
RESEARCH ARTICLE

Imaginary politics: Climate change and making the future

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Climate change places major transformational demands on modern societies. Transformations require the capacity to collectively envision and meaningfully debate realistic and desirable futures. Without such a collective imagination capacity and active deliberation processes, societies lack both the motivation for change and guidance for decision-making in a certain direction of change. Recent arguments that science fiction can play a role in societal transformation processes is not yet supported by theory or empirical evidence. Advancing the argument that fiction can support sustainability transformations, this paper makes four contributions. First, building on the imaginary concept, I introduce and define the idea of socio-climatic imaginaries. Second, I develop a theory of imagination as linked cognitive-social processes that enable the creation of collectively shared visions of future states of the world. This theory addresses the dynamics that bridge imagination processes in the individual mind and collective imagining that informs social and political decision-making. Third, emphasizing the political nature of creating and contesting imaginaries in a society, I introduce the role of power and agency in this theory of collective imagination. I argue that both ideational and structural power concepts are relevant for understanding the potential societal influence of climate fiction. Finally, the paper illuminates these different forms of transformational power and agency with two brief case studies: two climate fiction novels. I contrast a dystopian and utopian science fiction novel – Paolo Bacigalupi’s *The Water Knife* (2015) and Kim Stanley Robinson’s *Green Earth* (2015). The two books are very similar in their power/agency profile, but the comparison provides initial insights into the different roles of optimistic and pessimistic future visions.

Keywords: climate change; imaginary; transformation; power; climate fiction; cognition

I. Imagining transformational change

Responding to grand societal challenges such as climate change involves complex, systemic change in linked social, economic, political, cultural, and technological systems. Scholars have begun to conceptualize such fundamental change as transitions or transformations to sustainability (Olsson et al., 2014; Patterson et al., 2017; Smith and Stirling, 2010), implying that the kinds of changes required will fundamentally alter the nature and structural configurations of our current societies. Yet, little is known about the processes that enable deliberate transformations (O’Brien, 2012). Identifying conditions that are conducive to or can be exploited for transformative change is one of the key tasks of sustainability science.

Imagination lies at the heart of social change, but its causal role and social functions are poorly understood. The ability of individuals and groups to envision possible, likely, and desirable futures that can guide decision-making and direct social change in collectively determined

directions is an essential capacity for securing social well-being and prosperity in times of rapid and often unpredictable global change (Shaw et al., 2009; Sheppard et al., 2011; Wiek et al., 2006). W. Patrick McCray argues that managing these transformational shifts requires “creating visions of the future and the technologies that might help shape it.” McCray (2012, p. 16) stresses that this visioning “is a political act as well as an exercise of imagination”. Explicit visions of desirable (sustainable) and undesirable futures are necessary to motivate and guide any kind of change, but might be particularly important for triggering transformational change – a process of fundamentally altering the structure and character of a given system.

The need for imagination is particularly evident in the case of climate change (Wapner and Elver, 2016). Humanity’s slow and, so far, largely ineffective response to climate change demonstrates difficulties in creating compelling, shared visions of alternative futures that can trigger social transformations. The lackluster response of affected communities and societies reflects a double failure of imagination with significant implications for human well-being. First, there is a failure of imagination concerning the reality and severity of the risks of climate

change. Second, there is a failure to imagine solution pathways and visions of possible and sustainable futures.

Recently, some authors have suggested that climate (also speculative) fiction can play a role in societal transformation processes (Yusoff and Gabrys, 2011), but so far there is neither a theory nor empirical evidence to support this argument. There has been little attention in the social sciences to the role of art and (popular) culture in political processes of change, leaving a significant knowledge gap concerning the ways in which art does and can affect – possibly support – societal change. In the social sciences, the imaginary emerges as a central concept when it comes to collective imagination. The concept has been developed extensively in the field of science and technology studies (STS) and in sociology. However, political, psychological and cognitive-emotional dimensions of collective imagination implicit in the concept of the imaginary remain undertheorized. Further, it does not capture the role of fiction or other forms of pop-cultural storytelling.

Advancing the argument that fiction can support sustainability transformations, this paper makes four contributions. First, I introduce the idea of socio-climatic imaginaries, building on and adjusting the concept of the imaginary to the context of climate change and deliberate transformation. Second, I embed the idea of socio-climatic imaginaries in a theory of imagination as linked cognitive-social processes that enable the creation of collective visions of desirable future states of the world. This theory addresses the dynamics that bridge imagination processes in the individual mind and collective imagining that informs social and political decision-making. Third, I introduce the role of political power in this theory of collective imagination. I argue that both ideational and structural power concepts are relevant for understanding the potential societal influence of climate fiction.

Finally, the paper illuminates these different forms of transformational power and agency and their distribution among different actors with two brief case studies of imaginary-making activities in the climate change context: two speculative fiction novels. I contrast dystopian and utopian speculative fiction novels – Paolo Bacigalupi's *The Water Knife* (2015) and Kim Stanley Robinson's *Green Earth* (2015). The two books are very similar in their power/agency profile, but the comparison of the two stories provides initial insights into the different roles of optimistic and pessimistic future visions – socio-climatic imaginaries in story form.

My theoretical arguments build on an interdisciplinary literature review covering political science, STS and sociology, human geography, cognitive theory, futures and transformations. Despite the breadth of fields covered, a number of additional, potentially relevant bodies of literature have remained outside of this review, in particular research on culture, broadly defined, for example, in anthropology, literary criticism or the interdisciplinary field of cultural studies.

II. The imaginary

The concept of the imaginary has become central to theorizing about imagination as an essential feature of

social life. Cornelius Castoriadis used the concept of the social imaginary to refer to societies' ability to self-institute, i.e., to create and recreate institutions, norms and social relationships by first creating shared ideas or meanings about the reality of these – “the imaginary constitution of society” (Castoriadis, 1997). Steger and James offer a more recent definition of the imaginary as “patterned convocations of the social whole. These deep-seated modes of understanding provide largely pre-reflexive parameters within which people imagine their social existence” (Steger and James, 2013, p. 23). The concept has been adapted and applied across multiple disciplines, giving rise to the idea of socio-economic imaginaries (Jessop, 2010, 2004) and modern social imaginaries (Gaonkar, 2002; Taylor, 2004). In political science, Benedict Anderson's *Imagined Communities* (Anderson, 1983) stands out as a theoretical anchor point for understanding the central importance of imagination for any type of political process beyond the local or community scale.

1. Imaginaries and the Future

These various definitions emphasize the role of the imaginary in reflecting on and making conscious the otherwise backgrounded deep structure of a group or society. They focus on the group's present conditions, possibly including a historical dimension tending to the question of how the current structures took form. That changed in 2009, when Sheila Jasanoff and Sang Hyun Kim introduced the concept of sociotechnical imaginaries as an inherently future-oriented concept. The authors defined (2009, p. 120) sociotechnical imaginaries as “collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects. Imaginaries, in this sense, at once describe attainable futures and prescribe futures that states believe ought to be attained.” This new future-orientation of the imaginary raises important questions related to the role of shared future visions in social change processes, especially the psychological function of motivating change. It is this forward-looking aspect of imaginaries that make them potentially interesting for scholars of transformational change.

More recently, Jasanoff and Kim broadened their initial definition, suggesting that a sociotechnical imaginary can be held not just by a state, but any kind of collective. Importantly, Jasanoff adds (2015a, pp. 5–6) that imaginaries “encode not only visions of what is attainable through science and technology, but also of how life ought, or ought not, to be lived; in this respect they express a society's shared understandings of good and evil.” She rightly acknowledges that imagining a collective future always involves beliefs about values, norms and ways of life that characterize a society. Questions and visions of how life ought to be lived form the centerpiece of the need for and direction of change.

In their jointly edited volume, Jasanoff and Kim begin to develop more detailed insights concerning the processes by which imaginaries are established (e.g., the actors involved) and contested. They distinguish four phases, called origins (often involving individuals and their ideas),

embedding (turning ideas into material, institutional and behavioral realities), resistance (by defenders of the previously dominant imaginary) and extension (Jasanoff and Kim, 2015). They argue (Jasanoff and Kim, 2015, p. 338) that “Those imaginaries help explain, why societies differ (...), how they evolve through time (...), how powerful visions spread through space (...), and how they in turn burrow into human identity and subjectivity.”

