



Between Science, Movement, and Democracy: *Scientists for Future* in the Politics–Society Interface

Laura Herzog · Andrea Lenschow · Jan Pollex

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Abstract In the midst of the recent wave of climate activism, a group of scientists formed the initiative Scientists for Future (S4F) to support the Fridays for Future movement and emphasise the scientific evidence their activism is based on. While scientists have participated in policymaking by taking roles as advisers to policymakers in the past, forming a social movement is an unprecedented form of communicating scientific evidence. In this contribution, we assume that the S4F initiative aims to voice dissatisfaction both with prevalent decision-making processes and with the substance of these decisions. Using novel data from a survey conducted among members of this movement in the summer of 2021, we investigated their motivations and perspectives on the role of scientists in democratic processes and their attitudes about a reformist or more radical pathway towards a climate-neutral society and sustainable development. Our analysis shows that the majority of S4F members support democratic reforms rather than fundamental systemic change. Furthermore, most respondents show signs of a conviction that scientific expertise should take a superior role in climate policy rather than make room for wide participatory practices. Overall, the S4F is aimed at the diversification of political arenas to raise the impact of scientific knowledge in environmental and climate policymaking.

Keywords Climate activism · Social movement · Scientists for Future · Ecological democracy · Environmental democracy · Policy experts

Laura Herzog

Institut für Geographie, Forschungszentrum Institut für Umweltsystemforschung, Universität Osnabrück, Osnabrück, Germany
E-Mail: laura.herzog@uni-osnabrueck.de

Andrea Lenschow · ✉ Jan Pollex

Institut für Sozialwissenschaften, Universität Osnabrück, Osnabrück, Germany
E-Mail: jan.pollex@uni-osnabrueck.de

Andrea Lenschow

E-Mail: andrea.lenschow@uni-osnabrueck.de

Zwischen Wissenschaft, sozialer Bewegung und Demokratie: *Scientists for Future* an der Schnittstelle zwischen Politik und Gesellschaft

Zusammenfassung Inmitten der jüngsten Welle des Klimaaktivismus gründete eine Gruppe von Wissenschaftlern die Initiative Scientists for Future (S4F), um die Fridays-for-Future-Bewegung zu unterstützen und die wissenschaftlichen Beweise zu bekräftigen, auf denen ihr Aktivismus basiert. Während Wissenschaftler*innen in der Vergangenheit als Berater*innen von politischen Entscheidungsträger*innen an der Politikgestaltung teilnahmen, ist die Bildung einer sozialen Bewegung eine bisher beispiellose Form der Kommunikation wissenschaftlicher Erkenntnisse. Wir gehen in diesem Beitrag davon aus, dass die S4F-Initiative darauf abzielt, die Unzufriedenheit sowohl mit vorherrschenden Entscheidungsprozessen als auch mit der Substanz dieser Entscheidungen zum Ausdruck zu bringen. Anhand neuester Daten aus einer Umfrage unter Mitgliedern dieser Bewegung im Sommer 2021 untersuchen wir ihre Motivationen und Perspektiven zur Rolle von Wissenschaftlerinnen und Wissenschaftlern in demokratischen Prozessen und ihre Einstellungen zu einem reformistischen oder radikaleren Weg hin zu einer klimaneutralen Gesellschaft und nachhaltiger Entwicklung. Unsere Analyse zeigt, dass die Mehrheit der S4F eher demokratische Reformen als grundlegende Systemänderungen unterstützt. Darüber hinaus präferieren die meisten Befragten eine übergeordnete Rolle wissenschaftlicher Expertise gegenüber breiten partizipativen Praktiken. Insgesamt zielen die S4F auf die Diversifizierung der politischen Debatten ab, um den Einfluss wissenschaftlicher Erkenntnisse auf die Umwelt- und Klimapolitik zu erhöhen.

Schlüsselwörter Klimaaktivismus · Soziale Bewegung · Scientists for Future · Ökologische Demokratie · Umweltdemokratie · Politikexperten

1 Introduction

The *Fridays for Future* (FfF) movement has gained considerable public and political attention since Greta Thunberg's first school strike in 2018 (Reuters 2021). The FfF bases its demands for ambitious policy action on scientific evidence of anthropocentric global warming (Fridays for Future 2021). In support of the youth movement, German, Austrian, and Swiss scientists formed an initiative to support FfF, the so-called *Scientists for Future* (S4F). This bottom-up initiative commenced in response to a public statement published by German-speaking scientists confirming that FfF's demands are grounded in scientific evidence (Knispel de Acosta et al. 2021; Rust et al. 2022; S4F 2022a). The initiative is mainly active in Germany, comprising over 70 regional groups and nine topical working groups (S4F 2022b, c).

Such a movement of scientists is unprecedented. Traditionally, the political role of scientists is that of experts offering advice to decision-makers via ministerial working groups or parliamentary hearings. Their role may even extend beyond mere advice and into delegated decision-making powers in regulatory agencies. The S4F, in contrast, appears to take the form of a social movement complementing that of the FfF youth movement. The scientists address and mobilise the general public in

opposition to the status quo in climate policy. The question arises how the members of the S4F reconcile this “mere” role as citizens with the elitist stands often attributed to scientists in public policy processes and how this specific composition impacts the nature and activities of the group. Therefore, in this contribution, we seek to identify the main characteristics of S4F acting at the interface of science and civil society. We aim to offer valuable insights for investigating the nexus of democracy, sustainability, and science. Following this objective, we engage with the literature on the democracy–sustainability nexus and the science–politics nexus to analyse the unique features of this movement.

We chose to analyse this network of scientists from a social movement perspective. Movements, in general, emerge in response to new threats and risks (Kriesi et al. 1995; Offe 1985). Following Rootes (2004), we define *environmental* movements as “loose, non-institutionalised network[s] of organisations of varying degrees of formality, as well as individuals and groups with no organisational affiliation, that are engaged in collective action motivated by shared identity or concern about environmental issues” (p. 610). The founding of S4F is directly linked to the new wave of climate activism, in which FfF plays the leading role. A statement by Hagedorn et al. (2019) in spring 2019 sparked the scientists’ collective engagement; it refers to the FfF demonstrations and emphasises that the “*concerns of the young protesters are justified (...)*.” The S4F members participate in demonstrations, draft statements, or develop ways to communicate scientific insights. Additionally, our investigation shows that while preferring nonviolent protest forms, the S4F uses various methods to generate public pressure. Furthermore, our analysis reveals that the network of scientists relies on participation as its primary resource. While there are different organisational structures, e.g., regional or thematic groups, and moderate organisational resources, such as several part-time employees, to organise S4F activities, no professional interest group structures exist. Scientists engage in their free time and contribute their professional experience or expertise to the group’s efforts.¹ Both aspects, the forms of action and S4F’s primary resources, support the characterisation as a movement (see Diani and Donati 1999; della Porta and Diani 2020).

Our analysis addresses one of the core questions of social movement analysis. As della Porta and Diani argue, movements can be conceptualised as an expression of conflict (2020, p. 6). In this contribution, we assume that the formation of the S4F is a form to voice dissatisfaction with prevalent decision-making processes in climate policy on the one hand and with the substance of these decisions on the other hand. While scientists may provide academic insights for policy- and decision-makers, they seem to experience neglect of their positions. As a result, they seek new ways of affecting politics through collective action.

Our contribution builds on research discussing different conceptions of democracy concerning environmental protection, building on the concepts of environmental and ecological democracy, which to different degrees propose bottom-up procedures to involve the broader public in policymaking. We are interested in the motives, strategies, and both democratic and environmental visions of scientists participating in

¹ This assessment is based on part 1 of a survey conducted for this study. Although the movement’s organisational features are not fully elaborated on here, readers may refer to Annex I for an overview.

the movement and scrutinise whether, in shifting the arena, scientists aim to “participate” in the democratisation of expertise. Arguably, the literature on environmental and ecological democracy lacks a clear perspective on the role of science and scientists so far. The literature on the science–politics nexus, in turn, tends to juxtapose the role of scientists or experts with that of citizens and hence ignores the citizen role of scientists, which arguably manifests itself in the S4F movement. In short, we see the S4F movement potentially entangled in the broader debate on the relationship between democracy and sustainability on the one hand and the controversy over the role of expert knowledge in a democracy on the other hand. Therefore, three sets of research questions guide our analysis:

RQ1 What do members of S4F conceive as the appropriate policy pathway for tackling climate change? Do they advocate radical transformation or a more reformist perspective?

RQ2 Which role do S4F participants seek in the political decision-making of climate policy? Where do they position themselves on the continuum between “mere” citizens and expert elites with more exclusive access to decision-making?

RQ3 Which role do S4F participants seek to assume in the larger climate movement and vis-a-vis society as a whole?

The paper uses a survey design to study the S4F movement, investigating participants’ perspectives regarding their role in democratic processes. It provides a first exploration of this new movement and seeks to place it in the broader debates on the democracy–sustainability nexus (RQ1), and it also explores the role of expert knowledge in democracies (RQ2 and RQ3). As this analysis aims to generate hypotheses rather than to test established theories, we formulated these open research questions.

We proceed as follows: Following this introduction, offering first insights on the movement and its characteristics, we introduce the two strands of theory forming the basis of our analysis. We then present the research design and methods, covering data collection, operationalisation, and our analytical approaches, before turning to the analysis of our data. We close the paper with a discussion of our findings and their implications for the broader research on the role of scientists in the process of political opinion formation and the democracy–sustainability nexus.

2 Theoretical Foundation—Connecting Research on Democracy, Sustainability, and Experts in Democratic Processes

We base our analysis of the S4F movement on two research strands. Considering, first, the literature addressing the nexus of democracy and sustainability and, second, work on the role of experts in democratic processes, we aim to add new insights on the role and ambitions of scientists in climate policy. We suggest filling important gaps, as the literature on democracy and sustainability has so far rarely engaged with the role of science and scientists. Furthermore, existing research on the sci-

ence–policy interface mostly focuses on the professional role of experts but lacks consideration of scientists’ public activities.

2.1 Democracy and Sustainability

Reflections on the relationship between democracy and sustainability and the question of whether the first fits the accomplishment of the latter feed an ongoing debate. This debate revolves around perceived shortcomings of democracy hindering decision-makers and implementers from taking successful actions towards sustainability. These shortcomings range from aspects such as short-term electoral cycles inducing short-sighted political actions, knowledge deficits about social–ecological systems’ complexity, and power imbalances among interest groups to the decline of public trust in democratic institutions and the rise of populism (Eckersley 2020, p. 218; Wilks-Heeg 2014; Bang and Marsh 2018; Pickering et al. 2020). However, considering that nondemocratic systems fall even shorter in sustainable performance compared to democracies (for an overview, see Wilks-Heeg 2014), it is not democracy per se that constitutes a barrier to sustainable action but flawed democracy (O’Riordan 1996). In fact, key characteristics of democracy have been identified to support sustainable pathways, namely freedom of the press, transparency norms, and public information rights, facilitating open debates of citizens’ claims (Wilks-Heeg 2014).

