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0:00:05.7 Sarah Crespi: Welcome to the Science Podcast for July 16th, 2021. I'm Sarah Crespi. Each week we feature the most interesting news and research published in Science and the sister journals. First up this week, staff writer, Jennifer Couzin-Frankel, discusses how COVID-19 may change science in the future, and we look back at how past pandemics have changed the world. Next we have researcher Dan Shugar, he talks with producer Joel Goldberg about a devastating rock and ice avalanche that happened this year in Northern India, and why closely monitoring steep mountain slopes is so important for averting future catastrophes.

0:00:48.6 SC: COVID-19 is still here. There's no question, millions are being affected, but 16 months into the pandemic, we're taking a look at changes COVID-19 has wrought on the scientific enterprise. This week, Jennifer Couzin-Frankel is kicking off a series of news pieces by first looking back at the impact of pandemics in the past. Hi Jennifer.

0:01:10.3 Jennifer Couzin-Frankel: Hi, thanks for having me.

0:01:12.8 SC: Sure. You know, this really struck me, the point that you open with. It doesn't have any agency, COVID-19 is not in charge of things, we are. And so when people say, Oh, a pandemic changed the world, they really are saying something different.

0:01:26.9 JC: Yeah, that was something that struck me actually, when I started my reporting on this story. I reached out to a number of historians who have studied different epidemics, and often I started off by asking, "How did epidemics cause change in the scientific world?" And a couple of them really gently corrected me and said, "That's not how it works. The epidemic itself doesn't have agency, we have agency as people, and we are the ones who change society or don't change society in the wake of an epidemic."

0:02:00.4 SC: The first example you focus on is bubonic plague, which struck Europe in the 1340s and killed millions, and I think many are probably familiar with that, but it also had a really big influence on so many aspects of medicine and disease, for example, just being able to name the number of people who were killed.

0:02:20.4 JC: One of the many changes that followed or came during the Black Death, which was one of the major plague pandemics and spanned hundreds of years sort of sporadically was this push to record deaths from plague in different areas, but there were a number of other really fascinating changes that evolve with the plague years. Another one of those was how we understood disease. In the more distant past, disease was not a fixed entity, you didn't talk about individual diseases as distinct from one another. The plague came to be recognized as its own distinct disease in a way that hadn't been universal until that point, so that was definitely a real change, and there were others too around writing about disease, the plague really spawned a new kind of medical writing, which were called Plague treatises, and they were all different kinds of writings in different parts of the world, pamphlets, big documents.

0:03:20.3 JC: There is evidence that even before the invention of the printing press, these plague treatises were shared, at least some of them were shared, and some of the evidence for that is because some of the plague treatises have notes in the margins from physicians who weren't the authors of those treaties, so they appear to have been passed around from person to person, at least to some degree.

0:03:39.5 SC: I was really surprised to see terms like social distancing, quarantining and contact tracing in this context of the plague.

0:03:48.5 JC: Yeah, so that evolved again over time, the plague hastened the development of certain preventive tools, these separate quarantine hospitals that cropped up, there were efforts to impose social distancing requirements, and then a little later on, there's evidence of meticulous contact tracing that's by the late 16th century or so. It's funny because it's these terms that are now familiar to all of us, quarantine and social distancing and contact tracing, and these actually came about hundreds of years ago.

0:04:19.6 SC: Let's fast forward another couple hundred years in the 1800s, cholera spurred basically a new era of public health and cooperation. How did that come about?

0:04:31.1 JC: Cholera is caused by a bacterium that can be found in water, so then you drink the water and you can get very sick. It devastated a number of areas, including New York City in the 1800s. As you can imagine, cholera is linked to poor sanitation, so as understanding of that evolved, there was a push to improve sanitation. Now there is also debate among historians, it gets back to the point we talked about at the beginning with, "Do epidemics have agency?" No, it's really the people who have agency. Did the cholera epidemics themselves cause this rise of a public health infrastructure or was that going to happen anyway? It was probably some combination, often what epidemics do is they push forward change that's already in the works, but certainly there was a push for improved sanitation practices for public health institutions, for more standards around public health that came about at the time of the cholera epidemics.

0:05:29.0 SC: There's the other side of this, which is, for example, the 1918 flu where 50 million people died, we don't see a huge set of changes in medicine or in how people interacted with flu.

