The making of Antarctic futures: Participatory game design at the interface between science and policy

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Contents

Abstract

Recent literature on Antarctic futures includes sobering scenarios for the Southern Polar region in the era of Anthropogenic climate change. Contrasting current trajectories with what might be accomplished through appropriate policies and stewardship, such studies acknowledge that change involves more than exhortation through scholarly venues of communication. In this paper, we address the possibility of translating scenario-based Antarctic futures into the playable experience of a simulation and strategy game. Held in three of the Antarctic gateway cities—Hobart (Australia), Christchurch (New Zealand), and Punta Arenas (Chile)—the participatory design process invited young people in each of these cities to contribute ideas, narratives, representations, and critique. We detail these contributions alongside an account of the game's genesis and development. Employing the concept of 'playful futures', we consider the opportunities opened by the process of speculation and co-design itself to address science-policy interfaces for research through digital games. This article argues that serious games, as experimental sites of public science, can contribute to a collective imagining of alternative climate futures.

Keywords: Antarctic futures; Antarctic cities; Environmental change; Serious games.

Highlights

- Antarctic futures are a prominent feature of scenarios that seek to communicate the urgency of climate change.
- This paper describes the process of development of a serious game called Antarctic futures.
- Serious game design can be "experimentalised" as a method to engage with a range of Antarctic futures and elicit a debate about environmental forecasting.
- For the researchers involved, codesigning a game becomes a site to experiment with and test the limits of scientific scenarios and public engagement

1. Introduction

Increasing anthropogenic effects on Antarctica and the Southern Ocean feature prominently in scientific scenarios that seek to communicate climate change consequences. From the melting of ice sheets to the introduction of invasive non-native species and abrupt changes to marine and terrestrial polar ecosystems, the Antarctic region is at a critical stage upon which climate futures are anticipated, modelled and projected upon diverse public audiences. Simulations can be thought here as acts that are, in Judith Butler's (1988) term, 'performative', intending to make real worlds precisely through the production of imagined ones. Such projections are exhibited across literary (see Leane, 2012), political (see Dodds, 2010), legal (see French & Scott, 2009), scientific (see O'Reilly, 2017), and touristic (see Hall and Saarinen, 2010, Tin et al. 2013) fields and media.

As Hamilton (2015) argues, however, public recognition of the relevance of polar regions for the survival of planetary life remains low. Kahan et al. (2012) further suggest that communicating climate change depends upon more than the quality of science and the clarity of its communication. Factors such as avoidance of cognitive dissonance and peer or community identification can make beliefs resistant to contrary evidence even among individuals with high science literacy. Utilising but moving beyond interactive representations of science, made possible through techniques such as computational simulations for example, scientists and educators need new ways to inform and engage the public in practices of climate change citizen science (Groulx et al 2017) through the articulation of 'strategic narrative[s]' (Hajer & Pelzer 2018).

In this article we develop an exploratory account of one of these experimental methods, based on our experience developing a serious game based on environmental change simulations through a dialogical engagement with a specific and interested 'public'. The game was co-designed over an 18-month period (2017-2018) with 18-30 year old participants from three cities—Christchurch in New Zealand, Hobart in Australia, and Punta Arenas in Chile—as part of a larger collaboration designed to foster a sense of custodianship toward the Antarctic region. Alongside Cape Town (South Africa) and Ushuaia (Argentina), these cities make up the five internationally recognised Antarctic 'gateway cities'. Antarctic scientists, tourists, policymakers, and commodities travel through these port towns, which in turn have developed specific urban responses to this geographically privileged relationship (Dodds, 1997). These responses are often spatial in form: research centres, logistic infrastructure, cultural festivals, museums, and tourist facilities are examples of the physical locations in which Antarctic connections can be experienced in these cities (see Roldan, 2011).

The aim of the online game was to elicit a debate among urban youth about the role that Antarctic gateway cities do or may in future play in relation to the Antarctic in an era of global environmental change, by translating scenario-based futures into a playable experience. From its design to its eventual outcome as a software product, the process of game-building becomes, in our account here, itself both object of inquiry (Savage 2013) and critique of the limits of reductionist methods of future-making (Pink & Salazar 2017).

Such critique follows a long tradition of concern about the limits of scientific discourse. Discussing how climate models gain epistemic authority, Mike Hulme (2011; 2012) has argued, for example, that a new climate reductionism is observable in the hegemony exercised by the predictive natural sciences over contingent, imaginative and humanistic accounts of social life and visions of the future. Granjou et al. (2017) have further engaged with the modalities through which environmental futures—as contingent sets of probabilities and possibilities—are made present and decided upon, problematizing the ways in which emergent threatening futures are known, anticipated, fostered, preempted, and prepared for (Granjou et al. 2017). As Adam and Groves (2007) also argue, futures are not merely imagined, but also made, told, traded, tamed, transformed and traversed through uneven approaches to the future which they frame as doing, knowing and caring. Scenarios concern not only knowledge claims, but their translation to domains of action and ethics.

Rather than seek to critique how anticipatory techniques of scenario-building in the sciences are used and performed, our approach has addressed - through participatory game design - Antarctic futures as experimental sites of engagement. As we argue in the following sections, the game that we co-designed is illustrative of how expectations are linked to mobilisation as a way of enacting future users (Wilkie and Michael 2009). Our arguments centre on how, necessitated by the distance between Antarctic cities and the commensurate difficulties of working with participants remotely, these links were established for us, as facilitators, developers and scholars. In other words, our contribution is less about the impact of co-design on workshop participants – though we acknowledge these as they emerge – and more about its effect on our work, during and beyond the storyboarding and design phases documented here. Our concern is also with imagining alternative and preferred futures, and with how these are preempted, prefigured, and prepared for (Anderson 2010), or forged, negotiated, contested, colonised and tamed (Felt 2011). Building upon Hajer & Pelzer's (2018) further distinction between 'expected future' and 'desirable futures', deployed to characterise collaborative scenario development, we employ here the term 'playful futures' to describe how desires of co-design participants can be expressed, in creative contexts.