2. Imaginaries and Climate Change

Some authors have begun to connect the concept of the imaginary with climate change (Strauss, 2014; Whiteley et al., 2016; Wright et al., 2013). For example, Levy and Spicer define (2013, p. 662) a climate imaginary as “a shared socio-semiotic system of cultural values and meanings associated with climate change and appropriate economic responses”. They too conceive of the imaginary as “visions of ideal futures,” but focus more on the idea of “field stabilization” than large-scale societal change processes.

Both the view of imagination as a collective process of meaning- and world-making and the future-oriented concept of sociotechnical or climate imaginaries are relevant for understanding the political processes of creating shared ideas of possible climate futures. Yet, they appear limited in important ways that might be constraining our efforts to understand the role of imagination in social change processes more broadly.

One of these limitations is the *absence of nature*, for example, the climate system or other biophysical systems, in collective visions of the future, and the associated need to use scientific knowledge to inform visions of climate futures. Only Jasanoff and Kim pay close attention to science. Science is a natural ingredient of a sociotechnical imaginary, but in a very distinct way: new scientific knowledge triggers a new form of technology, which in turn shapes the future make-up of a social system, including its values, norms, beliefs practices and political institutions. What their imaginaries do not consider is the human environment as such – nature and a changing climate as a setting and driver for social change independent of – or rather interacting with – scientific and technological developments. Scientific knowledge is a necessary source material for climate imaginaries in a very different way: it facilitates our understanding of what the environmental conditions of future societies might look like. Taking a coupled human-environmental systems perspective, we need to pay attention to environmental change if we want to understand how and why societies change. Perceiving of the world in terms of coupled human-environmental systems draws analytic attention to the multiple relationships between, rather than the separation of, the social and natural worlds, highlighting their interdependence and co-evolution.

A second limitation of both Jasanoff’s sociotechnical imaginaries and Levy and Spicer’s climate imaginaries is their exclusive focus on desirable and attainable futures, ignoring a spectrum of undesirable and potentially unattainable ones. Dystopic visions of the future might harbor as much motivational potential as utopias.

3. Socio-Climatic Imaginaries

Releasing these two constraints – the absence of the biosphere and the focus on desirability – I define the **socio-climatic imaginary or socio-environmental imaginary** as:

- Collectively held visions of the future (Jasanoff), that
- Include the natural environment (informed by climate change science) possibly even as an agent rather than a mere object or context,
- Are informed by beliefs about patterns and pathways of environmental and social change (including political, economic and technological change),
- Pay attention to the complex interactions between natural and social systems over time, and
- Can include desirable, undesirable and mixed visions of possible futures.

Grounded in a systems perspective that acknowledges the tight coupling of human and environmental systems, this definition of the socio-climatic imaginary focuses on the interaction and interdependencies between the climate system and social-political system over time. Nature is not just a backdrop to social imagination and change; it actively shapes what can be and is imagined. Both human impacts on their shared environment (e.g., deforestation in the Amazon), and environmental impacts on the human experience (e.g., sunny-day floods in Florida) contribute to the process of collective future imagining. The role of nature in future thinking is strengthened by science, in particular the predictive components of climate change science, which continuously develops information about possible futures in the form of modeling results, temperature graphs, sea-ice measurements and descriptions of past worlds whose climatic conditions might have been similar to the ones we are currently moving towards.

The inclusion of positive-desirable (utopian), negative-undesirable (dystopian) and mixed visions of the future in my definition of socio-climatic imaginaries is an important departure from Jasanoff. All three types of future visions can have different cognitive-emotional effects on political actors. The full spectrum of future thinking on political behavior needs to be explored to develop a good understanding of the psychology of utopian vs. dystopian thinking and its motivational effects for creating sustainability transformations. For example, Skrimshire’s work on future-oriented ethics and climate change focuses solely on apocalyptic thinking in climate politics, making the case (2010, chap. 1) that the expectation of crisis and associated fears provide particularly important – yet so far neglected – impulses for political action in the present. His work begins to complement Jameson’s writing on the politics of utopia (2005), who explores the political functions of utopian thinking in a globalized world (e.g., representing otherness), explicitly drawing on works of science fiction.

This new emphasis on emotions points to the final and theoretically most challenging shortcoming of our current understanding of imaginaries: the *absence* of the individual and of all *cognitive processes* that create

ideas, systems of ideas and ultimately the ability to share meaning in a group. The (social) psychology of imagination and creativity as well as cognitive theories can provide a much richer account of the mental processes that contribute to and also constrain future thinking. Imagination is, in its very essence, a cognitive process, taking place in individual minds. All of the definitions of the imaginary I mentioned above – social, sociotechnical or climate – are grounded in a conception of imagination as a strictly collective phenomenon. Once we recognize the importance of cognition for the existence of an imaginary, we have to ask about the relationship between the ideas in one person's mind and collectively shared vision of the future. How do individual ideas become shared? How do shared ideas in a group affect the individual mind and its imagination abilities? Can one expand or limit the other? And how about the interactions between multiple social scales of imagination – the family, community, society, transnational NGO, etc.?

III. The cognitive-social nature of the imaginary

In this section I develop a theory of imagination as interdependent cognitive and social processes. This multi-scale conceptualization offers a more comprehensive approach to the study of imaginaries, especially in the context of transformational change. Bringing cognitive theory, political science and science and technology studies (STS) into conversation with each other, I outline how this theory of imagination can be used to study socio-climatic imaginaries.

I distinguish two dimensions of imagination: (1) the cognitive-emotional processes that generate imagination in individual minds and (2) the socio-political processes that produce shared imaginations within a group or society, including imaginaries – bounded, and emotionally coherent sets of ideas about possible futures. A theory of socio-climatic imaginaries also has to consider the dynamic linkages between the cognitive and social scales. Fiction can play an interesting role in shaping both cognitive-individual and social-collective imagination processes.

1. Cognitive-individual Imagination

The cognitive sciences and psychology treat imagination as a mental phenomenon with a variety of important functions for the flourishing of a human being. Imagination is involved in learning, abstract thinking, planning, problem-solving, motivation, and creativity. Some scholars define imagination rather broadly as “possibility thinking” (Greene, 1995) or discuss the necessary interdependence between perception and imagination for the ability to grasp reality (O'Connor and Aardema, 2005). However defined, it is a necessary part of thought, decision-making and action. More generally, imagination concerns the ability to generate in one's mind (novel) ideas and images of states of the world, which are not perceivable with the senses (e.g., sight or touch). This can involve states of the world that are no longer or not yet real (historical and future thinking, including

prediction and scenario thinking), fictional worlds, but also dimensions of the world that are real but simply not open to sensual experience (e.g., abstract ideas such as democracy, socio-ecological system or identity; real but inaccessible places like the deep ocean).

The ability to create mental images (Pelaprat and Cole, 2011) is often considered central to imagination, but the cognitive processes involved do a lot more, such as generating concepts, smells, sounds, stories, processes, emotions (O'Connor and Aardema, 2005) and combinations of these. The brain can not only create places in our mind (e.g., a planet not yet discovered), but it also allows a person to simulate the mental states of fictional characters, experience their emotions such as fear, jealousy or happiness. Imagination allows a person to hear non-existent sounds, or smell an ocean he or she has never seen.

Fiction writing as well as films can facilitate and boost such imagination processes, offering verbal and audio-visual source material for mental processes. Reading a fictional text stimulates and prods certain kinds of thoughts (mental representations), not only inviting the mind to generate certain images or to simulate a specific scene that relates to the words on paper, but guiding the reader's mind through this process (Burke, 2010). When we watch a movie, the producers have done much of this imagination work for the viewers' minds – they present images of a fictional world, characters with certain features, their voices, the places and environmental conditions they live in. Without these determinations, the mind would have to create rooms, spaces, facial features and body shapes, clothing and bird sound in the background without the clues provided by the movie's visual and audio material.

