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Advancing the potential impact of future scenarios by integrating psychological principles

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ABSTRACT

Engaging with the future to make better decisions in the present is key for sustainable development and climate change responses. In this conceptual paper, we suggest a scenario building approach that connects psychological principles of future thinking with future scenario development in order to advance the impact of scenarios. Future scenario work currently does not sufficiently consider processes of human communication, emotion, cognition and has only begun to focus on people's local contexts in recent years. We argue that more understanding of psychological processes, such as cognitive biases and heuristics, as well as psychological distance, which typically occur in future thinking, can improve the impact of scenarios. Specifically, we provide a psychological basis for systematically integrating emotion-evoking aspects into future scenario development, using tailored narratives and visuals to make content tangible and meaningful for a broad spectrum of audiences, and adapting content temporally, spatially, and linguistically to audiences, in combination with inclusive and creative co-creation of scenarios and sustainable solutions. We explain why this approach has the potential to overcome some recognised cognitive biases hampering scenario impact and intended sustainable change processes, and can therefore support the co-development of sustainable and inclusive policies and solutions that empower and connect individuals, communities, and decision makers.

1. Introduction

Engaging systematically with the future will help us to make better decisions in the present (Bruderer Enzler, 2015). Actively engaging with the future is in line with the United Nation's call to take global action towards the "Future We Want" (United Nations, 2012). Future scenarios have the potential to elicit relevant action for sustainable development, such as climate change adaptation and mitigation measures (Larsen and Gunnarsson-Östling, 2009). However, we argue that the use of future scenarios for environmental science and policy planning currently fall short of its potential impact. Butler et al. (2020) observe that conventional scenarios are often the end of a process rather than part of a dynamically and interactively developed strategy. The authors argue that the way scenarios are developed, communicated and evaluated should be revisited to better support localized decision making and community involvement.

We introduce a psychological perspective to scenario development and communication, putting the human dimension at the forefront of our discussion. Specifically, we focus on principles of human cognition, emotion and communication and how they can drive changes in attitudes and behaviour from individuals to communities. We discuss cognitive biases in future thinking and ways to overcome them. For this we are drawing on evidence from psychology and environmental communication research, referring to, for instance, the value of emotional storytelling and visuals (see Klöckner, 2015 for an overview). We derive practical recommendations for future scenario development and communication, emphasizing a localized community-involving perspective. We agree with other scholars previously pointing towards the lack of systematic evaluation of scenario outcomes and impacts (Butler et al., 2020; Elsawah et al., 2020; Trutnevyte, Guivarch,

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Lempert, and Strachan, 2016).

1.1. Types and uses of future scenarios

With the help of future scenarios, it is possible to describe the expected continuation of a current situation such as business as usual, or worst- or best-cases, for example (Schwartz, 2012). Scenarios often do not reflect accurate predictions of specific futures. Instead, they are constructions of one or multiple possibilities of how the future might look, based on qualitative or quantitative sources of data (Ogilvy and Schwartz, 2004).

Future scenarios can be classified into different types such as predictive (what will happen), explorative (what can happen) and normative (what should happen) (van Notten, Rotmans, van Asselt, and Rothman, 2003). These different scenario types make specific assumptions which all have important implication for the present. Predictive and explorative scenarios both assume that there will be changes in the future to which people will have to adapt whereas normative scenarios first define how the future could look like and then define ways of how to get to these futures, thereby assuming more agency. Most of the time, not one type of scenario is developed and used but a combination of them, depending on the aim of the exercise (Oteros-Rozas et al., 2015). provide an overview over how different types of scenarios could be mapped on two dimensions, 1) implications for the present (interrogating, mobilising, building capacities and planning) and 2) conceptualisation (probable and improbable, plausible, pluralistic, performative). On this map, the scenarios range from budget and policy analyses over trend analysis to participatory scenario planning and discourse analysis (Muiderman et al., 2020, Fig. 2). In our work, we do not refer exclusively to one particular type of scenario. However, different discussion points and recommendations are more relevant for certain types of future scenarios, which will be indicated.

1.2. Future scenarios in the natural sciences, politics and business

Future scenarios are commonly used in the natural sciences, in socio-political contexts and in business to help prioritise decisions under uncertainty, and to increase preparedness for potential futures. Future scenarios were first developed in the military (Quade and Boucher, 1968), then applied to economic and political decision making, and later in business (Bradfield et al., 2005). In the environmental context (the focus of this paper), natural and social scientists typically produce predictive and explorative scenarios, detailed prospects on a variety of dimensions such as greenhouse gas emissions or temperature changes (e.g. Mitter et al., 2019). These, in turn, can be used to drive models that explore the effects of those prospects on nature, for instance, the ocean environment, those that depend on it (e.g. the fishing industry), as well as the effectiveness of different management practices (e.g. the effectiveness of marine protected areas; (Fernandes et al., 2015; Queirós et al., 2021). Scenarios relating to environmental and planning issues are of course used by many other kinds of professionals beyond scientists, but in this paper, we draw primarily upon scientific papers on scenario research and scholarly reviews of scenario practice.

Explorative as well as normative future scenarios are also frequently used in socio-political contexts relevant for sustainable development (Sala et al., 2000). For example, the climate change modelling community developed the Shared Socioeconomic Pathways, scenarios that provide standardised "storylines" that include socio-economic considerations (about e.g. population, GDP, poverty) as well as technological development, representing different degrees of climate action, ranging from green (SSP1) to fossil-fuelled (SPP5) growth (Gidden et al., 2019). These in turn are combined with Representative Concentration Pathways (RCPs), scenarios which represent different trajectories for greenhouse gas concentrations (Van Vuuren et al., 2011. The global climate modelling community then applies these socio-political and climate scenarios in a scenario matrix architecture (Gidden et al., 2019) to sophisticated climate models, to estimate the response of the global climate system to these varied and multi-dimensional futures, representing different degrees of radiative forcing, and thus, global warming (Meinshausen et al., 2020). These scenarios aim to be value-neutral and are for example considered in the Intergovernmental Panel for Climate Change (IPCC 2021, see Fig. 1) to drive climate models (CMs, e.g. Earth-System Models of Intermediate Complexity, Atmosphere-Ocean coupled Global Circulation Models and Earth System Models), as well as integrated assessment models (IAMs, combining natural science and socio-aspects aspects of climate change). These global scenarios are designed to inform economic or political leaders as well as large institutions e.g., at the supra-national and national level (e.g. Monnier et al., 2020) on the value of curbing emissions (and the cost of not doing so), and are intended to support climate action.