The three workshops, conducted between September 2017 and August 2018, functioned as design sessions that sought active participation by urban youth in the game's ideation and construction. These events themselves mediated—at times in complex and confusing ways—the multiple expertise of academic researchers, game designers, institutional staff and young people themselves. By detailing these processual co-design activities, we seek not only to un-"black-box" serious game development, but to show how the process opened up alternative conjectures, simulations, narratives and modes of gameplay that for various reasons ended up on the cutting room floor rather than in the final product. Produced by young adult participants, these hidden paths that did not materialise in code nevertheless performed work: enacting a form of citizen science and registering protest even toward the sympathetic institutions orchestrating the workshops.

The focus of this paper is therefore on our experience in developing the game through a participatory process. Drawing on the findings and insights of these three workshops, we show how the processes just as much as the outputs of game design became, for us

researchers involved, “boundary objects” that straddle the domains of scientific scenarios and public engagement (Star and Griesemer 1989). Far from seamless, we also illustrate how these translations are fraught with other unexpected modes of engagement that were activated by the political materiality of the game development.

Combining participatory design and participant observation, detailed in the methodology section below, our findings have two key implications for efforts to connect climate change science to localised geographies of public engagement. First, regardless of its final form— an academic paper, digital game, film or fiction—the translation of climate change scenarios can be a terrain of collaboration between experts and other groups, through material objects that produce vital encounters between otherwise divergent social worlds. Second, these practices of translation may involve multiple, generative forms of imagination that do not necessarily filter down to the final output (in this case, the design of the game) but are still productive ‘dead-ends’ that can be deployed by researchers to explore the limits of scientific engagement.

This paper seeks to contribute to current epistemological debates about experimental, or what Lury & Wakeford call “inventive methods”, and their role in ecologies of scientific engagement (for extensive reviews, see for example Rocheleau and Roth, 2007 or Birkenholtz, 2011). We begin section 2 with a short discussion of the long-standing relationship between scientific simulations, anticipatory scenarios and the ways in which Antarctic futures have traditionally been engaged by the scientific community. We then bring this concern into dialogue with the existing literature on serious games, highlighting how this scholarship has mainly focused on the design outcomes rather than the process of scenario-building and co-designing of interfaces and gameplay that inventively bridge the gap between science and its sites of public engagement. After a short discussion of methods, we detail the three workshops, describing their respective outcomes and by-product discussions. We conclude with a reflection on the role of serious games in mobilising the politics of anticipatory science.

2. Bordering Science and Politics: Serious Games as Boundary Objects

Since at least the foundational *The Limits to Growth* (Meadows et al, 1972), scenarios have proven a common method for expressing the urgency of sustainability challenges to wider audiences (see Börjeson et al. 2006 for a typology). Scenarios can also convey the intricate relationship between the ecological, social, economic, ethical and institutional dimensions of sustainability issues, by “telling compelling stories that capture the imagination, understanding, and beliefs, hopes and dreams of participants” (Swart et al. 2004, p. 145). Scenarios, Swart et al. further argue, have also been crucial in incorporating human choice into sustainability science.

Polar sea ice projections are a common feature of scenarios that model and communicate the global nature of environmental challenges and their interconnectedness (see Tin et al, 2013). The specific role that Antarctic ice sheets currently and will in future play in sea level rise

informs many simulations of climate change (eg. DeConto & Pollard, 2016). In this context, the Antarctic, so inaccessible and yet so eloquently fragile, is uniquely placed to foster an exchange between scientists and the wider public (Hamilton, 2015).

Despite their efficacy within scientific discourse, simulation-based scenarios bear the limits of their communicative media with external publics (see Swart et al. 2004). Scientists themselves have acknowledged that, whilst scenarios are a staple for expressing climate change to the public, their demand for scientific literacy means their potential for civic engagement may be constrained (VanWynsberghe et al. 2003). Importantly, scientific scenarios often maintain a distinction between producers (the scientists) and receivers (the public) (see Robinson, 2008). In many domains of public engagement, however, these boundaries are less and less stable (Soneryd, 2016; Voß & Amelung, 2016). As Lezaun et al write (2016), there is a specific experimental dimension that cuts across these novel forms of public participation: the experimental format is a "means of intensifying the generative potential of these participatory experiences, while in the process producing new evidence and documentation about social and political life" (Lezaun et al. 2016, p. 195)

Drawing on this insight, and on the observed limits of scientific scenarios, our research project sought to use serious game design as an experimental site of public participation in the engagement with Antarctic futures. Through their ostensible function to induce play, serious games offer an ideal device for participatory and dialogical simulations (Michael & Chen 2006; Susi et al 2008; Breuer & Bente, 2010), and have found a large domain of applications in education (Ulicsak, 2010; Jain, 2011; De Freitas & Liarokapis, 2011; Alessi & Kopainski, 2015), including for climate change (see Kopnina, 2014). As a participatory experiment, the process that we detail in this paper served as a means to "make public" (see Marres, 2016) our object of inquiry and overall goal of the project.

Both serious games themselves, and the process of co-designing them, can be considered "boundary objects" (Van Pelt et al 2015), operating between various constituencies: scientists, industry, policy makers, and young people who through their interests can be considered as citizen scientists or urbanists-in-formation. In the classic definition by Star and Griesemer (1989), boundary objects inhabit multiple social worlds and, through this multiplicity, facilitate a space of discourse between disciplines, institutions or fields. Boundary objects include material items as well as intangible methods or protocols that "exist at junctures where varied social worlds meet in an arena of mutual concern" (Clarke & Star, 2008: 121). For Star and Griesemer, boundary objects allow processes of translation, where the interests and concerns of social actors are embroiled through negotiations, simplifications and problematizations in order to be enrolled in a wider caucus of sociality (see also Fujimura, 1992).

Designed for that purpose, serious games can function as boundary objects that relate in a multiplicity of ways to the Antarctic continent: as models of environment change; as representations that mobilise the region as a game setting; and as informational resources that could be deployed pedagogically. Serious games complement other forms of engagement with the future of Antarctica, such as speculative fabulation in the form of ethnographic

fiction (Salazar, 2017) or digital storytelling (Salazar & Barticevic, 2015), but they also, we suggest, may reveal the disjunctures between the practice and the politics of scientific engagement.

The relationship between simulation-based scenarios, serious games and citizen science that we explore in this paper is not, however, new (see Barrios-O'Neill & Hook, 2016). Multiple forms of experimentation have involved, for example, artistic endeavours (see Born & Barry 2010; Gabrys & Yusoff 2012). Less well studied however is the processual work that composes serious game boundary objects, and our contribution here is to emphasize the role that participatory game design played, for us as researchers, in translating concepts and practice between disciplinary fields, social groups and institutional forms.

