HL Influencers: Digital Transformation

TRANSCRIPT

Dr. Usama Kadri

Karishma Paroha	Hello, everybody, and welcome to another edition of *The Influencers*, our podcast conversation on digital transformation and law. I'm Karishma Paroha, a senior lawyer working in the product and insurance sector at Hogan Lovells, and the acting chair of the IUA's Developing Technology Monitoring Group, founded by my co-host Tom Hughes.
Tom Hughes	Thanks, Karishma. The DTMG is one of many groups exploring innovation and risk that we run as the IUA. We are an association and we represent many of the largest international insurance and reinsurance companies based in the historic London market. That means day to day I get to work with risk specialists, innovators and regulators on everything from marine and aviation to environmental and casualty insurance.
Karishma Paroha	Tom and I are hosting a special Future of Insurance mini-series on *The Influencers*, where we delve into exciting technology through an insurance lens and consider the risks and benefits of this cutting-edge world.
Tom Hughes	And I'd like to think that the world wouldn't be quite so cutting-edge without the support of the insurance community. A worthy moment to shout out the IUA's members. I hope insurers, of course, have a vital role to play in giving innovators the comfort they need to do what they do best to innovate, whether that's covering autonomous aircraft, renewable energy sources, or developers of smart medical devices.
Karishma Paroha	In this episode, we're exploring how the ocean speaks and gives us clues before a tsunami strikes, and how artificial intelligence is helping scientists listen more closely than ever before. We are diving underwater and exploring the science and technology that could transform early warning systems and save lives. It is an honor to welcome our guest today, Dr. Usama Kadri, whose work is helping push the boundaries of how we predict and understand tsunamis using this advanced technology. A reader in applied mathematics at Cardiff University, and an engineer whose work sits at the crossroads of Maths, Engineering, and Ocean Science.
Tom Hughes	Dr. Kadri's world-leading research focuses on how fluids move and behave, especially a fascinating type of signal known as acoustic gravity waves. These are fast-moving sound waves that travel through the ocean carrying

	information about events happening far below the surface. This emerging area of research is gaining rapid attention across the scientific community, with applications ranging from tsunami early warning and oceanography to energy, physics and even marine biology, addressing some of the most challenging questions with real impact on science and on society.
Karishma Paroha	So to start with Usama, your work on using acoustic gravity waves to improve tsunami projection is a major scientific achievement. In simple terms, what makes your approach different from traditional tsunami forecasting methods? And why is this such a breakthrough for early warning systems?
Usama Kadri	Thank you for having me. So first, tsunamis are often associated with submarine earthquakes. Submarine earthquakes involve a violent movement of the tectonic plates, which basically radiates all type of waves. Some of these are known as seismic waves. So these waves are traveling in the solid earth, and they're traveling very, very fast. So one of the traditional tsunami forecasting methods relies on seismic waves, because it's a very fast way of having the information about the source. Now, one problem with relying on seismic waves is that not necessarily that an earthquake, a submarine earthquake, would produce a tsunami. So you end up with false alarms. The other issue is that you also may overlook non-seismic sources for tsunamis. For example, from landslides, or even if you have a very small earthquake that results in a landslide which generates a tsunami like in the Palu case in 2018. The more accurate way maybe of actually measuring that tsunami is by measuring the water level. We use buoys to measure the water levels. The problem with this approach is that it requires the tsunami to physically be on the measuring spot, which means that while it can be very good for specific locations, for other locations it might not leave enough evacuation time. And also it means that you need a huge amount of buoys distributed in the ocean in order to prevent any leakage of information, if you want, that is valuable about the tsunamis. And it also has some issues with maintenance because of the rough ocean. They break and so on, so they have to maintain them all the time. A complementary approach would be using all kind of evolving technologies. One of these is the use of acoustic gravity waves, which is a complementary technology. So if you think about the tsunami generation in one way, and forget about the source, in order to generate a tsunami, at the end of the day, you actually need to elevate the water layer somehow. So there must be a vertical motion. That vertical motion, whether it starts from a landslide, or a submarine earthquake, or a meteorite impacting the surface of the ocean, or an underwater explosion, Eventually, it must result in a vertical movement, and that vertical movement compresses the water layer. As it compresses the water layer, it sends these acoustic gravity waves, which are essentially sound waves, very long sound waves that are modified by the effects of gravity. These sound waves, they travel very fast at the speed of sound in water. They can also couple with the sea floor, and then they might even double their speed. We talk about 1,500 meters per second, and they can reach up to maybe 3,000 meters per second, depends on the solid

