Research

More than just information: what does the public want to know about climate change?

Michael Murunga [1,2] (ORCID), Gretta T. Pecl [1,2], Emily M. Ogier [1,2], Peat Leith [3], Catriona Macleod [1,2], Rachel Kelly [1,2], Stuart Corney [1,2,4], Ingrid E. van Putten [2,5], David Mossop [1,2], Coco Cullen-Knox [2], Silvana Bettiol [6], Paul Fox-Hughes [7], Chris Sharples [8] and Jocelyn Nettlefold [9]

ABSTRACT. Public engagement on climate change is a vital concern for both science and society. Despite more people engaging with climate change science today, there remains a high-level contestation in the public sphere regarding scientific credibility and identifying information needs, interests, and concerns of the non-technical public. In this paper, we present our response to these challenges by describing the use of a novel "public-powered" approach to engaging the public through submitting questions of interest about climate change to climate researchers before a planned engagement activity. Employing thematic content analysis on the submitted questions, we describe how those people we engaged with are curious about understanding climate change science, including mitigating related risks and threats by adopting specific actions. We assert that by inviting the public to submit their questions of interest to researchers before an engagement activity, this step can inform why and transform how actors engage in reflexive dialogue.

Key Words: *climate change; climate change communication; public engagement; science communication; transdisciplinary research*

INTRODUCTION

Today more people are engaging with science than ever, both professionally and personally (Besley et al. 2019). Technology, including the internet, has made public engagement with science more accessible, for instance, through social media, blogs (Brossard 2013), and hubs for webinars (Kettle and Trainor 2015), aiding interplays between researchers, journalists, and the non-technical publics[1] (Nettlefold and Pecl 2022). These different actors, who come from diverse backgrounds and play various roles in society, are not just reporting on science but also shaping the direction, value, and meaning of science (Gregory and Lock 2008, Mach et al. 2020). However, their involvement can blur the boundaries of science, "with no clear divide between who can speak and who must listen, with many playing both parts" (Gregory 2015:222). Consequently, it is not surprising that calls for re-visioning public engagement with science have become prevalent at the science-society interface (Nowotny et al. 2003, Stilgoe et al. 2014), which remains "haunted" by the deficit approach of sharing scientific information (Pearce et al. 2015:615).

In practice, public engagement happens along a spectrum from raising awareness about scientific findings, via the knowledge-deficit model (Bubela et al. 2009), to more dialogical models that encourage conversation and participation between diverse actors (Rowe and Frewer 2005, Kawaka et al. 2017). Although the knowledge-deficit model presents an appealing and pragmatic view of provisioning the public with evidence-based information so that they can make better or more informed decisions, it has substantial failings (Hilgartner 1990). The deficit model has received criticism for being overly simplistic because it idealizes how people make sense of, evaluate, synthesize, and use information (Wynne 1992, Trench and Bucchi 2010). Moreover, the deficit model ignores the significant role of context, for example, social and personal norms (Goldberg et al. 2020) and other ways of knowing (Ogar et al. 2020, Fischer et al. 2022), which determine whether actors will receive, process, and use certain information (Kahan et al. 2012). Decades of such critique have led to a broad agreement that a focus on meaningful and iterative public engagement will make scientific information more socially robust (Gibbons 1999, Mach et al. 2020) by responding to the information needs, concerns, and interests of society (Jasanoff 2010, Leshner 2015, Dryzek et al. 2020).

There is no one-size-fits-all approach to public engagement with science. Previous studies have shown that public engagement events, for example, serve heterogeneous and interconnected objectives, including raising awareness and shaping the agenda of science, as opposed to a single specific aim, depending on the particular event (Davies 2019, Metcalfe 2019). Although public engagement with science events are many, for example, via science festivals, exhibitions, and fairs, they remain primarily one-way forms of sharing information that does not necessarily encourage the cultivation of engaging dialogues between researchers and the publics (Burri 2018). Consequently, these engagement activities have often been criticized for not being spontaneous because they are usually comprehensively planned events, with issues commonly chosen by a sponsor or group of scientific researchers, and often disconnected in time relative to public concerns (Powell and Colin 2009).

Given the contested and politicized nature of climate change science (Moser 2016), climate change communication and engagement remain a challenge for journalists, scientists, and policy makers because it is not solely a process of committing to

[1]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Australia, [2]Centre for Marine Socioecology, University of Tasmania, Hobart, Australia, [3]CSIRO Agriculture and Food, Castray Esplanade, Battery Point, Australia, [4]Australian Antarctic Program Partnership, University of Tasmania, Hobart, Australia, [5]CSIRO Oceans and Atmosphere, Castray Esplanade, Hobart, Tasmania, Australia, [6]College of Health and Medicine, Tasmanian School of Medicine, University of Tasmania, Hobart, Australia, [7]Bureau of Meteorology, Hobart, Australia, [8]School of Technology, Environments and Design, University of Tasmania, Hobart, Australia, [9]Australia Broadcasting Corporation Hobart, Hobart, Tasmania, Australia

Fig. 1. The public-powered approach to engagement with science. Its operationalization involves three phases: collaboration, consultation, and outreach, respectively. Using the Curious Climate project as a case example, phase one saw the establishment of a partnership between researchers allied to the University of Tasmania, Commonwealth Scientific and Industrial Research Organization (CSIRO), and journalists from the Australian Broadcasting Corporation Radio – Hobart. The arrows indicate the bi-directional flow of information between journalists and scientists. In phase two, Tasmanians were consulted through a multi-layered process to send their pressing questions about climate change to scientists via the media. Here, researchers spoke to the public through the media because the media has an established audience and medium for sharing information faster. The thin dashed arrow signifies that the public, using the media interface, can actively engage with scientists by submitting questions. In phase three, researchers and journalists organized outreach events based on the specific questions received in phase two, excluding those asked during live radio interviews, panel discussions, among others (see also Fig. A1.1).
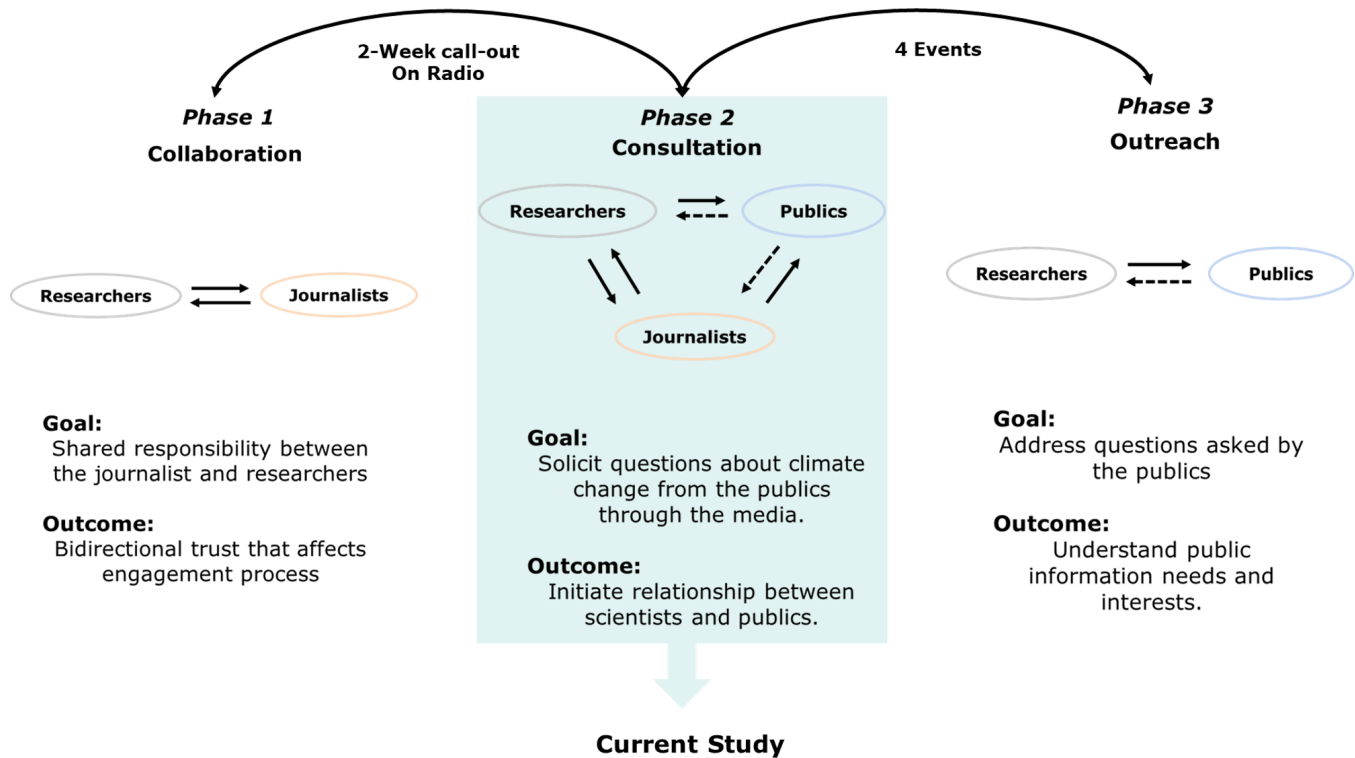
memory established scientific facts. Instead, public engagement with climate science seeks to affect how people develop awareness, attitudes, interests, and behaviors around climate change. The learning and debates, for example, around how to mitigate the impacts of climate change also have the potential to open fresh avenues of thought, and at times, provocative reflections among distinct actors, including the non-technical publics.

Scientists concede that engaging the public about climate change-related topics is challenging for several reasons, including lack of visible and direct causes, insulation of modern humans from their environment, and delayed or absent gratification for action, among others (Moser 2010). These challenges have specific implications for communicating climate change (Moser 2016). First, there is limited guidance on how to move the public from awareness, concern, and understanding to active, deep, and iterative engagement (O'Neill and Nicholson-Cole 2009) or deciding whose role this might be, institutionally speaking (Goldberg et al. 2020, Murunga 2022). Second, as the climate changes, we (referring to researchers of climate change-related topics) are forced to consider difficult questions such as how to communicate in a globalized, polarized, and fragmented media landscape that no distinct group can address alone (Schweizer et al. 2013, Smith and Lindenfeld 2014). Finally, converging and, at times, competing influences on scientific information by different societal actors, including policy makers, affects how researchers translate and transform understanding, concerns, and information needs into practice (Corner et al. 2014). In the current article, we attempt to inform these challenges by building on earlier studies (Cox 2010, Davies 2019) to introduce and present a subset of findings from an innovative—public-powered—approach to communicating climate change (Fig. 1; see also Appendix 1). Our work responds to recent calls for science communication and engagement to be strategic (Besley et al. 2019), evidence-based (Jensen and Gerber 2020), and inclusive (Hügel and Davies 2020). Central to the public-powered approach is the notion that researchers should take more responsible roles in creating a safe space where they can listen to and learn from the publics as well as speak and teach about science (Leshner 2015, Entradas et al. 2019).

