Joint LMS/IMA Meeting – speakers, titles and abstracts

Rebecca Killick (Lancaster University)
Change and the Environment: A journey of statisticians and environmental scientists

Climate Change is a phrase we hear a lot, from the media, government, experts, and general public. It is a general phrase that can mean different things to different people. This talk will introduce my statistical view of what I interpret Climate Change to mean and my ongoing work in assessing environmental change. As we discover more about statistical determination of change together, I will touch on collaborating with environmental scientists, the positives and frustrations of publishing in environmental journals, and ethical quandries.

Vera Melinda Galfi — Vrije Universiteit Amsterdam
Mathematical insights into climate extremes

The climate is a complex, high-dimensional, non-linear and chaotic system. It is a coupled system comprised of several interacting sub-systems: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere. The dynamics of this system are intricate, and its extreme events often occur unexpectedly, with significant impacts on society. Understanding and predicting weather and climate extremes - whether deterministically or probabilistically - can save lives and prevent damage. In this talk, I will introduce the fundamental properties of the climate system, with a focus on extreme events. I will also explore some of the most important mathematical tools available for analysing these extremes, such as extreme value theory and large deviation theory, and discuss the insights we can gain by applying them. Finally, I will discuss the implications of global warming on statistical properties of extreme events, as well as its impact on the application of the above mentioned mathematical tools.

Christina Cobbold — University of Glasgow
The role of individuals and their traits in determining the impacts of environmental change: from blowflies to mosquitoes.

Environmental change is having profound effects on populations, from dramatic global declines in biodiversity to increased incidence and geographical spread of vector borne diseases, such as dengue and chikungunya. Predicting complex species-environment interactions is crucial for guiding conservation and disease mitigation strategies in a dynamically changing world. Many species can rapidly

respond to their changing environment through phenotypic plasticity, where variable traits are expressed depending on environmental conditions experienced. For individuals, the effects of phenotypic plasticity can be quantified by measuring environment–trait relationships, but it is often difficult to predict how phenotypic plasticity affects dynamics at the level of the population. I will present a mathematical framework for capturing the interaction of environment, individuals and their traits to establish the role of phenotypic plasticity in mitigating the effects of climate change. I will show how this new mathematical framework leads to both interesting mathematical questions and novel dynamics and can be used to study the vector borne disease, dengue, spread by mosquitoes, helping to explain the location, magnitude and timing of historical and recent dengue outbreaks.

Onno Bokhove, University of Leeds

Visualising return periods of extreme flooding events and visualising cost-effectiveness of flood-mitigation measures

The Environment Agency (EA) stated (at least) two challenges for applied mathematicians in the network "Maths Foresees", which I led in 2015-2018 (EPSRC Living with Environmental Change network). The EA's first challenge was to create a fluid-dynamical set-up visualising what a return period is of an extreme (rainfall or river-flooding) event for a general audience. The EA's second challenge was less specific: to apply mathematics to flood mitigation with tools that are comprehensible to decision-makers. I will show how in Wetropolis flood investigator return periods emerge visually from a weather machine. The machine triggers extreme river-flooding events in a model city, events set off by one Wetropolis day (1wd=10s), two or three Wetropolis days of (consecutive) extreme rainfall. These rainfall events have return periods of ~(5,25,125)wd's. Wetropolis is based on a mathematical design that determines how return periods of tens or hundreds of years for extreme events can be scaled down to return periods of minutes for miniature extreme events in a set-up of circa one square metre. (See the Wetropolis video: https://www.youtube.com/watch?v=yUjYfg2SfY0). We developed a graphical tool to address the second challenge. In that tool, square lakes visualise river-flood mitigation scenarios, that aim to prevent the damage caused by a design flood with a specified target return period. Based on measured or calculated hydrograph data at a critical river location, each square lake of 2m-depth represents the flood-excess volume that needs to be mitigated to zero to eliminate damage, with each measure filling a fraction of the square-lake, and costs are overlaid. Various scenarios can thus be compared graphically. The tool has been used to design flood-mitigation scenarios when complicated engineering calculations are unavailable, as well as to visualise and assess these when they are available. The former has been done in Slovenia and the latter in France. I will also discuss that the tool, with its intended simplicity, has been able to reveal inconsistencies or errors in council plans. "