The UK Co-Benefits Atlas: An Interactive Visualisation Atlas to Understand the Impacts of Achieving Climate Action Targets

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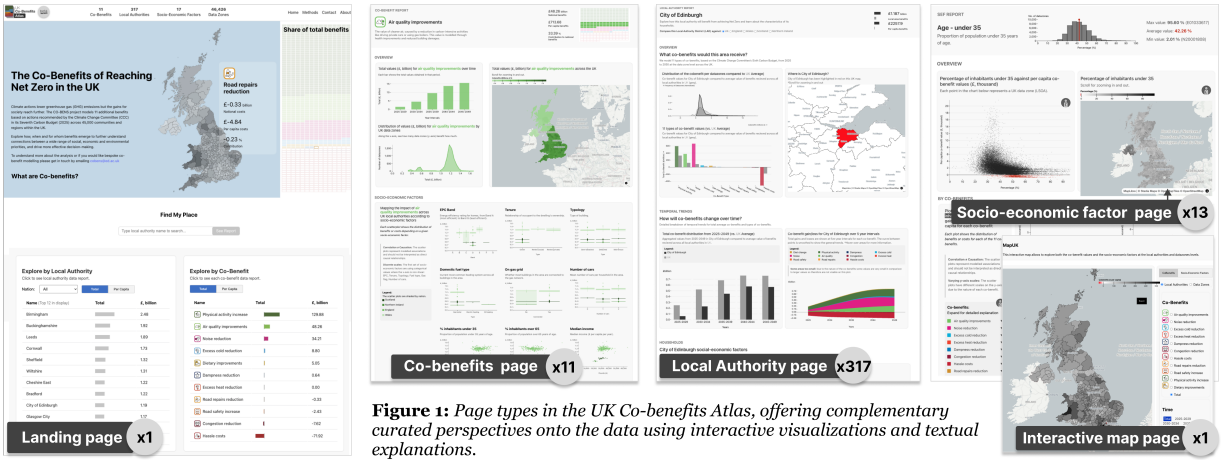

Figure 1: *Page types in the UK Co-benefits Atlas, offering complementary curated perspectives onto the data using interactive visualizations and textual explanations.*

Abstract

Clear communication and accessible data are key to informed discussions about climate change. To this end, we introduce the UK Co-Benefits Atlas, an interactive online visualisation atlas presenting and explaining data on the potential socio-economic impacts of achieving climate action targets in the UK. The data includes 11 co-benefits and co-costs of climate actions for 46,000 data zones, connected with 17 socio-economic attributes. Analyses and visualisations aim to make these data accessible, understandable, and useful for businesses, investors, researchers, third sector organisations and policymakers across Scotland and the wider UK: https://ukcobenefitsatlas.net

1 Introduction

Recent research has found that for every £1 spent on climate change mitigation in the UK, there can be up to £14 of social *co-benefits* in the form of improved public health, better urban connectivity, and increased productivity [6]. These co-benefits of achieving net-zero targets can have a significant impact on policy decisions and which technology and strategy might be preferred to achieve CO_2 emission reductions [3]. Climate action programs are frequently guided by key government, or government-facing agencies, such as the *Climate Change Committee* (CCC) in the UK, the *Haut Conseil pour le Climat* (France), or the *Expertenrat für Klimafragen* (Germany). Building on the advice from the CCC to the UK government, the model-based analysis underpinning our Atlas determines which climate actions are expected in 46,000 geographic units in the UK. Using 17 place-based socio-economic factors it estimates 11 co-benefits (and co-costs) of climate action for the next 25 years, through 2050 [6]. Co-benefits are expressed in pounds sterling (£) representing amounts gained or lost by, for example, public organizations such as the NHS or local governments. Negative co-benefits represent costs, for example, time lost when transport networks are congested due to an increase in number of vehicles.

A major challenge lies in making these data available to a variety of target audiences, including policy advisors and decision makers, businesses, climate activists and advocates, local communities, and the general public so that they can explore it and draw their own conclusions for their specific local entity. While visualisation has potential to help understand complex data in the context of climate change [4], approaches to data-driven storytelling are often too simplified while techniques for interactive exploratory tools are often too complex to quickly use. Hence, our question is *how we can make this enormous wealth of data available to diverse audiences, many of whom are not expert in climate science or data analysis?* This question combines communication about climate change [2] as well as the exploration detailed.

This poster describes our UK Co-benefits Atlas—an interactive web-based data platform. Inspired by other visualisation atlases [7], it provides a comprehensive set of 345 *pages* (June 2025), integrating design elements from dashboards [1] and reports, explanation of the main concepts, interactive exploration, and structured navigation across all pages. Based on a 10-month iterative and interdisciplinary co-design process among the authors, we present the current design of our atlas, along with the challenges and potentials we identified in developing it. This poster wants *a)* to provide scientific context to any interested policy advisor and stakeholder of our visualisation atlas, as well as *b)* be a resource to encourage visualisation researchers and designed to design visualisation atlases for complex (societal) problems.

