Modeling and understanding social–ecological knowledge diversity

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Abstract
The concept of social–ecological knowledge diversity (SEKD) provides a novel way of examining coupled human–environment interactions—it acknowledges differences in knowledge, values, and beliefs of stakeholder groups within social–ecological systems (SES). Thus, understanding and measuring SEKD is an essential component of sustainable management with implications for conflict resolution, collective action and policymaking. However, methods to efficiently define and model knowledge diversity are still underdeveloped. Using a semiquantitative cognitive mapping approach, we collected and analyzed stakeholder-specific knowledge and perceptions of the Western Baltic cod fishery to model SEKD. Results demonstrate substantial variation in perceptions across different individuals and social groups. SEKD was evident in (a) distinctive meanings attached to social factors relative to ecological factors, (b) causal relationships underlying the understanding of SES dynamics, and (c) social impacts of ecological changes on ecosystems (and vice versa). By identifying and representing knowledge-specific disparities in SES frameworks, our model explicitly improves the understanding of human–environment interactions with implications that could help reduce conflicts and legitimize management plans.

KEYWORDS
Baltic Sea, cod, fuzzy cognitive mapping, knowledge diversity, mental models, natural resource management, scenario analysis, social–ecological system, stakeholder engagement

1 | INTRODUCTION

Understanding the different ways in which human communities interact with ecosystems, and how these interactions influence unique perceptual and behavioral feedbacks between social and ecological systems (SES) provides a means to better manage natural resource systems used by multiple groups of stakeholders (Binder, Hinkel, Bots, & Pahl-Wostl, 2013; Sterling et al., 2017). We refer to this as social–ecological knowledge diversity (SEKD). Human communities construct their specific shared knowledge systems, as well as beliefs and values about the environment which surrounds them, depending on how they interact with these environments. Such shared knowledge systems, beliefs, and values influence how specific social groups perceive and react to real or
anticipated changes. These can be either environmental impacts of social changes or the societal (or cultural-specific) impacts of environmental changes. Furthermore, these shared knowledge systems are thought to be reflected in peoples’ mental models of SES, providing insight into how perceptions and behavior are shaped by their interaction with natural and social habitats (Aminpour et al., 2020; Oishi & Graham, 2010). To understand and model SEKD, however, we first need to consider various ways in which different communities interact with nature and how their distributed knowledge defines the social space of which they are a part.

Understanding SEKD across individuals and groups can provide insights into why collective action toward sustainability goals may fail. This is because the perceptions and cultural values attached to the structure and function of a SES differ across various stakeholder groups (Adams, Brockington, Dyson, & Vira, 2003; Linke & Jentoft, 2016; Manfredo et al., 2017). Further, such differences may lead to conflicts, by creating mistrust that may result in unaccepted management decisions and potentially limiting the implementation of sustainability policies (Adams et al., 2003; Biggs et al., 2011; Burns & Stöhr, 2011; EC, 2013; King, Cavender-Bares, Balvanera, Mpwapamba, & Polasky, 2015; Naranjo-Madrigal & van Putten, 2018). These conflicts can be attributed to the different ways stakeholders perceive the structure and function of natural resource systems, which in turn influences the perception of how and to what extent resource systems respond to management measures (Game et al., 2016; Gray, Chan, Clark, & Jordan, 2012).

At the same time, sustainable management of marine resources benefits from the participation of a multitude of stakeholders, and by extension the diversity of knowledge from resource users, environmental organizations, managers, and scientists (Folke, 2004; Reed, 2008; Steins et al., 2019; Voinov et al., 2016). In natural resource management, synthesizing different knowledge types distributed across diverse stakeholders may increase the potential for innovative ideas to emerge, and collectively provide insight into how these complex systems are structured (Folke, 2004; Gray et al., 2020; Steins et al., 2019; Stephenson et al., 2016). This is now considered an essential practice in the management of transboundary resources like marine fisheries (Berkes, Colding, & Folke, 2000; Folke, 2004).

