



# Production of knowledge on climate change perception – actors, approaches, and dimensions

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**Abstract.** Research on perceptions of climate change impacts contributes to understanding motivations for adaptation action and increases the legitimacy of climate adaptation research and policy. The body of literature on climate change perception (CCP) is extensive. Given that the perception of climate change is commonly presented as being dependent on an individual's sociocultural and spatial contexts and that climate change is an abstract concept with different dimensions of meaning, this paper systematizes the research in an actor-centered manner. Using a systematic literature review, the abstracts from 821 interdisciplinary studies on CCP were coded and statistically analyzed. The results show that predominantly knowledge about the CCP of vulnerable groups of actors and regions was generated using quantitative methods. Impacts at the collective and institutional levels of CCP were rarely explored. This indicates an individualizing perspective of research on climate adaptation of vulnerable actors. Conclusions for future research are drawn.

## 1 Introduction

Changes in precipitation patterns and increases in average temperatures, as well as extreme weather events that are increasing in frequency and intensity, have been measured all over the world (IPCC, 2022b). Since a sufficient reduction in greenhouse gas emissions is not expected to be met (UNEP, 2022), a further increase in the changes described is to be expected (IPCC, 2022a). Thus, scientists and policymakers are increasingly considering ways to adapt to climatic change in a locally specific way to minimize impacts (Sietsma et al., 2021). These adaptations can take different forms from isolated technical changes to the transformation of local infrastructures and economies (Klepp and Chavez-Rodriguez, 2018). To assess climate change impacts and adaptation needs, natural scientists are generating increasingly more precise data on climate change (Sietsma et al., 2021). It is evident however that more precise knowledge about climatic change does not automatically lead to sufficient adaptation implementation by individuals or policymakers (Cook and Overpeck, 2018). Governance research in the context of climate change investigates, at different administrative levels, those conditions that promote or inhibit

adaptation processes. Questions of legitimacy, appropriateness, and the social justice of climate adaptation measures and their implementation play a crucial role in this context (Newell et al., 2020). One strand of research in this field is concerned with how climate change is perceived by individuals (Clayton and Manning, 2018; Hathaway and Maibach, 2018; Soubry et al., 2020). Perception is considered to be an influencing factor for climate action and is included to increase the legitimacy of climate policies and knowledge production in the context of climate change (Hügel and Davies, 2020). Incorporating climate change perceptions can also help to improve the public or scientific communication of the phenomenon (Dziminska et al., 2021). At the same time, politics and lobby groups can influence the public perceptions of climate change through public communication strategies (Dunlap and Brulle, 2020).

Numerous studies exist on climate change perception (CCP) in diverse research contexts. Originally, questions of perception were a subject of psychology. Meanwhile, CCP has been included in many social sciences such as environmental sociology, political science, and human geography (Whitmarsh and Capstick, 2018). Perception takes place when an individual grasps and cognitively processes direct

environmental stimuli and/or their socially mediated interpretation (Whitmarsh and Capstick, 2018). How an environmental stimulus is perceived by an individual depends on the person's sociocultural and spatial context. In the case of climate change, this means that “perceptions of risk and responses to climate change are inextricably linked to social and cultural dimensions – beliefs, customs, identity, norms, religion, social organization, and values – which for many people who confront risk are often more important than scientific knowledge” (Ruhlemann and Jordan, 2021:425–426). However, many studies lack a definition of what exactly they mean by CCP (Soubry et al., 2020).

Against this background, the present article is based on three central assumptions: first, although the entry point for studying perception is typically individuals, individuals' perceptions depend on their specific sociocultural and spatial contexts (Ruhlemann and Jordan, 2021). Second, perception issues are a relevant component of knowledge production in the context of climate change and serve to increase the legitimacy of science and policy (Hügel and Davies, 2020). However, the production of knowledge in the context of climate change is not free of social and global inequalities, which can be problematic considering the participatory claims of climate policy and research. Mahony and Hulme (2018) suggest that knowledge production in the context of climate change is unevenly distributed globally, which may exacerbate existing inequalities related to climate change vulnerability. In this paper, we address those CCPs that are being researched and thus become part of global knowledge production on climate change, by reviewing which groups of actors become research subjects in CCP studies. Due to the geographical dimension of CCP and the spatial inequalities in global knowledge production around climate change, we are also interested in the regions where these actor groups are researched. In addition, we analyze how – i.e., with which methods and approaches – this knowledge is generated. Third, there is no consistent notion in the literature of how an individual may perceive climatic change and, consequently, what can specifically be understood by CCP (Soubry et al., 2020). Hence, we would like to establish the dimensions of climate change which actors may perceive. The guiding questions of this article are as follows:

1. Whose climate change perceptions are being researched and where?
2. Which methods and approaches are being used to generate knowledge about climate change perception?
3. Which dimensions of climate change do the actors perceive?

We answered these questions by reviewing the literature systematically. Previous literature studies on CCP analyze changes in public perceptions over time (Capstick et al., 2015; Ratter et al., 2012). Other reviews focus on the perceptions of specific groups of actors such as farmers (Soubry

et al., 2020) or health-care professionals (Hathaway and Maibach, 2018). Becerra et al. (2020) as well as Escudero and Mendoza (2021) evaluate studies based on their geographical location in coastal regions, while Amerigo et al. (2019) concentrate on the specific climate risk of floods. The novelty of our literature review on CCP is that we did not make any prior actor-specific, geographical, or other selection of the literature in order to obtain a broad picture of those actors researched in the CCP literature.

