Making sense of climate change—the lived experience of experts

Jean S. Renouf[1]

Abstract

While numerous challenges associated with climate change exist, it remains difficult to fully comprehend its full implications on one's life. Explanations for this range from psychological and cognitive barriers to social, political and economic impediments. This article provides the findings of a research project which investigated the lived experience of climate scientists and climate change experts to understand how they make sense of climate change. The research is based on qualitative interviews with 16 participants located in 12 different countries. The research finds that participants made sense of climate change through a diversity of ways, both professional and personal, including personal experience, emotions, exchanges with others and broader societal context. While for most, climate change started as an area of professional interest, it seems to have permeated their personal lives to a great extent. They see it as a disruption of the normal way of life and all concur about the gravity of the situation. The deeper implication of this study of the lived experiences of climate experts is that there is ground to be concerned.

1 Introduction

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2014) has made clear that an increase in the global temperature—leading to climate change—is happening and that human activity is 'extremely likely' to be the cause of it. The report offers four scenarios, from best to worse, as to the possible pathways lying ahead of us. According to official view, it is still possible to achieve the best scenario if we limit the average global temperature increase to less than 2 °C, and preferably to 1.5 °C, as agreed in the 2015 Paris Agreement (IPCC 2018). For this to happen, drastic social, economic and political changes need to be made very rapidly.

✉ Jean S. Renouf
jean.renouf@scu.edu.au

[1] Southern Cross University, Lismore, NSW, Australia

However, despite such lofty ambitions, it appears that climate scientists and climate change experts are unconvinced that such changes will be made in time and seem to have grave concerns about the direction our planet is heading in terms of global warming and ecological destruction (Anderson and Bows 2011; Bray and von Storch 2014, 2016; Head and Harada 2017; Clayton 2018; Gergis 2019). If such concerns are proven right, then it is entirely possible that dire changes lie ahead over the course of this century.

While scientists underscore a number of challenges associated with climate change, it remains difficult to fully comprehend the extent of its impact on the planet, and by extension, on one's own life. With this in mind, this article provides the findings of research which investigated the lived experience of climate scientists and climate change experts. In particular, it examined how they make sense of climate change. The research is the first step of a three-part research process and is based on qualitative interviews with 16 participants located in 12 different countries. These interviews were conducted as an exploratory research designed to inform a survey distributed globally to close to 5000 participants. While the data from the survey will be reported in another article, it was found that what emerged from this initial set of interviews was worthy of publication in and for itself.

The research finds that participants made sense of climate change through a diversity of ways, both professional and personal, including personal experience, emotions, exchanges with others and broader societal context. While for most, climate change started as an area of professional interest, it seems to have permeated their personal lives to a great extent. They see it as a disruption of the normal way of life and all concur about the gravity of the situation.

1.1 Climate change as overwhelming humans' cognitive abilities

Climate change has been described as a 'wicked problem' (Head 2008; Termeer et al. 2013), a phenomenon so complex that it defies a simple explanation, let alone easy solutions. The term 'wicked problem', coined by Rittel and Webber in 1973, referred to any issue that had some characteristics that made it unique; that was hardly, if at all, solvable; that was interdependent with other wicked problems in ways that any ameliorative actions would have unforeseen consequences; and that, because of its subjectivity, was likely to provoke disagreements about how to define, explain, solve or even determine when and if the problem is solved. Cases of wicked problems addressed in the scholarly literature include intractable issues such as overcoming Indigenous disadvantage or peace settlements in divided societies in the Middle East (Head 2008).

Climate change has also been dubbed a 'super wicked problem' (Lazarus 2009; Levin et al. 2012) whereby the 'super' version has additional characteristics pertaining to the *agents* examining it (i.e. time is running out for those trying to solve the problem) (Levin et al. 2012).

Morton (2013) describes climate change, alongside relativity, evolution or nuclear waste, as a 'hyperobject', something 'massively distributed in time and space relative to humans' (p. 1). In other words, climate change is seen as something that so fundamentally challenges our normal way of thinking and conception of the world that it 'outstrips' (Milkoreit 2015 p. 125) or 'overwhelms' human cognitive abilities (Boulton 2016, no page number). Lakoff refers to 'hypocognition' in the case of the environment and argues that humans lack frames—simple ways of seeing a complexity—that capture the reality of the situation (2010 p.76). Pahl et al. (2014, p.375) discuss the 'mismatches' between the human mind and its environment in regard to climate change. The magnitude of climate change, the way that it is non-local, ambiguous, abstract, complex, in motion, so vast in space and time, make it difficult, if outright impossible,

to truly understand it, not only intellectually but also ontologically, emotionally, socially and experientially.

1.2 Further challenges to appreciating the magnitude of climate change

In addition, humans are also ill-prepared to think about diffuse, slow, long-lasting events. This may be explained variously, ranging from psychological and cognitive barriers, to social, cultural and political impediments. Pahl et al. (2014) recall that because humans inherited a brain that developed when our ancestors had to focus on meeting immediate needs and surviving actual threats, we find it difficult to prioritize long-term perspectives compared to immediate futures.

Additionally, with over half of the world's population living in cities and urban environments Pahl et al. contend that humans have reduced their ability to experience seasonal shifts, weather patterns and therefore to build a 'baseline to compare changes against' (2014, p. 376). Perhaps as a result, Whitmarsh and Capstick argue climate change is perceived by the public as a 'distant issue' from which humans can dissociate themselves (2018, p.15). As Moloney et al. state 'climate change cannot, generally speaking, be seen, smelled, heard, or touched as a discernible object' (2014, no page number) and as such is 'deeply un-relatable at the personal level for most individuals' (Markowitz and Guckian 2018, p. 38).

Of course, humans who experience natural disasters of cataclysmic proportions that are attributed to a changing climate likely appreciate the gravity of the situation there and then. They may still struggle to understand the intricate global geophysical dynamics underpinning the event as well as the sheer extent of the impact, the policy implications, the economic consequences, the social and the psychological effects. Additionally, experiencing a natural disaster is by no means a predictor of even believing that the event could be related to the changing climate (Whitmarsh and Capstick 2008) as values influence what is inferred from evidence (Kahan 2012).