More generally, imagination is a cognitive process that has to adhere to basic principles of cognitive functioning, primarily the tendency to maximize (emotional) coherence (Thagard, 2006). Research in cognitive science has demonstrated that most complex reasoning tasks are driven by a process of maximizing coherence between different aspects of a situation, e.g., different goals, data and evidence, motivations and past experience. It is based “on the Gestaltian tenet that human cognition is substantially affected by mutual interaction of the constituent elements of cognitive representations” (Simon et al., 2015, pp. 370–371). Maximizing coherence in such a system of interdependent mental representations was initially considered to be a ‘cold’ cognitive process, relying on fact-based analysis, evidence evaluation, probability assessments, analogies etc. More recently, coherence-based reasoning was shown to involve not only cold but also ‘hot’ cognitions, such as valences, liking and emotions. Theories of emotional coherence assert that social cognition is a process that integrates analytic as well as evaluative, motivational and emotional reactions to everyday situations (Pessoa, 2008).

More generally, coherence-based reasoning theories imply that certain combinations of ideas are possible or more likely to be generated by the mind, and others are not possible or less likely to emerge due to the

interdependence of a variety of mental representations and their parallel activation. The drive towards mental coherence does not imply that the imagination has to be grounded in the sensible reality. For example, a mind is perfectly capable of entering a fictional world (e.g., being an avatar driver on planet Pandora) as long as the fictional world is emotionally coherent – it makes logical and emotional sense.

With regard to socio-climatic imaginaries, two dimensions of cognitive-individual imagination are particularly relevant: first, the ability to create sets of mental representations of what is not *yet* present – emotionally coherent belief systems of the future affected by changing social and climatic conditions, and second, the observed tendency of the brain to rely on memories of the past when trying to anticipate the future. The former is necessary to envision possible future states of the world that could be pursued or prevented. It provides the necessary motivation for strategic – goal-oriented – decision making in the present. Mentally exploring possible futures enables goal-setting, e.g., identifying future ways of life to avoid or forming the intention to create certain conditions, to develop certain technologies etc. Goals are a condition for strategic – goal-oriented – intentional action in the present; they enable an actor to identify sequences of actions and resources necessary to pursue and achieve goals. Envisioning futures also includes moral reasoning and can motivate a reconsideration of ethical principles in the present. Future-thinking inevitably entails a comparison to the present that can create motivational impulses, e.g., to preserve certain conditions or change a current trend.

The substance of future possibility thinking in the context of socio-climatic imaginaries has to involve a broad range of phenomena, including the concept of climate change itself, the physical-environmental processes one believes will unfold over the coming decades, their timing and interaction with each other. It further includes thoughts about the patterns of future social, economic, political and technological change. Both the imagination of environmental and social change require causality beliefs, (scientific) knowledge and a set of assumptions about the world (a mental model of change). Further, this kind of dynamic, long-term thinking has to pay attention to the multiple interactions (feedbacks) between environmental and social systems – a core insight of the global environmental change and resilience literature (Folke, 2006; Homer-Dixon et al., 2015; Smith and Stirling, 2010).

Today, such systemic imagination, paying attention to both changes in the physical world and the social world seems to take place only in the minds of artists. Climate fiction (cli-fi) books (Atwood, 2004; Bacigalupi, 2015; Turner, 1987) and movies (Nolan, 2014) tell stories and create images of worlds that have not merely been climatically changed, but whose characters, communities and societies have fundamentally altered in the process of grappling with climate change. These fictional accounts of possible futures play an important role in aiding their audiences' imagination processes and offering

opportunities to consider and evaluate these visions and their various dimensions of (un)desirability when considered as real-world trajectories.

The second relevant dimension of imagination – the link between memory and anticipation – serves as a constraint to emotionally coherent future-thinking. Imagining the future and remembering the past involve the same brain regions (Weiler et al., 2010a, 2010b; Viard et al., 2011), indicating an important link between these two forms of mental time travel. If Buckner and Carroll are correct when suggesting (2007, p. 49) that “past experiences are used adaptively to imagine perspectives and events beyond those that emerge from the immediate environment,” the past might serve to both enable and constrain the kinds of futures that humans can envision at a particular time (Mullally and Maguire, 2013; Schacter et al., 2012; Viard et al., 2011). This historical-contextual lens offers clues on the nature and boundaries of imagination. But it also means that the imagination can be expanded by creating novel experiences – adding to the storehouse of memory – even if such experiences are fictional, for example, based on reading a (climate) fiction novel or watching a movie.

2. Social-collective Imagination

Imagination is not only cognitive but also a social phenomenon, in two distinct senses. First, individual imagination occurs in a social (and natural) environment, and is shaped by communication with other people, symbolism, shared behaviors and institutions, and a diverse set of experiences and observations of nature. The brain does not work in isolation; it is an open system, receiving continual input from its surroundings and providing feedback to those surroundings through decisions and actions. This social environment includes all other people we interact with (family, social networks), but also institutions like the state, borders and markets, companies, artwork, technology, music or news media. Non-human environments – nature – can influence the imagination, too: our experience of or interactions with plants and animals, flooding rivers, disappearing lakes, and rising oceans, soil, mountains and glaciers, weather, climate and seasons, volcanic eruptions, a starry night sky. Those social and environmental contexts, to a large extent, determine the part of the world that is visible to us and therefore imposes certain ideas about reality, possibility and probability. Hence, individual future thinking as outlined above is highly contextual. Beyond the social environmental context there is also an ideational context. That includes history – dominant narratives of past events and how they are linked to the present that provide important guidelines and constraints for interpreting political events and conditions in the present. Scientific knowledge is another important contextual element, especially for climate change politics: What do we know about the state of nature (i.e., the climate system), how certain are we about that knowledge, what is it we don't know, and what does this knowledge tell us about possible futures, risks and opportunities?

Second, social processes can generate, change or suppress, collective imaginations – shared ideas of the

present or the future. The variety of social processes involved in collective imagination is huge, including all forms of communication, collective action and decision-making, partaking in professional activities or civic duties, attending an art exhibit, watching the news or going on a cruise. Consuming popular culture, including reading climate fiction, becomes a social, rather than individual-cognitive, process of imagination when the reader starts to talk about the book with their friends, when she reads a book review in the newspaper or when she comments on the story online. Once book-related ideas enter the communication process between multiple individuals, they can contribute to collective meaning-making processes with regard to possible futures. The story becomes an anchor point for conversations, questions of possibility, morality, risk tolerance, scientific uncertainty and so forth.

The products of these collective processes have been called imaginaries. As Kim and Jasanoff (Jasanoff and Kim, 2015) seek to demonstrate, these joint imaginations can generate both change and stability in social systems; they have the potential to (re-)direct collective behaviors, institutions and structures.

Scholarship on sustainable development has also recognized the importance of collective imagination for transformations in research on visioning processes. Constanza, for example, argued (2000, p. 5), "The most critical task facing humanity today is the creation of a shared vision of a sustainable and desirable society". Similarly, Wiek and Iwaniec wrote (2013, p. 1) that "positive visions about our societies' future are an influential, if not indispensable, stimulus for change. [...] Visions direct planning, decisions, actions and behavior." However, this work does not explore how such visioning or future-thinking takes place in larger societal contexts, outside of the constraints of participatory sustainability research projects, and how the imaginations produced in visioning-processes affect or contribute to processes of transformation.

While the existence of such shared ideational constructs – socio-climatic imaginaries, visions – is almost uncontested, they present a range of conceptual and definitional challenges. What is the nature of an imaginary and where in a social system does it 'reside'? Many scholars have claimed to have identified imaginaries of various kinds, and observed their manifestations in written text, decisions, objects and institutions. But there is no single location of the imaginary in its entirety, and its existence, also its content, seem to depend on the perceptions of the individual observer. How do we know that an imaginary is shared, and who is part of the group that shares it? Futures scholars use workshops (e.g., scenario development or back-casting) to generate shared ideas about possible futures in small groups. But what exactly happens that allows participants to share new ideas, and how does this work in society?

