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Observations, monitoring, modelling and artificial intelligence? What does the future hold?

Lee Chapman
University of Birmingham, Birmingham, United Kingdom (l.chapman@bham.ac.uk)

For over a century, the existing observation paradigm has seen networks of high precision sensors (i.e. weather stations) located as national networks. However, the number of sites are limited due to associated costs (e.g. equipment, personnel, management, maintenance). This has resulted in disparities in coverage across the globe with dense observation networks very much clustered within the developed world. However, even here the density of observations is often insufficient for various applications. For example, there are insufficient observations in cities to resolve the urban climate, whereas hazard warning systems (e.g. winter road maintenance, flooding) depend on tertiary networks and numerical modelling to fill the gaps. However, we now stand at a crossroads. Technology (i.e. the internet of things and opportunistic sensing / crowdsourced data) has advanced to the point where it is now possible to saturate the environment with cheaper, lower grade instrumentation - acknowledging the uniqueness of place and foregoing the accuracy or precision of individual measurements. By embracing these approaches, there are new opportunities to better resolve microclimatic impacts and associated vulnerabilities. However, this is far from straightforward and challenges much of conventional thinking. Firstly, is there a willingness to sacrifice the accuracy of data in the quest for more information? Secondly, how can this new data be best utilised? Numerical modelling has not only furthered our understanding of the physical environment, it is used commonly across meteorology for a range of applications. However, in this big and open data era, the role of numerical modelling can quickly be sidelined by data science techniques / Artificial Intelligence, with the latter becoming increasingly essential to make sense of the unstructured nature of disparate data feeds. In the UK, these issues are currently being tackled at the city-scale by using an urban observatory approach where datafeeds across six cities are assimilated into a single open access hub. Data is then freely available for real-time monitoring of vulnerabilities, or simply used to create new insights into the day-to-day operation of cities. The goal is a ‘digital twin’ of each city – a digital representation of the physical environment using real-time data and algorithms which can be used to simulate events, but crucially also update and change as the real world changes to aid hazard management. The concept of a digital twin provides one example of how once we begin to explore the possibilities beyond structured meteorological data, new areas of research will open up in data science and artificial intelligence which could prove truly transformative in the industry.