The cultural environment in which humans live indeed plays a role in framing climate change as a topic of interest—or not. Whitmarsh and Capstick (2018) explain that perceptions of climate change are formed through social interactions occurring within a particular cultural context. Von Storch et al. concur (2019). Adger et al. indicate (2012) that the rising greenhouse gas emissions themselves are the product of cultural choices, that is, of how a society choses to live, to organise itself and its modes of production. As a result, they argue that '[t]he consequences of these emissions—climate change impacts—are given meaning through cultural interpretations of science and risk' (Adger et al. 2012, p.1). Hoffman (2015) posits that humans use cognitive filters that reflect our cultural identity and that can overpower scientific reasoning. This is reflective of Markowitz and Guckian's summary of the literature which highlights a confirmation bias when people seek out information about climate change (2018, p.40).

This, in turn, reinforces Hoffman's point that 'the debate over climate change … is not about carbon dioxide and greenhouse gas models; it is about opposing values and worldviews through which that science is seen' (2015, p.5). Being part of a given culture shapes one's views of climate change as they intermingle with identity, values and cultural meanings. This is one of the reasons why populations in different countries have different levels of concern about climate change (Whitmarsh and Capstick 2018).

In turn and, through daily cultural practices, these views also contribute to shaping the society in which they take place. Political polarization is an example of this. In

the USA, for instance, the majority of Democrats believe in climate change, while the majority of Republicans do not (Hoffman 2015). As Markowitz and Guckian explain, 'people's understandings of and beliefs about the issue are largely mediated through the various messages and messengers they are most often exposed to' (2018, p. 39). In such contexts, political polarization is made worse by the politicized media landscape (Hoffman 2015).

Those challenges, inherent to climate change as a 'hyperobject' but also related to the cognitive, cultural, social and political biases that shape human worldviews, make it particularly difficult to comprehend, let alone solve, climate change.

1.3 Climate change, lived experience and sense-making

Given this, how then to make sense of it? Hulme (2008) argues that the meaning of climate is constructed differently across people, places and scales. Granderson contends that climate change is made sense 'through memories of past weather, current experience and future imaginaries, which are attached to particular places and practices' (2014, p. 57). Burnham, Ma and Zhang found that smallholder farmers in China's perceptions of climate are 'entangled in human and nonhuman worlds' (2015, p. 24).

Given its super-wickedness, there is no one way to make sense of it. Nuanced views about how we understand the concept of climate change have begun to emerge. For instance, Nash et al. contend that, by challenging the dominant scientific approach, social sciences and humanities allow highlighting of the cultural, historical and political context in which knowledge about climate is produced (2019). This, in turn, allows climate change to be comprehended in 'multifaceted ways' (Nash et al. 2019, no page). Making sense of climate change, defined in this article as the process of fathoming the challenging situation we face, varies in time and space. It implies that the process may be scientific, contextual, relational and/or introspective, resting on scientific undertakings as well as traits related to the human condition, such as experience, social interactions, thoughts or emotions (Maitlis et al. 2013; Milkoreit 2017).

Abbott and Wilson (2015) argue that 'lived experiences', a framework and method of data gathering and analysis of accounts of people's lives, is particularly useful 'to make sense of climate change' (p. 27). They contend that climate change 'cannot be dominated within singular disciplinary fields, but requires a more holistic picture drawing on both natural and anthropogenic related disciplines. It allows both science and lived experience to work together to recognise gaps in knowledge.' (2015, p. 96). McIntosh and Wright explain that this involves an 'interdisciplinary' and 'empathetic immersion' in the lives and concerns of people affected by and involved in it (2019, p. 463). Schwandt and Burgon however recall that lived experience as a conceptual framework and methodology is often critical of 'measurement-oriented' sciences (2006, p. 100). A robust method is therefore necessary to provide conclusive insight. This is done through a series of steps, that include first looking for patterns in the data, then uncovering a deeper meaning or at least making generalisations from these, which may enable 'to conceptualise it and put it to use' (Abbott and Wilson 2015, p. 20). They also explain that 'the soundness of [the] findings and their evolution are established through 'dialectics', that is, through critical engagement with others' (2015, p. 101). This dialogue is part of sense-making.

1.4 Scientists' lived experience in making sense of climate change

Rapley et al. recall that opinion polls reveal the very high levels of trust in scientists despite being held to overly idealised and unrealistic expectations of behaviour, and argue that climate scientists have a decisive role to play in engaging the public on climate science (2014). They however also specify that, for the message to be heard, it is 'crucial' that climate scientists should be using their 'authentic' and 'personalised' voice (2014, p. 127). Abbot and Wilson contend that 'scientists too have lived experiences' (2014, p. 12) and studying these can 'create a better understanding of discrepancies and/or convergence' (2014, p. 10) between stakeholders.

Few researchers have examined climate experts' perceptions of climate change, let alone the meanings and implications for themselves and their families. There is evidence that some scientists do take some measures such as reducing their carbon footprint, relocating or engaging in community activities, but reports on their actual lived experience have been largely confined to discrete anecdotal accounts occasionally published in popular magazines. A handful of academic authors have looked at climate scientists' experiential accounts, but the focus of their work tends to be on other issues, such as their opinion about the reality of human-induced climate change (Rosenberg et al. 2010), their perspectives on the science of climate change (Bray and von Storch 2016), their emotional burden and coping mechanisms (Head and Harada 2017; Clayton 2018), or their positions regarding geoengineering (Dannenberg and Zitzelsberger 2019). Among these authors, the work of Coulter (2018a, 2018b) nonetheless stands out. Coulter researched in what way personal factors influence the incorporation of climate change knowledge in adaptation decisions and concluded that personal differences such as subjective assessments of climate risk and adaptive capacity shaped climate experts' ability to think about future climates and how their lives could be affected (2018a). This echoes a study from Bray and von Storch who interviewed 28 climate scientists in the mid-1990s. They found that climate scientists disagreed about the extent of the hazards associated with climate change, which is 'dependent on the cognitive apparatus of the individual scientist' (1996, p. 54). Other research by Coulter found that 'even well-informed professionals who are willing to address climate change in public, are reluctant to discuss the topic in personal and social circles' (2018b, p. i) and engage instead in distance narrative. Coulter's research aptly underscores how even climate experts may not be able or willing to entertain the consequences of climate change in their own lives.