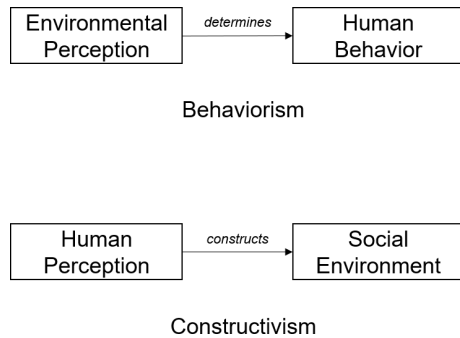
Based on the geographical debate on environmental perception (Sect. 2) and methodological elaborations on our procedure (Sect. 3), we are able to show which groups of actors from which spatial contexts were researched in terms of their CCP, which methods and approaches were used to generate this knowledge, and which dimensions of the abstract concept of “climate change” were perceived by the researched actors (Sect. 4). The results shed light on how the production of climate change knowledge is shaped, which is relevant for legitimacy aspects of research and policy. Research desiderata are identified, and recommendations for future research are made (Sect. 5).

## 2 Approaches to perceptions of environment and climate change

Since the 1960s, the perception of the environment has been a subject of research in human geography (Golledge, 2008). The goal of perception geographies is to study the relationship between humans and their environment (Gold, 1980). The starting point of perception research is that the subjective perception of the environment does not necessarily have to correspond to the objectively measurable conditions (Pocock, 1979). The perception of the environment not only depends on the specific physical dispositions of an individual such as (not) being able to see, hear, or feel. Environmental perception is also spatially, socially, and culturally shaped, as the contrast between indigenous countermapping and colonial mapping makes clear (Mesquita, 2018). Hence, different individuals can perceive the same space in different ways (Ruhlemann and Jordan, 2021). This spatial dimension makes questions of environmental perception relevant to geography. The emergence of perception geographies marked a structural shift in geography as a discipline: the move away from describing a purely objective landscape and the supposed characteristics of its inhabitants towards the inclusion of subjective perspectives on the environment (Golledge, 2008). In human geography, as in other social sciences, two approaches to perception research emerged, namely behaviorism and constructivism.

### (a) Behaviorism

The basic assumption of behaviorism is that human actions and decision-making processes can be better understood when subjective perceptions of the environment and related



**Figure 1.** Human–environment relation in behaviorism and constructivism (own illustration).

images and interpretations are considered (Golledge, 2008). This could be used to determine patterns in human behavior under certain environmental conditions and to predict future behavior under the same conditions (Rushton, 1979). Behaviorist approaches have been criticized and refuted many times: human perception and interpretation of the environment are indeed factors that influence, but do not determine, human action (Bunting and Guelke, 1979; Harvey, 1981). For example, awareness of environmental problems does not automatically lead to sufficient behavior to mitigate or to adapt to these problems (Kollmuss and Agyeman, 2002). Human actions and the contexts in which they take place are more complex than simply being explained by the perception of the environment and the resulting rational decision processes.

#### (b) Constructivism

In the course of the cultural turn in the social sciences, studies emerged that can be assigned to the “Imagined Geographies” (Said, 1979). The central argument of these approaches is that the perception of space is shaped by value systems, public discourses, or art. Urry (1995) shows that the way tourists perceive landscapes is shaped by literary works that refer to them. According to constructivist approaches, space and the environment are social constructs of the perceptions of individuals or groups, conveyed by language or symbols (Harley, 1989). One criticism of this approach is that a strict understanding of this assumption would lead to an overemphasis on the importance of language and a neglect of material conditions (Whatmore, 2006). Nevertheless, studies based on mental maps show how strongly the perception of the environment can depend on social and cultural ideas as well as individual practices (Mesquita, 2018). The interrelationships of the effects of the two approaches within perception geographies are summarized and visualized in Fig. 1.

Since the early 2010s, social science research questions on climate change perception have been established as a subfield of perception research (Clayton and Manning, 2018). Climate change alters the human environment and is therefore a relevant subject of social science perception research. Both

the perception of the gradual, but in many places increasingly obvious, impacts of climate change, such as changes in temperature and precipitation, and the perception of increasingly frequent and intense extreme weather events are being researched in numerous studies (Hathaway and Maibach, 2018; Soubry et al., 2020). This research is relevant for two main reasons:

First, climate change necessitates changes in people’s living environments and everyday practices. According to international climate agreements, emissions have to be reduced and adaptation to the changing environment is required. As detrimental impacts from climate change become inevitable in the absence of sufficient mitigation efforts, adaptation issues are increasingly becoming a political and scientific focus (IPCC, 2022a, b). There is an interest in which factors influence the behavioral changes required for this adaptation at the individual, collective, and institutional levels. Behaviorist approaches assume that the perception of climate change impacts is related to corresponding adaptation behavior. For example, personal experience with extreme weather events increases the willingness to take adaptation measures and probability of taking them (Kichamu et al., 2018; Li et al., 2021). However, the perception of local climate change does not mean that it is interpreted in the context of the phenomenon of global warming (Jorgensen and Termansen, 2016) or that sufficient adaptation action follows in every case (Ma et al., 2021). Thus, the perception of climate change impacts is not directly followed by adaptation as a supposedly rational response to the observed phenomenon. The relationship between perception and adaptation is more complex and depends on numerous factors, which makes research in this area practically relevant for policy-makers.

