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Inter-organisational Sustainability Cooperation Among European Regions and the Role of Smart Specialisation

Mirko Kruse¹

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Abstract

Innovation represents one of the most crucial levers for regional prosperity and sectoral renewal. Additionally, it is applied to address challenges such as a sustainable transition and the battle against climate change. Since innovation is the result of cooperation between different actors with different backgrounds, the topic is increasingly studied from a systemic perspective. Here, not only internal cooperation but also cross-border connections between regions become important. While smart specialisation, a European policy for innovation and cohesion, highlights the role of interregional cooperation, practical manifestations and research on this aspect have remained limited so far. This article addresses this gap by discussing the relevance of interregional cooperation for knowledge creation and presents empirical evidence on cooperation between organisations in different European regions in the field of environmental sustainability. The underlying dataset was constructed from Horizon 2020 (H2020) research projects with Northern Germany as an exemplary set of regions chosen as the core of a social network analysis (SNA). The findings reveal that involvement in interregional projects is concentrated particularly in urban regions and correlates with GDP and population density. On the other hand, also organisations in regions with different structural characteristics are involved in interregional cooperation, and H2020 managed to introduce new cooperation patterns. Finally, the empirical data do not adequately match the regional smart specialisation strategies (S3) which raises questions on updating smart specialisation as a policy.

Keywords Smart specialisation · Innovation policy · Europe · Interregional cooperation · Horizon 2020 · Social network analysis

JEL Codes R11 · O30 · O19 · Q55

✉ Mirko Kruse
kruse_mirko@web.de

¹ Faculty of Business Studies and Economics, University of Bremen, Bremen, Germany

Introduction

The economy in market-based societies is subject to constant structural change. Here, innovation and knowledge creation are key factors for companies, sectors, regions, and countries to successfully adapt to technological change (Landabaso, 1997). This recognition is even more true nowadays considering the multitude of severe events calling for adaptations of production processes, consumption patterns, value chains, or regulatory frameworks. Among these events are the COVID-19 pandemic, geopolitical tensions, the emergence of disruptive technologies, or the increasing urgency for a sustainable transition of the economy in accordance with planetary boundaries (Gong et al., 2022). Successfully managing said transition will require exploiting innovative capacity at all levels to develop new solutions and create new technological pathways. Innovation here functions as an instrument to tackle grand challenges including, but not exclusively, the sustainable transition of the economy (Fagerberg & Hutschenreiter, 2019; Losacker et al., 2021). Thereby, the distribution of innovative activity in space is not randomly distributed but tends to be spatially concentrated. As a consequence, the geography of innovation receives increasing attention (Coenen & Morgan, 2020).

In Europe, the European Commission has introduced the European Green Deal, a package of ambitious targets, specific policies, incentives, and directives, to achieve several objectives: overcome the pandemic-related recession and increase resilience against further crises, as well as the battle against climate change and the aspiration to become climate neutral (European Commission, 2021). The central levers to address these objectives are research and development (R&D) and innovation. Accordingly, the concept of smart specialisation, one of the key strategies of European innovation policy, comes into the spotlight again (Doranova et al., 2012; European Commission, 2020a). This approach was inspired by theories of regional innovation systems and the exploitation of place-based potential and has seen a remarkable career in the last decade following its implementation (Doranova et al., 2012; Van den Heiligenberg et al., 2017; Giustolisi et al., 2022). The concept has provoked academic criticism primarily because its origins are both political and theoretical, creating a certain level of fuzziness. As the concept now is increasingly discussed again in the context of the Green Deal and the sustainable transition of European regions, several questions must be answered, and shortcomings are to be addressed. One of the most severe shortcomings of smart specialisation so far is its outward-orientation, meaning the relevance of external cooperation and knowledge flows between regions. While the positive effects of knowledge transfer and mutual learning have been demonstrated empirically and smart specialisation conceptually strives to facilitate interregional cooperation (e.g. Guastella & Van Oort, 2015; Mitze & Strotebeck, 2018; Balland et al., 2019), practical implementation and empirical analyses have remained limited.

Thereby, deepening interregional cooperation is also crucial for the political goal of a gradual European integration and might become even more important as the current phase of globalisation appears to come to an end and internal cooperation increases in importance (Brodzicki, 2017; Gong et al., 2022). The fragmented

nature of the European research system has been identified as a major weakness preventing Europe from exploiting its full potential and catching up with more unified competitors such as the United States (European Commission, 2017). To exploit the full potential of European cooperation, which is also required to successfully address the grand challenge of climate change, existing policies such as smart specialisation will have to change as well. The paper at hand aims to contribute to this discussion by providing empirical evidence on interregional cooperation in Europe in the field of environmental sustainability. Thereby, a novel dataset to quantify cooperation is constructed analysing cooperative patterns between organisations in different European NUTS2 regions. As regions are no actors in a narrower sense, organisations within these regions are used as a proxy. While the majority of previous studies in this particular field rely on qualitative studies (e.g. Fellnhöfer, 2017), further empirical tools such as social network analyses and statistical methods are applied to provide a thorough overview and allow for deeper insights. To do so, the remaining of this paper is structured as follows: the “[Smart Specialisation, Sustainability, and Interregionality](#)” section introduces the policy of smart specialisation in the context of European innovation policy in general and discusses its recent relevance in the context of sustainability. In the following, interregional cooperation and its embeddedness in innovation system studies are outlined and discussed with regard to smart specialisation. Afterwards, the “[Inter-regional Scientific Collaboration in Europe](#)” section presents the data and methods used for the analysis before the findings are presented. The paper closes with a concluding outlook in the “[Conclusion](#)” section.

Smart Specialisation, Sustainability, and Interregionality

The Idea of Smart Specialisation

Smart specialisation represents one of the central strategies of European innovation and cohesion policy. The theoretic foundation of the concept is to be found in literature on regional innovation systems (RIS). This approach emphasises the crucial role of the regional level and geographical proximity between regional innovation actors for the generation of new knowledge and innovation (Tripl, 2008). The RIS concept was developed in the 1990s and builds upon the foundations of preceding theories such as national innovation systems (NIS), transition studies, innovative milieu, or industrial districts (McCann & Ortega-Argilés, 2015; Tödtling & Tripl, 2018; Rakas & Hain, 2019). Thereby, the rationale of smart specialisation as a policy goes back to the identification of, one the one hand, a manifesting productivity gap between Europe and other economic areas such as the USA, and, on the other hand, internal development gaps within Europe, particularly in the process of the Eastern enlargement (Janik et al., 2020). At the same time, it was discussed how to increase the efficiency of European cohesion and innovation policies as it showed that previous attempts had resulted in fragmentation and inefficient overlaps (Larosse et al., 2020; McCann & Soete, 2020). Previously, regional funding was invested thinly across several sectors without resulting in significant impact on

innovation capability and structural renewal as a result (Gianelle, Kyriakou et al., 2020). Smart specialisation came into play as the result of merging the two streams of discussion on interregional inequality and updating European cohesion policy (Foray et al., 2011; Kruse, 2023).

Content-wise, the pivotal idea of smart specialisation is place-based, meaning that the idea of a “one-size-fits-all” solution in terms of innovation policy is rejected. Instead, it is argued that each region needed to find its own niche and develop its own strategy to innovation instead of trying to emulate experiences from apparently successful regions (Gianelle, Kyriakou et al., 2020). As regions are unique in their economic and social structure, a successful strategy for one region might be a dead-end for others (Di Cataldo et al., 2020). Thereby, smart specialisation should motivate regions to prioritise and focus their resources on those innovative sectors which they are specialised in, and which offer the highest probability of performing well in the future (Rusu, 2013; Foray, 2014; Mora et al., 2019). By doing so, comparative advantages are to be built and potential agglomeration benefits can be realised (Gianelle, Kyriakou et al., 2020). Thereby, the choice of priorities should recognise the structural renewal of existing specialisations by focusing on complementing industrial and technological activities (Foray et al.; 2009; Vezzani et al., 2017; Balland et al., 2019). The selection of said investment priorities should not come from top-down planning but emerge from a process of entrepreneurial discovery, meaning the explorative involvement of regional experts from different backgrounds (Foray, 2013; Foray & Goenaga, 2013; McCann & Soete, 2020).

After its establishment, smart specialisation witnessed a remarkable career in European policy, being promoted as a fundamental pillar of cohesion policy in 2014 and as an *ex ante* conditionality for territories to be eligible for European funding (European Union, 2013; Janik et al., 2020; Di Cataldo et al., 2020). By now, most regions in Europe have applied the smart specialisation concept by developing individual smart specialisation strategies (S3), and the variety and quantity of research have increased remarkably (McCann & Soete, 2020). However, recent studies imply that smart specialisation is only partially implemented in regions and persistence remains to change established processes on a regional level (e.g. Gianelle, Guzzo et al., 2020; Larosse et al., 2020; D’Adda et al., 2021). Moreover, the fast success story of smart specialisation made the concept an example of “policy running ahead of theory” (Foray et al., 2011: 1), and several shortcomings have been outlined in recent years. One aspect of criticism refers to the term “specialisation” which often leads to the misunderstanding of interpreting smart specialisation as a modern kind of Porter-inspired cluster policy, whereby the concept aims towards diversified specialisation (Asheim et al., 2016). Further criticism revolves around the questions which regions do benefit. When smart specialisation was established, it was promoted as a measure to support less-developed regions while it later became clear that those regions benefit to a smaller degree as they lack the institutional capacity to implement the concept and conduct the process. Nevertheless, the basic idea of smart specialisation is widely received to be positive, underlining the place-sensitive approach, the focus on knowledge and innovation, and the involvement of regional actors in entrepreneurial discovery (Hassink & Gong, 2019; Foray, 2019).

Smart Specialisation and Environmental Sustainability

The partial implementation in practice and ongoing clarifications in theory underline that smart specialisation is far from being a completed concept. As the programming period 2014–2020 recently terminated, the discussion on how to update cohesion policy and smart specialisation for 2021–2027 has been extensive and remains ongoing. It is agreed that the update process should involve a critical evaluation of the past as well as a discussion which targets to address with smart specialisation (Tuffs et al., 2020a). In this regard, the primary task of smart specialisation has been to support innovation in regions helping them to shape structural change (Gianelle, Kyriakou et al., 2020). Recently, the discussion accelerated again to apply regional innovation strategies in order to foster green growth and support certain challenges such as renewable energy or eco-innovation (Foray et al., 2012; Esparza-Masana, 2021). While support in this challenge is required in every region, particularly less-developed regions which have been suffering from regional decline and are frequently specialised in non-green technologies that are likely to suffer from structural change, might benefit (Pîrvu et al., 2019; Provenzano et al., 2020).

The idea to deploy innovation policy to address certain targets is not new but aligns with earlier strategies such as Europe 2020 which called for not only growth in itself but smart, inclusive, and sustainable growth (McCann & Soete, 2020). This aspiration has recently been taken up by the idea of mission-oriented innovation policy as a new paradigm that regards innovation as an instrument to address larger societal missions. As previous missions have focused on topics such as defence, one of the most recent and pressing challenges to be addressed is climate change (Mazzucato, 2018a; Mazzucato et al., 2019). In this context, it is discussed whether smart specialisation might play a role for the implementation of the European Green Deal by integrating the targets of the Sustainable Development Goals (SDGs) and structural renewal in regional innovation strategies (Montresor & Quatraro, 2018; Gifford & McKelvey, 2019; Larosse et al., 2020; Nakicenovic et al., 2021). The discussion goes so far as considering renaming smart specialisation strategies (S3) into smart specialisation strategies for sustainability (S4). This need for reinterpretation, redesign, and reintegration of smart specialisation is also officially recognised by the European Commission (McCann & Soete, 2020; Nakicenovic et al., 2021). Although sustainability and smart specialisation have already been intertwined over time, the idea of including additional dimensions rather than strengthening the core idea first has also provoked criticism (Benner, 2020; Kruse, 2023).

