



Not just playing: The politics of designing games for impact on anticipatory climate governance

Joost M. Vervoort^{a,b,c,d,*}, Manjana Milkoreit^e, Lisette van Beek^{a,b}, Astrid C. Mangnus^{a,b,d}, David Farrell^{f,g}, Steven R. McGreevy^{d,h,i}, Kazuhiko Ota^d, Christoph D.D. Rupprecht^{d,i}, Jason B. Reed^j, Matthew Huber^k

^a Copernicus Institute of Sustainable Development, Utrecht University, Vening Meinesz building, Princetonlaan 8a, 3584 CB Utrecht, the Netherlands

^b Urban Futures Studio, Utrecht University, Vening Meinesz building, Heidelberglaan 8, 3584 CS Utrecht, the Netherlands

^c Environmental Change Institute, University of Oxford, 3 South Parks Road, OX1 3QY Oxford, United Kingdom

^d FEAST Project, Research Institute for Humanity and Nature, 457-4 Motoyama, Kamigamo, Kita-ku, Kyoto 603-8047, Japan

^e Department of Sociology and Human Geography, University of Oslo, Moltke Moes vei 31/Harriet Holters hus, 0851 Oslo, Norway

^f Department of Applied Computer Games, Glasgow Caledonian University, School of Computing, Engineering and Built Environment, G4 0BA Glasgow, United Kingdom

^g Paidia Consulting, LTD., 64 Southwark Bridge Road, London, England

^h Faculty of Behavioural, Management and Social Sciences, Section of Governance and Technology for Sustainability (CSTM), P.O. Box 217, 7500 AE Enschede, the Netherlands

ⁱ Department of Environmental Design, Ehime University, Johoku Campus, Matsuyama, Ehime, Japan

^j Libraries and School of Information Studies, Purdue University, 340 Centennial Mall Drive, West Lafayette, IN 47907, United States

^k Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47907, United States

^l Section of Governance and Technology for Sustainability, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

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ABSTRACT

Simulation games are increasingly popular tools for opening up future imaginaries, especially in the arena of sustainability policy-making and decision support. However, there is a lack of understanding regarding the potential power of games in anticipatory governance. We argue that the utility of simulation games in support of anticipatory climate governance can be greatly increased when game processes are consciously designed to impact present day planning and action. At the same time, game designers with the intention to support or intervene in governance and policy-making inevitably enter political arenas and bear responsibility for understanding and managing their influence at the science-policy interface. We present two case studies: a game simulating a sustainable food policy council with food system actors in Kyoto, Japan, and a game focused on the exploration and imagination of the global impacts of climate tipping points aimed at participants of the global climate negotiation community. Each case study represents a specific logic for translating game play into real-world impacts at different governance scales with distinct political implications. Based on these two case studies, we develop principles for the design and evaluation of simulation games that seek to impact anticipatory climate governance, based on five lenses: (1) purpose and positionality; (2) conceptions of the future and imaginaries; (3) beneficiaries, key stakeholders and participants; (4) the politics of game features and design; and (5) evaluation.

1. Introduction

In the ‘decade that matters’ the challenges associated with the need for radical transformations to sustainability are numerous, multi-dimensional, and connected, and all of them require collective

creative imagination to see beyond present economic, political and cultural conditions (Bai et al., 2016). This creative imagination should be closely connected to the inspiration of real collective action (Mangnus et al., 2021). The notion of ‘imaginaries’ – collectively held visions of the future – is key to this, since imaginaries can drive, limit and enable

* Corresponding author at: Copernicus Institute of Sustainable Development, Utrecht University, Vening Meinesz Building, Princetonlaan 8a, 3584 CB Utrecht, the Netherlands.

E-mail address: j.m.vervoort@uu.nl (J.M. Vervoort).

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motivation and action across all levels of society (Milkoreit, 2017). The expansion, pluralization, embedding, and, where necessary, counteracting, of future imaginaries appears to be a key pathway for transformative change.

The mobilization of collective imagination to create transformation pathways is the domain of various practices associated with futures and foresight (Vervoort and Gupta, 2018). However, in the context of global climate change governance, such practices are still often dominated by methods and disciplinary perspectives associated with economics and environmental sciences, in the languages of quantitative shifts of variables and targets to be achieved (Bai et al., 2016). As a result, many attempts at anticipatory climate governance – bringing futures into present-day governance spaces (Muiderman et al., 2020) – are limited by incomplete conceptions of what is possible, anchored in specific representations of past and present conditions that bias toward the maintenance of existing power structures (Muiderman et al., 2022). There is a need for futures approaches that are not only generative in the sense of creating novel, alternative ideas about possible and desirable futures, but that also grapple with the politics of transformative change (Dolejšová et al., 2021; Milkoreit, 2017). Such politically aware futuring has to recognize existing interests and power constellations, and engage with the role of collective human agency in social change processes (O'Brien, 2015).

Serious games offer much potential for to support anticipatory governance for sustainability transformations since they can involve imaginative, collaborative storytelling, role-playing and perspective-taking, experimentation with complex systems and settings, and more (Vervoort, 2019). This potential has long been recognized, e.g., the use of simulation games to investigate strategy and policy goes back to the earliest days of scenario planning, and even before that, in the context of war gaming (Mayer, 2009). The potential of serious games as a futures method has been bolstered by the technologies and design innovations of the rapidly growing commercial game sector, although the opportunities for leveraging commercial games for social impact remain untapped (Vervoort, 2019).

A diverse and extensive array of serious games focused on imagining climate futures has emerged over the last two decades. Game forms include live role-playing games, large-scale digital on-line games, VR games, as well as various hybrid formats, and they are played with societal actors from local to global levels (Wu and Lee, 2015). However, climate games remain largely disconnected from anticipatory climate governance processes. To the extent that they are used in policy-making contexts, the focus has been primarily on direct learning effects among the players of such games, and less on how gaming could impact climate governance beyond such learning (Vervoort et al., 2022), e.g., changing agendas, shaping interests of and dynamics between political actors. In this paper, we argue that serious gaming deployed in support of sustainability governance – public policy-making or international negotiations – could be valuable, but also presents unique challenges and risks. If researchers and game designers purposefully enter the domain of governance support, they are actively engaging in processes that are not just educational or bureaucratic, but deeply political. This intention to use game practices to create change (rather than supporting decision-makers regardless of their aims) renders game designers, funders and researchers as political actors with an agenda. Therefore, offering serious games as governance interventions requires that these actors understand the existing political dynamics at play, and their own responsibilities as political actors. Since no rules or codes of conduct for such politically aware and intentional gaming exist, we aim to provide preliminary guidance for actors in this space based on our experience with two specific serious games designed with the purpose of supporting sustainability policy making. We address two questions:

(1) How can serious games be designed and positioned consciously to impact present day policy-making and governance?

(2) What are the implications of active engagement in governance for those developing and leading game-based processes?

The above framing questions entail a view of games as ‘political creatures’ (Weiss, 1993) and ‘boundary objects’ (van Pelt et al., 2015), rendering game design and use processes as ‘boundary work’ (Chaudhury et al., 2013; Clark et al., 2016). In this, we recognize that anticipatory governance games engage with future imaginaries as sites of politics with impacts on present action, and that the what, how, why and who of such game-based practices are all political (Light, 2021). Considerations of impact and political reflexivity can be in tension with each other, or, when approached intelligently, can strengthen each other in an anticipatory gaming process.