Second, it is evident that the legitimacy of the necessary everyday life changes in the context of climate change is enhanced when stakeholders are involved in the research and decision-making processes (Hügel and Davies, 2020). It may be useful for decision-makers to align the communication of climate adaptation measures with which climate-change-related problems and associated values are perceived as relevant by certain groups of actors (Dziminska et al., 2021). Third, for participatory research methods, it is useful to understand which problems have a high relevance for those researched and how these are interpreted and named. Climate change impacts vary locally and are linked to various other perceptible phenomena, such as biodiversity loss or environmental pollution. Furthermore, constructivist contributions show that the term “climate change” is linked to diverse ideas, images, and values (Elixhauser et al., 2018). For these reasons, it is plausible to assume that individuals understand very different things under the abstract term climate change and make different mental associations. In non-formalized conversations and discussions at conferences and workshops, many social scientists share with us the experience that the term climate change should be avoided with those actors being researched, as it can be imprecise and possibly emotion-

ally charged. As researchers, it is important to be aware of potential dimensions of the meaning of the term in order to conduct targeted research and to avoid misunderstandings.

In summary, CCPs have mostly been studied using two approaches: behaviorist and constructivist approaches. While behaviorist approaches aim to figure out which factors influence climate action, constructivist studies analyze how climate change is collectively interpreted and charged with emotions or values. Indeed, including knowledge about CCP may contribute to a higher level of legitimacy and acceptance of research and policy processes in the context of climate change.

### 3 Systematic review of climate change perception literature

#### 3.1 Data collection

We conducted a systematic review of CCP literature. The aim of the review was to analyze a wide range of studies with respect to the questions outlined above in order to identify patterns and deficits in CCP research. Since CCP has a clear geographic dimension but is the subject of diverse social sciences and interdisciplinary sustainability sciences, we decided to create a cross-disciplinary body of literature. The Web of Science Core Collection covering many scientific disciplines acted as the source for the literature selection. The string that was applied was “‘climate change’ perception” for the title of the publications. We only selected journal articles and manually excluded papers that were irrelevant to the research question because, for example, they were not social science oriented or did not directly target perceptions of climate change or its impacts. Related terms such as climate awareness, attitude, or opinion were specifically not searched for. On the one hand, including all of the studies with these keywords would have made the body of data too large for this study. On the other hand, there would have been a danger of moving too far away from questions of perception and which dimensions are included.

The result of this data acquisition was a data set with a total of 821 studies from 1991 to the end of 2021. A few articles were not assigned to a year, which is why the number of studies in timelines in this paper may differ slightly. As Fig. 2 shows, publication activity on CCP was at a consistently low level until 2010. However, after 2010 and 2013, the number of articles on CCP increased sharply. The number of scientific publications multiplied by a factor of 25 from 6 articles in 2010 to 147 in 2021. One reason for the increasing interest in research questions on CCP may be a general trend of intensifying social science research on climate change. In addition, numerous climate records were recorded all over the world in the decade from 2001 to 2010, which may have led to an increasing interest in their perception (WMO, 2013). Scientific and policy milestones such as the Intergovernmental Panel on Climate Change’s Fifth Assessment Report in

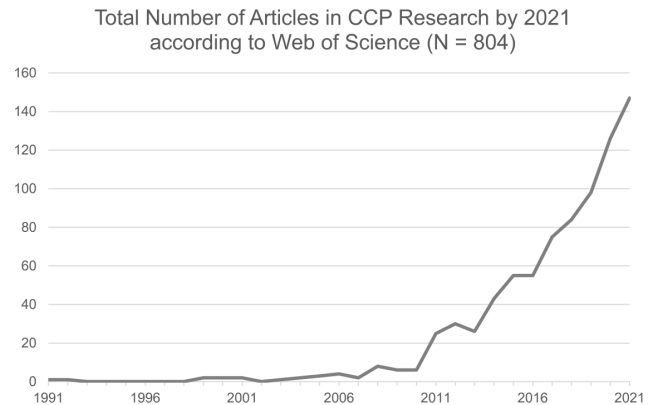


Figure 2. Total number of articles in the field of CCP research by 2021 according to the Web of Science (own illustration).

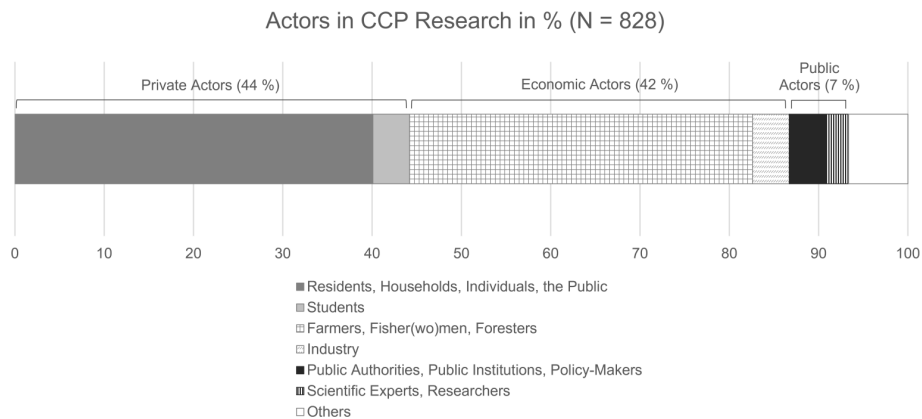
2014 or the 2015 Paris Agreement may also have led to increased attention to CCP issues in the mid-2010s.

