

On Simulating Shocks and Stresses in Climate Change Games: A Review of Game Design Strategies

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Abstract. In the last few decades, simulation games have been successfully used around the world in the context of addressing climate change related challenges. A particular game design challenge in these games is simulating both short-term events (shocks) and long-term gradual changes (stresses) and their interplay as a result of climate change. In response to encountering this challenge in the design of a climate change game, the study presented in this paper aimed to identify game design strategies and mechanisms to simulate both shocks and stresses in climate change games. Games included in recent review papers on climate change games were reviewed, resulting in the identification of four game design strategies: (1) time-based simulation with triggered events; (2) shocks as changing probabilities; (3) jump to a future climate scenario; and (4) climate change as a game condition. Each strategy is briefly described with examples of mechanisms used in games. From a research perspective, the presented study serves as a precursor to specify research questions and a review protocol for conducting a systematic review on this topic, thereby addressing this study's limitation of missing relevant games not covered in the review papers. From a game design perspective, the study and identified strategies offer guidance and inspiration for game designers working on climate change games.

Keywords: Game design, Game mechanisms, Climate change, Shocks, Stresses

1 Introduction

Addressing climate change is one, if not the most pressing global challenge of our time. To support finding and initiating transitions in the context of climate change, simulation games have been successfully used to convey its complexity, raise awareness, and facilitate collaboration and dialogue [1-4]. Depending on the aim, a particular design challenge for such games can be how to simulate both short-term extreme events (shocks) and long-term gradual processes (stresses) resulting from climate change and their interplay.

The above described design challenge was encountered while developing the Delta Management Game, a multiplayer climate change game where players explore salt intrusion adaptation and mitigation strategies in the Dutch delta. Salt intrusion of surface water concerns the physical process of salt sea water flowing further in-land in estuaries when the counteracting river discharge is low. The intended game experience aims to show the physical process of salt intrusion in periods of droughts (shock) while also capturing how sea level rise (stress) is likely to affect salt intrusion in the future.

In support of the design challenge, this study reviewed climate change games to identify game design strategies and mechanisms to simulate both shocks and stresses. The presented review and identified strategies serve as guidance and inspiration to game designers, but also as a precursor to specify research questions and a review protocol for conducting a systematic review.

2 Method

To explore the different game designs strategies, games included in recent review papers on climate change games [1-4] were reviewed, focusing specifically on how these games included both stresses and shocks. No inclusion/exclusion criteria or quality assessment were applied. The

games were reviewed based on papers, documentation, or playing them if e.g. a web-based version was available. The games were subsequently categorized into game design strategies.

3 Results & discussion

Below, the identified game strategies are described and illustrated with examples. Climate change games explicitly only focusing on either long-term processes [e.g. 5] or short-term, extreme events [e.g. 6] are not represented in these strategies.

3.1 Time-based simulation with triggered events

Most games identified concern playing a (mostly turn-based) time-bound scenario (e.g. some years) [7-14]. Shock events can occur at any simulation step based on one or a combination of factors like an underlying climate change scenario or player actions. Events may therefore also become more extreme as the game progresses. In *Aqua Republica* for example [7], players take 12 turns that represent around 20 years passing. Events, including climate-related like flooding and droughts, happen as a result of player actions in previous turns and are communicated to players at the start of each turn. Depending on simulated river discharges and prior player actions in the *Sustainable Delta Game* [13, 14], multiple drought or floods can occur during simulated steps covering up to 25 years. Players receive detailed feedback at the start of each turn on the impacts of events, accompanied with newspaper headlines describing past events.

3.2 Shocks as changing probabilities

Some board games include shock events as probabilities that may change during gameplay to simulate climate change impacts [15-17]. Probability changes alter the in-game frequency of event occurrence, but not their extent or intensity. Focusing on communicating changing probabilities of extremes under climate change, *CAULDRON* uses six-sided dice where initially throwing one particular side triggers an extreme event [16]. The dice cannot be inspected by players and are replaced during the game, presenting players with new, unknown, and varying probabilities. *Dissolving Disasters* takes a similar approach [15], though replacing the die after a few turns with a truncated cone to make it difficult for players to assign probabilities to event occurrence.

3.3 Jump to a future climate scenario

Other games immediately present players with a future affected by climate change [18-21]. In this future scenario, players face a climate change related challenge, which may still be time-based on a much finer resolution. In *Forage Rummy* for example [18], players take 13 turns to develop year-round livestock forage production and animal diet regime given future climate conditions in 2050. Extending on *Forage Rummy*, *FARMORE* covers three years with future climate variability [19], where one year can represent extreme weather to evaluate the adaptive capacity of the players' developed system.

3.4 Climate change as a game condition

Some games include the extent of climate change as a game condition that players directly or indirectly influence and that can lead to (delayed) effects [22-24]. The board games *KEEP COOL* [22] and *THE FARMERS* [23] use (global) carbon levels that fluctuate based on player actions. As a result of these levels, events happen at the start or end of turns, some of which can be seen as shocks. Similarly, in *Broken Cities*, players randomly draw event cards when cumulative emissions surpass certain thresholds, shown as highlighted squares on a track [24].

4 Concluding remarks and next steps

The aim of this study was to identify game design strategies and mechanisms to include both climate change induced shocks and stresses. Four strategies were identified: (1) time-based simulation with triggered events; (2) shocks as changing probabilities; (3) jump to a future climate scenario; and (4) Climate change as a game condition. A limitation of this study is that it only looks at games covered in review papers on climate change games. Relevant games may therefore be overlooked if these did not pass the review papers' inclusion criteria or were published after the conducted reviews. These limitations are addressed by conducting a systematic review, informed by this study. As a precursor to such a review, the identified strategies should be seen as preliminary, but already offer guidance for designing climate change games, including the Delta Management Game.

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