As an example of national-scale scenarios guiding political decision making, the UK National Ecosystem Assessment (UK NEA) has developed future scenarios for the United Kingdom in 2060, illustrating what the country could look like under different driving forces such as consumerism, social cohesion, international relationships or autonomy (Lead et al., 2010).

1.3. Challenges connected to future scenarios and their communication

For future scenarios to unfold their true potential we need to apply communication science and integrate a psychological understanding of cognitive and emotional processes in future thinking. To do this, we reflect on two current, linked challenges, from a psychological perspective: the challenge of communicating complexity in future contexts and the challenge of evaluating the effects of scenarios on different audiences.

The challenge of communication complexity means that scenarios are not sufficiently tailored in terms of different audiences' understanding and behavioural application (e.g., McMahon et al., 2015; Xexakis and Trutnevyte, 2021). The purpose of scenarios developed by natural scientists or environmental economists is to guide global and national policy making. If they fail to consider psychological principles of future thinking and principles of communication, judgement and decision making, they will, however, miss opportunities for effective uptake by respective policy makers and thereby, impact (Bosetti et al., 2017). We posit that integrating psychological insights will improve the effectiveness of scenarios as tools to support understanding and motivate behavioural change at the individual, community, and global level (Harold et al., 2016; Thaler, 2016). Another challenge is the over-use of scientific terminology. Presenting classic scenarios, as employed by the IPCC or UK NEA, to lay audiences may be ineffective if they lack the expert knowledge to fully understand the message (Gifford, 2011; Xexakis and Trutnevyte, 2021). It can even trigger feelings of reactance[1] in the audience, and make them feel overwhelmed, unmotivated and helpless (Hamilton and Kasser, 2009; Marshall, 2015). Some studies have begun to investigate the presentation of scenarios from the perspective of the recipient, all concluding that more tailoring is needed between the scientific information and the target audience (Dulic et al., 2016; McMahon et al., 2015; Sheppard and Meitner, 2005; Xexakis and Trutnevyte, 2021).

Due to the lack of thorough evaluation, little is known about how scenarios influence decision making and communication tools. It is often claimed that communication using future scenarios increases knowledge, however, there is little empirical evidence supporting this claim (Trutnevyte et al., 2016), mainly due to a lack of systematic evaluation. The few studies or projects evaluating effects of societal change processes involving future scenarios point to ambiguous results, some pointing out that learning from future scenarios might be different from

[1] Reactance is "motivational state directed toward the reestablishment of [a] threatened or eliminated freedom" (Brehm, 1966, p. 15)

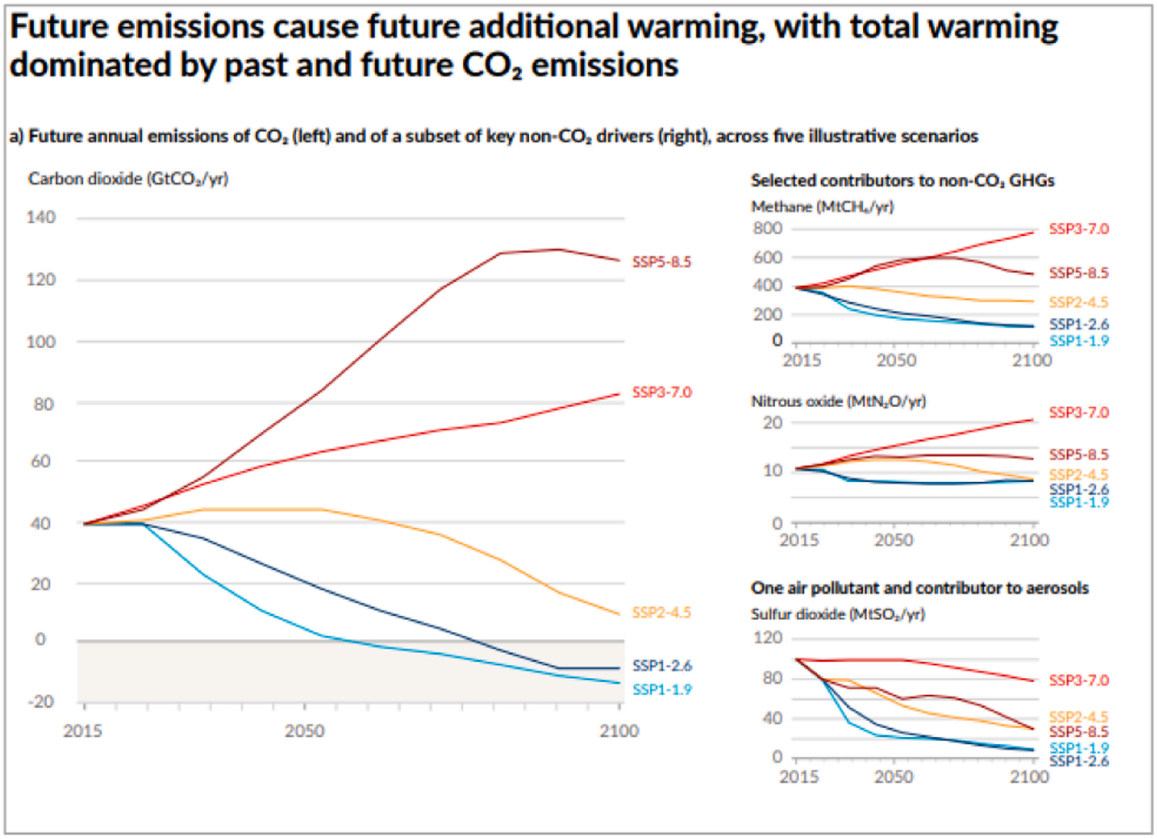

Fig. 1. : Example of different degrees of global CO2 emissions trajectories, estimated based on SSP-RCP scenarios employed by CMIP and reported in Figure SPM.4, Panel (a) from IPCC, 2021.

