Gaming on Climate Change

Discursive Strategies of Environmental Problems in Strategy Games

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Abstract

Due to the life-threatening impacts of climate change, the generation and communication of knowledge associated with it is given high priority. In recent years, environmentally changing behavioral knowledge can also be found in popular culture in a generally understandable form (= inter-discourse). Accordingly, the authors examine the games ANNO 2070, URBAN EMPIRE, and FATE OF THE WORLD with regard to their respective environmental discourse. For this purpose, the authors designed an analytical framework, which addresses current scientific discourses and investigates games for completeness, topicality, and validity of knowledge and mechanics and their aesthetic implementation. Overall, the authors identified three types of games: agenda, realistic and mixed-type games covering criteria of both other types. Despite the fact that games like URBAN EMPIRE or ANNO 2070 do not adequately reflect the complexity of real-world environmental problems (such as FATE OF THE WORLD), they effectively simulate intervention logic, understanding, and systemic representation. The authors contribute to the discourse on the environment and Serious Games' design by providing an analytical framework that practically identifies environmental discourses and has been tested successfully on three games. The analytical framework and consecutive systematization of games into realistic and agenda games can be of importance for didactics and guidelines when using digital games for school teaching: School teachers could specifically select games to portray certain aspects of environmental discourses.

The Discourse of Climate Change: Between Disaster Metaphors and Scientific Language

"Radical Appeal," "Warning to mankind," "Greenhouse gas emissions at record levels,""Hurricanes,"and "strong rainfalls, rising see level and warmer oceans"[1]— along with reoccurring extreme weather events and world climate conferences, the catastrophic climate change narrative with its drastic metaphors gets invoked constantly.

Against the background of discourse analysis, the authors understand climate change not as a well-established fact, but as a discursive phenomenon. Such a phenomenon is created through strategies and the practice of language as well as its validity, determination and consequences negotiated by different actors in public space.[2] This view is particularly relevant for climate change, since it is not directly evident to or experienceable by humans; whether extreme weather events are isolated phenomena or caused by climate change, is still debated among experts.

From the perspective of cultural studies the focus therefore shifts towards climate change as a meaning generating discourse: the drastic nature and collective-symbolistic clarity (tsunamis, storms, greenhouse gases, etc.) utilized in order to portray a rather abstract phenomenon such as climate change are part of a strategy trying to establish the need to act, "[a]nd this poses the question, what form of enactment, even perhaps, visualization is possible and necessary to overcome this abstract nature and uncover climate change and its apocalyptical consequences."[3] As a global and future-oriented narrative, climate change must not remain an expert discourse only. Instead, climate change and the narrative behind it intend to prompt people to act more climate-friendly.

Climate change must become a narrative which is more easily communicable and more tangible. Furthermore, climate change must attain a certain level of attention in the daily lives of lay people in order to conceptualize daily routines (decision to buy a car, choice of energy provider) or the way weather phenomena are experienced as climate change impacts. According to Jürgen Links

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1   http://orf.at/stories/2414697/2414703/ , from 19.11.2017.

2   Keller, Reiner: *Wissenssoziologische Diskursanalyse. Grundlegung eines Forschungs-programms*, Wiesbaden: SV 2008.

3   Beck, Ulrich: *Weltrisikogesellschaft*, Frankfurt a.M.: Suhrkamp 2015.

epistemological discourse analysis[4] these discourses are called interdiscourses. They use metaphors, accentuated narratives, like friend-foe schemes, or drastic enactments. Art, for example, is an interdiscursive generator which does not simply reduce complexity of expert discourses, but instead converts it to a more subtle representation. Such art interdiscourses can occur in conventional forms such as the US American disaster movies (e.g., Roland Emmerichs THE DAY AFTER TOMORROW) or more experimental forms such as Ernest Callenbachs novel *Ecotopia* (1975). Against this background, digital games are especially complex interdiscourses due to their multimediality as well as interactivity and immersion. They enable us to simulate experiences to which we otherwise would have no access in real life.