We will start by discussing the linkages between games, imaginaries and anticipatory governance. Next, we will discuss the experience of designing and playing two serious games for governance support: (1) a game aimed at local food system actors in a climate change context in Kyoto, Japan; and (2) a global-level game aimed at participants of international climate change negotiations. Then, drawing on these experiences and on a broad literature on foresight, theory of change, public participation, and governance, we develop process design principles for integrating gaming and anticipatory climate governance that are sensitive to the political nature of ‘game interventions for impact’.

2. Games, imaginaries, and anticipatory climate governance

Anticipatory climate governance can be differentiated from broader notions of climate governance because it explicitly aims to engage with and explore (longer-term) futures to shape actions in the present, often through methods like scenario planning or the development of desired visions of the future (Vervoort and Gupta, 2018). In this future and long-term focused sphere of governance the concept of (social, ecological, climatic) future imaginaries – the shared understandings of possible future realities (Milkoreit, 2017) – gains prominence. The interplay between anticipatory governance and imaginaries can be understood as deeply political – imaginaries, informed by and representing political values and ideologies, shape and limit anticipatory practices and action in the present (Burch et al., 2019; Granjou et al., 2017; Hajer and Versteeg, 2019).

Gaming has a specific role in the context of future imaginaries, because in games, participants and players are actively interacting with or co-creating imagined futures, and such futures draw from and potentially shape future imaginaries. Players make active use of their understandings of imaginaries to determine actions in the game setting, giving them a level and form of interaction with imaginaries that goes beyond other media (Farca, 2018; (Vervoort et al., 2010)). This is all the more relevant since commercial games make up an important part of the current media landscape (Vervoort, 2019).

The political nature of imagination and imaginaries, in particular in sustainability transformations, raises a number of important questions related to agency, power, inclusiveness and legitimacy. For example, Moore and Milkoreit (2020) conceive of imagination as a capacity of transformative agency, which would render serious game play a capacity-building activity for change agents in sustainability transformations. Those who control and design collective imagination processes – including games for sustainability – act as agenda setters and hold power over what is imagined. As research has shown, this power is often used to reinforce current power relations and the imaginaries that support them, closing down possibilities for change rather than opening them up (Moore and Milkoreit, 2020; Stirling, 2014) Another power dimension of games as imagination processes and anticipatory governance instruments concerns the ability to determine who is included and excluded in game design and game play, e.g., via process decisions and player recruitment.

The use of games as a way to engage with questions of the governance of sustainability challenges has evolved along with more general

scientific ideas about governing complex systems, and alongside other approaches like modelling and scenario planning (Mayer, 2009). Over recent decades, an increased interest in public participation in governance around sustainability issues has also increased the focus on the potential of games as tools for public engagement (Hassan, 2017; McGonigal, 2008; Shaw et al., 2009). At the same time, since the 1970s, the digital commercial game sector has developed rapidly in terms of the possibilities for games to represent immersive, realistic and complex game worlds (Siwek, 2017). Such rapid developments have been a driver for serious game developers to attempt to harness the potential of games as public engagement interventions. Games and the developments in the commercial game sector have been a particular point of focus for those interested in creating more ‘experiential’ futures interventions that emphasize engaging all human senses and imaginative capacities though as Vervoort (2019) indicates, much of this potential is still untapped. There are possibilities for integrating commercial game development with serious game development and experiential futures into new types of meaningful, engaging games (Vervoort et al., 2022).

Within the serious games space, a wide range of different games exist that relate specifically to climate change, aimed at a range of outcomes from providing basic knowledge to consumer behavior change to (in a few cases) focusing on generating ideas for action (Reckien and Eisenack, 2013; Wu and Lee, 2015). Such games take the form of digital games (online and offline), card games, board games, role playing games and more; and focus on various climate issues around risks and disasters, broader adaptation, and mitigation; and have geographical scopes that range from local to global. A major distinction can be made between (1) games targeting publics, which are mainly focused on learning and engagement/mobilization goals, and (2) policy support games, which might aim at providing complex systems understanding, future thinking and planning, decision-making, and institutional design.

When we look specifically at the last category - climate games aimed at public, state-driven governance processes - through an anticipatory governance lens, we see a clear opportunity. Most research into the use of games for climate anticipation focuses on learning effects among their players (Reckien and Eisenack, 2013; Zhou and Mayer, 2017). However, there is a gap when it comes to games that are aimed at supporting specific anticipatory governance processes with concrete outcomes. Such outcomes could include, for instance, developing new policies and strategies, establishing new actor networks, prototyping new governance structures to be realized later, ensuring public support for transformative visions, and so on. Secondly, anticipatory game design does not typically focus on how imaginaries might be constituted, extended, or challenged. This gap is multi-dimensional and relates both to practice and academic research.

3. Case Studies: Global Tipping Points and Local Food Policy

How does this challenge of designing anticipatory gaming for impact in a politically reflexive manner play out in practice? Here, we discuss two contrasting cases that we as the authors have conducted ourselves. These two cases were chosen because they are both examples of holistic thinking about how game-based interventions could be connected to or embedded in governance processes. At the same time, the two cases are very different from one another in terms of game purpose, topic, scale, participants, the roles of the game designers, format, and the engagement with governing actors. These two diverse cases help us draw out design principles in Section 4. Since the scale of application of these two games is a major distinction point, we will refer to them as global and local examples. One might question whether games operating at such different scales might be comparable at all. But as we will see, in practice, each game engages with a small, live group of players in game play focused on decision making and storytelling around imagined futures.

For each case, we will discuss 5 analytical lenses that will help us derive insights to structure our principles. These lenses are drawn from anticipatory governance, futures and games literature (Mangnus et al.,

2022; Mayer et al., 2014; Vervoort and Gupta, 2018) and connect to main considerations during the development and play of the games discussed. They are as follows: 1. The game’s purpose and the positionality of the project leaders; 2. conceptions of the future used in the project, and how imaginaries are engaged with; 3. Beneficiaries, stakeholders and participants; 4. how game features relate to all other process aspects, and 5. the evaluation of effects and outcomes. In our analysis, we will focus especially on how we as the project leaders sought to address the questions we encountered regarding the political implications of our project, and the practical challenges that came with them. We believe reporting on these challenges is more valuable than presenting the cases as we understood them after the fact.

