Climate Change and Simulation/Gaming

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Abstract

In this guest editorial, we survey some of the main themes and issues in anthropogenic global warming. We emphasize the great potential of simulation/games as an educational strategy. The diversity of issues in climate change is matched by the variety of simulation/games. We then provide a summary of the main points of each of the eight articles, which together contain a wide range of perspectives on climate change, of types of simulation/gaming, of level of abstraction, and of method of implementation.

Keywords

adaptation, global warming, climate, climate board game, climate change, climate-change simulation/games, climate negotiations, climate politics, companion modeling, CO2 emissions, ecological systems, economic development, energy, fossil fuels, game design, global politics, global warming, greenhouse gases, interdisciplinarity, knowledge coproduction, mitigation, natural disasters, renewable energies, role-playing, simulation/games, social networks, sustainability, UNFCCC, water management

The scientific evidence for anthropogenic global warming is unequivocal. On the other hand, the very limited progress of the climate negotiations at the UN level calls for alternative approaches to address the challenges of climate change. This Symposium will showcase different ways of approaching climate change—through the lens of simulation/games. The issue of climate change has increasingly been taken up by

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game developers and practitioners, allowing us to present a collection of highly interesting examples. The Symposium will emphasize the potential of games to represent, to research, and to teach issues of global environmental change from different perspectives, in an effort to approach "one of the greatest challenges of our time" (United Nations, 2012).

Since the late-19th century at least (Arrhenius, 1896, based on theoretical considerations), researchers have been warning that carbon dioxide (CO_2) emissions and global warming might be connected. A rising CO_2 concentration has been measured in the atmosphere since the early 1960s (Keeling, 1960, 1970). In June 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature by UN member states. In March 2004, the required ratifications were received and the convention entered into force. Its primary objective is the "stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992).

In fact, however, GHG emissions (with CO_2 being the most prominent one) continue to rise, in world totals as well as per capita. Only in 2009, the total global CO_2 emissions decreased slightly because of the world financial crisis and its economic implications. Since then, emissions have been rising again. The last international negotiation rounds under the UNFCCC (in Doha, 2012; Durban, 2011; and Cancun, 2010) have shown that international politics are far from being able to reach a global agreement to jointly reduce GHG emissions.

On the other hand, the last few years have seen a vast amount of promising activities to address climate change. For example, city mayors all over the world meet to discuss and set emission reductions. Subnational jurisdictions, such as California, and supranational entities, such as the European Union, take the lead in unilateral action. The German energy system will undergo a fundamental transition. Development of green technologies has been accelerating in some economies. Last, but not least, the increasing knowledge base on climate change is taught more and more at schools, companies, and universities. This discrepancy between limited progress on the international level and promising activities in other places emphasizes the need for broadening our perspective on climate change. The problem of global warming cannot be solved solely by nation-states within the UN system.

We argue in this symposium that simulation/gaming offers one toolbox that can be particularly useful to analyze and teach alternative and complementary views on climate change. Games can simulate quite complex actor relations, between nation-states and between transnational, subnational, individual, and hybrid actors. They can focus on individual behavior, but they can also teach political affairs. Games can offer new ways to raise awareness and empower people to deal with climate change.

Simulation games have a long history as an alternative to traditional instruments for awareness raising, education, training, and research for environmental issues. *Simulation & Gaming* has already published occasionally research and practice examples of environmental games with a specific focus on climate change (e.g., Ahamer, 2006; de Vries, 1998; Robinson & Ausubel, 1983; see also Klabbers, Swart, van Ulden, & Verlinga, 1994). The related issues of natural resource management

and international negotiations have also received coverage (e.g., Barreteau, Le Page, & Perez, 2007; Mayer, 2009; Toth, 1994), and Ulrich (1997) gave an overview of games on environmental issues more than 15 years ago. Climate change has now (sadly) become a *subject* in its own right (see Reckien & Eisenack in the introduction to this Symposium, "Climate-Change Gaming on Board and Screen: A Review"), with increasing recognition among the public and in the media. This development is sufficient in itself to warrant a whole symposium of *Simulation & Gaming* on climate-change simulation/games.

The following paragraphs recall some background knowledge on climate change. They should give an idea of the richness of topics in this field that are suitable for being considered in climate-change games.