In this paper the authors want to describe the discursive construction of climate change on the basis of three digital games. These games represent strategy and simulation genre games on the topic of global politics and city building: URBAN EMPIRE, ANNO 2070 and FATE OF THE WORLD.[5] While games such as ABZÛ and INSIDE portray environmental problems from subjective, aesthetic, and affective points of view,[6] the authors' selected games represent abstract perspectives encompassing more complex interdependencies in global politics or city building. Therefore, these games are able to depict expert discourses and knowledge. The paper utilizes a conceptual framework based on criteria from environmental sciences and system dynamics as well as policy sciences in order to describe and compare the selected games. The authors address the question in how far the games are able to transform expert discourses into interdiscourses on the topic of climate change.

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4   Link, Jürgen/Parr, Rolf: "Semiotik und Interdiskursanalyse," in: Bogdal, Klaus-Michael (ed.): *Neue Literaturtheorien. Eine Einführung,* Göttingen: Vandenhoeck & Ruprecht 2005, pp. 108-133.

5   ANNO 2070 (Ubisoft 2011, O: Blue Byte Software/Related Designs); URBAN EMPIRE (Reborn Games 2017, O: Kalypso Media Digital); FATE OF THE WORLD: TIPPING POINT (Red Redemption 2011, O: Red Redemption).

6   Brittner, Sascha: "Tabula Rasa. Wie Videospiele Klimawandel verarbeiten," in: *WASD. Bookazine für Gameskultur* 11 (2017), pp. 122-127.

ANALYTICAL FRAMEWORK AND SELECTION OF GAMES

In order to more easily compare the selected games, our analytical framework utilizes binary variables along all analysis criteria. The binary defined variable levels represent extreme position on a spectrum of available dispositions in order to better illustrate differences.

The analysis category "aesthetic elements and supplementary information" investigates visual, acoustic and game mechanic means which represent environmental quality. The authors describe "expert discursive explanatory notes" as inbuilt Wiki's or didactic supplementary digital materials referencing in-game representation with discourses outside the game. From a holistic perspective the system of bio-geophysical processes (here defined as the term "environment"), which guarantees the function of human society, encompasses a number of indicators. Against this background, besides climate change other global environmental challenges are relevant: Steffen et al. characterizes this in the concept of planetary boundaries, which defines different indicators for environmental quality relevant for a safe operating space of human society.[7] In this regard, the authors defined the analytical criteria "representation of environmental quality" depicting how environmental quality can be perceived by players. In order to account for the complexity and holisticity of environmental challenges in our society the paper also investigates the importance of different environmental quality indicators (complex: climate change or biodiversity) and their representation (e.g., specific: greenhouse gas emissions or extinction rate).

Inter- and transdisciplinary in sustainability sciences attribute high importance to complex and systemic approaches in order to better understand environmental problems and interventions to combat them.[8] The debate on systemic analysis of

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7   Steffen, Will/ Richardson, Katherine/Rockström, Johan et al.: "Planetary Boundaries: Guiding Human Development on a Changing Planet," in: *Science* 347 (2015), p. 1259855.

8   Frame, Bob: "'Wicked', 'Messy', and 'Clumsy': Long-Term Frameworks for Sustainability," in: *Environment and Planning C: Government and Policy* 26(6) (2008), pp. 1113-1128; Metzner, Andreas: *Probleme sozio-ökologischer Systemtheorie: Natur und Gesellschaft in der Soziologie Luhmanns,* New York et al.: Springer 2013; Verweij, Marco/Douglas, Mary/Ellis, Richard et al.: "Clumsy Solutions for a Complex World: The Case of Climate Change," in: *Public Administration* 84(4) (2006), pp. 817-843. Whyte, Kyle P./Thompson, Paul B.: "Ideas for How to Take Wicked Problems Seriously," in: *Journal of Agricultural and Environmental Ethics* 25(4) (2012), pp. 441-445.