However, research on how smart specialisation could contribute to sustainable development at regional level is still limited but increases gradually. At the same time, the attention towards environmental innovation and sustainability is also growing in related fields such as regional studies and economic geography (e.g. Truffer & Coenen, 2011; Markard et al., 2012; Gibbs & O'Neill, 2017; Montresor & Quatraro, 2018; Losacker et al., 2021). In the context of smart specialisation and sustainability, existing research has been focusing on the opportunities for regional innovation offered by circular economy approaches (Hristozov & Chobanov, 2020), renewable energy (Steen et al., 2018), or structural change in old industrial areas (Prause et al., 2019) with certain regions as examples (Polido et al., 2019).

Interregional Cooperation in Europe

Interregional collaboration concepts are based on the recognition of a crucial role of regions for innovation. This assumption is backed by economic geography and extensive research analysing the concentration of economic activity in time and space (Audretsch & Feldman, 2004; Guastelle & van Oort, 2015; Hidalgo et al., 2018). Accordingly, regions exhibit a critical mass of economic actors interacting in a regional innovation system allowing for a free flow of knowledge and the emergence of innovation. Since spillovers do not easily travel across space, spatial concentration of innovative activity is the result. This effect is likely to be self-enforcing represented in the fact that most of the growth in Europe in the last decade has been concentrated in cities (Asheim et al., 2018; McCann & Soete, 2020; Pinheiro et al., 2022). Therefore, regions are also discussed as ideal starting points in the context of sustainable transition (Potts, 2010; Montresor & Quatraro, 2018).

However, regions do not act in isolation, and positive effects do not only arise from intra-regional cooperation but also from inter-regional cooperation with other regions. Such external cooperation contributes to innovativeness, particularly in less-developed regions, shapes regional development and diversification, allows for the exploitation of synergies, and prevents regional lock-in effects through the promotion of diversification (e.g. Benneworth et al., 2014; De Noni et al., 2017; Santoalha, 2018; Mikhaylov et al., 2018; Schulz, 2019). Particularly in a globalised learning economy, the external aspect of cooperation should therefore not be left out of consideration. This is even more true as the recent framing of innovation policy with a stronger focus on transformative change also highlights the relevance of interregional cooperation (McCann & Ortega-Argilés, 2016; Schot & Steinmueller, 2018; Giustolisi et al., 2022). Grand challenges, such as a sustainable economic transition, require different perspectives and diverse knowledge to be addressed and lay beyond the scope of individual regions or even countries (Attolico & Scorza, 2016; van den Heiligenberg et al., 2017; Angelis, 2021). Empirically, it is suggested that knowledge spillovers depend on distance and different kinds of proximity—among others geographical, relational, functional, institutional, cognitive, social, or technological proximity—between regions (Lundquist & Trippl, 2009; Boschma & Frenken, 2010; Basile et al., 2012).

Accordingly, innovation systems, focusing on the role of interaction between different actors, stretch across borders. Concepts of global innovation systems (GIS), national innovation systems (NIS), or technological innovation systems (TIS) have adopted a cross-border approach from early on (Carlsson, 2006; Shapiro et al., 2010; Binz & Truffer, 2017). For instance, Chesnais (1992) demonstrated how the operations of multinational enterprises influence the structure of NIS. Regional innovation systems (RIS) have for a long time been analysed in isolation rather than in cooperative cross-border settings (Gosens et al., 2014; Li et al., 2022). Stepwise, the approach has been broadened leading to the establishment of the concept of cross-border regional innovation systems (CBRIS). Conceptually, CBRIS incorporate informational exchange and knowledge diffusion across borders and can be understood as the most advanced form of integration between regions towards an integrated innovation space (Lundquist & Trippl, 2009, 2011; Asheim et al., 2011; Pietrobelli & Rabellotti, 2011; Korhonen et al., 2021). Interregional cooperation

across borders can also relate to a worldwide level, associated with foreign direct investment (FDI), or global value chain (GVC) concepts (Audretsch & Feldman, 2004; Asheim & Herstad, 2005; Boschma, 2021). However, cross-border cooperation is a more common topic in the literature, referring to the high level of proximity between neighbouring regions (Lepik & Krigul, 2014; Scott, 2015).

In Europe, research on cross-border cooperation is long established as it can be understood as an aspect of European integration (De Sousa, 2012; Del Bianco & Andevy, 2015). The process of transnational and interregional cooperation in Europe increased in the nineteenth century and took off after World War 2 resulting from a political will for integration (Van der Vleuten & Kaijser, 2005; Scott, 2015). This understanding was facilitated by agreements such as the Maastricht Treaty and institutionalised in cross-border cooperation agreements, or the establishment of “euroregions” and “macroregions” as testbeds for practical transregional and transnational cooperation (Lina & Bedrule-Grigoruta, 2009; Hudec & Urbancikova, 2010; Studzieniecki, 2016; Noferini et al., 2020). Moreover, an additional incentive to E cooperation across regions is the prospect to fully exploit the potential of the European internal market by overcoming its fragmentation. The establishment of a European research area with coordinated and integrated interregional research activities has been promoted as a vision in this regard (Frenken et al., 2007; European Commission, 2020b; Rakhmatullin et al., 2020). Interregional projects such as INTERREG or HORIZON represent an institutionalisation of this aspiration (Cassi et al., 2008; Martin-Uceda & Vicente Ruffi, 2021; European Commission, 2022). Also, European instruments such as smart specialisation cannot be separated from the idea of interregional cooperation. However, since smart specialisation has emerged from RIS studies, the limitations described above apply equally and the almost exclusive focus of smart specialisation on endogenous knowledge flows is among the most common criticisms mentioned in academic research and policy documents (Tuffs et al., 2020b; Woolford et al., 2021).

Until now, the majority of smart specialisation strategies (S3) do not include or facilitate interregional cooperation despite an “outward-looking” orientation being named as a constituting element of the approach from the very beginning (Foray et al., 2012). This aspired outward orientation was backed by the fact that structural change and regional innovativeness both benefit from cooperation, external connectedness, and knowledge exchange with regions facing similar challenges. Moreover, the resources and knowledge that a region needs for its development might not be available at home but outside the region. Different regional characteristics therefore allow for different perspectives and solutions, as smart specialisation highlights with its focus on finding the niche and regional competitive advantage for future specialisation (McCann et al., 2015; Mariussen et al., 2019; Foray, 2018). Also, the cohesion aspect of smart specialisation is addressed by extra-regional collaboration since particularly less-developed and technologically lagging regions often lack the internal capabilities and networks that they require for a catch-up process (Radosevic & Ciampi Stancova, 2015; Barzotto et al., 2019; Ghinoi et al., 2020). The same holds for the focus on grand challenges such as climate change which require the cooperation of different regions. In this regard, Castellani et al. (2022) found indications of a positive influence of different forms of FDI on regional specialisation in green technologies, indicating a positive influence of cooperation for a green transition. Most

likely, an exclusive focus on European regions might not suffice, but an improved European research cooperation appears to be a necessary foundation for a successful implementation of the Green Deal targets (Woolford et al., 2021; Tuffs et al., 2020a). Instead, also cooperation with non-EU regions considering certain challenges might come into play (Uyarra et al., 2014).

However, not only implementation but also research on interregional cooperation and smart specialisation has remained limited so far (Radosevic & Ciampi Stancova, 2015; Balland & Boschma, 2021; Weidenfeld et al., 2021). Apart from policy papers and qualitative studies, for instance, by Muller et al. (2017), authors like Gianelle et al. (2014), Girejko et al. (2019), and Kruse and Wedemeier (2021) present methodologies to identify common priorities between regions as a foundation for common smart specialisation strategies (S3). However, these papers do not empirically test the efficiency of cooperation and confine to offering a theoretical toolkit for policymakers to assess the potential of cooperation with other regions. Other, more qualitatively oriented, papers presented by Sörvik et al. (2016) or Mueller-Using et al. (2020) place an emphasis on the factors that motivate or prevent regions from cooperation. As a result of these shortcomings, transnational collaboration and strengthening the outward orientation of smart specialisation are among the demands when it comes to updating cohesion policy and smart specialisation (Esparza-Masana, 2021; Woolford et al., 2021). This also includes strengthening the already-existing interregional partnership platforms on smart specialisation and SDGs which the European Commission has been working on since 2015 and previous approaches to interregional collaboration such as the Vanguard Initiative (Rakhmatullin et al., 2020; Smart Specialisation Platform, 2022a). Moreover, the Interregional Innovation Investment (I3) instrument represents an additional European attempt to promote interregional investment particularly in areas relevant for transformation. The future interconnection with smart specialisation and other instruments, however, is still under development (Tuffs et al., 2020b).

Interregional Scientific Collaboration in Europe

Materials and Methods

The most common approach in academic research to quantify and map interregional knowledge flows is the application of patent statistics and co-patenting analyses involving different regions. With a focus on Europe, Greunz (2005), Sebestyén and Varga (2013), Guastella and Van Oort (2015), Montresor and Quatraro (2018), Santoalha (2018), Barzotto et al. (2019), Balland and Boschma (2021), and Li et al. (2022) apply patent-based analyses. Moreover, von Proff and Brenner (2011) deploy this approach for German regions, and Yang et al. (2019) and Dosso and Lebert (2020) do the same for co-patenting on a worldwide level. Co-patenting data are also used in China, e.g. by Ye and Xu (2021), to construct inter-city cooperation networks, by Cao et al. (2021) to map the technological field of energy saving, or by Sun and Cao (2015). However, it has extensively been discussed in the literature that patent data come with several limitations. One of the most striking ones is that not

all kinds of research necessarily lead to patents as not all inventions are patentable or patented (Grilliches, 1998). Moreover, patenting activity differs significantly across scientific disciplines and technologies (Hoekman et al., 2008). This leads to a regional bias with less-developed regions being structurally neglected in patent-based analyses (Kakderi et al., 2020). Therefore, other measures of interregional cooperation are suggested and applied, e.g. co-publications (Hoekman et al., 2008; Acosta et al., 2011), foreign direct investments (FDI), or monetary flows (Makkonen et al., 2016; Todeva & Rakhmatullin, 2016). Interregional trade data flows in Europe are assessed by Gianelle et al. (2014) or Basile et al. (2016), each based on data from PBL Netherlands Environmental Assessment Agency. Wall and van der Knaap (2011) construct a dataset of multinational companies and their ownership linkages with international subsidiaries, while Mitze and Strotebeck (2018) deploy a commercial industry directory to assess research collaborations in the German biotechnology industry. Less common are qualitative approaches in interregional analyses. Here, interview-based studies are presented by Miörner et al. (2018) and Uyarra et al. (2018), while cooperation networks in cross-border regions are qualitatively analysed by Fratzek-Müller and Mielczarek-Zelmo (2020).