3.1. Local example: the Food Policy Council simulator

Our local example, the *Food Policy Council (FPC) Simulator*, is a live, card-based role playing game designed to allow food system actors in Kyoto, Japan, to experiment with a new participatory governance format, a Food Policy Council (Schiff, 2008), in the face of long-term futures, including the challenge of climate change. The game play in Kyoto combined this focus on a Food Policy Council with the need to creatively combine game elements that represented innovative food system practices (Mangnus et al., 2019). The *FPC Simulator* game sessions in Kyoto were played at the beginning of a multi-year project, FEAST, led by a number of the authors, and used as a kick-starter to help frame and direct local collaborations around food system governance reform. It was combined with a visioning and back-casting process (Robinson et al., 2011). In this game, players either played themselves, or took on each other’s roles as food system actors. They all played as members of a fictional food policy council. Different cards were selected by the group, one each to represent innovative food system practices in (1) Kyoto, (2) elsewhere in Japan and (3) elsewhere in the world. Local Kyoto-based practices were sourced by the FEAST project team; other practices were drawn from the global ‘Seeds of Good Anthropocenes’ database (Bennett et al., 2016). Players received a fictional budget and were asked to use this budget to come up with project proposals inspired by the combination of the three practices they were offered. Climate change was part of the game through a series of climate events that could be triggered randomly. These events had to be taken into account in the FPC’s planning. A game master judged the feasibility of the plans. The players had a limited number of rounds to score points through the number of successful FPC projects. Two or more groups were competing against each other for the high score. The game, with the help of continuous FEAST project engagement, ultimately resulted in concrete steps being taken together with local government toward a real Kyoto Food Policy Council; as well as leading to a spreading of the application of futures methods among Kyoto-based and other Japanese food system actors.

For this case example, our insights are drawn from extensive interviews conducted by the author team before play, questionnaires after play, and interviews conducted with participants a year after the game play workshops occurred. Two workshops were held, of 3 hours each, for a total of 16 participants. The pre –and post interviews and questionnaires have been reported in more detail elsewhere (Mangnus et al., 2019). The interviews conducted a year after the play sessions are in a forthcoming publication. Further insights are provided by the organizing team and based on design notes during different iterations of the game and process design.

Purpose and positionality: The FEAST research team consisted of locally connected researchers and international researchers, with backgrounds in sociology, anthropology, human geography, foresight, game design, ethics, philosophy and sustainability transformations. The team was looking for a combination of futures methods and games to help build local food system networks for visioning. A collaboration with Utrecht University led to the introduction of the ‘Seeds’-approach – which draws on local-scale, radical and alternative practices (‘seeds’) as

fuel for the imagination of new futures and the expansion of future imaginaries (Bennett et al., 2016; Pereira et al., 2019). Previous work with the seeds project had indicated that there was much potential in combining seeds with experimental forms of governance as two elements of new future visions and scenarios. Food Policy Councils, a new governance mode that emphasizes horizontal responsibility sharing to develop integrative policies (Mooney et al., 2014) - were largely unknown in Japan. The FEAST project team, strongly embedded in the local context, saw this governance concept as fitting well with the needs and interests of local food system actors and thought a game would be a good format to expose people to this idea in a playful, open manner. More generally, by playing together, players had a chance to get to know each other and were also introduced to each other's activities and initiatives, helping to create new networks in the Kyoto Food System. Players also had the opportunity to learn about innovative food system practices outside of Kyoto. In terms of the relationship between positionality and purpose, the research team of the FEAST project had a directive role in proposing the Food Policy Council as a format to explore in Kyoto; but was very open in terms of what participants might do with this experience.

Conceptions of the future and imaginaries: In terms of the conception of the future, the research team and their Kyoto-based networks were taking a visioning approach that sought to mobilize diverse and pluralistic local futures (Muiderman et al., 2020), while also including climate change as a contextual uncertainty. The FPC simulator expressly sought to use the notion of the Food Policy Council as a governance structure around which to explore a new imaginary for local food systems in a climate future, built on diverse, inspirational local food system practices. Furthermore, the Seeds approach was to be used to offer inspiration across different local practices with their associated future imaginaries. Important to note is that bottom-up future visioning processes were largely non-existent in this context so far – and that in terms of power dynamics around imaginaries, there was a strong push from the national government for local municipalities and organizations to adopt a top-down national vision, including on food, sustainability and climate change. In the research team there was an interest in mapping the existing visions of the future present among potential players – both to understand what people's links to existing imaginaries were and how these could be expanded; and because images of the future known to one player might be very novel to another. Pre-play interviews were conducted to surface individual visions, as a baseline and to provide inputs for the play session. Next to the Food Policy Council as a new concept, other elements brought in to extend imaginaries were the radical food system practices from elsewhere in Japan and the world. Climate science played a role in the game through chance-based drawing of uncertain climate events that were locally impactful and that had to be dealt with by the fictional Food Policy Council.

Beneficiaries, key stakeholders and participants: The game sessions were organized as a starting point for collective visioning among Kyoto food system actors; and as such, the focus of these workshops was not as specific as might be the case when, for instance, a local strategy is being developed that has a high chance of being implemented. The FEAST project had a strong network of local contacts to bring people to the game sessions; but these people mostly came from alternative food practice networks and did not include mainstream food actors. The local government was also not involved. Though in terms of mandate and efficacy, this means that the workshops were arguably less likely to be impactful, in reality, there were also benefits to this engagement focused on alternative food system actors. It meant that these people could experiment relatively safely with the notion of a Food Policy Council, and start making plans afterward for approaching the City Council. The counterfactual situation where the City Council would have been involved in play is impossible to check in this one case, of course – though it might have put more pressure on the play session, it might also have accelerated the adoption of the Food Policy Council model. More

diverse perspectives among the player based would have probably increased the analytical rigor of the visioning. But in this case, experimentation with a new mode of governance and an encountering of new ideas were arguably more important than analytical rigor. In terms of co-design and capacities, the fact that the FPC simulator is a card game with easily adjustable content turned out to be important. This meant that local Kyoto food practices could be added and local roles could be adjusted to the players present.

The politics of game features and design: The game drew upon local practices to open up future imaginaries to new possibilities for the Kyoto food system, and offer alternatives to top-down visions provided nationally. The Seeds approach and the addition of the Food Policy Council concept were used specifically for this purpose. The local focus of the game and the use of real-world practices, including a real-world governance concept, brought in realism. Each policy plan generated by the fictional FPC was required to have a year-long schedule of deployment, a budget plan for accomplishing the policy outcomes, and if they were required, contingency plans in the event of a natural disaster or some similar disruption. In other words, output from the simulations was applicable to the food system context in Kyoto and was in a readily actionable form to deploy when the Kyoto FPC was established. The situations and issues facing food systems in Kyoto were real and the policy proposals generated considered actual conditions and real-world actors and initiatives. Synergies between in-game policy proposals and real-world initiatives were encouraged. Random natural disasters and other barriers to successfully implementing new policies forced players to renegotiate plans and deal with unexpected situations. However, the tone of the game play was encouraged by the facilitators to be imaginative and playful, stimulating weird and novel combinations of different existing seeds. In this game, while the outcomes of the play sessions yielded possible actionable scenarios, these results were not the main point of the play, and so the politics of who contributed to them were less relevant as well. In terms of engagement, the rules of the game were very light and mostly dependent on a game master who could respond to the dynamics of each game session. The format of the game was accessible to a range of players with different levels of game and digital literacy; especially compared to a video game used elsewhere in the FEAST-led process which was considerably less accessible to older players. The game was very open in design, allowing for the easy replacement of Seed practices; while most of the other content was player-created. It was also easy to experiment with different parameters like budgets for the Food Policy Council. The downside of all of this accessibility and flexibility was that the sessions were only possible in small groups, and required direct facilitation – thereby strongly reducing large-scale accessibility compared to digital games or more stand-alone, more structured analogue games.