The public-powered approach builds on knowing your audience concepts, including framing, that operationalizes the tailoring of messages to a specific medium and audience, using carefully researched metaphors, allusions, and examples (Nisbet 2009). It recognizes public engagement as malleable and subject to changes (positive or negative) by changing practices (McKinnon and Vos 2015). It addresses a crucial gap identified in the climate change communication literature, where scholars note that scientists often initiate, prime, and control public engagement activities with little opportunity for public input (Weingart and Joubert 2019). Many scientists are familiar with communicating to individuals without formal scientific training, including journalists and policy makers, but are less familiar with listening to their views and perspectives (Leshner 2021). Scientists seldom engage the non-technical public in genuine or true dialogue, where both sides listen respectfully and are willing to work together on problems (Wynne 2006, Leshner 2021). Conceptually, the public-powered approach recognizes that diverse actors in society have locally situated knowledge and pressing information needs and that integration, albeit challenging, is crucial for innovating solutions to adapt to or mitigate the perceived impacts of climate change (Barnes et al. 2020, Ward et al. 2021). It attempts to transform engagement under climate change by responding directly to information needs, interests, and concerns of the non-technical publics. Listening to the publics or asking them to contribute to the debate by asking what pressing questions they may have on, for instance, our changing world can shape how researchers and practitioners imagine the future. We assert that the public-powered approach sets a new frontier for scientists and journalists to work together to engage the public with climate science, that is, by soliciting related questions and then co-designing outreach events that respond directly to those questions (Fig. 1), as shown in the Curious Climate Tasmania initiative (Kelly et al. 2020).

In this paper, we present a thematic content analysis of questions on climate change received from the public in the island state of Tasmania, Australia (Fig. 1, Fig. A1.1). We ask the following question: What do the types of questions raised and thematic issues identified from Tasmanians indicate about the science of, research into, and potential role of engagement on climate change?

METHODS

Case study site: Tasmania
In this paper, we use the island state of Tasmania, Australia, as a case study to illustrate the variation in perspectives, interests, and concerns about climate change among Tasmanians (Fig. 2). Tasmania is a temperate region with rich biodiversity and a high level of endemism (McDonald et al. 2013). Yet, it is also a global climate change hotspot, where coastal waters are rapidly warming (Hobday and Pecl 2014). Tasmania is being affected by heatwaves in terrestrial and marine environments that have become more frequent over the past century (Oliver et al. 2018), with the elderly, the young, and those disadvantaged at most risk (Campbell et al. 2021). For example, in the marine environment, sea surface waters off eastern Tasmania are warming at four times the global average (Fig. 2), resulting in poleward shifts of many marine species, habitat changes, the decline in giant kelp, and increased prevalence of urchin barrens (Ling et al. 2015). These environmental changes have implications for ecosystems, communities, and the economy

(Fogarty and Pecl 2021), with livelihoods already affected (Pecl et al. 2019).

For five decades, Tasmanians have experienced entrenched polarized discourses (or conflicts) linked to the use, management, ownership, and conservation of marine and terrestrial resources (Lester and Hutchins 2012, Leith et al. 2014). These environmental conflicts are highly mediatized, particularly for vital industries such as aquaculture, fisheries, and forestry, where conservation needs, industry interests, and public concerns on environmental change intersect (Cullen-Knox et al. 2021). Environmental conflicts are social conflicts. They are often caused, at least in part, by market forces (Scheidel et al. 2020) and frequently overlap with pressing issues such as inequality, systemic marginalization, and challenges such as fake news, misinformation, and disinformation (Scheufele and Krause 2019). As the impacts of climate change intensify, there is a need to disrupt the status quo that dictates whose voice matters, how people engage with each other, in what form, and to what end (Lucas 2021). In Tasmania, like elsewhere, where climate change is resulting in social-ecological changes (Ward et al. 2021), there remains a need for distinct societal actors, that is, scientists, industry, journalists, and non-technical publics, to talk with and not at each other, for example, via mediated interfaces, about issues that might affect them. Tasmania provides a real-life setting (where climate change affects people and nature) to investigate and analyze what people want to know about climate change.

Data collection
In this paper, we analyzed questions about climate change from Tasmanians to researchers and journalists based in Tasmania (i. e., between 27 May and 10 June in 2019; Fig. 1; Appendix 1). In brief, recipients' questions were obtained through an adapted (licensed to the Australian Broadcasting Corporation [ABC] Hobart) Hearken interface, an engagement platform used by journalists and media practitioners to get comments from the public (Nettlefold and Pecl 2022). The data submitted and obtained through the Hearken interface followed ABC Editorial policies and social sciences human research ethics guidelines of the University of Tasmania (ethics approval granted on application number H0018145; Appendix 2). We targeted anyone above the age of 18 across Tasmania. Despite bounding the initiative to Tasmania, around 381 questions arose from people around Australia, of which 290 were Tasmanians. People also provided postcode information that enabled the project to tailor outreach events to specific locations around Tasmania (East: St. Helens, West: Queenstown, North: Launceston, and South: Hobart). In this paper, we only analyze and report on the questions submitted from Tasmania (Fig. 1), from which research ethics were approved (using the postcodes as a guide; Fig. 2).

Empirical data analysis
We conducted a thematic content analysis of the response questions received from Tasmanians, following established methods for synthesizing qualitative data (Campbell et al. 2013, Deterding and Waters 2018). Thematic content analysis is undertaken by categorizing data using recurrent themes and those that help answer the research question (Bengtsson 2016). Central to the process of conducting thematic content analysis is determining the meaning that researchers attach to textual data (Krippendorff 1989, Hsieh and Shannon 2005), because a text

Fig. 2. Map of Tasmania, Australia. Curious Climate Tasmania was a state-wide project that sought to engage communities with climate science. Engagement activities took place in four locations (Hobart, The Antarctic Gateway City and the Capital of Tasmania, located in the south; Launceston, a riverside city in the North; St. Helens, a coastal sea change community in the northeast coast and home to an older demographic of many retirees; and Queenstown, a town in the West with solid ties to the mining industry). These areas account for more than half of Tasmania's population (approx. population 339,072 of 541,000) with the rest living in small towns; adapted from Kelly et al. 2020).

may have more than one meaning in the same context, and thus requires researcher effort to condense and categorize hard-to-place data (Vaismoradi et al. 2016; Table A3.2). In this analysis, the content of questions was coded to identify patterns and themes, and the relationship between these themes expressed in climate science questions by participants in the study.

We followed four steps to analyze the data as outlined by Bengtsson (2016) and Deterding and Waters (2018). These steps generated a hierarchical frame of thematic codes, associated categories, and high-level thematic clusters (Fig. 3; Table A3.1).

Step 1: Data preparation and organization. We organized and indexed the data in a spreadsheet using unique identifiers to protect the confidentiality of respondents. Moreover, we considered contextual information (e.g., profession, local ecological conditions) provided by respondents to interpret and explain the questions.

Step 2: Data review, first-pass coding, and identification of tentative connections. The sets of questions were then read and re-read to undertake exploratory identification of analytic codes and journaling the process of developing the coding frame allowing familiarization with the process of analysis, linking question data to specific thematic codes. First-pass coding allowed initial identification, classification, and consistent labeling within and between textual data (to make tentative connections and summative statements). In our examination, first-pass coding enabled us (as researchers) to begin coding based on previous experience on related works and with insights obtained from scholarship on climate change communication (Corner et al. 2014). All initial analytic codes (n = 41; Fig. 3; Table A3.2) were emergent from the respondent's questions (Deterding and Waters 2018). We kept the decisions of the analytic codes selected close to the text by using keywords within the questions as initial codes (Vaismoradi et al. 2016), and also by

Fig. 3. Coding steps followed in conducting a thematic content analysis. These steps are used to generate a hierarchical frame of thematic codes that inform the high-level thematic clusters (see also Table A3.2).
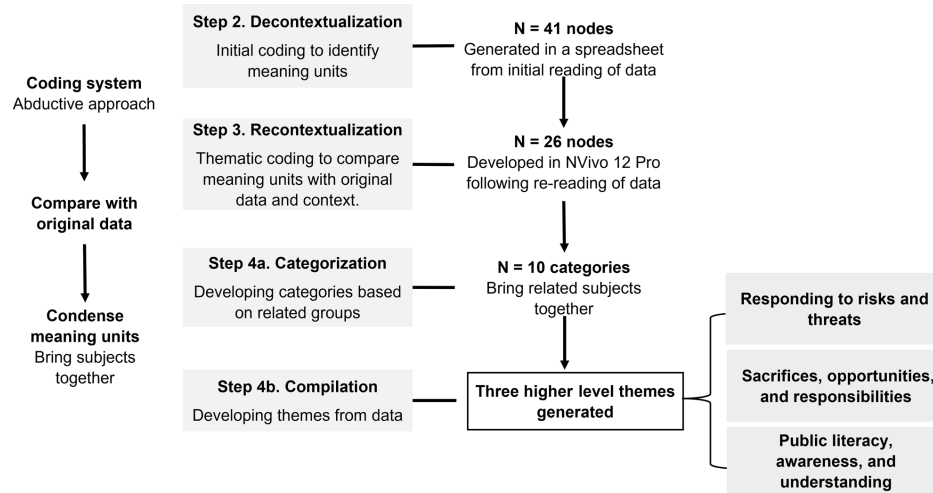
understanding our assumptions, background, and previous experiences (Erlingsson and Brysiewicz 2017), in maintaining construct validity (Miles et al. 2014).

Step 3: Data analysis and iterative refinement of the coding frame: The spreadsheet dataset was uploaded into NVivo 12 Pro (QSR International Pty Ltd. 2018), a software tool for organizing and managing data, and for undertaking objective and independent thematic content analysis. Before full coding, we coded a random sample (n = 15) of the dataset to check for consistency leading to an iterative refinement of the coding frame (Campbell et al. 2013). The coding frame consisted of a hierarchy of nodes, or specific themes, to which sections of question text were to be "coded" where the relevant theme was identified in the text. Coding was conducted by the lead researchers and re-assessed by two other coders for intercoder agreement after each round of analysis to assure consistency (Campbell et al. 2013). For example, the coders differed on how to code the notion of "anxiety"; some proposed that it should be under "preparedness," but after deliberation on the meaning and context under which people experience feelings of anxiety, we decided to create a new node "Beliefs" and within it embed "anxiety" as a child-node (Table A3.1). During coding, the text in some questions was coded against several different nodes because text can have more than one single meaning within a context (Schreier 2014). Several rounds of coding were undertaken as necessary to overcome the inherent challenges of thematic content analysis, and in particular, our biases associated with focusing on selected aspects of both latent and manifest meanings to address our research question (Graneheim et al. 2017:31). The process of code revision and validation allowed us to develop a more precise definition of the categories.

Step 4: Verification of final coding frame and thematic clusters. To ensure that the final themes used to report the findings were valid and responded to the research questions, we verified our interpretation against the raw data by checking whether all aspects of the content were covered concerning the aim of the research

(Bengtsson 2016), further maintaining meaning in context (Schreier 2014). For example, following this step of verification and re-contextualization, we combined sub-themes of respondents who asked about "prediction accuracy" to category "literacy." The combination of related themes enabled the refinement of the final thematic clusters and confirmation that a rational interpretation of the data had been reached. The inductive data analysis process created 26 nodes (Table A3.2), linked to 10 higher level categories with 52 subcategories that collectively informed the final three abstract themes. In addition to the thematic content analysis, we undertook exploratory quantitative data analysis (i.e., summary statistics) to describe the demographic attributes of the respondents and any effect of age clusters on higher level thematic interests.

In the following, we present our findings of themes and patterns of what Tasmanians wanted to know about climate change. We applied well-established methodological approaches for representing participants' voices using quotations in qualitative research (Deterding and Waters 2018). We use questions from Tasmanians as quotes in this work to enhance readability, understanding of the case, and produce a cohesive narrative (Nowell et al. 2017). The quotations supply Tasmanian voices, reflecting contributions from each of the different regions of Tasmania (east, west, south, north), and demonstrate some strong patterns in the dataset. Then, we discuss high-level insights on how our results may advance the practice of communicating the science and potential impacts of climate change.

RESULTS
The public responses revealed that Tasmanians hold diverse thoughts and views on climate change, including its potential impact on the economy, ecosystems, and society. The diversity of questions demonstrates the intricacies of communicating about the science and perceived effects of climate change, particularly to a broad audience.