By investigating how climate scientists and climate change experts from a variety of countries, both developed and developing, make sense of climate change, this research seeks to add to this nascent body of literature.

2 Methodology

The present research asked how those at the forefront of climate knowledge make sense of climate change given their professional knowledge. The research reported in this article is part of a larger mixed-methods research project made of three stages: a first round of qualitative interviews, followed by an online quantitative survey, leading to another set of qualitative interviews. The research was approved by the Southern Cross University Human Research Ethics Committee (ECN-19-013) in February 2019. The present article is based on the first phase of the larger research project and seeks to uncover the deeper meaning climate change

experts give to climate change through a 'lived experience' analysis of accounts of their lives. It provides unique data and findings that have not been published elsewhere.

'Lived experience' is a concept that is little defined in the literature; however, this research adopts Boylorn's definition:

> [lived experience involves] representation and understanding of a researcher or research subject's human experiences, choices, and options and how those factors influence one's perception of knowledge … [it] responds not only to people's experiences, but also to how people live through and respond to those experiences (2008, cited in McIntosh and Wright 2019, p. 452).

While recognising lived experiences as being inherently subjective, Abbott and Wilson (2014, 2015) explain in depth why it usefully completes any scientific understanding of climate change and argue that sense-making is made from 'both lived experience and science' (2015, p. 65). In the footsteps of Abbott and Wilson (2015) who researched the lived experiences of climate change by lay persons, this article studies the lived experiences of climate change experts.

Conceptually, this research is exploratory in nature and aimed at paving the way for the second stage of the research project, namely the online survey. Its purpose was to provide insights about the research topic to ensure the subsequent survey would ask relevant questions. As such, this research did not seek to be representative; therefore, representativeness across culture, location, academic discipline, gender or else was not considered. It was not planned initially that this first research phase would lead to a publication; however, the richness of the data collected led to the conclusion that it was valuable in and for itself.

The research draws on 16 qualitative interviews with climate scientists and climate change key informants (individuals who are not climate scientists but who have engaged professionally in depth with the topic of climate change). Three participants were selected following a purposive sampling process because they had demonstrated an interest in the research's topic in previous publications and were therefore persons whose views were expected to be particularly relevant to the research. The remainder of the participants were chosen randomly—as in fortuitously picked—from a list of authors and contributors to the IPCC reports published between 2009 and 2019.

Thirteen out of the 16 participants have been, or are, contributors to one or several of the IPCC reports. Several participants were climate scientists per se, others were climate researchers from different academic disciplines, one was an environmental worker and one an environmental economist. The least experienced participant had 10 years of working experience in the area of climate change, and the most experienced had well over 30 years. Eight of the participants are women and eight are men and all but two are parents. Participants were located in 12 different countries including Australia, Botswana, Canada, Fiji, Germany, India, Japan, Norway, Pakistan, Switzerland, the United Kingdom (UK) and the USA. Interviews were conducted in English. While interviews were conducted primarily via Zoom, two were also done by emails and one in person. The data collected by email was comparatively less rich than the data collected otherwise. Data collection happened between February and May 2019 and ceased when it was clear that there was enough data to prepare the next stage of the research process.

Conducting semi-structured interviews with open questions was chosen as the data collection technique as it provides an insight into people's personal accounts as well as into context and meaning. Topics covered during the interviews included participants' views on the

average global temperature increase and associated possible futures; the meaning that they gave to climate change; and their emotions and their concerns associated with the changing climate. Interviews covered other topics, in particular the mitigation and adaptation activities of the experts being interviewed. However, given the wealth of data collected, these will be published in another article.

Given past scandals and the politicisation of climate change (Grundmann 2012), participants were guaranteed confidentiality. As a result, participants' names have been omitted in this paper, but at times background information is provided to contextualise some of their answers.

Interviews were recorded and transcribed, and then coded and analysed by the author using the NVivo software, version 12. The analysis was two-fold, first, by comparing participants' answers after having grouped them under each question and, second, by identifying emerging themes from the coding. This not only allowed for the provision of a set of answers to the interview questions, but also to identify patterns that arose during the interviews.

3 Findings

3.1 Perceptions about the global average temperature increase

A relevant, if simplistic, data in understanding climate change is that of the global average temperature increase since the beginning of the Industrial Revolution. As the IPCC reports, 'climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C' (2018, p. 11). In other words, the 1.5 °C and 2 °C thresholds underscore that such a global temperature increase would have dire consequences to life on earth and human societies. Therefore, understanding what temperature increase climate change experts personally believe the planet will have reached by the end of the century is an indicator of the sort of future they consider possible on earth.

When asked what global average temperature increase the world will be facing in 2100, participants all agreed that it would continue to increase compared to the current average, which is considered to be at 1 °C (IPCC 2018) above the pre-industrial age. No one believed that the temperature increase would remain under the 1.5 °C threshold that was agreed upon in the 2015 Paris Climate agreement. While this seemed obvious to many, one participant from Fiji, a Pacific island country already dealing with the consequences of sea level rise and other manifestations of climate change, struggled to answer the question directly. It is only when asked again if she believed the temperature would remain under the 1.5 °C threshold that she shared: "Probably not, but it'll be a fight". This underscores a difficulty to face what is seen as an inescapable reality by all other participants.

Beyond this, participants had different perspectives regarding the temperature increase. While two were too unsure to say, the perception of the remaining participants varied. An expert in climate adaptation was "cautiously optimistic" that by 2100 the temperature would be below 2 °C, but with an overshoot beyond 2 °C during the century. For her, the world would be able to rein in the temperature increase thanks to increased awareness about climate change across the planet, a shared sense of urgency, changes in behaviour and new technologies.

The majority of the participants nonetheless stated that they believed that the temperature increase would go beyond 2 °C, and perhaps, 3, 4 and even 5°. The following quote from a UK

climate scientist captures well this variation in perceptions: "At the moment, it's looking like it's going to be around about 3°C with a large uncertainty around that unless we really get a grip on the situation quite urgently".

