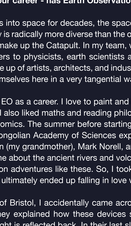
Prospero

News from the Satellite Applications Catapult

Part of our ambition for Prospero is to connect more directly with our community. In each edition, we will be sharing conversations, insights, and expertise from our Catapult team members, exploring how their roles affect us as an organisation, their impact on the wider sector, and what drives them personally.



MARAL BAYARAA

This month, we sat down with Maral Bayaraa, Senior Earth Observation Consultant here at the Catapult. We discuss the unusual start to her career in space, why Earth Observation is so important to society, and her academic journey.

Tell us a bit about the start of your career - has Earth Observation always been a focus for you?

Although we have been launching satellites into space for decades, the space sector is evolving very fast. This means, the kinds of people and skills it needs today is radically more diverse than the ones any of us could have imagined before. You can see this in the different skills that make up the Catapult. In my team, we have a mix of engineers and scientists, from software, telecommunication engineers to physicists, earth scientists and geographers. Another example is our user-centred-design team, historically made up of artists, architects, and industrial design engineers. The people working in the space industry of today find themselves here in a very tangential way, full of fascinating twists and turns.

I actually did not know I wanted to pursue EO as a career. I love to paint and have done from an early age. When I was younger, I had hoped to become an artist. I also liked maths and reading philosophy, so I thought a natural combination might be a degree in philosophy and economics. The summer before starting university, I worked as a translator on an American Museum of Natural History – Mongolian Academy of Sciences expedition to the Gobi Desert, co-led by the prestigious palaeontologists Khand Yondon (my grandmother), Mark Norell, and Mike Novacek. I was fascinated by the way they could read the rocks. They told me about the ancient rivers and volcanoes where I stood and I was captivated by the idea that you could get paid to go on adventures like these. So, I took some time out to read more about earth sciences and ultimately ended up falling in love with geology.

Whilst studying geology at the University of Bristol, I accidentally came across an evening lecture discussing the use of hand-held spectrometers in mining. They explained how these devices shined light at rocks to understand what minerals they are made up of by the way light is reflected back. In their last slide, they mentioned how this may also be done on a larger scale from space. When I think back to that moment, it all gets a bit dramatised in my head! It felt like everything stopped and I had this rare moment of clarity, mixed with excitement and what you may call, a 'vision'. It's funny how once something is in memory-land, time can get so twisted, and everything exaggerated. It was about how I was spending weeks walking around trying to map the rocks of a tiny area, but now with space technology I might map whole countries just from my laptop. I was determined to find out more about this new exciting field. For my masters thesis, I explored this topic by bringing together my incredible supervisors Matt Watson (an expert in atmospheric remote sensing), Frances Cooper and Orolmaa Demberel (geology lecturers specialising in metal deposits).

After my masters, I went to work for Airbus Defence and Space before joining the Satellite Applications Catapult.

How did you find out about The Satellite Applications Catapult?

I ended up initiating an intense discussion in one of the technical sessions at the RSPSoc (Remote Sensing and Photogrammetry Society) conference. At that time, Mark Jarman was chairing the session, who was previously head of the EO team. Mark approached me afterwards thanking me for the lively discussion and invited me to apply for an open position in his team. After some reading into the Catapults, I immediately felt like the Catapult Network was the right kind of place for me, I then interviewed for the position and got accepted! I am grateful to Philippa Mason (lecturer at Imperial), for inviting me to the RSPSoc organising committee that year. There, I met my long term friends and advisors in the field, including the original remote sensing geologists, Kathie Bowden (then UKSA, now Catapult) and Luke Bateson (BGS).

What does your role involve here? What does a typical day look like?

A typical day can be very varied. My favourite part of the role is helping develop the science behind the technology and helping companies develop their ideas into prototypes. This often means testing and applying latest machine learning approaches for extracting useful insight from the raw satellite data. The kinds of projects and companies we work with are at the cutting edge of the technology and space is the driving force of their development.