Contextual attributes of the respondents
Questions were provided by people from all regions of Tasmania (Fig. 4). Most questions were asked by men (53%), followed by women (33%) and others (14%), that is, individuals who use other gender identities (Kennelly et al. 2001). Over 65% of the respondents' questions were from southern Tasmania (Fig. 4). The percentage of questions linked to higher level themes differed by age cluster (Fig. 5). The mean age of respondents was 52 years old, and the majority were in age clusters 51–65, i.e., accounting for over 43% of questions asked. Table 1 provides a synoptic overview of the dominant categories linked to the three higher level thematic groups (i.e., risks, literacy, and sacrifices) used to report our findings of the thematic content analysis. A vast majority of the respondents (86%) were interested in at least one higher level thematic area, followed by 13% interested in at least two themes, while 1% were interested in more than two higher level thematic areas (described below). Most of the questions were about responding to threats (n = 133), understanding the scientific basis of climate change (n = 111), and human responsibility (n = 46) on climate change.

Fig. 4. Distribution of respondents' questions by gender and region. Total N is shown above the graphs.
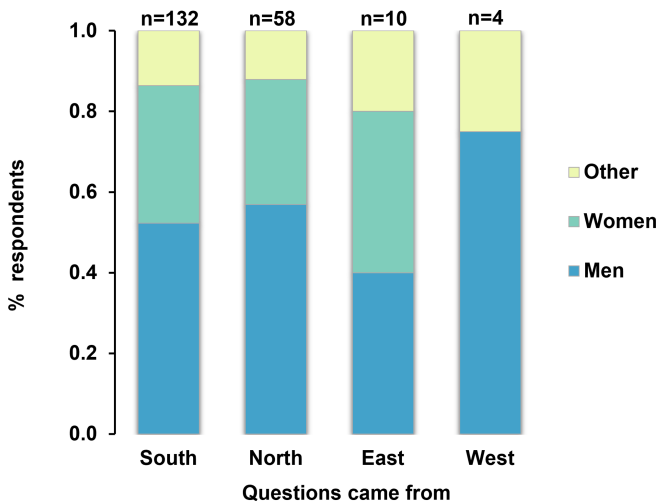
Responding to threats and risks
Questions about climate change-related risks were prevalent in the dataset (Table 1). Responding to the impact of climate change moves the debate from being about cognitive processes (e.g., framing) or heuristics that leverage sociopolitical relationships to sustain, disrupt, and influence action on climate change toward approaches that probe how specific interventions may affect the broader social-ecological system. As one respondent said, "... what are the most critical changes that ordinary Tasmanians can make to their lifestyle, and what impact (positive or negative) would these changes have on our island if everyone adopted them?" (FN_82). Another respondent asked, "... how much vegetation on the foreshore will help to slow the rising sea level?" (NF_181). These questions indicate that people are thinking about proactive approaches that can lessen the impact of climate change. Respondents want to know how and why they should collectively act to address climate change-related risks.

Respondents' questions often highlighted threats such as wildfires, floods, and drought but appeared to be wanting to weigh these against costs of mitigation and inaction. One respondent said, "how can we tell how much money the government should put into climate change versus personal changes or monetary donation?" (SF_15). Another respondent asked, "how will the action of Australians to reduce greenhouse gas emissions directly correlate to a reduction in future extreme weather events such as bush fires, droughts, floods and cyclones in Australia" (MW_169). These arguments show that the public is not oblivious to the risks (e.g., property loss), but that they want to understand the economic cost of mitigation over time, including how emissions reductions achieved by Australia would help Australians to address recurrent challenges.

Respondent's questions also raised concerns regarding the threat to critical coastal infrastructures like airports, bridges, or buildings. For example, one respondent asked, "the Hobart airport runway is right on the seven-mile beach ... could the runway be at risk of inundation if sea-level rise [further commenting] ... should the airport be devising long-term plans for relocation?" (SF_52). Similarly, another respondent asked, if "...the Midway Point Sorell causeway, on which they are currently planning to invest millions - is this being future-proofed against sea level rises?" (SF_80). The questions about safeguarding critical public assets show that people are aware of the complex trade-offs that must be made, to ensure that the lives of local communities who regularly use these infrastructures are not disrupted, for example, by sea-level rise.

Economic impacts were a significant point of reflection regarding specific industries such as agriculture, fisheries, and tourism. For example, one respondent asked, "what impact will climate change have on Southern Rock lobster stocks on East Coast Tasmania?" (EM_35). This respondent, like many others analyzed, expressed interest in understanding the current potential impact on the productivity of the resource system, including alternative opportunities that might occur because of climate change. Different respondents asked, "will we see more green lip abalone spread southwards" (EM_141). While another linked agricultural production to pollination by asking, "given that the window of pollination is becoming brief, how can we help pollinators cope with the delays in fruiting, flowering and mating times?" (FS_97). The latter respondent raised concerns about food insecurity, how pollinators (wild and managed) might be under threat from climate change, and whether this may influence how humans produce food, or as another respondent asked, "will it be possible to survive here [on the island of Tasmania] and grow food as ecological conditions deteriorate" (SF_61).

In summary, respondents show that they understand that preparing for uncertainties due to climate change is crucial (Table 1). Based on the above findings, we note that communicating about climate change-related risks is a balancing act for those involved. In other words, respondents' questions show that there should be a balance between presenting evidence on risks with actions needed to bring about systemic changes, a crucial but still contested issue in scholarship.

Awareness and understanding of climate change
Responses related to climate literacy, awareness, and the need to understand subjects associated with climate change were also

Fig. 5. The proportion of questions linked to specific higher level themes and clustered by age. Total N is shown above the graphs.
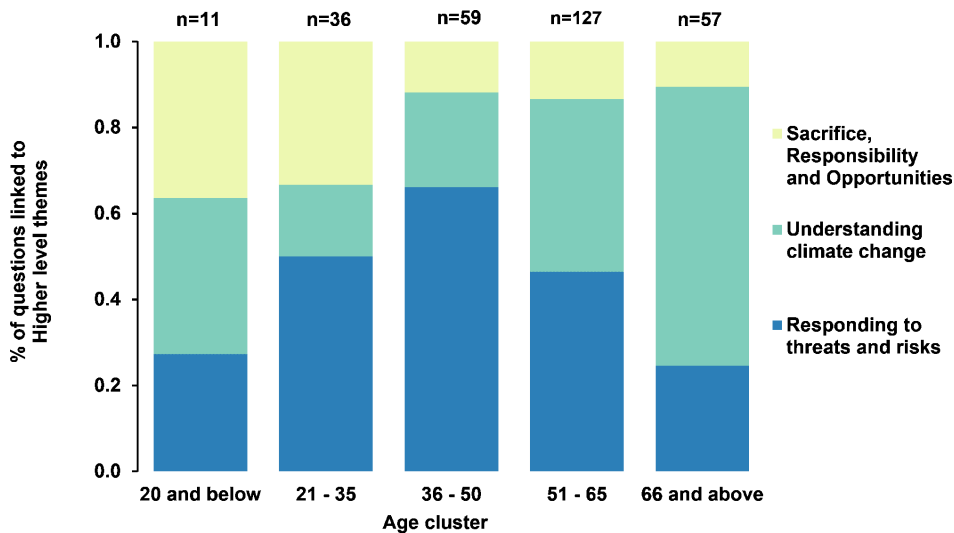
prevalent among the respondents' questions (Table 1). The information people have about an issue, for example, derived from lived experience, affects how they perceive further learning as useable in debates and decision making.

In this cluster, respondents (n = 56) sought to know how the current knowledge regarding climate change can be explained using historical and longitudinal data. For example, one respondent asked, "...how did we go from the medieval warm period to the little ice age and then out of the little ice age if the vast majority of man-made carbon dioxide was emitted after the 1900s..." (OS_01). Another respondent asked, "...is there any merit to the argument that human-induced climate change may delay the ice age that we are overdue for ... leading to less species loss in the long term ... ?" (FS_07). Although some respondents asked questions that were complex in nature, other respondents (n = 19) aspired to know basic facts about greenhouse gas emissions, for example, "how much water vapor is in the atmosphere and how does that compare to CO_2?" (FN_12); or "why does CO_2 concentration always follow temperature changes?" (MS_179). These questions clarify that many respondents might have some prior knowledge of greenhouse gases contributing to climate change but needed more information about human contributions.

The respondents wanted to know about the physical processes driving climate change, including its impact on the resource systems at local and global levels. For example, one respondent asked, "what changes to the average temperature should be expected in North Tasmania [an agricultural area] over the next 30 years because our crops require a certain number of chill hours for production?" (MN_20). Another respondent asked, "if we lose ice caps in Antarctica (and the Arctic) to warming oceans, what happens to the circumpolar current that transports nutrients around the globe?" (OS_41). These questions show that the different publics are neither homogenous in their thinking nor necessarily ignorant of the impacts of climate change on the local

and global social-ecological system because they can conceptualize ecosystem processes in conjunction with local knowledge to infer the meaning of current changes.

However, some respondents' questions pointed to the fact that the complex nature of climate change threats and disturbances renders it challenging for them to imagine immediate and expected impacts. For example, one respondent said that "... if the ice is melting and the sea level rising, how come it has not affected the beaches around Devonport, where I have lived for more than 50 years ... [continues to argue that] ... the only thing that has changed is we have good media footage" (MN_99). Other respondents argued that they do not believe in anthropogenic climate change, referencing contrasting information read on the internet, implying that climate change is fake news. These arguments suggest that the use of specific and distant imagery or frames of reference in the media to emphasize the size of the climate change challenges faced may be counterproductive, that is, has the potential to engender disbelief, limiting people's ability to debunk misinformation (Scheufele and Krause 2019).

Respondents raised questions about the accuracy of the climate change evidence and how they ascribe meaning to that data because interpretation is influenced by context. For example, a respondent asked, "to what degree is anthropogenic climate change real, or is the world going through natural cycles?" (SM_168), while another respondent asked, "how much has the sea risen due to anthropogenic climate change?" (SM_66). A third respondent provided context by describing how in the "last few years, we have had windy weather all year round. How has climate change affected this, and will it get more frequent in the future"? (SF_110). This abstract cognition of climate change as something real tries to delimit the boundary between what can and cannot be explained with current evidence. It extends beyond the dominant skeptic-believer dichotomy on climate governance that has not just split the public but also researchers and policy makers (Corry and Jørgensen 2015). For instance, it is echoed strongly

Table 1. Overview of the main results and descriptions. The three higher level thematic clusters are linked to the 10 dominant response categories. Percentage in parenthesis indicates the proportion of respondent questions associated with a specific dominant theme. (NB: there exist some interdependencies among the different dominant categories because most questions were attached to several codes; see Table A3.1).

Higher level Thematic Cluster	Category	Description of response category	N	(%)
Responding to threats and risks	Risk	Understand risks associated with climate change such as wildfires, coastal erosion, and sea-level rise. It also captures questions about risk immediacy and prevalence.	68	(23.2)
	Energy security	Energy security, alternative technologies, and inquiries on how to transition to a low carbon economy.	32	(10.9)
	Economy	The economic cost of climate change, including costs associated with collective action and lack thereof.	31	(10.6)
	Critical infrastructure	The impact of climate change on principal public infrastructures, including bridges, airports, and roads.	28	(9.6)
	Biodiversity	Threats to biological diversity (plants and animals), including scenarios of species gain and loss.	23	(7.8)
	Food security	Understand the impact of climate change on food production (i.e., scarcity, quality, surplus, variety).	21	(7.2)
Awareness and understanding of climate change	Literacy	Understand "general" climatic processes, climate change, and associated imperatives.	40	(13.7)
	Beliefs	Includes domain-specific questions of belief (i.e., whether it is happening). It connotes that knowledge about climate change is an artifact of innate human existence.	10	(3.4)
Sacrifices, responsibilities, and opportunities	Responsibility	Small structural changes that people can install at a household or organizational level to help address the challenge of climate change.	31	(10.6)
	Preparedness	How people and the state of Tasmania should or could be preparing for climate change and the resources required to do so.	9	(3.1)

by respondents who say that they "... encounter climate change deniers at work, in family and social groups. They say I cannot prove that climate change is real ... I want access to reliable information so that I can converse with such people?" (FN_129); or more importantly, "what is the best [reliable] source of evidence for anthropogenic climate change statistics that we can use to converse with those who deny or are misinformed about climate change" (MS_74). These questions and levels of cognition suggest that respondents are thinking beyond solutions that make sense to them to include their social networks, opening the stage for multiple interpretations of the evidence on climate change. The respondents are looking for proactive ways of informing and allying others using the best available research evidence. These responses show that some publics do take climate change as seriously as climate researchers suggest they should.