Evaluation: The ideas about effects and outcomes that inspired the FPC Simulator consisted of several elements: (1) local embeddedness is important for effective, engaged participatory research; (2) local visions should be created by local actors involved in sustainability action to help create new imaginaries for local systems change; (3) real initiatives can be combined to create viable futures; (4) new approaches to governance (like the Food Policy Council) can be experimented with to make the likelihood of their adoption in the present higher; (5) local actors learning about each other and making new connections is crucial to transformation and (6) researchers should be flexible and open to the needs of local actors and the unpredictable process coming out of anticipatory gaming. These ideas were in line with local participants and networks, but notably clashed with the desires for top-down vision implementation in the National government. These assumptions led to questions for pre- and post-play questionnaires; to during-play observations by the research team; and to elements of in depth interviews 1.5 years after play. The game results were also considered as relevant data. Through the post-play questionnaire, most participants had indicated that they had (1) learned new things about other people's activities; (2) gained new ideas about food systems practices; (3) learned about the

Food Policy Council concept; and (4) were interested in realizing it. These elements can be translated as helping to initiate and inspire new future imaginaries. The post-play questionnaires also showed that players were not always comfortable with taking on each other's roles when the other people were in the room with them. Interviews with project team members and players/local food system actors one year after the play sessions yielded results of a different kind. Specifically, the play sessions were the starting point for local food system actors to work with the FEAST project and the Kyoto City Council to begin to make a Food Policy Council a reality. A major unintended effect of the play sessions was, moreover, that the FPC Simulator play sessions and other futures methods were repeated in other contexts across Kyoto and elsewhere in Japan, often with more focused organizational contexts. This spreading of the method was considered one of the major outcomes of the play sessions: unintended, but welcome.

3.2. Global example: the Tipping Point Negotiations

Our global example, *The Tipping Point Negotiations*, was designed to engage participants of the international climate negotiations in learning and future-thinking regarding climate tipping points (van Beek et al., 2022). This game differed from the most prominent game in this space – The World Climate by Climate Action (Sterman et al., 2012) – along two key dimensions. First, it focused on climate tipping points, a specific and still poorly understood aspect of climate change among policy makers rather than the collective action nature of mitigating global emissions. Second, the game's intended key audience were *the climate negotiators themselves*, targeting a specific group of influential actors rather than a broader public and formal educational settings. A key choice was to play this game at the sidelines of international climate negotiation sessions to facilitate access to this target audience. Five workshops were scheduled during United Nations Framework Convention on Climate Change (UNFCCC) meetings in Bonn and Katowice in 2018. The project sought to align its play sessions with key moments: the release of the IPCC special report on 1.5 °C (IPCC, 2018) and the Talanoa dialogue (Lyster, 2019). These were seen as windows of opportunity for opening/adjusting the negotiation agenda based on scientific input.

The game consisted of two connected parts: (1) a simulation of the UNFCCC negotiations among 30 countries organized in ten alliances over a 25-year time period, supported by a digital game that contains simplified climate and tipping points modelling, and (2) a storytelling exercise set in 2118, building on the negotiation outcomes. The game's tension in part 1 comes from players seeking to further domestic agendas while also avoiding the triggering of tipping points. By structuring the game around simulated negotiations, players adopt an expected schema for interaction. Parties engage in both off and on-the-record discussion with one another before declaring their Nationally Declared Contributions in five-year intervals. At the end of a turn, the game measures the impact of carbon emissions on global climate, calculates each country's GDP, and presents a series of "leaderboards" and impacts of the last 5 years of simulated life. Part 2 starts with a 'time jump' where the results of player decisions in part 1 contribute to a scenario for a collaborative storytelling exercise set in the year 2118. This step provides an opportunity to make inferences and claims about the impacts of their individual and collective decisions on the world. This way, the game is asking players to "live through" a decades-long struggle to balance national priorities with the global fight against climate increase and tipping points. Among other things, the game resulted in measurable increases of the understanding of climate tipping points among its players.

In terms of methods used in the design process, the team kept track of design decisions and actively discussed the political implications of design choices. Game testing was used to validate assumptions about game effects; and lessons for future versions of the game were tracked in a project document. In terms of studying game effects, we used a combination of quantitative and qualitative methods to study game effects:

surveys with closed and open questions, participant observation during play, and interviews (van Beek et al., 2022). The combination of methods proved insightful regarding the scope of the effects (survey, quantitative) as well as *how* the game led to these effects (survey and observations, qualitative): deeper insights in varying cognitive-affective dimensions as well as deeper insight in which game element was effective in what way.

Purpose, positionality, and key assumptions: The primary purpose of *The Tipping-Point Negotiations* game was to develop climate negotiators' actionable knowledge and risk perceptions related to climate tipping points and their relevance for the global climate negotiations, i. e., the immediate policy implications of tipping points. The team posited that tipping points deserve more attention in global negotiations, and that there is a need for action and agenda setting. Building on this idea was the notion that individual understanding of science matters for the political process of negotiations. The team believed that serious games could create such improved understanding; if we could get the right individuals in the room, game-related learning could be carried into various delegations (either orally or using information we provided to players on flash drives). A secondary objective was to foster players' ability to actively imagine long-term climate futures, especially futures that have been affected by the passing of tipping points. Given these goals, the research team sought to gauge the state of knowledge and knowledge needs among the target audience before starting the game design process. Approaching negotiators was considered a better strategy than targeting national-level policy makers due to the global nature of tipping points and the need to add tipping to the negotiation agenda. Preliminary research was conducted (surveys and interviews with climate negotiators) to inform game design choices, e.g., what aspect of tipping to foreground or which tipping points to focus on, making the game maximally useful and responsive to stakeholder realities and needs. Given the findings of this pre-design research, we determined that increasing players' basic understanding of tipping points, especially their temporal features, would be the most important goal of the game, followed by increasing awareness of this topic and its link to mitigation and adaptation planning.

Conception of the future and future imaginaries: In terms of its conception of the future (Muiderman et al., 2020), the project can be understood as working from a complete stance: combining elements of a 'risk mitigation' angle (aiming to prevent foreseeable risks), a 'navigating uncertainty' angle (helping policy makers recognize deep uncertainty) and a 'mobilizing pluralistic futures' angle (actively aiming to guide transformative action through imagining different future stories). The Climate Tipping Point Negotiations game sought to extend present day climate imaginaries in two ways. First, through emphasizing climate tipping points in the negotiations phase (part 1), the aim was to make these risks much more concrete and prominent in the negotiators' climate imaginaries in ways that tied them concretely to the outcomes of negotiations. In terms of climate science, the credibility of the science used to power the digital game component was crucial for the game to be seen as a valuable and legitimate 'learning device'. Given the target audience, scientific legitimacy was closely tied to information provided by the IPCC. Hence, we used IPCC reports and modeling to inform game design and presentations about climate tipping points. A scientific model, DICE, (Nordhaus and Sztorc, 2013) formed the basis for the (highly simplified) simulation of the results of climate negotiations, including the probabilities of triggering various climate tipping points. In part 2, by jumping ahead in time to 2118, climate imaginaries were attempted to be stretched far beyond what would normally be considered. Through the use of emotionally resonant storytelling, the game aimed to turn imagined future realities into present-day "apparent realities" in an emotionally real way (Frijda, 1988). In summary, the extension of imaginaries was aimed at making climate tipping points both more pronounced conceptually and more resonant emotionally.