These are questions about the nature of ideas that cognitive science can help answer. At the heart of these questions is the relationship between the individual and his cognitive processes on the one hand, and the social

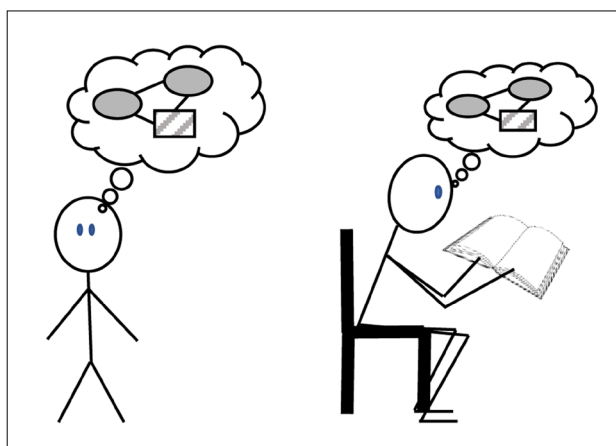


Figure 1: Individual cognition. This figure illustrates the idea of coherent cognition, where an individual's mind is conceptualized as a coherent network of concepts (mental representations) that are consistent over time. The individual's mental patterns, here represented as a network consisting of three fully connected nodes in the thought bubble above the person's head, remain stable over time and when performing different cognitive tasks (e.g., thinking and reading). DOI: <https://doi.org/10.1525/elementa.249.f1>

group, including what the group collectively believes, on the other. How do individual ideas become a shared, social reality? And how does a shared belief affect an individual group member?

In the previous section, I argued that the individual mind can be conceptualized as a network of mental representations of concepts, ideas, images etc. Meaning emerges from the absence and presence of links between network nodes, and the parallel activation of multiple nodes through these links. This network is subject to certain rules and principles. The most important principle is emotional coherence, which imposes certain constraints on the kinds of thoughts that occur in a certain situation and the kinds of belief systems that are possible. The ideas in a belief system are not a random collection, but interdependent – they make sense due to their relationship to each other. **Figure 1** illustrates this conceptualization of individual cognition as coherent networks of mental representations in a highly-simplified fashion. The individual's mental network, here consisting of only three nodes, is the same in two distinct situations: when thinking or reading, without interacting with other individuals.

Groups do not have a group brain that has collective mental representations. However, each individual belonging to a group can develop mental representations that he attributes to the group (including mental representations of the group itself, its characteristics, members, activities, norms, etc.) or that he believes – based on the information he receives from his social environment – are shared by many members of the group. As a group member, the individual is part of and contributes to a broad range of social and communication processes that allow each member to share and discuss

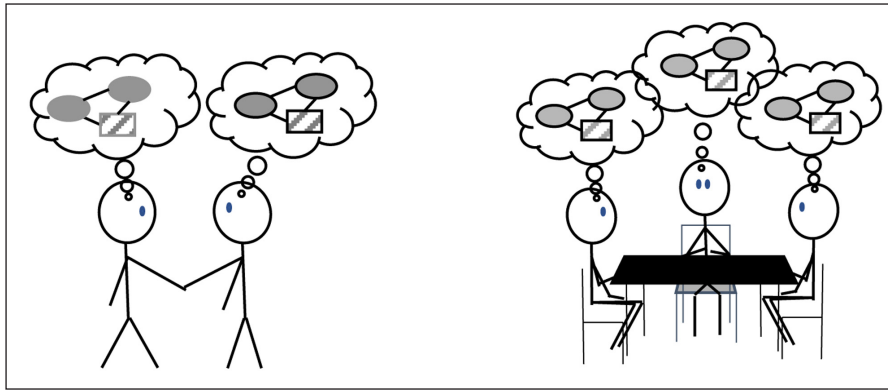


Figure 2: Collective cognition. This figure illustrates the process of collective cognition. It represents instances of social interaction between two or three individuals, where each individual displays the same cognitive patterns. The phenomenon of synched belief systems is represented as simple networks of mental representations in thought bubbles above each person's head. All individuals involved display the same system of ideas. Their interactions contribute to the process of mental convergence by giving individuals the opportunity to share and receive ideas. DOI: <https://doi.org/10.1525/elementa.249.f2>

ideas and values, to learn about reality, to contest, refine and agree on what is desirable and undesirable. These communication processes include dinner-table and water-cooler conversations, Facebook posts, reading newspapers, book club meetings, and protesting. Over time, these social processes can result in the convergence of mental representations of multiple individuals. Such convergence – the development of similar networks of mental representations across many minds – facilitates the emergence of shared or collective beliefs. Once a certain threshold has been reached, i.e., enough members of the group are perceived to hold a certain belief or value, it takes on the status of a shared belief or value (Milkoreit and Mock, 2014). The concept of collective cognition is illustrated in **Figure 2**, which shows multiple individuals interacting while having the same cognitive patterns – here, represented as a simple conceptual network containing three nodes. The figure shows two distinct interaction settings: a meeting and conversation between two individuals and a meeting or dinner-table conversation between three individuals. These are contexts where each individual receives information from others and can share ideas with others, contributing to the continuous process of mental convergence in a group.

Of course, a huge number of variables influences this process of idea convergence and competition, from neural firing to language (the availability of words or the use of them, such as framing or rhetoric), to social networks (i.e., who interacts with whom), the availability of knowledge (i.e., the state of science), technology as a tool for communication (i.e., what can be and is communicated and represented), institutions that structure social processes, including markets and elections, etc. Climate fiction books and movies are part of these processes and structures, e.g., providing language and terminology, containing lessons about science, being tweeted about, being sold online, etc.

Importantly, shared beliefs are subject to the same rules as individual beliefs: they exist in systems of emotionally

coherent ideas that cannot be changed randomly (Milkoreit and Mock, 2014). At the same time, different groups will develop different sets of shared ideas that often compete in a political environment. The non-convergence of ideas between different group is a key driver for political conflict and contestation.

Applying these insights to the challenge of creating shared imaginations of the future among many members of a society, the socio-climatic imaginary is no longer a distributed phenomenon that depends on the subjective interpretation of an observer. The imaginary is a system of emotionally coherent ideas about the future that exist (as mental representations) in the minds of the members of a group, and can be studied as neural, cognitive and emotional processes as well as social and communication processes.

The socio-climate imaginary as a system of interdependent ideas can motivate behaviors and decisions, and becomes a material and institutional reality through various enactments. For example, imaginaries can motivate individuals to start engaging in new behaviors (e.g., to join the Transition Town movement) or learn new skills (e.g., growing food using hydroponic technology); they might motivate entrepreneurs to adapt technologies for novel purposes and start organizations; they might motivate governments to favor certain technologies over others.

Socio-climatic imaginaries are also dynamic cognitive-social phenomena – changing over time. Even more importantly, different groups can have different – conflicting – socio-climatic imaginaries, depending on their shared set of ideas and values concerning the present and the future. For example, in the United States, the conservative business-as-usual fossil-fuel powered imaginary of a future where climate change is a non-issue has so far been politically more successful than a liberal socio-climatic imaginary that relies on renewable energy, community-based adaptation and urban resilience. This inherently value-laden and hence political nature of the imaginary is what drives the politics of future-making.

3. Challenges and constraints

Defining imagination as multilevel cognitive-social processes implies a range of constraints on the substance of imagination. At the cognitive level, some things might simply not be imaginable, or at least not at this point in time. Borrowing from Stuart Kauffman (Kauffman, 2000), some ideas may lie beyond the 'adjacent possible,' making them inaccessible to the mind at this point in history. The bounds of imagination are hard to define – by definition every thought we have lies within them and our minds are not able to access ideas beyond them. The current reality is clearly not the boundary of the imaginable, otherwise we would not be able to think of alternative realities, develop utopias or dystopias, or create novel ideas. Yet, there might be limits to possibility thinking given existing patterns of knowledge, experience, power and patterns of social, economic, cultural, political and technological existence and the possibility space they create. For example, 50 years ago, it would not have been possible for anybody to imagine a Bitcoin trade or a Presidential tweet. These ideas entered the possibility space of imagination only with the emergence of new technologies and new social and economic activities. Similarly, 50 years from now, other things will be imaginable that my mind is simply not able to conjure today because the required social, material and corresponding cognitive resources are not yet available.