All in all, and despite the many uncertainties, most participants believed that the average global temperature increase would go beyond 2 °C by 2100. For the participants to acknowledge this means that they do expect an increase in the risks associated with global warming as projected by the IPCC (2018).

3.2 The meaning of climate change to participants and their descendants

Considering participants' views about the temperature the planet is likely to reach by 2100, they were asked what does such a changing climate mean to them and their (grand)children. Their answers varied, with some relating it to existential considerations, others to more practical implications, but it became clear that no one was insensitive to the likely implications of significant temperature increases. Participants' answers can be grouped in three themes: those who made sense of climate change by referring to its constituent parts (e.g. its manifestations on the earth systems or its impacts on human societies), those for whom climate change means taking action of some sort and those who view it through the prism of its consequences on the lives of their children.

Among those who made sense of climate change through referring to its constituent parts, an Australian sustainability expert found it "very difficult" to see climate change as an abstract whole so instead described its climatic manifestations and how these would affect human societies. An environmental worker based in Fiji stated that climate change "is a shift in the physical state of that environment, influenced by the climatic variables" that meant for her a "disruption… a disturbance in terms of what used to be". She illustrated this by explaining how sources of livelihoods that were once taken for granted had become unreliable. Along the same lines, an academic based in the UK explained that, to her, climate change meant gradual but tougher changes to daily life. She made sense of climate change by describing its implications on her society:

> Things are going to get harder for us … Things are going to get more expensive. We won't be going abroad so much and we won't be eating the kinds of foods we're used to eating. There's going to be a tonne more precarious labour migration and exploitation of migrants.

Among those for whom climate change led them to take action, a Canadian participant confided that for her, climate change meant "a sense of urgency". She explained that the changes in weather patterns associated with climate change were happening very quickly—"quicker than expected", and even quicker "than the ability to prepare for". Arguing that one does not have to be a climate scientist to take relevant climate action, she explained that this sense of urgency is what gave her the inclination to return to university and study Science Communication. She is now a published expert in climate science communication. Similarly, an academic from the USA shared that his knowledge about climate change imparted a sense of responsibility: "I'm trying to do what I can to deal with the problem". In addition to teaching and researching about climate change, he also provides advice to public and private institutions. While he saw his work as the main driver for climate action, he was also active within his local community. Living in a wildfire prone area, he supported the work of a volunteer fire-fighting agency.

Given the incremental impact of climate change this century, several participants viewed climate change as something that primarily was more of concern for their children. For instance, a participant mother of four shared her worries that climate change would primarily impact her children's lives. She explained that life in Spain would become untenable due to the increasing heat, subsequent droughts and water insecurity, and considered buying a property in Canada instead. Similarly, a climate scientist living in Switzerland wondered if his children would have the same opportunities he has had or if they were going instead to live in a world rife with economic and societal problems. A climate change expert expressed some regrets in regard to his descendants:

> I worry about the world that I will be leaving my children and my grandchildren, because I don't think we've done nearly enough to secure their future, and I think that's … well, it's something I regret … It's certainly something that I feel bad about, yes.

He added it was "difficult" to talk about it with his (adult) children and admitted being more honest with his students about the impacts of climate change than with his children.

All but two described feeling personally vulnerable to the effects of climate change. Those two participants live in developed countries and showed confidence in the lesser vulnerability and greater adaptive capacity of their country compared to others. The remaining participants described the impacts of climate change not only on distant countries, but on the country they lived in, on themselves and on their family. In this sense, climate change was not only a topic of work, but embodied knowledge.

The research found that participants primarily described climate change through the prism of its perceived impacts on human societies and/or life on earth. They shared a sense that climate change is disrupting a normal way of life, be it for society, or themselves or their children. As such, they anchored their understanding of climate change to its consequences, for others or for themselves.

3.3 Most significant concerns related to the impacts of climate change

When asked what participants were most worried about regarding the impacts of climate change, answers could be grouped in three main themes. First were concerns related to the impacts of climate change over access to water and food. Then, concerns over the destructive impact on ecosystems. Finally, the impacts of climate change on human societies were also prominent.

Water and food insecurity were the most widely shared concerns among participants. In the words of a Japanese participant, "the most serious impact will be on agriculture, which may induce serious food crises worldwide". Another completed the picture: "Failure of the harvest in the northern hemisphere where most of the grain is grown, could lead to rapid social and financial breakdown". An academic from India explained that

> A lot of the water comes to us from glaciers up in the Himalayas through our rivers and that's something that concerns me that we will have to cope with much less water than we currently use.

This concern was echoed by a mathematician and climate modeller based in neighbouring Pakistan.

Another widely shared concern related to ecosystem destructions. As a participant put it,

> There's just so much beautiful ecosystems that we're just about to lose, which I find really scary that very likely my kids are not going to be able to go snorkelling on beautiful reefs.

Others shared their melancholy and had difficulty expressing some of their thoughts:

> Our ecosystems, different ecosystems – like our forest ecosystems, our wetland ecosystems, our coral reefs, our mangroves ecosystems, our [silence] … I think the lasting impacts will be on ecosystems.

Likewise another participant confided feeling sorry "for all the species that aren't gonna … you know … [survive]". Similarly, a climate scientist confided: "there's a few things [including extinction] that I don't talk too often about when it comes to climate change…".

Participants also shared concerns regarding the impacts of climate change on human societies, either because of their impact or because of they would make some places unliveable. A participant located in India shared his concerns about heat waves and added that the increasing humidity alongside the heat would make the temperatures "unbearable". A UK climate scientist concurred with such concerns:

> Very high temperatures and humidity will make the tropical parts of the world just too hot to handle, possibly even uninhabitable sooner or later if it keeps going. So huge areas [will become] somewhere where people can't really live.

Similarly, another participant concerned about sea level rises and their consequences shared his worry that "in the next 30 or 40 years we will see huge coastal cities with large parts being declared uninhabitable".

Reflecting on the implications on her own life, a participant confided that "I worry for my children, because I don't know where they are going to be able to live". A climate scientist who is very active in developing the adaptive capacities of his country shared that he feared "not getting ready in time for the big changes that will come sort of suddenly, to be caught out by changes even though we actually knew they were coming".