Following up on these aspects, two ideal–typical conceptualisations of democracy, i.e., environmental and ecological democracy, have taken this debate to the next level (cf. Pickering et al. 2020). *Environmental democracy* proposes a reform of current liberal democratic systems, while *ecological democracy* more fundamentally questions the ideals, norms, and institutions of liberal democracy (Eckersley 2020, p. 215). *Environmental democracy* strives for the ecological modernisation of societies, in which policymakers and citizens revitalise norms and rules of liberal democracy and reconcile them with a to-be-reformed capitalist economic system. Its viewpoint remains anthropocentric, but it aims to foster greater public awareness of environmental issues and to engage citizens in policymaking across all levels and bodies of the government. Environmental democrats further view civil society as an active partner in bringing about environmental change, supporting civil and political rights, advocating for the rights of neglected communities, and pursuing greater accountability of policymakers (Eckersley 2020; Pickering et al. 2020).

The specification of *ecological democracy*, on the other hand, evolved in two waves. Both currents are ecocentric, valuing the respect and care for nonhumans, seeing humans as embedded within ecological relations (Eckersley 2020, p. 226), and call for the representation of future generations and nonhumans in decision-making processes (Pickering et al. 2020, p. 4). They differ with regard to envisioned institutional transformations. The first current claims that territorial borders of nations are arbitrary from an ecological standpoint (Eckersley 2020, p. 218), picking up the fact that sustainability challenges often reach across borders and have global impacts. It is argued that the capitalistic system and the multilateral state system are contributing to and perpetuating the ongoing ecological problems, justifying calls for radical transformation. Scholars particularly pointed out that economic globali-

sation has led to a separation between those actors *causing* ecological harm, those who know about it, those who are exposed to it, and those who are *formally responsible* for it, concluding that those affected must be represented in decision-making processes. Authors of the first wave, therefore, aspire to a deliberative democracy in which different types of knowledge come together, laypersons and experts share views, and expertise is generated through social learning (Eckersley 2020; Pickering et al. 2020). A new materialist current of ecological democracy goes a step further, seeking a form of deliberative democracy from below, with local publics within civil society, the building of countermovements, and the anchoring of democracy and ecological action in daily life. The objective is to actively involve those not yet committed to sustainability and motivate them to, e.g., self-organise and engage in action to address ecological issues (Eckersley 2020, p. 223).

Relating these perspectives to our research focus, both visions also contemplate environmental movements. These act within the logic of environmental democracy when they “defend (...) and utilise (...) the rights, regulative ideals and institutions of liberal democracy to win legitimacy for their environmental claims” (Eckersley 2020, p. 217). From an ecological democracy perspective, a movement that builds “around ecological concerns in everyday life is an enactment of ecological citizenship as political responsibility-taking, and a demonstrative rejection and critique of systems of ‘organised irresponsibility’ (...): markets and states” (Eckersley 2020, p. 226). *Thus, we deem the analysis of S4F as promising to gain insights into the position of this particular movement along the democracy–sustainability nexus (RQ1).*

The S4F is “particular,” of course, solely consisting of scientists, a group not highlighted in the cited literature. To better grasp the role of science and scientists in politics in general and in democracy in particular, we turn to another literature strand in the next section.

2.2 Role of Experts in Democratic Processes

The literature on the role of science and experts in politics is manifold, and we cannot thoroughly review it here. We offer a brief account of the controversy concerning experts’ role in democratic processes (see the introduction to this special issue) and then focus on the link between experts and social movements. This provides a context for our study of S4F participants, who appear to have distanced themselves from the role of experts in the inner circles of policy-making and have turned towards broader forms of participation.

The role of experts in democracies has been discussed controversially. On the one hand, experts may play a role in *rationalising* democratic decision-making, safeguarding governments from potential capture by powerful interest groups and closing capacity gaps to deal with complex issues such as climate change. While not a new phenomenon, the involvement of experts in political decision-making has increased with the complexity of problems to be addressed by state actors. This trend has culminated in calls for “better regulation,” “evidence-based” decision-making, “impact assessments,” or “evaluation” (Adelle et al. 2012; Dunlop and Radaelli 2016; Pollitt 1998, Vedung 1997)—in short, knowledge-based politics (Radaelli 1995). On the other hand, we witness rising critiques of the role of experts as undermining fun-

damental democratic standards and even falsely claiming “neutral” and “superior” problem-solving competence. For instance, Maasen and Weingart (2005, p. 2) refer to the politicisation of science and the associated loss of credibility in the public’s eyes due to, e.g., inconclusive evidence or even a complete lack thereof. Critical and interpretive policy research highlights the socially and culturally contingent dimension of expert-based political decisions (Fischer 2000; Wynne 1995). Moreover, scholarship reveals regular political (mis)use of experts and expert knowledge by policymakers who seek legitimacy for and substantiation of previous decisions and preferred solutions (e.g., Boswell 2009).

Two reform strategies follow from the critical assessment of the expert role in democracies. Some scholars call for institutional solutions to integrate expert knowledge better and thus raise the epistemic quality of democratic decision-making. Such institutional solutions may aim to increase the trust in scientists, hold them accountable, and ensure epistemic diversity (Holst and Molander 2019). Pickering and Persson suggest that experts should participate in policymaking “not only as descriptive mapmakers but also as risk advisers or ‘warning-sign posters’” (2020, p. 65) while making room for policymakers and citizen involvement in subsequent steps of policy formulation and decision-making. Others call for a more far-reaching democratisation of expertise in decision-making, suggesting that citizens, performing as lay experts, add valuable normative perspectives and local knowledge to decision-making, a perspective that corresponds to the second wave of ecological democracy scholarship. Accordingly, scientific experts would not play a privileged role in policymaking but would participate alongside normal citizens in deliberative settings aiming at more reflexive governance (Fischer 2000; Hoekema 2001). *Our analysis of S4F allows us to inquire whether and to what extent the participating scientists regard their role as experts in democratic policymaking (RQ2) or as citizens aligned with other social movement groups or laypersons participating in politics (RQ3).*

Finally, relations between social (environmental) movements and science have been discussed as always ambivalent because “science and technology are often an integral part of the ‘enemy’ against which the new social movements mobilise” (Bucchi and Neresini 2008, p. 454), advocating risky technologies ranging from nuclear energy to genetically modified organisms and being instrumentalised by particularistic economic interests (Etzkowitz 1990). On the other hand, claims of social and environmental movements and nongovernmental organisation activists have gained legitimacy by relying on scientific analyses and forecasts (Yearley 1995) and scientists taking on an advocacy role. Furthermore, political action by scientists has occurred throughout the twentieth century. In the 1960s and 1970s, social-responsibility-in-science and radical science groups emerged (Biggins 1978; Moore 2006), largely directed against mainstream science, however. The radical science movement’s criticism concerning the political instrumentalisation of (mainstream) science and against certain epistemological biases culminated in calls to democratise science and support people’s science (Moore 2006). Hess et al. (2008) suggest that the tradition of social responsibility has taken on several organisational forms. Arguably, the S4F adopts the form of “grassroots support organisations, which are social movement organisations, rather than organisations of scientists”

drawing on their expertise to develop critiques of and promote alternatives to existing government policies (2008, p. 477). *Yet we aim to produce more evidence on this organisational self-perception and situate S4F in the triangle between science, politics, and civil society (RQ2 and RQ3).*

Finally, we consider the present political context characterised by rising populism and scepticism towards evidence-based arguments that might put the S4F in a complicated position between aiming to be a grassroots social support movement and, at the same time, acting as a scientific association in its own defence.

3 Methods and Data

In our analysis, we follow an exploratory research design. We take hints from Stebbins (2001) and his definition of exploration, which emphasises the generation of insights from (qualitative and/or quantitative) data. Thus, we do not test hypotheses but rather aim to generate points of departure for future research (Faulbaum 2019; Stein 2019). In the discussion, we highlight relevant insights that could be addressed in further analyses.

3.1 Methods of Data Collection

To explore and provide an analysis of S4F Germany, we chose to use an online survey.² This survey, containing 25 questions, was in the field between July and September 2021, with the use of several mailing lists run by the S4F. Before distributing the survey, we conducted a pretest with colleagues to check the design, question wording, and overall comprehensibility. Table 1 provides an overview of the respondents.

The S4F movement understands itself as a “decentralised, self-organised movement” (S4F 2022e) and consisted at the time of the survey of 81 regional groups, six thematic working groups, a coordinating committee, an advisory board, a network support team, a technical support team, a support team for law and finances, and temporal projects and working groups (as of February 2022; for an overview, see Fig. 6 in the Appendix). While having a large number of signatories to the S4F’s initial statement indicates great interest in the initiative and broad support from the scientific community, we estimate, based on estimates from S4F members at the national level and our own projections, that around 1000 scientists became active in the groups mentioned above (S4F 2022d; Table 6 in the Appendix). The precondition for becoming active in the movement is scientific training as outlined in the charter of S4F.³ Yet there is no official membership because the movement is not a registered association.

² For the questionnaire, see Table 5 in the Appendix.

³ “Participation in S4F is open to all trained scientists who are committed to this charter and to the goals of the original S4F statement. Prerequisites for participation are academic titles (Dr., Prof., etc.) or a higher university degree (Master, Diploma, etc.) or professional contributions as (co-)author in a scientific publication” (S4F 2022e; own translation).

Table 1 Overview of respondents

Respondents	129	–
Age average	50.9 (median 52.5)	–
Gender distribution	Female: 36% Male: 61% Without indication: 3%	–
Disciplines	Natural sciences	41.8%
	Life sciences	14.7%
	Engineering	13.9%
	Social sciences	10.9%
	Interdisciplinary	10%
	Humanities	3.9%
	Other	4.7%
Affiliation	University	35.7%
	Research institutes	23.2%
	Independent researcher	14.7%
	Unemployed	3.1%
	Other	23.3%

In order to reach the members of the movement's groups, we sent our questionnaire via contact persons in the regional groups' email lists, the coordinating team email list, the advisory board email list, and the working groups email list; we sent the questionnaire directly to the network team, the technical support team, and the support team for law and finances. These email lists are not open lists that allow individual subscriptions. Rather, each active person within the movement belongs to a group or a team (e.g., a regional or working group) according to their field of activity. Therefore, these email lists are the main vehicle for internal communication used by the group members and (most frequently) coordinators. Thus, the email lists mirror a member list. However, as S4F is best characterised as a movement with somewhat fluid participation, we cannot guarantee that all active (or only active) members received the survey. Nevertheless, we are convinced that our approach of reaching out to participants generated characteristic insights into S4F. We received 310 responses, and 129 respondents (41.6% of 310) answered the essential questions needed for our analysis. Therefore, we are confident that our data provide a reasonable insight into this movement.