what was originally intended (Xexakis and Trutnevyte, 2019) some supporting the use of scenarios due to its effectiveness (Butler et al., 2016), some emphasising its shortcomings (Totin et al., 2018). There seems to be a difference in effects depending on the degree of involvement. Studies reporting the effects of co-developed scenarios report more positive effects than studies assessing the effects of communicating through pre-developed scenarios (Elsawah et al., 2020). There is no study so far actively evaluating this concrete assumption. In general, more systematic research is needed to identify the most effective means of communicating scenarios. Specifically, the potential to help overcome cognitive biases and to engage policy makers, scientist as well as the society more broadly in the sustainable decision-making process. In the remainder of this piece, we will briefly summarise relevant principles and biases accruing in human future thinking and then make suggestions on how to address these in scenario planning.

2. The psychology of future thinking

While some sections of society are very aware and active in combating climate change and environmental degradation (e.g. researchers, environmental protection agencies, Fridays for Future and other activist groups), others remain sceptical or uninterested. There are a number of psychological explanations for this lack of engagement that could potentially be, and already have been addressed using future scenarios.

Scenarios, like those used in Fig. 1, often depict situations far into the future, illustrating global consequences. Distant time horizons such as 2050, or end-of-century, may be difficult for most people to imagine (Butler et al., 2020), especially because a typical time horizon for human cognition is 10 years into the future (Tonn et al., 2006). This is particularly the case if meeting subsistence needs is the priority, as it is the case in developing countries and communities (Richter, Sumeldan et al., 2021). A global framing in future scenarios may also create a cognitive barrier, due to the sheer geographic and thematic scale (Butler et al., 2020; Dulic et al., 2016), as will be discussed below.

2.1. *Psychological distance and abstraction*

Psychological distance is the 'cognitive separation' within an individual's mind between themselves and external concepts. This means, the extent to which a person perceives other people, places and events as being conceptually removed from themselves (for an overview see Liberman et al., 2007; Maiella et al., 2020). The larger the separation, the more a concept is perceived as abstract as opposed to concrete. This abstraction can lead to the perception that the concept is intangible and irrelevant. In the case of threats such as climate change, this distance can lead to a lower willingness to take protective action (McDonald et al., 2015). Researchers have argued that traditionally, climate change and connected risks has been communicated in a way that this separation and abstraction have been increased (for an overview see Maiella et al., 2020).

Psychological distance operates on a number of dimensions including geographical, temporal and social distance. These three dimensions in particular have been examined in relation to climate change. Indeed, climate change is perceived to happen in places that are far away from us (Lorenzoni et al., 2007), to occur at a time distant in the future (Pahl et al., 2014) and to affect people who are socially different to ourselves (Spence, Poortinga, & Pidgeon, 2012). Further, a combination of spatial optimism ("things are better here than there") and temporal pessimism ("things will get worse") implies that climate change is still often perceived as something abstract rather than concrete (Gifford et al., 2009). Often, people tend to think others will be worse affected than they will be, which may prevent action (Pahl et al., 2005). Researchers are exploring ways to overcome this psychological distance,

for example, through the proximation of climate change effects (Spence & Pigeon, 2010). Potential strategies are promoting feelings of global connectedness (Loy & Spence, 2020), communicating via immersive media and experiential visualization, such as the Future Delta 2 video game (Breves and Schramm, 2021; Dulic et al., 2016) or projects like the World Bank COP23 Virtual Reality project, Our Home, Our People (www.ourhomeourpeople.com). Evidence is still scarce around the effectiveness of these approaches and evaluation of scenario effects is lacking therefore caution must be applied. Immersing people in issues that are already perceived as proximal and threatening may also result in adverse effects because people may feel overwhelmed and helpless (Breves and Schramm, 2021), highlighting again the need to tailor scenarios to their intended audience.

2.2. Cognitive and affective biases in future thinking

It is rare that people make decisions purely based on rational evaluation and analytical thinking (Zhao and Luo, 2021). Instead, people employ cognitive 'shortcuts', known as heuristics, to make judgements under uncertainty (Tversky and Kahneman, 1974). The use of heuristics can result in predictable biases and research has shown that people fall victim to biases whilst deciding for or against pro-environmental behaviour (for example Brick et al., 2017; Vega-Zamora et al., 2014). Some of the most relevant heuristics in the context of future thinking are the interrelated heuristics of availability, simulation and affect.

The availability heuristic describes the phenomenon that people judge the probability of an event happening based on the ease by which similar events are cognitively available i.e. salient and prominent in the mind. This heuristic can influence perceptions of the likelihood of climate change effects, for example when people can easily recall instances of extreme weather (Netzel et al., 2021; Ogunbode et al., 2020). However, if people have no such easily available reference point, they might judge the probability of climate change happening to be low, and this can be linked to low motivation for climate action. Well-designed scenarios have the potential to increase the availability of climate change within the mind, leading to a higher likelihood of protective action.

The simulation heuristic refers to probability judgements based on the ease with which future events can be imagined; future events that are easy to imagine are perceived as more likely (Kahneman and Tversky, 1981) and events that are perceived as more likely are in turn connected to more adaptative thinking and behaviour. In contrast, future events that are difficult to imagine (positive as well as negative) are not considered likely and therefore do not lead to adaptative behaviour. In health psychology, mental imagery is successfully used to increase behavioural changes such as reduced alcohol consumption, increased exercise or smoking cessation (Oettingen, 2012). Mevissen et al. (2012) found that allowing people to self-generate future risk scenarios increased the imaginability of future events and in turn increased perceptions of personal susceptibility, as compared to 'prefabricated' scenarios. This highlights the importance of co-creation in scenario development, as reviewed below.