	earth property. But in order to actually make use of them in real time, that requires the development of analytical models and physics-informed AI.
Tom Hughes	Thank you, Usama. And it's an incredibly interesting piece of research. And I must admit, one of the things for Karishma and I that we are constantly battling with and working with the insurance and legal community to try and assist with is staying as close as possible to the forefront of technological development. And I think that's why we're so excited to speak to you today, because it feels like you are at the very frontier of this new tech. But of course, for us and for our communities, understanding the value that this tech can provide is key. So can you walk us through how analytical models and physics-informed AI actually process ocean data, seismic signals or wave behavior to generate faster or more accurate predictions? What types of data would you say are most critical for the system to learn effectively?
Usama Kadri	So in order to have analytical models that you can use to analyse the acoustic gravity waves in real time, You need to, and this is what we've done almost a decade ago, you need to solve the mathematical problem that links between the source properties and the generated flow field from the source properties and the event itself. And by the generated flow field, I mean both the tsunami, which we often refer to as surface gravity waves, and the acoustic gravity waves. which also means the pressure that is induced by these waves, the acoustic waves. Now, this pressure is recorded in real time by hydrophones, which is an underwater microphone. For example, we have access to data from the Comprehensive Nuclear Test Ban Treaty Organization that is monitoring the ocean in real time. And in order to be able to analyze the data, in real time, you need to be quick. So going back to the analytical models, what is needed is an explicit expression between the properties of the source and this flow field. But then in reality, we don't have the properties of the source itself. Now, if we had it, then once you plug it in the model, then you have the solution immediately because the relation between the input parameters and the output parameters is explicit. So you don't need all that computation time. This is what makes it real-time, useful in real-time analysis. So for that reason, we had also to solve the inverse problem. The inverse problem says, okay, we don't have the properties. We want to find the properties. But we do have the pressure field from the recordings at the hydrophone. And we have the relation between the pressure field and the properties. So by solving the inverse problem now from the pressure field itself, we can get the properties of the source. And once we have the properties of the source, we can assess the tsunami globally, actually. And it would take probably less time than the time I tried to explain it to get the assessment. It takes 10s of seconds only to make a global assessment from the pressure signal. The very same pressure signal we've used in machine learning models. We train the model using the acoustic data, the same acoustic data from the Comprehensive Nuclear Testament Reorganisation as an input parameter. And we use the buoys that give us the size of the tsunami as an output parameter. Now it's very important that it's a physics-informed AI, knowing the main features to be

	extracted for the training of the model in order to reduce the uncertainty in the result.
Tom Hughes	And Usama, to my mind, one of the most interesting areas about this technology and the developments you're talking us through is I'm imagining that they couldn't even have been envisaged a few years ago, but because of the rate of technological change, the capacity that we have to process and to use data, I suppose we don't yet know where we will be in another two or three years, which is an incredibly exciting prospect.
Karishma Paroha	So Usama, if this technology were deployed at scale, what practical changes could communities, governments and emergency responders expect, for example, in terms of warning time, evacuation planning, and overall resilience?
Usama Kadri	So acoustic gravity wave technology complements the existing technologies, the traditional and also the emerging technologies. What I can say is that it would enhance the response time, reduce false alarms, optimize evacuation, which also means saving lives, increasing reliability of the system, reducing financial impact as well. for example, due to false alarm evacuation. Moreover, I can also say that it is a more affordable tech to developing countries and small island developing states.
Tom Hughes	And of course, that's an incredibly important consideration when it comes to the rollout of any new tech at scale. Now, we'll just shift our attention slightly and have a look at the insurance perspective. Of course, my favorite part of the discussion. Better prediction can change everything from catastrophe modelling and underwriting to capital planning and recovery response. How do you see AI-driven tsunami forecasting helping insurers make better decisions and manage risk more intelligently? And where do you see opportunities for collaboration between universities, governments, insurers, and of course, tech companies?
Usama Kadri	So in general, AI can improve the catastrophe risk analytics, which can support pricing and portfolio decisions. If we talk about real-time AI assessment, it has another maybe layer of importance that it strengthens the warning operations by delivering faster, more reliable estimates of the likely impact, which in turn reduces false alarms and enables targeted evacuations, which helps insurers with rapid loss strategy, parametric triggers, and claims mobilization. If we think in terms of a big collaboration win between the universities, governments, insurers, and tech firms, I think the universities would, we talk about building, validating, and the designs. The governments would come into play by providing the logistics to deploy the sensors and the warning systems. The insurers probably would bring the exposure or claims insight and the decision needs. And the tech firms can optimize the whole system to reduce the uncertainties and make it run more reliably in real time.