The S4F are organised mostly in regional groups (S4F 2022b; Table 6 in the Appendix), which corresponds to the 63% of respondents who stated they were active in such a regional group; 12% referred to thematic working groups as their main channel for participation. Moreover, 7% and 8% of participants stated they were active in the national coordination team and the advisory board, respectively. Thus, the survey appears to have attained a diverse set of participants, allowing us to comment on the organisational nature and offer differentiated insights into membership logics.

The average age of respondents was 51 years (for an overview of respondents' years of birth, see Fig. 7 in the Appendix), and most respondents (41.8%) had a background in the natural sciences, which may also explain the majority of re-

spondents identifying themselves as being male (61%) and only about a third (36%) as being female. The rather high age average may be explained by the fact that S4F was initiated by senior researchers reaching out to their peers, and young researchers either may not yet perceive themselves as sufficiently established scientists or may be engaged with other environmental movements. The biggest single cohort in our sample consisted of postdoctoral researchers (20.2%), followed by professors (14.7%) and those who indicated working in “other” fields (14%). Only 11.6% of the respondents were PhD students (Fig. 8 in the Appendix).

3.2 Operationalisation

With the survey, we sought to describe the movement, assess participants’ attitudes towards democracy and sustainability, and grasp their perception of their role as scientists in the science–democracy–policy interface. In general, our survey used closed-ended questions, which we complemented with some half-closed questions that allowed participants to add aspects not covered in the options. Furthermore, we added one open question to gather insights into participants’ viewpoints on potential reforms of democratic processes in Germany. The survey questions (SQs) were ordered to first capture and then maintain the respondents’ interest in completing the survey. That is, the survey starts by addressing motives to participate in a climate movement before turning to deeper reflections on the democracy–sustainability and the science–politics nexus, respectively. Moreover, we slowly raised the questions’ level of complexity. Therefore, the order of the SQs does not correspond to the order of our research questions (RQs), which follows an analytical logic. However, we make the link between the SQs and RQs transparent in the following paragraphs (Table 2).

Framed by sets of questions on the inner organisation of the movement and the sociodemographic background of the respondents, the core of the survey addresses the overarching research questions. First, with a set of descriptive questions (SQs 8–12), we explored the respondents’ views on the position of S4F in the larger climate movement and in society at large (RQ 3). These questions aim at learning more about the nature of the newly adopted citizens’ role of the responding scientists.

Table 2 Survey questions and their relation to our analysis

Bloc of questions	Thematic focus	Type of analysis	Analytical part and reference to research questions (RQs)
Questions 1–7	Inner structure of Scientists for Future (forms of participation and organisation)	Descriptive analysis	Identification/determination of the type of movement—RQ 3
Questions 8–12	Participants’ perspectives on the role of science within climate policy	Descriptive analysis	Role of experts in democracy—RQs 2 and 3
Questions 13–19	Participants’ positions towards democracy	Cluster analysis and descriptive analysis	Scientists for Future on the democracy-sustainability continuum—RQ 1
Questions 20–25	Demographic and socioeconomic data	Cluster analysis and descriptive analysis	All three of the above

A second set of questions (SQs 13–19) forces the respondents to position themselves with regard to the nexus between climate policy and democracy and the role of scientists in this context: On the one hand, the questions focus on identifying respondents' views on designing democracy for sustainability and adequate climate policy (RQ 1). We first asked whether respondents think democratic processes in Germany are suitable to produce adequate answers to climate change. We then posed several dichotomous questions with contrasting statements related to either the perspective of environmental or ecological democracy. Contrasting two statements allows us to identify participants' preferences (Schnell 2019) and how they align themselves with issues related to either a more reformist perspective (i.e., environmental democracy) or a transformative one (i.e., ecological democracy).⁴ On the other hand, we inquired about the participants' perspectives on the role of scientists and science in the current debate on and within climate policy. We looked into general perceptions of the scientific expert roles in policymaking and views on wider citizens' involvement in decision-making (RQ 2). In addressing society, scientists may call for greater citizen involvement and support lay expertise, or they may assume an elite role in acting as educators suggesting a “public” role of scientists. For this purpose, we used dichotomous questions again. Apart from getting a good sense of our respondents' position with respect to the larger debate, this question design allowed us to perform a cluster analysis. By encouraging participants to clearly position themselves in choosing one of two options, we aimed to identify different camps within the S4F.⁵ Those clusters are thus derived from survey participants' responses, indicating their preferences by choosing one statement over the other.

To dig deeper into the ideas of our respondents on democratic structures most suitable for dealing with climate change, we added a free-text question (SQ 14) allowing respondents to elaborate on whether they saw a need for reform of democratic processes. We used a qualitative approach to analyse the answers ($n = 102$) and coded the text segments inductively using MAXQDA. In this analytical step, we performed two independent rounds of coding and discussed the results within the research team to ensure the validity of our coding.

3.3 Methods of Data Analysis

Apart from simple descriptive statistics, we opted for a cluster analysis to identify potential subgroups within our sample ($n = 129$) that build along the respondents' attitudes towards environmental or ecological democracy (RQ 1).

Clustering is a data mining method and a numeric classification of multidimensional data. It aims to discern a “pattern (...) of similar objects within a data set of interest” (Kassambara 2017, p. 3). A cluster analysis does so by “dividing the objects into groups (clusters) of objects, such that objects in a cluster are more similar to each other than to objects in other clusters” (Wu 2012, p. 2). A cluster analysis

⁴ Some of the respondents did not answer every dichotomous question. Thus, we have a small number of missing answers (between one and 13 for four of the five questions), which we treated as neither/nor answers and which are treated as such in our cluster analysis.

⁵ Respondents were able to not answer the questions, thus indicating an ambivalent perspective.

is an approximation of an optimal division of a data set into groups (clusters) and is based on the distance measures between the data points one is interested in. Most commonly, the Euclidean distance or the Manhattan distance are used for cluster analysis (Leisch 2006, p. 526). The cluster algorithm then runs on the distance matrix of the given data set, allocating the data into clusters based on the distance between pairs of data.

For our analysis, we first ran a hierarchical cluster analysis, applying the Ward method and the Euclidean distance measure, to identify the number of clusters to be expected in our data set (Murtagh and Contreras 2012, p. 87; Murtagh and Legendre 2014, p. 275; for the dendrogram of the hierarchical cluster analysis, see Fig. 9 in the Appendix). In addition, we calculated the optimal number of clusters using the elbow method (Ketchen and Shook 1996; Nainggolan et al. 2019; see Fig. 10 in the Appendix). The elbow method indicates the best cluster value from the sum of square error value that shows an elbow-shaped decrease in the graph and has a lower value (Nainggolan et al. 2019, p. 3). Our analysis reveals an ambiguous result, as can be the case with this method (Ketchen and Shook 1996, p. 446), hinting at an optimal distribution at two clusters and another potentially optimal distribution at six clusters. Based on our research interest, we closely inspected the data and determined that with regard to the differences between respondents' positions on environmental vs. ecological democracy, three main clusters depicted differences between groups best. We performed a K-means cluster analysis (Leisch 2006, p. 531), indicating the number of clusters beforehand, which gives insights into the characteristics of the clusters (for an in-depth description of the K-means cluster analysis, see Appendix, *Background—The K-Means Cluster Analysis* and Tables 7, 8, 9, 10, and 11).

4 Analysis

4.1 S4F on the Democracy–Sustainability Continuum

To assess respondents' attitudes towards either environmental or ecological democracy, we assigned them into subgroups, also called clusters. The Ward hierarchical cluster analysis allowed us to identify the number of clusters (in our case, three), while the K-means cluster analysis sheds light on the clusters' characteristics. Table 3 shows the results of the K-means cluster analysis.

The clusters identified by our analysis show respondents to favour aspects linked to either environmental or ecological democracy. Furthermore, we can identify a third group that is rooted in an environmental democracy notion but deemphasises a merely anthropocentric perspective and, rather, adopts an *integrated* view on environmental policy and politics. This explicit focus on nature is evident in an emphasis on the well-being of animals, future generations, and nature as a whole instead of emphasising just human well-being.⁶ We further detail the clusters below.

We describe the first and largest cluster, comprising 56 respondents (43.4%), as an *integrated environmental democracy cluster*. In this cluster, respondents share

⁶ In particular, we rely on research discussing animal and multispecies justice as an element of environmental justice (see, e.g., Fitz-Henry 2022). Discussing this strand of research lies, however, beyond the

Table 3 Results of the K-means cluster analysis regarding stance on ecological democracy and on citizen councils as well as expert councils as tools to reform democratic processes

Variables on attitude towards ecological democracy, more deliberative democracy, and scientists' roles within the democratic system	Clusters and cluster centroids		
	Integrated environmental democracy cluster (1)	Transformative ecological democracy cluster (2)	Environmental democracy cluster (3)
<i>n</i> (129) /%	56/43.4%	24/18.6%	49/38%
Decisions on climate policy should be made deliberatively	0	1	0
Political measures should focus on the well-being of nature	1	0	0
The legal framework should be radically transformed	0	1	0
The economic system should be fundamentally changed	1	1	0
Consider needs of future generations, people in other world regions, and nonhuman living beings	1	1	1
Consultation of expert panels	0	0	0
Need for citizen councils that inform politics	0	1	0

a critical stance on the economic system and a mutualistic attitude towards nature, nonhuman beings, future generations, and people in other world regions.⁷ Members of this cluster do not perceive the need for substantive legal or political reforms and do not favour deliberative formats, thus lacking support for a transformational democratic agenda. Since they favour the focus on natural well-being and nonhuman living beings when considering policy instruments and general needs, we claim this cluster to represent respondents with a modified environmental democracy perspective open to integrated viewpoints.

The second and smallest cluster of 24 respondents (18.6%) we consider the *transformative ecological democracy cluster*. In addition to the items supported by cluster 1, members of this cluster strongly favour elements of deliberative democracy (including citizens councils), as do proponents of ecological democracy. Moreover, they deem it necessary to radically transform both the legal framework and the economic system.

We call the third cluster, with the remaining 49 respondents (38%), the *environmental democracy cluster*, whose members perceive little need for structural reforms of liberal democracy but aim at some substantive policy improvements in demanding responsibility towards people in other world regions and nonhuman beings. By rejecting the need for more bottom-up participation, respondents implicitly support

scope of this contribution. The term integrated is derived from the Brundtland Report (WCED 1987) detailing this notion of integrating, e.g. of future generations or wildlife into a sustainability perspective.