The affect heuristic (Finucane et al., 2000; Slovic et al., 2002) highlights the role of affective judgements (positive or negative feelings associated with predicted future outcomes) in the perception of future risks and associated protective behaviour. People often tend to unconsciously rely on emotions instead of logic to guide decision making, resulting in fast but sometimes inferior choices. The mental simulation of future events (prefactual thinking as described by Sanna, 1996) is associated with anticipatory emotions such as fear and hope, which have been shown to motivate behaviour (for example Abraham and Sheeran, 2004). There is evidence that emotions have stronger influence on behaviour than do cognitive evaluations (see Loewenstein et al., 2001 for a review), and that positive and negative emotions affect climate change risk perception in different ways (Leiserowitz, 2006).

2.3. Other biases and concepts of relevance

The optimistic bias describes the human tendency to overestimate the chance of a positive outcome for themselves, and underestimate negative outcomes (Gouveia and Clarke, 2001). This may be linked to the social dimension of psychological distance, as people may be more inclined to believe that climate change will affects others negatively rather than themselves. Remaining optimistic about the climate crisis has been found to contribute to personal wellbeing and indicates a self-protection mechanism (Ojala, 2013).

The role of optimism as a protective mechanism is addressed by the Protection Motivation Theory (Rogers, 1975). Under this theory negative emotions can be central to behaviour change; however, it is important to consider the level of perceived danger and the balance between perceived threat and their own self-efficacy. Self-efficacy refers to beliefs about one's own capacity to perform an action, in this case an action that protects against harm (Bandura et al., 1999; O'Neill and Nicholson-Cole, 2009). Building a worst case scenario means focusing on negative aspects of the future to elicit emotions such as fear, anger or sadness (Leviston and Walker, 2012), and can be referred to as 'fear appeals'. Fear is aversive and humans are motivated to protect themselves from it (Morris et al., 2020). If people feel that they do not have the ability to respond to the fear appeal appropriately (i.e. danger control), threatening information can lead to maladaptive responses (i.e. fear control). With the right conditions in place, anticipated negative consequences have been found to evoke pro-environmental intentions (Carrus et al., 2008; Morris et al., 2020) or risk prevention behaviour in areas like diet, vaccinations or information seeking (Dillard and Anderson, 2004; LaTour and Tanner Jr, 2003). Exploring negative predictions relating to people's local environment have been found to lead to pro-environmental behaviours such as choosing green electricity (Hartmann et al., 2014). The relevance of group processes related to worst-case future scenarios becomes apparent in a study by Chen (2015) in which co-developed fear-eliciting narratives led to feelings of collective effectiveness and protective action intentions.

Another relevant concept relates to stable interindividual and intercultural differences when it comes to future thinking (Carmi & Arnon, 2014). As a consequence of personality and cultural background, people can vary in the extent to which they care about the consequences of their current behaviour and the steps they take to address imminent environmental problems (Milfont et al., 2012). This construct is called "Consideration of Future Consequences" (CFC) and explains long-term, stable inter-individual and inter-cultural variance in future-oriented behaviour (Murphy and Dockray, 2018; Strathman et al., 1994). Although there is no clear evidence yet if and how CFC can be strengthened to foster sustainable decision-making (Joireman et al., 2012), well-designed scenarios may provide a way to connect people with the future, boost their level of CFC and potentially encourage sustainable behaviour change (see initial evidence in Richter, Sumeldan et al. (2021).

3. Integrating psychological principles into scenario development

We propose that future scenarios can achieve maximum impact in inclusive sustainable environmental management if they explicitly consider and integrate the principles of human cognitive and affective (=emotional) mechanisms, to avoid adverse effects of suboptimal decision making as a result of heuristics and biases. We recommend the development of scenarios that 1) appropriately elicit emotions and mental imagery, 2) are made understandable with the help of narratives and visuals, 3) are temporally, spatially and linguistically tailored to the target audience, and 4) are co-created and feature a suite of co-created, locally relevant solutions and actions for the identified problems. In addition, we call for thorough evaluation of future scenario effects to build the knowledge base of future scenarios as a communication tool.

This integrated approach is illustrated in Fig. 2 and explained in more detail below.

3.1. The role of emotions for future thinking

Emotion-evoking communication often triggers active engagement which might work as a catalyst for sustainable behaviour (Nabi et al., 2018). Predictive scenarios are characterised by objectively identifying major trends to create expected projections of a possible future and not to purposefully evoke emotions. However, it is possible that emotional reactions, both positive and negative, arise when people are confronted with predictive scenarios, depending on what this future holds for them. Explorative and normative scenarios, however, can be purposefully developed to reflect optimistic or pessimistic outlooks into the future and thereby influence the emotional reaction in either the positive or negative direction (Blythe et al., 2021).