Tom Hughes	Usama, you talk about the importance of collaboration. It's something that we have absolutely spoken about as part of discussions on this Influencers podcast before. How have you found collaborating between so many different stakeholders in respect of this emerging tech? Has it tended to be an efficient process from your perspective?
Usama Kadri	Well, for me it was, and still actually, a learning journey. I guess the big learning outcome is that dealing with science, often we think about problems from one perspective, but when you try and bring these problems to the actual world, you see that there are so many different parameters that are playing a role. Like from the acoustic perspective, you say, okay, the hydrophone should be here, and this would be for the benefit of all these states and so on. But that interaction with, for example, different governments and big companies and so on, teaches you the diplomacy and the politics involved and that the approach that you need in order to make things work would require a different approach sometimes to get things moving at the intergovernmental scale.
Tom Hughes	And it's certainly a process that we're very familiar with in the London market. The majority of the insurance policies that are written in London are done so by multiple insurers working together to provide significant capacity, to provide solutions for really complex risks. And you mentioned there are parametric triggers and I hope that raising awareness of this kind of technology will allow insurers to build those new products, to provide solutions through these new distribution methods that bring coverage to clients far quicker than might be possible today.
Karishma Paroha	Usama, I can't let you go without asking you just one last quick question. If you suddenly had unlimited computing power and a dream research budget for one year, what bold or slightly crazy problem would you love to tackle next?
Usama Kadri	Okay, so if you think about two trains of surface water waves that are interacting together, under certain conditions, under certain configuration, they can actually produce acoustic wave. And this is a mechanism which is we call a triad resonance. A triad because it involves 3 members, 2 gravity waves and one acoustic mode. And vice versa, if you have, you can have also two acoustic modes and one gravity wave, and they can exchange energy via this triad resonance mechanism, which has an amazing consequence, amazing consequences, I must say, both in fundamental physics, but also at a machining scale. For example, one crazy idea they can think about. If you have a tsunami, so going back to tsunamis, if you have a tsunami and if we had a technology to actually generate these extremely large scale acoustic gravity waves, and we also have the technology to finely tune them with the tsunami which is approaching a shoreline, in theory, we can make them interact in a way that they withdraw energy from the tsunami and redistribute it over a larger space. And by that, they would reduce the height of the tsunami and as a result, the impact on the shoreline. Now, of course, this sounds like a fantasy, but if you take it to

	a more modest scale, maybe we can still use the same principle for wave energy harnessing. It's a more feasible scale, right? Because with wave energy, we talk about a wave field, water surface waves that we know the properties of these waves and we have more relaxed time if you want because they're not going to devastate any location. So that becomes more visible. And in fact, using the same idea, you can think about some kind of distant movements like oil spills or even sending nutrients to microorganisms to make a healthier ocean in certain locations. But of course, this requires a lot of research on the impact on the environment and in general, a better understanding of what makes our planet healthier.
Karishma Paroha	Really mind-blowing. Thank you, Usama.
Tom Hughes	I'm sure all of our listeners share the same hope that Karishma and I do, which is that in a couple of years, we're inviting you back, Usama, to talk about this breakthrough technology that you've succeeded in. So we'll keep our fingers crossed. Now, despite having felt a little out of my depth during this podcast on the science, we've learned a great deal in the discussion. I think there's a huge amount that has insurance and legal communities we can gain from engagement with academia. We've had just a brief 15 or 20 minute chat with Usama and obviously there have been some fascinating insights that we've been able to absorb. For insurers, the takeaway would be to consider how this real-time advanced tech can allow us to provide innovative and effective solutions for clients. And for the tech community, please do make the most of industry partners and reach out and share the fascinating solutions that are starting to be developed within your communities and see how they can make real world impacts on our respective communities.
Karishma Paroha	We've learned a great deal today, but when you step back from the equations, models and data sets, what personally motivates you, Usama, to work on something as high stakes as tsunami prediction? Is there a moment or experience that reminds you why this work really matters?
Usama Kadri	Saving lives.
Tom Hughes	Thank you so much, Usama, for joining us today.
Usama Kadri	Thank you for having me.
Karishma Paroha	Yes, many thanks, Usama. There's something extraordinary about the idea that the ocean speaks before it strikes, and that we're finally learning how to listen to the ocean. Your remarkable work reminds us that science isn't just about predicting disasters, but about understanding the planet a little better, and using that understanding to protect and save the people who live on it. And that's a powerful thing to leave our listeners with. Thank you all for tuning in. Stay curious, even underwater. And please do join us again soon. For now, take care and goodbye.

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