When it comes to socio-climatic imaginaries, we collectively attempt to create shared meaning about non-existent things: futures that have not yet come to pass. That often requires the use of scientific information as a source of ideas about future environmental change, theories of change to grapple with possible social change, and the interaction between these two (i.e., what kinds of societal change could be triggered by changing environmental conditions). Scientific knowledge and what is knowable play a major role in determining what the brain is capable of conceiving, constructing and designing. But science as an information source has important limitations. The literature on science communication and knowledge politics highlights some of these limitations, pointing, for example, to problems of access, synthesis, learning, cultural cognition and political manipulation (Grundmann, 2007; Kahan et al., 2011; Lindkvist and Norberg, 2014; Meyer, 2010; Milkoreit, 2015; Sarewitz, 2011).

Further, despite the existing work in futures research, the scientific and social processes for engaging with the future (e.g., scenario workshops, foresight and back-casting methods) tend to be available only to a very limited number of individuals, reducing the breadth and diversity of ideas developed, but also concentrating imagination capacity and power in the hands of a few. Individuals who have the opportunity to engage in future-thinking processes tend to be in privileged and often powerful positions: small groups of high-level managers with strategic responsibility in large corporations, policy-makers or elected officials and scientists. The imaginations of these individuals tend to be more influential in guiding the direction of a social system than the imaginations

of citizens. Even in the exceptional case that researchers engage a diverse group of citizens in future-thinking processes (Felt et al., 2014; Macnaghten, 2010; Tompkins et al., 2008), these exercises are naturally limited to a few dozen, maybe a few hundred, participants.

Books and movies change the logic of imagination as an elite privilege linked to resource and time limitations. A climate fiction story or movie is accessible to large public audiences (Miller and Bennett, 2008, p. 597). Regardless of profession, position of authority, geography or political orientation, fiction offers the same imaginative opportunities to all individuals who share the work's language.

The brain's tendency to maximize cognitive-emotional coherence (Thagard 2006) within any given worldview (Kahan 2012; Homer-Dixon et al., 2014) might also limit the imagination – our minds might reject or not even allow into our consciousness ideas that clash with our current views of the world, how it is and how it ought to be, because they are a major source of incoherence. As long as they don't fit into the ways we currently can conceive of the world, they are disturbing and unproductive. Making these disruptive ideas coherent with our current worldviews, including pathway ideas that explain how our society might reasonably transition from the current reality to the imagined one, will require meaning-making work, immense tolerance for sustained mental incoherence and a keen intention to explore all elements of such possible futures – not just possible technologies or adaptive behaviors, but different forms of social organization, governance, sets of values, possible identities, professions, family structures and ways of life.

Finally, it is important to recognize that reality itself – the way societies, economies and cultures are organized and experienced today as well as the ways in which technologies facilitate experience of the natural and social world – serves as a major constraint on the imagination of alternative future realities (Wright et al., 2013). We suffer from what could be called, "hardening of the categories" – the reification of understandings and practices (Wapner and Elver, 2016, chap. 1). Things that exist heavily shape what we understand to be possible, desirable, and ultimately, what is mentally conceivable (Milkoreit, 2016, p. 175). For example, the presence (and past success) of capitalism makes it seemingly impossible to conceive of a post-capitalistic or non-capitalistic world, especially when considering the failure of other models, such as the planned economy. Where are alternative models supposed to come from? Whose mind is capable of constructing them?

To sum up, social imagination refers to the multiple external influences on an individual's mental processes but is also the arena in which a person intervenes in social processes (based on their mental processes) and contributes to the collective meaning-making processes with regard to the future. This multi-scale, cognitive-social conception of imagination offers a more refined understanding of the nature of the imaginary as a coherent and interdependent set of ideas about the future that is shared by a large number of people who have developed

convergent mental representations over time through their social and environmental interactions.

IV. The politics of imagination

Jasanoff emphasizes (Jasanoff, 2015b) that the collective dynamics of imagining the future are inherently political. When generating and propagating an imaginary, actors lay claims to the future, seeking to create a future that suits their interests and represents their values. Hence, creating and contesting imaginaries is a political act of shaping the change trajectory of a social system. In order to understand this process of future-making, the relevant political actors and their respective interests need to be identified, as well as their sources of power and influence, and ultimately their strategies for creating and enacting an imaginary.

1. Political actors as imaginary makers

A diverse range of political actors and institutions co-produce and reify socio-climatic imaginaries in interaction with natural systems; for example, using extreme-weather events as signifiers of change to come. These actors can include elected officials, government agencies, corporations, scientists and scientific organizations, social movements, and artists. Each actor type relies on a specific set of power, resources and strategies, which are rooted in the current system. Depending on these political resources, strategies for influencing politics of future-making differs, ranging from the publication of visioning documents, lobbying for and against policies, sponsoring legislation, conducting science, to writing and publishing stories. These strategies condition the success of each imaginary in the competition among different constructions of the future.

At the global scale, socio-climatic imaginaries for humanity and the planet are created by international organizations, most importantly the UNFCCC, their representatives, diplomats, transnational networks, corporate actors and NGOs. Recently, some international organizations have begun to use unconventional ways to communicate climate change in their efforts to change the global imaginary. For example, the World Meteorological Organization has produced a series of short videos presenting fictional weather reports from different countries in the year 2050: “WMO Weather Reports 2050” (World Meteorological Organization, n.d.). This is an interesting strategy, combining scientific knowledge about likely climatic changes, video technology and the Internet, to shape the way people around the world imagine their climatic future or that of their children. The World Bank has collaborated with film director and producer James Cameron and used his climate change documentary “Years of Living Dangerously” to draw attention to climate change (Cameron, 2014). The UNFCCC has initiated projects like the *Momentum for Change* initiative: “By shining light on the most inspiring and transformational mitigation and adaptation activities, known as ‘Lighthouse Activities’, Momentum for Change aims to strengthen motivation, spur innovation and catalyze further change towards a low-emission, high-resilient future” (UNFCCC, n.d.).

At the national scale, important actors include presidents and other individual leaders (e.g. Jasanoff and Kim traced nuclear imaginaries to Presidential speeches), government departments and regulatory agencies, institutions like markets, schools and universities, companies and industry associations, interest groups, social movements, or people coming together for a protest. One actor group is often ignored in political analysis: artists, art producers and what one could call the “makers of culture.” While these individuals and groups hardly ever take a political stance, their work, e.g., books, music, movies, TV shows, can reach millions of minds, aided by technology and mass media. In 2016, Leonardo DiCaprio, named the United Nations Ambassador of Peace, in collaboration with the National Geographic Channel, released a documentary entitled “After the Flood”. Given the actor’s popularity and the international reach of the medium he chose to communicate about climate change, this documentary has the potential to influence the beliefs of millions of people around the world. Combing ‘star power’ and structural power – material wealth, networks in the centers of American cultural production, access to political and economic leaders – Leonardo DiCaprio exercised a unique form of power, flying under the radar of mainstream political science.

As the DiCaprio example and many others (e.g., James Cameron’s *Years of Living Dangerously*, *Avatar*, *Wall-E*) show, each actor type makes use of different kinds of power, using specific strategic and action options available to them. Presidents give speeches, courts issue rulings, agencies regulate, markets offer products and services, NGOs stage actions, authors publish books, actors and producers make movies. Often their interventions are tied to their resources and structural position, determining, along with other factors, how powerful both the actors and their actions are.

2. Power

Different forms of power can be distinguished. International relations scholars have built on Dahl’s behavioral-coercive definition of power (1957, p. 202) – “getting someone to do something they would not have done otherwise” – to explore ‘hard’ power differentials between state actors. The larger a state’s economy, military and natural resources, the more able it is to pursue its self-interest by forcing its will upon others. Coercion and behavior control are not the most useful approaches when it comes to generating a shared set of ideas about the future within a certain community. However, the idea that material-economic wealth can be translated into political influence is important in this context, and applies not only to states, but also non-state actors. For example, money can buy influence in a political system that permits the financial incentivization of political decision makers through campaign finance regulations.

This kind of system-enabled influence can also be called structural power, a concept introduced by Susan Strange, who asserts (1996, p. 53) that “Power... is to be gauged by influence over outcomes rather than mere possession of capabilities or control over institutions.” She explores the

opportunities and constraints of influence embedded in a certain constellation of institutions and norms (Bachrach and Baratz, 1970, chap. 1). Both a Marxist and a Neo-Gramscian perspective emphasize that such structural power is often tied to material wealth: those who own and control the means of (knowledge) production, heavily influence to what purpose a system can be used, i.e., what kinds of imaginaries can be generated and popularized within it (Cox, 1996).