#### 3.2 Data processing

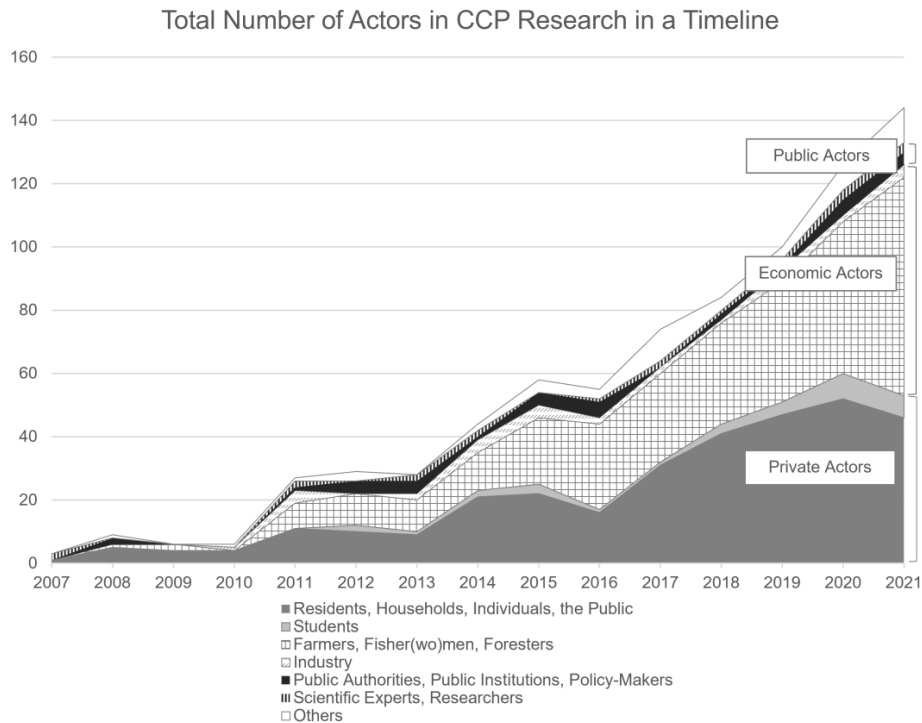
In the next step, six variables derived from the research questions were applied to the data set. The variables *actors* and *locations* were relevant because, as described above, we assume that perception is socially and spatially shaped and we want to make statements about the participation of different actors and regions in the generation of knowledge in the context of climate change. The variable *methods* allowed us to make statements about how this knowledge is generated. The relationship to the binary variable *climate action* was examined, as it allows conclusions about potentially behaviorist approaches. The variable *dimensions* provided information about which aspects of climate change the actors perceive. The expressions of the variables *methods* and *dimensions* were inductively derived from the title and/or abstract of the articles, coded by software, and clustered by content. The expressions of the variable *location* were selected deductively because the plausible expressions were known. The characteristics of the variable *actors* (private, economic, and public actors) were given deductively, and the subcategories were derived inductively from the material in order to make more concrete statements about groups of actors. All variables and their expressions were tested and further developed on 100 articles before being applied to the entire data set. The variables, their possible expressions, and the corresponding research interest are shown in Table 1. The resulting database was analyzed descriptively using Microsoft Excel and IBM SPSS Statistics. Cramér’s  $V$  correlation coefficient was calculated between nominally scaled variables. When statistical correlation is referred to in the following, it implies at least a moderate expression of Cramér’s  $V$  ( $> 0.2$ ). The references given in Sect. 4 below are examples of characteristic studies on the topics listed because it would be too extensive to list all of the associated articles.

**Table 1.** Applied variables, possible expressions, and research interest.

Variables	Possible expressions	Research interest
Actors whose CCP is being researched	The three given categories of actors (private, economic, public) are inductively expanded from the content to include the following subcategories: – private actors including (a) residents, households, individuals, and the public and (b) students – economic actors including (a) farmers, fisher(wo)men, and foresters and (b) industry – public actors including (a) public authorities, public institutions, and policy-makers and (b) scientific experts and researchers.	Whose climate change perceptions are being researched?
Locations where CCP research takes place	Study regions were grouped by geographic location: – North America – Europe and Russia – Australia and New Zealand – Asia – Africa – South and Central America – the Caribbean and island states – global.	What is the spatial context of the actors being researched?
Methods that are being used	The key research methods for data collection and analysis are as follows: – survey – qualitative interview – focus group discussion – econometric or statistical modeling – media or document analysis – literature review.	Which methods are being used to research perception?
Meaning dimensions, of climate change, which can be perceived	Seven dimensions of climate change are relevant in the CCP literature: – sensory observations – risk – awareness, attitude – information, knowledge, uncertainty – discourses, interpretations – risk management – policy field.	Which physical, social, cultural, or economic impacts and manifestations of climate change are perceived by actors?
Climate action, which is assumed by the researchers	The link between CCP and mitigation or adaptation is determined in a binary fashion: – yes, a relationship is established between CCP and action – no, no link is established between CCP and action.	Is CCP associated with climate action?