However, others believe that the chances for meaningful climate change debate are not given equally to all. For example, a respondent said, "I assume in your coverage (mass media) of climate change, you do not need a 'denier' to balance the debate" (MS_118). Another respondent argued that they get "skeptical of anyone who puts a number on the future" (SM_22), especially in the mass media. These arguments suggest that some publics feel climate change assertions should be challenged by those who have alternative viewpoints and voices to shed more light on overlooked dimensions. For example, one respondent asked, "how confident should we be in our current predictions" (FN_12). The latter questions show while models of future climate are fit for inciting conversations, they can fall short in engendering trust among other societal actors because the models hold a degree of uncertainty when it comes to projecting future climate conditions.

Sacrifices, responsibilities, and opportunities
Broadly, respondents showed a keen sense of social responsibility (Table 1). Social responsibility is a call to action, something that should or must be done by both governments and distinct societal actors, including scientists (see also Entradas et al. 2019). Considering oneself responsible for the success or failure of a social-ecological system is not trivial or easy because it shifts the balance of responsibility from showing that there is a problem that needs solving to asking how we should prepare. In this thematic cluster, one respondent asked, "if we are to make changes in lifestyle or behavior, what would be the most powerful action to combat climate change, we can take on at an individual, business, and government level ...?" (SF_53). Another respondent said that "everyone he/she associates with is keen to adopt a personal carbon budget, as a guide to making mobility decisions" (OS_66). These questions show that people aspire to act as responsible stewards, but they need guidance. Responsibility is not only tied to personal actions but also businesses. One respondent asked, "what can the big industries, for example, agriculture, aquaculture, and forestry, do to reduce their impact on the climate" (MS_144). The latter question evokes a more ubiquitous socioeconomic and policy dimension that is beyond the scope of this current paper, although still vital for reflection on the role of those essential industries to conversations about climate change.

Mitigating the impacts of climate change requires society to transition from dependence on non-renewables to renewable energy. However, current energy transition efforts have a suite of challenges, such as grid stability, new storage systems, and involvement of many actors, among others (see also Koehrsen 2017). These issues affect how actors, including businesses, promote energy transitions. For example, different respondents recognized that fossil fuels are influential drivers of global warming and indicated they would like to switch to low-carbon alternatives, but as one respondent said, "what is the financial cost of transitioning to 100% renewable and what would my electricity bill look like if all retail power was 100% renewable?" (SM_22). The commentary asks for a proactive estimate, grounded in evidence, to inform personal actions. Although it seems like a dynamic way of approaching the transition to low-carbon power, others call for a precautionary approach to energy transitions arguing that renewable technologies are as destructive as fossil fuel. A respondent asked, "what is the time required to offset the energy used to dig the minerals required to produce, transport, and install the wind turbines and solar panels" (NM_34). These arguments, coupled with other challenges such as battery waste disposal and impact on wildlife, shift the debate from just promoting low-carbon power to our collective and broader responsibility to nature.

DISCUSSION
This research considers how inviting the public to submit questions of interest on a particular topic can help researchers move toward inclusive and reflexive engagement (Ogar et al. 2020), in our case, what they would like to know about climate change. Adapting to and mitigating the effect of climate change needs distinct societal actors, for example, journalists, policy makers, and the non-technical public, to have a genuine dialogue, where both sides listen respectfully and work together to address associated problems (Leshner 2021). In Tasmania, there is a strong recognition of the relevance of public engagement on climate change (Nettlefold and Pecl 2022). Although there is no one-size-fits-all approach to engendering meaningful dialogue on climate change, the Tasmanians we engaged wanted to know about the underlying causes, associated impacts, and how to respond to impacts of climate change. These cross-cutting themes infer a need for distinct kinds of conversations, conversations that extend beyond just sharing information about climate change. As many societal actors call for meaningful engagement on climate change (Sachs et al. 2019, Obura et al. 2021), simply providing scientific evidence may not be enough to transform attitudes and behaviors because people consume and understand such information using their pre-existing cognition, socio-cultural and political context, and perception of risks (Shackley and Wynne 1996, Kahan 2015).

We draw four insights from our findings on how researchers can transform engagement under climate change. We note that there is a need to: (1) develop capacity for meaningful dialogue, (2) integrate distinct kinds of knowledge, (3) make scientific facts accessible, and (4) engage the non-technical public from the beginning. These insights encourage reflexivity and changing engagement practices under climate change.

Develop capacity for meaningful dialogue
Humans, like other animals, are curious, adaptive, and have a set of response mechanisms, such as flexibility and cooperation for

combating ecological threats beyond fear and negative emotions (O'Neill and Nicholson-Cole 2009, Davies 2019). The people we engaged within our study expressed the need to develop their agency to steer toward a stable and robust future and that relational and deep (as opposed to shallow) engagement with scientists may help connect different actors to issues of climate action, rather than doing so solely through a persuasive appeal (Goldberg et al. 2020). They showed via their questions that they recognize the need to address the challenge of climate change without understanding the full complexity and associated uncertainties. These results align with more recent studies that argue non-technical publics may not understand the complexities of climate science (it is unrealistic to ask them to), but they might be aware of distal or proximal potential impacts and associated imperatives (Brügger et al. 2015). Thus, empowering people to deliberate with others remains imperative in responding to climate change.

The respondents, however, also showed that they do not know what is required to bring about systemic changes. Specifically, people wanted to understand how they can act at an individual or organizational level, for instance, exercising choice over certain kinds of food to eat, reducing their global carbon footprint, or probing their local governments to create policies to offset specific actions. This finding is consistent with existing evidence on the challenges people encounter when making decisions about transitioning to a low-carbon lifestyle (Whitmarsh et al. 2011). Our results offer reliable signals that people we engage with (from Tasmania) want to be empowered to take initiatives, try innovative ideas, or even attempt local climate actions. Yet, for engagement with climate science, such concerns present a fundamental dilemma on promoting things that the public (who play many roles in society) should or should not do. Nonetheless, as more recent studies note (Simpson et al. 2021), and we assert based on our findings, understanding anthropogenic causes of climate change is vital to increase climate change literacy (Kelly et al. 2022) and build adaptive capacity to respond to climate change (Barnes et al. 2020, Murunga 2021). However, to support public agency to act, researchers and practitioners must focus on strengthening the interplay between education (tailored to improving understanding), communication (focused on social influence and learning), and individual perceptions of risks (linking to the transaction cost of action and inaction) associated with climate change.

We assert that researchers must address public information needs, concerns, and interests when deliberating on climate change. Based on our synthesis, we maintain that such an approach could transform engagement, allowing distinct actors, such as the media, to tell compelling stories of local climate action (O'Neill 2020) and policy makers to design policies that respond directly to the effects of climate change (Aklin and Mildenberger 2020, Steger et al. 2020).

Integrate distinct kinds of knowledge to facilitate inclusive conversations
As society increases the demand for knowledge co-production, the importance of bridging scientific knowledge with other knowledge increases (Latulippe and Klenk 2020, Ogar et al. 2020). For engagement with climate science to be most effective, information must be received, processed, and synthesized in a form that fits into existing societal frameworks, needs, and

interests (Mach et al. 2020, Ward et al. 2021). Based on our results, we argue that the Tasmanians we engaged have an amorphous perception of how climate change risks link to the economic cost of mitigation and inaction. Like earlier studies (Nursey-Bray et al. 2012), we found that Tasmanians are genuinely concerned about the impacts of climate change on the economy, critical infrastructure, and biodiversity. Thus, engaging the public on climate change and related actions might remain challenging for researchers and journalists as, in most cases, the impacts remain invisible, distant, and lack immediacy (Moser 2010). Nonetheless, more recent work from other parts of Australia where citizens have been involved in monitoring climate-driven range shifts offers reliable signals that scientists should and can engage the public by making science locally meaningful (Nursey-Bray et al. 2018). Local actors understand their environments better, and thus their experiential knowledge can complement scientific information when exploring plausible climate actions, as shown in a recent study exploring South African farmers and fishers (Ward et al. 2021).

Drawing insights from respondents' questions, we argue that people use many kinds of knowledge (i.e., scientific: what causes climate change; technical: are there tools that might help us address it; ethical: is it okay to suggest specific actions for the whole community; market: does the cost of transition make sense; local and indigenous knowledge: how it affects my livelihood) to reflect upon plausible solutions (Ward et al. 2021). Thus, simply sharing scientific evidence on climate change is not enough to engender action because people have concerns, needs, and interests that remain rooted in context. These public concerns are affected by politics, power asymmetry, and social inequalities (Turnhout et al. 2020, Murunga 2021). Consistent with earlier research (Nerlich et al. 2010, Besley et al. 2019), we note that there is a pluralism of knowledge and values in play when scientists engage the public on climate change. Thus, we argue proponents of action on climate change, including scientists and researchers, risk alienating their constituencies by partitioning knowledge too strongly, for example by deliberately, or inadvertently talking about the science of climate, without discussing how to respond, including failing to embrace other ways of knowing, which might promote distinct positions on how to respond to the impacts of climate change (Ogar et al. 2020).

Make scientific facts accessible to reduce susceptibility to misinformation

Citizens, companies, organizations, and governments use scientific information selectively to align with their needs, interests, and concerns. Scientific information as a public good is subject to interpretive flexibility (Star 2010). Thus, it is difficult, at times, for people to distinguish scientific evidence from misinformation and fake news, especially in the current information-saturated mediascape (Entradas et al. 2019, Scheufele and Krause 2019). In our findings, respondents wanted to know the "best" credible source of information for anthropogenic climate change to share with families, relatives, and co-workers who do not regularly interact with science. People want access to climate change evidence, that is, understandable and relatable to local information needs and via websites or databases that have not engaged in distortion (Hilgartner 1990). Although there are specific strategies proposed in the literature to evaluate and address the issue of misinformation, such as giving

people information before exposure to fake news and exposing denialists through fact-checking and corrections, it is not enough (Cook et al. 2017). Unfortunately, as literature confirms (Stecula and Merkley 2019), the suggestions of countering misinformation may not keep up with the vast amount of information produced and disseminated through the mass and social media (Iyengar and Massey 2019, Nettlefold and Pecl 2022). Nonetheless, they provide a plausible approach to reducing susceptibility to misinformation.

In our analysis, some respondents saw the media as a vital knowledge broker. As in other studies (Cullen-Knox et al. 2021), we assert that the media can proactively connect researchers and the non-technical publics, improving two-way discussions. The media also have the responsibility of reporting scientific facts and curating news on local climate action. Actively involving the media to share scientific facts shifts attention from what researchers want to talk about to what the public wants or needs to know about climate change (Nettlefold and Pecl 2022). Although researchers can engage the public on climate change working independently, their impact is often limited to a specific region, audience, and expertise. We assert that cooperation with the media can expand the reach of climate researchers. Also, when scientists and journalists work together, they can facilitate genuine dialogue across scales with the non-technical public, where each side listens respectfully to supporting and dissenting viewpoints. Such insights align with more recent studies on transdisciplinary collaboration that requires researchers from different disciplines and institutions to work together to engage the public about issues that might affect them (Kelly et al. 2019). Cross-institutional collaborations can help researchers and journalists navigate socio-political, economic, and cultural forces that might undermine meaningful deliberation on climate change.

