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Introducing design in the development of effective climate services

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ABSTRACT

Seasonal to decadal climate predictions have the potential to inform different sectors in adapting their short to medium term practices and plans to climate variability and change. The data these predictions generate, however, is still not readily usable, nor widely used in decision-making. This paper addresses two key challenges: a ***domain challenge*** pertaining to an emerging climate services market, where users, tasks and data may be unknown; and an ***informational challenge*** pertaining to the interpretation, use and adoption of novel and complex scientific data.

The paper provides insights into the contributions design can offer to the development of climate services. We illustrate the key steps and share the main lessons learnt from our experience in the creation of Project Ukko (http://project-ukko.net), a fully working climate services prototype developed within the European project EUPORIAS. To address the domain challenge in climate services, extensive engagement with science and industry stakeholders was required. To address the informational challenge, we applied visualisation techniques that can help users to interpret and utilise the information as simply and quickly as possible. Fostering interdisciplinary teams of design researchers, climate scientists and communication specialists brought a wide range of expertise and competences in all stages of climate services development. Specifically, the project recognised the role of users in co-designing the product. This helped to improve the usability of climate predictions, tailor climate information to answer actual needs of users, better communicate uncertainty, and bridge the gap between state-of-the-art climate predictions and users' readiness to apply this novel information.

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Practical Implications

Recent advances in data provision from climate modelling can increase resilience of society to climate variability and change. Seasonal to decadal climate predictions deal with forecasts for future times ranging from more than two weeks to one year (seasonal) and up to 30 years (decadal). Seasonal to decadal climate predictions can inform short to medium term decisions in different sectors. This data is, however, still of a limited use and scientists are on a learning curve in their understanding of how to tailor climate information to support decision-making in different sectors, and ultimately facilitate its uptake in the industry arena. To demonstrate the potential to transform this information into useful and usable products, epitomised in climate services, this research developed a fully working prototype of a climate service to provide climate predictions tailored to the specific requirements of users in energy sector.

Climate services need to meet users' needs, capabilities and decision framings and thus collaboration with potential users from an early stage of the service design process is necessary to provide products and services that are likely to be used. The emerging field of climate services also entails an evident informational challenge. This concerns the probabilistic nature of climate predictions,

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i.e. this information gives the probability of occurrence of certain outcomes as projected by the model, rather than a deterministic, single future prediction. The informational challenge in climate services presents also the requirement to communicate and present complex scientific information to decision makers in industry, particularly considering various decision-making framings and the diversity of the needs that should be addressed. In this context, design and data visualisation are well-established fields with extensive experience in tackling informational challenges.

To put the seasonal forecast service into practice, we introduced a design research and visual design component to tackle the recognised challenges related to an emerging climate services market and complex scientific data interpretation, as well as its translation into usable and relevant knowledge. An interdisciplinary team, composed of design researchers and climate scientists, accompanied by a data designer, worked on integrating a design and visualisation approach in the development of the climate service. The result of this collaboration, which broke from a standard single discipline approach, was a climate service prototype – Project Ukko.

The Project Ukko visualisation interface provides seasonal wind speed predictions for decision makers in wind energy. It presents seasonal wind speed forecasts by using symbols that summarise different forecast parameters in the dimensions of a single line. Specifically, these lines encode prediction skill through opacity, predicted wind speed through line thickness, and predicted trend of wind speed through line tilt and colour. A multidimensional data display enables drawing the viewers' attention immediately to those spots with larger probabilities of significant changes in wind speed.

The development of Project Ukko included involvement of potential end-users throughout the climate service design and visualisation process, using different user engagement methods and deploying various communication channels. This helped strengthen the provider-user interface for the climate service.

By describing the key steps in the development of the climate service prototype tailored to the specific requirements of users, this work provides recommendations and guidelines to overcome the challenges entailed in the development of a climate service. The main lessons learnt in this process that we would like to share with climate services developers are the following:

1. The first step is to identify, through user consultation, in which areas climate predictions can improve decision-making processes and convey the utility of specific services in the effectiveness of users' day-to-day work. The early stage of the development process should be devoted sufficient time, to encompass extensive domain and task characterization and bridge the gap between the languages of experts with different fields of expertise.
2. An interdisciplinary team, bringing together scientists, users and designers, is needed to develop an effective solution to putting probabilistic information into an interface that might be used by decision makers. Interdisciplinary teams, however, need clear contexts of collaboration and sufficient learning time to develop mutual understanding.
3. Establishing an effective service provider–user interface is necessary to elicit requirements for a product that the user may previously not have considered. End-users and other relevant actors in the science, industry and design sectors should be engaged throughout all stages of the design of a climate service. Applying a variety of user-engagement methods, including conventional ones – surveys, interviews and consultations, as well as more novel ones – design workshops, interactive exhibits and festivals, can help define the problem and domain space, collect user feedback on early versions of prototypes or evaluate the final climate service.
4. Visually representing probabilistic information can entail a compromise between scientific soundness, functionality and aesthetics. A successful visual design application helps users to capture and understand the information provided by a climate service as simply and quickly as possible.
5. A well-structured dissemination and engagement strategy executed through different communication and discourse channels, as well as direct involvement of potential users in the prototype co-creation, can make more likely the penetration of a climate service in users' decision-making processes.
6. Finally, due to the complexity and novelty of the climate services field, it is not always possible to meet user expectations or fully answer their needs. Any climate service design should, however, consider and evaluate users' feedback to the greatest extent possible and adopt full co-design as a primary strategy, particularly when it comes to user interface characteristics and additional data and functionalities needed.

1. Introduction

In the last decades climate change has caused impacts on natural and human systems on all continents and across the oceans (IPCC, 2014). Socio-economic costs, associated with climate change damage and need for adaptation, are expected to escalate. Increased costs are not only related to increased frequency and severity, but also to the timing uncertainty of these extreme events (Van Alast, 2006; IPCC, 2014). Access to credible weather and climate information has the potential to improve our resilience to climate variability and change. Advances in the science behind climate predictions are creating an unprecedented potential to provide climate forecasts over the coming months, seasons and decades (Doblas-Reyes et al., 2013; Goddard et al., 2010).

Seasonal to decadal (S2D) climate predictions deal with forecasts for future times ranging between more than two weeks and slightly longer than one year (seasonal) up to 30 years (decadal) (Doblas-Reyes et al., 2013). We are, however, still on a learning curve in our understanding of how to tailor S2D climate information to support decision-making in different sectors, and ultimately facilitate its uptake. Awareness of recent advances in S2D climate predictions and their possible applications is limited in the industry arena (Bruno Soares and Dessai, 2016; Dilling and Lemos, 2011; McNie, 2007). To demonstrate the potential to transform this information into useful and usable products, epitomised in climate services, the EUPORIAS project set out to develop fully working prototypes of climate services to provide climate predictions tailored to the specific requirements of users in different sectors.

To date, the emergence of an industry of climate services has been driven principally by climate information providers, such as national meteorological agencies and climate research institutes (Vaughan and Dessai, 2014). Since the publication of the European Commission's roadmap for climate services (EC, 2015; Street, 2016), it has been clear that it is necessary to strengthen the

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