3. Environmental Game Design: Background and Methods

In the context of climate change specifically, serious games are a promising area of experimentation for informing, educating and engaging young people (see Kopnina, 2014; Wu & Lee 2015; Katsaliaki & Mustafee 2015; Vervoort 2019). The potential of gaming has also been recognised by leading global advocacy groups, such as Al Gore's Climate Reality Project, which has instigated creative games to communicate the importance of lobbying emission-reduction policies (Reckien & Eisenak 2013).

One popular game form is the negotiation/policy role-play game (RPG). With origins in tabletop games such as Dungeons & Dragons in the 1970s, computerised RPGs can be offline (eg. Mayer et al 2004) or online (eg. Sterman et al 2015), and when transposed to 'serious' and pedagogical contexts, can be employed to pose scientific scenarios that require the player to make complex decisions. RPGs involve sophisticated narrative elements—a back story, rich settings and characters, and multi-step and adaptive gameplay—making it a form well suited to the embedding of such scenarios. These characteristics motivated our own choice of genre for the co-designed game prototype discussed in this paper.

While existing research suggests that this kind of role-play gaming can foster public learning and collective action, very little has however been documented and discussed about the actual design processes through which serious games come into existence (Khaled & Vasalou, 2014). With few exceptions (e.g. All et al 2013; Gugerell & Zuidema 2017), the development of serious games remains a "black box" and their learning and engagement potential is often only assessed *ex post*, in the context of fully developed, functioning products. This reflects a practical dimension to game development: most games—serious or otherwise—are built to specification by software and design teams, and usability testing is typically the only time a wider public is invited to participate. Through participatory design, not only does the engagement potential of serious games begin much before actual play, but also the process of its observation and documentation begins to understand the multiple translations of science into other matters of concern.

Our workshop-based research aimed at "experimentalising" (Marres 2016) game design, through the making of a new collective that involved the material features of the game itself, Antarctic future scenarios, the research team and youth from three of the gateway cities. Our motivations for inviting young people included an interest in the kinds of engagement that the process itself would produce. Other motives were more pragmatic: namely, to improve the user-friendliness of the eventual interface, and to ascertain relevant digital platforms, game genres and thematic interests that would feature in the final product and elicit debate.

At key phases of the game development—during initial concept development, design mock-up, and prototype testing—we conducted workshops in the three cities (see *Figure 1*). At least four members of our team—comprising social scientists and game developers—were able to travel to or were already located in each of the cities, with one member able to attend all three workshops. The workshops also featured between 10 and 15 young people, recruited by partner organisations in each of the cities: University of Canterbury in Christchurch; Chilean Antarctic Institute (INACH) in Punta Arenas; and the University of Tasmania in Hobart. For reasons of cost and timing, each of the workshops was aligned to specific phases of the game development. The first two workshops, in Christchurch and Punta Arenas in late 2017, coincided with the storyboarding of the game. In the eight months between the 2nd and 3rd workshops, we developed a game prototype which employed elements of both RPG and simulation formats. The prototype functioned as an object for design critique but also as a device for discussing climate and Antarctica-related issues during the 3rd workshop, conducted in Hobart mid-2018.

Insert Figure 1

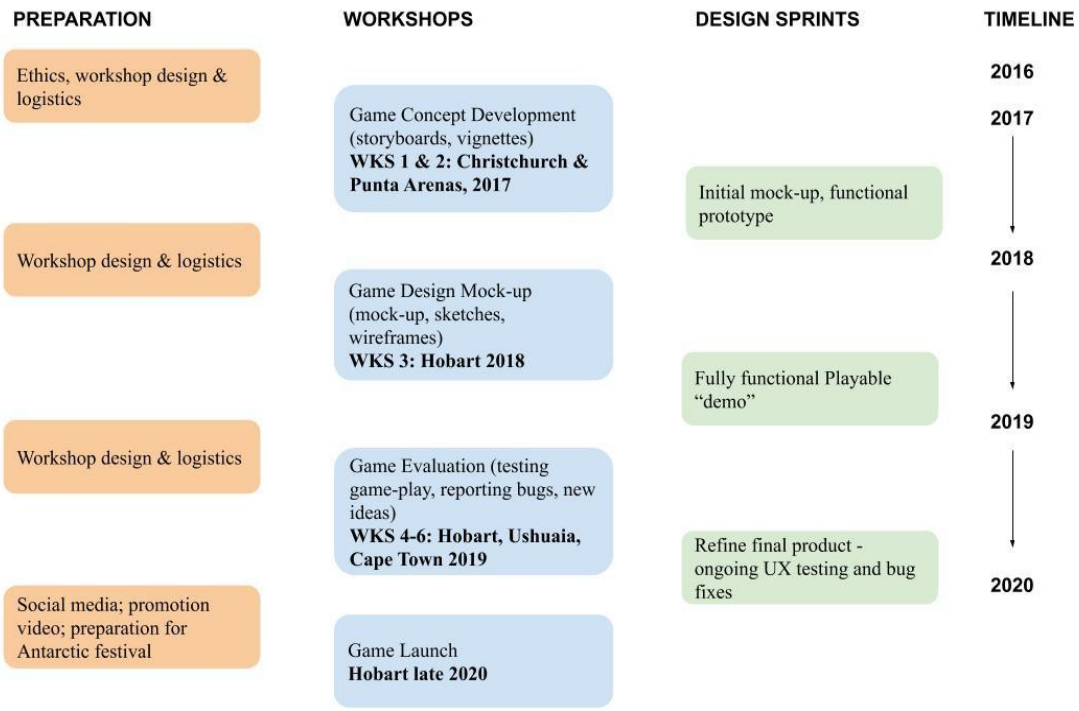


Figure 1 - stages of game co-design (the paper focuses on the first three workshops)

In each workshop, at least one note-taker would record quick observations about the unfolding of the session. These included both direct ideas and, for Workshop 3, feedback on the game prototype, as well as participant asides and comments about the wider purpose of the exercise – whether the game should purely entertain, or have some kind of factual content embedded within it for example. These notes would be later complemented by an ex-post discussion with other workshop facilitators, and supplemented by their observations and additional notes. For convenience, some of these discussions happened in person and others online. Our protocol was meant to keep data collection unobtrusive, but also to focus our accounts on our roles as participant observers, rather than as researchers outside the process of design.