To empirically assess interregional cooperation at a regional level, particularly in the field of environmental sustainability, an appropriate dataset is required. For the European case, this task is challenging for two reasons: on the one hand, the European statistics department Eurostat does not provide regional trade data which would make a good indicator of interregional involvement and interregional networks. On the other hand, sustainability is a cross-cutting topic which cannot be assigned to traditional sector classifications such as the NACE classification. The majority of the previously described analytical approaches falls short of the task of constructing a regional level database on sustainability cooperation. Instead, it was decided to use the CORDIS (Community Research and Development Information Service) database for this task. The CORDIS database contains information on research projects funded by the EU under the HORIZON and FP7 programmes. Although there are other funding schemes such as INTERREG which particularly focus on interregional cooperation, these data are less accessible and not compatible with CORDIS and have been dropped for these reasons. Here, it needs to be remarked that cooperation between organisations is tracked rather than cooperation between regions as such. The geographical location of these organisations in different NUTS2 regions, however, allows to apply inter-organisational cooperation as a proxy for cooperative patterns between regions although the analytical level is different, and organisations rarely address policies or strategies as regions do as a motivation.

One of the advantages of CORDIS in comparison to other approaches is that the project data can be transformed to a quantitative form and filtered thematically. For this paper, the projects funded under the Horizon 2020 research and innovation programme were analysed (last update 21.01.2022). Horizon 2020 was running from 2014 to 2020 with a budget of about €80 billion to fund multi-national research and innovation projects in Europe dealing with societal challenges (Mazzucato, 2018b; Giarelis & Karacapilidis, 2021). These programmes have a scientific focus and include diverse organisations from different regions primarily from Europe but also from beyond (Boezeman & de Coninck, 2018). The CORDIS database lists

qualitative information about projects, their focus and results, as well as about participating organisations, their type, location, and role. Since the programming period recently ended and Horizon 2020 was replaced by Horizon Europe, the list can be assumed to provide a complete overview (CORDIS, 2022). However, it has to be noted that Horizon 2020 primarily addressed technology-oriented project partners. While Interreg might have provided a more general picture, analysing Horizon data inevitable involves a technology bias.

To produce a subset of those projects related to environmental sustainability for later analysis, a two-step approach was applied: (1) projects were selected on the basis of funding calls related to environmental sustainability (see [Annex 1](#)), and (2) the project list was filtered for the key terms “green” (1622 projects), “sustainab*” (1538 projects), and “environment” (9179 projects) in their title or abstract. Finally, both lists were merged, doublings eliminated, and each project abstract qualitatively checked to exclude projects not fitting the desired criteria of environmental sustainability. This allowed to reduce the set of 23,378 projects involving 172,730 organisations funded by Horizon 2020 to 9777 projects and 39,519 organisations. The post-codes associated with the organisations involved in the projects were then used to link each region to the respective NUTS3 and NUTS2 region. After all, 72 organisations could not be linked to a NUTS region due to missing information. Moreover, each project was attributed to a textual topic to allow for further differentiation. Five hundred seventeen projects were related to “bioeconomy”, 114 projects to “blue economy”, 451 to “circular economy”, 410 to “climate research”, 85 to “sustainable construction”, 1429 to “renewable energy”, 555 to “sustainable mobility”, and 307 to “sustainable technology” (see [Annex 2](#)). The numbers give an impression of the internal focus of environmental sustainability projects in Horizon 2020.

To gather information about interaction between organisations and regions within the dataset, a social network analysis (SNA) was conducted. SNAs are receiving increasing attention particularly in economic geography and regional innovation studies as they allow for an empirical analysis of inter-organisational interaction as well as knowledge flows inside a network (Tel Wal & Boschma, 2009; Stuck et al., 2015). Studying the relationship between actors promises to reveal additional information compared to studying the actors independently. Moreover, SNAs are regarded as an appropriate tool to analyse cross-regional and interregional innovation systems (Cooke, 2001; Stuck et al., 2015). Common analytical aspects of SNAs involve the identification of the role of actors in a network and their relationship among each other as well as the identification of hubs, communities, or authorities via quantitative graph analysis (Wasserman & Faust, 1994; Bandyopadhyay et al., 2010; Alamsyah et al., 2013; Tabassum et al., 2018). SNAs can be constructed on different kinds of data that involve various regions (Cidell, 2020; Ghinoi et al., 2021). Also, CORDIS data have previously been used for SNA, for instance, by Ertan (2016), based on project data from the 7th Framework Programme, the predecessor of Horizon 2020, or by Bralić (2018), Doussineau et al. (2020), and Morisson et al. (2020) each based on Horizon 2020 data.

In this paper, the full dataset of cooperation is additionally broken down to a regional subset covering Northern Germany (involving the NUTS2 regions DE50, Bremen; DE60, Hamburg; DE80, Mecklenburg-Vorpommern; DE91, Braunschweig;

DE92, Hannover; DE93, Lüneburg; DE94, Weser-Ems; DEF0, Schleswig-Holstein). Constructing a subset was motivated by the fact that the full dataset would be too large to analyse individual connections so that a focus had to be applied. Thereby, Northern Germany qualified itself through the diverse nature of regions including large cities (Hamburg, Bremen) on the one hand and more rural regions (Lüneburg, Weser-Ems) on the other hand. Also, the region has been analysed in the context of sustainable transition, matching the focus of this paper (Hassink et al., 2021; Kruse & Wedemeier, 2022). This regional subset complements Morisson et al. (2020) who conducted a network analysis based on the Italian region of Calabria. Constructing a network with the eight Northern German NUTS2 regions as the core and without modelling connections among the partner regions with each other results in an SNA with 9179 edges and 357 unique combinations of the eight regions cooperating with each other and other regions around the world. Calculations were conducted using the R Studio programme (version 4.2.0) including the igraph and sna packages (Csardi & Nepusz, 2006; Butts, 2020). Graphical illustrations were prepared using the Gephi programme (version 0.9.5 202205022109).

Results

In a descriptive way, Figs. 1 and 2 illustrate the absolute number of organisations involved in projects on environmental sustainability in European regions. Thereby,

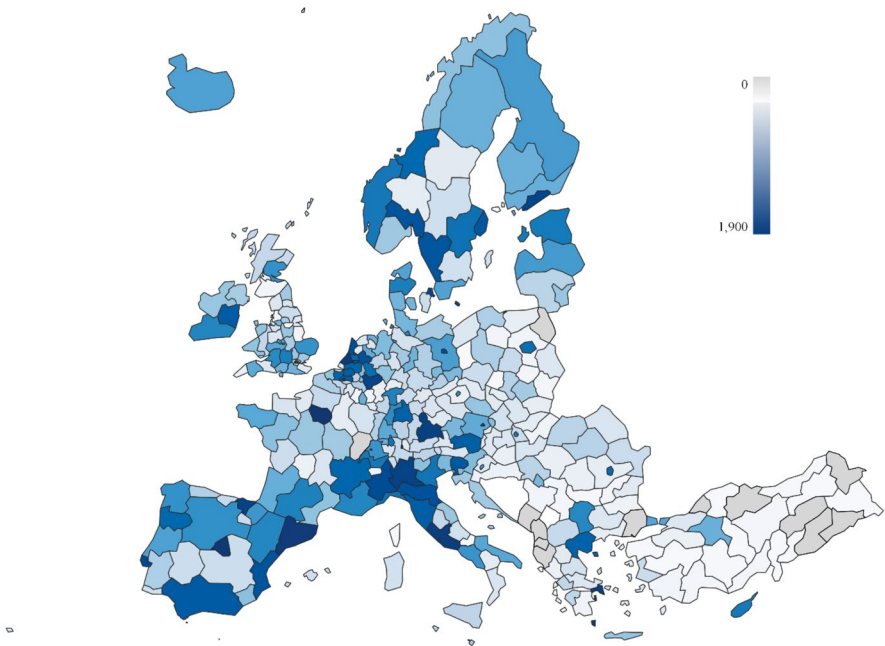


Fig. 1 Organisations involved in interregional H2020 Sustainability Projects, NUTS2 level, 2022. Source: CORDIS (2022), own depiction

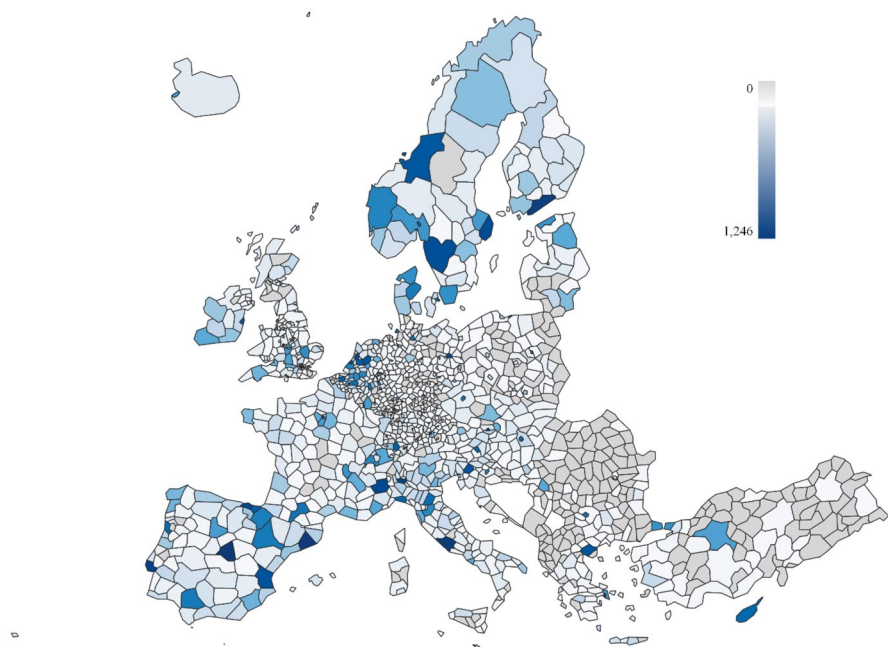


Fig. 2 Organisations involved in interregional H2020 Sustainability Projects, NUTS3 level, 2022. Source: CORDIS (2022), own depiction

it was decided to abstain from a differentiation subject to certain years as the analysed projects have different durations. Moreover, project funding received was not included as a weight since it did not match with further analytical steps of SNA. Instead, the number of organisations was accumulated per region as a measure of the strength of interregional involvement in sustainability research (for the list of regions and number of identified organisations on NUTS2 level, see [Annex 3](#)). The geographical mapping follows the NUTS classification (“nomenclature of territorial units for statistics”) provided by Eurostat (2021). As can be seen, the distribution is not even, but organisations involved in interregional projects are highly concentrated in certain regions. Generally, there is no clear West-East or North-South picture as the intensive of cooperation is highly shaped by individual hotspots (see [Fig. 2](#)). While these hotspots tend to be capital regions or highly urbanised areas, they are found in all parts of Europe. A dominance of Western or Northern Europe, as found in other European studies (e.g. Kruse et al., 2022), is not observable here. However, in Eastern Europe, many regions have not been involved in projects on environmental sustainability so far which represents a potential still to be tapped.