0:05:43.6 JC: Yeah, so I think we need to be really careful here in thinking about epidemics, pandemics and change that follows them or comes with them, because that's not always the case, and we don't know what's going to happen with COVID really right now, how things will or won't change, across science and more broadly. Sometimes you might look at an epidemic and say, This was massive upheaval and terrible suffering and had such an impact at the time, and then everyone just kind of moves on and it goes into the past. So the 1918-1919 flu pandemic is a good example of that as a historian explained to me, we would have thought that it would lead to all sorts of changes in science, and it really didn't, and part of that, I think is because it was overshadowed by the end of World War I. Now we look back and we study that history, but at the time it wasn't like it spurred a whole lot of changes in the scientific infrastructure, like new funding or new public health infrastructure, that sort of thing.

0:06:40.3 SC: Well, on the other end of the spectrum, we have HIV/AIDS, which was ignored and downplayed for years before it was recognized as a crisis, at least in the US, but it did end up catalyzing change in how patients are involved in their treatment, and even in the development of treatments.

0:07:00.2 JC: Of course, this is a much more modern example than the others that we're talking about, but one of the... I would say the legacies of the early days of the HIV/AIDS epidemic in the US was a real change in how drugs came to be approved and made available to people in this country. And that's because there were these patient activists at the time, and many people may remember that, who just really fought hard for access to experimental treatments that they needed or felt they needed for their survival, and they did really reshape the government policies for drug approvals in this country in a way that has endured.

0:07:40.1 SC: In light of what's going on today, is there anything that's happened in the past regarding conspiratorial thinking about pandemics or pushback on public health efforts?

0:07:50.5 JC: I don't know that there were conspiracy theories, or at least not ones I came across, but I think there was a pushback against certain concepts. So for example, in cholera, and prior to that as well, that if you contracted a disease like this, it was more about your morality than just having been exposed to a germ that was out of your control. I think that cholera in particular, and sort of the rise of the germ theory, the idea that germs could cause disease really changed the thinking there. And also just our better understanding of statistics and a pursual of statistics made clear that this wasn't about morality. So that was an interesting shift that I saw in the history, but there may well have been conspiracy theories as well.

0:08:35.2 SC: Well, before we wrap up, we should probably at least say something about the Coronavirus pandemic. Are there any glimmers now of change that we can say may be long-lasting or are at least pretty striking?

0:08:47.9 JC: Well, I think there are changes that people are talking about or are aware of. One of the things that epidemics do is they kind of shine a light on issues or problems that may already be there. So for example, inequalities across society. Of course, that was a huge has been and still is a huge, terrible problem with COVID-19 and even now with vaccine distribution, we've always had those inequalities, but we're really seeing them in this very sharp painful relief now, I think.

0:09:17.0 JC: So, one could imagine that there might be a push, a broader push for change in that area, an effort to reduce inequality where possible. I don't know if that's going to happen, of course, we'll have to see. And then I think within the scientific enterprise, will there be changes in how labs are run, will there be changes in clinical trials, will there be changes in how scientists communicate with each other? We don't really know yet. We'll have to see what happens, and I'm hoping that these news articles can kind of give a sense of what's evolving now. Of course, this is gonna play out over a long time.

0:09:50.6 SC: Thank you so much, Jennifer.

0:09:53.1 JC: Thank you.

0:09:54.2 SC: Jennifer Couzin-Frankel is a staff writer for Science, you can find the link to the new story we discussed at sciencemag.org/podcast. Stay tuned for a chat with researcher Dan Shugar about a devastating rock and ice avalanche that happened this year in Northern India, and what we've learned about preventing similar events.

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0:10:20.6 Joel Goldberg: Now, we'll speak with Dan Shugar, Associate Professor of Geoscience and Director of the Environmental Science program at University of Calgary. I'm Joel Goldberg. On February 7th, a massive rock and ice avalanche descended the Himalayas from Ronti peak into the valleys in Northern India. This resulted in more than 200 deaths and missing persons and leveled vital infrastructure in the region. In this week's Science Magazine, Shugar and colleagues investigate the hazards that led to the disaster. Hi, Dan.

0:10:50.9 Dan Shugar: Hi, there, nice to be here.

0:10:52.8 JG: For those who aren't familiar with the Chamoli, India avalanche, could you describe what occurred?

0:10:57.3 DS: So in the morning of February 7th, we saw from real-time eyewitness videos uploaded to YouTube and Facebook and Twitter, this wall of water traveling down the Rishiganga and the Dhaulinganga valleys, and as they did, they destroyed two hydropower plants, one of which was still under construction, one of which was operational. The big question was, Well, where did all this water come from? Was it a glacial lake that had burst? Was it a storm that had dumped a lot of water? What we were able to determine from a variety of lines of evidence was a really large landslide way up in the mountains that was essentially converted to liquid water.