⁷ This set of values combines a social altruistic and biospheric orientation discussed in environmental psychology (e.g., Stern and Dietz 1994).

a status quo that assigns expert advice an institutionalised role in climate decision-making.⁸

The fact that our clusters do not match exactly the images of either ecological or environmental democracy underlines that these concepts are ideal types, which are hardly found in reality. While only a minority of the S4F members fit the ecological democracy ideal type with a clearly ecocentric perspective and the perceived need for radical political and economic transformation, most respondents support some features of this perspective and universally present social altruistic values. Yet turning to the core interest of this paper, the vast majority of the respondents (clusters 1 and 3) do not contemplate political transformation and a deliberative turn.

A look at the composition of the cluster members reveals that no specific disciplinary or professional subgroup dominates in the respective clusters, but that respondents spread unevenly across the three clusters. For instance, one might suspect that respondents in junior positions tend towards more radical positions than older respondents with secure and high-status positions. This expectation could not be supported (for a list of the distribution of respondents' different socioeconomic backgrounds within the clusters, see Table 13 in the Appendix). Similarly, we find that scientific discipline plays no unambiguous role in explaining the clustering. The fact that we find most natural scientists, life scientists, and engineers in the *integrated environmental democracy* cluster (1) may correspond to their relative dominance in political expert groups and, thus, relative scepticism regarding participatory formats. Interdisciplinary researchers and those working in the humanities and in the economic and social sciences have a larger share in cluster 2 and support ecological and political transformation. However, they are also overrepresented in cluster 3, which is most conformist with existing structures. In short, within S4F, there is no clear disciplinary stratification with respect to the democracy–sustainability nexus.

When looking at respondents' areas of activity within the movement, we see once more no evidence that organisational units match with particular clusters. While members of the national coordination team and people active in the expert council are somewhat more prone to belong to cluster 2, given the small size of this cluster it is not dominant. Yet, while we can provide only a first glimpse, we note that within the S4F movement, a deeply transformational impulse seems more likely to emerge from within the coordination team, the expert groups, or the expert council than from the ranks in the regional groups. This mirrors existing insights from movement research pointing to the crucial role of movement leadership in mobilising and shaping activities (Morris and Staggenborg 2004). For instance, movements are—generally speaking—confronted with recurring conflicts on, e.g., appropriate measures, target audiences, and core messages (Dietz 2014). In many instances, leaders “interpret relevant structural contexts and identify their weaknesses, strengths, and contradictions and make decisions about how they are to be exploited for movement purposes” (Morris and Staggenborg 2004, p. 191).

However, respondents' relative reluctance to advocate deep transformative change related to the idea of an ecological democracy is also confirmed in their general

⁸ The clusters' stances towards ecological democracy and environmental democracy are supported by the cluster analysis run solely for the ecological democracy variables (Table 12 in the Appendix).

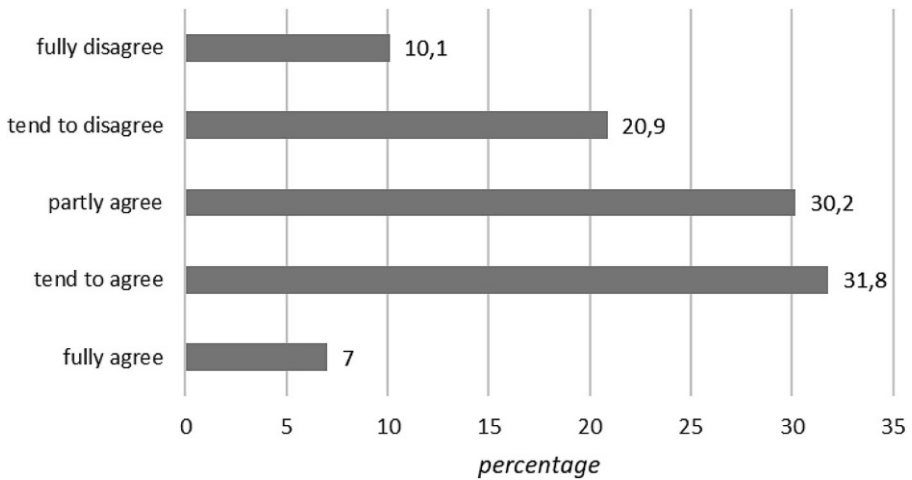


Fig. 1 The democratic processes in Germany are suitable for producing answers to the climate crisis (survey question 13, $n = 129$)

attitudes towards existing political processes. When confronted with the statement that the *democratic processes in Germany are suitable for producing answers to the climate crisis* (SQ 13), less than a third chose “tend to disagree” or “fully disagree.” Given the explorative and novel character of this analysis, we lack an adequate benchmark to interpret this finding. Taking the 2021 Eurobarometer surveying the population at large with regard to their satisfaction with democratic procedures in their country, 27% of the German population were not or rather not satisfied (Eurobarometer 2021). Although the Eurobarometer posed the question without reference to climate change, the level of dissatisfaction within S4F (31%) is only slightly higher than the level in the population at large. Correspondingly, 72% of the German population think the democracy is functioning very or rather well (while 1% answered “I don’t know”). In our survey, close to 69% of the scientists at least “partly agree” that the German democracy is functioning well. Given that in our survey we are not dealing with the population at large but with a social movement, i.e., a segment of the population protesting against the status quo, we consider the 39% of our sample who at least “tend to agree” (the top two scores on the five-score scale) that democratic processes are useful in combating climate change to be remarkably high (Fig. 1). Whether those who (tend to) disagree with the statement favour bottom-up induced change or call for more hierarchical and possibly expert-led decision-making patterns is a question that we turn to below.

4.2 Role of Experts in Democracy

Our discussion of existing scholarship on the role of science and experts in democracies pointed to three issues to consider when analysing the S4F: (1) scientists’ self-reflection on their contribution to democracy, (2) scientists’ relationship to civil society, and (3) consequences of postfactual discourses. Considering, first, the con-

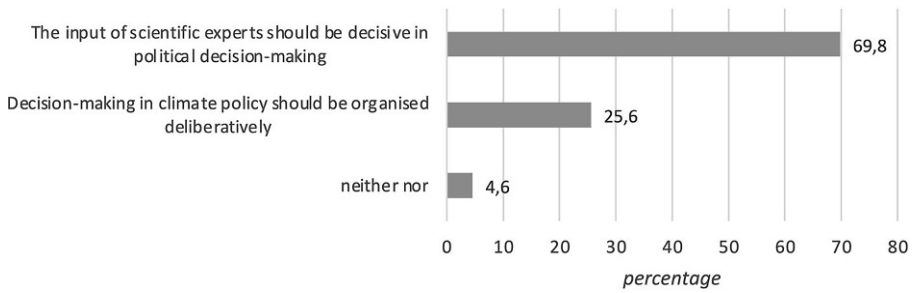


Fig. 2 Which form of decision-making do you prefer when confronted with the two statements? (Survey question 15, $n = 129$)

troversial debate on the relationship between experts and policymakers, we wondered whether members of the S4F reflect critically on the role of expertise in democratic policymaking. There is little evidence that this is the case. When asked to choose between two extreme decision-making modes in a democracy, namely expertocracy vs. deliberative democracy, a remarkable 70% opted for greater reliance on scientists, and only 25% preferred wider citizen participation (SQ 15, Fig. 2).

Further, the coded open answers rather convey the view that science does not receive enough attention in policymaking. Some respondents explicitly called for giving experts decision-making powers in climate change. Although a significant number of S4F participants also called for wider citizen participation (see below), our data offer no signs that the scientists perceive a privileged role of experts as a problem in democratic governance. In terms of civil society engagement, most S4F activists are generally active in civil society organisations. In the triangle linking science, politics, and civil society, S4F places a lot of emphasis on empowering the general public to join the fight against climate change (Fig. 3).

Here, the focus lies on information and educational activities, using the specific knowledge resources of its participants. These responses hinted at the self-perception of S4F as distinct from the general public and endowed with superior knowledge and expertise, whereas the wider public suffers from a deficit in the understanding of science (Wynne 1991, 1995). One function of the movement appears to be to close this gap by contributing to empowerment of the public.

At the very least, there exists some tension between such perception and the appreciation of lay expertise, which is being called for, especially in the critical and interpretive strands of the literature. So far, the link between S4F and civil society does not appear to be informed by these notions of a democratisation of expertise. Some open statements characterise S4F as being overly elitist, not reaching out far enough to other civil society organisations beyond the FfF movement, which is also no longer a primary addressee of S4F (Figs. 3 and 4). In this context, we also note that participants in the movement are occupied with internal communication and networking (Fig. 5); hence the scientific exchange plays a significant role in the movement's activities.

In joining a social movement, the S4F members adopted a social role outside their professional remit. While some of them claim to advise political actors (29.5%), the

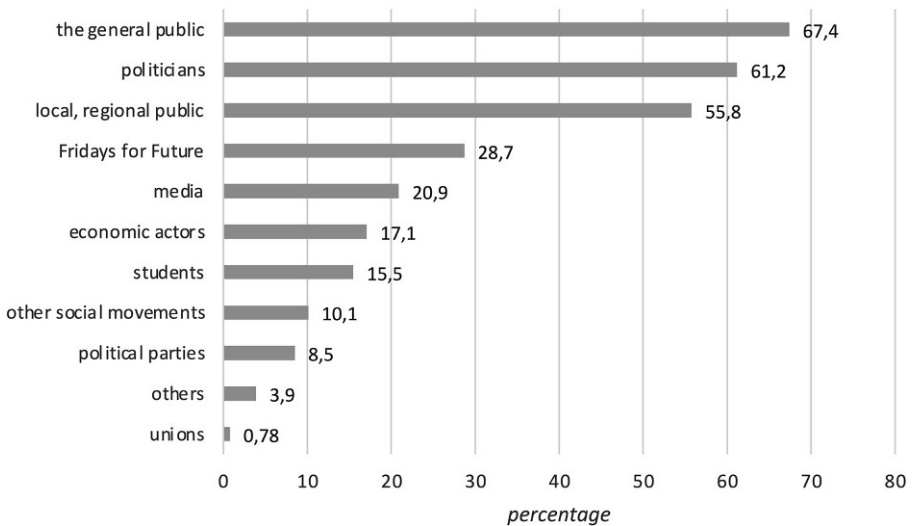


Fig. 3 What is the main reason for your engagement with the S4F? (Survey question 8, $n = 129$)

bulk of activities addressing the political level takes the form of protest action such as participation in demonstrations (mentioned by 69.8% of all respondents). This dominant protest mode indicates that political advocacy takes priority over concrete policy advice (Fig. 2). While we cannot provide a comprehensive analysis of S4F's public activities, we note that typical scientific products such as policy briefs appear to take a back seat compared to protest actions. At the same time, S4F does not appear to act in a partisan fashion because contact with political parties was considered by only 8.5% of the respondents as important (Fig. 3). Hence, our scientist-citizens largely remain politically nonpartisan while fighting for a common cause.

