Jim Gatheral Travel Scholarship 2023-2024

Erin Bryce

About me

My name is Erin Bryce and I am a British postgraduate researcher in Statistics. My research interests lie in the statistical modelling of landslide hazard, conducted in a Bayesian framework with spatial-temporal models implemented using specific inference techniques. My supervisors are Dr Daniela Castro-Camilo (Department of Mathematics and Statistics, University of Glasgow), Prof Janine Illian (Department of Mathematics and Statistics, University of Glasgow) and externally, Dr Luigi Lombardo (Department of Applied Earth Sciences, University of Twente). I was awarded the 2023-2024 Jim Gatheral Travel Scholarship for £2800 to fund a two-month visit to the University of Twente, The Netherlands to learn from my external supervisor. I was awarded the Scholarship in my second year although my visit happened during my third year of study.

Why did I apply for the Travel Scholarship?

I am working on spatiotemporal models for the probability of landslide occurrence in space, in time, and their associated intensity (how large an impact). I am implementing these models in a Bayesian framework as opposed to a classical framework for the benefits of uncertainty estimation and prior information. I use the Integrated nested Laplace (numerical) approximation (INLA) to estimate the posterior distributions for elements of the model, rather than a simulation-based method such as Markov Chain Monte Carlo, and I do this using R.

Presently, I am working on a marked point process model with the Barrier model, in which a point process can be thought of as a point pattern in space (and time) and the interest lies in the spatial (and temporal) distribution of the points. The mark is some additional value of each point and the Barrier model is defined to capture the non-stationarity of the underlying spatial random effect. In this case, the points are landslides that have occurred across Japan and their mark is the associated landslide size. This project aims to capture two elements of landslide hazard; the probability of occurrence in space and the intensity. A second project is a geostatistical spatiotemporal model for surface deformation across Manchester. This work is just beginning and aims to look at the separable and non-separable aspects of space and time.

I began working with my external supervisor, Dr Luigi Lombardo, on my Honours dissertation project. He provided me with data on the landslide inventory and environmental characteristics of the Island of Dominica after it was hit by Hurricane Maria in 2017, and I completed a joint hurdle model analysis. Since then he has provided me with landslide data for Japan, Scotland and Manchester. As my background lies in Statistics, there are physical processes which cause landslides (that might impact the choice of modelling) which were unknown to me.

Additionally, I was unaware as to how data is extracted from, for example, Digital Elevation Maps (DEMs), and to the process of mapping landslide inventories and geographical/geological information at specific resolutions necessary for the interpretation of landslide hazard. Even how landslide data are obtained in the first place was a mystery to me. These gaps in my knowledge I thought could no better be filled than by learning from Dr Luigi Lombardo. I, therefore, applied for the Scholarship to have the opportunity to learn and work with him face-to-face.

Details of my visit

I travelled to the University of Twente's Faculty of Geo-Information Science and Earth Observation in Enschede, the Netherlands. I arrived on the 1st of January 2024 and came back on the 1st of March 2024. I hoped to gain an in-depth understanding of the physical processes that cause slopes to fail, and the different underlying mechanisms that trigger these slope failures, distinguishing between the types of landslides. I hoped to learn where my data comes from and the necessary skills to build a landslide inventory, becoming proficient in the software that enables this. I also hoped to network and build connections with other PhD students and Geoscientists to exchange knowledge.

I was introduced to the Geospatial Computing platform (Crib) for the Department, in which applications like GRASS GIS and QGIS are located. I was taught by Dr Hakan Tanyas how to navigate GRASS GIS as this is important for the calculation of the resolution of the data. I was also taught how to use Google Earth Engine (GEE). From this, one can write Java scripts to extract geographical/geological information from anywhere in the world, by defining the area of interest and specifying which mapping system to use (e.g. Shuttle Radar Topography Mission, Climate Hazards Group InfraRed Precipitation with Station data etc.). One can then import this extracted information into GRASS GIS. Transforming the information from raster to vector and into the correct coordinate plane is also something I learned how to do. There exist scripts to pass into the console that first remove the flat areas in your area of study and then generate the slope unit (desired resolution of data) in vector format, one can also input the raster maps of the geographical information and extract the values of the information at this desired slope unit.

I met Sofia LI, a PhD student in the Department who was looking to fit a point process model to her flood data with multiple resolutions. I helped her with her analysis here, implementing a log-Gaussian Cox process model with inlabru (a wrapper for INLA, designed specifically for spatial models). We are still working together.

I had many learning sessions with Dr Luigi Lombardo in which we talked about landslide hazard, functional regression, dynamic explanatory variables, deep-learning on-going research in landslide susceptibility and the pathways of passive and active satellites in collecting data.

Dr Hakan Tanyas had available the surface deformation for Manchester for over 30 years from InSAR (a satellite-based mapping technique) and he passed the data matrix to me after help from Chakshu Gururani - a master's student also working with the data - with data cleaning.

From here, I fitted a space-time geostatistical model with separable covariance with the spatial component defined by a Besag model and the temporal component defined by an AR1 process using INLA. Ongoing is fitting a non-separable covariance space-time model.

Dr Luigi Lombardo arranged for me to have an on-camera interview to talk about my research interests and my time at the University of Twente. This was intended to be part of his YouTube GeoHero channel where he has a collection of interviews with researchers in the Geosciences.

I also had the pleasure of meeting Prof Alfred Stein, a professor in Spatial Statistics and Image Analysis who organised an opportunity for me to present my work on the marked point process with the Barrier model across Japan to the Department at the end of my stay. For this, I needed to wrap up the Japan project and part of this involved extracting a variable that explains the landslides triggered by earthquakes. In the inventory, I have available landslides triggered by both intense precipitation and earthquakes, but only a variable explaining precipitation measures. To get the relevant variable, I met with Ashok Dahal, a PhD student of Dr Luigi Lombardo, and he showed me where I could extract a Japanese surface velocity map with the appropriate resolution and summary statistic. Additionally, I worked with Dr Luigi Lombardo on creating hazard map figures for the estimated landslide count and landslide size in ArcGIS.

Figure 1: Faculty of Geo-Information Science and Earth Observation, University of Twente, NL.

Figure 2: Selfie with Dr Luigi Lombardo, myself, Dr Hakan Tanyas, and Jana Lim at my farewell dinner.

Impact of the Travel Scholarship

I have learnt so much about my data, its generation, and the geoscientific aspects of landslide hazard that I can now better justify my choice in statistical models and their interpretation. I now have the skills to build my data and the understanding that comes with that, which is very useful when writing up my Thesis and for any publication. I believe my understanding in this now allows me to have complete coverage of my research area, and now I can focus on statistical developments and novelties knowing that my choices make sense in the geoscientific sense. I also think this visit taught me to explain my work better. This Scholarship provided me with such a unique experience as a postgraduate researcher, and it was so incredible for networking and building ideas with others.

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