The European Union, for example, established so-called Advisory Councils (ACs) aiming to increase the participation of different groups in fisheries management at regional level. ACs were an attempt to better resolve existing conflicts by maintaining dialogue and cooperation, increasing legitimacy and acceptance of management decisions, and creating social capital in the development and implementation of fisheries policies (Linke, Dreyer, & Sellke, 2011; Long, 2009, 2015; Linke & Jentoft, 2016). However, the incorporation of diverse knowledge systems did not dissipate persistent conflict (Burns & Stöhr, 2011; Long, 2017; Linke & Jentoft, 2016). A very relevant example in European fisheries management is the Western Baltic cod (Gadus morhua), characterized by several management measures met with different levels of public acceptance. These include highly fluctuating catch quotas, a daily catch limit for anglers, and increased designation of marine protected areas. In these cases, if knowledge diversity and stakeholder participation are seen as essential to understanding and managing marine fisheries, why does conflict persist?

Further, how can we (a) increase our understanding of the disparate social–cultural spaces different stakeholders belong to, and (b) better determine where there is agreement and disagreement in how fishery SESs are structured and function?

Many researchers have looked to mental models to understand the relationship between anticipated social–ecological changes and differences in knowledge and perception (Biggs et al., 2011; Gray et al., 2012; Halbrendt et al., 2014; Jones, Ross, Lynam, Perez, & Leitch, 2011; Stier et al., 2017). Mental models are cognitive representations and interpretations of the external world, that is, an internal model of how the world works (Biggs et al., 2011; Jones et al., 2011). However, the analytical use of mental models to operationalize SEKD is somewhat limited, due to the (a) predominantly qualitative nature of mental model representations (Jones et al., 2011), (b) lack of standardized methods for comparing mental models within and across individuals or groups (Gray et al., 2012), and (c) challenge of eliciting knowledge about resource systems across a broad spectrum of stakeholders. Any attempt to compare mental models, however, is not generalizable to settings outside the SES context for which the mental models were collected. This is due to the highly dynamic and complex nature of these models, as well as their dependence on survey context. Nevertheless, their results remain relevant for other SES contexts and resource management situations.

To overcome these limitations, we applied a semi-quantitative fuzzy cognitive mapping (FCM) approach (Kosko, 1986) to understand and measure SEKD based on mental model variations. FCMs are characterized as external representations of internal mental models, which are graphical representations of peoples’ knowledge and values (Gray et al., 2012; Gray, Hilsberg, McFall, & Arlinghaus, 2015; Halbrendt et al., 2014). They are used to represent peoples’ system-level understanding by modeling perceived components, causal relationships,
and the degree of positive or negative influence between components, which has implications for understanding system's dynamics (Gray et al., 2012). FCMs can visualize a person's mental model using a mathematical graph of nodes and connections that represents the individual knowledge and understanding of causal associations between qualitative components. For building an FCM, the person needs to identify important elements to describe a problem, a phenomenon or a system:

1. Components: Also known as “concepts” or “factors” that represent important variables participants use to describe a system, for example, ecological component—cod, phytoplankton; social components—trawl fisheries, tourism. Components must be variables that can increase or decrease in quality or quantity, and are anecdotally defined and labeled based on participants' understanding.

2. Causal relationships: Positive or negative connections between components that explain how they influence each other. Participants might draw an arrow (i.e., directed link) from one component to the other with a (+/−) sign assigned to it. These are also known as “edges” in a graph.

3. Strength of causal relationships: Degree of positive or negative influence between components. Participants can numerically/qualitatively determine the strength of causal relationships (e.g., the numeric edge weights between the nodes or qualitative Likert scales to specify the magnitude of relationships ranging from very weak to very strong). Based on fuzzy sets theory (Kim & Lee, 1998), these quantitative or qualitative weightings (i.e., strength) can be mapped into a normalized numeric scale between 0 and 1. The weighted, directed graphs resulting from FCM approach can be analyzed using artificial neural network analysis, which can computationally simulate the dynamic of the system they represent (see Supporting information).

These FCMs can therefore be compared across individuals and groups in terms of (a) qualitative and contextual understanding stakeholders attach to system components (i.e., how stakeholders qualitatively define and measure components); and (b) structural characteristics of the network of causal connections (how stakeholders perceive causal relationships that link their individually defined components), and (c) system dynamics (how these networks of causal relationships predict systems response to artificial changes and stimulate stakeholder perception of system behavior).

Here, we focused on stakeholder groups in Germany who are affected or involved in the fisheries management of Western Baltic cod, which we associated with different social groups grounded on their varying interactions with the same ecosystem. Based on a systematic literature review, we identified six stakeholder groups: commercial fisheries, recreational fisheries, tourism, nongovernmental organizations (NGOs), management, and science. Representatives of these stakeholder groups interact differently with cod fisheries at local, regional, national, and international levels, and thus strongly represent SKED in the present case study.