global environmental problems und their solutions is complemented by more re-
cent concepts such as the Anthropocene.[9] The Anthropocene represents the era of
human development characterized by planetary anthropogenic environmental
change. This concept recognizes important aspects increasing the understanding
of as well as solutions for global environmental problems such as climate
change:[10] Against this background, it constitutes 1) anthropogenic global response
patterns, 2) global socio-ecological networks, and 3) global socio-ecological sys-
tem dynamics and interdependencies illustrating the relationship among complex
systems (economy, environment, etc.). Consequently, this article investigates the
prevalence of characteristics of such a systemic representation of societal and nat-
ural systems in the concept of the Anthropocene (represented as analytical criteria
"Systemic representation").

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9   Crutzen, Paul J.: "The 'Anthropocene'," in: Ehlers, Eckart/Krafft, Thomas (eds.),
     Earth System Science in the Anthropocene. Emerging Issues and Problems, New York
     et al.: Springer 2006, pp. 13-18; Steffen, Will/Grinevald, Jacques/Crutzen, Paul. et al.:
     "The Anthropocene: Conceptual and Historical Perspectives," in: *Philosophical
     Transactions of the Royal Society of London, A: Mathematical, Physical and Engi-
     neering Sciences* 369 (2011), pp. 842-867.

10   Donges, Jonathan F./Lucht, Wolfgang/Müller-Hansen, Finn et al.: "The Technosphere
     in Earth System Analysis: A Coevolutionary Perspective," in: *The Anthropocene Re-
     view* 4(1) (2017), pp. 23-33; Donges, Jonathan F./Winkelmann, Ricarda/Lucht, Wolf-
     gang et. al.: "Closing the Loop: Reconnecting Human Dynamics to Earth System Sci-
     ence," in: *The Anthropocene Review* 4(2) (2017), pp. 151-157; Steffen, Will/Crutzen,
     Paul J./McNeill, John R.: "The Anthropocene: Are Humans Now Overwhelming the
     Great Forces of Nature," in: *AMBIO: A Journal of the Human Environment* 36(8)
     (2007), pp. 614-621; Verburg, Peter H./Dearing, John A./Dyke, James G. et al.:
     "Methods and Approaches to Modelling the Anthropocene," in: *Global Environmen-
     tal Change* 39 (2016), pp. 328-340.

Table 1: Analytical Framework

aesthetic elements and supplementary information		
aesthetic representation of climate change via visual and graphical elements (e.g., environmental pollution as dark areas) or audio effects (e.g., gloomy music)	utilized	not utilized
expert discursive explanatory notes	utilized (e.g., in-build Wiki, mouse-over info texts)	not utilized
representation of environmental quality		
complexity	simplistic: a single indicator represents environmental quality	complex: more than one indicator represent environmental quality
level of abstraction	abstract: aggregated, highly abstracted indicator (e.g., ecological footprint, ecological assessment)	specific: indicator for a specific environmental quality (e.g., rise of temperature)
systemic representation		
influence on environmental quality	direct-univariate: direct influence on a single parameter (e.g., productivity)	direct/indirect-multivariate: direct or indirect influence on more than one parameter
causality of indicators	mono-causal / no system mechanisms	interdependent / existing system mechanisms
impact of interventions on system performance	equilibrium / no side-effects in systems	side-effects present: interventions produce un-intended side-effects
representation of interventions		
quality of intervention	mono-thematic: only a single intervention type is available to solve an environmental problem (e.g., engineering, or one type of building)	holistic: more than one type of intervention solve an environmental problem
logic of intervention	curative, symptomatic response: corrective measures, polluter pays principle	preventive, root cause response: measures avoid harm, precautionary principle
environmental politics and negotiation	regulated: simple or not represented; via, for example, top-down decisions	negotiated: environmental problems are political and can be negotiated
narrative representation		
please see expert discursive explanatory notes		

Discursive concepts in systems theory[11] and system dynamics[12] have developed as a kind of standard for understanding environmental problems: system barriers and thinking via representation and relationships of variables (univariate versus multivariate); reciprocal and interdependent interaction or feedback loops (mono-causal versus interdependent) between different systems (equilibrium solutions versus unintended side-effects).