Finally, we hinted above that the emergence of postfactual discourses in society and politics may have undermined the alliance and identification of the scientists' movement with the public at large and instead reinforced elitist perceptions. Although several respondents in the open-text answers explicitly mentioned the need to base political decisions on facts ($n = 14$) and to withstand populist tendencies as well as "fake news," postfactual politics does not appear to have been the main motive for S4F to form. By contrast, 39 respondents called for more inclusive and direct participatory structures in political decision-making (e.g., citizen councils). However, the fact that the reverse quantitative pattern emerged in the closed questions (see Fig. 2; only 25.6% favoured deliberative structures over science-based ones) suggests considerable heterogeneity and ambiguity within the movement on the proper balance of lay and scientific expertise in climate policymaking.

A somewhat larger concern than the spread of "fake news" and populism appears to be the influence of lobbyists on political decisions: 17% of all respondents mentioned the need for greater transparency in lobbying in their answers to an open question (SQ 14) regarding factors that may explain why Germany is or is not capable of producing effective climate policies. The fact that almost 70% of those

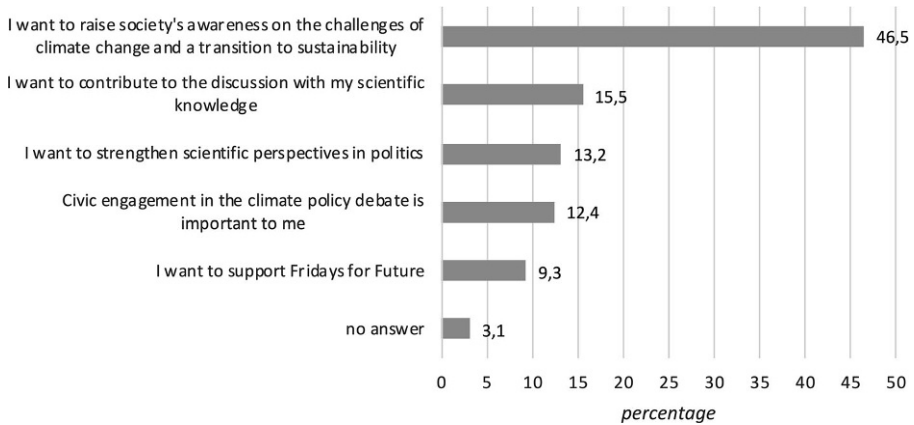


Fig. 4 What characterises your engagement with S4F? (More than one option possible; survey question 10, $n = 129$)

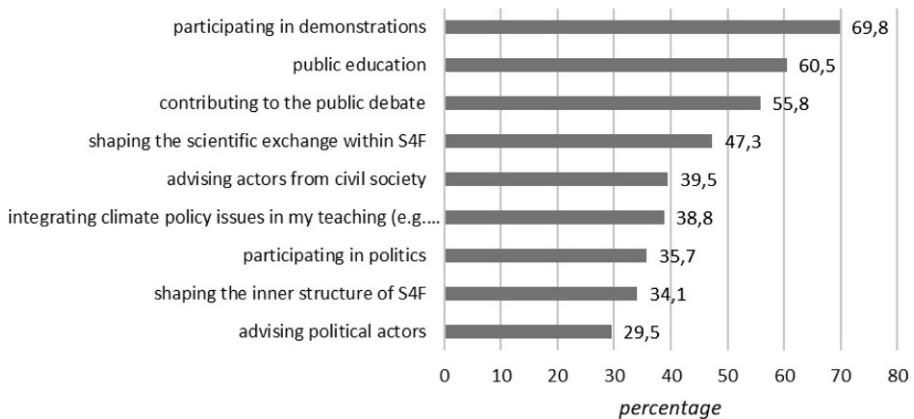


Fig. 5 Which are the most important addressees for your work with the S4F? (Survey question 9, $n = 129$)

respondents who criticised the nontransparent nature of lobbyism also stated that experts need to be heard more in decision-making (Table 4) suggests that one important motive for scientists to join S4F is rooted in disenchantment with the ineffective institutionalised access of experts to policymakers compared to a powerful business lobby. Hence, scientists feel the need to seek alternative avenues to become heard.

5 Discussion and Conclusion

This special issue set out to look into climate policy's normative and empirical implications for modern liberal democracies. To what extent are liberal democracies capable of making radical decisions that may be needed to address climate change effectively? This contribution looks at one rather specific actor group, the S4F, whose scientist members not only aim to play a decisive role in supporting

Table 4 Proportions of respondents in favour of more transparency regarding lobbying and in favour of experts' input into decision-making in climate politics

	(1) In favour of transparency in lobbying	(2) Also in favour of experts' input into decision-making	(3) Also in favour of citizen councils that should inform politics	(4) Explicitly criticise lobbying (<i>without an indicated solution</i>)
<i>n</i>	22	15	4	2
% of total N	17	11.6	3.1	1.6
% of <i>n</i> (1)	100	68.2	18.2	9.1

progressive climate policy decisions but also, by joining a social movement, position themselves closer to ordinary citizens. Whether this new role implies merely a political arena choice, reflecting on perceived deficits in the public responsiveness of existing democratic structures, or whether this role switch also goes hand in hand with the aim to democratise expertise is at the heart of this article. Based on the first survey of S4F in Germany, we inquired about the nature of the social movement and perceptions of the scientists of their role in politics and their visions of democracy.

Analytically, our contribution links research discussing the nexus of democracy and sustainability with that on the role of science in policymaking. In joining the S4F, scientists opted for new forms of advocacy combined with a new arena for participating in policymaking. In this contribution, we asked if and how this choice may be interpreted as a critique of the (German) political system and its capacity to offer adequate solutions in climate policy. More specifically, we aimed to find out whether the participants of S4F support visions of *ecological democracy*. The ecological democracy ideal type links far-reaching and systemic ecocentric transformations to equally transformative changes in democratic processes, calling for both more inclusive and deliberative participatory practices. Thus, leaving expert circles around decision-makers for political engagement in a social movement might imply support for such transformative change. However, our findings reveal that the S4F are a rather heterogeneous group with no such shared political vision. Although most scientists appear open to reflecting critically on a largely anthropocentric and often parochial outlook in climate policy, we find rather limited support for fundamental democratic change. The majority support democratic reforms rather than system change. Furthermore, the formation of this social movement must not be mistaken as general support for participatory, deliberative, or even community-based political processes. Similar to what colleagues found concerning the FfF movement (della Porta and Portos 2021), the S4F looks towards governments to fight the threat of climate change rather than hoping for local community action or general lifestyle change. While the latter might be a side effect of public empowerment efforts, the primary goal is to reinforce public pressure on the government.

This observation connects to the next question, namely the perception of the (future) role of science and scientists in politics. The survey produced hardly any evidence that S4F is committed to a deep democratisation of science. Most respondents showed signs of a conviction that scientific expertise should take a superior

role in climate policy. Yet in light of the slow responsiveness among decision-makers, this expertise shall be directed not only to the top but also increasingly to the wider public. In other words, the S4F aims at the diversification of political arenas to raise the impact of scientific knowledge in policymaking. The movement should neither be misunderstood as a collective expression of a turn towards citizens' science nor of a strategic reorientation towards bottom-up pressure politics. Indeed, we see evidence that our respondents aim to act as bridge-builders (cf. Pickering and Persson 2020), both into society and into politics. As evident in the wide range of activities mentioned, the S4F are active in the area of public education and as experts in open dialogue formats on the one hand and in classical advisory fora in the inner circles of policymaking on the other hand.

Overall, our survey hints more strongly at an implicit, yet largely democracy-friendly, elitist understanding among the S4F of their own role in that they hope to influence policymakers and facilitate the *well-informed* participation of a wider public in politics. This attitude appears to match a wider position in German society. Findings of the "Wissenschaftsbarometer 2021" not only reveal a high level of trust in science among citizens, but the average of the respondents also tends to agree (point 2 of a 5-point scale) that political decisions should rely on scientific findings, and 50% expect scientists to develop recommendations for policymakers (Wissenschaftsbarometer 2021, Tables 10 and 13).

Against the backdrop of the wider debate on sustainability, the S4F movement is evidence of a differentiation of environmental activism. As Hammond (2019, p. 68) argues, sustainability should be understood as a perpetual process in which societal reflection, e.g., on the objectives and forms of adaptation to climate change, is crucial to pave the way for transformation. In this line of argumentation, S4F members play their part in amplifying the voice of science. As our analysis shows, many participants are motivated not just by an intrinsic drive to make scientific evidence heard but also by the perception of an inadequate role science has played in the ongoing climate policy debate. This perception amplifies opinions in the wider society, which on average lean slightly towards hoping for a greater role of science in politics (Wissenschaftsbarometer 2021, Tab. 9). Overall, liberal democracy per se is not seen as the problem, but rather too-business-friendly stances of policymakers resisting the necessity to act and implement far-reaching policy measures suitable to avert a climate crisis. In this context, movements play a crucial role in rebalancing policy debates (see already Offe 1987; Rucht 1994). In our view, S4F participants play an interesting double role because they both advocate for a stronger role of science and scientists in policymaking and aim to contribute to the knowledge resources and thus empowerment of other climate advocates not limited to the FfF movement.

In this first exploration of the S4F initiative, we contribute to the growing body of research on a new wave of climate activism ranging from the largest movement, FfF, to smaller and more disruptive movements, e.g., Extinction Rebellion (see de Moor et al. 2021). While existing research has taken an interest in the core demands of FfF and their reception (e.g., Marquardt 2020; Berker and Pollex 2021, 2022) and provides first accounts of FfF's position in the long history of environmental movements (de Moor et al. 2021), the differentiation of climate activism and its

many manifestations requires in-depth research. Based on our survey, we were able to describe this scientific movement as falling predominantly into the moderate camp of activism due to its focus on strengthening the role of science in environmental policymaking and its neglect of disruptive forms of protest. Yet the identification of positional clusters also hints at some internal tension between those seeking policy improvement and corresponding reforms in public governance and those aiming at a radical transformation of both economic and political structures. We know of similar controversies within the FfF movement (Marquardt 2020). Arguably, both movements are leaning towards a nonideological, nonpartisan, and science-based “rational” discourse, aiming at their greater inclusion in political decision-making processes rather than a potentially disruptive critique of the status quo from the outside.