We found that the specific qualitative meanings stakeholders attach to social components, as opposed to ecological components, varied greatly across groups. Additionally, while stakeholders demonstrated higher degrees of shared understanding in their perceptions of causal relationships between ecological components (i.e., ecological-ecological relationships), these perceptions varied more considerably across groups regarding social–ecological and social–social causal relationships, respectively.

2 | METHODS

2.1 | Data collection

2.1.1 | Five-step process for capturing stakeholders’ mental models

Six relevant stakeholder types were identified in a stakeholder analysis: representatives of commercial fisheries (ComFish comprising 21.2% of the sample), recreational fisheries (RecFish = 12.1%), tourism (12.1%), NGOs (18.2%), managers (18.2%), and scientists (18.2%). We selected study participants (N = 33) by performing purposeful sampling strategies using two key criteria: stakeholders needed to (a) be associated with a German institution by either their job or honorary position, and (b) have been involved in the Western Baltic cod fishery for more than 5 years (description of interviewed stakeholders in Supporting Information, Table S1). The first criterion is based on the intention of a national survey, whereas the second one was chosen as a reference point to ensure that the interviewees have established themselves in their position (job, volunteer) and are familiar with the subject of cod fishery in the Western Baltic Sea. Both criteria led to the exclusion of some actors, including stakeholders from the fishing industry or people who have only recently started working on this topic, for example, trainees.

We elicited stakeholders’ mental models using a five-step process (Figure S1, Table S1). First, participants were given a handout to prepare for the interview 1 week in
advance (Step 1). To avoid misunderstanding, again the handout was explained in detail before stakeholders’ mental models were created (Step 2). These steps were followed by an identification of the system components and their causal relationships by the participants (Step 3), from which they then drew a concept map representing their mental model following routine FCM data collection practices with open-ended concepts (Step 4; Gray, Zanre, & Gray, 2014). These maps were digitized after the interview and sent back to the interviewees for validation (Step 5).

2.2  Data analysis

2.2.1  Qualitative analysis of system components

While the vast majority of FCM studies are mainly based on the analysis of the structure and dynamics of mental models, we chose to qualitatively analyze how stakeholders describe, define, and measure components included in their map. Specifically, while defining causal relationships that linked their individual components, stakeholders were asked to attach meaning to them by continuously using one unit of measure and one definition. In order to carry out a qualitative analysis of the component definitions, we first identified categories that allowed us to classify each definition: (a) a component is explicitly defined the same way it is labeled or by using a synonym, (b) a component is defined by identifying examples (e.g., jellyfish = species like fire jellyfish and ear jellyfish), (c) a component is defined using a general description (e.g., consumer = person, who eats fish), (d) a component is described by a short explanation of its task or role in the system (e.g., fishery = sector that deals with the capture and marketing of fish), and (e) a component is defined by a description of its impact on the whole system or system components (e.g., porpoise = predator on cod).

To analyze the variations in the qualitative semantics of system components represented in the cognitive maps, we used the overall ratio of how many unique measures or definitions were used by stakeholders ($m$) to how often that component was mentioned in total ($u$).

$$R = \frac{du}{dm}$$

Slope values ($R$) closer to one exemplify higher disagreement in how stakeholders define or measure a component. Note that this measure of disagreement illustrates the overall slope of variation among all individuals, and thus it does not necessarily show variation between stakeholder groups. Rather, it provides useful information about how the entire sample, on average, attaches diverging meanings to components.

2.3  Analyzing the network structure of causal relationships

Individual mental models were aggregated mathematically to create a model representing the collective perception of each stakeholder group (Gray et al., 2012). Aggregation took place once all individual models were transformed into adjacency matrices (Özesmi & Özesmi, 2004). We combined individual mental models by stakeholder types to form stakeholder-specific group models using the arithmetic mean of their adjacency matrices (see for more detail Gray et al., 2012; Aminpour et al., 2020). To measure agreement/disagreement of causal relationships (i.e., network structure of links among components) across stakeholder-specific group models, we first identified components that were mentioned by the majority of the six stakeholder groups (i.e., at least half of the groups have the component in their collective mental models). We then compared the set of causal connections (i.e., edges) between these components across different stakeholder groups to examine how similar/different these causal relationships were between stakeholder groups. We quantified the degree of structural similarities (agreement) by measuring Jaccard similarity coefficient (JSC) between any pairs of stakeholder groups (Tantardini, Leva, Tajoli, & Piccardi, 2019). JSC is a measure of similarity for the two sets of data (here, the sets of causal relationships between components), with a range from 0 to 1, where higher values represent more similar sets. Given two graphs $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$, JSC is defined as:

$$JSC(G_1, G_2) = \frac{|E_1 \cap E_2|}{|E_1 \cup E_2|}$$

where $V_1$ and $V_2$ being the set of nodes, and $E_1$ and $E_2$ being the set of edges in the graphs (i.e., FCMs) that link those nodes. We measured pairwise JSC between all stakeholder groups for sets of causal connections (edges) that link two ecological components (eco), two social components (soc), or one ecological and one social components (soc–eco).

2.4  Analysis of system dynamics

Stakeholder-specific FCMs can also be analyzed dynamically using certain artificial neural network analysis
called autoassociative neural networks (Kramer, 1992; Özesmi & Özesmi, 2004). Here, we used FCM computational analysis to demonstrate how stakeholders predict the changes in the state of the system's components, given an artificial (hypothetical) change in one or combination of components. This is referred to as scenario analysis (Özesmi & Özesmi, 2004). A hypothetical increase (or decrease) in the value of a component (also known as component activation) can impact all other components that are causally dependent on it, and leads to a cascade of subsequent changes to other system components. This iterative propagation of the initial change continues until the system converges into a new, so-called “system state” (Özesmi & Özesmi, 2004). By comparing the system states (i.e., the activation of components) before and after running a scenario, FCM can be used to implement “what if” scenario analysis, and therefore represent the perceived dynamic behavior of the system (in this case, western Baltic cod fisheries) (see Supporting Information for mathematical representations).

We computationally manipulated aggregated models of six stakeholder groups to compare how social–ecological dynamics were perceived differently across groups (Supporting Information, Figures S3–S8). To measure the agreement/disagreement of network dynamics across multiple stakeholder groups regarding the dynamic functionality of the models, we ran two scenarios: (a) decreasing cod, which simulates an ecological shock, and (b) increasing cod quota simulating a social intervention. Selected scenarios were based on the components which, as described by stakeholders, will undergo the greatest change in the next 5 years. We quantified the agreement between stakeholder groups by measuring the percentage of matched patterns across groups regarding the changes in system components' values as a result of running a scenario. This included 10 social and ecological components that were mostly impacted by simulated changes in cod and cod quota (using 10 most strongly impacted components ensured that we included all of those components that changed considerably, that is changing more than 50%).

3 | RESULTS

3.1 | Qualitative perception and understanding of system components

The qualitative analysis of components’ measures and definitions showed that stakeholders mainly attached the same meaning to ecological components, but there was much wider variation in the meanings attached to social ones. This greater variation (i.e., slope) in qualitative meanings attached to social components compared to ecological components is illustrated in Figure 1a,b, where the red line in (b) has a greater slope than the blue line in (a). In addition, while 96% of measures for ecological components demonstrated full-agreement (i.e., 0% variation in qualitative meanings attached to them), only 47% of the measures for social components demonstrated full-agreement (Figure 1c). Only for one ecological components (i.e., age structure of cod) varying meanings regarding the component's measure were attached. However, this component was only mentioned within NGOs. At the same time, stakeholder-specific contextual attachment to social components showed much greater variations. For a total of 20 components, there was considerable variation in meanings attached to the component measure. Greatest SEKD was found for nature conservation (e.g., strength of emotional attachment to nature conservation; level of quality of nature conservation), which occurred both between and within groups.

Components’ definitions were also subject to variation regarding the specific contextual attachments by stakeholders. In total, 42 social components showed diverging meanings attached to them by individuals across groups; for 17 out of these components the definitions varied 100% (e.g., assumed stock size, regulations, or technical development). However, again only one ecological component (i.e., jellyfish) showed 100% variation across groups in terms of component’s definition (detailed documentation on these variations regarding components’ measures and definitions in Supporting Information, Tables S3 and S4a,b).