Engage the non-technical publics from the beginning

People perceive climate change differently. For instance, while some respondents recognize its urgency, calling for concerted action to mitigate potential impacts, others use distant examples to undermine the need for immediate action. We assert that such complexities reinforce calls for engagement on climate change to be strategic (Besley et al. 2019), particularly on sharing scientific facts (Pennycook et al. 2021), increasing social capital (Murunga et al. 2021), and building adaptive capacity (Barnes et al. 2020). This view aligns with other recent findings in the literature, calling on climate scientists to "reflect on the social impact of their communication" (Entradas et al. 2019:81), especially when communicating uncertainty to the public, who "expect more public engagement from scientists than what scientists perform" (Yuan et al. 2019:114).

Based on our findings, we assert that inviting the public to submit questions (as information needs, interests, and concerns) to climate scientists and researchers presents a pragmatic step for bridging the divide between science and society regarding climate change (Leshner 2015). Such measures can inform climate science communication and engagement to be reflexive, strategic, and respond to vital public information needs (Salmon et al. 2017), further helping re-vision ongoing criticisms about public engagement as a public relations exercise (VanDyke and Lee 2020). Consequently, it can enable researchers to make changes in research practice, re-defining the process of finding research

questions that not only include the needs and interests of the public but also present the opportunity to foster enduring effects (e.g., by changing attitudes, feelings, and beliefs) and change (e.g., sustainable resource use). Although limited in scope and breadth, the public-powered approach introduced through the Curious Climate initiative and reported herein offers reliable signals about how critical reflective practice and reflective dialogue, among researchers, journalists, and the non-technical public, could support the governance of climate change.

Methodological limitations

All methods would involve bias of some description (Bernard 2006). In our study, we used a flexible and broad approach to overcome the challenges of non-response bias, following best practices for conducting social surveys (Kelley et al. 2003) and collaborative interdisciplinary research (Kelly et al. 2019). We used all Australian Broadcasting Corporation (ABC, our project partner) outlets in Tasmania (three newsrooms and two radio stations) to reach out to Tasmanians. This approach was deemed relevant and effective because of the challenges of getting people to talk (let alone ask scientists questions) about pressing issues like climate change. This is because critical scholars argue this issue remains superficial to most and vulnerable to frequent revision (Moser 2010), politicization (Latulippe and Klenk 2020), and distortion (Scheufele and Krause 2019). Also, we shared posts via social media (Twitter, Facebook) and invited people to participate through other community networks. We note, though, that some voices and perspectives might have been left out, such as those of young people, people working from remote environments with limited internet, and those unconcerned about climate change (Lucas 2018). The latter (unconcerned) would be hard to reach no matter what method was employed. Also, we did not ask for specific socio-demographic information such as primary occupation and education that would have enabled us to analyze by different demographic, occupational, or industry sectors. An industry-sector-specific inquiry would have helped broaden knowledge of how Tasmanians working across major industries perceive climate change. Notwithstanding, the range of questions received reflected diversity in perspectives regarding uncertainties, pressures, and opportunities presented by climate change. We are confident that we had sufficient responses that enabled us to address our research question, given the many recruitment strategies deployed, the wide age ranges (14–82 years old), the distribution of questions from distinct publics in rural to urban areas, and because participation decreased after 10 days.

CONCLUSION

This research has the potential to influence future research and advance communication about climate change in multiple ways. The public-powered approach used amplifies the voice of the public during the engagement. It provides a means to reconcile not only how the public perceives climate change issues, but also specific interventions, which we argue might help scientists to overcome challenges of institutions of science such as when to engage or not to engage with the public on issues with high stakes such as climate change. Bringing the people and their valuable insights directly into the conversation enables scientists, researchers, and other practitioners, to examine opportunities for sharing potential actions against climate change. Further, communication is now a conversation with society, speaking back

to science through questions, providing a unique opportunity for knowledge exchange that does not shy away from criticism and negotiation. The public-powered approach transforms public engagement from being hierarchical to distributed, a process where actors not only receive facts but also shape the nature of the shared information. For example, inquiries about the procedural and distributive outcomes and justice of societal choices, beliefs, and ethics, cannot solely be addressed by generating better research questions with, by, and for the scientists. Instead, these issues advocate for a different approach to public engagement, one that must proactively involve distinct societal actors, including a non-technical public. However, there are still many vital mechanistic and communication questions that need to be addressed, including "who should be framing research problems at the science-media-public interface"; "how can the public powered approach change research needs and interests"; and "who should decide about public engagement"? These questions present unique dilemmas (ethical, social-cultural, and policy-related) on the complex challenge of communicating climate change.

_____

[1] In social scientific scholarship on public engagement, the term publics, as opposed to the general or diverse public, is accepted. Publics recognize the heterogeneity and uniqueness of people who may or may not have formal training in science but regularly encounter and interact with science.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.
php/13147

Data Availability:

The data are currently not publicly available. There are restrictions related to the original dataset because it might contain sensitive participant information, including age, gender, names, and physical location.

LITERATURE CITED

Aklin, M., and M. Mildenberger. 2020. Prisoners of the wrong dilemma: why distributive conflict, not collective action, characterizes the politics of climate change. Global Environmental Politics 20(4):4-27. https://doi.org/10.1162/glep_a_00578

Barnes, M. L., P. Wang, J. E. Cinner, N. A. J. Graham, A. M. Guerrero, L. Jasny, J. Lau, S. R. Sutcliffe, and J. Zamborain-Mason. 2020. Social determinants of adaptive and transformative responses to climate change. Nature Climate Change 10 (9):823-828. https://doi.org/10.1038/s41558-020-0871-4

Bengtsson, M. 2016. How to plan and perform a qualitative study using content analysis. NursingPlus Open 2:8-14. https://doi.org/10.1016/j.npls.2016.01.001

Bernard, H. R. 2006. Research methods in anthropology: qualitative and quantitative approaches. Fourth edition. AltaMira, Oxford, UK.

Besley, J. C., K. O'Hara, and A. Dudo. 2019. Strategic science communication as planned behavior: understanding scientists' willingness to choose specific tactics. PLoS ONE 14(10): e0224039. https://doi.org/10.1371/journal.pone.0224039

Brossard, D. 2013. New media landscapes and the science information consumer. Proceedings of the National Academy of Sciences 110(Supplement_3):14096-14101. https://doi.org/10.1073/pnas.1212744110

Brügger, A., S. Dessai, P. Devine-Wright, T. A. Morton, and N. F. Pidgeon. 2015. Psychological responses to the proximity of climate change. Nature Climate Change 5(12):1031-1037. https://doi.org/10.1038/nclimate2760

Bubela, T., M. C. Nisbet, R. Borchelt, F. Brunger, C. Critchley, E. Einsiedel, G. Geller, A. Gupta, J. Hampel, R. Hyde-Lay, E. W. Jandciu, S. A. Jones, P. Kolopack, S. Lane, T. Lougheed, B. Nerlich, U. Ogbogu, K. O'Riordan, C. Ouellette, M. Spear, S.

Strauss, T. Thavaratnam, L. Willemse, and T. Caulfield. 2009. Science communication reconsidered. Nature Biotechnology 27 (6):514-518. https://doi.org/10.1038/nbt0609-514

Burri, R. V. 2018. Models of public engagement: nanoscientists' understandings of science-society interactions. NanoEthics 12 (2):81-98. https://doi.org/10.1007/s11569-018-0316-y

Campbell, J. L., C. Quincy, J. Osserman, and O. K. Pedersen. 2013. Coding in-depth semistructured interviews: problems of unitization and intercoder reliability and agreement. Sociological Methods and Research 42(3):294-320. https://doi.org/10.1177/0049124113500475

Campbell, S. L., T. Remenyi, G. J. Williamson, D. Rollins, C. J. White, and F. H. Johnston. 2021. Ambulance dispatches and heatwaves in Tasmania, Australia: a case-crossover analysis. Environmental Research 202:111655. https://doi.org/10.1016/j.envres.2021.111655

Cook, J., S. Lewandowsky, and U. K. H. Ecker. 2017. Neutralizing misinformation through inoculation: exposing misleading argumentation techniques reduces their influence. PLoS ONE 12 (5):e0175799. https://doi.org/10.1371/journal.pone.0175799

Corner, A., E. Markowitz, and N. Pidgeon. 2014. Public engagement with climate change: the role of human values. Climate Change 5(3):411-422. https://doi.org/10.1002/wcc.269

Corry, O., and D. Jørgensen. 2015. Beyond 'deniers' and 'believers': towards a map of the politics of climate change. Global Environmental Change 32:165-174. https://doi.org/10.1016/j.gloenvcha.2015.01.006

Cox, J. R. 2010. Beyond frames: recovering the strategic in climate communication. Environmental Communication 4(1):122-133. https://doi.org/10.1080/17524030903516555

Cullen-Knox, C., A. Fleming, L. Lester, and E. Ogier. 2021. Perceiving environmental science, risk and industry regulation in the mediatised vicious cycles of the Tasmanian salmon aquaculture industry. Social Epistemology 35(5):441-460. https://doi.org/10.1080/02691728.2021.1913661

Davies, S. R. 2019. Science communication is not an end in itself: (dis)assembling the science festival. International Journal of Science Education, Part B 9(1):40-53. https://doi.org/10.1080/21548455.2018.1540898

Deterding, N. M., and M. C. Waters. 2018. Flexible coding of in-depth interviews. Sociological Methods & Research 004912411879937.

Dryzek, J. S., D. Nicol, S. Niemeyer, S. Pemberton, N. Curato, A. Bächtiger, P. Batterham, B. Bedsted, S. Burall, M. Burgess, G. Burgio, Y. Castelfranchi, H. Chneiweiss, G. Church, M. Crossley, J. de Vries, M. Farooque, M. Hammond, B. He, R. Mendonça, J. Merchant, A. Middleton, J. E. J. Rasko, I. Van Hoyweghen, and A. Vergne. 2020. Global citizen deliberation on genome editing. Science 369(6510):1435-1437. https://doi.org/10.1126/science.abb5931

Entradas, M., J. Marcelino, M. W. Bauer, and B. Lewenstein. 2019. Public communication by climate scientists: what, with whom and why? Climatic Change 154(1-2):69-85. https://doi.org/10.1007/s10584-019-02414-9

Erlingsson, C., and P. Brysiewicz. 2017. A hands-on guide to doing content analysis. African Journal of Emergency Medicine 7(3):93-99. https://doi.org/10.1016/j.afjem.2017.08.001

Fischer, M., K. Maxwell, Nuunoq, H. Pedersen, D. Greeno, N. Jingwas, J. Graham Blair, S. Hugu, T. Mustonen, E. Murtomäki, and K. Mustonen. 2022. Empowering her guardians to nurture our ocean's future. Reviews in Fish Biology and Fisheries 32:271-296. https://doi.org/10.1007/s11160-021-09679-3

Fogarty, H. E., and G. T. Pecl. 2021. Lessons and recommendations for the climate adaptation of key Tasmanian fisheries. Pages 245-258 in T. Bahri, M. Vasconcellos, D. Welch, J. Johnson, R. I. Perry, X. Ma, and R. Sharma, editors. Adaptive management of fisheries in response to climate change. FAO Fisheries and Aquaculture Technical Paper No. 667. Food and Agriculture Organization, Rome, Italy.