Beneficiaries, key stakeholders and participants: The research team's decisions to focus on climate negotiators and to conduct game

workshops at the sidelines of negotiation sessions were intended to maximize the game's political impact, increasing the chances that players' experiences would spill over into the official negotiation space, e.g., through conversations with other delegates. The process logic of the project was that playing the game at the actual sites of the negotiations may increase the possibility of game play affecting the actual negotiations, as players may reflect on their experience and carry their insights into the real-life negotiation context – though the project leaders were aware that many other political forces play on this context. A downside of choosing this timing and avenue was that involving negotiators meant competing for their time with many other events, leading, in practice, to a limited number of participants from national delegates compared to non-state participants. A stronger institutional mandate for the game, for instance its inclusion in an official COP side event, was not yet possible with these first trials. Target players consisted of the international climate negotiation community - diplomats, the UNFCCC Secretariat, the IPCC, and observer groups, including NGO and industry representatives, researchers and educators. These participants had diverse political interests (consider, for instance, small island states that are to be highly affected by tipping points). Important to note is that political interests in this group related to climate tipping points are generally underdeveloped and poorly understood due to the limited understanding of the concept - because academic understanding of political interests is ahead of actual political conversations. In terms of participation and inclusivity, the focus on running the game sessions at major climate negotiation events, and the relative length of the game sessions (4 hours) offered challenges and limitations in terms of who could participate. This relative lack of inclusivity was seen as the price for political efficacy. Opportunities to scale up the game's player base and to engage with other player groups were discussed, however. The game can be seen as a tipping points-focused variation on existing climate negotiation games like World Climate (Sterman et al., 2015) which have been used successfully in thousands of different settings so far. But this wider application was beyond the scope of the original project. In terms of co-design, in the absence of easy access to the game's intended players, various iterations of the game were tested with students at the participating universities. In terms of co-design during game play, while step 1 offered a specific structure, there is significant freedom for players to organize and shape the content of its role-playing; and the storytelling step (2) of the game offered players much freedom in developing their own future scenario narratives, based on a brief story seed. In terms of capacities, players' familiarity with the negotiations appeared to make game play intuitive to pick up.

The politics of game features and design: The Climate Tipping Point Negotiations game was significantly more pre-structured and defined, at least in part 1, than the FPC Simulator. Its use of digital components required more pre-framing of game choices. Moreover, the specific focus on budget allocations to mitigation and national and global adaptation framed the game play strongly in terms of communicating the challenge of climate tipping points as something that can be solved by collective budget allocation through the venue of the COPs. The same can be said for the choice for the DICE model and its associated economic and climate change assumptions. The inclusion of these digital elements inevitably made this part of the game more of a black box – reducing transparency, but also, arguably, creating the necessary infrastructure for surprising outcomes of the negotiations and likelihood-based impacts in terms of climate tipping points. The narrative development in part 2 of the Tipping Point Negotiations game was, in essence, more of a visioning exercise than a gamified element – meaning that the main design choice was in the pre-written story seeds. In terms of the overall process, after game steps 1 and 2 there was a facilitated debrief discussion with all participants that encouraged reflection upon both parts of the game. One run of the full Earth Remembers experience was between three and four hours. This was a significant time investment for players, particularly country delegates who had numerous demands on their time during the negotiations. Some

participants also felt overloaded by the amount of information, in addition to the information on climate tipping points each participant received a packet with information related to their assigned country to help them role-play a realistic version of that country.

Evaluation: The Gaming Climate Futures project team sought to enhance the knowledge of those involved in climate negotiations through game play – by fore fronting climate tipping points conceptually and emotionally in the experiences of national delegates and other actors involved directly or indirectly in the negotiations. Specific indicators selected for understanding the effects of the game were risk perception; and perceived self-efficacy and collective efficacy vis-à-vis the prevention of climate tipping points (van Beek et al., 2022). A limitation of the use of surveys was that the surveys were very long, which cognitively overloaded participants, and this may have affected gameplay. The debriefing session was crucial in obtaining deeper insights in participants' learning experiences and emotions during the game. Some of the questions were more closed (yes/no), which proved less insightful than more open questions where participants are more free to reflect on their experiences. The research results showed that the game play sessions had had a significant impact on players' risk perceptions of climate tipping points; and specifically, that risks had become more concrete. There was also evidence that players were emotionally moved by the game play. Effects on self-efficacy and collective efficacy were more inconclusive. This is perhaps not surprising since the game was not specifically designed to teach players about strategies to move negotiations in favor of preventing climate tipping points – it was simply designed to let players experiment with the relationship between global collective climate decisions and climate tipping points and their impacts.

4. Guiding principles for politically aware serious game design and deployment

Drawing on our experience with these two games, and on existing scholarship on anticipatory governance, critical systems theory, theory of change, and game design, we develop a set of guiding principles the design and use of serious games in support of anticipatory governance. These principles – often formulated as questions game designers should ask themselves throughout the process of game development – generate a focus on the political implications of various dimensions of the game, especially on how games might shape future imaginaries and consequently present day political dynamics. These guiding principles and questions can be used to design or evaluate game-based anticipatory processes. Our two core considerations – impact and political reflexivity – run through these questions. When used for design purposes, these guidelines should be used iteratively. A more detailed version of these principles can be found in the appendix of this paper.

4.1. Purpose and positionality

Sharply defining the purpose or intended outcome(s) of any game-based process is key to the design of the process, the game(s) or game-based methods that are a part of it, and the evaluation. The Climate Tipping Point Negotiations game had a global focus on the risk perceptions of climate negotiators – and this made it a very different game from the FPC simulator with its explorative focus on local governance. Purpose, in turn, is tightly connected to the positionality of the game designers and process leaders. The Kyoto-based team was embedded in local food practices; while the team working on tipping points were coming into a space as researchers where access was more limited. We see the following principles as important:

- (1) Consider the purpose of the anticipatory game process. The question of purpose - goals, changes in the world, intended game effects - is highly political. Examples of purposes could be enabling learning and knowledge creation; changing beliefs,

perceptions and perspectives; enhancing futures literacy; creating governance/policy change; generating new networks and relationships; increasing inclusivity; and institutionalizing game play as anticipation.

- (2) Consider the positionality of game designers and project leaders. What is/are their role(s) in the process? What is the worldview from which the purpose is set (Midgley, 2000)? How might the positionality of those leading and framing the game and process contribute to the potential closure of supposedly open participation processes, if biases and perspectives are not acknowledged (Stirling, 2014)?