To empirically test whether certain structural characteristics of regions influence the number of organisations involved in interregional research, a Pearson’s product-moment correlation was calculated and tested using NUTS2-level data (see [Table 1](#)). The tested variables included GDP per capita at current market prices (GDP) and

Table 1 Pearson Correlation and Test Results

	GDP	GVA	Age	Density	GERD	WASTEEMP	WASTEGEN	Cooling
Correlation coefficient	0.4162655	0.7825878	-0.1283997	0.3618056	0.3716083	0.6668699	0.4090069	0.07141354
t-test statistic	7.0924	19.475	-1.9932	5.9747	5.3851	12.172	4.9507	1.0858
Degrees of freedom	240	240	237	237	181	185	122	230
p value	1.47E-11	< 2.2e-16	4.74E-02	8.39E-09	2.23E-07	< 2.2E-16	2.40E-06	2.79E-01
Confidence Interval	[0.3062361,	[0.6283639,	[-0.251201853,	[0.2462146,	[0.2394596,	[0.5787589,	[0.2507749,	[-0.05791786,
(95%)	0.5153195]	0.8270705]	-0.001529623]	0.4672486]	0.4902390]	0.7395908]	0.5459523]	0.19838746]

Sources: Eurostat (2023a, b, c; d; e, f, g, h), own calculations

gross value added (GVA) which allow for a quantification of the development stage of the regional economy. The indicators for median age of the population (AGE) and population density (DENSITY) describe regional structures, while gross domestic expenditure on R&D (GERD) refers to the relevance attributed to research in regions. Moreover, indicators were analysed that can function as a proxy for environmental aspects. Since the availability of environmental data for Europe is limited, particularly at regional level, these data can only be an approximation. An indicator was included measuring the employment in waste collection, treatment, and disposal activities as well as materials recovery (WASTEEMP) as well as an indicator measuring the amount of municipal waste in tonnes (WAGEGEN). The latter data come from a pilot project and therefore are only available for 2013, while all other data refer to 2019 as the base year. The generation of waste gives an idea of the public awareness towards environmental affairs. Finally, an index was included measuring the need for additional cooling of buildings as an indicator of regional climate change impact (COOLING). (Eurostat, 2023a, b, c, d, e, f, g). Naturally, testing data of a single year does not yield a sufficient number of observations to provide empirical significance. However, the correlation test helps to interpret and classify the results.

The p value of the results implies correlations of different strengths between the engagement of regions in environmental sustainability research projects and the tested variables. For the interpretation of results, the effect strength suggested by Cohen (1988) is applied. Based on this assumption, GDP and GVA underline that the involvement in interregional projects is affected by economic strength. Interestingly, the spending on R&D (GERD) is only moderately correlated allowing to conclude that research projects are also initiated in regions which are still in the process of transformation towards a knowledge economy. Also, the population density is only moderately correlated as well as the median age of the population with a weak negative correlation. These results suggest that highly urbanised regions are more equipped to get involved in interregional cooperation, but an urban structure does not represent a definite requirement. Finally, the environmental indicators are moderately (WASTEGEN) and highly correlated (WASTEEMP). This can be seen as an indication that the involvement in interregional sustainability projects does indeed reflect regional environmental awareness to a certain degree and the involvement can be interpreted also as a measure of regional sustainability relevance. On the other hand, the regional impact of climate change (COOLING) does not significantly influence whether regions get involved in related research projects.

Considering that smart specialisation is promoted as a tool to support regional structural change and sustainable transition, the question arises whether the empirical results of certain regions being strongly involved in interregional projects on environmental sustainability match the smart specialisation strategies (S3) formulated by the regions. To test this assumption, the Eye@RIS3 database, containing information about priorities in S3 of European NUTS2 regions, which is the level S3 are implemented at, was filtered for those regions listing domains related to environmental sustainability in their strategy (Smart Specialisation Platform, 2022b). Regarding the domains, only the scientific domains were analysed since cooperation data relate to Horizon 2020 representing a framework of research and innovation

Regarding the constructed network of Northern German NUTS2 regions, the social network is shown in Fig. 3. Those regions that Northern Germany frequently cooperates with are shown in the middle of the network with coloured edges as an additional weight indicating the intensity of cooperation. The NUTS codes reveal that cooperation in interregional projects on environmental sustainability focuses primarily on other regions in Germany as well as Austria, Belgium, Denmark, Finland, France, Italy, the Netherlands, Poland, Spain, Sweden, Switzerland, and the UK. It appears to be of no coincidence that, apart from Luxemburg, all neighbouring countries to Germany are among the most important cooperation partners. The full cooperation network is provided in Annex 5. An additional perspective is provided in Fig. 4 which illustrates the intensity of cooperation between Northern Germany

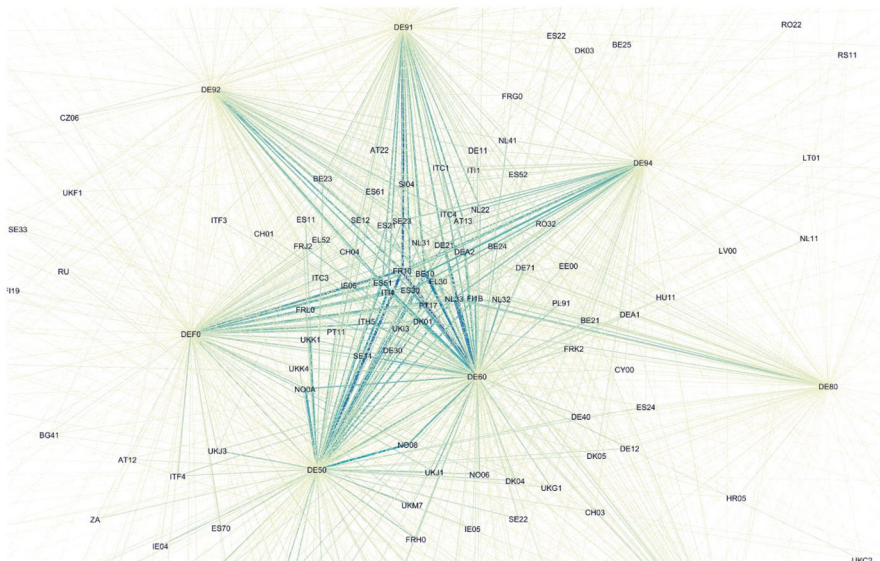


Fig. 3 Weighted network of Northern German Regions in H2020 Sustainability projects, 2022. Source: CORDIS (2022)

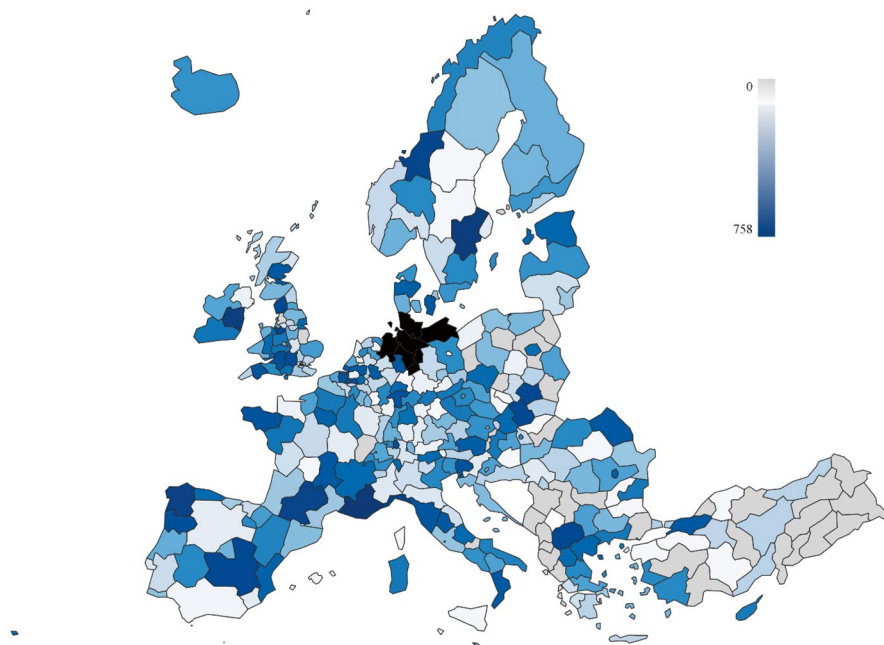


Fig. 4 Interregional cooperation of Northern Germany in H2020 Sustainability Projects, NUTS2 level, 2022. Source: CORDIS (2022), own depiction

and European regions. Here, it is revealed that neighbouring regions tend to cooperate with Northern German regions. This supports the assumption of (geographical and cultural) proximity as a facilitating factor for cooperation. However, geographical proximity is not a limiting factor for cooperation, as strong cooperative ties are observable with regions in all parts of Europe including non-EU countries such as Turkey or the UK. This picture can partly be explained by the nature to receive funding. Nevertheless, Fig. 4 allows to state that environmental cooperation is not geographically limited in Europe and the Horizon funding scheme appears to have succeeded in connecting researchers from regions which would not have cooperated assuming the traditional proximity hypothesis.

An Additional empirical analysis of the network has been conducted by measuring different kinds of centrality, namely, closeness, betweenness, degree, and eigenvector centrality. These measures give an indication on the overall position of a node and the theoretical time it would take to reach other nodes (closeness centrality), the extent at which a node lies between other nodes in the network and the percentage of shortest paths passing through the node (betweenness centrality), the number of links incident upon a node (degree centrality), and the relative score of each node measuring how well a well-connected node is connected to other well-connected nodes (Tabassum et al., 2018). Table 2 lists the top-20 regions for each measure of centrality and the respective value. Not surprisingly, the Northern German regions score the highest which is due to the design of the network putting said regions in the centre

Table 2 Centrality measures of the network of Northern German regions in H2020 Sustainability projects, 2022

Rank	Closeness centrality		Betweenness centrality		Degree centrality		Eigenvector centrality	
	DE60	0.002283	DE60	16985.7835	DE60	1982	DE60	1.0000
1	DE60	0.002283	DE60	16985.7835	DE60	1982	DE60	1.0000
2	DE50	0.002262	DE50	15367.3087	DE50	1927	DE50	0.9490
3	DE91	0.002183	DEF0	9211.3129	DEF0	1320	DEF0	0.6742
4	DEF0	0.002141	DE91	9000.5362	DE91	1206	FR10	0.5932
5	DE94	0.002066	DE94	6180.0952	DE94	1018	DE91	0.5809
6	DE92	0.002024	DE92	4329.4028	DE92	869	DE94	0.5076
7	DE80	0.001942	DE80	3311.3653	DE80	574	BE10	0.4247
8	DE93	0.001842	DE93	1646.5477	DE93	425	DE92	0.4124
9	CH02	0.001420	FR10	1.5533	FR10	306	ES30	0.3990
10	CH04	0.001420	ES51	1.0067	BE10	222	NL33	0.3864
11	DE21	0.001420	NL33	0.9708	ES30	209	ITI4	0.3433
12	DEA2	0.001420	BE10	0.9097	NL33	206	DE21	0.3340
13	ES51	0.001420	DK01	0.8054	ITI4	176	ES51	0.3246
14	FR10	0.001420	ES30	0.7047	ES51	174	DK01	0.2982
15	NO08	0.001420	ITI4	0.5825	DE21	171	DE80	0.2750
16	UKJ1	0.001420	EL30	0.3955	DK01	153	EL30	0.2596
17	EL30	0.001420	FI1B	0.3883	EL30	137	FI1B	0.2497
18	ITI4	0.001420	UKI3	0.3416	FI1B	132	DEA2	0.2461
19	NL31	0.001420	DE21	0.3236	DEA2	129	UKI3	0.2294
20	PT17	0.001420	NO08	0.2876	UKI3	115	NO08	0.2208

Source: own calculations

of it. However, the regions beyond Northern Germany, which play an important role within the cooperation network, are similar to those in the centre of Fig. 3.