Investigating how players can influence the game-mechanic (representation of interventions), provides insights into system understanding and intervention logic of the game as well as the degree of knowledge to be gained by players on how to solve environmental problems. In this regard, the authors analyze the spectrum of possibilities as well as the diversity of possible alternative solutions to solve environmental problems (mono-thematic versus holistic), logic of intervention, (curative versus preventive), and the negotiation of preferred interventions (regulated versus negotiated).

In the discourse of sustainability sciences, environmental problems such as climate change or biodiversity loss are defined as so-called 'wicked problems' ('wicked' can be defined as complex, ambivalent, or dangerous).[13] Accounting for the characteristics of wicked problems is important[14] when designing interventions or approaches of political steering: According to Head/Alford[15] these characteristics comprise 1) social pluralism, 2) institutional complexity, and 3) scientific uncertainty.

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11   Von Bertalanffy, Ludwig/Sutherland, John W.: "General Systems Theory: Foundations, Developments, Applications," in: *IEEE Transactions on Systems, Man, and Cybernetics* 4(6) (1974), p. 592.

12   Sterman, John D.: Business Dynamics: Systems Thinking and Modeling for a Complex World, New York et al.: McGraw-Hill 2000.

13   Jones, Roger/Patwardhan, Anand/Cohen, Stewart et al.: "Foundations for Decision Making," in: Edenhofer, O. et. al (eds.), Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, New York: Cambridge University Press 2014, pp. 195-228; Rittel, Horst W. J./Webber, Melvin M.: "Dilemmas in a General Theory of Planning," in: Policy Sciences 4(2) (1973), pp. 155-169.

14   Head, Brian W./Alford, John: "Wicked Problems: Implications for Public Policy and Management," in: *Administration & Society* 47(6) (2015), pp. 711-739; Verweij, Marco/Douglas, Mary/Ellis, Richard et al.: "Clumsy Solutions for a Complex World: The Case of Climate Change," in: *Public Administration* 84(4) (2006), pp. 817-843.

15   Head, Brian W./Alford, John: "Wicked Problems: Implications for Public Policy and Management," in: *Administration & Society* 47(6) (2015), pp. 711-739.

Ad 1) Solutions or interventions to solve environmental problems such as climate change[16] are affected by a multitude of different actors on different levels (international to local) with different interests (civil society objectives for increased participation or free-market goals such as free trade).[17] Against this background, the authors investigate game-mechanics in relation to occurrence of different actors and their degree of involvement in interventions. The type of interaction can vary between protests, economic/military sanctions, or involvement in political and diplomatic negotiations (regulated versus negotiated).

Ad 2) Due to the interrelationship of different actors and organizations, coordination mechanisms need to be in place to account for their steering capacity or decision-making power in solving environmental problems. The prevalence of decision-making power can manifest via different pathways on the intervention logic: 1) technocratic interventions (e.g., environmental technologies such as wind power or carbon capture and storage), 2) sectoral interventions (agriculture, transport, or energy production), or 3) different policy instruments as interventions (emission standards, fiscal instruments such as taxes) can be utilized to solve environmental problems. In their analytical framework the authors consider the simultaneous application of all three forms of intervention as a holistic approach to solve environmental problems (mono-thematic versus holistic).