Future research needs to dive deeper into this movement, its political visions, and its struggles over strategy. Although our analysis rests on a solid number of respondents, we cannot draw conclusions about the whole movement. It is not only an intricate exercise to estimate the number of (regular) participants in a movement without formal membership, given the voluntary participation, but we were also not able to control for selection effects in our survey. In particular, the numbers were too small to elaborate more fully on the relationship between participants’ social backgrounds and the strategic preferences debated within the movement. Our findings point to surprisingly little influence of stratification differences within the movement; the same holds true for disciplinary identities. Future research looking at both discursive and power dynamics within the movement may be able to provide further substance or counterevidence and suggest an explanation.

We understand our inquiry as a first exploratory approach to introduce the S4F as part of climate activism sparked by the FfF movement. Continued research will need to trace S4F—and FfF, for that matter—as evolving movements adapting their strategies to current developments. We provide an analysis at a given point in time. Research should carefully monitor whether political developments, e.g., more or less ambitious climate policy or the spread of so-called fake news in society, spark a shift in forms of protests, composition of movements, or joint actions between parts of the larger climate movements.

6 Appendix

Table 5 Survey questionnaire^a

No	Question	Type of questions and additional description
1	<i>Since when are you active in the Scientists for Future (S4F)?</i>	Open question; respondents were asked to add a date (month and year) in which they started engaging with the S4F
2	<i>How did you learn about the S4F?</i> Via a work-related network (e.g., mailing lists) Via a personal network or contacts Via a colleague who asked me to join Via a demonstration Other	Closed question with the opportunity to add an answer
3	<i>How would you describe your engagement with the S4F?</i> I focus on content work I concentrate on the coordination of a group I concentrate on public relations I concentrate on fundraising I participate in meetings and events Other	Closed question with the opportunity to add an answer
4	<i>In which subgroup of the S4F are you active?</i> Topic group Regional group Advisory board Coordination team Other	Closed question with the opportunity to add an answer. Respondents were asked to select the answer best describing their main contribution in the event they were involved with more than one subgroup
5	<i>How often (virtually or digitally) do you meet with your colleagues from S4F?</i> More than once per week Once per week Once per month Less than once a month	Closed question
6	<i>For what main purpose do you meet with other members of the S4F?</i> Sharing information Preparing activities Coordination of projects Development of strategies Content work Other	Closed question with the opportunity to add an answer

Table 5 (Continued)

No	Question	Type of questions and additional description
7	<p><i>Which communication channels do you use to interact with your Scientists for Future colleagues?</i></p> <p>Mailing lists Video conferences (e.g., via Zoom) Individual communications (messaging, phone calls, meetings) Messenger groups (e.g., via WhatsApp) Communication platforms (e.g., Slack) Project managing platforms (e.g., Trello) Social media (e.g., Twitter) Other</p>	Closed question with the opportunity to add an answer
8	<p><i>What motivates you to engage with the Scientists for Future? Please rank the following aspects starting with the most important one.</i></p> <p>I want to contribute to the climate change debate with my scientific knowledge. I want to support Fridays for Future. I get involved because I want to make society aware of the challenges of climate change I am committed to making scientific perspectives more heard in the political arena. I get involved because civil society engagement in the climate protection debate is important to me.</p>	Respondents could bring the answers into an order
9	<p><i>Which addressees are the three most important for your activities at Scientists for Future?</i></p> <p>The general public The local/regional public Politicians Fridays for Future Students The media Trade unions Political parties Other social movements besides Fridays for Future Actors from the economy (e.g., trade associations, companies) Other addressees</p>	Respondents were able to rank the order of the answers
10	<p><i>Please indicate which statements apply to your involvement with Scientists for Future. You can select multiple options.</i></p> <p><i>I get involved with Scientists for Future by</i></p> <p>... participating in protest events such as demonstrations or rallies ... participating in shaping the public debate (e.g., at panel discussions, with scientific statements) ... participating in politics (e.g., launching or supporting petitions, holding political office) ... providing scientific advice to political actors ... providing scientific advice to other civil society actors (e.g., other movements) ... supporting public educational activities (e.g., in the form of lectures, workshops) ... introducing the topics of climate and environmental protection in lectures (at universities, universities of applied sciences) ... contributing to the scientific exchange within Scientists for Future ... contributing to the internal organization of Scientists for Future ... other</p>	Respondents were asked to select up to three answers; they could add aspects under “other”

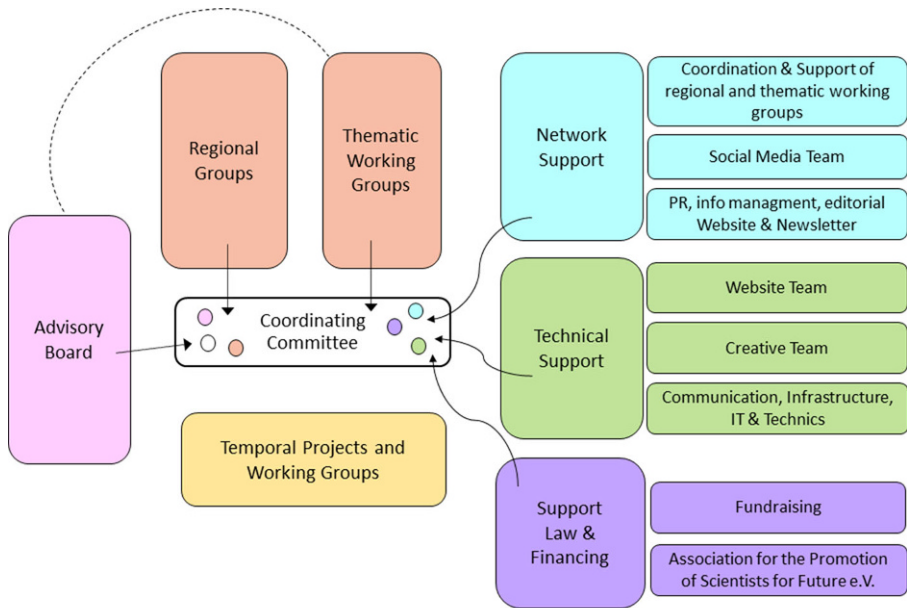
Table 5 (Continued)

No	Question	Type of questions and additional description
11	<p><i>What do you think would be important for the future work of Scientists for Future? You can select several answers.</i></p> <p>No changes are necessary. The movement should be enlarged. The content work within the movement should be intensified. The internal work structures should be expanded and solidified. The spectrum of activities should be broadened. Other</p>	Respondents were asked to select the most important aspect. If they chose "other," they were asked to specify
12	<p><i>Please indicate which of the following statements you agree or disagree with.</i></p> <p><i>As part of my commitment to climate protection, I also support the following formats:</i></p> <p>A peaceful disturbance of public life (e.g., traffic) A (symbolic) occupation of places (e.g., of forest areas) Blocking access, e.g., to company premises Resisting police measures (e.g., breaking up a demonstration) Violent forms of protest</p>	Respondents could agree or disagree with each statement separately
13	<p>Please take a position on the following statement: The democratic processes in the Federal Republic of Germany are capable of producing adequate responses to the climate crisis</p>	Respondents could reply on a five-step scale ranging from "fully agree" to "fully disagree"
14	In the following, you can explain your position.	Respondents could add their views on the topic in an open-text field
15	<p><i>Please select the statement you tend to agree with more:</i></p> <p>The assessments of experts should be decisive for political decisions in climate policy. Decisions regarding climate policy should be made deliberatively and with the involvement of as many people as possible.</p>	Dichotomous question; respondents were asked to select one of the statements
16	<p><i>Please select the statement you tend to agree with more:</i></p> <p>Policy measures for climate protection should focus on the well-being of nature. Policy measures to protect the climate should focus on the well-being of people.</p>	Dichotomous question; respondents were asked to select one of the statements
17	<p><i>Please select the statement you tend to agree with more:</i></p> <p>The existing legal framework in Germany should be reformed to change the way we deal with the environment. The existing legal framework in Germany needs to be radically transformed to change the way we deal with the environment.</p>	Dichotomous question; respondents were asked to select one of the statements
18	<p><i>Please select the statement you tend to agree with more:</i></p> <p>The existing form of market economy in Germany should be reformed to protect the environment and climate. The existing form of market economy in Germany should be fundamentally changed to protect the environment and climate.</p>	Dichotomous question; respondents were asked to select one of the statements
19	<p><i>Please select the statement you tend to agree with more:</i></p> <p>The needs and interests of future generations should be considered in decision-making processes. The needs and interests of future generations, of people in other regions of the world, and of nonhuman living beings should be taken into account in decision-making processes.</p>	Dichotomous question; respondents were asked to select one of the statements

Table 5 (Continued)

No	Question	Type of questions and additional description
20	<i>Are you involved in any other organizations?</i> Trade union Political party Nongovernmental organisation (NGO)/association No other membership Other	Closed question; respondents could add an answer under “other”
21	<i>What is your current professional position?</i> Doctoral student Postdoctoral/scientist after doctorate Professor Lecturer (Lehrkraft für besondere Aufgaben) Consultant Other	Closed question; respondents could add an answer under “other”
22	<i>Where are you currently employed? Please indicate your main job.</i> University University of applied sciences Research institute Self-employed Without employment Other	Closed question; respondents could add an answer under “other”
23	<i>With which of the following disciplines do you associate most closely? Please indicate your current focus of work.</i> Humanities (e.g., ancient cultures, history, theology) Economic and social sciences (e.g., sociology, political science, economics, law) Life sciences (e.g., biology, medicine, neuroscience) Natural sciences (e.g., physics, chemistry, geography) Engineering sciences (e.g., material sciences, production engineering, computer science) Interdisciplinary focus Other	Closed question; respondents could add an answer under “other”; selection based on the DFG’s (Deutsche Forschungsgemeinschaft) disciplinary groups
24	Please indicate your year of birth.	–
25	<i>Please indicate the gender to which you feel you belong.</i> Diverse Female Male Other	Closed question

^aThe survey was conducted in the German language. Here, we provide a translation by the authors



Note: arrows indicate delegation to the coordinating committee

Fig. 6 Structure of the Scientists for Future movement in Germany (adapted from Knispel de Acosta et al. 2021, p. 3; own translation)

Table 6 Participation in substructures of the Scientists for Future movement (as of February 2022)

Type of group	People engaged (optimistic estimates)
Advisory board	120
Coordinating committee	15
Network support	5
Regional groups (81)	$81 \times 10 = 810$
Support law and financing	3
Technical support	5
Temporal projects and working groups	?
Thematic working groups (6)	$6 \times 7 = 42$
Estimation of the movement's size	1000

Some people were active in more than one group, so duplications occurred

6.1 Background—The K-Means Cluster Analysis

The data set for our cluster analyses—the Ward hierarchical cluster analysis and the K-means cluster analysis—is the bloc of dichotomous questions on the respondents' attitudes towards environmental and ecological democracy, respectively (survey questions 15–19; see also Table 2 in the manuscript); the data are thus binary.