**Figure 3.** Actors in CCP research (own illustration).



**Figure 4.** Actors in CCP research on a timeline (own illustration).

## 4 Actors in climate change perception research

### 4.1 Whose climate change perceptions are being researched and where?

In some of the 821 publications, several groups of actors are researched in one study (see Fig. 3). Almost half of the actors (44 %) represent *private actors*. These are mainly characterized by the fact that they live in a specific area that is potentially affected by climate change impacts such as residents of coastal regions (Ngo et al., 2020) or of cities during heat events (Madrigano et al., 2018). The group of private actors also includes students (4 %), who are seen as multipliers for climate change knowledge and awareness in their families or later professional fields (Anåker et al., 2021). Of the actors studied, 42 % are described by their *economic* role. The largest share of these can be attributed to the agricultural sector. This includes farmers, fisher(women), and foresters (Soubry et al., 2020). For agricultural stakeholders, the close connection to and dependence on their environment and the weather makes it plausible that they are both particularly sensitive to perceptions of climate change and vulnerable to potential climate damage (Altea, 2020). The CCP of other economic actors is examined in 4 % of the articles. These are mostly from the tourism industry, which is vulnerable to climate change impacts in certain regions (Trawöger, 2014). Research on the climate change perceptions of *public actors* accounts for less than 10 % of the studies. As subgroups in this category, we can identify public administrations, institu-

tions, and decision-makers (Chondol et al., 2020) as well as scientists (Kornek et al., 2020). Public actors are relevant for perception research in that policy-makers, administrations, and institutions are responsible for the legal basis and execution of climate policy, while scientists play a major role in generating knowledge on climate issues.

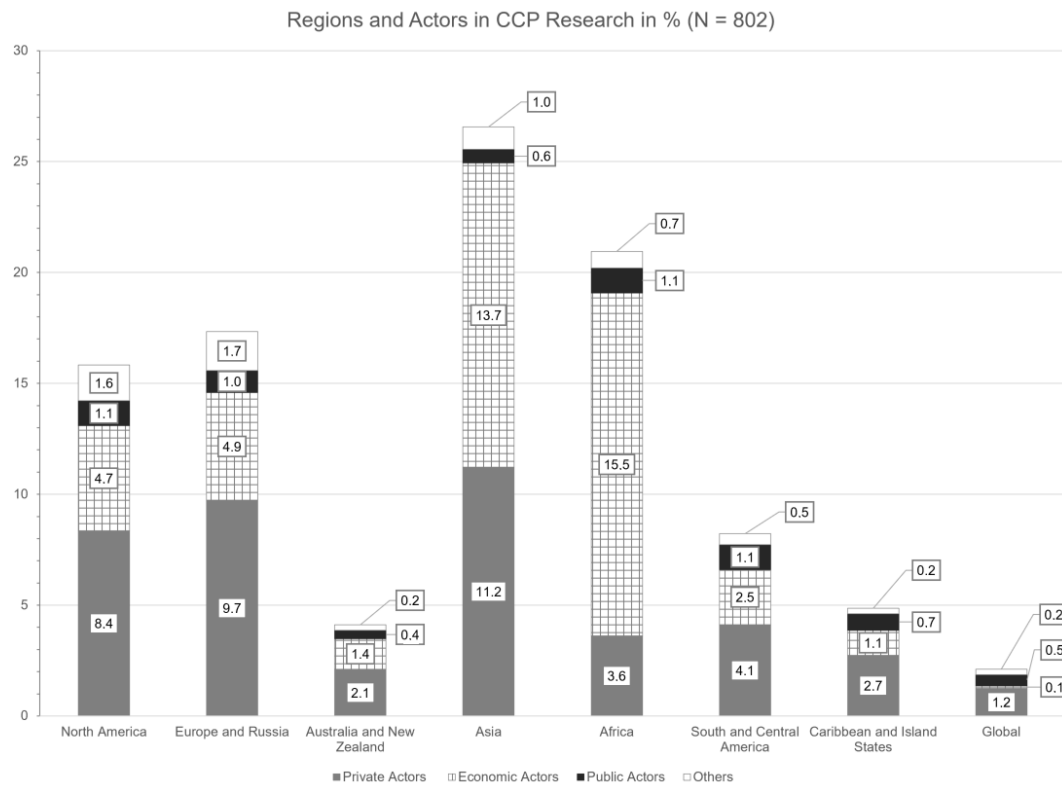
The timeline in Fig. 4 shows that the number of studies on public actors in the field of CCP research remains relatively constant at a low level over the long term. Although interest in private actors increased sharply after 2016, it has recently been subject to a decline, while publication activity on economic actors, especially those from the agricultural sector, continues to rise.

Figure 5 shows that more than half of the studies on CCP focus on actors from Asia, Africa, South and Central America, and the Caribbean and other island countries. One-third of the articles explore perceptions of actors in North America, Europe, and Russia, as well as Australia and New Zealand, which can be attributed more to the Global North. These results suggest that there is a high level of research interest in perception issues in Asia and Africa, which could be justified by the higher vulnerability of many regions there to climate impacts.

However, normalizing the number of studies in the regions with the corresponding population figures yields a different picture. As Table 2 shows, there is an underrepresentation of studies in Asian contexts. However, this normalization should be viewed with caution for two reasons: first, stud-

**Table 2.** Shares of population and CCP research by region in percent (own calculations according to UNFPA, 2022).

Region	North America	Europe and Russia	Australia and New Zealand	Asia	Africa	South and Central America	Caribbean and island states	Total
Population share in %	4.8	9.9	0.4	58.8	16.8	8.0	1.3	100
Share of CCP research in %	16.2	17.7	4.2	27.1	21.4	8.4	5.0	100



**Figure 5.** Regions and actors in the field of CCP research (own illustration).

ies were not conducted in every country in the regions, but the population shares span the entire region. Second, a higher population size does not automatically mean that more studies will generate more knowledge about that region. For example, in a country with twice as many inhabitants, twice as many representative surveys do not need to be conducted to draw more valid conclusions.