Social breakdown and/or violence, alongside climate-induced migrations, were also frequently mentioned as concerns associated with climate change impacts on human societies. For instance a participant argued that

> Within the lifetime of most of the people around us, we will see huge disruptions. We will see issues with food security, but more importantly we will just see a lot of violence. That's what people tend to do when they get upset and hungry and it's not going to be pretty.

Another participant concern's related to what he saw as inevitable rising political instability and wondered what could be done about it. A participant from Spain concurred with such views:

> People will be forced to leave, and they will leave and try to reach other places and with these pressures we will see more and more of these tensions of refugees and migrants trying to move to one place to another. I think that it will be inevitable.

3.4 Emotions arising when thinking about climate change

When asked what emotions the participants felt when thinking of the impacts of climate change on humanity, five themes arose. These emotions were self-reported by the participants

as opposed to identified by the researcher, and as such may not provide a comprehensive picture of the range of emotions. First were those for whom emotions evolved and no single over-arching emotion could be identified. Second were those who expressed primarily or only negative emotions, such as anxiety, rage or sadness. Third were those who, consciously or unconsciously, adopted an emotional distance with the topic. Fourth, one participant also confided that she had "accepted" the consequences of climate change and found peace in the process. Fifth, participants also reported being hopeful, but only three mentioned it *spontaneously*. And even then, it was qualified. For the majority, it is only when *specifically* asked about it, that participants explained what gave them hope. This is the reason why hope is presented in the next sub-section.

Regarding those who confided that their emotions are diverse and evolving, a climate scientist shared for instance feeling "sometimes fear, sometimes a kind of determination to deal with it, and sometimes sadness as well". Another climate scientist likewise confided "things evolve. I mean, it may even depend on the day you contact me whether I see things more positively or negatively". Similarly, a geo-ecologist explained

> on the one hand it's a concern and an increasing concern, but on the other hand when I see all this engagement of, for instance, Greta Thunberg, or … all these international treaties or agreements that were signed in 2015, I am more hopeful that change is in sight … But, I also get often frustrated that things are so slow.

Other emotions that participants stated they feel when thinking of the impacts of climate change on humanity were primarily negative emotions. Those were of varying nature and included sadness, rage, anxiety, concerns and feeling sorry about it. For instance, an environmental economist shared that

> Rage just summarises it, but it also includes a feeling of frustration ... The fact that it's all the result of selfish behaviour and self-interest on the part of people who are involved in capitalism.

Similarly, a UK environmental social scientist expressed a mixture of negative emotions: "Sad. And loss. Yeah, I think the grief. And I think increasingly you feel the wasted opportunity, like, we could have stopped it". A Swiss climate scientist expressed that "It's a lot of feeling sorry about all the negative impacts, particularly for those who don't have the potential to adapt to those changes".

Emotional distance was also reported. For instance, a US academic shared that

> I tend to be an optimistic person, so I mostly tend to think of it as a ... sort of a challenge, as a thing for us to ... I don't want to use the word manage, but, you know, deal with.

A climate scientist confided that "somehow you keep your optimism and you can't think about it every second, but there's a risk that you start to just push it away and not think about it". Analysing her emotional distance, another participant considered "it sometimes amazes me how much I actually know but how much I can put aside".

A climate change expert with 30 years interest in the field did not see it as an issue, and explained "I've thought for so long about climate change as an issue threatening humanity that I don't personalise it to the extent that other people do".

In contrast, one academic confided having "accepted" the reality and consequences of climate change: "… we have lost. The climate will change now for the next thousands and thousands of years". This realisation brought her some inner peace:

There's a feeling of submission that I felt recently that I didn't have before ... It's a submission to the fact that it's happening, you know, in that pure sense of letting go of the fight and resisting. So, I lost a slight bit of that tension.

3.5 Hope in the face of climate change

The reasons for hope were primarily four-fold. Hope was based on witnessing an increasing social awareness about climate change, in particular among the youth. The second reason for hope was that this awareness was seen as conducive to social changes. Third, participants were hopeful that innovations and new technologies offered promising alternatives to a dystopian future. Finally, several participants shared their faith in humanity's ingenuity and adaptability.

When asked specifically what gave participants hope about climate change, the most common answer was the recent awareness among the world's young people. In the words of a participant, "[the climate crisis] appears to be, at least, galvanising young people more than before". A German participant expressed her surprise at the extent of the student protests: "students are so massively protesting [that] it's kind of surprising me".

A participant based in India confided that he is a "big fan" of the school strike movement. He explained that anything driven by children would have a different impact than "us middle-aged types going and striking" as it would be perceived as more legitimate to make demands about their future. Another participant noted that the younger generations seem to be driven by different values: "… they are really much more convinced, or much more conscious, of the importance of a healthy environment". She believed that thanks to this, they would be able to shape environmentally sustainable societies.

Some participants observed with satisfaction some promising societal changes. For instance, a US academic explained that "you can see the cultural changes, you know, there are behavioural changes happening… and so, the hopeful thing is that the tipping point is soon, right?" By tipping point, the participant referred to a sudden and irreversible moment when societies would request meaningful climate action. An academic from Botswana explained that her hope rose from the assumption that a worsening situation would entice more people to act. Looking forward, another academic observed that,

> [there's] hope you could have a non-linear shift in us as much as you can have a non-linear shift in the climate and that we could flip into something different as a society.

Other developments that appeared to give participants hope regarding climate change were new technological innovations, in particular new modes of energy supply and transport systems. A participant living in Germany was excited by the rapid changes in mobility and the subsequent positive behaviour changes it led to. She then added that these societal changes were so rapid that

> The models that we look at are not able to capture that. They assume a much slower pathway, and so these kind of fundamental transitions really show that we might even be too conservative in what we assume is actually possible.

A US-based climate economist concurred and was also excited by how innovations such as the electric car or the shared economy, allowed to provide the same services in ways that were more sustainable. An academic based in India expressed his optimism about renewable

energies and believed we are close to a "tipping point" before these would replace old polluting sources of energy.