0:11:37.7 JG: So these lines of evidence pointed you toward the cause of the event, but at first there was thought to be another cause?

0:11:43.7 DS: I first heard about the event on the morning of the 7th. I was tagged in a tweet by Rakesh Bhambri, who's an Indian colleague who works in Germany at the moment, and he had forwarded one of these videos of this water traveling down the valley. Within half an hour or so, I was able to find some satellite imagery from that morning suggesting that the ultimate cause was not a glacial lake outburst flood or a GLOF, as was being suggested in some of the early social media reports and very early media reports. This isn't the first large disaster to have occurred.

0:12:21.1 DS: In 2013, there was a very large flood that killed about 4000 people in the Chamoli, Uttarakhand districts that was related to glaciers as well, but a very different kind of event. That one was the breach of a glacial lake, and that caused a flood downstream. And so, initially that was what was thought to have occurred, and then over the course of the rest of the day, more satellite imagery came in and showing pretty clearly to me anyway, that this was caused at least in part by a large landslide, and not a glacial lake outburst flood. In fact, it had nothing to do with the glacier that was down in the valley bottom, and the glacier that was involved was what we call a hanging glacier, which is almost like a tooth kind of plastered on to the side of the very steep slope, way, way up near the ridge.

0:13:10.5 JG: If this was a landslide, then where did the water come from?

0:13:13.5 DS: The initial rock and ice that was up on the steep slopes of Ronti peak descended almost two kilometers to the valley floor and then began to disintegrate and flow downstream and then descended another kilometer and a half or so vertically. The heat that was generated by the friction of all of that rock material breaking up and disintegrating very, very rapidly, produced an enormous amount of heat, which was able to melt all of that ice and convert it to water. In some ways you can think of it as a worst case combination of rock and ice, so not worst case in terms of the disaster that ensued, 'cause that really can always be worse. But the ratio of rocks, so in other words, the exact amount of rock and the exact amount of ice that fell a very far distance vertically was almost perfect to convert all of that ice into liquid water, which has what made this extremely mobile and allowed it to flow almost like a flood that we see in those videos.

0:14:17.5 JC: Now, let's transition a bit and get into how the research was conducted. The observation methods in your paper seemed to run the gamut, satellite imagery, seismic data, eyewitness accounts, media reports, how did these all factor into your research?

0:14:33.8 DS: Over the next few days, a variety of companies, Planet Labs and Maxar, European companies as well, started to acquire a very high resolution satellite imagery of the area, and in some cases, in STEREO, were able to build three-dimensional models of the terrain and measure how large this landslide was, how much erosion and deposition resulted in the valley below, etcetera. And we combined that with some seismic data normally used to measure earthquakes, and these seismometers were not nearby, these were in Nepal, a couple of hundred kilometers away, I think, but nevertheless, they picked up the seismic energy released during the impact of the material when it fell that two kilometers to the valley bottom. We also used a lot of these eyewitness videos that were posted to Facebook Live and YouTube and Twitter to estimate the speed of the water and how much water and sediment, of course, was barreling down the valleys here.

0:15:35.3 DS: And then lastly, we had some numerical models, so computer simulations of the event transitioning from a rock and ice mass eventually into a debris flow. And we combined all these different lines of evidence, and they all seem to match, they all seem to kinda reinforce one another, which in our minds we're probably interpreting this thing correctly now.

0:15:58.0 JG: What are the natural features of this region that may have made it vulnerable to such an event?

0:16:01.8 DS: That's a good question. The Himalaya are famous for being the highest mountain range on earth, but of course, along with that is that their slopes are extremely steep. And many of these valleys are glaciated or have permafrost or both, and the combination of these different factors can lead to very large slope detachments or large landslides, and when water is present, either as liquid water or glacier ice or snow, that can cause this enhanced mobility and become a much more mobile flow than a purely dry landslide might.

0:16:40.2 JG: Did you find that climate played a role in the event?

0:16:42.5 DS: Climate change... Everybody wants to know if that was the cause, and we were unable to conclusively demonstrate that. But going forward, as the climate is changing, we need to be thinking about these very steep glaciated permafrost landscapes as non-static. They are changing and so, we need to be doing detailed hazard assessments for any infrastructure downstream, but importantly, we need to be repeating those hazard assessments because the landscape itself is changing.