3.2 | Quantitative understanding of system structure

In addition to the qualitative measures and the analysis of qualitative contact of social and ecological components, our results also indicated that multiple stakeholder groups perceived the structure of the causal relationships between system components differently. We found a greater agreement across groups (i.e., similarity) in the perceived structural patterns of the causal relationships linking ecological components, referring to as ecological–ecological relationships (eco–eco) (the average between-group JSC for eco–eco relationships is 0.22) (Figure 2). However, social–ecological (soc–eco) relationships showed comparatively less agreement across stakeholder groups (the average between-group JSC for soc–eco edges is 0.15) (Figure 2). More importantly, the causal connections that link only social components referred to as social–social relationships (soc–soc), demonstrated the lowest level of agreement (the average between groups
JSC for soc–soc edges is 0.12). These results, together, indicate that the structure of the casual relationships for which a social component is involved may demonstrate higher variation across groups compared to the structure of causal relationships that link ecological factors, thereby more greatly representing SEKD.

### 3.3 Quantitative understanding of system dynamics

Comparative analysis of how group FCMs simulated the system responses to scenario changes revealed that variations in the perception of system dynamics by stakeholders were more evident in social components than ecological ones (Figure 3, Table S5a,b). For both applied scenarios, there was little agreement on the dynamic changes of social components. In response to a decrease in cod (Scenario 1), managers perceived an increase in control, but a decrease in the number of anglers (recreational fisheries). On the contrary, commercial fishers predicted a decline in the income of fishery (side and main income). In addition, recreational fisheries and tourism identified a significant decline in recreational fisheries and related areas such as angling shops and angling tourism, while NGOs and scientists noted an increase in protected areas. However, all stakeholders across groups agreed on a decline in cod quota resulting from a decreasing cod biomass, but the strength of the influence varied (Figure 3, Table S5a,b).

On the contrary, when calculating the perceived changes in ecological components, we found greater agreement among components that were mostly impacted. As an example, a decrease in cod (Scenario 1) was seen, across all stakeholder groups, as a positive effect on prey abundance (e.g., herring and sprat populations). The increase in the cod quota (Scenario 2) reflected a similar outcome: a greater common understanding of changes in ecological components, but greater variations of perceived system dynamics in social components (Figure 3, Table S5a–c).

### 4 DISCUSSION

Our study empirically demonstrates that the perception and understanding of the dynamics of the Western Baltic cod fishery SES varied across multiple stakeholder groups. Importantly, we provide evidence that while there is general agreement across groups about the structure and function of ecosystem dynamics, disagreement in their knowledge about SES can be largely explained by looking at how different social groups attach themselves to the natural environment. We drew on mental model theory and semiquantitative cognitive mapping techniques to measure these variations in social–ecological
FIGURE 2  Agreement of the structure of the causal relationships between system components mentioned by the majority of groups (i.e., components that exist in the maps of more than half of all groups are visualized). The map of each group is shown in (a) by a directed graph, where nodes are classified by ecological (blue) and social (red) components, and edges illustrate the causal relationships between components. Between-groups pairwise agreement of ecological connections (b), social connections (c), and social–ecological connections (d). This agreement is measured by the Jaccard similarity coefficient (JSC) between the set edges in any pairs of groups. Box plots in (e) demonstrate the distribution of between-group pairwise JSC agreements for each class of connections, where the mean of JSC is highest for ecological connections (0.22) and is lowest for social connections (0.12)
knowledge. We considered disparities in qualitative meanings stakeholders attach to system components, the perception of causal relationships between them, as well as the functional implications of perceived SES changes by different social groups. These variations (here referred to as SEKD) were found to be more evident in social dimensions—while there was general agreement about ecological dimensions when considered in isolation.

Although many transboundary, large-scale fisheries management follow the ecosystem-based and participatory approaches to governance (Long, Charles, & Stephenson, 2017; Pitcher, Kalikoski, Short, Varkey, & Pramod, 2009), a state-of-the-art approach that allows for modeling the differences in system knowledge, values, beliefs, and perceptions across social groups is underdeveloped. Although there are many formal models showing how ecosystems function (Plagányi, 2007), for example, Ecopath (Watari et al., 2018) or Ecopath with Ecosim (Püts et al., 2020), a considerable gap remains in how social groups attach themselves to these dynamics. Collective understanding of ecosystem dynamics forms the basis for the establishment of reference points and is frequently used to determine sustainable catch quotas.