Discussion and Limitations

The descriptive findings show differentiated geographical patterns when it comes to the involvement of European regions in interregional research projects dealing with environmental sustainability. At NUTS2 level, a light distinction between Western and Eastern Europe becomes visible (see Fig. 1). Thereby, Eastern European NUTS2 regions in their majority are in fact involved in interregional projects rather than being not involved at all, but to a considerably smaller degree than other regions. The picture becomes clearer when looking at the NUTS3 regions (see Fig. 2). Here, it can be seen that interregional activity is highly concentrated in particular regions which are also to be found in Eastern or Southern Europe which often are regarded as less-developed areas in regional studies. Hoekman et al. (2008) describe these patterns as “elite structures”. These regions with particularly strong interregionality

scores are particularly urban, and most NUTS3 concentration patterns refer to capital or major city agglomerations. The conducted correlation analysis confirms that a connection between regional factors such as GDP or economic structure and inter-regional orientation can be assumed (see Table 1). More rural areas, for instance, in Eastern Europe but also in large parts of Germany, are not active in interregional cooperation. This finding partly contradicts Santoalha (2018) identifying regions in Benelux, Germany, and Central and Eastern Europe to be relatively strong in inter-regional collaboration. However, this contradiction might be due to the focus of the particular dataset in this paper on environmental sustainability as Horizon projects are research-oriented and high-tech research tends to be spatially concentrated to a high degree. Moreover, the dataset cannot provide an answer to the question whether certain groups of regions do not deal with environmental sustainability at all or whether they simply do not engage in high-level research and interregional collaboration. This is further amplified by the fact that organisations rather than regions themselves were analysed. As sustainability is hardly measurable using individual indicators, the findings need to be complemented by additional research applying different datasets to paint a more complete picture.

Thereby, the observed concentration patterns align with related literature on regional innovation. Spatial clusters of knowledge-intensive regions are regularly identified and attributed to urban advantages, density, and clusters of innovation actors from the triple helix (Van den Heiligenberg et al., 2017). Particularly complex economic activities and scientific research tend to concentrate in larger cities and metropolitan areas (Acosta et al., 2011; Balland et al., 2018; Tödtling & Trippel, 2005). From a cohesion perspective, these findings are alarming: smart specialisation and innovation policy in Europe focus on bridging existing regional disparities by empowering less developed regions. The evidence that particularly those regions that would benefit most from interregional knowledge exchange are the least involved was expectable but is not desirable from a policy perspective (Camagni & Capello, 2013; McCann & Ortega-Argilés, 2015; Corradini, 2019). Moreover, the future topic of a sustainable transition, which is also particularly relevant for less-developed regions as they tend to be more vulnerable due to an old-industrial economic structure and fewer green specialisations, again reveals structures to the disadvantage of less-developed regions. Existing policy instruments apparently have not managed to overcome the persistent dichotomy which is likely to reproduce since research generally also translates into economic hard facts in the long run. However, the picture might become more differentiated when other, less competitive, collaborative programmes such as Interreg, as opposed to Horizon 2020 data in this paper, are considered, as suggested by Woolford et al. (2021).

Regarding the fit between scientific specialisation mentioned in official S3 and actual performance as measured by involvement in research projects, both spheres do not fully match. The analysis has shown that a group of regions which are quite active in interregional projects on environmental sustainability do not mention this as a strength in their S3, while, on the other hand, some regions officially announce a specialisation which is not backed by statistical analysis. Here, it needs to be remarked that organisations rarely address policies or strategies such as smart specialisation strives to do. As organisations are used as a proxy

for interregional cooperation, they must not necessarily have an impact on smart specialisation strategies. In this context, a different methodological approach was chosen by D'Adda et al. (2018) asking the same question for technological domains in Italian regions. Also here, the findings imply that S3 and real-life performance are characterised by a certain level of divergence. The same finding is mentioned by Sörvik and Kleibrink (2015) as well as Deegan et al. (2021) implying that European smart specialisation and European science policy need to be better aligned and the preparation of S3 requires a stronger statistical foundation.

The second analytical step of this paper, the construction of a cooperation network of Northern German regions, also confirms previous studies. It is generally assumed that knowledge spillovers tend to focus on close regions whereby different measures of proximity such as geography, similar languages, culture, and policies are relevant (Greunz, 2005; Basile et al., 2012; Dosso & Lebert, 2020). Our analysis shows that Northern German regions cooperate with all parts of Europe and also several countries beyond Europe (see Annex 5). Although strong cooperative ties are observed with regions in direct proximity, the Horizon programme has successfully contributed to the establishment of scientific cooperation with regions which would otherwise not have cooperated following the proximity hypothesis. This can be interpreted as a step towards the establishment of a European research area as HORIZON allows to bridge some of the major obstacles, namely, that researchers cooperate based on geographical proximity and tend to cooperate with similar organisations in similar regions (Frenken et al., 2007). Moreover, in light of grand challenges, such as the fight against climate change, external cooperation is strongly advised (Uyarra et al., 2014). Northern Germany matches this suggestion, and the analysis blends in with other papers assigning the region an important role for a sustainable transition (e.g. Hassink et al., 2021; Kruse & Wedemeier, 2022).

Conclusion

Innovation has been identified as one of the key levers for regional prosperity and sectoral renewal. Accordingly, innovation in Europe is not only discussed in terms of cohesion and bridging interregional disparity but also as a means to contribute to a sustainable transition facilitated by the EU Green Deal. In this context, cooperation and knowledge exchange have led to the recognition that innovation is to be studied from a network perspective, institutionalised in systematic theories such as regional innovation systems (RIS). These also form the theoretic foundation of smart specialisation, the European policy approach to support innovation and regional positioning. Cooperation, mutual learning, and knowledge exchange are thereby evidently important factors for regional economic prosperity, new path development and diversification (Mariussen et al., 2016). Despite smart specialisation highlighting the relevance of interregional cooperation since the time the concept was developed about a decade ago, practical implementation and empirical research in this regard have remained limited. The paper at hand addresses this issue by discussing how smart specialisation might contribute to the grand challenge of a sustainable transition in Europe and which role interregional cooperation can play in this regard.

Moreover, the current state of research on interregional cooperation in Europe is presented showing that the previous studies predominantly rely on patent data for empirical analyses. To broaden the picture and overcome the limitations of patent data, such as a technological and regional bias, data on Horizon 2020 (H2020) research projects in Europe were analysed and a database of interregional activity related to environmental sustainability was constructed.

The findings reveal that organisational involvement in interregional European projects is highly concentrated in urban and capital regions. A correlation analysis confirms that regional characteristics such as GDP or population density positively influence a region's involvement in interregional research projects on environmental sustainability. This aspect is alarming from a policy perspective as existing divergency patterns are reproduced this way instead of being bridged. Particularly an urban-rural separation is likely to keep manifesting when today's research translates into economic strength in the future. Moreover, this development contradicts the aspiration of smart specialisation to use innovation policy for the achievement of regional convergence. Also, it was shown that smart specialisation strategies (S3) do not adequately match practical specialisations when it comes to interregional activity. Since other studies suggest the same implication of S3 not reflecting economic reality, this raises questions for an update of smart specialisation which should pay more attention to statistical analyses prior to the strategy formulation process. To receive further insights into the internal network structure of the database, a social network analysis (SNA) was conducted, placing the Northern German NUTS2 regions in the centre. This analysis proved that cooperation appears to be positively influenced by geographical and cultural proximity, but cooperation is also observable with regions that are neither geographically nor culturally proximate. It can be assumed that the aspiration of Horizon 2020, to promote interregional cooperation and facilitate knowledge flows between regions, has been successful to the point where cooperation networks are established that would not have emerged without European research funding. This is particularly relevant in the field of environmental sustainability research considering the increasing need to adapt to the UN SDGs and to overcome previous limitations of a fragmented European research area (Kattel & Mazzucato, 2018; Mazzucato & Penna, 2020). Generally, the analyses in this paper confirm that innovation cooperation on environmental sustainability in Europe is established but further measures are required to address certain shortcomings such as regional convergence.

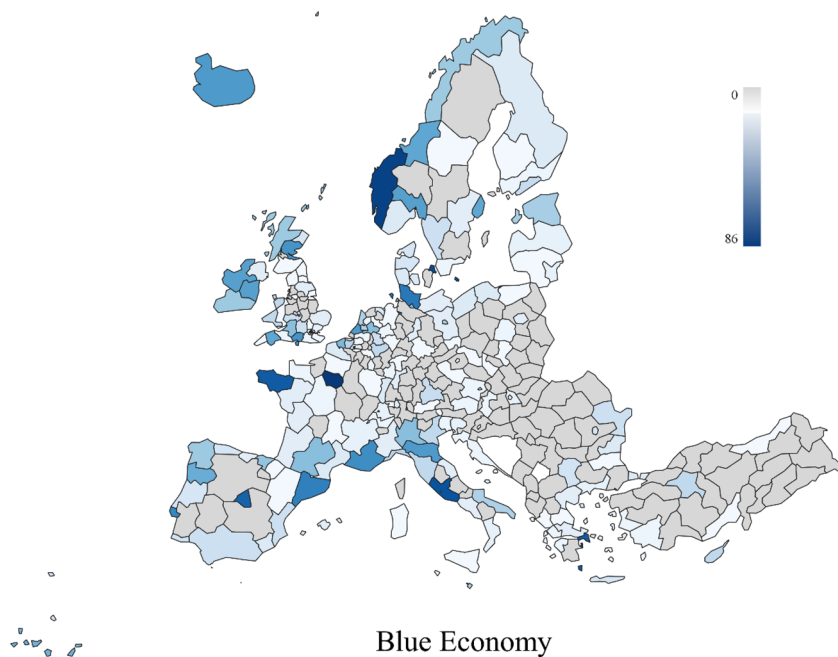
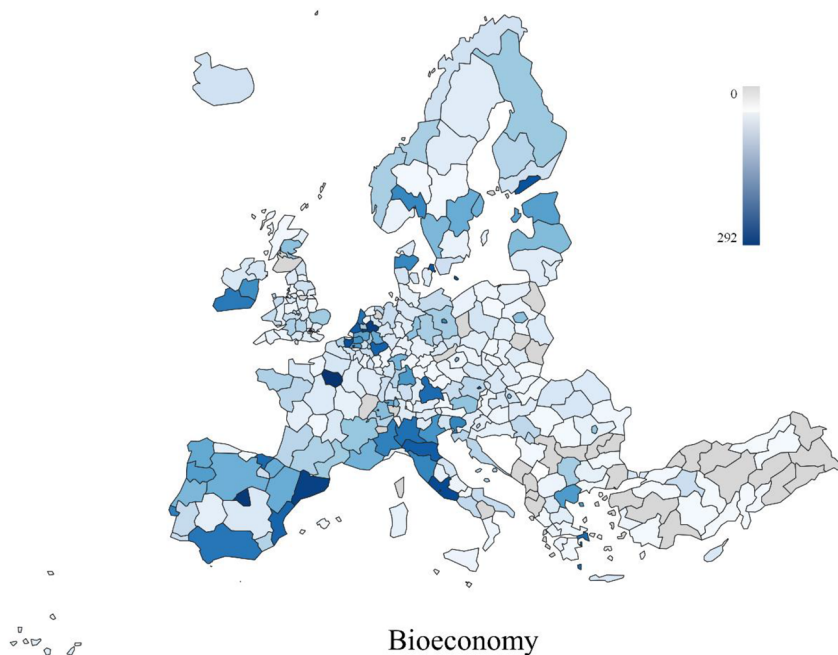
Annex 1. Horizon 2020 Calls Related to Environmental Sustainability