We however also collected the outputs produced by the research participants during the workshop activities. Due to physical arrangements of the sessions, with each group sharing a general working area and with researchers working as facilitators, audio recording and transcription would have been impractical and, most likely, obstructive. Instead we took photos of design outputs—gameplay workflows and interface designs—and in a number of cases, could also draw observations from notes and pro-forma worksheets, which are included in our accounts below. These notes, diagrams and facilitator reflections were distilled through debriefing sessions after each event, and reassembled for this article to illustrate how the specific participatory phases – storyboarding in workshops 1 and 2, and more applied design and feedback in workshop 3 – together generated distinctive encounters between various kinds of expertise. We then organized feedback received in the sessions in a design backlog that kept track of all the suggestions received during the activities, even those that either because of budget constraints or for their lack of realism, would be impossible to follow up. This format and arrangement of the workshop poses limitations: we were not, for example, evaluating the codesign process, and have little direct evidence of sustained material change brought about by the process as a result. Nevertheless, through this procedure we were able to record the uncharted directions that the game could have taken, as well as surprising and often amusing avenues our collective conversations took. As we discuss below, these not only informed the design of the game, but our own orientation towards its purpose: we became less concerned about its explicit pedagogical function, and more interested in its ability to provoke discussion about alternative pathways to a more sustainable future.

4. Storyboards, Prototypes, Designs: Making Games Together

4.1 Storyboarding: Workshops 1 & 2

The purpose of the first two workshops was to storyboard the game: to develop a basic plot synopsis that would frame and outline the basic mechanics of the gameplay. The first

workshop was held at the Antarctic Centre in Christchurch in September 2017, while the second took place at the offices of INACH (Instituto Antártico Chileno / Chilean Antarctic Institute) in Punta Arenas in November 2017. Both adopted the same broad structure, a 2.5-3 hour session conducted by members of the research team and staff from Christchurch City Council and INACH.

Both workshops began with introductions to the project, the game and the role of the co-design session itself. We asked participants to envision future Antarctic stories that would engage young people in gameplay, and which would also be scientifically plausible, and in some sense, pedagogical. After introductions to the project and the workshop, participants were divided into four groups of between three and six participants, along with one or two facilitators responsible for keeping the discussion focussed and flowing, and for recording the group's ideas at the end of each session. Between the Christchurch and Punta Arenas workshops, we drafted a more systematic storyboard instrument for capturing these aspects.

As a further guiding instrument, each group was presented with two future trends whose present direction is uncertain, and therefore "up-for-grabs" in the context of the game: worsening climate change and heightened geopolitical conflict. As shown in *Figure 2*, each of the four groups were given one of four scenarios, depending upon whether each of these trends continued at low or high levels. For example, *Group 1* was asked to imagine a future in which climate change and geopolitical conflict are at *low* levels, while *Group 2* needed to consider a situation in which geopolitical conflict remained low, but climate change accelerated at worst case levels.

Research team members facilitated loosely structured discussions for approximately 50 minutes; after a break, over the course of another hour, the outcomes of those discussions were then organised into storyboards worksheets. In addition to responding to the questions above, these sheets also recorded observations about the resources and threats the game would include; how the game might work with multiple players; and other considerations—aesthetics, controls, player "personas"—that might influence later development.

Insert Figure 2

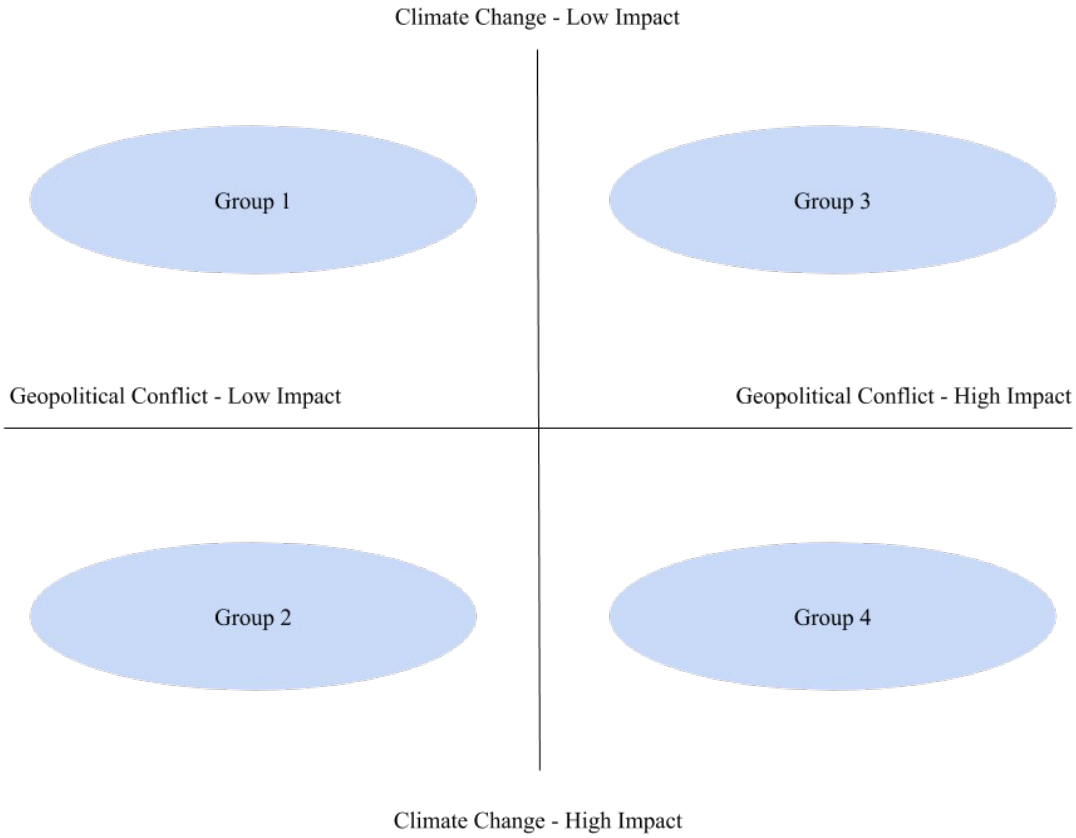


Figure 2: Future scenarios

Below, we describe two opposing scenarios – low climate change / high geopolitical conflict, as developed by Group 3 in Christchurch, and high climate change / low geopolitical conflict as developed by Group 2 in Punta Arenas. Aside from the useful contrast in scenarios, these two groups offered detailed game storyboards that helped influence the prototype but also, as we discuss, produced narratives that put into question the modes of citizen-science engagement with Antarctic futures.