We further converted two response types of the open-ended question (survey question 14) into two additional variables that were also dichotomous: the respondents' statement that more citizen councils are needed in climate policy and their

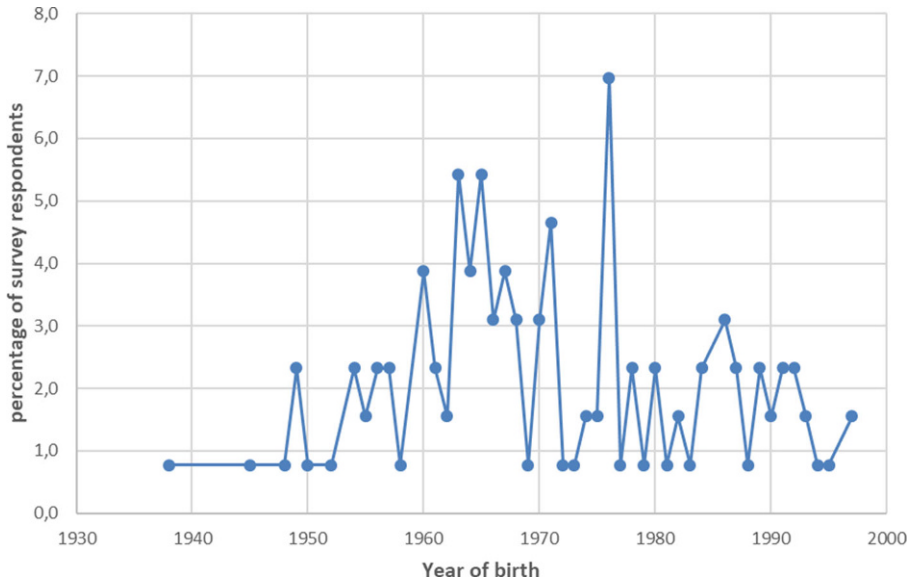


Fig. 7 Frequency of year of birth of survey respondents in % ($n = 129$; years 1938 to 1997)

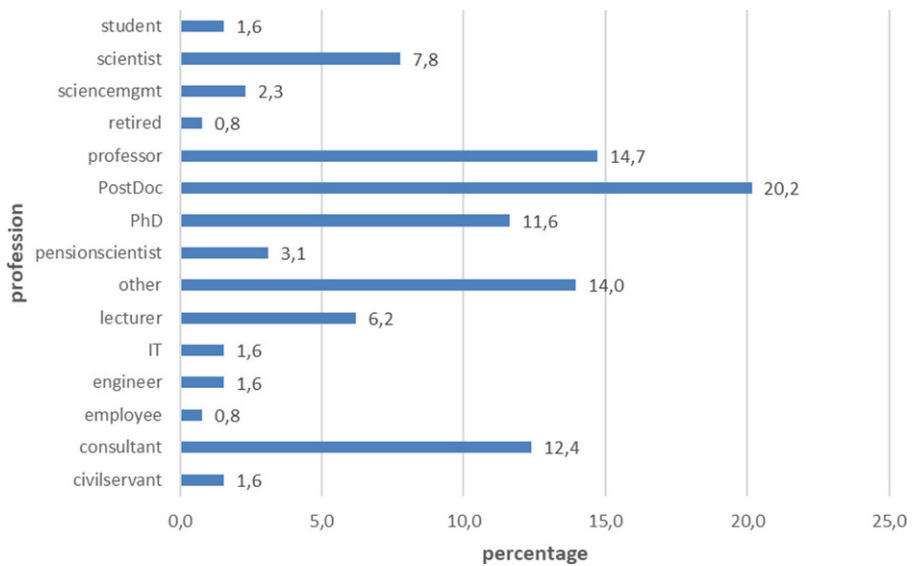


Fig. 8 Frequency of profession of survey respondents in % ($n = 129$)

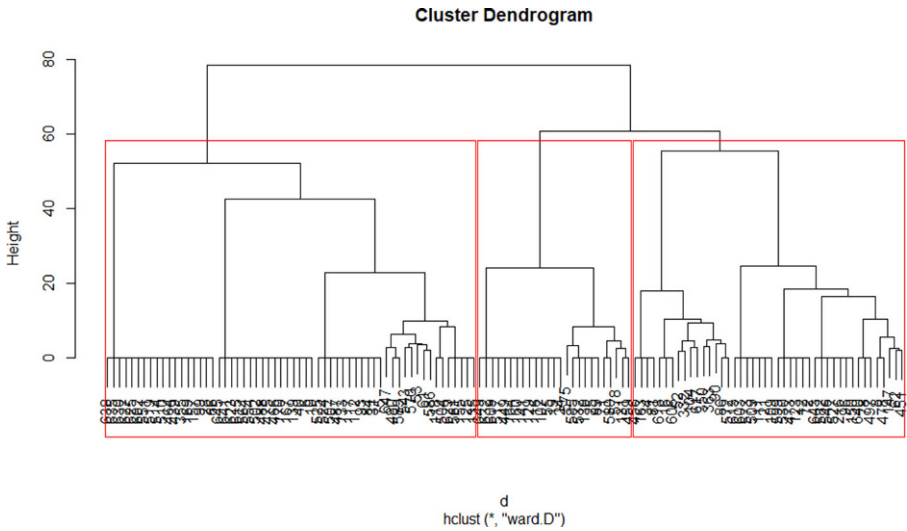


Fig. 9 Cluster dendrogram of the hierarchical cluster analysis with Ward linkage highlighting the three clusters of interest; computed in RStudio

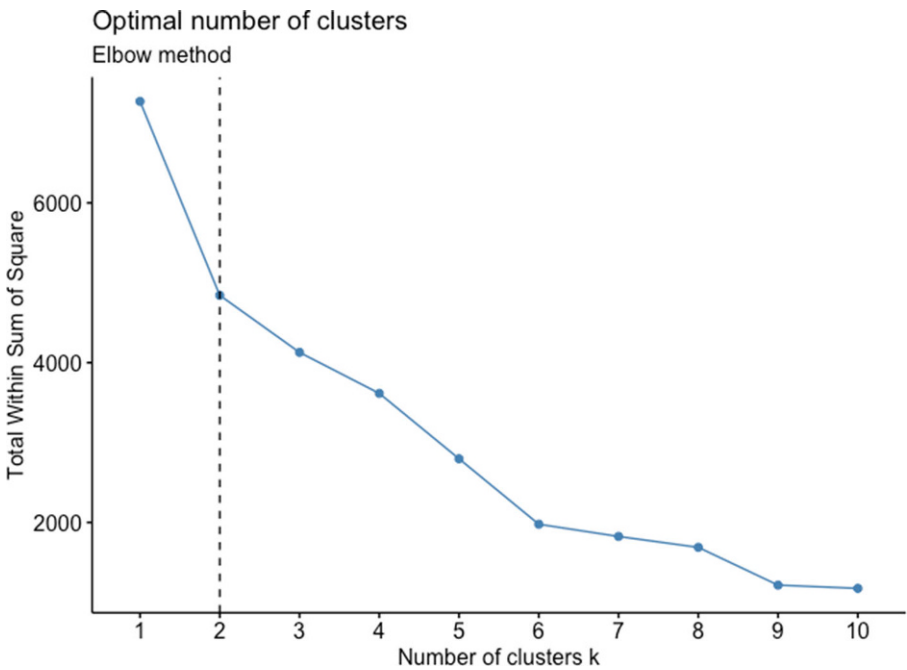


Fig. 10 Optimal number of clusters using the elbow method; computed in RStudio

Table 7 Notes on the K-means cluster analysis run in SPSS Statistics based on the five variables on ecological democracy, the variable *pro citizen council*, and the variable *pro expert panel*

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Comments		–
Input	Data	C:\Users\xxx\Documents\Meine Bibliothek\Paper Sustain-Democracy-Nexus\data analysis\cluster data 2021-12-09.sav
	Active data set	DataSet1
	Filter	<none>
	Weighting	<none>
	Split file	<none>
	Number of lines in the work file	129
Treatment of missing values	Definition for “missing”	User-defined missing values are treated as missing
	Cases used	Statistics are based on cases with no missing values for any variable used
Syntax		QUICK CLUSTER Deliberat FocusNat LegalFrameTrans EconTrans FutGenNonhuman PrioChangeExpertpanel PrioChangeCitizenCouncil /MISSING=LISTWISE /CRITERIA=CLUSTER(3) MXITER(10) CONVERGE(0) /METHOD=KMEANS(NOUPDATE) /SAVE CLUSTER /PRINT ID(Profession) INITIAL CLUSTER DISTAN

Table 8 Initial cluster centres

	Cluster		
	1	2	3
Deliberat	0	1	1
FocusNat	1	1	0
LegalFrameTrans	0	1	0
EconTrans	1	1	0
FutGenNonhuman	1	1	0
PrioChangeExpertpanel	1	0	0
PrioChangeCitizenCouncil	0	1	0

statement that the assessments of experts in the form of expert panels and advisory boards should have a strong weight in political decisions on climate policy. The first variable is a further indication of a respondent’s stance on more deliberative democracy and thus on ecological democracy; at the same time, it hints at a nonelitist self-perception. The latter hints at a respondent’s perception of an elitist role for scientists within the democratic system.