There is a moderate statistical relationship (Cramér’s  $V = 0.24$ ) between the study region and the group of actors studied in CCP research. While private actors predominate in countries of North America, Europe and Russia, Australia and New Zealand, South and Central America, and the Caribbean and other island states, as well as in international studies, there is a concentration of economic actors predominantly from agriculture in countries of Asia and Africa.

Figure 5 therefore demonstrates that existing CCP research tends to examine the perceptions of actors who are

most vulnerable to climate change, such as farmers in Asia and Africa, rather than those who bear the responsibility for climate governance like policy-makers in the Global North. This result could be interpreted as including (multiple) vulnerable groups of actors in the process of knowledge production on climate change, thus favoring their participation. However, there is another statistical relationship (Cramér’s  $V = 0.28$ ) between the actors researched and the assumed climate action of the actors. There is ample research on how climate change perceptions affect climate action among agricultural actors, while there is less research on the link between perceptions and climate action among private and public actors. There are only 17 studies (2% of CCP articles) on the relationship between climate action and the CCP of decision-makers who set legal and financial frameworks and thus those who bear the responsibility for climate policy. Consequently, research tends to examine perceptions and ac-

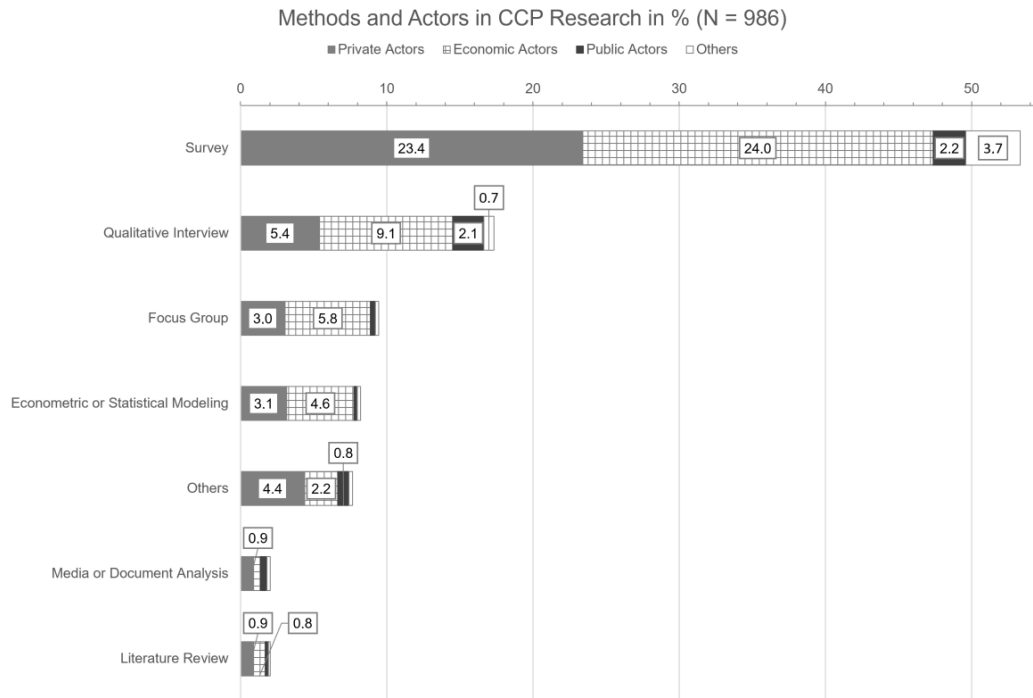


Figure 6. Methods and actors in CCP research (own illustration).

tion strategies of affected parties rather than those who bear the responsibility for climate governance.

#### 4.2 Which methods and approaches are being used to generate knowledge about climate change perception?

How climate change is perceived is predominantly measured using quantitative research methods. Conducting a survey is the most frequently used method. The results on perception are compared with meteorological data in 1 in 10 studies to check the extent to which actors perceive objectively measurable climate changes. Interviews and focus groups are the most popular qualitative tools. Economic actors are significantly overrepresented in studies using these qualitative methods, as Fig. 6 shows. Nevertheless, the results indicate that CCPs tend to be quantified and that qualitative aspects are still underrepresented in research to date.

Whether the studies take a more behaviorist, constructivist, or other approach to CCP cannot be clearly determined from the abstracts. However, two indicators can provide clues: the methods used and whether the authors make a direct connection to climate action. With regard to methods, we can surmise that constructivist approaches would be more likely to use qualitative methods such as interviews, focus groups, or media and document analysis. These are less common in CCP research, as discussed above. A direct link between climate action and perception is made in 53 % of the abstracts, which could suggest behaviorist approaches.

Of these, 29 % relate to climate mitigation and 71 % relate to climate adaptation. These results suggest that behaviorist approaches are more frequently chosen in CCP research than constructivist approaches (or other approaches).

#### 4.3 Which dimensions of climate change do the actors perceive?

We identified seven dimensions of climate change that research actors may perceive. They can be located at or between three impact levels: the individual, the collective, and the institutional level (see Fig. 7). These levels can be viewed as sites where climate change appears. However, the levels cannot always be clearly distinguished from one another and can interact with one another. The classification in this article aims to systematize the dimensions of perception more strongly according to their degree of impact. Sensory observations, for example, tend to affect an individual, while discourse requires a collective and policy requires institutions.