4.2. Conceptions of the future and engaging with future imaginaries

Conceptions of how the future is connected to the present are related to how future imaginaries are engaged with in anticipatory gaming. Dominant future imaginaries persist because they are embedded in institutions and continually performed by influential societal groups (Milkoreit, 2017). Extensions, challenges and alternatives to such imaginaries are also created, performed and reinforced through diverse means – through representation in various fiction and non-fiction media (including commercial games), through social networks, through prefigurative action by niche groups, and other means. Futures processes can reflexively engage with existing imaginaries; and work to develop new imaginaries – images of the future that can be collectively held and institutionally embedded, even if this is limited to niche groups or local contexts at first, as with climate negotiators or Kyoto food system actors. In anticipatory climate gaming, climate science plays an important role as how it informs and is informed by different imaginaries – but it can be very direct, as in the global case; or a contextual factor, as in the Kyoto case. This brings us to the following principles:

- (1) Consider what basic assumptions made about how futures should be engaged with, and how futures impact the present. Muiderman et al. (2020) offer an analytical framing based on an analysis of various literatures relevant to anticipation and futures, from prediction via complexity to pluralistic visioning and critical societal investigations.
- (2) Consider how the game interacts with and shapes imaginaries. Which existing future imaginaries might implicitly inform the game process? Which of these are dominant and which are more marginal? How might new futures be created or imagined as distinct from or challenging existing imaginaries? And what is the role of climate science in these imaginaries?

4.3. Beneficiaries, key stakeholders and participants

Considerations around the who of the game-based process, both in terms of co-designers, interest groups, and players (often overlapping categories), are crucial, and a fundamental component to developing a game-based process. The Climate Tipping Point Negotiations game worked with a relatively inaccessible group of players and therefore worked with other ways to make sure the game was suitable – through interviews and playtests with other audience; while the Kyoto-based FPC simulator had more opportunities to work with more diverse, accessible players; and as a result, could embed the game and support on-going engagement. We propose the following principles:

- (1) Consider criteria for involving participants/players and others in the process. Stirling (1999) frames reasons for participation as follows: legitimacy, political efficacy and analytical rigor. Participants can be involved in the process for any or multiple of these criteria/reasons. This includes who gets given the opportunity to shape the design of the game or game-based process, and who does not (Khaled et al., 2014). What are the key capacities and skills among beneficiaries of the game-based intervention

that the organizers seek to draw on? (Dryzek, 2009; Lebel et al., 2006; Light, 2021)?

- (2) What are the possibilities for generating a mandate for and commitment to the project, e.g., through formal or informal institutional support, public support or other means, to ensure engagement and increase the chances of success (Hebinck et al., 2018)?

4.4. The politics of game features and design

How might the politics of anticipatory gaming for impact inform the actual game and its design? Games have a specific ‘procedural rhetoric’ (Bogost, 2010) – through their rules, roles, visualizations and other affordances, they show and tell players something about how the world should be understood. The FPC simulator framed the world through the eyes of a fictional Food Policy Council, and worked with seed initiatives to provide a basis for the imagination of bottom-up alternatives. The Climate Tipping Point Negotiations game impressed upon players the urgency of climate action to avoid tipping points – centralizing the role of global negotiations and then the lives of people affected by these global-scale negotiation processes. We propose the following principles:

- (1) Consider how the game relates to non-game realities. How do the game rules, writing, visuals, roles and other affordances represent, support and limit different existing imaginaries and the creation of new imaginaries? How closely does the game relate to the governance realities the game process is trying to impact? What are the political considerations in terms of game outputs as they might be used in present day action (Vervoort et al., 2022)?
- (2) Consider the politics of engagement. Who is attracted to or engaged by this game? Who is excluded due to the game’s style and affordances (Cairns et al., 2019)? How flexible and open is the game design? What are the consequences of choices for avenues, locations, organizational contexts, on-line platforms et cetera?

4.5. Evaluation

Finally, all the above questions have consequences for how evaluation of anticipatory games is conducted, either ex post facto or, preferably, by integrating evaluation considerations into process design. Many game-based projects fail to scale because not enough attention is placed on concrete evaluation of the game’s impacts (Mayer et al., 2014); and incomplete evaluations obscure core assumptions and intended effects of the game process. We believe that evaluation should not just involve the game play and its immediate impacts, but also, if relevant, tracking impacts on policies, strategies, networks, governance formats, discourses and more. A clearly defined theory of change can be important to formulate, for which the questions below form a basis (Weiss, 1997). The global case’s team had a highly focused theory of change, linked to specific psychological metrics; while the local case in Kyoto had a much more open theory of change; and both were suited to their games and the ways in which these were connected to their contexts. We see the following principles as central:

- (1) Consider why the team believes certain changes happen – based on theory, detailed empirical evidence and/or previous experience. Based on this, what are key variables that can be evaluated (Mayer et al., 2014)? Critical evaluation theory emphasizes that it is especially important to dig down to the level of behavioral changes (Weiss, 1997). How does/do the theory or theories of change of the designers relate to the theories of change of key actors in the process (Weiss, 1993)?
- (2) What are unintended consequences, positive or negative, of the game-based process? What are process dynamics that have been marginalized through pre-existing biases in the project?

5. Conclusions

In this paper, we have advocated for a holistic, systemic and politically sensitive, ethical and responsible approach to gaming in anticipatory climate governance contexts. We started with the Kyoto-based Food Policy Council simulator and the global-level Climate Tipping Point Negotiations game as example cases.

Drawing on our two example cases and relevant literatures, we have outlined a set of principles game developers can use to guide their work to make game interventions impactful (question 1), as well as considering the politics of such interventions (question 2). Our two cases offer examples of the choices made and challenges and limitations faced in the development of games that were explicitly focused on or embedded in anticipatory governance processes. Both games benefitted from early engagement with potential players, and using different methods for game co-design as their contexts allowed. Their differences in scale, participants and goal provide a striking contrast. The Tipping Points Game tried to engage a specific set of high-level decision makers, aiming to have a very specific global impact, this global focus necessarily meant more limited possibilities for embedding the game in governance contexts, which, in turn, resulted in the need for very targeted goal-setting focused on knowledge increase at the right time and in the right place. By contrast, the FPC Simulator's goals could be much more explorative and open, since it was part of an on-going, accessible engagement with local stakeholders. Both games did not have a strong focus on win conditions - the game experience was valuable - maybe even more insightful - without the ability to determine a winner. For example, in some sessions of the Tipping Point Negotiations, players were significantly affected by the triggering of tipping points - a collective failure - which might have generated more learning than game sessions that avoided tipping points. There is another, fundamental difference between these two cases, however. The Tipping Point Negotiations game project had more resources for game design, but it was a relatively small, short and stand-alone project; whereas the FPC Simulator had far fewer resources, but was situated in a major five-year research project (FEAST) within a locally connected organization (the Research Institute of Humanity and Nature, Kyoto). We can understand both of these games as essentially successful pilots. The Tipping Point Negotiations Game could be empowered significantly by having the time and resources to develop close affiliation with and institutional embedding in key organizations engaging with UNFCCC processes - expanding its visibility and player base around COP events. The use of the Tipping Points game could also be expanded beyond COP contexts, and serve as an educational experience, much like World Climate (Stermann et al., 2015) which has been played many times in many settings, but with a specific tipping points focus. There are also significant opportunities for scaling down. Similarly, the FPC Simulator has garnered much interest as a game to be played in other contexts, and in a fully resourced project, the game materials could be developed to make such out-scaling both within Kyoto and across Japan much easier. In both cases, the strong attention paid to evaluation will make it easier for the games to develop from their first phases to more widely applied games - a crucial lesson for anticipatory governance games.