The climate is the long-term manifestation of our weather. It is expressed by a 20 to 30 year average of meteorological data of temperature or precipitation. The climate is influenced by solar radiation and the interactions between atmosphere, oceans, vegetation, and ice cover. Solar radiation, entering the Earth's atmosphere, has a high energy level. After reflection from clouds or the Earth's surface, it loses energy. Low-energy radiation is more easily reflected by atmospheric trace gases, such as CO_2, methane, and water vapor, known as GHGs. GHGs act as blockers that keep low-energy radiation in the atmosphere. This process is called the greenhouse effect. Without this natural greenhouse effect, the Earth would be so cold that life as we know it would be impossible.

Humankind has increased the concentration of CO_2 in the atmosphere from about 280 ppm in 1750 to more than 393 ppm today (Conway & Tans, 2012). Most CO_2 emissions stem from the burning of the fossil fuels, used for the production of energy. The conversion of tropical forests for agricultural use and the emissions from other land use (e.g., methane after thawing of permafrost, rice cultivation, and cattle farming) also contribute to the anthropogenic greenhouse effect. As a consequence, the global mean temperature has risen by about 0.6°C in the 20th century, with much larger increases for certain regions. It is projected to increase substantially more in the future. Global warming has already influenced ecological systems worldwide. In the northern hemisphere, earlier springs and a continuous shift of the distribution of plants have been observed (northwards and upwards). The melting of glaciers in the Alps, thawing of permafrost in Siberia, and reduced freezing of rivers are observed. For the future, impacts on agricultural productivity are expected, as well as loss of biodiversity; water shortage will affect more regions. It is also expected that natural disasters like storms, floods, droughts, and heat waves will increase in frequency and/or strength in many regions; all this with further social and economic consequences.

Thus, next to the reduction of GHG concentrations in the atmosphere, adaptation measures to reduce the consequences of climate-change impacts are increasingly being discussed in recent years. Examples for technological adaptation measures are raising dykes and installing flood plains to reduce the damage of floods and sea level rise, building reservoirs and new deep wells to prevent water shortage, and so on. It must be expected that the costs of technological adaptation measures rise with increasing global warming and that limits to adaptation are likely. Moreover, adaptation

requires new coordination activities and adjusted social or economic institutions, for example, appropriate insurance schemes.

Global warming can only be limited if emissions of GHGs are drastically reduced. Although no binding international agreement on emission reductions exists, experts estimate that a significant reduction of GHG emissions is necessary by the mid of this century. This requires improved energy efficiency and a shift from fossil fuels to renewable energies. As emissions can be reduced at any place in the world, but the benefits of reduced global warming will accrue to everyone, the international climate policy arena has to solve a tricky, multiactor puzzle. That is why the topic of climate change lends itself to public goods games (see, for example, Holt & Laury, 1997). Although the UNFCCC's contracting parties have committed themselves to avoid "dangerous anthropogenic interference with the climate system," no effective global agreement exists on sharing the burden of this objective. The UNFCCC's subsequent Kyoto Protocol, established in 1997, scheduled emission reductions of about 5% on average for a number of contracting parties from 1990 to 2012. However, the United States did not ratify the Protocol, and the current negotiations for a possible post-Kyoto agreement are far from being successful. One crucial part of these negotiations is to define binding national targets for GHG emission reductions. Financial and technological transfers between developed and developing countries also play a major role. At international climate negotiations, different coalitions of countries with similar interests were formed. For example, the United States and its partners—in contrast to the European Union—are very hesitant about their commitment to climate protection. The G 77 is a strong and large, but also a diverse, group of developing countries, of which some are rapidly industrializing or petroleum exporting countries, which have made no commitment to reduce emissions yet. While the small Pacific islands demand massive reductions, countries like China and India want to use their coal for economic development. The clean development mechanism allows a country with an emission reduction commitment under the Kyoto Protocol to implement an emission reduction project in developing countries. The reductions thus achieved count toward the industrialized country's own emission targets. These are examples for trading with obligations to reduce emissions. Emission trading systems are also implemented in the European Union, some federal states in the United States and, recently, in Australia. Social groups are strongly involved in climate politics—either directly at international climate conferences or indirectly by political lobbying in their countries. Apart from environmental groups (like Greenpeace or WWF), the oil and coal industry, as well as development aid organizations, try to exert an influence on climate politics.

Most of the issues introduced above, plus many not yet mentioned, form the focus of climate-change games. Some of them are covered by this symposium. We now give a short overview of the individual articles to be found here.