On the individual level, climate change can be *observed sensually* (Faisal et al., 2021). The change in temperature, precipitation, and landscapes can be sensually recorded, i.e., seen or felt, by individuals. Sensory observations are collected in one in five studies and are sometimes compared with meteorological data. Figure 8 shows that sensory observations of agricultural actors are predominantly researched, as they directly experience climate impacts. The central question of this research is the following: to what extent do individuals perceive objectively measurable changes in climate



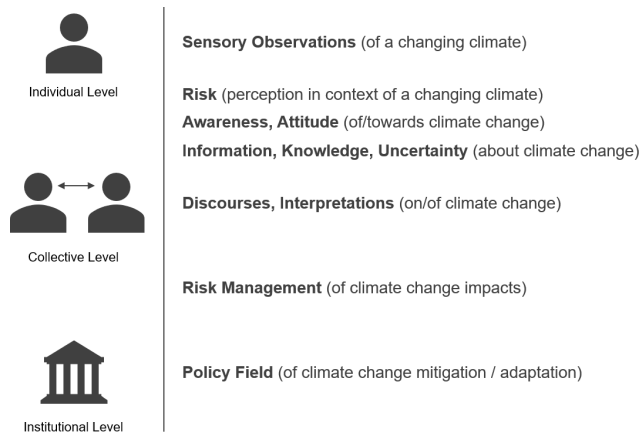


Figure 7. Levels and dimensions of CCP (own illustration).

conditions? This comparison of subjective and objective observations not only serves to verify the correctness of individual perceptions but can also be used to integrate the experiences of local actors into bodies of knowledge generated by scientific methods. Valdivia et al. (2010) develop an approach in which scientific approaches to climate and environmental change are complemented with indigenous observations of the changing environment to ensure better adaptation. Different bodies of knowledge can be linked in this way.

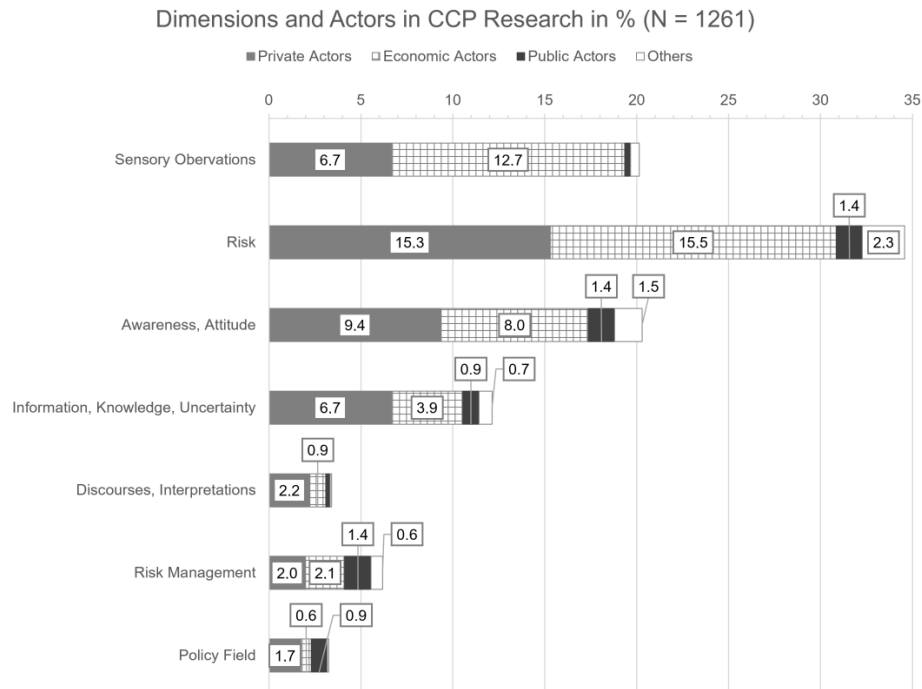
Between individual and collective levels, the actors who are researched can perceive three dimensions of climate change. *Risks* from extreme weather events increase. Individuals perceive and interpret these risks more or less rationally. This dimension always assumes an (expected) level of damage due to climate change impacts. The research focuses, for example, on perceived risks in the area of health (Tripathi et al., 2021) or agricultural losses (Ahmed et al., 2021). Questions from this research include how different actors subjectively perceive increased risk from climate change impacts, how they cognitively classify it, and which socioeconomic factors play a role in these processes. Climate change as a human risk factor is explored in more than one in three studies of CCP, making it the most intensively researched dimension of climate change in the CCP literature. CCP is discussed in one in five studies as *awareness or attitudes* about or towards the emergence and consequences of climate change (Trawöger, 2014). The central question is the following: to what extent are actors aware of the existence of anthropogenically induced climate change and its direct consequences for them and their living environment? Studies in this context repeatedly conclude that there is a so-called awareness–action gap: many people are increasingly aware of global warming but do not mitigate it or adapt sufficiently (Kollmuss and Agyeman, 2002).

Closely related to awareness is the perception of climate change as a complex of *knowledge, information, and uncertainty* (Cherif et al., 2017). To understand the origins

of climate change and its impacts, actors require information and knowledge, some of which is uncertain and/or politically contested. Exactly how actors perceive uncertainty in climate change knowledge is explored in CCP research (Sara et al., 2016). About one in eight studies asks what certain groups of actors know about climate change (Sorgho et al., 2020). The focus is disproportionately on private actors such as households or residents. In the knowledge dimension of climate change, similarly to the sensory observations, links are established between local knowledge about environmental changes and the global climate science discourse (Hameso, 2018; Sara et al., 2016). Studies on CCP as a knowledge–uncertainty complex often aim to identify and address deficits in the knowledge levels of certain groups of actors.