Borrowing from sociology, the constructivist turn in political science introduced the concept of constitutive (rather than regulative) rules and along with that the concept of ideational power. Social constructivists argue that intersubjectively shared ideas could be the source of social change. Control over the process of meaning-making is a form of ideational (also discursive) power (Bachrach and Baratz, 1970, chap. 3; Ruggie, 1998; Wendt, 1992). Wielding ideational power, for example, to reshape a group's identity, moral norms or policy preferences does not always require material resources. Therefore, this form of power is available to a broader range of political actors, including transnational activist networks (Keck and Sikkink, 1998), epistemic communities (Haas, 1989), and fiction authors. Ideational power, understood as the ability to create new ideas and motivations in actors' minds, might be the most relevant for the purpose of making and unmaking imaginaries.

Power is a key element of the political structure, but deserves being singled out as a possible constraint on collective imagination. The distribution of material (e.g., financial), structural and ideational power determines who is able to create and suppress certain kinds of thinking about the present, the possible, and the desirable. For example, alliances of conservative actors in the US have been able to leverage their financial resources to shape the American climate discourse, keeping it focused on the question whether climate change is a problem rather than how to address it (McCright and Dunlap, 2003; Oreskes and Conway, 2011). Further, these actors have created new forms of structural power by establishing think tanks and news outlets that constantly produce and distribute material on climate change (e.g., reports, books, news articles, commentary on TV), placing doubts on the reality of the problem or the ability of humans to do something about it (Jacques et al., 2008).

3. Structure and agency

The political structure serves as enabler and constraint of collective imagination in multiple ways. Within the given structure, political actors can shape collective imagination processes only to the extent their resources and structural power allow them to. For example, institutions and their processes can create or close down imagination opportunities by dedicating time and resources to exploring the future. Further, a particular distribution and mobilization of power in the political system can protect and advance certain ideas about the future, e.g., that the economy would collapse without fossil fuels.

In certain situations, the political context might be too constrained to allow the imagination to flourish. For

example, if actors do not possess sufficient knowledge about climate change or do not face any challenges that incentivize them to address the problem, they are unlikely to engage in a collective process of imagining solutions.

A range social of factors, such as poverty and crisis, may also depress imagination. Economically disadvantaged people not only have fewer resources and less time to engage in future thinking (e.g., by buying and reading fiction or going to the movies), their imaginations will also have a different substantive focus. Apart from such context- and resource-driven constraints on the imagination, some actors might actively seek to suppress specific kinds of imaginaries or imagination in general.

Too much political context might strangle the imagination, leading all participants to similar, obvious conclusions. This process can be observed in the UNFCCC, where the only solutions discussed have to take the form of an international agreement – a body of text – distributing the burdens and benefits of climate action, arrived at through well-known processes and rules of international negotiations. Other forms of communicating, interacting, thinking and solving are not possible within the highly contextualized environment of the UNFCCC. Even conceiving of alternatives to the UNFCCC, e.g., a 'multilateral' (Eckersley, 2012) or club approach (Weischer et al., 2012), is anathema to many of its participants.

Institutional processes and their flexibility determine to a large extent where imagination can take place and what kind of imagination is permitted. Imagination requires time and space – literally, places where people can interact to think and talk about the future. Political, economic or scientific Institutions can create these conditions, and deploy "techniques of futurity" (Yusoff and Gabrys, 2011) in support of developing new ideas about possible and desirable futures. Different institutions can do so in different ways, leveraging their convening power (e.g., networks), their expertise (e.g., scientific knowledge), or their financial resources to design imagination processes. Most institutions do not consider this kind of activity a part of their mission, making institutional processes a major constraint for the development of socio-climatic imaginaries.

V. Case studies: Fiction and the politics of the future

Jasanoff (2015b, p. 337) refers to science fiction as a "repository of sociotechnical imaginaries, visions that integrate futures of growing knowledge and technological mastery with normative assessments of what such futures could and should mean for present-day societies." Similarly, Miller and Bennett (Miller and Bennett, 2008) argue that the narrative-based stories of science fiction offer useful tools for long-term thinking about technology and constructing futures. This points to a potentially powerful and, so far, not well-understood source of novelty when it comes to the political imagination. Art and cultural phenomena can provide important inputs to or triggers for political imagination processes. Many books and movies in the past have had this effect, for example,

Aldous Huxley's *Brave New World* (Huxley, 1932), George Orwell's *1984* (Orwell, 1949), or Neville Shute's *On the Beach* (Shute, 1957).

Human geographers have long taken an interest in fiction writing too, exploring what they call literary geographies or geographical imaginations – in essence, the role of place in imagined worlds, and what it can tell us about the condition of modern society. Among the few authors in this field who are interested in the political implications of such place-based imagination of the future, Strauss studies the spatial relationship between climate fiction and collective imaginations of political transformations (Strauss, 2014). She usefully points out that all imagination of the future has to be situated in particular places, where both imagined environmental and social dynamics can play out – imagination requires geography. Yusoff and Gabrys are not interested in specific places, but also link imagination to the material world. They define (2011, p. 516) imagination “as a way of seeing, sensing, thinking, and dreaming that creates the conditions for material interventions in and political sensibilities of the world”.

These existing approaches to imagination do not engage with the cognitive and political theories I have begun to sketch above. The cognitive power of story and the ability of fiction to provide real-world learning and to facilitate cognitive change (i.e., belief revision in individual minds) are central mechanisms in the processes that Jasanoff, Strauss, and Yusoff and Gabrys describe. When political imagination triggered by a fictional storyline is conceived as a process of complex cognition, we can develop a number of hypotheses concerning the kinds of effects a story can have on which kind of reader and why. For example, given the complexities of a story and the complexity and diversity of readers' belief systems, it is unlikely that any story will have the same effect on all its readers' minds. The interaction between the story and a reader's existing beliefs can produce a variety of cognitive processes, opening a range of interesting research questions concerning this response diversity and its explanations. For example, it is possible that politically conservative readers respond differently to a specific utopian climate fiction novel than liberal readers do. One can also hypothesize that the reader's identity, for example, as a parent or a professional, including his or her place-based identity, will mediate the cognitive effects of a story. For example, readers living in the place of the fictional story (e.g., a coastal city) will respond differently than those who do not share place-based experiences with the fictional characters (e.g., readers living in a rural town in the Midwest).

In addition to these direct cognitive effects of a story on its individual reader, a novel can influence social-political processes in multiple ways. It can enter public, political discourse through reactions in print and social media, on radio and television, and in book reviews and commentaries. Book club discussions and dinner table conversations also contribute to collective processes of discussing, critiquing, adapting, rejecting or embracing the imaginaries presented in a speculative or climate

fiction novel. All of these forms of communication, from a Tweet or a chat at the water cooler to a discussion on NPR's *Science Friday*, are significant components according to Mansbridge's theory of deliberative systems (Mansbridge, 1999; Parkinson and Mansbridge, 2012). Politics is not only a matter of legislative debates and presidential speeches; it is a part of everyday life. Some novels are able to enter this everyday sphere of political deliberation more easily than others. For example, Atwood's *MaddAddam* trilogy is currently being adapted for an HBO TV series with the potential to reach millions of viewers in addition to the millions of readers of the books (Vineyard, 2014).

Not only books or stories, but also fiction authors can be conceived of as political agents of change, and not only because representing a possible future in the present is a political act that invites and challenges citizens and decision-makers to respond to these cues. Beyond writing and publishing a story that can serve as an ideational resource for the process of societal imaginary-making, authors can and do contribute to public and political discourse. They give public lectures, speeches, and interviews; they write commentaries in newspapers and magazines, and they use social media. These contributions are particularly powerful if the author has reached celebrity status with many thousand followers. Margaret Atwood and Kim Stanley Robinson are good examples for such authors with star power and an environmentally-oriented political agenda.