Our two cases help us emphasize that iteration between the principles presented in this paper is key. Questions about framing and purpose can be revisited frequently together with actor groups involved. Co-design processes can lead to choices related to the when and where of the game process. Asking questions about evaluation can help reconsider how incumbent actors are involved or approached, and so on. Our principles are meant to be applicable to a wider range of game-based interventions, processes and projects around anticipatory climate governance. They are also meant to be valuable for a range of hybrid interventions that have game-like elements. Concretely, there principles are currently being used to inform design and reflection around playful creative practices in the Dutch Research Council Vidi project Anticiplay (anticiplay.medium.com) and the European Union Horizon project

CreaTures (creatures.eu). Beyond this, a number of future directions for developing principles for games as political interventions can be imagined. The first is considering what the full institutionalization of game-based anticipatory governance would be like. How can institutional spaces and processes be developed and evaluated that create truly embedded roles for game play as a form of anticipatory governance? Furthermore, what would design and evaluation principles look like for truly bottom-up public anticipatory gaming, including forms that support activist and protest game design and play?

The world faces a future that requires collective engagement with dauntingly complex realities, and in which, at the same time, game media are only expected to grow. The principles offered in this paper hope to make a contribution to exploring gaming's more utopian possibilities, and avoid the more dystopian gamified futures - especially the many possible unintentional dystopias.

CRedit authorship contribution statement

Joost M. Vervoort: Conceptualization, Methodology, Writing – original draft. **Manjana Milkoreit:** Conceptualization, Methodology, Writing – original draft. **Lisette van Beek:** Conceptualization, Methodology, Writing – original draft. **Astrid C. Mangnus:** Conceptualization, Methodology, Writing – original draft. **David Farrell:** Conceptualization, Methodology, Writing – original draft. **Steven R. McGreevy:** Conceptualization, Methodology, Writing – original draft. **Kazuhiko Ota:** Conceptualization, Methodology, Writing – original draft. **Christoph D.D. Rupprecht:** Conceptualization, Methodology, Writing – original draft. **Jason B. Reed:** Conceptualization, Methodology, Writing – original draft. **Matthew Huber:** Conceptualization, Methodology, Writing – original draft.

Declaration of Competing Interest

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Appendix A. Supplementary material