Instead of eliciting fear with a worst-case future scenario, another option is to build scenarios that focus on a positive future. Positive emotions such as happiness, hope or empowerment have been shown to have the potential to encourage pro-environmental behaviour (Ojala, 2012). It was found that the more positive expectations people have about the future, the more preparation-actions they undertake (Kornadt et al., 2015). Imagining a positive scenario can also make it more likely for this future becoming reality, especially if people have a high level of self-efficacy (Adriaanse et al., 2010; Oettingen et al., 2009). This technique is called mental contrasting and has its roots in positive psychology. People performing mental contrasting have been found to exercise more, live healthier relationships, and eat more vegetables (Christiansen et al., 2010; Oettingen and Gollwitzer, 2010; Sheeran et al., 2013). Beyond the behavioural effects, positive future scenarios can evoke resilience and psychological wellbeing (Stoknes, 2015). Future scenarios can be designed purposefully optimistic or pessimistic to evoke respective emotions and thereby function as a catalyst for sustainable behaviour (as demonstrated by Richter, Sumeldan et al., 2021). Another option is combining negative and positive aspects within the future scenarios (as in the local climate change visioning framework used by Shaw et al., 2009), to potentially harvest the best of both worlds on emotions. In any case, it is vital to combine emotion-evoking scenarios with specific action advice to promote the feeling of self-efficacy (Tannenbaum et al., 2015). This could be accomplished with a blended form of explorative and normative scenario, where different visions are combined with back casting to arrive at concrete action steps. For example, emotions could be induced through representations of air pollution scenarios (as for example done by Sommer, Swim, Keller & Klöckner, 2019) and then combined with simple behavioural options such as car sharing, cycling or creating community gardens.

3.2. Creating narratives about the future

For human cognition, narratives and storylines are an important way of making sense of situations (Weber and Johnson, 2006). Reading a moral narrative as compared to an neutral, informative text was shown to encourage more sustainable behaviour amongst children (Ebersbach and Brandenburger, 2020). Narratives can also be used in the context of scenarios too as for example demonstrated by Milkoreit (2016); Wyborn et al. (2020) or Nash et al. (2022). Considering psychological principles in the construction of narratives can support successful uptake of the narrative content: When narratives feature a protagonist similar to the audience, confronted with similar problems in similar environments, it provides people with the opportunity to identify with the content and evoke engagement (Bilandzic and Busselle, 2013; Pahl and Bauer, 2013). Good storytelling is further characterised by causally connecting events in a pace that the audience can follow, by holding attention with well selected characters and plots and by sparking the audience's curiosity (Ma et al., 2012). As an example, narrative scenario communication could place the protagonist in a possible future, this being a stereotypical community member of the audience to encourage a feeling of similarity and connection, perhaps even social comparison (as an example see Richter, Sumeldan et al., 2021). Benefit of narratives are that they trigger episodic (as compared to semantic) processing (i.e. remembering a sequence of events rather than disconnected facts). Future narratives can trigger episodic foresight, the future directed counterpart of episodic memory (Suddendorf and Moore, 2011), leading to adjustment of current behaviour according to the anticipation of the

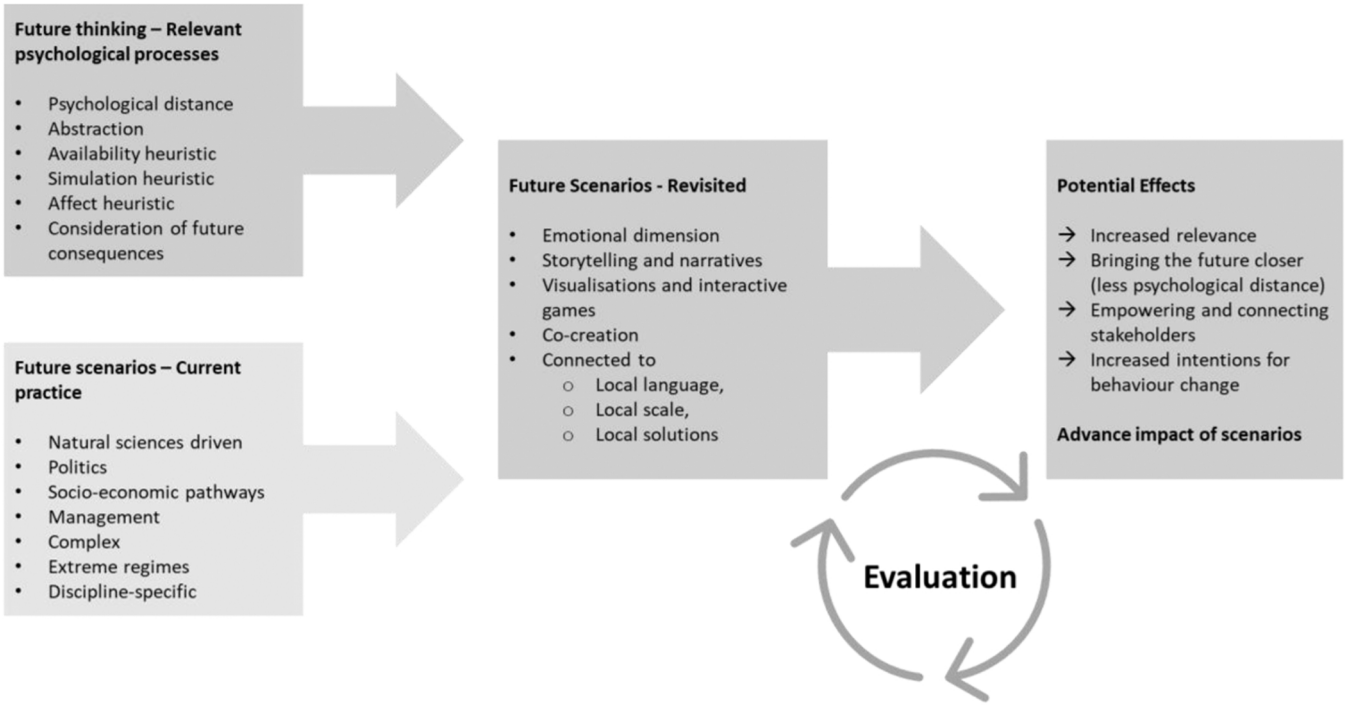

Fig. 2. Illustration of how psychology can be integrated into future scenario development, potential outcomes and feedback loop of evaluation.

future (Suddendorf, 2017). Looking at the benefits that narratives have for effective uptake of information, we suggest integrating narratives more and more thoughtful into scenario communication. If using narratives, we advise to describe a potential event in detail as this increases its perceived likelihood and frequency, also known as the "unpacking effect" in the cognitive psychology literature (Redelmeier et al., 1995). This is due to detailed descriptions making it easier to mentally simulate what an event will be and feel like and to generate vivid mental imaginary (Kahneman and Tversky, 1981; Strack et al., 1985). This can reduce uncertainty about the future (Hardisty and Weber, 2009) and counteract the optimism bias (Joireman et al., 2004). There are several examples of here narratives have been used to communicate scenarios (Blythe et al., 2021; Merrie et al., 2018), which have been reported to be emotion-evoking, engaging and inspiring. However, these narratives have not been explicitly evaluated for their effects on behaviour change.