Finally, hope was also based on the opportunity for humans to apply their ingenuity and adaptability. For instance, an environmental social scientist shared that "what gives me hope is that actually this is a challenge that might bring us together as humanity". Likewise, a climate scientist explained: "humans as a species are pretty ingenious and can do amazing things when we pull it together and put our mind to it". A Swiss climate scientist had similar views: "I'm relatively hopeful that we can cope with … and adapt to quite a few of the effects, direct impacts …" A UK-based academic stated that climate change offered a unique opportunity to "restructure society and being a better humanity".

4 Discussion

The complexity of climate change, its non-locality, extension in deep time and space, subtle geophysical intricacies, multiple manifestations and diverse impacts and implications make it difficult to comprehend, let alone to be solved.

Yet, given its all-encompassing nature, climate change affects all of what matters to humans: our environment, our access to shelter, water and food, our physical and emotional safety and security, our health, our livelihoods, our economy and our culture. As such, it is important that we address the nature and scale of the challenges before us as well as the complex ontological implications. By investigating the lived experience of climate scientists and climate change experts, the present article has presented some 'authentic' and 'personalised' (Rapley et al. 2014) insights into the way in which this existential challenge is being viewed by those at the very forefront of climate knowledge.

The research reveals that those at the frontline of climate science make sense of it from varying perspectives and take away different lessons. They react to it differently and have distinct concerns about it, yet patterns emerge, allowing for a deeper analysis.

Pattern 1: by underlining the likely increase of the global average temperature beyond 2 °C by 2100, participants' views convey a grave situation Even if participants disagree with the speed of warming, they agree that the average global temperature is increasing, and that this has life-altering implications. Both of these points concur with those of Rosenberg et al. (2010) and Bray and von Storch (2016) and are also in line with the IPCC reports published in the past decade. This research also adds weight to Anderson and Larkin's findings (2011) by underscoring that participants do not believe that the global average temperature will remain below the 1.5 °C threshold.

Pattern 2: climate change is associated with a diversity of concerns In particular, in terms of the intellectual understanding of its consequences on human societies and the natural environment and the associated emotional response this provokes, this diversity of concerns is unusual. This research found that an increase in water and food insecurity was most frequently mentioned, followed by ecosystem destructions, disasters associated with disruptive weather and negative impacts on human societies. In contrast Steentjes et al. (2017) found that when asked what people think the most likely impacts are for their country, those were predominantly linked to weather conditions. Moloney et al. (2014) had similar findings in their survey of Australian scientists, government employees and community

members. Also, compared to climate diplomats (Milkoreit 2017), participants seem to be the only group actively concerned about environmental damage in addition to human, economic and social impacts. This may be explained by the fact that their professional role leads them to engage with different sorts of knowledge and make them more aware of the diversity of impacts associated with climate change.

Pattern 3: participants widely share a sense that climate change is disrupting a normal way of life, be it for society, or for themselves, but the meaning that they give to the wicked problem of climate change takes different forms This echoes the point made by Hulme (2008) and others that the meaning of climate is constructed differently across people, places and scales. Some participants understand it as tangible geophysical manifestations such as changes in weather patterns that need to be studied or documented, while others give it meaning by focusing on the implications of these changes on human societies and ecosystems. Yet, others live it as a call to action and devote significant parts of their life to it. Actions were either life changing in order to align to this new understanding, or appeared to be small steps implemented in daily life that were nonetheless resolutely shaped by a drive to 'do something useful about it', which resonates with Milkoreit (2015). Participants who are also parents associated climate change with its possible consequences on the lives of their (grand)children, from a mental health and well-being perspective, as well as more practical and ontological ones, and sought to protect, inform or prepare their offspring to these. The research confirms previous findings (Head and Harada 2017; Coulter 2018a, b) that climate scientists and experts show reluctance to talk about climate change to their children, but it also provides evidence of the contrary, with multiple participants mentioning ongoing conversations with their descendants, albeit of varying depths. This could be related to a 'Greta effect', whereby young leaders such as Greta Thunberg, who has reached global prominence in 2019 through the organisation of school strikes, have influenced youth's awareness and engagement with the topic. This in turn may have increased the opportunities for participants to talk to their children about climate change.

Pattern 4: for most participants, climate change is not just the focus of their work but embodied knowledge All but two participants described the impacts of climate change not only as a professional interest or on distant countries, but on the country they lived in, on themselves and on their family. Bray and von Storch found that climate scientists 'were vague on their perceptions on impacts' (1996 p. 19), but participants to this research were specific. Coulter also found that '[p]erceptions of low personal vulnerability and high adaptive capacity reduced motivation to imagine climate challenges as personal' (Coulter 2018a, p.101). This research however found different results as most participants shared personal, and at times, intimate details about how climate change affected them or would affect them. Climate change was then not only a topic of study/work, but embodied knowledge—something made sense of through experience and emotions. This research suggests that participants may have been influenced by the evolving global conversation about climate change. In the past few years, the mediatisation of multiple disasters of unprecedented proportions across the planet in parallel with the publication of the landmark 2018 IPCC report alongside other academic (Bendell 2018; Steffen et al. 2018; Lenton et al. 2019) and non-academic publications have allowed societies, including scientists and climate change experts, to openly refer to and envision more catastrophic perspectives at global and local scales. Movements like the School Strikes 4 Climate and Extinction Rebellion have ensured that the topic is not forgotten. As a result,

climate experts may feel more vulnerable to the impacts of climate change, as well as more able and/or freer, to engage in future thinking in a personal fashion as international research paves the way in outlining dystopian futures, and as disasters strike closer to home.

Pattern 5: there is some correspondence between participants' professional expertise of climate change and their perceptions of the most significant concerns related to the impacts of CC, but participants are not limited by it Several of the participants stated concerns about CC that reflected their professional expertise. For instance a climate scientist explained being "primarily" concerned about the changes in weather and climate extremes, which he explained "is specifically my research interest". Similar observations were noted throughout, underscoring some correspondence between participants' technical expertise and their perspectives on CC. However, and illustrative of the fact that participants were not limited by their professional outlook, the participant mentioned here also added being concerned not only "specifically for the country I'm living in, about heatwaves and precipitation" but also "about the indirect effect on my personal life."