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References

- Bai, X., van der Leeuw, S., O'Brien, K., Berkhout, F., Biermann, F., Brondizio, E.S., Cudennec, C., Dearing, J., Duraipapp, A., Glaser, M., Revkin, A., Steffen, W., Syvitski, J., 2016. Plausible and desirable futures in the Anthropocene: a new research agenda. *Global Environ. Change* 39, 351–362.
- Bennett, E.M., Solan, M., Biggs, R., McPhearson, T., Norström, A.V., Olsson, P., Pereira, L., Peterson, G.D., Raudsepp-Hearne, C., Biermann, F., Carpenter, S.R., Ellis, E.C., Hichert, T., Galaz, V., Lahsen, M., Milkoreit, M., Martín López, B., Nicholas, K.A., Preiser, R., Vince, G., Vervoort, J.M., Xu, J., 2016. Bright spots: seeds of a good Anthropocene. *Front. Ecol. Environ.* 14 (8), 441–448.
- Bogost, I., 2010. *Persuasive Games: The Expressive Power of Videogames*. MIT Press, Cambridge, MA.
- Burch, S., Gupta, A., Inoue, C.Y.A., Kalfagianni, A., Persson, Å., Gerlak, A.K., Ishii, A., Patterson, J., Pickering, J., Scobie, M., Van der Heijden, J., Vervoort, J., Adler, C., Bloomfield, M., Djalante, R., Dryzek, J., Galaz, V., Gordon, C., Harmon, R., Jinnah, S., Kim, R.E., Olsson, L., Van Leeuwen, J., Ramasar, V., Wapner, P., Zondervan, R., 2019. New directions in earth system governance research. *Earth System Governance* 1, 100006. <https://doi.org/10.1016/j.esg.2019.100006>.
- Cairns, P., Power, C., Barlet, M., Haynes, G., Kaufman, C., Beeston, J., 2019. Enabled players: the value of accessible digital games. *Games Culture*, 1555412019893877.
- Chaudhury, M., Vervoort, J., Kristjansson, P., Ericksen, P., Ainslie, A., 2013. Participatory scenarios as a tool to link science and policy on food security under climate change in East Africa. *Reg. Environ. Change* 13 (2), 389–398.
- Clark, W.C., Tomich, T.P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N.M., McNie, E., 2016. Boundary work for sustainable development: natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *PNAS* 113 (17), 4615–4622.
- Dolejšová, M., Ampatzidou, C., Houston, L., Light, A., Botero, A., Choi, J., Wilde, D., Altarriba Altarriba Bertran, F., Davis, H., Gonzales Gonzales Gil, F., Catlow, R., (2021) Designing for transformative futures: creative practice, social change and climate emergency. In: ACM International Conference Proceeding Series.
- Dryzek, J.S., 2009. Democratization as deliberative capacity building. *Comp. Political Stud.* 42 (11), 1379–1402.
- Farca, G., 2018. *Playing Dystopia Nightmarish Worlds in Video Games and the Player's Aesthetic Response*. Transcript Verlag, Bielefeld.
- Frijda, N.H., 1988. The laws of emotion. *Am. Psychol.* 43 (5), 349–358.
- Granjou, C., Walker, J., Salazar, J.F., 2017. The politics of anticipation: on knowing and governing environmental futures. *Futures* 92, 5–11.
- Hajer, M., Versteeg, W., 2019. Imagining the post-fossil city: why is it so difficult to think of new possible worlds? *Territory Politics Governance* 7 (2), 122–134.
- Hassan, L., 2017. Governments should play games: towards a framework for the gamification of civic engagement platforms. *Simulat. Gaming* 48 (2), 249–267.
- Hebinck, A., Vervoort, J.M., Hebinck, P., Rutting, L., Galli, F., 2018. Imagining transformative futures: participatory foresight for food systems change. *E&S* 23 (2). <https://doi.org/10.5751/ES-10054-230216>.
- IPCC, 2018. *Global Warming of 1.5°C*. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.
- Khaled, R., Abeele, V.V., Van Mechelen, M., Vasalou, A., 2014. Participatory design for serious game design: Truth and lies, CHI PLAY 2014 – Proceedings of the 2014 Annual Symposium on Computer-Human Interaction in Play, pp. 457–460.
- Lebel, L., Anderies, J.M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T.P., Wilson, J., 2006. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecol. Soc.* 11 (1) <https://doi.org/10.5751/ES-01606-110119>.
- Light, A., 2021. Collaborative speculation: anticipation, inclusion and designing counterfactual futures for appropriation. *Futures* 134, 102855. <https://doi.org/10.1016/j.futures.2021.102855>.
- Lyster, R., 2019. The idea of (Climate) justice, neoliberalism and the talanoa dialogue. *J. Human Rights Environ.* 10 (1), 35–61.
- Mangnus, A.C., Oomen, J., Vervoort, J.M., Hajer, M.A., 2021. Futures literacy and the diversity of the future. *Futures* 132, 102793. <https://doi.org/10.1016/j.futures.2021.102793>.
- Mangnus, A.C., Vervoort, J.M., McGreevy, S.R., Ota, K., Rupprecht, C.D.D., Oga, M., Kobayashi, M., 2019. New pathways for governing food system transformations: a pluralistic practice-based futures approach using visioning, back-casting, and serious gaming. *E&S* 24 (4). <https://doi.org/10.5751/ES-11014-240402>.
- Mangnus, A.C., Vervoort, J.M., Renger, W.-J., Nakic, V., Rebel, K.T., Driessen, P.P.J., Hajer, M., 2022. Envisioning alternatives in pre-structured urban sustainability transformations: too late to change the future? *Cities* 120, 103466. <https://doi.org/10.1016/j.cities.2021.103466>.
- Mayer, I., Bekebrede, G., Hartevelde, C., Warmelink, H., Zhou, Q., van Ruijven, T., Lo, J., Kortmann, R., Wenzler, I., 2014. The research and evaluation of serious games: toward a comprehensive methodology. *British J. Educ. Technol.* 45 (3), 502–527.
- Mayer, I.S., 2009. The gaming of policy and the politics of gaming: a review. *Simulat. Gaming* 40 (6), 825–862.
- McGonigal, J., 2008. *Superstruct. Institute for the Future*.
- Midgley, G., 2000. *Systemic Intervention: Philosophy, Methodology and Practice*. Kluwer Academic, New York.
- Mooney, P.H., Tanaka, K., Ciciurkaite, G., 2014. *Food Policy Council Movement in North America: A Convergence of Alternative Local Agrifood Interests? Alternative Agrifood Movements: Patterns of Convergence and Divergence*. Emerald Group Publishing Limited, pp. 229–255.
- Milkoreit, M., 2017. Imaginary politics: climate change and making the future. *Elem. Sci. Anth.* 5 <https://doi.org/10.1525/elementa.249>.
- Moore, M.-L., Milkoreit, M., 2020. Imagination and transformations to sustainable and just futures. *Elem. Sci. Anth.* 8 (1) <https://doi.org/10.1525/elementa.2020.081>.
- Muiderman, K., Gupta, A., Vervoort, J., Biermann, F., 2020. Four approaches to anticipatory climate governance: different conceptions of the future and implications for the present. *WIREs Clim. Change* 11 (6). <https://doi.org/10.1002/wcc.v11.610.1002/wcc.673>.
- Muiderman, K., Zurek, M., Vervoort, J., Gupta, A., Hasnain, S., Driessen, P., 2022. The anticipatory governance of sustainability transformations: hybrid approaches and dominant perspectives. *Global Environ. Change* 73, 102452. <https://doi.org/10.1016/j.gloenvcha.2021.102452>.
- Nordhaus, W., Sztorc, P., 2013. *DICE 2013R: Introduction and User's Manual*. DICE 2013R: Introduction and User's Manual.
- O'Brien, K., 2015. Political agency: the key to tackling climate change. *Science* 350 (6265), 1170–1171.
- Pereira, L.M., Bennett, E., Biggs, R., Mangnus, A.C., Norstrom, A.V., Peterson, G., Raudsepp-Hearne, C., Sellberg, M., Vervoort, J.M., 2019. Seeding change by envisioning good anthropocenes. *Solut. J.* 10.
- Reckien, D., Eisenack, K., 2013. Climate change gaming on board and screen: a review. *Simulat. Gaming* 44 (2-3), 253–271.
- Robinson, J., Burch, S., Talwar, S., O'Shea, M., Walsh, M., 2011. Envisioning sustainability: recent progress in the use of participatory backcasting approaches for sustainability research. *Technol. Forecast. Soc. Chang.* 78 (5), 756–768.
- Schiff, R., 2008. The role of food policy councils in developing sustainable food systems. *J. Hunger Environ. Nutr.* 3 (2-3), 206–228.
- Shaw, A., Sheppard, S., Burch, S., Flanders, D., Wiek, A., Carmichael, J., Robinson, J., Cohen, S., 2009. Making local futures tangible-Synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building. *Global Environ. Change* 19 (4), 447–463.
- Siwek, S.E., 2017. *Video Games in the 21st Century: The 2017 Report*. Entertainment Software Association.
- Sterman, J., Fiddaman, T., Franck, T., Jones, A., McCauley, S., Rice, P., Sawin, E., Siegel, L., 2012. Climate interactive: the C-ROADS climate policy model. *Syst. Dyn. Rev.* 28 (3), 295–305.
- Sterman, J., Franck, T., Fiddaman, T., Jones, A., McCauley, S., Rice, P., Sawin, E., Siegel, L., Rooney-Varga, J.N., 2015. World climate: a role-play simulation of climate negotiations. *World Climate. Simulat. Gaming* 46 (3-4), 348–382.
- Stirling, A., 1999. The appraisal of sustainability: Some problems and possible responses. *Local Environ.* 4 (2), 111–135.
- Stirling, A., 2014. Transforming power: social science and the politics of energy choices. *Energy Res. Social Sci.* 1, 83–95.
- van Beek, L., Milkoreit, M., Prokopy, L., Reed, J.B., Vervoort, J., Wardekker, A., Weiner, R., 2022. The effects of serious gaming on risk perceptions of climate tipping points. *Clim. Change* 170, 31.
- van Pelt, S.C., Haasnoot, M., Arts, B., Ludwig, F., Swart, R., Biesbroek, R., 2015. Communicating climate (change) uncertainties: Simulation games as boundary objects. *Environ. Sci. Policy* 45, 41–52.
- Vervoort, J., Gupta, A., 2018. Anticipating climate futures in a 1.5°C era: the link between foresight and governance. *Curr. Opin. Environ. Sustain.* 31, 104–111.
- Vervoort, J., Mangnus, A., McGreevy, S., Ota, K., Thompson, K., Rupprecht, C., Tamura, N., Moosdorff, C., Spiegelberg, M., Kobayashi, M., 2022. Unlocking the potential of gaming for anticipatory governance. *Earth Syst. Governance* 11, 100130. <https://doi.org/10.1016/j.esg.2021.100130>.
- Vervoort, J.M., 2019. New frontiers in futures games: leveraging game sector developments. *Futures* 105, 174–186.
- Vervoort, J.M., Kok, K., van Lammeren, R., Veldkamp, T., 2010. Stepping into futures: exploring the potential of interactive media for participatory scenarios on social-ecological systems. *Futures* 42 (6), 604–616.
- Weiss, C.H., 1993. Where politics and evaluation research meet. *Eval. Practice* 14 (1), 93–106.
- Weiss, C.H., 1997. Theory-based evaluation: Past, present, and future. *New Direct. Eval.* 1997, 41–55.
- Wu, J.S., Lee, J.J., 2015. Climate change games as tools for education and engagement. *Nature Clim. Change* 5, 413–418.
- Zhou, Q., Mayer, I., 2017. Models, simulations and games for water management: a comparative Q-method study in The Netherlands and China. *Water* 10 (1), 10. <https://doi.org/10.3390/w10010010>.