3.3. Visualizing the future

Using visual imagery to explore unknown futures is not new (Pereira et al., 2019). However, knowing how visual images affect human cognitions and emotions can help us to use them more strategically and ethically (Sheppard, 2001). Visuals can be quick and easy to grasp compared to information provided in text form and can provide a direct experiential link to attention and emotions (Ettinger et al., 2021; Nyhan and Reifler, 2019; van der Linden et al., 2014). Visualisations can compensate for the lack of observability and tangibility of risks, especially when they reveal things only encountered in the future (Zhao and Luo, 2021), ie. making the invisible visible (Pahl et al., 2016). Examples of future risks that have been visualised include global warming over time (Hawkins 2018), ecosystem changes under different projections (Meredith et al., 2019) and sea ice decline during the last century (Holmes, 2009).

It is important to note that visualisations can come in a wide variety of forms: from very abstract to highly realistic. Each form has benefits and drawbacks depending on its purpose and audience (e.g. Bishop and Lange, 2005); Sheppard (2005) explored the potential of visualization for influencing perceptions and behaviour around climate change, but research is still needed on the actual psychological implications of different visualisation approaches (van der Linden et al., 2014; Wang et al., 2018). In scenario research, visuals have been used extensively in various forms, such as graphs (e.g. Fig. 1), enhanced maps, or photo-realistic 3D modelling (e.g. Fig. 3). For example, visualisations are often used in order to engage a target audience, spark discussions and enhance understanding, as when Van den Brink et al. (2007) used geo-visualisations to communicate with stakeholders about future scenarios.

In research on local climate change scenarios, Sheppard (2012) and colleagues used animated maps and photorealistic visualisations of Canadian communities to visualise potential effects of sea level rise (flooding) or temperature increase (snow line rising, see Fig. 3). These studies found that the visualizations and associated dialogue sessions influenced emotional response to climate change and increased self-reported understanding of adaptation and mitigation measures (Cohen et al., 2012). Another example of future directed eco-visualisations are future vision murals co-created with local community members. (Fig. 4, Richter, Sumeldan et al., 2021). More evaluation is needed to understand how such visual images of the future affect human cognition, attitudes and decision making, though there are already indications that co-created visuals are particularly powerful (Richter, Sumeldan et al., 2021).

Interactive visuals that allow the viewer to navigate or modify the data have also been found to be superior to non-interactive visuals in their informativeness and engagement levels (Salter et al., 2009). Interactive visualisations of future scenarios can be achieved in the form of board- or video games (Vervoort et al., 2022), such as Future Delta 2 (Fig. 5 A & B, Angel et al., 2015) or ECO (Fig. 5, Angel et al., 2015; Fjællingsdal and Klöckner, 2017; Fjællingsdal and Klöckner, 2019), or even virtual reality (Jamei et al., 2017). Using immersive technology to present future scenarios may also be a fruitful strategy to increase the proximity of climate change, reduce psychological distance and increase risk perceptions (Breves and Schramm, 2021).

3.4. Temporal, spatial and linguistic tailoring of future scenarios

Kushnir et al. (2019) as well as Butler et al. (2020) argue for near-term scenarios operating on annual to decadal timescales (in contrast to end-of-century scenarios) as they are directly relevant for stakeholders and decision makers and can facilitate stepwise climate change adaptation. Similarly, Tonn et al. (2006) recommend applying a "human" time horizon of 10–15 years ahead or another established,