However, the cultural and social impacts of structural changes in ecosystems and management frameworks are poorly understood. Our research finds that variation in social measurements and specific contextual attachments likely form the basis of disagreement, and could explain, at least partially, some of the multigroup conflict in natural resource management. Fisheries management routinely utilizes bio-econometric models to assess the economic impact of stress factors like tourism or fishing (Fulton, Smith, Smith, & van Putten, 2011) and evaluate different management strategies such as closed areas or quotas (integrated ecosystem assessment) (Levin, Fogarty, Murawski, & Fluharty, 2009). While they do integrate certain social components into policy assessment, most modeling techniques fail to address the many other human dimensions central to understanding the social impacts of management decisions (Hornborg et al., 2019). Incorporating the various objectives of stakeholders and diverging specific attachments they assign to system components might vastly increase both dialogue and conflict resolution when management decisions are being considered.

To strengthen the sustainable management of natural resources and to more fully understand fisheries as

**FIGURE 3** Agreement of dynamic changes across stakeholder groups as a result of (a) decreasing cod and (b) increasing cod quota. Bubbles’ sizes show the percentage of mostly affected concepts; boxes represent the distribution of agreement. Ecological concepts that are mostly affected by decreasing cod and increasing cod quota are more aligned across stakeholder groups as illustrated by larger bubbles for higher degrees of agreement (degree of agreement is measured by the number of groups from 1 to 6 that agree). Detailed presentation of the concepts in each bubble is provided at Table S5c.
complex SES, we argue it is of utmost importance to involve a range of resource users and associated interest groups in the process. Of course, the individual case must be considered. Nevertheless, it is possible that the inclusion of people who, for example, have been involved in a fishery for only a short time, might have a different perspective on existing conflicts, and could potentially break up deadlocked problems by steering them in another direction. Future research could, therefore, incorporate these newer perspectives to explore how knowledge, values and beliefs may vary based on time spent in that specific fishery.

Without considering the broad spectrum of specific contextual attachments that stem from different stakeholder groups, variations in social–ecological knowledge are likely to undermine the practical implementation of management strategies and effective decision-making (Adams et al., 2003; King et al., 2015). By applying semi-quantitative cognitive mapping analysis, we are better able to model the variations reflected in stakeholders’ perceptions of, knowledge about, and contextual attachments to system components, their causal relationships, and their dynamics. The novelty of our approach is particularly evident in the capture and representation of knowledge and perception divergences in a way that creates access for different stakeholders, with a particular emphasis in making this understandable for decision-makers. Although our study represents a single case study only, our approach demonstrates practical applicability to other research fields and to other geographical regions, worldwide. This enables others to analyze and understand resource conflicts of various kinds and validates the high adaptability of our novel approach to current issues in the field of nature conservation and natural resource use.

While a participatory approach is contemporarily routine to the management of large-scale fisheries (EC, 2013) and other transboundary SES like MPAs (Davies, Murchie, Kerr, & Lundquist, 2018), modeling the unique ways in which social groups attach meaning to SES components has yet to be incorporated into decision-making. Doing so could diminish conflicts, legitimize management plans, and ultimately lead to a better understanding of human–environment interactions.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
Heike Schwermer, Payam Aminpour, and Steven Gray: Conceptualization; Heike Schwermer, Payam Aminpour, and Steven Gray: Methodology. Heike Schwermer, Payam Aminpour, and Steven Gray: Formal analysis. Heike Schwermer and Christian Möllmann: Investigation. Heike Schwermer, Payam Aminpour, Caitie Reza, Steven Gray, and Christian Möllmann: Writing—original draft preparation. Heike Schwermer, Payam Aminpour, Caitie Reza, Steffen Funk, Steven Gray, and Christian Möllmann: Writing—review and editing. Heike Schwermer: Validation. Heike Schwermer, Payam Aminpour, and Steffen Funk: Visualization. Heike Schwermer and Christian Möllmann: Funding acquisition. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT
All necessary data supporting the findings of this study are available as Supporting Information. Data for obtaining the FCM of individuals are available and can be downloaded as Excel spreadsheets on https://osf.io/f45ux/.

ETHICS STATEMENT
All subjects gave their informed consent via email for inclusion before they participated in the study. The study was hence conducted in accordance with the Declaration of Helsinki.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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