Beyond technical work, a big part of our responsibility is in acting as a bridge between academia, industry, and government. This means I get to work directly with all types of users of the technology from mine engineers, farmers, to government officials. And my favourite part is in openly sharing the knowledge about remote sensing and its benefits to society through publication in scientific journals, conferences, giving training courses, and high-level meetings.

Why is geospatial technology so important to our world?

In a nutshell, space and satellite technologies have a critical role to play in addressing some of the most pressing issues of today, here on Earth, including addressing the climate emergency, ensuring food security and metal resources. I like to think of satellites and Earth Observation EO as 'macro-scopes' floating around the Earth. Just like the way micro-scopes have given us insight into the world on the tiny, 'micro'-scale and helped solve many diseases, EO macro-scopes are helping our understand on the large scale. Satellites were one of the first instruments that helped quantify and bring attention to the changing climate. And this is recently recognised in Antarctic glaciers being named after ***satellites!***

Let me give you an example through one of my recent projects, the Asset Level Data Project. A big part of the puzzle in addressing the climate emergency is, tackling industrial emissions. There is a global non-profit coalition called Climate TRACE (Tracking Real-Time Atmospheric Carbon Emissions), backed by leading environmentalists such as Al Gore. Climate TRACE provides the largest available global emissions inventory. I am proud that one of the fundamental datasets within Climate TRACE have been developed within our Asset Level Data project. We trained deep learning algorithms to characterise cement plants and help fill in the biggest gaps in the data. In a typical Catapult fashion, we brought together a consortium of partners led by Oxford University's Smith School of Enterprise and the Environment, Alan Turing Institute, and commercial SMEs.

You've recently started pursuing your PhD, can you tell us more about that decision?

The inspiration for my PhD came from my experiences representing the Catapult in Peru, Chile, and Brazil. Once, I was working at a mine in Peru at an altitude of 4000 meters! I started developing some ideas that I felt would make a huge difference in making mining safer and more sustainable. But my ideas were too new and therefore, lacked the fundamental research and evidence required before the mines and government stakeholders could adopt them. I remained obsessed with these ideas for a couple of years. I tried various avenues to convert my ideas into a project, but it became clear that the technology readiness level (TRL) was just too low and therefore, was seen as too risky. As you know, low TRL is the world of research, which is why I decided that a PhD research is the best route for pursuing my ideas.

We are very lucky at the Catapult to be surrounded by some of the most exceptional individuals in our industry. I have a team of friends and colleagues behind me, who helped develop my obsessive ideas into reality, especially Dr. Cristian Rossi and Daniel Wicks. They are visionaries and passionate leaders. Cristian is a renowned scientist and is behind much of Catapult's thinking on thought leadership and science. Daniel is the mastermind behind the Catapult's strategy around geospatial innovation and commercialisation.

Once I had refined my idea, the route forward became clearer, and meeting my inspiring supervisor Dr. Brian Sheil and the Industrial Fellowship from the 1851 Royal Commission made up the missing pieces of the puzzle. As one of our alumni and Nobel laureate Prof. Peter Higgs said, the 1851 Royal Commission is where you come to taste the freedom and 'the freedom not to follow a strict party line in your research'. I love that.

Can you tell us a little more about your PhD research project?

The World Bank estimates that we need 3 billion tons of metals to make the electric vehicles and renewable energy systems we urgently need for the energy transition. You can see that our future is a metal hungry reality. This is a huge challenge set to the mining industry, especially because the metals make up a tiny portion of the material that is dug out of the ground (see image below). This small, metal globule represents 4.1 million tons of copper dug out of this South African mine, Palabora. Look how much more material had to be taken out of the ground! All this material ends up as mine waste, often stored behind huge dams called tailings dams.

Because mining is one of the oldest industries, there are more than 30 thousand tailings dams in the world – a quarter of which are abandoned with nobody monitoring them. If these dams collapse, the results can be catastrophic. My research ambitions are on developing a satellite based remote early warning system for these structures. This necessarily brings together three separate fields - geotechnical engineering, satellite remote sensing and machine learning. I have already published a paper on the most prestigious geotechnical journal, *Bayaraa et al (2022)*; and I am currently preparing my second publication for one of the most renowned remote sensing journals.