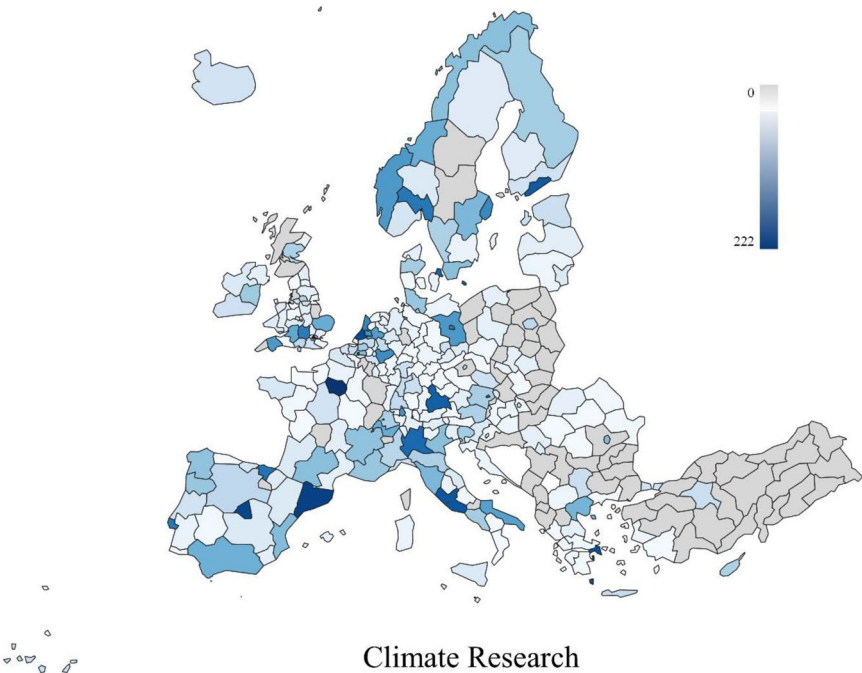
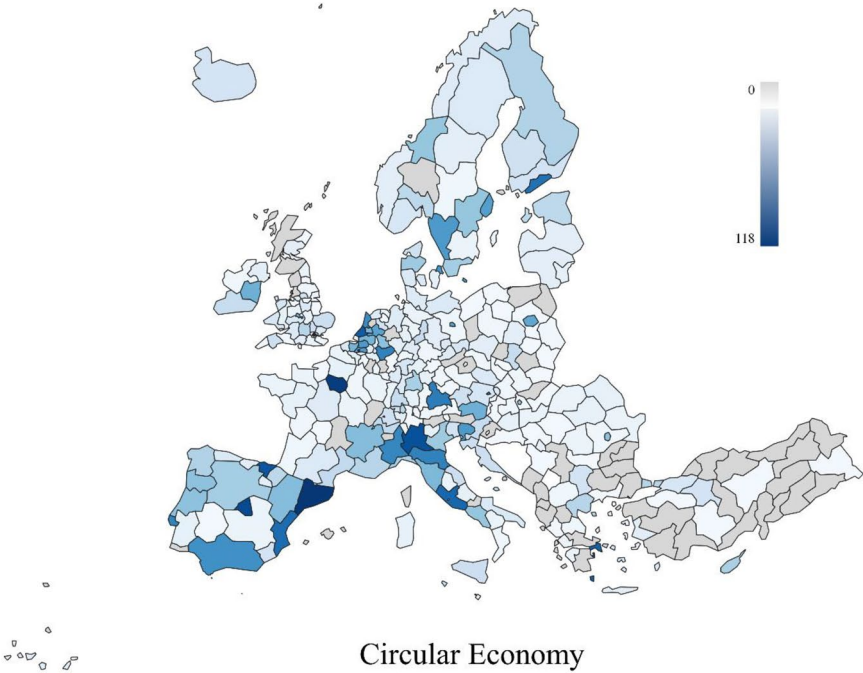
Section	Work programme	Time	Call	Topic
Excellent science	Future and Emerging Technologies	2018–2020	<i>FET proactive topics in the EIC Enhanced Pilot (2019-2020)</i>	FETPROACT-EIC-08-2020
Industrial leadership	Leadership in enabling and industrial technologies	2014–2020	<i>Factories of the Future</i>	FoF 3 – 2014
				<i>Energy-efficient Buildings</i>
				EeB 5 – 2015
				EeB 6 – 2015
				EeB 7 – 2015
				EE 2 – 2015
				<i>Sustainable Process Industries</i>
				SPIRE 2-2014
				SPIRE 4-2014
				SPIRE 6-2015
				SPIRE 7-2015
				LCE 2-2014/2015
				LCE 3-2014/2015
				EE 18-2014/2015
				Waste 1-2014
Societal challenges	Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy	2014–2015	<i>Call for Sustainable Food Security</i>	SFS-x-20xx
				<i>Call for Blue Growth: Unlocking the Potential of Seas and Oceans</i>
				BG-x-20xx
				<i>Call for an Innovative, Sustainable and Inclusive Bioeconomy</i>
				ISIB-x-20xx
		2016–2017	<i>Call Sustainable Food Security - Resilient and Resource-Efficient Value Chains</i>	SFS-xx-20xx
				<i>Call Blue Growth - Demonstrating an Ocean of Opportunities</i>
				BG-xx-20xx
				<i>Call Rural Renaissance - Fostering Innovation and Business Opportunities</i>
				RUR-07-2016
		2018–2020	<i>Call Sustainable Food Security</i>	SFS-xx-20xx
				LC-SFS-19 bis 25 - 20xx
				<i>Call Blue Growth</i>
				BG-xx-20xx
				<i>Call Food and Natural Resources</i>
				FNR-xx-20xx

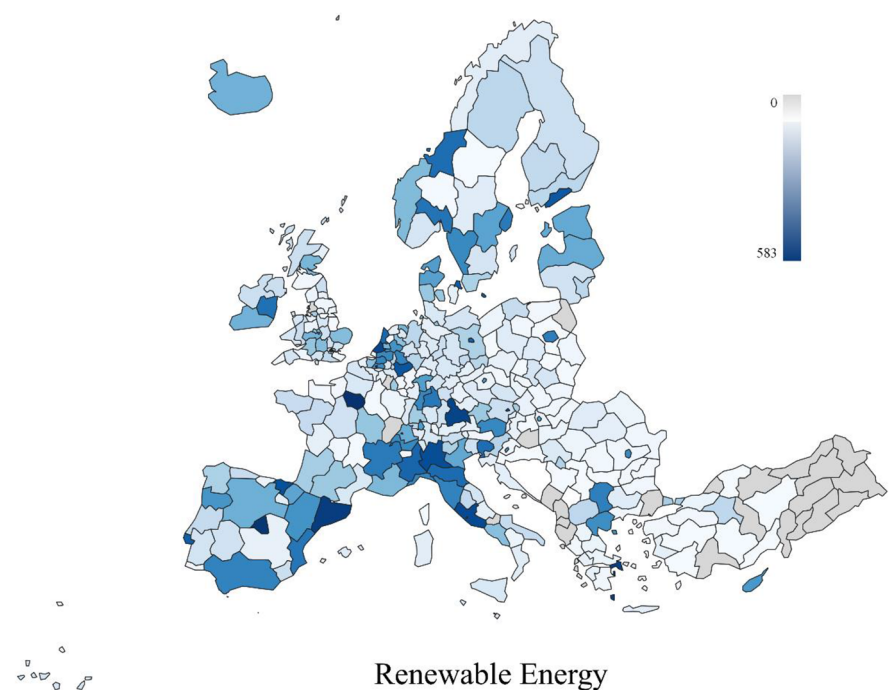
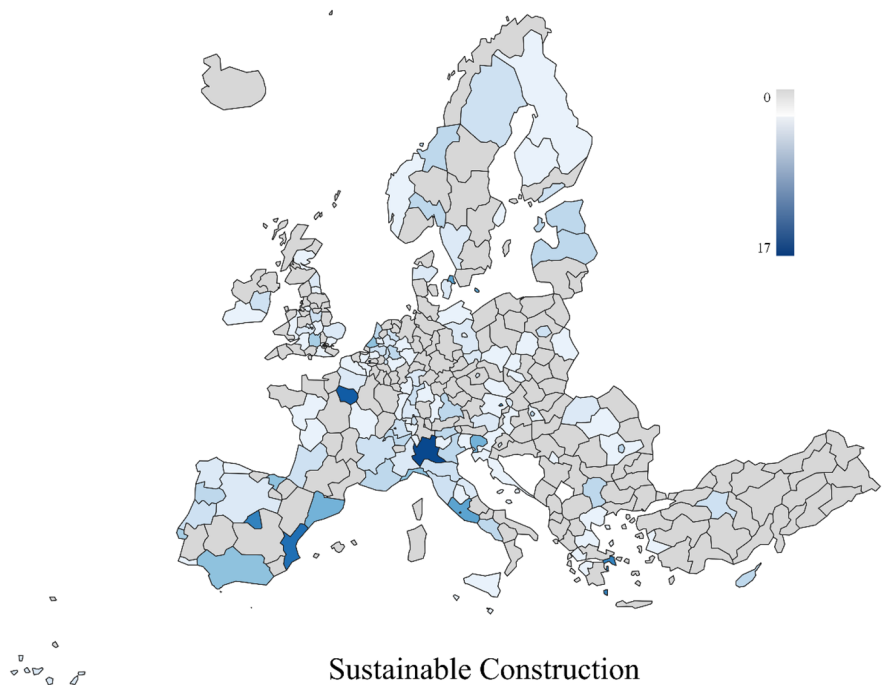
Section	Work programme	Time	Call	Topic
	Secure, Clean and Efficient Energy	2014–2015	<i>Call Energy Efficiency</i>	EE x - 20xx
			<i>Call Competitive LOW-CARBON Energy</i>	LCE - x - 20xx
			<i>Call Smart Cities and Communities</i>	SSC - x - 20xx
			<i>Call SMEs and Fast Track to Innovation for Energy</i>	SIE x - 20xx
		2016–2017	<i>Energy Efficiency Call 2016-2017</i>	EE-xx-20xx
			<i>Call Competitive Low-Carbon Energy</i>	LCE - x - 20xx
	Smart, Green and Integrated Transport	2014–2015	<i>Call Mobility for Growth</i>	MG.x.x-20xx
			<i>Call Green Vehicles</i>	GV.x.20xx
		2016–2017	<i>Call 2016-2017 Mobility for Growth</i>	MG-x.x-20xx
			<i>Call 2016-2017 Green Vehicles</i>	GV-xx-20xx
		2018–2020	<i>Call 2018-2020 Mobility for Growth</i>	LC-MG-x-x-20xx
				MG-BG-xx-20xx
			<i>Call Building a Low-Carbon, Climate Resilient Future: Green Vehicles</i>	
				LC-GV-xx-20xx

