Machine Learning for Understanding the Political Economy of a Global Coal Phase-Out

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Project summary

Coal consumption is a major threat to global planetary health. Coal is the most carbon intensive energy carrier and CO2 emissions from coal-fired power plants are a major source of global greenhouse gas emissions (UN Environment 2017, Le Quéré *et al* 2018). In addition, associated air pollution detrimentally affects human health and the environment (Buchanan *et al* 2014, Carlson and Adriano 1993). Further, coal mining can, along with other negative impacts, pose serious risks to water resources, directly and indirectly damage wildlife and fundamentally transform landscapes and natural ecosystems (Chadwick *et al* 1987, Cortes-Ramirez *et al* 2018). A timely phase-out of coal is therefore not only a necessary condition to achieve the ambitious long-term climate goals of the Paris Agreement (Rockström *et al* 2017), but also a major step towards a more responsible management and use of natural resources and the environment as a whole.

However, current national emission reduction commitments (nationally determined contributions - NDCs) fall short of the required ambition to meet these goals by a large margin (Rogelj *et al* 2016, Meinshausen *et al* 2015). Though about 20 countries joined the "Powering Past Coal" coalition launched in 2017 and a number of countries (e.g. Denmark, France and UK) have previously announced plans to phase out their coal sector outside of the negotiations, none of the NDCs of major coal producing and consuming countries include clear clauses for a coal exit (UNFCCC 2016). One major reason for this may be that the structural changes necessary for a transition away from coal are hindered by rigid political economy constraints (Kriegler *et al* 2018). Broadening the focus of coal transition discussions from climate to wider considerations of detrimental impacts on human and ecosystem health may help to overcome some these.

This project takes a broad sustainability perspective on the discussion around coal use in the UK. It aims to 1) understand what has shaped the political discourse around coal consumption in the UK since the industrial revolution and what role climate change as well as environmental and human health have played over time; and, 2) to study the political economy of coal transitions as well as the structure and influence of the relevant actor network on political and public discourses. The UK is a prime case study to investigate this. Its rise during the industrial revolution is directly associated with growing coal use. In recent times, though, energy and climate regulations have helped the UK to steer away from coal more successfully than other industrialized countries.

In recognition of the advent of "big literature" (Minx *et al* 2017a), with large and fast growing archives of text, this project applies tools from natural language processing such as topic modelling (Blei *et al* 2010), causality mining (Girju and Moldovan 2002), sentiment or emotion analysis (Di Bari *et al* 2013) as well as other machine learning techniques to achieve these aims. For example, parliamentary text reaching back to 1800 will be analysed to understand how frames of reference have changed over time in the coal discussion and how major events in UK and international policy have influenced this discussion. Document corpora from science and other actor groups can be used to study the penetration of arguments into the political process – potentially in combination with data on actor networks. Other data sources such as Twitter data can help to understand peoples' sentiments and underlying reasoning for their positioning

and attitudes in specific discourses. As such this interdisciplinary project will push forward the frontier of knowledge on public attitudes on climate, environment and health and their interaction with discourses and political processes.

For this, we are seeking a student with a strong interest in interdisciplinary work and computational methods to pioneer new forms of computer-assisted text-analysis in the field of climate and environment. The team of supervisors is experienced in interdisciplinary work. Our expertise covers all relevant aspects of the project from social sciences and environmental management to health and computing. We have identified gaps in the application of big data, big literature and machine learning in the fields of climate change and sustainability (Ford *et al* 2016, Minx 2018, Minx *et al* 2017a) and started applying these tools in a variety of projects (Minx *et al* 2017b, Lamb *et al* 2018a, 2018b). The project will involve web crawling and database development as well as the application and development of skills in natural language processing. Beyond those technical aspects the project will involve learning on all fundamental aspects of academic writing including clear structuring, efficiency of style, skilled framing within the relevant academic and political debate as well as the adequate interpretation of results. We encourage the development of transdisciplinary elements around stakeholder involvement as well as clear plans for communicating published research widely.

Fit to NERC science

In line with NERCs mission to generate a new generation of researchers with a diverse set of skills that enables to generate knowledge across scientific fields, we have designed an interdisciplinary project that spans from environmental to the social sciences as well as to computation and linguistics. Our project responds to NERCs focus on 'Societal Challenges'. It is relevant to `Benefiting from Natural Resources' by generating solution-relevant knowledge that help us to live within the Earth's limit, protect planetary and human health and steward natural resources for future generations. It is further relevant to `Managing Environmental Change' as it helps to inform responsible management of the environment for multiple benefits by widening the climate-centric discourses on coal transitions to wider impacts on environment and human health. Our project directly links to a variety other research programmes such as "Understanding the Pathways to and Impacts of a 1.5°C Rise in Global Temperature" by understanding the political economy of transitions away from fossil fuels". Finally, our project complements NERC Innovation Activities such as "Environmental Data" by using machine learning techniques on large archives of text or "Energy" by understanding political economy frictions that hinder rapid transitions towards a secure, affordable and safe energy mix.

Student profile

The prospective student should have, or expect to receive, a first class BSc degree, or a distinction at Masters level, in a relevant discipline. We expect proven, advanced programming skills in a relevant language such as Python, C++ or R and a desire to work on climate and sustainability in an interdisciplinary setting. Existing skills in natural language processing or text mining are an advantage as is experience in discourse analysis or policy evaluation. A range of funding sources are available for the project which the candidate can apply to in collaboration with the supervisors.

Skills and training

It is the ambition of this project to pioneer computer-assisted text-analysis in the field of climate and global planetary health to address ´big literature' and reap the opportunities for enhanced learning and new enquiry provided by large digital archives of text. Our supervision team involves experts from all relevant fields, i.e. environmental, social and health sciences as well as computational linguistics. This set-up will secure the growth of the candidate as an interdisciplinary researchers that can soundly apply

and blend methods and insights from different fields. We will ensure adequate training opportunities through our supervision. The project directly links to other research activities of our labs that will provide an international network of partners for the successful candidate. The student will be supported and mentored to publish their work in reputed peer-reviewed scientific journals, and attend and present at leading conferences.

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