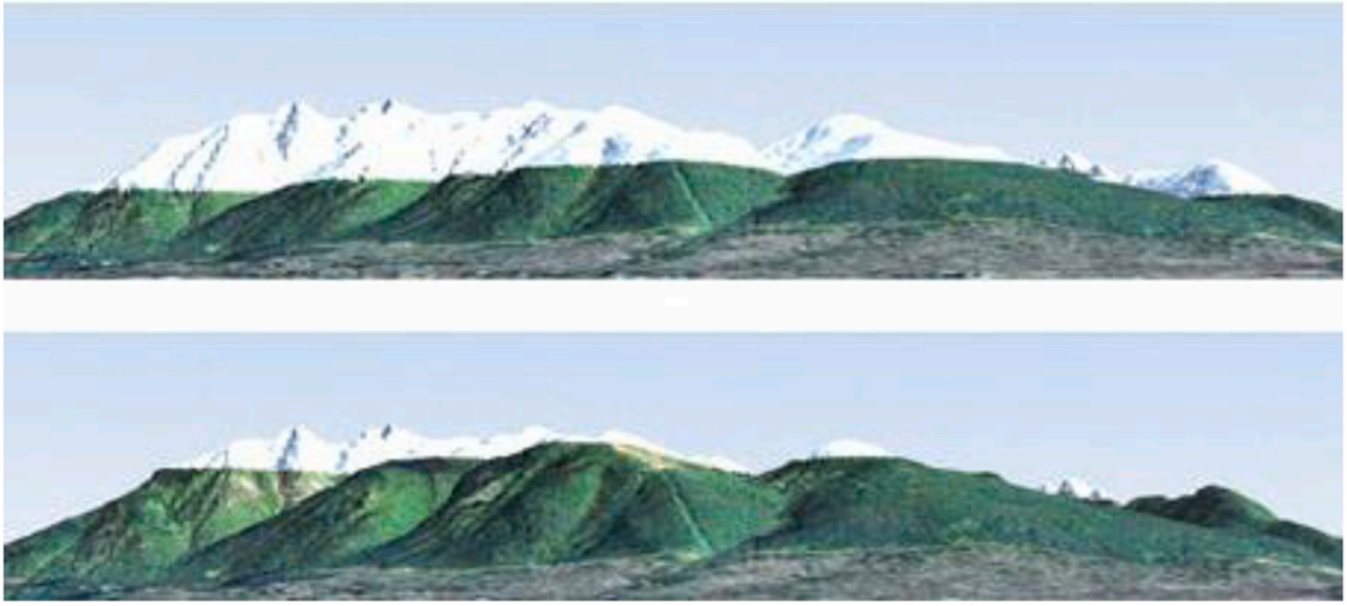

Fig. 3. : Visualisation of average level snow line rise between 2007 and 2090, based on Canadian Global Climate Model (CGCM3) A2 scenario; (Visualization: David Flanders, UBC CALP).

Fig. 4. : Three Future Scenario Murals co-created by community members of Taytay, Northern Palawan.

meaningful time horizon in the specific context. The use of shorter time horizons can encourage emotional involvement, the alignment of attitudes and behavioural intentions and counteract psychological distance (Rabinovich et al., 2010). These scenarios do, however, present their own challenges to the development of scenarios linked to sustainability. Projecting climate change often requires the consideration of longer-term time horizons because climate signals are significantly modified by regionally scaled climate cycles that operate on shorter timeframes. One potential approach to solve this challenge would be focusing on the moment of emergence of climate signals (Hawkins and Sutton 2012, IPCC 2019) as it can demonstrate that climate change is already underway at present, and this may be easier to understand as people struggle with understanding gradual change. This solution may reduce the distancing effects associated with considering long term climate change projections in isolation in the development of sustainability strategies and promote engagement with those analyses.

Furthermore, psychologists and communicators interviewed by Jarreau et al. (2017) agree on the importance of relating to local, relevant signals of climate change to overcome psychological biases found in future thinking. In their case study conducted in Louisiana, it turned out that the involved communities were most interested in climate change effects affecting their own communities. Sheppard and colleagues developed a procedure ("localise, spatialise, visualize") for downscaling climate change projections through a co-created visioning process (Sheppard, 2012), producing recognizable landscape visualisations such as melting snow caps on local mountains, something that affects popular leisure activities of the local population (Fig. 3). Burgess et al. (1998) conducted in depth interviews with local residents in the UK and the Netherlands, and also find that localised forms of communication can be used to counteract scepticism. Linguistically adapting scenario communication to the local customs is another suggestion we would like to make here in order to support understanding and uptake of future scenarios. A case study on climate change communication conducted by Mycoo (2015) in indigenous communities in Trinidad also indicated that traditional (e.g. verbal) forms of communication instead of modern communication technology (e.g. social media) were more successful. They also found that most Trinidadians prefer face to face communication as compared to other information sources (Fig. 6, A). Locally adapted forms of communication have also been applied by Richter, Sumeldan et al. (2021) who explored forms of communication typical for the community of study, in this case, mural paintings.

3.5. *Co-creating sustainable solutions*

Co-creation is defined here as "collective creativity" which involves researchers, stakeholders and community members alike (Sanders and Stappers, 2008) as form of participatory research (Jull et al., 2017). In line with Pereira et al. (2019) we argue for creative scenario co-development, which has similarities with the concept of ethnographic futures research (EFR) (Textor, 1995; Veselsky and Textor, 2007). Creative scenario co-development can foster self- and collective efficacy, the preconditions for sustainable behaviour change (Jugert et al., 2016; Schutte and Bhullar, 2017), especially when we slightly tweak the traditional EFR concept and focus on collaboratively elaboration on specific solutions and actions together and in great detail as demonstrated in Richter, Avillanosa et al. (2021) or Iwaniec et al. (2020). When people feel that they are part of a collective movement towards sustainability, a feeling of efficacy can transfer from the group to the self and affect behavioural intentions positively (Landmann and Rohmann, 2020). This can also strengthen social networks and commitment, which ultimately increases the chance for (behaviour) change to happen (Rosenthal and Dahlstrom, 2019). Ensuring that these solutions are feasible in terms of the audience's (perceived) ability stimulates response efficacy and equips the audience with the tools and confidence to face uncertain futures (Lemmen et al., 2020; Oteros-Rozas et al., 2015). In line with the traditional EFR concept, we recommend involving actors from various disciplines and backgrounds in the discourse about sustainable development as this has been found to be a successful strategy to elicit trust (Kok et al., 2007; Murshed-e-Jahan et al., 2014; Totin et al., 2018) and to encourage people to "think outside of the box" (Becu et al., 2008). Collective decision making is a natural protection against superficial information processing (Tetlock et al., 2014). As an example, the use of local working groups (combining experts and community stakeholders) in co-creating future scenarios proved successful in developing, communicating, and implementing climate change adaptation solutions in Southern Africa (Pereira et al., 2018) as well as in Canadian communities (Fig. 6; Shaw et al., 2009; Sheppard et al., 2011). Additional examples of creative engagement with future scenarios in Honolulu, Toronto and other locations are presented by Candy and Kornet (2019). The involvement of marginalised communities in developing countries in particular still needs further strengthening especially as they are potentially the ones who will be most affected by climate change (Eckstein et al., 2017; Fudge et al.,

Fig. 5. : Examples of interactive, digitally simulated climate change or ecosystem games: Future Delta 2.0 (A,B; https://calp.forestry.ubc.ca/future-delta-2–0/) and ECO (C: ECO/www.strangeloopgames.com).