Group 3, Christchurch

During the first workshop in Christchurch, Group 3 noted that the game should be "aspirational", one "that makes people think about the future". In response to the prompt, participants set their version of the game in the context of a new economic "Cold War" emerging over contention for Antarctic resources, especially fresh water. In the lead-up to 2048, just as a renewal of the Antarctic Treaty System is being negotiated, a new state actor —not a signatory to the existing Treaty—builds a base causing … a 'free-for-all' race to claim territory.

Combining strategy (*Civilization*) and city-building (*SimCity*) game modes, players act as nation-states that control, maintain and extend territorial stakes on the Antarctic continent. Rather than a political or military leader, their "persona" is that of a scientist leading an expedition on Antarctica. Gameplay involves deploying resources in pursuit of one or more multiple strategies, such as conservation, exploration, diplomacy or resource exploitation, each with "different advantages / disadvantages". According to the group, all strategies "should be viable", but also require that "moral decisions" be made.

Play takes place at different sites on the continent, with variation on ice coverage and sea access. Crises in other parts of the world—for example, "food shortages", "climate change" and "war"—would produce "trickle down" events that players would also need to respond to. The group gave considerable thought to various ways players might interact with each other. Players could for example join forces and "choose alliances" when undertaking missions, in ways similar to strategy games such as *StarCraft II*. An online forum could allow players to discuss the game itself "as well as Antarctic issues".

The group also gave thought to the game's mechanics and design. The main interface would be a top-down representation of areas of Antarctica, and contain an overlay or "mini-map" for moving around different areas of the continent. Core activities would include harvesting resources and building bases, and the game's difficulty settings would determine how much detail players would need to know about base development: power levels, numbers of turbines, the working hours of scientists, and so on. Noting the need for the game to be playable on the phone, many elements would need to be represented as "symbols", and its style would need to be cartoon-like rather than realistic, as this would make it "timeless". To incentivise sustained play, both the game and online forums might have badges and prizes to award successful players.

Group 2, Punta Arenas

The storyboard developed by Group 2 in Punta Arenas was strikingly different. Working on a narrative in response to the "high climate change / low geopolitical conflict" scenario—a future world which marries international cooperation with potential environmental catastrophe—this group speculated that the catastrophe in question is the spread of a mysterious virus kept frozen and secret on the Antarctic continent until glacial melting caused it to be released into the atmosphere.

In this scenario, the absence of geopolitical tensions and anticipated innovations in renewable energy and autonomous vehicles mean global travel is cheaper than today. One consequence is that the virus can travel more easily. Mysterious rumours of a scientist infected on the Antarctic continent lead to the player, adopting the persona of a medical coroner, racing against time to prevent global viral contagion. Adding to the intrigue: the scientist is a friend of the player, and leaves important clues in their correspondence. The player must visit Antarctica to locate the source of the virus, in order to begin research into a possible cure.

The game begins with a briefing about the mission in one of the Antarctic cities, after which most of the game action takes place on the Antarctic continent itself. Once underway, the

gameplay is of the 3D survival genre, viewed from either first- or third-person perspective. In "single player" mode, the player must make use of scant resources and locate various sites of newly thawed fungi and mushrooms in unexplored areas. As a multiplayer game, gameplay functions similarly to "Team Fortress" or "Capture the Flag" games: teams compete to locate the virus' source as quickly as possible.

The group was keen to allow as much character customisation as possible, allowing players to choose gender, country of origin, clothing, and, for the multiplayer mode, whether they belonged to a "philanthropic" (saving humanity by finding a cure) or "misanthropic" (controlling access to, and weaponising, the virus) team. In either mode, players could pick up resources, such as water, food, scientific equipment, first aid kits, fuel for heating and upgrades, and as they progress, they can also unlock new abilities.

As an educational tool, players can ask questions of robot assistants located at Antarctic bases. Answers to these questions about the Antarctic continent help to locate the virus source. In multiplayer mode, team-based chat provides another conduit to learning, helping players to strategise more effectively by knowing more about Antarctic conditions.

4.2 Prototyping: Between the Workshops

The first two workshops aimed to create an overall narrative for the game, and to help decide other questions of game genre and platform. This process was facilitated by the imaginative efforts of the young adults who participated in the co-design sessions, but, as these two narratives illustrate, what emerged from these early phases of treating game design as an experimental and participatory tool was a more complex ecology of engagement.

First, participants were interested in making Antarctic futures playable in ways that, somewhat contrary to the team's expectations, reframed in both dystopic and aspirational forms the relationship between the workshop sites (two of the Gateway cities) and Antarctica. In this sense, the two workshops yielded imaginative ways of experiencing playful futures that combined science, adventure and urban aspirations in the engagement of climate change and its relationship to the southernmost continent.

Second, what became clear to the research team was that the storyboarding process itself, even in the parts that were not incorporated in the game prototype, had become a way to politicise the kind of citizen science that the research project aimed to elicit. In other words, what young participants questioned in our approach was the idea that climate science could be the sole narrative of the game. They offered alternative affective dimensions of conflict, adventure and catastrophe. These were framings that exceeded normative readings of the relationship between climate science and political action, and, as such, even if the scenarios were infeasible for our game, we considered them as important inspirations for what we eventually produced.

For practical reasons, not all these suggestions could be incorporated in the game design. The eventual game prototype could not, as mentioned earlier, feature the multiple kinds of

adventurous engagements that the first two workshops had called for. Due to cost constraints and project timelines, the discrepancy between these ambitions and the first software outcome generated several dead ends: possibilities that we considered and had to discard. These included some prototypes with 3D Antarctic worlds, generated with *Unreal Engine 4.0*. While these immersive environments had visceral appeal, they posed multiple challenges: how to reconcile a first person perspective with a regional and global spatial scale; how to deploy a 3D game to mobile devices; and whether the time requirements of 3D modelling would overwhelm budget and our desire to spend sufficient time to the simulation model that would underpin the game. These experiments were not, however, unproductive. They allowed us to grasp not just the limits of gaming, but also of the design as a process that, in our hopes, would generate a boundary object between scientific scenarios and playful futures.