The introductory article by Diana Reckien and Klaus Eisenack ("Climate-Change Gaming on Board and Screen: A Review") gives a systematic overview of existing climate-change games. They are so numerous today that they should be seen as a subfield of simulation/games on sustainability and environmental issues in its own right. Early publications date back to 1983, but in 2008 and 2009, the year of the UN climate

conference in Copenhagen, the number of published games on the issue peaked. The first commercial game appeared in 2004. Most climate-change games are board games and role-playing games, with computerized games occupying an increasing share. Themes covered by the games show a split: most focus either on the global scale or on local ways to deal with climate change. Few games bring together both scales. Most games convey basic declarative knowledge on climate-change issues, and focus, in particular, on reductions of GHG emissions. Another large number of games focus on policy processes, on impacts of and adaptation to climate change, and on energy-related issues.

Gilbert Ahamer ("Game, Not Fight: Change Climate Change!") argues in favor of running games when it comes to negotiating and managing large-scale global problems. Global change as one example of a large-scale problem asks for an explorative, reflexive dialogue that enables continuous adaptation, rather than a theory-driven predesigned solution. As an example for such procedural structuration, the web-based negotiation game SURFING GLOBAL CHANGE is introduced and graphically analyzed. This game allows one to walk through the complex argumentative landscape along changing roles and to identify societal consensus.

Derek Kauneckis and Matthew Auer ("A Simulation of International Climate Regime Formation") present a classroom simulation that specifically addresses the international relations dimension of global warming. Here, the issue is selected as a salient example in the context of interdisciplinary teaching in political science. Students represent real-world countries in international negotiations about the global extent and distribution of carbon dioxide emission reductions. Teaching goals are strategic thinking, applying theory of international relations, and training of methodological skills. Students have to prepare their roles by own research and analysis of relevant country data and positions. The article thus represents an interesting case for the debate about the value of using simulations in international relation courses.

Klaus Eisenack ("A Climate-Change Board Game for Interdisciplinary Communication and Education") takes a global perspective with the board game KEEP COOL, which integrates issues of GHG mitigation, climate-change adaptation, and global politics. The article describes how this game is successfully used as a tool for interdisciplinary communication and for teaching climate change. By focusing on the free-rider problem and international interest groups, it represents a social simulation environment where players can craft and negotiate global institutions. This is backed by economic and climatologic game mechanics. Developed by scientists, and published in 2004, it was the first board game on climate change that was available from a commercial publisher. The article also illustrates the timeliness of games on global change, as is reflected by the spin-off projects and the media coverage of KEEP COOL.

Joey Lee, Pinar Ceyhan, William Jordan-Cooley, and Sung Woonhee ("GREENIFY: A Real-World Action Game for Climate-Change Education") present an action-based learning tool designed to teach adult learners about climate change and motivate informed environmental and sustainable actions in the real world. It uses social networking as a primary communication form and associated peer-group formation as the main motivator. It is one of the first games using social-network media to inform,

share, rate, and motivate climate-change-relevant actions among peers, thereby moving climate-change gaming out of the classroom and away from role-playing environments into the very individual and social environment of the participants.

Pieter Valkering, Rutger van der Brugge, Astrid Offermans, Marjolijn Haasnoot, and Heleen Vreugdenhil ("A Perspective-Based Simulation Game to Explore Future Pathways of a Water-Society System Under Climate Change") take the more local perspective on adaptation to climate change. The case study is water management in the Netherlands under future climatic conditions. The game dynamically maps the involved actors' norms and beliefs relative to water management within a scenario exercise. This perspective-based simulation game builds on the theoretical frame of cultural theory. It highlights the role of common or compatible perspectives in the development of advocacy coalitions to achieve long-term, adaptation pathways in a (sometimes abruptly) changing environment. At the same time, concrete adaptation options are developed within the game, which is played with on-ground experts.

Patrick d'Aquino and Alassane Bah ("Land Policies for Climate-Change Adaptation in West Africa: A Multilevel, Companion-Modeling Approach") present another local-level adaptation study, in which climate-change games are applied in on-the-ground situations. In the participatory modeling approach followed in the study, the roles of scientific modelers, facilitators, and participants are opened up to achieve a coproduction of knowledge. Land-use options under climate and regulatory change are investigated by social simulation (with a board game) and simulation models in combination. Participants are actively engaged in crafting rules for the board game, including the applied climate scenario. The case study from Senegal shows how this can lead to organizational learning in communities that are affected by climate change. The game serves as a laboratory for developing local adaptation policies.

Robert Szafran, Jerry Williams, and Jeffery Roth ("If Local Weather Was Our Only Indicator: Modeling Length of Time to Majority Belief in Climate Change") focus on the perception of climate change. The long-term, gradual process of climate change is difficult to apprehend for both individuals and communities because local, fast-fluctuating weather patterns vary from year to year. In this article, the authors estimate the length of time it would take localities to simultaneously acknowledge climate change if the only source of information was local weather. Computer simulations employ a varying degree of unusual weather on a real-world data set. The results show that a time period of one or more generations is necessary for the localities to believe in climate change depending on the kind of modeled weather events.