Table 9 Iteration protocol^a

Iteration	Change in cluster centres		
	1	2	3
1	1.008	0.766	1.017
2	0.064	0.144	0.045
3	0.095	0.126	0.086
4	0.093	0.059	0.120
5	0.000	0.000	0.000

^aConvergence was achieved due to little or no change in cluster centres. The maximum modification in absolute coordinates for each centre is 0.000. The current iteration is 5. The minimum distance between initial centres is 2.000

Table 10 Cluster affiliation

Case number	Profession	Cluster	Distance	Case number	Profession	Cluster	Distance
1	Other	1	1.060	27	PostDoc	3	1.173
2	IT	2	0.877	28	Consultant	1	1.432
3	PostDoc	1	0.581	29	PhD	2	1.010
4	Lecturer	3	0.734	30	Pensionscientist	3	1.155
5	Consultant	2	1.361	31	Consultant	1	1.141
6	Professor	3	0.522	32	Scientist	1	1.737
7	PhD	2	0.660	33	PhD	3	0.522
8	PhD	3	0.522	34	Pensionscientist	2	1.010
9	Professor	3	0.930	35	PostDoc	2	0.660
10	PhD	1	0.718	36	Engineer	1	0.766
11	Employee	1	0.766	37	Lecturer	3	0.885
12	Other	3	1.119	38	Retired	2	1.010
13	PhD	1	0.581	39	Consultant	3	1.073
14	Consultant	3	0.994	40	PostDoc	3	1.024
15	Other	3	0.522	41	PhD	1	0.875
16	Professor	3	0.522	42	PostDoc	3	0.522
17	Consultant	1	0.766	43	PostDoc	3	0.930
18	Scientist	2	0.923	44	Scientist	3	0.522
19	PostDoc	1	0.718	45	Other	1	0.766
20	IT	3	0.885	46	PhD	1	0.875
21	PostDoc	3	1.024	47	Lecturer	1	0.581
22	Professor	1	0.766	48	PostDoc	3	0.522
23	Consultant	3	1.063	49	Civilservant	2	0.923
24	Other	3	1.328	50	Scientist	3	1.155
25	PostDoc	1	0.766	51	Scientist	1	0.875
26	PostDoc	1	1.125	52	Consultant	1	0.718
53	Consultant	3	0.522	93	Other	1	0.718
54	Lecturer	3	1.119	94	PostDoc	1	0.581
55	PostDoc	3	0.885	95	PostDoc	2	0.776
56	Professor	1	0.581	96	Consultant	1	0.581
57	Scientist	2	0.967	97	Other	1	0.581

Table 10 (Continued)

Case number	Profession	Cluster	Distance	Case number	Profession	Cluster	Distance
58	Scientist	1	0.581	98	Consultant	1	1.125
59	Sciencemgmt	3	1.155	99	Other	2	0.660
60	Professor	3	0.994	100	PhD	3	0.930
61	Lecturer	1	1.231	101	Scientist	3	0.930
62	PhD	1	0.718	102	Other	3	0.885
63	Professor	2	1.478	103	Professor	2	0.923
64	Other	2	1.298	104	Other	3	1.173
65	PostDoc	3	0.522	105	Professor	1	0.766
66	PhD	1	1.141	106	Consultant	2	1.163
67	Pensionscientist	3	1.119	107	PostDoc	3	0.734
68	Other	3	0.522	108	Professor	1	1.141
69	PostDoc	2	0.967	109	Sciencemgmt	2	1.010
70	PostDoc	1	0.581	110	PhD	1	1.156
71	PostDoc	3	0.734	111	Professor	3	0.522
72	Consultant	1	0.581	112	Consultant	2	0.660
73	Other	2	1.163	113	PostDoc	1	0.581
74	Professor	1	0.875	114	PhD	3	1.668
75	Lecturer	1	0.766	115	Professor	1	1.156
76	Other	1	1.060	116	Student	1	0.581
77	Consultant	3	1.281	117	Student	2	0.967
78	Pensionscientist	1	0.581	118	PostDoc	1	1.141
79	PhD	3	1.073	119	Scientist	1	0.875
80	Professor	1	0.766	120	PostDoc	1	0.718
81	Other	2	1.010	121	Consultant	3	0.522
82	PostDoc	1	0.718	122	PhD	1	0.718
83	Other	1	0.718	123	Engineer	2	1.298
84	Professor	3	1.091	124	Scientist	3	1.063
85	PostDoc	1	0.718	125	PostDoc	1	0.581
86	Professor	1	0.766	126	Lecturer	2	0.923
87	Professor	1	0.766	127	Sciencemgmt	1	0.581
88	Other	3	1.155	128	Civilservant	1	0.875
89	Lecturer	3	0.734	129	PostDoc	3	0.885
90	Professor	3	1.173	–	–	–	–
91	Other	1	0.766	–	–	–	–
92	Professor	3	1.155	–	–	–	–

Table 11 Distance between cluster centres of the final solution

Cluster	1	2	3
1	–	1.046	1.119
2	1.046	–	1.264
3	1.119	1.264	–

Table 12 Results of the K-means cluster analysis regarding stance on ecological democracy

Variables on attitude towards ecological democracy	Clusters and cluster centroids		
	Integrated environmental democracy cluster (1)	Transformative ecological democracy cluster (2)	Environmental democracy cluster (3)
<i>n</i> (129) /%	36/27.9%	40/31%	53/41.1%
Decisions on climate policy should be made deliberatively	0	0	0
Political measures should focus on the well-being of nature	1	1	0
The legal framework should be radically transformed	0	1	0
The economic system should be fundamentally changed	1	1	0
Consider needs of future generations, people in other world regions, and nonhuman living beings	1	1	1

Cluster 1 The integrated environmental democracy cluster: no need to transform the legal framework, and an implicit focus on the importance of experts for decision-making in climate politics

Cluster 2 The transformative ecological democracy cluster: an implicit focus on the importance of experts for decision-making in climate politics

Cluster 3 The environmental democracy cluster: an explicit claim to also consider the interests and needs of people in other world regions and of nonhuman living beings

Table 13 Socioeconomic background of people in each cluster

Socioeconomic background	Cluster			Total
	1	2	3	
	56/43.4%	24/18.6%	49/38%	129
	Number of persons/% of subgroup's total number / % of people in the cluster			
<i>Profession</i>				
Civil servant	1/50% / 1.8%	1/50% / 4.2%	0	2
Consultant	7/43.75% / 12.5%	3/18.75% / 12.5%	6/37.5% / 12.2%	16
Engineer	1/50% / 1.8%	1/50% / 4.2%	0	2
Information technology	0	1/50% / 4.2%	1/50% / 2%	2
Lecturer	3/37.5% / 5.4%	1/12.5% / 4.2%	4/50% / 8.2%	8
PhD	8/53.3% / 14.3%	2/13.3% / 8.3%	5/33.3% / 10.2%	15
Postdoctoral researcher	12/46.2% / 21.4%	3/11.5% / 12.5%	11/42.3% / 22.4%	26
Professor	9/47.4% / 16.1%	2/10.5% / 8.3%	8/42.1% / 16.3%	19
Retired	1/20% / 1.8%	2/40% / 8.3%	2/40% / 4.1%	5

Table 13 (Continued)

Socioeconomic background	Cluster			Total
	1	2	3	
	56/43.4%	24/18.6%	49/38%	129
	Number of persons/% of subgroup's total number / % of people in the cluster			
Science management	1/33.3% / 1.8%	1/33.3% / 4.2%	1/33.3% / 2%	3
Scientist ^a	4/40% / 7.1%	2/20% / 8.3%	4/40% / 8.2%	10
Student	1/50% / 1.8%	1/50% / 4.2%	0	2
Other	8/42.1% / 14.3%	4/21.1% / 16.6%	7/36.8% / 14.3%	19
<i>Employer</i>				
Administration	1/33.3% / 1.8%	2/66.6% / 8.3%	0	3
Company	3/42.9% / 5.4%	0	4/57.1% / 8.2%	7
Industry	2/28.6% / 3.6%	1/14.3% / 4.2%	4/57.1% / 8.2%	7
Research institute	11/36.6% / 19.6%	9/30% / 37.5%	10/33.3% / 20.4%	30
Retirement	1/25% / 1.8%	2/50% / 8.3%	1/25% / 2%	4
Self-employed	9/47.4% / 16.1%	4/21.1% / 16.6%	6/31.6% / 12.2%	19
Unemployed	4/100% / 7.1%	0	0	4
University of applied sciences	3/37.5% / 5.4%	0	5/62.5% / 10.2%	8
University	18/46.2% / 32.1%	5/12.8% / 20.8%	16/41% / 32.7%	39
Other	4/50% / 7.1%	1/12.5% / 4.2%	3/37.5% / 6.1%	8
<i>Discipline</i>				
Economic and social sciences	4/28.6% / 7.1%	4/28.6% / 16.6%	6/42.8% / 12.2%	14
Energy	0	0	2/100% / 4.1%	2
Engineering	9/50% / 16.1%	2/11.1% / 8.3%	7/38.9% / 14.3%	18
Humanities	1/20% / 1.8%	1/20% / 4.2%	3/60% / 6.1%	5
Interdisciplinary	4/30.8% / 7.1%	3/23% / 12.5%	6/46.2% / 12.2%	13
Life sciences	12/63.2% / 21.4%	2/10.5% / 8.3%	5/26.3% / 10.2%	19

Table 13 (Continued)

Socioeconomic background	Cluster			Total
	1	2	3	
	56/43.4%	24/18.6%	49/38%	129
	Number of persons/% of subgroup's total number / % of people in the cluster			
Natural sciences	26/48.1% / 46.4%	9/16.6% / 37.5%	19/35.2% / 38.8%	54
Other	0	3/75% / 12.5%	1/25% / 2%	4
<i>Area of activity at Scientists for Future</i>				
Coordination team	2/22.2% / 3.6%	3/33.3% / 12.5%	4/44.4% / 8.2%	9 ^b
Expert council	3/30% / 5.4%	3/30% / 12.5%	4/40% / 8.2%	10
Expert groups	6/37.5% / 10.7%	3/18.75% / 12.5%	7/43.75% / 14.3%	16
Regional groups	39/48.1% / 69.6%	11/13.6% / 45.8%	31/38.3% / 63.3%	81
Other ^c	6/46.2% / 10.7%	4/30.8% / 16.6%	3/23% / 6.1%	13

^aThe category “Scientist” refers to persons who have a university degree or a PhD and work in the industry, at a research institute, or as a freelancer

^bAs 15 people are part of the national coordination team, our survey covers 60% of them

^cThe category “Other” here covers persons engaged in other teams within the movement, for instance the information technology team or the Association for the Promotion of Scientists for Future e. V.

In the K-means cluster analysis, the distance measure of each respondent is calculated based on the variables deployed. The algorithm then detects the initial value for each cluster—the number of clusters being indicated beforehand—based on the number of observations, i.e., respondents with their distance value, with minimum distance. All other observations are assigned given their distance to the cluster’s initial value. The initial value is reiterated based on the observations newly assigned to the cluster until the final cluster centroid is determined. Respondents are thus grouped into a cluster based on their minimal distance or, put differently, their similarity to the cluster’s centroid (Ordóñez 2003, p. 13).

Table 8 depicts the initial cluster centroids resulting from the variables of interest, Table 9 indicates the iteration of the cluster centroids, Table 10 lists the respondents’ distance value and cluster affiliation, and Table 11 shows the distance between the cluster centroids. The values of the examined dichotomous variables that come into play within a cluster are presented in Table 3 in the manuscript (Ordóñez 2003).

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Conflict of interest L. Herzog, A. Lenschow, and J. Pollex declare that they have no competing interests.

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