Both before and after the first two workshops, we examined a number of existing game options. A successful game that also made use of a minimalist and, from a design perspective, cost-effective set of interface elements, we selected *The Plague Inc* as a reference point for our own game design. *The Plague Inc* is a blend of simulation and strategic RPG where the player adopts the persona of a virus or bacteria charged with spreading itself across the world and wiping out humanity. In our version, we considered re-casting this misanthropic premise to a philanthropic one, where the player must use a minimal set of resources and policy options to arrest the effects of climate change.

For the purposes of building a prototype for the third workshop, we wanted a minimum viable product: a playable game which would intentionally lack the polish of a finished product. In addition to the central premise, we made a number of adaptations. For example, *The Plague Inc* uses a standard global map as the main interface element; our version also uses a map, but oriented toward Antarctica as the centre. Each country on the map is modelled in the game, with properties such as GDP and population that determine the effectiveness of particular policy options selected by the player.

The model we adopted is a highly simplified version of the simulation scenario developed by Rintoul *et al*. (2017). By default, when the game runs, the climate slowly degrades, in line with a "business as usual" case. By selecting a combination of policy options, made available as the game simulation unfolds, the player can influence the rate of degradation, leading to, if the game is played well, a best case scenario of minimal long-term climate impact. The game was built upon *Cocos2d-x*, an open source multi-platform game framework, and a web version was published on a private server for the third workshop.

One consequence of our internal deliberations after the first two workshops was an acknowledgement of certain limits of participatory design, conducted under constraints. For some participants, the opportunity to consult on digital or electronic games solicits a response inspired by so-called "AAA" or "Triple-A" games, produced with high budgets, and playable on consoles or high-end personal computers. Despite our efforts to deflate expectations during the workshops themselves, their outputs tended toward game storyboards that would be ambitious in scale and costly in execution. While, as discussed above, this had merits and

was certainly enjoyable to facilitate, one lesson from this exercise is to include constraints—perhaps, in the spirit of participatory budgeting, "tokens" that could be spent on certain game features—that would focus and direct even these early, and deliberately open-ended, brainstorming sessions.

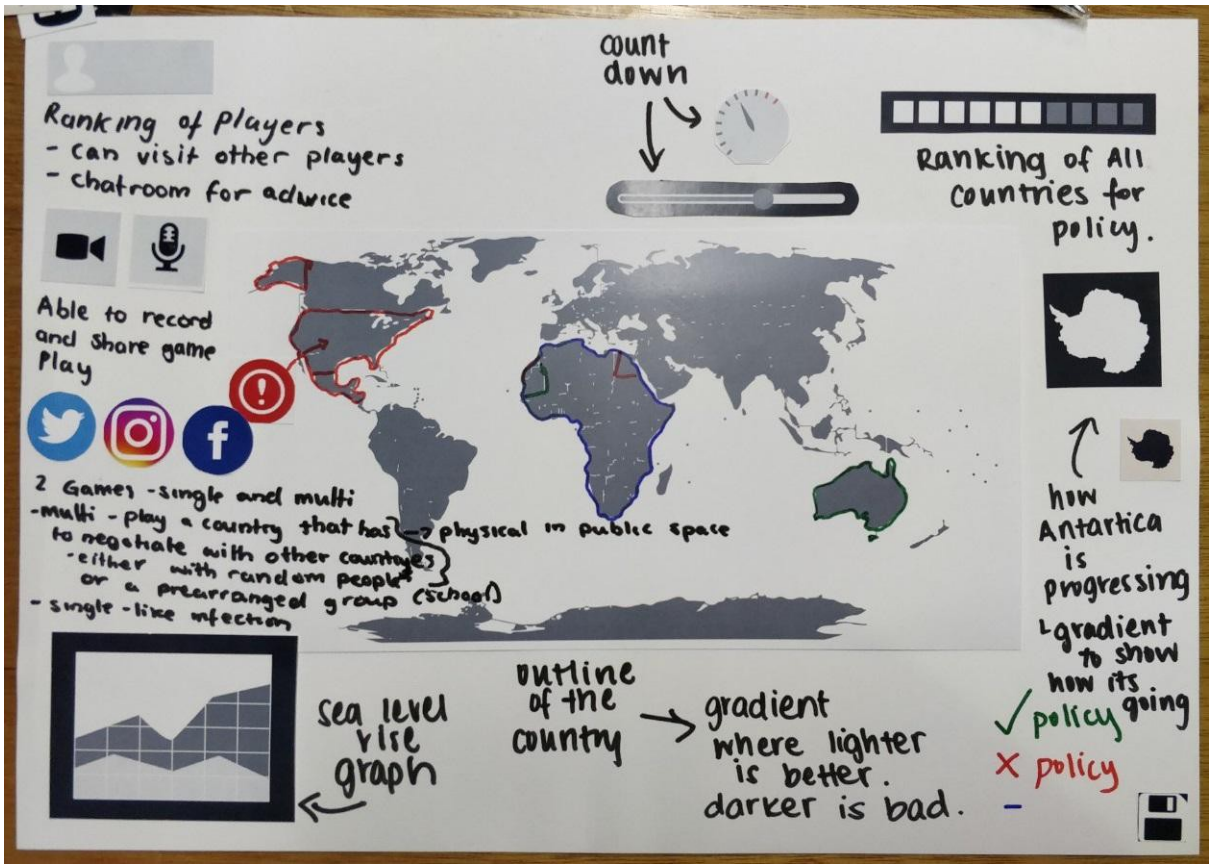
4.3 Co-Designing: Workshop 3

We conducted the third codesign workshop in August 2018 in Hobart, Tasmania. We recruited 9 participants in total, all aged 18 to 25. Some were enrolled in social sciences and humanities courses at the University of Tasmania, while other participants found out about the workshop through gaming communities or personal contacts. Five of our research team facilitated the three-hour workshop, which was subdivided in four different activities. First, the participants were informed about the research project, and asked to share their personal experience with gaming, an activity which also functioned as an ice-breaking exercise. Once briefed about the overall purpose of the serious game in relation to the broader engagement aims of the project, we provided a short introduction to the scenarios discussed by Rintoul et al (2018), in order to contextualise the narrative on which the game prototype was based. Third, participants were presented with the game, and its narrative and objective were explained.