Ad 3) Due to the fact that complex or wicked problems require unconventional solutions and that scientific knowledge for solutions is fragmented and imperfect, interventions follow a precautionary principle:[18] Solutions addressing the root

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16 Corell, Elisabeth/Betsill, Michele M.: "A Comparative Look at NGO Influence in International Environmental Negotiations: Desertification and Climate Change," in: *Global Environmental Politics* 1(4) (2001), pp. 86-107; Wittneben, Bettina. B./ Okereke, Chukwumerije/Banerjee, Subhabrata Bobby et al.: "Climate Change and the Emergence of New Organizational Landscapes," in: *Organization Studies* 33(11) (2012), pp. 1431-1450.

17 Rietig, Katharina: "The Power of Strategy: Environmental NGO Influence in International Climate Negotiations," in: *Global Governance: A Review of Multilateralism and International Organizations* 22(2) (2016), pp. 268-288; Spaargaren, Gert/Mol, Arthur P.: "Greening Global Consumption: Redefining Politics and Authority," in: *Global Environmental Change* 18(3) (2008), pp. 350-359.

18 Epstein, Larry G.: "Decision Making and the Temporal Resolution of Uncertainty," in: *International economic review* 21(2) (1980), pp. 269-283; Foster, Kenneth R./Vecchia, Paolo/Repacholi, Michael H.: "Science and the Precautionary Principle," in: *Science* 288 (2000), pp. 979-981; O'Riordan, Timothy/Cameron, James: *Interpreting the Precautionary Principle*, Vol. 2, London: Earthscan 1994.

cause of the problem compared to damage control or mitigation measures (i.e., polluter pays principle) are represented by different analytical criteria (curative versus preventive).[19]

Besides a micro-structural analysis—the utilized analytical framework and its analysis criteria on the representation of the environment –, the authors also add a narrative analysis of the macro-structure—the narration of climate change. Therefore, they use a simplified form of Greimas[20] narrative analysis, which is f.e. used by Viehöver[21] for climate change narratives. The basic narration of climate change deals with the fact that an actor (civil society, environmental NGO, politics) tries to metaphorically disconnect (extreme weather phenomena, rise of temperature etc.) or connect from an object (decrease of greenhouse gas emissions, species protection etc.) while at the same time putting up resistance against a villain or anti-hero (industry, consumer society, lobby groups etc.).

URBAN EMPIRE

In URBAN EMPIRE the player assumes the role of the mayor in the fictional country of Swarelia. The story of the city is played over five historical periods. In an isometric perspective the player designs the city by building streets, deciding on the planning scheme, and proposing regulations to the city council. The quality of life in the city is represented by the so-called "Wheel of life". It is a quantitative indicator constituting the quality of life in the city from the perspective of a citizen: it subsumes six basic needs (e.g., built environment, safety, personal development, health). In each period the demands of citizens change. The player can influence these basic needs by utilizing different building options (infrastructure and public services such as a sewer system) or regulations.

This game does not utilize explicit climate change related nor any generic environmental quality indicators (complexity: simplistic). The player has difficulty figuring out for themselves how interventions (i.e., regulations or measures for city building) work and what their impact on the environmental quality is, since

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19   Kiehl, Jeffrey T.: "Geoengineering Climate Change: Treating the Symptom over the Cause?," in: *Climatic Change* 77(3) (2006), pp. 227-228.

20   Greimas, Algirdas Julien/Courtés, Joseph: *Semiotics and Language. An Analytical Dictionary*, Bloomington Ind. et al.: Indiana University Press 1982.

21   Viehöver, Willy: "Öffentliche Erzählung und der globale Klimawandel," in: Arnold, Markus/Dressel, Gert/Viehöver, Willy (eds.), *Erzählungen im Öffentlichen. Über die Wirkung narrativer Diskurse*, Wiesbaden: SV 2012, pp. 173-215.

the game does not offer any supplementary notes except for very short texts. For example, the technology section "internet of things" encompasses the measure "taxation of car traffic". The indicator for environmental quality is highly aggregated and represented by "built environment" (level of abstraction: abstract), and iconically represented by a tree. The tree symbolizes the citizens perspective on the built environment. Accordingly, the indicator is influenced by interventions such as street lights as well as the building of parks and introduction of electric vehicles. Therefore, the indicators do not represent the objectively measured environmental quality, but rather a subject-oriented value of built environment (i.e., the subjective valuation of environmental quality by citizens).