Gibbons, M. 1999. Science's new social contract with society. Nature 402(S6761):C81-C84. https://doi.org/10.1038/35011576

Goldberg, M. H., A. Gustafson, and S. van der Linden. 2020. Leveraging social science to generate lasting engagement with climate change solutions. One Earth 3(3):314-324. https://doi.org/10.1016/j.oneear.2020.08.011

Graneheim, U. H., B.-M. Lindgren, and B. Lundman. 2017. Methodological challenges in qualitative content analysis: a discussion paper. Nurse Education Today 56:29-34. https://doi.org/10.1016/j.nedt.2017.06.002

Gregory, J. 2015. Science communication. Pages 219-224 in J. D. Wright, editor. International encyclopedia of the social & behavioral sciences. Second edition. Elsevier, Amsterdam, The Netherlands. https://doi.org/10.1016/B978-0-08-097086-8.95088-8

Gregory, J., and S. J. Lock. 2008. The evolution of 'public understanding of science': public engagement as a tool of science policy in the UK. Sociology Compass 2(4):1252-1265. https://doi.org/10.1111/j.1751-9020.2008.00137.x

Hilgartner, S. 1990. The dominant view of popularization: conceptual problems, political uses. Social Studies of Science 20 (3):519-539. https://doi.org/10.1177/030631290020003006

Hobday, A. J., and G. T. Pecl. 2014. Identification of global marine hotspots: sentinels for change and vanguards for adaptation action. Reviews in Fish Biology and Fisheries 24(2):415-425. https://doi.org/10.1007/s11160-013-9326-6

Hsieh, H.-F., and S. E. Shannon. 2005. Three approaches to qualitative content analysis. Qualitative Health Research 15 (9):1277-1288. https://doi.org/10.1177/1049732305276687

Hügel, S., and A. R. Davies. 2020. Public participation, engagement, and climate change adaptation: a review of the research literature. Climate Change 11(4):e645. https://doi.org/10.1002/wcc.645

Iyengar, S., and D. S. Massey. 2019. Scientific communication in a post-truth society. Proceedings of the National Academy of Sciences of the United States of America 116(16):7656-7661. https://doi.org/10.1073/pnas.1805868115

Jasanoff, S. 2010. A new climate for society. Theory, Culture and Society 27(2-3):233-253. https://doi.org/10.1177/0263276409361497

Jensen, E. A., and A. Gerber. 2020. Evidence-based science communication. Frontiers in Communication 4(January):1-5. https://doi.org/10.3389/fcomm.2019.00078

Kahan, D. M. 2015. Climate-science communication and the measurement problem. Political Psychology 36(S1):1-43. https://doi.org/10.1111/pops.12244

Kahan, D. M., E. Peters, M. Wittlin, P. Slovic, L. L. Ouellette, D. Braman, and G. Mandel. 2012. The polarizing impact of science literacy and numeracy on perceived climate change risks. Nature Climate Change 2(10):732-735. https://doi.org/10.1038/nclimate1547

Kawaka, J. A., M. A. Samoilys, M. Murunga, J. Church, C. Abunge, and G. W. Maina. 2017. Developing locally managed marine areas: lessons learnt from Kenya. Ocean & Coastal Management 135:1-10. https://doi.org/10.1016/j.ocecoaman.2016.10.013

Kelley, K., B. Clark, V. Brown, and J. Sitzia. 2003. Good practice in the conduct and reporting of survey research. International Journal for Quality in Health Care 15(3):261-266. https://doi.org/10.1093/intqhc/mzg031

Kelly, R., K. Evans, K. Alexander, S. Bettiol, S. Corney, C. Cullen-Knox, C. Cvitanovic, K. de Salas, G. R. Emad, L. Fullbrook, C. Garcia, S. Ison, S. Ling, C. Macleod, A. Meyer, L. Murray, M. Murunga, K. L. Nash, K. Norris, M. Oellermann, J. Scott, J. S. Stark, G. Wood, and G. T. Pecl. 2022. Connecting to the oceans: supporting ocean literacy and public engagement. Reviews in Fish Biology and Fisheries 32:123-143. https://doi.org/10.1007/s11160-020-09625-9

Kelly, R., M. Mackay, K. L. Nash, C. Cvitanovic, E. H. Allison, D. Armitage, A. Bonn, S. J. Cooke, S. Frusher, E. A. Fulton, et al. 2019. Ten tips for developing interdisciplinary socioecological researchers. Socio-Ecological Practice Research 1(2):149-161. https://doi.org/10.1007/s42532-019-00018-2

Kelly, R., J. Nettlefold, D. Mossop, S. Bettiol, S. Corney, C. Cullen-Knox, A. Fleming, P. Leith, J. Melbourne-Thomas, E. Ogier, I. van Putten, and G. T. Pecl. 2020. Let's talk about climate change: developing effective conversations between scientists and communities. One Earth 3(4):415-419. https://doi.org/10.1016/j.oneear.2020.09.009

Kennelly, I., S. N. Merz, and J. Lorber. 2001. What is gender? American Sociological Review 66(4):598-605. https://doi.org/10.2307/3088925

Kettle, N. P., and S. F. Trainor. 2015. The role of remote engagement in supporting boundary chain networks across Alaska. Climate Risk Management 9:6-19. https://doi.org/10.1016/j.crm.2015.06.006

Koehrsen, J. 2017. Boundary bridging arrangements: a boundary work approach to local energy transitions. Sustainability 9(3):424. https://doi.org/10.3390/su9030424

Krippendorff, K. 1989. Content analysis. Pages 403-407 in and L. G. E. Barnouw, G. Gerbner, W. Schramm, T. L. Worth, editors. International encyclopedia of communication. Oxford University Press, New York, New York, USA.

Latulippe, N., and N. Klenk. 2020. Making room and moving over: knowledge co-production, Indigenous knowledge

sovereignty and the politics of global environmental change decision-making. Current Opinion in Environmental Sustainability 42:7-14. https://doi.org/10.1016/j.cosust.2019.10.010

Leith, P., E. Ogier, and M. Haward. 2014. Science and social license: defining environmental sustainability of Atlantic salmon aquaculture in south-eastern Tasmania, Australia. Social Epistemology : A Journal of Knowledge, Culture and Policy 28 (3-4):277-296. https://doi.org/10.1080/02691728.2014.922641

Leshner, A. I. 2015. Bridging the opinion gap. Science 347 (6221):459. https://doi.org/10.1126/science.aaa7477

Leshner, A. I. 2021. Trust in science is not the problem. Issues in Science and Technology 37(3):16-18.

Lester, L., and B. Hutchins. 2012. The power of the unseen: environmental conflict, the media and invisibility. Media, Culture & Society 34(7):847-863. https://doi.org/10.1177/0163443712452772

Ling, S. D., R. E. Scheibling, A. Rassweiler, C. R. Johnson, N. Shears, S. D. Connell, A. K. Salomon, K. M. Norderhaug, A. Pérez-Matus, J. C. Hernández, S. Clemente, L. K. Blamey, B. Hereu, E. Ballesteros, E. Sala, J. Garrabou, E. Cebrian, M. Zabala, D. Fujita, and L. E. Johnson. 2015. Global regime shift dynamics of catastrophic sea urchin overgrazing. Philosophical Transactions of the Royal Society B: Biological Sciences 370 (1659):20130269. https://doi.org/10.1098/rstb.2013.0269

Lucas, C. H. 2018. Concerning values: what underlies public polarisation about climate change? Geographical Research 56 (3):298-310. https://doi.org/10.1111/1745-5871.12284

Lucas, C. H. 2021. Climate friction: how climate change communication produces resistance to concern. Geographical Research. https://doi.org/10.1111/1745-5871.12514

Mach, K. J., M. C. Lemos, A. M. Meadow, C. Wyborn, N. Klenk, J. C. Arnott, N. M. Ardoin, C. Fieseler, R. H. Moss, L. Nichols, M. Stults, C. Vaughan, and G. Wong-Parodi. 2020. Actionable knowledge and the art of engagement. Current Opinion in Environmental Sustainability 42:30-37. https://doi.org/10.1016/j.cosust.2020.01.002

McDonald, J., J. Harkin, A. Harwood, A. Hobday, A. Lyth, and H. Meinke. 2013. Supporting evidence-based adaptation decision-making in Tasmania: a synthesis of climate change adaptation research. National Climate Change Adaptation Research Facility, Griffith University, Gold Coast, Australia.

McKinnon, M., and J. Vos. 2015. Engagement as a threshold concept for science education and science communication. International Journal of Science Education, Part B 5(4):297-318. https://doi.org/10.1080/21548455.2014.986770

Metcalfe, J. 2019. Comparing science communication theory with practice: an assessment and critique using Australian data. Public Understanding of Science 28(4):382-400. https://doi.org/10.1177/0963662518821022

Miles, M. B., A. M. Huberman, and J. Saldana. 2014. Drawing and verifying conclusions. Pages 275-322 Qualitative data analysis: a methods sourcebook. Third edition. SAGE, London, UK.

Moser, S. C. 2010. Communicating climate change: history, challenges, process and future directions. Climate Change 1 (1):31-53. https://doi.org/10.1002/wcc.11

Moser, S. C. 2016. Reflections on climate change communication research and practice in the second decade of the 21st century: what more is there to say? Climate Change 7(3):345-369. https://doi.org/10.1002/wcc.403

Murunga, M. 2021. Towards a better understanding of gendered power in small scale fisheries of the Western Indian Ocean. Global Environmental Change 67:102242. https://doi.org/10.1016/j.gloenvcha.2021.102242

Murunga, M. 2022. Public engagement for social transformation: informing or empowering? Environmental Science & Policy 132:237-246. https://doi.org/10.1016/j.envsci.2022.02.031

Murunga, M., S. Partelow, and A. Breckwoldt. 2021. Drivers of collective action and role of conflict in Kenyan fisheries co-management. World Development 141:105413. https://doi.org/10.1016/j.worlddev.2021.105413

Nerlich, B., N. Koteyko, and B. Brown. 2010. Theory and language of climate change communication. Climate Change 1 (1):97-110. https://doi.org/10.1002/wcc.2

Nettlefold, J., and G. T. Pecl. 2022. Engaged journalism and climate change: lessons from an audience-led, locally focused Australian collaboration. Journalism Practice 16(1):19-34. https://doi.org/10.1080/17512786.2020.1798272

Nisbet, M. C. 2009. Communicating climate change: why frames matter for public engagement. Environment: Science and Policy for Sustainable Development 51(2):12-23. https://doi.org/10.3200/ENVT.51.2.12-23

Nowell, L. S., J. M. Norris, D. E. White, and N. J. Moules. 2017. Thematic analysis: striving to meet the trustworthiness criteria. International Journal of Qualitative Methods 16(1). https://doi.org/10.1177/1609406917733847

Nowotny, H., P. Scott, and M. Gibbons. 2003. "Mode 2" revisited: the new production of knowledge. Minerva 41(3):179-194. https://doi.org/10.1023/A:1025505528250

Nursey-Bray, M., R. Palmer, and G. Pecl. 2018. Spot, log, map: assessing a marine virtual citizen science program against Reed's best practice for stakeholder participation in environmental management. Ocean & Coastal Management 151:1-9. https://doi.org/10.1016/j.ocecoaman.2017.10.031

Nursey-Bray, M., G. T. Pecl, S. Frusher, C. Gardner, M. Haward, A. J. Hobday, S. Jennings, A. E. Punt, H. Revill, and I. van Putten. 2012. Communicating climate change: climate change risk perceptions and rock lobster fishers, Tasmania. Marine Policy 36 (3):753-759. https://doi.org/10.1016/j.marpol.2011.10.015

O'Neill, S. 2020. More than meets the eye: a longitudinal analysis of climate change imagery in the print media. Climatic Change 163:9-26. https://doi.org/10.1007/s10584-019-02504-8