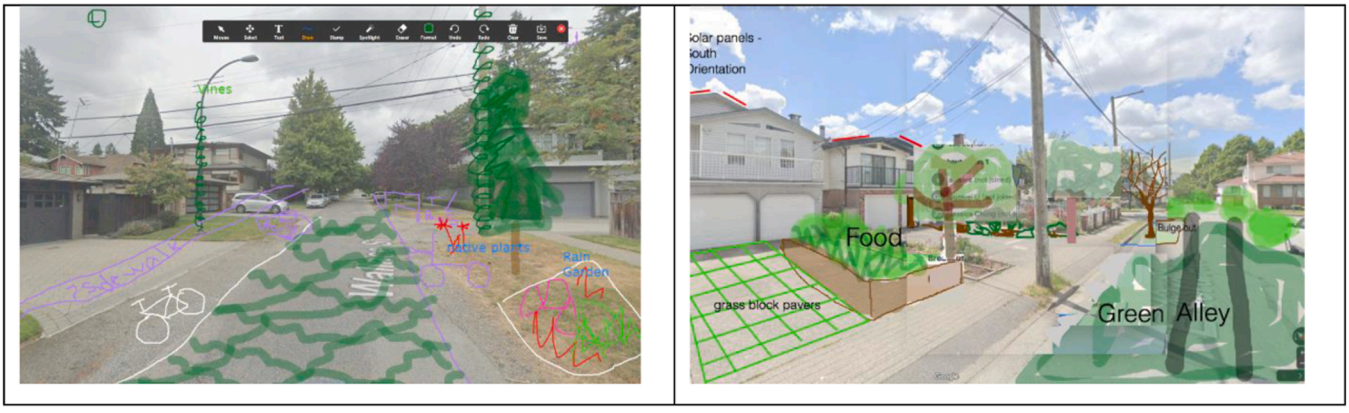

Fig. 6. : Inclusive community-led climate action planning through the 2020 "Cool 'Hood Champs" online training workshops for local climate champions, held by CALP (Collaborative for Advanced Landscape Planning) in partnership with local community centres in Vancouver, showing future visions of local neighbourhoods co-created by residents using Zoom Annotate https://calp.forestry.ubc.ca/home/cool-hood-champs/.

2021; Heras et al., 2016). Further and more systematic evaluation is needed to determine the effects of different types of co-developing future scenarios.

4. Future research

Our suggestion to enhance future scenarios with psychological insights needs to be evaluated thoroughly in order to validate or refute its impact in practice, such as scenario communication should be in general (Butler et al., 2020; Elsawah et al., 2020; Trutnevyte et al., 2016). More research is needed that shines a light on the fine tuning of future scenario development to user needs and local contexts (e.g. "What are the core activities for a scenario workshop?" (Elsawah et al., 2020)) and on the psychological and behavioural effects of differently framed future scenarios. We believe that different groups of people require different forms of future scenarios to effectively engage with their future and engage with solution development. Only if we understand which types of scenarios are most successful for different audiences in sparking sustainable change can we strategically apply them.

Specifically, the direction of emotional involvements needs to be investigated in more depth. The literature points towards the importance of affective involvement in order to spark behaviour change, however, it is not clear how positive or negative connotations in future scenarios are linked to different emotions and outcomes. So far, results are slightly contradictory with Blythe et al. (2021) indicating that pessimistic scenarios evoke more empathy but Richter, Sumeldan et al. (2021) finding that optimistic scenarios evoke more empowerment.

Further, the extent of what can be interpreted as 'local' needs to be defined and flexibly adjusted. We argue for localized future scenario communication, but it is unclear, what level of 'local' (people's village, region or country) is appropriate for different purposes. Especially when engaging mixed audiences, the ability to connect with a future scenario may depend on one common denominator that lies beyond a geographic region. From a psychological perspective, a common denominator is important as it ensures in-group cohesion and collective efficacy (Jugert et al., 2016), preconditions for collective action. This call for explicit communalities might stand in contrast with concept of pluralistic worldmaking in scenario development as described by Vervoort et al. (2015). From a psychological perspective we recommend highlighting heterogenous worldviews when the purpose is scoping multiple perspective and emphasizing communalities when the purpose is collective behaviour change.

Another area of research would be the evaluation of different forms and delivery methods of visualisations of future scenarios. Digital technologies such as virtual reality are promising in their power to connect people with their future environment and their options. These technologies can however often be relatively expensive and limited in their use in marginalized communities. As Schroth et al. (2015), Xexakis and Trutnevyte (2019), and Blythe et al. (2021) have pointed out, interactive, technology-based tools are not always superior to traditional narratives. More systematic research on trade-offs and benefits of different forms of visualisations will help to make appropriate decisions with different target groups. It would also be important to evaluate the psychological impacts and effectiveness of visualizations used in common practice by professionals beyond the scientific and research community, in order to develop best practices (e.g. https://www.ltoa.org.uk/resources/visualisations-protocol-for-urban-forestry (Macias and Sheppard, 2020)).

Elsawah et al. (2020) call for consistency within and between scenarios (freedom from internal contradictions as well as agreement and compatibility between scenarios), an issue that we see as critical. Priorities and trade-offs need to be carefully considered here. From a psychological point of view, we tend to prioritise the fit between what is communicated and the audience we communicate to. Elsawah et al. (2020) acknowledge themselves that there is a conflict between scenario consistency and scenario diversity.

5. Conclusion

In this conceptual paper, we suggest a scenario building approach that connects psychological principles of future thinking with best practice future scenario development. The integration of psychological theories and concepts into the development and communication of future scenarios can help to mitigate the cognitive challenges humans face in future thinking and potentially enhance the uptake and impact of future scenarios as communication tool for different audiences. Despite scenarios being widely used to increase understanding about uncertainties connected to the future, their effects on the people involved at different scales is still under-researched. We would therefore like to underline the need for careful development of future scenarios, adaptation of each scenario to its target audience and evaluation of psychological and behavioural effects of future scenarios to determine exactly what aspects of scenarios most efficiently promote understanding and action, and under which circumstances. Ultimately, people, their perceptions, their local stories and challenges, as well as their agency are at the heart of inclusive sustainable development.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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