Pattern 6: understanding climate change is often relational and contextual In a similar way to Abbott and Wilson (2015) who researched the lived experiences of lay people affected by climate change, this research found that the social and geographical context in which participants live influence their lived experience. Participants frequently appreciated climate change through the prism of its effects on humans, be it themselves, their families or strangers living in another country, as well as on our natural environment. Additionally, the country they live in and its adaptive capacities in the face of CC, the weather events they have experienced, their job and their family situation also shaped their views.

Pattern 7: participants' lived experience of climate change is akin to carrying an emotional burden Participants expressed detachment and hope, but mostly it is heaviness that transpires through the research. Participants do not necessarily express this when living their daily lives, but it emerged during the interviews, perhaps because the process of reflecting on the topic as part of the interview allowed them to give space to deeper emotions. In the process, this research underscores that participants are affected by their understanding of climate change. This highlights that some climate experts may not only demonstrate an emotional distance which allows them to approach climate change from an apparent emotion-free, rational, perspective, but also be affected by it *at the same time*. This distancing mechanism observed among some participants confirms previous findings (Milkoreit 2015; Head and Harada 2017; Coulter 2018b). Head and Harada (2017) suggested that this distance could be the result of multiple pressures faced by those experts, in particular not only the necessity to be perceived as rational actors, but also the need to maintain mental health well-being.

Pattern 8: despite the challenges lying ahead, many participants remain hopeful Those findings echo that of Head and Harada (2017), Coulter (2018b) and Clayton (2018). The latter contends that '[c]limate scientists may be able to draw on their knowledge and their social connections to build constructive hope' (p. 61), which is confirmed by this research. Benzein, Norberg and Saveman found that the lived experience of hope by cancer patients is a 'tension between various dimensions of hope; to hope *for something*, that is the hope of being cured, and living *in hope*, that is reconciliation with and comfort with life and death' (2001, p. 123,

emphasis added). In this research, participants' hope was almost entirely focused on a 'hope for something', namely new technologies or changes in our lifestyles. Participants' hopes may provide a reason to be optimistic, but only to a certain extent as their hope did not relate to whether such changes would effectively reduce or reverse the effects of climate change. One participant appeared to be 'living in hope' as she confided finding inner peace by accepting CC as inevitable. This reconciliation and comfort with life and death resonate with Gosling's question of whether we need a more 'radical hope' in the context of climate change (Gosling 2016, cited in Bendell 2018).

The eight patterns underscore that participants make sense of the wickedness of climate change both through their professional understanding of it and their personal engagement with it. While for most, climate change started as an area of professional interest, it seems to have permeated their personal lives to a great extent. Climate change is then made sense of through a mix of intellectual and scientific understanding, personal experience, thoughts, emotions, exchanges with others and broader societal context. This, in turn, adds weight to the views that given the super wickedness of CC, a diversity of perspectives are indeed necessary for us mere humans to fathoming it.

The deeper meaning of this study of the lived experiences of climate experts is that there is ground to be concerned. This corroborates the current body of scholarly literature on the gravity of climate change and adds a new level of depth to its subjective understanding. Given its wickedness, climate change is a particularly difficult reality to apprehend, but the research does indicate that the situation is grave indeed. Understanding how grave it is perceived to be by climate experts will be the object of the next stage of this research.

Although the research was based on semi-structured interviews, several participants expressed their gratitude for the "conversation", that is, for an open and authentic exchange on a topic of shared interest. For them, the interview created an opportunity to not only reflect on their own experience but also to openly share their emotions regarding the subject of their work. As a result, some confided that they had expressed thoughts that they would otherwise not have, which aligns with the lived experience framework. This said, the research also suggests that the personal views of climate experts are influenced by their environment. As such, the research is limited by the fact that interviews took place in a given point in time— early 2019 at the height of the Australian bushfire season that made headlines globally—and it is likely that future interviews with climate knowledge holders would offer both similar and different findings.

5 Conclusion

In order to better comprehend not only the overwhelming magnitude of climate change, but also the very real impacts it is having and will continue to have on the planet, the present research sought to understand, through a lived experience analysis, how climate experts make sense of climate change. The diversity of perceptions about climate change identified in this research likely reflects participants' different life circumstances, knowledge, risk perception and location, but it also reaffirms that climate change is a complex, multifaceted, super-wicked issue. Indeed, the research makes clear that even those at the frontline of climate science look at it and make sense of it from varying perspectives, both professional and personal, and take away different lessons. Yet, climate experts almost always viewed climate change through

the prism of its perceived impacts. They see it as a disruption of the normal way of life and all concur about the gravity of the situation.

While each of us in turn will take away from the participants' experiences reported here what our cognitive, cultural, social and political biases will indicate to us is the most relevant, we would be well advised to accept, as they do, that the situation is grave indeed.

References

Abbott D, Wilson G (2014) Climate change: lived experience, policy and public action. Int Jnl Clim Chang Strat and Manag 6(1):5–18. https://doi.org/10.1108/IJCCSM-04-2013-0040

Abbott D, Wilson G (2015) The lived experience of climate change, Springer International Publishing

Anderson K, Bows A (2011) Beyond 'dangerous' climate change: emission scenarios for a new world. Phil Trans R Soc A 369:20–44. https://doi.org/10.1098/rsta.2010.0290

Bendell J (2018) Deep adaptation: a map for navigating climate tragedy. IFLAS occasional paper 2. https://www.iflas.info. Accessed 3 Oct 2018

Benzein E, Norbgerg A, Saveman BI (2001) The meaning of the lived experience of hope in patients with cancer in palliative home care. Palliat Med 15:117–126. https://doi.org/10.1191/026921601675617254

Boulton E (2016) Climate change as a 'hyperobject': a critical review of Timothy Morton's reframing narrative. WIREs Clim Change 7:772–785. https://doi.org/10.1002/wcc.410

Bray D, Von Storch H (1996) Inside science, a preliminary investigation of the case of global warming. Max-Planck-Institut für Meteorologie, Report 195

Bray D, Von Storch H (2014) A survey of the perceptions of climate scientists 2013. https://doi.org/10.13140/RG.2.2.27842.79043

Bray D, Von Storch H (2016) The Bray and von Storch 5th international survey of climate scientists 2015/2016. https://doi.org/10.13140/RG.2.2.11802.85443