The last and main section of the workshop involved dividing the participants in three small groups, which were formed by making sure that each contained people with both limited and considerable gaming experience. Using a toolkit of prompts as well as coloured markers, we asked the teams to prototype on paper alternative versions of the existing game shown earlier. Specifically, the groups were asked to re-design two of the main features that had been planned for the game. The toolkit featured a range of maps, buttons and icons typically used on gaming dashboards, and also included basic shapes that could be used more freely to create additional elements.

The objective of the activity was to validate, and eventually rethink on the basis of the responses, two of the interface choices that underpinned the minimum viable product. The first task entailed considering whether a world-oriented visualisation successfully served the purpose of communicating the centrality and connectedness of Antarctica in relation to the two policy scenarios. The second task involved rethinking the visualization of positive and negative changes on the game dashboard. The results of these two activities, shown as an example in the table below, partly confirmed the design hypothesis underpinning the minimum viable product, but also recommended that the game would increase its focus on the Antarctic content, to fully express the two scenario narratives. In addition, as evident from the workshop results, the activity allowed participants to go beyond the explicit workshop questions. Multiple additional options were codesigned by the participants, even in the absence of a brief to add design elements (see Image 1). One aspect of the game logic that was questioned was the fact that the prototype mirrored the "virus vs. cure" narrative inherited from *Plague Inc*. According to all three groups, this was a simplification that did not serve the game's goal. In a propositive spirit, they suggested, for example, that the game included more complex cause-effect dynamics, producing mixed effects and outcomes.

Insert *Image 1*



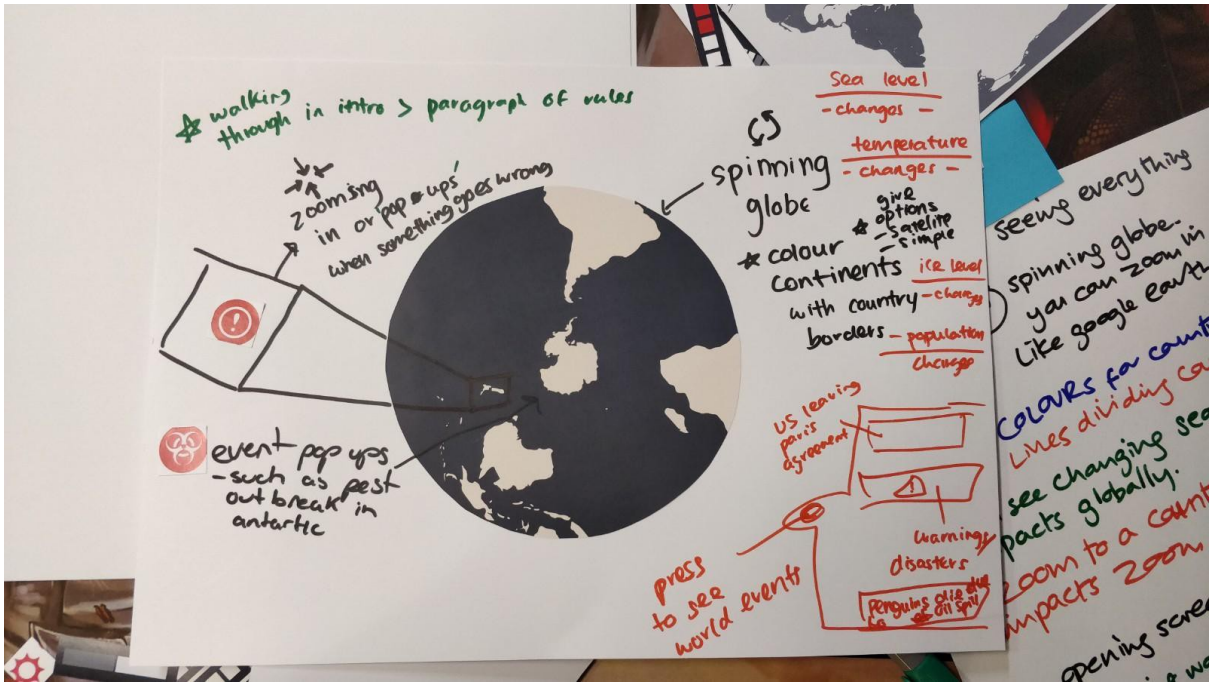
Design Feature	Group 1	Group 2	Group 3
Show a Google-Earth-like spinning map	□□		□□
Show a map focused on Antarctica/ show a bigger Antarctica	□□	□□	□□
Show cities to enact local policies			□□

Show natural change (e.g. sea level) on different layers	☐☐	☐☐	
Use realistic map colours	☐☐	☐☐	
Show bar charts to track good and bad changes	☐☐	☐☐	☐☐
Show events on map	☐☐	☐☐	
Visualize a timer countdown		☐☐	☐☐

Table 1. Summary of the codesign results, testing the hypothesis that a world-map-based dashboard is a feasible option to translate the Rintoul et al. scenario into a playable gaming platform.

Lastly, we asked participants to go beyond the single-player mode of the prototype, and speculate as to how a multi-player gaming experience might be possible for this style of game. During this last section of the workshop, it became evident that the codesign activity in itself was seen by the participants as a tool for engaging the scientific scenarios on which the game was based, as well as the real-world complexity of environmental policy and political action.

Insert image 2



Whilst some of the suggestions were expected—replicating existing multiplayer features such as social media integration, online forums or leaderboards—all three teams also discussed ways of politicising the game through social functions. For example, participants considered various forms of creative engagement and collaboration that the game could potentially foster through team play. Two groups proposed that the game included prompts to join environmental lobbying groups or actively target local politicians to improve their climate change agendas (see table 2). One team also suggested that the game should incorporate real news relating to climate change, such as headlines about environmental crises or consequential political actions. The United States' decision to withdraw from the Paris Climate Accords was used as an example of a real-world event that, once incorporated into the gaming experience, could trigger awareness and potential political action. As shown in *Image 2*, one of the groups designed on paper a trigger system that would help players join political parties or environmental groups in response to real events. For them, the game should inform and provide the possibilities to call out climate change inaction of local decision makers: through a button of the game, they explained, players should be able to engage their political representatives.