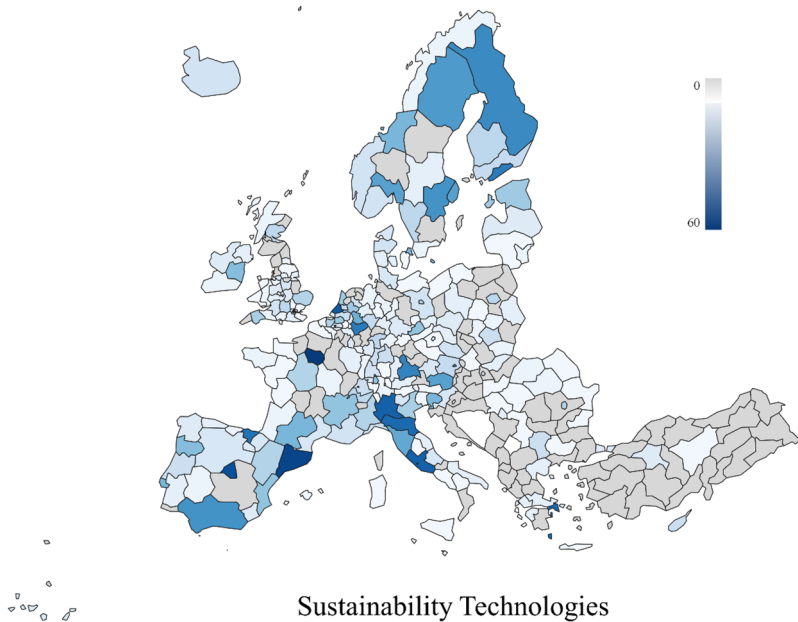
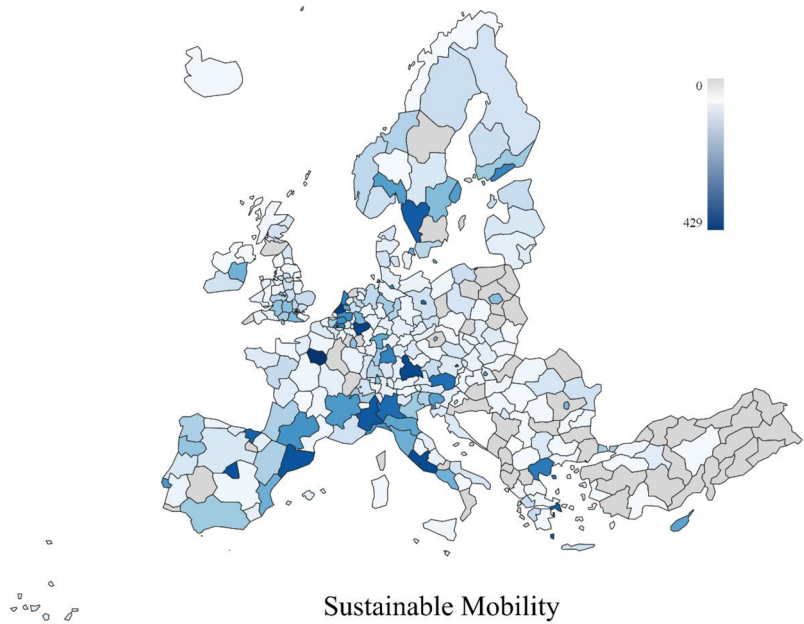
Section	Work programme	Time	Call	Topic
Europe in a changing world	Climate Action, Environment, Resource Efficiency and Raw Materials	2014–2015	<i>Call Waste: A Resource to Recycle, Reuse and Recover Raw Materials</i>	WASTE-x-20xx
				<i>Call Water Innovation: Boosting its value for Europe</i>
				WATER-x-20xx
				<i>Call Growing a Low Carbon, Resource Efficient Economy with a Sustainable Supply of Raw Materials</i>
				SC5-x-20xx
		2016–2017	<i>Call Greening the Economy</i>	SC5-xx-20xx
		2018–2020	<i>Call Building a Low-Carbon, Climate Resilient Future: Climate Action in Support of the Paris Agreement</i>	LC-CLA-xx-20xx
				<i>Call Greening the Economy in Line with the Sustainable Development Goals (SDGs)</i>
				CE-SC5-xx-20xx
	Secure societies - Protecting freedom and security of Europe and its citizens	2014–2015	<i>Call Disaster-Resilience: Safeguarding and Securing Society, Including Adapting to Climate Change</i>	DRS-9 bis 11 - 20xx
Focus areas		2018–2020		TRANSFORMATIONS-03-2018-2019
				TRANSFORMATIONS-06-2018
		2018–2020	<i>Societal Challenge 3 Secure, Clean and Efficient Energy</i>	SC3 - x - 20xx
				<i>Societal Challenge 4 Smart, Green and Integrated Transport</i>
				SC4 - x - 20xx
				<i>Societal Challenge 2 Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy</i>
				SC2 - x - 20xx
				LEIT – NMBP

Annex 2. Thematic Priorities in H2020 Projects on Environmental Sustainability, NUTS2 Level. Source: CORDIS (2022), Own Depiction









Source: CORDIS (2022), own depiction.

Annex 3. Number of Organisations Involved in H2020 Projects on Environmental Sustainability and Scientific S3 Priorities, NUTS2 Level, Source: CORDIS (2022)

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest	1246	0	1
BE21	Prov. Antwerpen	290	0	1
BE22	Prov. Limburg (BE)	50	0	1
BE23	Prov. Oost-Vlaanderen	270	0	1
BE24	Prov. Vlaams-Brabant	300	0	1
BE25	Prov. West-Vlaanderen	72	0	1
BE31	Prov. Brabant wallon	47	0	0
BE32	Prov. Hainaut	44	0	0
BE33	Prov. Liège	56	0	0
BE34	Prov. Luxembourg (BE)	4	0	0
BE35	Prov. Namur	20	0	0
BG31	Severozapaden	2	0	0
BG32	Severen tsentralen	4	0	0
BG33	Severoiztochen	16	0	0
BG34	Yugoiztochen	7	0	0
BG41	Yugozapaden	191	0	0
BG42	Yuzhen tsentralen	21	0	0
CZ01	Praha	180	1	0
CZ02	Střední Čechy	10	1	0
CZ03	Jihozápad	24	1	0
CZ04	Severozápad	16	1	0
CZ05	Severovýchod	16	1	0
CZ06	Jihovýchod	72	1	0
CZ07	Střední Morava	16	1	1
CZ08	Moravskoslezsko	13	1	0
DK01	Hovedstaden	527	1	1
DK02	Sjælland	35	1	1
DK03	Syddanmark	98	1	1
DK04	Midtjylland	202	1	1
DK05	Nordjylland	128	1	1
DE11	Stuttgart	279	1	1
DE12	Karlsruhe	179	1	1
DE13	Freiburg	121	1	1
DE14	Tübingen	48	1	1
DE21	Oberbayern	717	1	1
DE22	Niederbayern	18	1	1

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
DE23	Oberpfalz	23	1	1
DE24	Oberfranken	18	1	1
DE25	Mittelfranken	37	1	1
DE26	Unterfranken	33	1	1
DE27	Schwaben	43	1	1
DE30	Berlin	412	1	1
DE40	Brandenburg	132	1	1
DE50	Bremen	153	1	1
DE60	Hamburg	187	1	1
DE71	Darmstadt	197	1	1
DE72	Gießen	13	1	1
DE73	Kassel	36	1	1
DE80	Mecklenburg-Vorpommern	59	1	1
DE91	Braunschweig	99	1	1
DE92	Hannover	63	1	1
DE93	Lüneburg	27	1	1
DE94	Weser-Ems	86	1	1
DEA1	Düsseldorf	239	1	1
DEA2	Köln	619	1	1
DEA3	Münster	46	1	1
DEA4	Detmold	25	1	1
DEA5	Arnsberg	73	1	1
DEB1	Koblenz	10	1	1
DEB2	Trier	5	1	1
DEB3	Rhein Hessen-Pfalz	45	1	1
DEC0	Saarland	15	1	1
DED2	Dresden	87	1	0
DED4	Chemnitz	52	1	0
DED5	Leipzig	87	1	0
DEE0	Sachsen-Anhalt	55	1	1
DEF0	Schleswig-Holstein	96	1	1
DEG0	Thüringen	39	1	1
EE00	Eesti	217	1	1
IE04	Northern and Western	70	0	0
IE05	Southern	196	0	0
IE06	Eastern and Midland	311	0	0
EL30	Attiki	800	1	1
EL41	Voreio Aigaio	17	1	0
EL42	Notio Aigaio	14	1	1
EL43	Kriti	72	1	1
EL51	Anatoliki Makedonia, Thraki	13	1	1

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
EL52	Kentriki Makedonia	284	1	1
EL53	Dytiki Makedonia	16	1	1
EL54	Ipeiros	9	1	1
EL61	Thessalia	27	1	1
EL62	Ionia Nisia	3	1	1
EL63	Dytiki Ellada	45	1	1
EL64	Stereia Ellada	21	1	1
EL65	Peloponnisos	6	1	1
ES11	Galicia	167	0	0
ES12	Principado de Asturias	54	0	1
ES13	Cantabria	38	0	1
ES21	País Vasco	673	0	1
ES22	Comunidad Foral de Navarra	156	0	1
ES23	La Rioja	36	0	0
ES24	Aragón	195	0	1
ES30	Comunidad de Madrid	1111	0	1
ES41	Castilla y León	178	0	1
ES42	Castilla-la Mancha	35	0	1
ES43	Extremadura	35	0	1
ES51	Cataluña	1008	0	1
ES52	Comunitat Valenciana	382	0	1
ES53	Illes Balears	29	0	1
ES61	Andalucía	315	0	1
ES62	Región de Murcia	81	0	1
ES63	Ciudad de Ceuta	0	0	0
ES64	Ciudad de Melilla	0	0	0
ES70	Canarias	83	0	1
FR10	Île de France	1900	0	1
FRB0	Centre - Val de Loire	68	0	0
FRC1	Bourgogne	65	0	0
FRC2	Franche-Comté	0	0	1
FRD1	Basse-Normandie	25	0	1
FRD2	Haute-Normandie	16	0	1
FRE1	Nord-Pas-de-Calais	56	0	1
FRE2	Picardie	42	0	1
FRF1	Alsace	53	0	1
FRF2	Champagne-Ardenne	14	0	1
FRF3	Lorraine	26	0	1
FRG0	Pays-de-la-Loire	81	0	1
FRH0	Bretagne	122	0	1
FRI1	Aquitaine	106	0	1

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
FRI2	Limousin	8	0	1
FRI3	Poitou-Charentes	34	0	1
FRJ1	Languedoc-Roussillon	75	0	1
FRJ2	Midi-Pyrénées	201	0	0
FRK1	Auvergne	23	0	1
FRK2	Rhône-Alpes	270	0	1
FRL0	Provence-Alpes-Côte d'Azur	195	0	1
FRM0	Corse	2	0	1
FRY1	Guadeloupe	4	0	1
FRY2	Martinique	3	0	1
FRY3	Guyane	1	0	1
FRY4	La Réunion	1	0	1
FRY5	Mayotte	0	0	0
HR02	Panonska Hrvatska	8	0	0
HR03	Jadranska Hrvatska	65	1	0
HR05	Grad Zagreb	140	1	0
HR06	Sjeverna Hrvatska	18	1	0
ITC1	Piemonte	456	0	1
ITC2	Valle d'Aosta/Vallée d'Aoste	6	0	1
ITC3	Liguria	233	0	1
ITC4	Lombardia	691	0	1
ITF1	Abruzzo	29	0	1
ITF2	Molise	3	0	0
ITF3	Campania	161	0	1
ITF4	Puglia	123	0	1
ITF5	Basilicata	14	0	1
ITF6	Calabria	23	0	1
ITG1	Sicilia	47	0	1
ITG2	Sardegna	29	0	1
ITH1	Provincia Autonoma di Bolzano/Bozen	47	0	1
ITH2	Provincia Autonoma di Trento	76	0	1
ITH3	Veneto	232	0	1
ITH4	Friuli-Venezia Giulia	87	0	1
ITH5	Emilia-Romagna	403	0	1
ITI1	Toscana	297	0	0
ITI2	Umbria	43	0	0
ITI3	Marche	69	0	1
ITI4	Lazio	870	0	1
CY00	Kypros	217	1	0
LV00	Latvija	142	1	1
LT01	Sostines regionas	70	1	0