On the collective level, (media) *discourses and interpretations* take place, which shape how individuals perceive climate change and how they negotiate it socially. Questions of this research are, for example, which events and observations are medially linked to climate change or which images, narratives, and ideas are associated with it (Islam et al., 2020). This discursive mediation of climate change is embedded in contested values that can shape the relevance that is attributed to climate change and how it is interpreted socially (Stammler and Ivanova, 2020). Between the social and institutional levels, climate change can be perceived as *risk management* that is undertaken by decision-makers. The focus is less on how actors perceive changes in the natural environment and more on how measures are perceived that are taken for climate adaptation or mitigation like urban green spaces or renewable energies. These measures are an integral dimension of climate change, representing an infrastructural and/or organizational transformation of the individual living environment (Wagner et al., 2019). At the institutional level, individuals may view climate change as a *policy field*. These studies ask at which political level or in which political institution the responsibility for which climate action is seen and how political leadership can be located in this context (Essl and Mauerhofer, 2018).

The CCP research reviewed for the present study revealed that individuals may perceive seven, sometimes interrelated, dimensions of climate change at different levels. In summary, a focus of CCP research on sensory observations, risks, awareness, and attitudes, as well as information, knowledge, and uncertainty, in the context of climate change can be identified. The role of discourse, perceptions of climate risk management and political responsibility, has received little attention. Consequently, while there is considerable knowledge at the individual level and with the transition to the collective level of CCP, there is a desideratum at the collective to the institutional level. The dimension of sensory observations is most likely to be examined in research for its connection to climate action. This connection suggests that behaviorist approaches are more likely to focus on sensory perceptions of climate change as triggers for climate action. The discurs-



**Figure 8.** Dimensions and actors in CCP research (own illustration).

sive or interpretive dimension of climate change was the least likely to be examined for its relationship to climate action. CCP studies on discursive or interpretive dimensions of climate change can be assumed to be constructivist perception research.

## 5 Conclusions

The wide range of studies on CCP from different social sciences covers diverse groups of actors in different spatial contexts. Our systematic literature review reveals that the research landscape in this area focuses on vulnerable groups such as households or actors from agriculture, forestry, and fisheries from Asia and Africa. In terms of how knowledge is generated, we find that quantitative approaches, primarily in the form of surveys, are central to CCP research. There is circumstantial evidence that behaviorist approaches predominate. Studies explore seven dimensions of climate change that actors may perceive: sensory observations; risk; awareness and attitudes; information, knowledge, and uncertainty; discourses and interpretations; risk management; and climate as a policy field. We found that studies on the first four dimensions occur the most frequently.

Exploring CCP is relevant to understanding the motivations behind sufficient climate action on the one hand and to increasing legitimacy and participation in climate change research and policy actions on the other. Since perception depends on the sociocultural and spatial context of an individual, it is important to investigate whose perception is

researched, how this knowledge is generated, and which dimensions of the abstract concept of climate change an individual may perceive. Mahony and Hulme (2018:411) emphasize the relevance of understanding the way knowledge is produced in the context of climate change:

Acting in the world may be a corollary of knowing the world, but how one acts is already bound up with how one knows. Different knowledges lead to different actions.

Accordingly, an understanding of how a knowledge base is composed may give an indication of how complex social phenomena like climate change work.

In terms of CCP, we conclude, first, that there is a focus on “the vulnerable of the vulnerable” whose perceptions are studied. This can be seen as positive in terms of participation and legitimization of generating knowledge on climate change. Conversely, it also means that there is a research deficit on CCPs of the actor groups which, according to international climate agreements, bear the main responsibility for climate policy, such as decision-makers from the Global North. Further research could further investigate the connection between perception and adaptation of actors who have the responsibility and capacity for change on different scales.

Second, research desiderata exist in more qualitatively oriented CCP research. This could help to better understand the complex relationship between perception and climate action in behaviorist approaches. Our differentiation by actor groups, their geographic localization, and perceived dimensions of climate change may support this aim. Constructivist

approaches can also use our systematization to analyze how the perception of different dimensions of climate change constructs social realities. In particular, the impact of political or private campaigns on different dimensions of CCP provides avenues for further research.

We can identify a third deficit in the perception of dimensions of climate change that are at the collective or institutional level. These findings are consistent with the critique of Klepp and Chavez-Rodriguez (2018) that climate adaptation is often relegated to the level of individual responsibility of affected people, rather than politically pushing for broader solutions. This passing on of the responsibility to individuals to adapt to climate change takes place in a similar way with climate mitigation (Tozer, 2019) and is embedded in a general discursive context of neoliberal governance (Pyysiäinen et al., 2017). The result of this review shows that producing knowledge on CCP supports the tendency towards an individualization of climate adaptation through the selection of researched actors and approaches. The results of this paper do not provide information on the drivers of CCP or the interplay of different dimensions of CCP.

**Data availability.** The research is based on a self-created database. Extracts from this database are available on request.

**Author contributions.** AZ: conceptualization, formal analysis, investigation, methodology, project administration, visualization, writing (original draft preparation), writing (review and editing). SSc: conceptualization, funding acquisition, methodology, supervision, writing (review and editing). ST: data curation, writing (original draft preparation).

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