not all wells are close to surface water and not all monitors are in locations where an impact could be detected (e.g., the closest water monitor may be upstream from a well). Thus, the estimated impacts over all monitors in a watershed is likely small due to the distance between wells and monitored water.

Are we to conclude from this that fracking is dangerous?

The takeaway from this study is not that fracking is dangerous or safe. The honest answer is that we still don't know, and that is for two reasons: First, due to the aforementioned

limitations of available water-quality measurements; and second, because we study chemicals that are not that dangerous per se. Our analysis focuses on salts, like barium, bromide, chloride and strontium, that are signatures because they are commonly present in fracturing wastewaters. While wastewaters and fracturing fluids also contain chemical substances that are potentially more dangerous, they are not included in many public databases, making a large-sample, statistical analysis infeasible at this point. This is not meant to imply that if we had data for these chemicals, our approach would also estimate significant associations between these chemicals and fracturing activities. We simply do not know and leave this issue to future research.

Are there any policy takeaways from this?

Related to my previous point, the big takeaway is that we need better and more frequent monitoring and water measurement to get a greater understanding of the environmental implications. For instance, federal and state environmental agencies could consider placing monitoring stations in a more targeted fashion to better track potential water-quality impacts. More extensive water measurement for a broader array of substances clearly requires adequate funding for these agencies.

What about wellbeing or social implications?

This is a very difficult question. On the one hand, our study shows that hydraulic fracturing is related to the quality of nearby surface waters for several U.S. shales — with all the aforementioned caveats regarding those findings — and this clearly has implications for the environment. In addition, some studies have shown negative health effects for people living close to fracking sites. On the other hand, there are a number of factors to consider.

First, operators have improved their practices over time. Until 2010/2011, the industry wasn't particularly regulated. But with more public scrutiny and regulation, including the disclosure rules we study in a related paper, practices have improved. For instance, in the related paper on the disclosure-regulation consequences, we find that after the adoption of disclosures on fracturing fluids, the quality of surface water in areas exposed improved, although this finding is still preliminary.

Second, fracking played a big role in replacing coal as a source of energy, and some studies show that, relative to periods of massive coal-burning, the overall quality of surface water has improved.

Third, as many studies suggest, fracking has also brought jobs and economic development to underdeveloped areas. Fourth, and more at the macro-level, fracking has led to abruptly lower energy prices and more energy security. Since the optimal social level of pollution is probably greater than zero, a broader welfare analysis has to weigh these costs and benefits, which is very difficult. Such a cost-benefit analysis is beyond the scope of the paper.

Would you say your project could contribute to improved environmental outcomes?

Our study provides evidence that hydraulic fracturing is associated with the quality of nearby surface waters and suggests that better and more frequent water monitoring is needed for a more complete understanding of the environmental impacts. This should be relevant evidence for those interested in improving environmental outcomes. An even more complete understanding of these impacts would be valuable to all stakeholders — including the industry, communities, NGOs and activists — for the cost-benefit analysis we just talked about. Moreover, studying regulatory efforts is useful for learning more about which incentives lead operators to further improve their practices.