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2 Background

This project is a collaboration between researchers in social science at the Edinburgh Climate Change Institute (ECCI) and researchers in data visualisation from the School of Informatics at the University of Edinburgh and Inria Bordeaux. The data showcased within the atlas results from the modelling of socio-economic impacts of the Seventh Carbon Budget [5],[1] at the local level across the UK. The research groups households into archetypes at the data zone level using random forest models based on localized socio-economic indicator data, and distributes the recommended net-zero interventions across households determined by these archetypal groupings. The data from the baseline activity to the implemented actions result in a modelled benefit (or cost). For example, switching from petrol cars to electric vehicles results in reduced noise pollution and improved air quality. The distributional implications of these impacts are determined by place-based factors; densely-populated areas benefit more from air quality improvements as greater populations benefit from health improvements. Road types and travel speeds vary from urban to rural environments, resulting in varying effects on noise levels. Each of the 46,000 data zones were modelled independently based on their specific conditions, population characteristics, and archetypal groupings according to UK Greenbook methodologies. The net-zero actions implemented in each locality, as well as their specific conditions, result in a complex overview of alternating complimentary and contrasting impacts, requiring considered visualisation techniques to communicate.

3 The Atlas pages

The general structure of the Atlas is shown in Figure 1 and is composed of a set of distinct *pages*. The Atlas **landing page** highlights key statistics with the aid of a waffle chart and introduces individual benefits and costs in pound sterling with a total of £144.54bn. The landing page also features tables equipped with drop-down menus that allow users to filter local authorities and co-benefits by various metrics. The landing page links to the other three main types of pages, each featuring interactive, exploratory, and explanatory visualisations relating to co-benefits. Each report page focuses on a particular dimension of the data, either *i)* a co-benefit/cost, *ii)* a local authority, or *iii)* a socio-economic factor.

11 Co-benefits pages, one for each co-benefit/cost, present key statistics, such as total national benefits, highlight temporal trends, and feature an interactive choropleth map. This is followed by a small multiple grid showing benefits and costs broken down by socio-economic factors; **17 Socio-economic factor pages**, one for each socio-economic factor include UK-wide distributions and small multiple scatter plots for each co-benefit, allowing for the exploration of potential relationships between socio-economic conditions and projected co-benefit outcomes; **Local authority pages** with a total of 317 report pages for each local authority (LAD) which group data zones within each district. These pages highlight how each LAD may receive benefits or incur costs, and include a summary of the area's socio-economic profile. In addition to the report pages, there is an open-ended **map exploration page** using gradient shading to represent values associated with co-benefits or socio-economic indicators. Users can filter the map view using toggle buttons and checkboxes, enabling selection of spatial granularity and specification of the time period over which data is displayed.

4 Design challenges and solutions

Currently, the Atlas follows a **bottom-up and data-driven design**, meaning that, contrary to traditional design methodologies, we did not have a clear set of user personas or tasks. Instead, the Atlas focuses on providing balanced and comprehensive access to all the data. A convenient tool to that end are the individual report pages presenting data about an individual concept in the data, such as a co-benefit or a data zone. Curating these individual pages **requires a balance** between showing potentially all values in the data and avoiding overlap and redundancy across charts. For example, inspired by dashboard design, we compiled general statistics, provided overview charts (e.g., map) on the top of the page, and added a larger number of charts (e.g., 17 socio-economic factors) to the bottom. Each report is structured into subsections.

We also opted for relatively **standard visualisations** (barcharts, scatterplots, choropleth maps) in the current version to explore the expressive limits of these traditional charts and to rely on visualisations we know are widely familiar. An exception may be the waffle chart on the landing page used to summarise all contributions. We opted for such a waffle chart to avoid the perceptual limitations of pie charts. We also aimed at **making every visualisation standalone** so it could be easily read, understood, and interpreted if seen out of context, e.g., in a presentation, in a search result, or linked from another page within or outside the Atlas. To that end, each visualisation comes with a title, a brief explanation of its visual encoding, and detailed unit and label descriptions.

To establish **visual consistency**, to help orient within the Atlas, and to reinforce the central role of co-benefits, each co-benefit is assigned a unique colour and icon. This visual identity is applied uniformly across all pages and visualisations, helping users quickly identify and compare co-benefit-related content. To avoid confusion or overlap, shades of grey are used in charts regarding socio-economic factors to ensure that this dimension remains visually distinct. In these grey-scale plots, red is occasionally used as a highlighter for key features such as averages or negative values.

A defining characteristic of atlas-style platforms is **coherent and intuitive navigation**. To support this in the UK Co-benefits Atlas, users can interact with most visual marks in charts to move to a linked page. For example, clicking a region on a choropleth map takes users to the corresponding local authority report page. This interconnected design mirrors the experience of browsing a traditional atlas and encourages exploration [7]. Another final guiding principle is to **maximise transparency** by making as much of the underlying data as accessible as possible [7]. In the Atlas, this is facilitated by giving users the option to explore different data representations. For example, toggling between per capita values and total values in charts allows for flexible and comparative analysis tailored to the user's needs.

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[1] https://www.theccc.org.uk/publication/the-seventh-carbon-budget

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