The manipulation of the "built environment" is a simple game-mechanic: Interventions and measures taken in a certain area or district directly improve the indicator (influence on environmental quality: direct-univariate), and consequently in the whole city (causality of indicators: mono-causal). Infrastructure improvements, such as parks, also influence other basic needs such as health or social interaction. All basic needs next to "built environment" can only be changed in a positive way. The impact of interventions is displayed directly in short info-texts. The only limiting factor is the city council budget, which covers running costs of interventions. Since system mechanics or un-intended side effects are absent, urban environmental problems are easily deal with targeted interventions and can be kept relatively stable (equilibrium / no side-effects in systems). In addition, the quality of "built environment" is only influenced by the periodically increasing demands of citizen. Consequently, it is irrelevant how the player influences the indicator "built environment" (e.g., by building new industrial areas). It is only the relative change in citizens perceptions due to recently introduced interventions that influences the indicator "built environment". Thus, environmental quality is perceived as a static indicator.

It is difficult to respond to the questions of 'quality of intervention' and 'logic of intervention', since environmental quality is hidden within the highly aggregated indicator "built environment". Only in the technology section game-mechanic the player recognizes certain topics of environmental quality: In each period the player can access different scientific advancements via research points. Advancements such as "sustainability," "health care system," or "smart growth" comprise a diverse set of interventions (quality of intervention: holistic) in the environmental sector (i.e., infrastructure, services, new regulations). Interventions can be broadly categorized into curative ("taxation of car traffic") or preventive ("protection of water bodies," "fair trade") without having any impact on the game-mechanic.

Environmental policy and negotiation of interventions play a central role in the game: The city council, which serves as the decision-making body, votes on all interventions and regulations. The city council is comprised of different parties which have their own agenda and preferences for particular regulations and environmental concerns. Therefore, environmental interventions are not simply decided by top-down decisions but are subject to negotiation processes.

Similar to infrastructure or urban planning interventions, regulations proposed by the city council have little influence on other indicators: According to info-texts, the introduction of a regulation on "measures to reduce greenhouse gas emissions" improves the indicator "built environment" while at the same time reduces the turnover from industrial companies. The player can only make the assumption about the system mechanisms of how specific company sectors generate less turnover, which in turn influences employment and overall satisfaction. Many of the possible interventions only negatively influence the city budget without any other conflicts or unintended side effects, but almost exclusively positively influence basic needs: Introducing "taxation of car traffic" negatively influences basic needs "social relations" and "personal development" (equilibrium / no side-effects in systems). Environmental interventions only affect the city budget and are targeted sure-fire success and automatically increase "quality of life".

Due to the rather static and hidden environmental quality indicators, the narrative representation is difficult to assess; the source of environmental problems or polluters cannot be identified, the indicator "built environment" is too abstract and highly aggregated to act as indicator for environmental quality, causality of indicators is difficult to assess. Protagonists of environmental quality refer to infrastructure ("large park", "recycling centre") as well as regulations affecting changes in mindsets ("fair trade", "smart growth"). The latter is hardly perceived in digital games which commonly refer to technocratic interventions for environmental quality.

ANNO 2070

Ubisoft's ANNO series exists since 1998 and comprises of seven different games. In this city-building game the player colonizes islands, develops economic sectors to produce goods and services to satisfy needs of the population. This in turn generates increased satisfaction generating income, which enables the setup of more complex economic sectors and systems of production and consumption. In ANNO 2070 the player is involved in a world that is already heavily impacted by climate change. The introductory movie describes a world prone to resource scarcity, rising sea levels and melting of polar caps. At the same time infertile lands turned

into fertile lands and new mineral deposits could be accessed. In this post-apocalyptical setting, three factions compete with each other: the "Eden Initiative" utilizes renewable energy and represents a strongly democratic society; the "Global Trust" focuses on non-renewable energy sources, heavy industries, and capitalism; the "S.A.A.T." (Scientific Academy for Advanced Technologies) focuses on scientific advancement.