However, beyond these various strategies of using their ideational-discursive power, authors (and their stories) have limited resources and opportunities to influence politics. Importantly, their power is to a large extent constrained by other actors and economic structures that determine which stories are being published, and which ones remain unknown on hard drives and in desk drawers. As Bacigalupi notes in an interview on WIREd, “Novelists want to be published and need a publisher to decide to print 20,000 copies. So you need to entertain on some level” (Rogers, 2015). Publishers and editors are the gatekeepers of story power, although self-publishing is increasingly popular. Their policies and decisions are embedded in the global political economy of book markets – a powerful structural constraint on any author. Technology is another important variable that shapes the political power of fiction authors and their stories. For example, changing technologies for distributing and reading stories (e.g., the e-book, self-publishing etc.) can increase authors' reach, circumventing the gate-keeping power of print publishers.

1. Two stories

Paolo Bacigalupi's *The Water Knife* (2015) is a thriller set in the near future in the American Southwest, where dwindling water supplies have dramatically changed (transformed) the social, economic and political fabric of the country. With waning federal influence, the Western states have closed their borders to environmental migrants from the East and are increasingly governed by corporations and militias. The cities of Phoenix and Las

Vegas are on very different development paths with the latter increasingly cutting off water from the former. One major difference between the two cities is that one has chosen to rely on long-term data and careful planning, while the other has not. However, the success of Las Vegas is not only based on data-smarts, but also on a culture of political corruption and violence. The city engages in intimidation, coercion and even violent activities to appropriate its water from surrounding cities and farmers. The use of force is an important instrument in the city-state's efforts to preserve its future. While luxurious 'arcologies' spring up in Las Vegas, flaunting their technology-driven ability to produce food and recycle air and water, Phoenix is running dry. Citizens can buy water at Chinese pumps with erratic prices and drink water recycled from their own urine in 'clearsacs'. Against the backdrop of widening class differences, growing poverty and ecological calamity, the lives of three protagonists intersect when rumors of a vast new water source emerge in Phoenix. Angel Velasquez – the "Water Knife" – is a hired assassin and spy working for Catherine Case, an executive of the Southern Nevada Water Authority. Lucy Monroe, a gritty East Coast journalist, cannot help but stay put in Phoenix and report on the fate of the city, its inhabitants and victims. Maria Villarosa is a young refugee from Texas, struggling to survive in a parched, hot and increasingly dangerous city.

Green Earth (2015) is the abridged version of Kim Stanley Robinson's 'The Science in the Capital Trilogy,' published between 2004 and 2007. While *The Water Knife* offers a regional-scale narrative, *Green Earth* is national and even international in scope. Robinson's book leads the reader through a process of sustainable civilization building, triggered by a set of abrupt climate catastrophes, including a major storm and flooding of Washington, D.C., a coastal deep freeze, and the stalling of the Gulf Stream. Except for the last example, all of these are reminiscent of events in the US over the last five years (e.g., Hurricane Sandy in 2012; Polar Vortex in 2013–14). This complicated and often frustrating process of developing solutions to climate change involves not only changing mindsets about climate change and related societal values, but a complicated set of often radical changes in political and scientific institutions, a reallocation of resources, the revamping of organizations and the development of new technologies (in particular a range of geo-engineering technologies), a new focus on equity and lots of international cooperation. In short, the protagonists are engaged in a process of deliberate transformation, restructuring the existing social, political, institutional and technological fabric. What fuels this utopian scenario is a marriage of science and politics. These two concepts are represented by the two main characters (Frank Vanderwal is a scientist from California temporarily seconded to the National Science Foundation (NSF) and Charlie Quibler is a climate policy advisor to a Democratic Senator running for President), and the story ends with a literal marriage between the Senator, who is elected as President of the United States, and the National Science Advisor he appoints.

2. Two imaginaries

The two books offer two very distinct visions of the future. Bacigalupi's 'broken future' depicts a dark world of hardship, struggle and inequality that is the result of past mistakes, mismanagement and waste of water resources, and the negligent ignorance of previous warning signs. In a WIRED interview (Rogers, 2015) the author says: "I write extrapolations. I look at data points and ask what the world could look like". Conceivably, the newly parched and harsh Western frontier he describes in *The Water Knife* is simply the result of the continuation of present trends – sprawling cities in the desert that exist and continue to grow, water consumption without regard for its increasingly limited supply, and climate change affecting the region's hydrology, especially the flow of the Colorado River. On National Public Radio Bacigalupi explains that "this world is built on the assumption that people don't plan, don't think and don't cooperate – which makes for a pretty bad future!" (NPR, 2015). The world of water knives, arcologies and climate refugees forced into prostitution serves as a warning of possible, but avoidable things to come. It demarcates a place in the future that Americans, especially Arizonans, would want to avoid. In Bacigalupi's words (quoted in Rogers, 2015): "Almost every one of the futures I have is not one that any of the characters would have chosen for themselves. They're always like, goddamn, if we'd just done something different a little further back".

The key lessons to be found between the lines of *The Water Knife* are most relevant for US citizens living in the Southwest, but in particular for city officials, planners and water managers in the region. While he cannot control who reads his book, Bacigalupi wants his audience to consider the potential effects of not acting on climate change in the present and the massive future implications for human wellbeing. He shows them around their home city in the not-too-distant future, points to deteriorating class relations, vastly declined human health and happiness when compared with today, and to uncontrolled crime and violence. Most importantly, the author elevates the role of water in everyday life and draws his readers' attention to visible signs of change today. As he explains in an interview with the Imagination and Climate Futures Initiative (ICF) at Arizona State University, he wants his readers to recognize that Lake Mead's bathtub ring is not just picturesque but terrifying: "... once somebody closes the book and returns to this present moment, I hope they will look at the world differently. ... the present moment will be recontextualized for them" (Imagination and Climate Futures Initiative, 2016a). He also implies that decision-making can make a big difference for the kind of futures we create: "When I was writing *The Water Knife* one of the things I wanted to do was model two different versions of a city. Las Vegas has said, the data doesn't look good, let's start planning. Phoenix says, maybe it won't be as bad. And Phoenix is devastated."

In Robinson's world, the protagonists also struggle with climate change, but at a point in time when there is still a chance to prevent 'a broken Phoenix'. Extreme events, such as a major flood of Washington D.C., offer

warning signs of things to come – short glimpses into a possible future – but they take place at the beginning of a period of impending change, rather than at the end. If Bacigalupi's Phoenix experienced warning signs, they happened long before the story takes place and were ignored. In Robinson's *Green Earth*, Washington, D.C., and the United States still have options to shape the way they will live with the effects of climate change. The protagonists' decisions will determine whether climate-driven changes might break the city (and the country), or whether they manage to change the trajectory climate change has put them on. In other words, their task is a deliberative transformation of the social-political system at a national, even international scale. Through their use of scientific knowledge and technology, their redirection of existing organizations, as well as their commitments to equity and cooperation, they succeed in coordinating what scholars would call a process of transformational change.

Green Earth is a story about human triumph, technological prowess, lots of cooperation and planning, but also reason and rationality. What is important is that solutions in Robinson's future do not emerge magically from a well-functioning market; they have to be created through the strategic effort of a large set of actors that are not driven by a profit motive. Utterly optimistic about the ability of individuals and existing American institutions of science and politics to change the current direction, the author offers lessons about pathway thinking, complex systems, human-nature interactions and social change, all with the aim of showing the reader how the world could get from the present to a sustainable future. He mirrors a range of insights from the scholarship on deliberate social-ecological transformations.

3. Utopia vs. dystopia

In an interview with *The Atlantic* (Beauchamp, 2013), Kim Stanley Robinson outlines what he considers the social functions of science (or climate) fiction:

“Science fiction can be regarded as a kind of future-scenarios modeling, in which some course of history is pursued as a thought experiment, starting from now and moving some distance off into the future. ... it is a way of thinking about what we're doing now, also where we may be going, and, crucially, where we should try to go, or try to avoid going. Thus the famous utopian or dystopian aspects of science fiction.”