O'Neill, S., and S. Nicholson-Cole. 2009. "Fear won't do it": promoting positive engagement with climate change through visual and iconic representations. Science Communication 30 (3):355-379. https://doi.org/10.1177/1075547008329201

Obura, D. O., Y. Katerere, M. Mayet, D. Kaelo, S. Msweli, K. Mather, J. Harris, M. Louis, R. Kramer, T. Teferi, M. Samoilys, L. Lewis, A. Bennie, F. Kumah, M. Isaacs, and P. Nantongo. 2021. Integrate biodiversity targets from local to global levels. Science 373(6556):746-748. https://doi.org/10.1126/science.abh2234

Ogar, E., G. Pecl, and T. Mustonen. 2020. Science must embrace traditional and indigenous knowledge to solve our biodiversity crisis. One Earth 3(2):162-165. https://doi.org/10.1016/j.oneear.2020.07.006

Oliver, E. C. J., V. Lago, A. J. Hobday, N. J. Holbrook, S. D. Ling, and C. N. Mundy. 2018. Marine heatwaves off eastern Tasmania: trends, interannual variability, and predictability. Progress in Oceanography 161(February):116-130. https://doi.org/10.1016/j.pocean.2018.02.007

Pearce, W., B. Brown, B. Nerlich, and N. Koteyko. 2015. Communicating climate change: conduits, content, and consensus. Climate Change 6(6):613-626. https://doi.org/10.1002/wcc.366

Pecl, G. T., E. Ogier, S. Jennings, I. van Putten, C. Crawford, H. Fogarty, S. Frusher, A. J. Hobday, J. Keane, E. Lee, C. MacLeod, C. Mundy, J. Stuart-Smith, and S. Tracey. 2019. Autonomous adaptation to climate-driven change in marine biodiversity in a global marine hotspot. Ambio 48(12):1498-1515. https://doi.org/10.1007/s13280-019-01186-x

Pennycook, G., Z. Epstein, M. Mosleh, A. A. Arechar, D. Eckles, and D. G. Rand. 2021. Shifting attention to accuracy can reduce misinformation online. Nature 592(7855):590-595. https://doi.org/10.1038/s41586-021-03344-2

Powell, M. C., and M. Colin. 2009. Participatory paradoxes: facilitating citizen engagement in science and technology from the top-down? Bulletin of Science Technology Society 29 (4):325-342. https://doi.org/10.1177/0270467609336308

Rowe, G., and L. J. Frewer. 2005. A typology of public engagement mechanisms. Science, Technology, & Human Values 30 (2):251-290. https://doi.org/10.1177/0162243904271724

Sachs, J. D., G. Schmidt-Traub, M. Mazzucato, D. Messner, N. Nakicenovic, and J. Rockström. 2019. Six Transformations to achieve the Sustainable Development Goals. Nature Sustainability 2(9):805-814. https://doi.org/10.1038/s41893-019-0352-9

Salmon, R. A., R. K. Priestley, and J. Goven. 2017. The reflexive scientist: an approach to transforming public engagement. Journal of Environmental Studies and Sciences 7(1):53-68. https://doi.org/10.1007/s13412-015-0274-4

Scheidel, A., D. Del Bene, J. Liu, G. Navas, S. Mingorría, F. Demaria, S. Avila, B. Roy, I. Ertör, L. Temper, and J. Martínez-Alier. 2020. Environmental conflicts and defenders: a global overview. Global Environmental Change 63:102104. https://doi.org/10.1016/j.gloenvcha.2020.102104

Scheufele, D. A., and N. M. Krause. 2019. Science audiences, misinformation, and fake news. Proceedings of the National Academy of Sciences of the United States of America 116 (16):7662-7669. https://doi.org/10.1073/pnas.1805871115

Schreier, M. 2014. Qualitative content analysis. Pages 170-183 in U. Flick, editor. The SAGE handbook of qualitative data analysis.

SAGE, London, UK. https://doi.org/10.4135/9781446282243.n12

Schweizer, S., S. Davis, and J. L. Thompson. 2013. Changing the conversation about climate change: a theoretical framework for place-based climate change engagement. Environmental Communication 7(1):42-62. https://doi.org/10.1080/17524032.2012.753634

Shackley, S., and B. Wynne. 1996. Representing uncertainty in global climate change science and policy: boundary-ordering devices and authority. Science, Technology & Human Values 21 (3):275-302. https://doi.org/10.1177/016224399602100302

Simpson, N. P., T. M. Andrews, M. Krönke, C. Lennard, R. C. Odoulami, B. Ouweneel, A. Steynor, and C. H. Trisos. 2021. Climate change literacy in Africa. Nature Climate Change 11:937-944. https://doi.org/10.1038/s41558-021-01171-x

Smith, H. M., and L. Lindenfeld. 2014. Integrating media studies of climate change into transdisciplinary research: which direction should we be heading? Environmental Communication 8 (2):179-196. https://doi.org/10.1080/17524032.2014.906479

Star, S. L. 2010. This is not a boundary object: reflections on the origin of a concept. Science Technology and Human Values 35 (5):601-617. https://doi.org/10.1177/0162243910377624

Stecula, D. A., and E. Merkley. 2019. Framing climate change: economics, ideology, and uncertainty in American news media content from 1988 to 2014. Frontiers in Communication 4:6. https://doi.org/10.3389/fcomm.2019.00006

Steger, C., G. Nigussie, M. Alonzo, B. Warkineh, J. Van Den Hoek, M. Fekadu, P. H. Evangelista, and J. A. Klein. 2020. Knowledge coproduction improves understanding of environmental change in the Ethiopian highlands. Ecology and Society 25(2):2. https://doi.org/10.5751/ES-11325-250202

Stilgoe, J., S. J. Lock, and J. Wilsdon. 2014. Why should we promote public engagement with science? Public Understanding of Science 23(1):4-15. https://doi.org/10.1177/0963662513518154

Trench, B., and M. Bucchi. 2010. Science communication, an emerging discipline. Journal of Science Communication 09(03). https://doi.org/10.22323/2.09030303

Turnhout, E., T. Metze, C. Wyborn, N. Klenk, and E. Louder. 2020. The politics of co-production: participation, power, and transformation. Current Opinion in Environmental Sustainability 42:15-21. https://doi.org/10.1016/j.cosust.2019.11.009

Vaismoradi, M., J. Jones, H. Turunen, and S. Snelgrove. 2016. Theme development in qualitative content analysis and thematic analysis. Journal of Nursing Education and Practice 6 (5):206-212. https://doi.org/10.5430/jnep.v6n5p100

VanDyke, M. S., and N. M. Lee. 2020. Science public relations: the parallel, interwoven, and contrasting trajectories of public relations and science communication theory and practice. Public Relations Review 46(4):101953. https://doi.org/10.1016/j.pubrev.2020.101953

Ward, C. D., G. Cundill, G. F. Midgley, and A. Jarre. 2021. Drawing on diverse knowledge systems to enhance local climate understanding in the southern Cape, South Africa. Ecology and Society 26(4):10. https://doi.org/10.5751/ES-12712-260410

Weingart, P., and M. Joubert. 2019. The conflation of motives of science communication — causes, consequences, remedies. Journal of Science Communication 18(03). https://doi.org/10.22323/2.18030401

Whitmarsh, L., G. Seyfang, and S. O'Neill. 2011. Public engagement with carbon and climate change: to what extent is the public 'carbon capable'? Global Environmental Change 21 (1):56-65. https://doi.org/10.1016/j.gloenvcha.2010.07.011

Wynne, B. 1992. Misunderstood misunderstanding: social identities and public uptake of science. Public Understanding of Science 1(3):281-304. https://doi.org/10.1088/0963-6625/1/3/004

Wynne, B. 2006. Public engagement as a means of restoring public trust in science - hitting the notes, but missing the music? Public Health Genomics 9(3):211-220. https://doi.org/10.1159/000092659

Yuan, S., J. C. Besley, and A. Dudo. 2019. A comparison between scientists' and communication scholars' views about scientists' public engagement activities. Public Understanding of Science 28 (1):101-118. https://doi.org/10.1177/0963662518797002

Appendix 1

The Curious Climate Tasmania initiative was a public-powered approach of engagement with science that sought to advance how scientists communicate climate science by changing how the media, science, and the non-technical public interact (Entradas et al. 2019). The public-powered approach builds on other public engagement models that seek to engage the public about complex societal topics, including climate change (Brossard and Lewenstein 2010). A frequent problem with sharing complex, uncertain, and high-stakes evidence is the need to reinforce relevance – giving the audience a good reason to listen to the communication offered (Bucchi 2008). We argue that the approach reported herein attempts to inform solutions to the problem of communicating climate change by proactively involving and iteratively engaging the public in defining the engagement agenda by first submitting vital questions and comments they most wanted to know more about Climate Change, and second, participating in an outreach event curated to respond to those questions (Fig. A1.1.). Implementation of the Curious Climate Tasmania initiative was in three phases, including collaboration, consultation, and outreach (see **Fig. 1 in the main text**). In the current paper, we present evidence emanating from the public consultation phase.
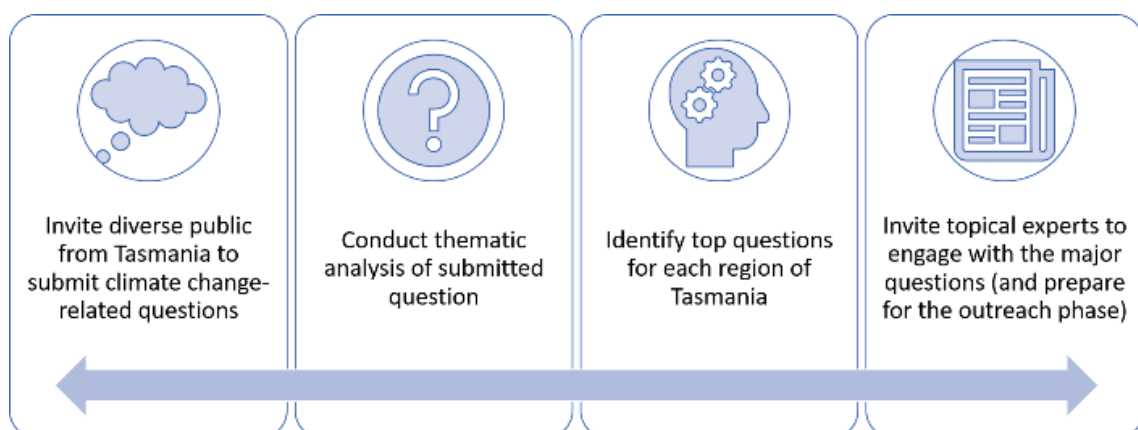
Fig. A1.1. Steps taken in the consultation phase.

Phase 1: Collaboration

In this initial phase, crucial relationships were forged between researchers allied to the University of Tasmania, Commonwealth Scientific and Industrial Research Organization (CSIRO, and journalists from the Australian Broadcasting Corporation (ABC) Radio station. The researchers and journalists engaged in productive discussions on how best to engage the public in deliberation about climate change (noting ongoing challenges of fake news and misinformation (Scheufele and Krause 2019)).

Phase 2: Consultation

In the second phase, the public contributed to the design of the engagement activities by asking scientists questions over two weeks through the Hearken Interface licensed to ABC Radio Hobart (Nettlefold and Pecl 2020). The media (ABC Radio Hobart) acted as the knowledge broker - a conduit between scientists and the non-technical public because they have an established audience and are 'trusted' by the public (Meyer 2010). The transdisciplinary team of scientists and journalists met at the end of the public callout to deliberate on the questions, which then informed the structure of phase three - the outreach events. The public submitted about 290 questions that were analyzed thematically to identify topics for discussion in the outreach phase (Miles et al. 2014). This phase forms the basis of the current paper.