The symposium closes with Thomas Fennewald and Brent Kievit-Kylar ("Integrating Climate-Change Mechanics Into a Common-Pool Resource Game") reflecting on the challenges in the design of climate-change games. Crucial issues are, for example, asymmetric players or delays in the climate system. The authors demonstrate some novel ideas to represent such aspects in a game. For example, an innovative game mechanism can fill a gap between purely competitive and purely cooperative play, called independent goals condition. Different ways to combine these design options with different delay mechanisms are assessed with respect to players' strategies. Delay effects lead to more difficulties with solving the collective-action problem

involved, and have strong and differing distributional effects on the players. The article also summarizes and analyzes some published games that address climate change or, more broadly, sustainability issues, with a specific focus on the game mechanics involved.

We are happy to present this Symposium issue, after an intensive time of reviewing and editing. We are convinced that this Symposium is both informative and astonishing, and that it will engage and challenge a wide, interdisciplinary readership.

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References

Ahamer, G. (2006). SURFING GLOBAL CHANGE: Negotiating sustainable solutions. *Simulation & Gaming: An Interdisciplinary Journal*, *37*, 380-397.

Arrhenius, S. (1896). On the influence of carbonic acid in the air upon the temperature of the ground. *Philosophical Magazine*, *41*, 237-276.

Barreteau, O., Le Page, C., & Perez, P. (2007). Simulation and gaming in natural resource management. *Simulation & Gaming: An Interdisciplinary Journal*, *38*, 181-184.

Conway, T., & Tans, P. (2012). *Recent global CO2. NOAA/ESRL*. Retrieved from http://www.esrl.noaa.gov/gmd/ccgg/trends

de Vries, B. (1998). SUSCLIME: A simulation/game on population and development in a climate-constrained world. *Simulation & Gaming: An Interdisciplinary Journal*, *29*, 216-237.

Holt, C. A., & Laury, S. K. (1997). Classroom games: Voluntary provision of a public good. *Journal of Economic Perspectives*, *11*, 209-215.

Keeling, C. D. (1960). The concentration and isotopic abundances of carbon dioxide in the atmosphere. *Tellus*, *12*, 200-203.

Keeling, C. D. (1970). Is carbon dioxide from fossil fuel changing man's environment? *Proceedings of the American Philosophical Society*, *114*, 10-17.

Klabbers, J., Swart, R., van Ulden, A., & Verlinga, P. (1994). Climate policy: Management of organized complexity through gaming. In D. Crookall & K. Arai (Eds.), *Simulation and gaming across disciplines and cultures* (pp. 122-133). Thousand Oaks, CA: Sage.

Mayer, I. S. (2009). The gaming of policy and the politics of gaming: A review. *Simulation & Gaming: An Interdisciplinary Journal*, *40*, 825-862.

Robinson, J., & Ausubel, J. H. (1983). A game framework for scenario generation for the CO2 issue. *Simulation & Gaming: An Interdisciplinary Journal*, *14*, 317-344.

Toth, F. (1994). Simulation/gaming for long-term policy problems. In D. Crookall & K. Arai (Eds.), *Simulation and gaming across disciplines and cultures* (pp. 134-142). Thousand Oaks, CA: Sage.

Ulrich, M. (1997). Games/simulations about environmental issues: Existing tools and underlying concepts. In Proceedings of the 28th Annual Conference of the International Simulation and Gaming Association. Tilburg, Netherlands: Tilburg University Press.

United Nations. (2012). *The future we want—Zero draft of the outcome document of the United Nations Conference on Sustainable Development, Rio de Janeiro, 20-22 June 2012*. Retrieved from http://www.uncsd2012.org/rio20/index.php?page=view&;type=12&nr=324&menu=20

United Nations Framework Convention on Climate Change. (1992). *Full text of the convention, Article 2*. Retrieved from http://unfccc.int/essential_background/convention/background/items/1353.php

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Diana Reckien is research scholar at the Center for Research on Environmental Decisions, Earth Institute, Columbia University, USA. She has worked at the Potsdam Institute for Climate Impact Research from 2000 to the beginning of 2012, where she started to test the explanatory power of games for climate-change issues in urban planning environments. She is interested in modes of learning and decision making, particularly for complex environments such as urban areas, climate change, and planning. Her current research focuses on climate and weather impacts and adaptation options and their social differentiation in large urban areas in India, Europe, and the United States.

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