Bacigalupi's dystopian Southwest and Robinson's utopian Washington, D.C. are very different attempts at emotional engagement with their readers. *The Water Knife*, while thrilling and entertaining to read, subtly works with fear, disgust and concern. As the author describes it in an interview: “What I am aiming to provoke is a sense of anxiety” (Imagination and Climate Futures Initiative, 2016b). He hopes that this anxiety translates into an awareness and understanding of the warning signs of climate change in the readers' present

environment. Ultimately, Bacigalupi seeks to mobilize his readers for actions that avoid his broken future. He states:

“Without question, I have a certain agenda and a certain set of ideas that I want people to experience more deeply and viscerally because they're highly abstract. I can play out a thought experiment through fiction, which is the only way we have to engage with people's lives that aren't our own. Here's a version of our lives in the future. Theoretically you now have the opportunity to make different decisions and vote for different politicians. Climate change is a giant unforced error.” (Rogers, 2015)

Robinson's emotional engagement strategy is very different. In contrast to Bacigalupi's warning signs of current movements towards a broken future (“look for mistakes to avoid”), he offers pathway thinking that leads into a desirable future (“here's one way to do it”). In a podcast on his most recent novel *New York 2140* (Molinsky, n.d.), Robinson argues that dystopian fiction can induce complacency and paralysis among readers instead of alarm and activity. He contrasts his intentions with those of dystopian writers: “... to the extent that I am a science-fiction writer pushing for something, instead of showing the bad ways, the warning sign, I am showing some positive ways as encouragements, that we should try for this.” Speaking about emotions in another interview in 2015, he argues that “Dystopias express our fears and utopias express our hopes. Fear is a very intense and dramatic emotion. Hope is more fragile, but it's very stubborn and persistent.” Working with the fragility of hope, he insists “that science fiction in general, and my work in particular, is about what could happen if we did things right” (Molinsky, n.d.).

While both authors invite the reader to “see” the present differently in order to start doing things differently, they leverage different messages and motivations: warning and fear contrast with encouragement and hope. Robinson believes that ultimately, both utopian and dystopian fiction have the same purpose:

“Science fiction ... presents possibilities, which together make a range of potentiality. When we see the full range of potentials by reading a lot of science fiction, we can figure out better what we should be trying for as a society now. Thus I think all science fiction has a utopian underpinning, in that it's a tool of human thought for deciding on current actions to make a better world for our descendants. Even the dystopias are part of that, by way of their warnings.” (Molinsky, n.d.)

4. Parallel strategies

While Bacigalupi and Robinson create very different futures in their books, their imaginary-making strategies beyond storytelling are rather similar. Both engage in public discourse on climate change using social and conventional

media channels. Bacigalupi is particularly active on Twitter (@paolobacigalupi) and maintains a very dynamic website (www.windupstories.com). Robinson relies more on public speaking and publishing essays. Both have appeared on public radio to discuss their books; they have even had joint appearances to discuss their different approaches to future storytelling. Both accept public speaking engagements, and interact with researchers at American universities. Robinson has given multiple conference speeches, including on “Rethinking our Relationship to the Biosphere” (Bioneers, 2015) and on “Valuing the Earth and Future Generations: Imagining Post-Capitalism” (Center for Values in Medicine, Science, and Technology, 2012). Bacigalupi has given a public lecture at Arizona State University on “Deliberate Dystopias: Uncovering our Climate Futures” (2015). Through these various forms of public communication, they not only promote the sales of their books, but repeatedly create links between their stories and the present social and political conditions. They actively encourage their audience to make those connections and to rethink their decisions and behaviors in light of these linkages.

VI. Conclusion

Deliberative transformations require imagination. This paper has introduced a multiscale theory of imagination as interdependent cognitive-social processes that can synchronize individual beliefs about the future to create collective imaginaries. The diverse cognitive processes of imagination, i.e., the generation of mental representations of the non-perceivable or non-real, is subject to certain principles of cognitive functioning, most importantly, the tendency to maximize emotional coherence. Emotional coherence theories assert that cognitive processes including imagination integrate analytic ('cold') as well as evaluative and emotional ('hot') components. The paper highlighted two particularly important dimensions – opportunities and constraints – of individual-cognitive imagination: the ability to generate mental representations of possible futures, and the brain's reliance on memories of the past to generate such not-yet realities in the mind. These abilities and limitations enable and constrain future-oriented goal setting and (strategic) goal pursuit, which are essential components of social change. The social processes of imagination involve a mutual influence between an individual and a group. Individual imagination always takes place in a social context, and is shaped by interactions with other people, institutions, and built, technological and natural environments. And then there are collective imagination processes through which collectives come to share beliefs, fears and desired with regard to the future. The result of these social processes of imagination – coherent sets of shared ideas about the future – are imaginaries. This cognitive-social understanding of imagination opens up the concept of the imaginary to empirical study with a broader set of approaches than is currently reflected in the literature.

Drawing on the well-established concept of the imaginary as the product of collective thinking about the

future, and applying it to climate change, I have defined socio-climatic imaginaries as collectively held visions of the future, both desirable and undesirable, that are informed by science and can support deliberation and decision-making in the present. This definition builds on previous theorizing on the imaginary, but adds in multiple key dimensions in the context of climate change, including the representation of the natural environment, the dynamic interactions between social and natural systems and beliefs about patterns and pathways of change in couple social-natural systems.

Drawing attention to the political nature and function of imaginaries and imaginary-making, I explored the diversity of political actors involved in creating, maintaining or contesting imaginaries, ranging from Presidents and international organizations to scientists and fiction authors. Discussing the broad range of strategies and resources these actors deploy, I have argued that structural and ideational power are particularly important for creating, changing or suppressing certain visions of possible climate futures that can guide social change. Structural power is the system-enabled ability to influence political outcomes due to one's unique structural position and corresponding control of resources or others' behavior. Ideational power, understood here as the ability to create new ideas, identities, values and motivations in the minds of different actors, is arguably the most important form of power when it comes to the political making of – and competition between – socio-climatic imaginaries. Different political actors have different forms of ideational power, for example, scientist and scientific institutions largely control what counts as legitimate knowledge and facts about the nature of the world. Successful fiction authors have a unique ability to reach large numbers of people through their stories.

Two speculative fiction novels, one utopian and dystopian, served as illustrative case studies for the concepts of the socio-climatic imaginary and the structural-ideational power of fiction authors as political actors. The imaginaries created by Paolo Bacigalupi and Kim Stanley Robinson offer starkly contrasting visions of the future and climate change's role in it. Each author deploys different cognitive and emotional tools to engage individual readers in future thinking, ultimately with the same goal of creating a different engagement with the present. At the same time, both authors' social and political strategies for communicating and deliberating with their audiences about the stories and climate change in the real world are very similar.

Studying the political processes related to the creation of and competition between socio-climatic imaginaries is a research task for the future. Key questions concern the involvement of various actors, their different sources of power, their strategies and ultimately their success in present-day imaginary-making. For example, if US Presidents are powerful imaginary makers, how do the Obama and Trump administrations differ in their use of various forms of power regarding a socio-climatic imaginary for the United States? President Obama's socio-climatic imaginary presented climate change as an

urgent problem that could, and ought to be, addressed with government policies, technological innovation and job-creating economic change, i.e., the expansion of the renewable energy sector. Optimism and hope were infused in his vision of a clean-tech future. By contrast, President Trump does not emphasize the future or even mention any climate-related threats to the US when he discusses climate change. His imaginary is focused on the present, and his stated goal is to protect American industries and workers, especially coal miners, presumably from the negative effects of climate action. Trump's imaginary emphasizes what he perceives to be an unfair international agreement, giving other countries undeserved economic advantages. Defensiveness and fear are the central emotional themes. Which imaginary will be more successful in the long run and why? What is the role of science, social movements, corporations or international organizations in this process of creating, undoing and changing shared visions of the future? For example, with a growing understanding of the role of science in international climate governance, how does and how should the Intergovernmental Panel on Climate Change fulfill its function as a contributor to global processes of imagining climate futures responsibly?

Finally, tracing the cognitive and social effects of climate fiction on minds and societies remains an intriguing empirical-methodological challenge. While this paper has offered a conceptual framework for approaching this task, the design of effective methodological approaches for studying such interdependent cognitive-social processes calls for innovative scholarship at the boundary of the social sciences and humanities.

Data Accessibility Statement

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Competing interests

The author has no competing interests to declare.

Author contributions

This is a single-authored manuscript; all contributions were made by MM.

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