Phase 3: Outreach events
A second call-out was made, inviting the public to participate in four outreach events held in different regions of Tasmania. The outreach events were purposefully structured to allow for reflective dialogue, where the scientists listen respectfully and share scientific facts (Salmon et al., 2017). The outreach events were structured to respond to the most asked questions for each region of Tasmania (Hobart, Launceston, Queenstown, St. Helens). The inquiries are available on the project website: https://www.curiousclimate.org.au/).

Literature cited in the appendix 1.

Brossard, D., and B. V. Lewenstein. 2010. A critical appraisal of models of public understanding. Page *in* L. Kahlor and P. Stout, editors. *Communicating Science: New Agendas in Communication*. first. Routledge.

Bucchi, M. 2008. Of deficits, deviations and dialogues: theories of public communication of science. Pages 57–76 *Handbook of public communication of science and technology*.

Entradas, M., J. Marcelino, M. W. Bauer, and B. Lewenstein. 2019. Public communication by climate scientists: what, with whom and why? *Climatic Change* 154(1–2):69–85.

Meyer, M. 2010. The Rise of the Knowledge Broker. *Science Communication* 32(1):118–127.

Miles, M. B., A. M. Huberman, and J. Saldana. 2014. Drawing and verifying conclusions. Pages 275–322 *Qualitative Data Analysis: A Methods Sourcebook*. Third edition. SAGE Publications Inc., London, England.

Nettlefold, J., and G. T. Pecl. 2020. Engaged Journalism and Climate Change: Lessons From an Audience-led, Locally Focused Australian Collaboration. *Journalism Practice* 0(0):1–16.

Scheufele, D. A., and N. M. Krause. 2019. Science audiences, misinformation, and fake news. *Proceedings of the National Academy of Sciences of the United States of America* 116(16):7662–7669.

Appendix 2

Participants Information Sheet

A. Invitation to participate in Curious Climate Tasmania

You are invited to participate in Curious Climate Tasmania, which is a collaborative project that offers the public the ability to submit their questions about climate change and have them answered by a team of scientists and researchers. Part of the team will also analyze the questions to gain further insight into the major climate change themes and language used.

What is the purpose of this project?

This project creates a new pathway for climate change information by empowering the public to pose questions that are important and relevant to them. Through this process we aim to better understand the major themes of interest and types of language used by the Tasmanian public in relation to climate change. We also aim to identify potential communication gaps between the public and the scientific community. Additionally, we are interested in the experience of the public in engaging with the scientific community in this way.

How is the project being funded?

This project is being funded by a National Science Week Grant provided by the Department of Industry, Innovation and Science.

What does participation in this project involve?

Participation in this project is limited to residents of Tasmania only due to the scope of the project. Participation is via ABC's Curious Climate Tasmania webpage where you can submit your questions about climate change along with personal information ('age' and 'postcode' are the only mandatory fields). This is estimated to take less than 5 minutes. Note: all data provided to UTAS by ABC for analysis will be de-identified to protect the identify of participants. The submitted climate change questions will be assessed by our research team and answers will be provided through free, optional public presentations for the most asked questions/themes. The submitted questions and demographic information (for participants aged 18 and over) will also be analyzed to better understand the areas of concern and relevance for the public, and the presence of potential information and knowledge gaps.

Are there any benefits from participation in this project?

We aim to provide public benefit by providing evidence-based answers to the most asked questions on climate change. This project will also advance our knowledge of the climate change themes of importance to Tasmanian residents which will assist future engagement activities.

Are there any risks from participation in this project?

There is a potential risk of feeling discomfort associated with receiving answers to climate change questions which involve negative future impacts, or which challenge alternate points of view.

What if I change my mind during or after the project?

You are not obligated to participate in any part of this project. Once you have submitted a question through the ABC webpage it will not be possible to remove your climate change question from the dataset, however your personal details can be removed. Contact details for the research team are provided below *[removed in this manuscript]*.

What will happen to the data when this project is over?

Data will be non-identifiable. It will be stored on a University of Tasmania server for five years from the date of project completion. This server is password-protected and only accessible to the researchers of this study. Data will be destroyed at the end of the five years following publication.

How will the results of the project be published?

A Curious Climate Tasmania website will be developed. This will provide participants and the wider public updates on the most asked climate change questions and the corresponding answers provided by scientists in the form of short videos. The results of project research will be published in a peer-reviewed journal and links will be provided on the website. A plain language summary will also be provided on the website.

How can I agree to be involved?

If you would like to participate, please fill out the question form on the ABC Curious Climate Tasmania webpage. In doing this your consent to be involved is implied.

What if I have questions about this project?

If you have any queries, concerns, or issues with this study, please feel free to contact us:

[*contact details removed in this manuscript to conform to journal policy – however, they were made available to participants in the original text*]

This study has been approved by the Tasmania Social Sciences Human Research Ethics Committee - approval number for this project - H0018145.

Thank you for your time.

Appendix 3

Table A3.1. A detailed description of the categories (in bold) and sub-categories (italicized)

Category and *sub-category*	Description of categories
Beliefs	Includes domain-specific questions of belief (i.e., whether it is happening). It connotes that knowledge about climate change is an artifact of innate human existence.
Anxiety	Responses that express anxiety (fear, worry) of a climate change future.
Desperation	Responses that show some level of frustrations towards a lack of collective action (calls to address in-action are referenced here).
Biodiversity	Threats to biological diversity (plants and animals), including scenarios of species gain and loss.
Species gain	Responses that seek clarification or presents examples of how new species might change agricultural and fishing practices.
Species loss	Responses that look to know impact of species loss and 'when' that may be expected.
Stressors	Responses that show how different plants behaviors have shifted and influence of different stressors in the aquatic environment.
Economy	The economic cost of climate change, including costs associated with collective action and lack thereof.
Agriculture	Responses that relate to cost on agriculture and associated products and practices.
Fisheries	Responses that relate to cost on fisheries and impact on the fisheries.
Housing and infrastructure	Responses that look to know how property (land tenure) rights will shift in a "sea level scenario".

Insurance	Responses that look to understand the utility of insurance on private property and key infrastructure in the state.
Mitigation Cost	Responses that look to guidance on the "how to" reallocate mitigation related cost at both household, regional and state-wide level. The "who" will pay for the mitigation cost is referenced here.
Tourism	Responses that seek clarification on how the tourism economy will change.
Energy security	Energy security, alternative technologies, and inquiries on how to transition to a low carbon economy.
Dams	Responses that relate to a multi-purpose dam development (specifically for hydropower generation and water supply for agriculture).
Fossil fuel	Responses that seek clarification and insight on a shift from fossil fuel.
Manufacturing	Responses that look to understand how manufacturing (incl. mining) will be affected by climate change.
Renewable Energy	Responses that seek advice on green and renewable technology.
Food security	Understand the impact of climate change on food production (i.e., scarcity, quality, surplus, variety).
Food quality	Responses that look to know how food quality might change.
Food scarcity	Responses that look to understand if scarcity will become the new norm.
Food surplus	Responses that look at opportunities to grow new foods and how that might present some new opportunities.
Food variety	Responses that present examples and look to know how food varieties will change and how adoption of vegan-based diets might support efforts to address climate change.
Nutrition	Responses that relate to nutrition needs if people change to plant-based diets.
Infrastructure	The impact of climate change on principal public infrastructures, including bridges, airports, or roads, around Tasmania.
Airport	Responses that relate to the need to consider impact of sea-level rise on the runway among key infrastructure at the airports.

Asset ownership	Responses that relate to how ownership rights might change on personal assets especially those close to water bodies.
Bridges	Responses that relate to impact on bridges.
Dams	Responses that relate to opportunities supplied with dams and risks
Engineering	Responses that relate to engineering-based solutions and options.
Housing	Responses that relate to impact of sea level rise on housing and pressure of climate refugees to housing.
Human migration	Responses that relate to population influx into the region and possibilities of outmigration.
Strategic planning	Response that looks to understand how best states and individuals can plan for Climate Change.
Literacy	All response questions that are "general" in nature, based on a need to want to know more about climatic processes.
Access to information	Responses that look to know where to find information that relates to climate change or data that can be used for discussion at local levels.
Indigenous knowledge	Responses that look to know the place of other worldviews and how such knowledge can be used to address some climate-related risks.
Prediction accuracy	Responses that seek clarification on prediction accuracy and reliability of information shared by scientists.
Preparedness	How people and the state of Tasmania should or could be preparing for climate change and the resources required to do so.
Ageing	Response that looks to know how the elderly and retired from work citizens should be preparing for climate change.
Coastal Erosion	Responses that look to know on how to prepare for increased coastal erosion.
Local scale	Responses that look to know how to prepare at a local scale
Resilience	Responses that seek clarification on how resilient the state is to climate related stressor and actions being taken.

Responsibility	Small structural changes that people can install at a household or organizational level to help address the challenge of climate change.
Lifestyle	Responses that relate to changing lifestyle in acclimate change scenario.
Opportunity	Responses that relate to finding windows of opportunities to change.
Pollution	Responses that relate to how pollution will continue to affect life.
Population	Responses that relate to reducing population growth and how that might help.
Role of Government	Responses that look to know the role of government (incl. local councils).
Risk	Climate-related risks such as wildfires, coastal erosion, and sea level rise. It also captures questions about risk immediacy and prevalence.
Coastal erosion	Responses that relate to increased coastal erosion.
Critical infrastructure	Responses that relate to risks on critical infrastructures.
Energy	Responses that relate to energy related risks.
Extreme Weather	Responses that relate to extreme weather conditions (temp., rainfall, drought).
Fire	Responses that relate to increase in fire intensity and frequency.
Health	Responses that relate to prevalence and intensity of diseases to human health.
Diseases	Responses that relate to risk on human health.
Lifestyle changes	Responses that look to know if people will need to change their lifestyle and how soon will that need to happen.
Sea level rise	Responses that look to understand sea level rise at a local scale and associated impacts such as human displacement.
Social capital	Responses that look to know how social capital will be undermined in a climate change future.

Trust	Responses that look to know how trust as an element of social capital will be influenced as climate change impact becomes a reality (locally).
Species loss	Responses that look to know effect on biodiversity (eps. Species loss).

Table A3.2. A detailed description of thematic codes and categories generated during qualitative data analysis.

Step 2. **Decontextualization** - Initial coding to identify meaning units	N= 41 Nodes	Access to Information; Ageing; Beliefs; Biodiversity Loss; Clarity; Culture; Cooperation; Communication; Deforestation; Denials; Diseases; Economics; Energy; Erosion; Engineering; Food security; Fire; Invasive species; Infrastructure; Indigenous knowledge; Integrity; Literacy; Lifestyle; Landownership; Mitigation; Media use; Misinformation; Nutrition; Opportunity; Population; Pollination; Resilience; Responsibility; Risk; Species redistribution; Transport; Tourism; Technology; Uncertainty; Water use; Weather		
Step 3. **Recontextualization** - Thematic coding to compare meaning units with original data and context.	N=26 Nodes	Access to information; Beliefs; Biodiversity; Economy; Energy security; Engineering; Food security; Health; Human migration; Local knowledge; Infrastructure; Insurance; Lifestyle; Literacy; Manufacturing; Nutrition; Opportunity; Pollution Population; Prediction accuracy; Preparedness; Resilience; Responsibility; Risk; Tourism; Trust		
Step 4a. **Categorization** - Developing categories based on related groups	N= 10 categories	Beliefs; Biodiversity; Economy; Energy security; Food security; Infrastructure; Literacy; Preparedness; Responsibility; Risk		
Step 4b. **Compilation** - Developing themes from data	Three abstract themes	Responding to threats and risks	Sacrifices, responsibility, and opportunities	Awareness and understanding of climate change