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
LT02	Vidurio ir vakaru Lietuvos regionas	49	1	0
LU00	Luxembourg	104	1	1
HU11	Budapest	216	0	0
HU12	Pest	35	0	0
HU21	Közép-Dunántúl	22	0	0
HU22	Nyugat-Dunántúl	18	0	0
HU23	Dél-Dunántúl	10	0	0
HU31	Észak-Magyarország	14	0	0
HU32	Észak-Alföld	6	0	0
HU33	Dél-Alföld	23	0	0
MT00	Malta	59	1	1
NL11	Groningen	102	0	1
NL12	Friesland (NL)	20	0	1
NL13	Drenthe	22	0	1
NL21	Overijssel	110	0	1
NL22	Gelderland	387	0	1
NL23	Flevoland	17	0	1
NL31	Utrecht	247	0	1
NL32	Noord-Holland	417	0	1
NL33	Zuid-Holland	879	0	1
NL34	Zeeland	13	0	1
NL41	Noord-Brabant	277	0	1
NL42	Limburg (NL)	83	0	1
AT11	Burgenland (AT)	14	1	1
AT12	Niederösterreich	110	1	1
AT13	Wien	562	1	0
AT21	Kärnten	22	1	1
AT22	Steiermark	291	1	1
AT31	Oberösterreich	95	1	0
AT32	Salzburg	20	1	0
AT33	Tirol	34	1	1
AT34	Vorarlberg	15	1	1
PL21	Malopolskie	62	1	1
PL22	Ślaskie	51	1	1
PL41	Wielkopolskie	57	1	1
PL42	Zachodniopomorskie	20	1	1
PL43	Lubuskie	1	1	1
PL51	Dolnoslaskie	34	1	1
PL52	Opolskie	3	1	1
PL61	Kujawsko-Pomorskie	5	1	1
PL62	Warmińsko-Mazurskie	11	1	0

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
PL63	Pomorskie	56	1	1
PL71	Lódzkie	38	1	1
PL72	Swietokrzyskie	4	1	1
PL81	Lubelskie	20	1	1
PL82	Podkarpackie	4	1	1
PL84	Podlaskie	0	1	1
PL91	Warszawski stoleczny	236	1	1
PL92	Mazowiecki regionalny	5	1	1
PT11	Norte	260	1	0
PT15	Algarve	30	1	1
PT16	Centro (PT)	129	1	1
PT17	Área Metropolitana de Lisboa	472	1	1
PT18	Alentejo	56	1	1
PT20	Região Autónoma dos Açores (PT)	27	1	1
PT30	Região Autónoma da Madeira (PT)	22	1	1
RO11	Nord-Vest	49	1	1
RO12	Centru	51	1	1
RO21	Nord-Est	24	1	1
RO22	Sud-Est	37	1	1
RO31	Sud - Muntenia	13	1	1
RO32	Bucuresti - Ilfov	254	1	0
RO41	Sud-Vest Oltenia	10	1	1
RO42	Vest	10	1	1
SI03	Vzhodna Slovenija	85	1	0
SI04	Zahodna Slovenija	330	1	0
SK01	Bratislavský kraj	84	0	0
SK02	Západné Slovensko	28	0	0
SK03	Stredné Slovensko	22	0	0
SK04	Východné Slovensko	12	0	0
FI19	Länsi-Suomi	103	0	1
FI1B	Helsinki-Uusimaa	564	0	1
FI1C	Etelä-Suomi	104	0	1
FI1D	Pohjois- ja Itä-Suomi	141	0	1
FI20	Åland	1	0	0
SE11	Stockholm	343	0	1
SE12	Östra Mellansverige	234	0	1
SE21	Småland med öarna	30	0	1
SE22	Sydsverige	128	0	1
SE23	Västsverige	351	0	1
SE31	Norra Mellansverige	32	0	1
SE32	Mellersta Norrland	16	0	1

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
SE33	Övre Norrland	103	0	1
UKC1	Tees Valley and Durham	23	0	0
UKC2	Northumberland and Tyne and Wear	65	0	0
UKD1	Cumbria	19	0	0
UKD3	Greater Manchester	92	0	1
UKD4	Lancashire	4	0	0
UKD6	Cheshire	28	0	0
UKD7	Merseyside	9	0	0
UKE1	East Yorkshire and Northern Lincolnshire	18	0	0
UKE2	North Yorkshire	34	0	0
UKE3	South Yorkshire	2	0	0
UKE4	West Yorkshire	59	0	0
UKF1	Derbyshire and Nottinghamshire	69	0	0
UKF2	Leicestershire, Rutland and Northamptonshire	57	0	1
UKF3	Lincolnshire	5	0	0
UKG1	Herefordshire, Worcestershire and Warwickshire	122	0	0
UKG2	Shropshire and Staffordshire	22	0	0
UKG3	West Midlands	148	0	0
UKH1	East Anglia	165	0	0
UKH2	Bedfordshire and Hertfordshire	69	0	0
UKH3	Essex	65	0	0
UKI3	Inner London - West	421	0	0
UKI4	Inner London - East	127	0	0
UKI5	Outer London - East and North East	66	0	0
UKI6	Outer London - South	5	0	0
UKI7	Outer London - West and North West	67	0	0
UKJ1	Berkshire, Buckinghamshire and Oxfordshire	215	0	0
UKJ2	Surrey, East and West Sussex	101	0	0
UKJ3	Hampshire and Isle of Wight	101	0	0
UKJ4	Kent	15	0	1
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	185	0	0
UKK2	Dorset and Somerset	20	0	0
UKK3	Cornwall and Isles of Scilly	8	0	1
UKK4	Devon	118	0	0
UKL1	West Wales and The Valleys	73	0	1
UKL2	East Wales	44	0	1
UKM5	North Eastern Scotland	37	0	1
UKM6	Highlands and Islands	43	0	1
UKM7	Eastern Scotland	167	0	1
UKM8	West Central Scotland	6	0	1
UKM9	Southern Scotland	4	0	1

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
UKN0	Northern Ireland (UK)	58	0	1
IS00	Ísland	131	0	0
LI00	Liechtenstein	0	0	0
NO02	Innlandet	14	0	0
NO06	Trøndelag	267	0	0
NO07	Nord-Norge	76	0	1
NO08	Oslo og Akershus (statistical region 2016)	356	0	1
NO09	Agder og Rogaland (statistical region 2016)	66	0	1
NO0A	Vestlandet (statistical region 2016)	222	0	1
NO0B	Jan Mayen og Svalbard	0	0	0
CH01	Région lémanique	218	0	0
CH02	Espace Mittelland	160	0	0
CH03	Nordwestschweiz	104	0	0
CH04	Zürich	230	0	0
CH05	Ostschweiz	42	0	0
CH06	Zentralschweiz	24	0	0
CH07	Ticino	31	0	0
ME00	Crna Gora	0	1	1
MK00	Severna Makedonija	42	0	0
AL01	Veri	0	1	0
AL02	Qender	0	1	0
AL03	Jug	0	1	0
RS11	Beogradski region	92	1	0
RS12	Region Vojvodine	49	1	0
RS21	Region Sumadije i Zapadne Srbije	5	1	0
RS22	Region Juzne i Istocne Srbije	4	1	0
TR10	Istanbul	125	0	0
TR21	Tekirdag, Edirne, Kırklareli	0	0	0
TR22	Balıkesir, Çanakkale	3	0	0
TR31	Izmir	36	0	0
TR32	Aydın, Denizli, Muğla	5	0	0
TR33	Manisa, Afyonkarahisar, Kütahya, Uşak	1	0	0
TR41	Bursa, Eskişehir, Bilecik	9	0	0
TR42	Kocaeli, Sakarya, Düzce, Bolu, Yalova	19	0	0
TR51	Ankara	103	0	0
TR52	Konya, Karaman	3	0	1
TR61	Antalya, Isparta, Burdur	4	0	0
TR62	Adana, Mersin	4	0	0
TR63	Hatay, Kahramanmaraş, Osmaniye	1	0	0
TR71	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir	1	0	0
TR72	Kayseri, Sivas, Yozgat	4	0	0

NUTS2	Region	Interregional projects	Scientific priorities	
			NUTS1	NUTS2
TR81	Zonguldak, Karabük, Bartın	0	0	0
TR82	Kastamonu, Çankiri, Sinop	1	0	0
TR83	Samsun, Tokat, Çorum, Amasya	0	0	0
TR90	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane	2	0	0
TRA1	Erzurum, Erzincan, Bayburt	1	0	0
TRA2	Agri, Kars, Iğdir, Ardahan	0	0	0
TRB1	Malatya, Elazığ, Bingöl, Tunceli	0	0	0
TRB2	Van, Mus, Bitlis, Hakkari	1	0	0
TRC1	Gaziantep, Adıyaman, Kilis	2	0	0
TRC2	Sanliurfa, Diyarbakir	0	0	0
TRC3	Mardin, Batman, Siirt	0	0	0

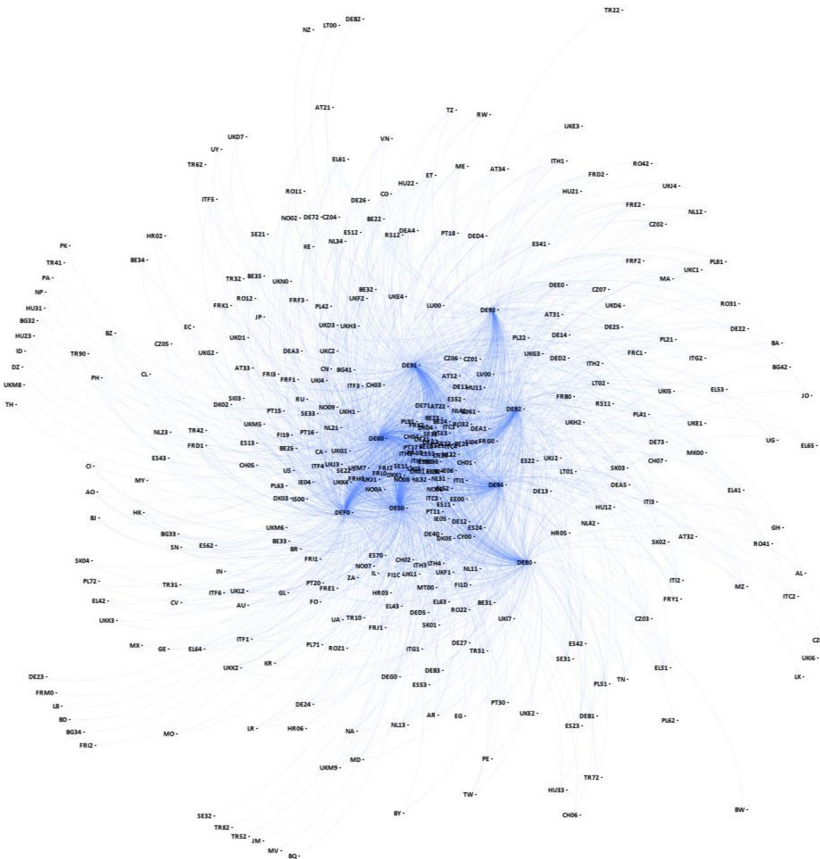
Source: CORDIS (2022); Smart Specialisation Platform (2022a, b)

Annex 4. Scientific S3 Domains Related to Environmental Sustainability

Scientific domain	Scientific subdomain
01—Exploration and exploitation of the earth	01.01—Atmosphere 01.02—Climate and meteorological research 01.07—Sea and oceans
02—Environment	(All subdomains)
04—Transport, telecommunication, and other infrastructure	04.26—Protection against harmful events in town and country planning
05—Energy	(All Subdomains)
08—Agriculture	08.72—Agriculture forestry impact on the environment

Source: Smart Specialisation Platform (2022a, b).

Annex 5. Network of Northern German Regions in Sustainability-related H2020 Projects. Source: CORDIS (2022)



Source: CORDIS (2022).

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