As a boundary object in the making, the game was used by the workshop participants to suggest more possibilities than those indicated by the research team. These suggestions illustrate how the codesign workshop was not only functional for testing our hypotheses about the prototype, but also challenged some of the simplifications that were made in the prototyping process. Our assumption had been that the game narrative translated a scenario into a playful experience that would, in turn, elicit a politicization of the scenario. But we did not consider the possibility that the game itself could be used for politically engaging the real world. What the participants suggested, instead, was to link the scenario to real-world events and create practical possibilities of engagement, through online forums, political parties and

lobbying groups (see table 2). Together, these responses, unprompted by the workshop structure but encouraged by the facilitators, show a desire to push serious games beyond convenient pedagogical instrumentation—a rationale used in our own institutional funding submission, as with many others—to become a means for individual and collective petitions to other institutional actors.

In a way, this was also a critique of the experimental design process, as participants to the third workshop did not shy away from highlighting that, as researchers, we had thought of the game as an unnecessarily *bounded* object, and not embraced its multiple possibilities for engagement with actual Antarctic futures. In other words, participants were critical of the "institutional" and contextual limits of the game, and against our initial thoughts, demanded a more overt politicisation of elements the game was in fact trying to "gamify". Equally, where we thought efforts to model plausible policy and scientific relationships might be overkill, precisely these elements drew most criticism: members of the co-design workshop wanted to see a stronger causal relationship between, for instance, what they thought were incompatible game choices and the catastrophe they expected to see as a result. These have since become productive concerns as we move toward the next stages of this ongoing project. The workshops have informed future iterations of the game, where we are looking to integrate elements of real-time tracking, and provide links to avenues for action, such as local government and the Antarctic Science Foundation (ASF). The value in involving young people throughout the lifecycle of game development had additional benefits: in addition to ensuring the game spoke, in some sense, to the interests of at least some Antarctic cities' residents, it also opened a conduit to actors in other institutions, included the ASF, government and media – all of whom were encouraged or interested in the participatory design process.

Design Feature	**Group 1**	**Group 2**	**Group 3**
Social media integration	□□	□□	□□
Multiplayer option	□□	□□	□□
Global leaderboard	□□		□□
Include past games as examples of possible policy scenarios	□□		
Include chat room/forum		□□	□□
Integrate real climate change news to prompt political action	□□	□□	
Include feature to lobby local politicians for climate change action	□□		□□

Table 2. Summary of the codesign results for possible ways of rendering multi-player gaming modes.

5. Conclusion

We have detailed the process of developing a serious role-play game aimed at translating scientific information on Antarctic futures to a wider audience of urban youth living from Antarctic gateway cities. In the process, we have indicated ways through which processes of codesign can function as objects that straddle and bridge boundaries between the sciences of climate change and discrete publics. In this case, our public is constituted by young people living in three gateway cities with immediate but often overlooked relations to a region at the centre of a changing climate. As boundary objects, such games serve the purpose of translating two crucial elements of scenarios—their anticipatory orientation and their multiple possible futures—into a gamified experience where these futures are enacted as simulations. Importantly however, as we have argued, serious games begin to realise their potential if the audience is explicitly included in the design process, joining in vital encounters between the otherwise disconnected social worlds of researchers and young game players and citizens of the Antarctic gateways.

This paper contributes to three interrelated concerns of serious game design in the field on climate change and, more generally, about the communication of climate futures. First, it shows a possible way for bridging the divide between serious game researchers and their end-users—e.g. the eventual audiences of serious games that are designed to communicate climate change futures—through the design process. Our experience suggests that it is possible to track and evaluate how the codesign process, when explicitly conceived as such, serves as a tool for experimenting with forms of science engagement that are alternatives or supplements to scenarios. Codesign, we have shown, involved more than finessing and refocusing the design intuitions and hypotheses at the base of games, but acts as a process in which existing institutional arrangements were brought into question. In this sense, we have argued that the interface features or the game narratives are not neutral, technical elements. As demonstrated especially in the third workshop, their construction can be serendipitously political. Scenario-building and codesign may involve multiple, generative forms of imagination that do not necessarily filter down to the final design of the game. They are still crucial for its development, constituting productive "dead-ends" that nevertheless engage part of the public, and, importantly, allow researchers to reflect on the limits of their assumptions.

Second, this paper attests to the possibility of bringing the future into play, rather literally, in a game where the key narrative is built around fictional policy decisions with planetary outcomes, showing both their complexity and impact. Through the establishment of what we have called "playful futures", the game's codesign process offers an exploratory case of the idea of "anticipatory governance", one of the salient features of "Anthropocene Thinking" (Derickson Driscoll, 2018) – making this idea, perhaps, and always within the limited scope and scale of academic projects, more tangible and available to further inquiry and critique. The significance of anticipatory research techniques such as climate modelling are illustrative of a peculiar—and perhaps defining—quality of a time marked by unprecedented social-

ecological predicaments. Such prominence given to thinking and acting in relation to the future, in an increasingly pervasive "regime of anticipation" (Mackenzie 2013), is usually predicated on algorithms, positivist models, and risk scenario planning. A playful version of such anticipatory stance, we argued, offered experimental sites in which futures were envisioned, imagined and performed according to alternative, affective and sensory coordinates.

Last, this paper speaks to the wider politics of communicating the urgency of climate change action in an age when the claims of science are continuously questioned. This relates to a long standing interest in democratising science (Marres, 2016) with tools that make it a feature of citizenship. Digital games have now joined other creative approaches, including speculative fiction and theatre, as part of a wider toolkit for furthering science communication and, more aspirationally, notions of what Latour et al. have termed a "geosocial politics" (2018). Our work contributes to a demystification of the inner workings of media production, and shows how inclusion of youth audiences in these very processes fosters engagement with global challenges. Boundary objects, thought here as temporal and co-constitutive processes, help orient collective attention towards *other* objects left otherwise obscure and untouchable: in this case, the future of the most remote, untouched region of the planet, which is yet central to planetary survival in the Anthropocene.

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