0:17:12.6 JG: In your paper, you discuss also the way that natural features interacted with what is on the ground in terms of population and infrastructure. Could you describe what sort of human activity is present in that region?

0:17:27.1 DS: Keep in mind that I'm speaking as somebody who has not actually been to the site, but a landslide, even a landslide of this size, and that was this mobile doesn't become a disaster unless it has impacts on humans and human-built things, infrastructure, roads, pipelines, hydropower plants, etcetera. And so, in this case, there were villages in the valleys below, but more importantly, there were these two hydropower plants right in the valley bottom, one of which was very large and under construction. And so, most of the people unfortunately killed or who remain missing were workers at those plants and the vast majority of them were workers at the Vishnugad Tapovan plant, which was the second one to be destroyed, lower down. It raises the interesting question, where are these plants suitable?

0:18:14.8 DS: The downstream populations are very thirsty for power and quite understandably, and hydropower, generally speaking is a green source of energy. But we need to be very careful about where these are sited in places that might be very hazardous, especially in a changing climate.

0:18:31.9 JG: How could people develop these places more carefully?

0:18:35.5 DS: One thing that this disaster has taught me, and I hope teaches others is that we need to be leveraging data and tools like satellite data to cast a much wider geographic net when we're looking at what might present a hazard, what might present a risk to a particular development or to a particular village before we start building. As we put infrastructure in different places, we're very much changing the risk equation, and I think for the most part, the infrastructure is not directly making the hazard worse, in other words, not making the slope more likely to fail necessarily, but certainly changing the risks.

0:19:17.7 DS: In other words, what the repercussions of that might be if that slope were to fail? One big wrinkle in that statement is road building. So roads are really tough to build in very steep terrain, because they make the slopes steeper. Steeper slopes, all else being equal, are more likely to slide than non-steep slopes. And as we push roads further and further into the mountains, that very well may cause more landslides. And not necessarily the size of what we saw in February, but smaller landslides, which if you're a farmer or a villager, and that landslide impacts you, it doesn't really matter how big it is, if it's big enough to take out your house or your fields or something like that.

0:20:03.6 JG: Why is the cause of the event so important?

0:20:06.4 DS: One of the things that I think is important to keep in mind is that for those people that were in those eyewitness videos, seeing that wall of water coming down, what caused the event doesn't matter, what was important was to get to safety as quick as possible. Why understanding the cause of the event is important is now, as we reflect back on it and think about, Well, what can we learn from this event, how can it inform infrastructure projects, hazard assessments, etcetera, going forward? So in other words, if we have our blinders on, so to speak, and we're only looking for glacial lakes as the prime hazard in some of these valleys, we may overlook equally hazardous steep slopes that can be calamitous if they collapse.

0:20:50.5 JG: Could a tragedy like this have been avoided?

0:20:53.0 DS: It's a really challenging question to consider. If we knew beforehand that this was a dangerous slope, a hazard assessment, really warning, etcetera, for this particular slope could have been done. The issue is, as I see it anyway, is that areas where we have such high steep topography, the Himalaya, the Andes, the Alps, Western North America, there are hundreds of thousands, tens of thousands of steep slopes. So the trick is to know, well, which ones are going to fail or which ones might fail. As a geoscientist, might fail soon, could mean tomorrow, it could mean in 100 years, could mean in 5000 years. Time is very different to a geoscientist than to a planner or a politician. Just looking at the mountain range or a region today is not quite good enough. We need to be doing these repeatedly every five years or every 10 years, depending on the location.

0:21:51.0 JG: Dan, thanks for joining us.

0:21:52.6 DS: Thank you, Joel, thanks for having me on.

0:21:55.6 JG: Dan Shugar is an Associate Professor of Geoscience and Director of the Environmental Science program at University of Calgary. To find a link to his paper, as well as other research from this week's issue, please visit sciencemag.org/podcast.

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0:22:11.5 SC: And that concludes this edition of the Science Podcast. If you have any comments or suggestions for the show, write to us at sciencepodcast@aaas.org. You can listen to the show on the Science website at sciencemag.org/podcast. On the site you'll find links to the research and news discussed in the episode. And of course, you can subscribe there or anywhere you get your podcasts. The show was edited and produced by Sarah Crespi, with production help from Podigy, Meagan Cantwell, and Joel Goldberg. Jeffrey Cook composed the music, transcripts are by Scribie. On behalf of Science Magazine and its publisher, AAAS, thanks for joining us.