Burnham M, Ma Z, Zhang B (2015) Making sense of climate change: hybrid epistemologies, socio-natural assemblages and smallholder knowledge. Area 48(1):18–26. https://doi.org/10.1111/area.12150

Clayton S (2018) Mental health risk and resilience among climate scientists. Nat Clim Chang 8:260–271. https://doi.org/10.1038/s41558-018-0123-z

Coulter L (2018a) Future Climate Narratives: Combining Personal and Professional Knowledge to Adapt to Climate Change. In: Serrao-Neumann et al (eds.), Communicating Climate Change Information for Decision-Making, Springer Climate

Coulter L (2018b) Future climate narratives: knowledge informing climate change adaptation, Thesis (PhD Doctorate), Griffith University. http://hdl.handle.net/10072/380061. Accessed 29 Aug 2019

Dannenberg A, Zitzelsberger S (2019) Climate experts' views on geoengineering depend on their beliefs about climate change impacts. Nat Clim Chang 9:769–775. https://doi.org/10.1038/s41558-019-0564-z

Granderson AA (2014) Making sense of climate change risks and responses at the community level: a cultural-political lens. Clim Risk Manag 3:55–64. https://doi.org/10.1016/j.crm.2014.05.003

Grundmann R (2012) "Climategate" and the scientific ethos. Sci Technol Hum Values 38(1):67–93

Head B (2008) Wicked problems in public policy. Public Policy 3(2):101–118

Head L, Harada T (2017) Keeping the heart a long way from the brain: the emotional labour of climate scientists. Emot Space Soc 24:34–41. https://doi.org/10.1016/j.emospa.2017.07.005

Hoffman AJ (2015) How culture shapes the climate change debate. Stanford University Press, Stanford

Hulme M (2008) Geographical work at the boundaries of climate change. Trans Inst Br Geogr 33:5–11

IPCC (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A. Field CB et al (eds.). Cambridge University Press, Cambridge, New York, 1132 pp

IPCC (2018) Summary for Policymakers. In: Global Warming of 1.5°C. Masson-Delmotte V et al (eds.). World Meteorological Organization, Geneva, Switzerland

Kahan D (2012) Why we are poles apart on climate change. Nature 488:255. https://doi.org/10.1038/488255a

Lakoff G (2010) Why it matters how we frame the environment. Environ Commun 4(1):70–81. https://doi.org/10.1080/17524030903529749

Lazarus RJ (2009) Super wicked problems and climate change: restraining the present to liberate the future. Cornell Law Rev 94(5):1153–1234

Lenton T et al (2019) Climate tipping points — too risky to bet against. Nature 575:592–595. https://doi.org/10.1038/d41586-019-03595-0

Levin K, Cashore B, Bernstein S, Auld G (2012) Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. Policy Sci 45(2):123–152. https://doi.org/10.1007/s11077-012-9151-0

Maitlis S, Vogus TJ, Lawrence TB (2013) Sensemaking and emotion in organizations. Organ Psychol Rev 3(3): 222–247. https://doi.org/10.1177/2041386613489062

Markowitz EM, Guckian ML (2018) Climate change communication: challenges, insights, and opportunities. In: Clayton S and manning C. Academic Press, Psychology and Climate Change, pp 35–63

McIntosh I, Wright S (2019) Exploring what the notion of 'lived experience' offers for social policy analysis. J Soc Policy 48(3):449–467. https://doi.org/10.1017/S0047279418000570

Milkoreit M (2015) Science and climate change diplomacy: cognitive limits and the need to reinvent science communication. Sci dip: new day or false Dawn? Sci Clim Change Dipl 6:109–131. https://doi.org/10.1142/9789814440073_0006

Milkoreit M (2017) Mindmade politics: the cognitive roots of international climate governance. MIT Press, Cambridge

Moloney G et al (2014) Using social representations theory to make sense of climate change: what scientists and nonscientists in Australia think. Ecol Soc 19(3):19. https://doi.org/10.5751/ES-06592-190319

Morton T (2013) Hyperobjects, philosophy and ecology after the end of the world. University of Minnesota Press, Minneapolis

Nash N, Whitmarsh L, Capstick S et al (2019) Local climate change cultures: climate-relevant discursive practices in three emerging economies. Clim Chang 163:3–4. https://doi.org/10.1007/s10584-019-02477-8

Pahl S, Sheppard S, Boomsma C, Groves C (2014) Perceptions of time in relation to climate change. WIREs Clim Chang 5:375–388. https://doi.org/10.1002/wcc.272

Rapley CG et al. (2014) Time for Change? Climate Science Reconsidered. https://www.ucl.ac.uk/public-policy/policy-professionals/policy-commissions/ucl-policy-commission-communication-climate-science. Accessed 2 Dec 2019

Rittel HWJ, Webber MM (1973) Dilemmas in a general theory of planning. Policy Sci 4(2):155–169. https://doi.org/10.1007/bf01405730

Schwandt TA, Burgon H (2006) Evaluation and the study of lived experience. In: Shaw I, Greene JC, Mark MM (eds) The SAGE Handbook of Evaluation. Sage, London

Steentjes K et al (2017) European perceptions of climate change: topline findings of a survey conducted in four European countries in 2016. Cardiff University, Cardiff

Steffen W et al (2018) Trajectories of the earth system in the Anthropocene. PNAS 115(33):8252–8259. https://doi.org/10.1073/pnas.1810141115

Termeer C, Dewulf A, Breeman G (2013) Governance of wicked climate adaptation problems. In: Knieling J, Leal Filho W (eds) Climate change governance. Climate Change Management. Springer, Berlin, Heidelberg

Vogt VP (2005) Dictionary of statistics & methodology, 3rd edn. SAGE Publications, Inc., Thousand Oaks. https://doi.org/10.4135/9781412983907.n1482

Von Storch et al. (2019) Attitudes of young scholars in Qingdao and Hamburg about climate change and climate policy - the role of culture for the explanation of differences. Adv Clim Chang Res https://doi.org/10.1016/j.accre.2019.04.001

Whitmarsh L, Capstick S (2018) Perceptions of climate change. In: Clayton S, Manning C (eds) Psychology and Climate Change. Academic Press, Cambridge, pp 13–33