From an isometric perspective the player plans the economic development in a world comprised of only small islands. On the aesthetic level environmental quality is depicted in a cinemato-graphic and collective-symbolic enactment via an introductory movie and small video-sequences during game-play: green meadows and tree lines represent high levels, grey and withered plains and leafless treetops low levels of environmental quality. The three factions are also enacted in a collective-symbolic appearance: White buildings in the "Eden Initiative" are contrasted with sooty-grey ones by "Global Trust". The central indicator for environmental quality is "eco balance". "Eco balance" represents a highly aggregated numerical indicator for environmental quality which is calculated by adding or subtracting "eco balance" points (level of abstraction: abstract; complexity: simplistic). Each island starts with a positive "eco balance" (i.e., no negative influence of production). The construction of buildings generally decreased the indicator (negative influence), while only a few special buildings increase (positive influence) the indicator (influence on environmental quality: direct-univariate). The decrease of the "eco balance" not only graphically changes the land, but also reduces productivity of buildings producing goods, and, consequently, general satisfaction of the population (particularly of the "Eden Initiative") as well as tax income (causality of indicators: interdependent / existing system mechanisms). However, system mechanisms are limited to islands and thus represent closed systems in themselves which are not interdependent. There is no further information on relationships among indicators or interventions which point towards the prevalence of equilibrium / no side-effects in systems. Similar to URBAN EMPIRE environmental quality is perceived a static indicator, which is only influenced by interventions set by the player.

With regards to possible interventions the game is designed in a simple way: One can distinguish between different interventions (quality of intervention: mono-thematic) primarily by deploying certain technologies in different sectors (energy provision, waste water recycling etc.). One of the few exceptions are found in certain buildings of the "Eden Initiative" (education cluster: data policy "new from old" reduces the need for certain products), which target changes in mindset and values. Accompanying explanatory texts only explain game-mechanics and therefore do not represent expert discursive explanatory notes establishing

a relation between game-internal and external discourses (this would be particularly interesting for exotic technologies such as the "ozone maker station"—a zeppelin purifying the air). With regards to intervention logic, most of the interventions can be characterized as curative, symptomatic response (e.g., sewage system, weather control station, carbon capture and storage, ozone maker) and are implemented with negotiation (environmental politics and negotiation: regulated). The only exception is the sector energy provision where the "Eden Initiative" utilizes buildings which focus on preventive measures (logic of intervention: preventive, root cause response).

Investigating the narration, the separation of major actors (the "Eden Initiative" and the "Global Trust") serves a prominent cliche: the environment polluting omnipotent multi-national player ("Global Trust"—anti-hero) and the democratic, environment preserving actor ("Eden Initiative"—hero). However, even the presumably responsible heroes of this narrative negatively impact the environment due to their consumption patterns, which in turn only affect the source of origin on their home island (one independent "eco balance" indicator on each island).

FATE OF THE WORLD

Against the background of escalating climate change, in FATE OF THE WORLD (FOTW) the player assumes the role of the *Global Environment Organisation ("GEO")*, namely the world government. In a first step, the players select a scenario defining winning and losing conditions. With regards to aesthetics the game is similar to a turn-based board game, wherein one round normally comprises 5 in-game years starting with 2025 and normally ending in 2200. In the center of the screen the player sees the globe, which only changes according to the rise in temperature and the prevalence of extreme weather events (aesthetic elements are hardly implemented). During each round of gameplay, the status of environmental quality is communicated via news-entry like animations: reports by journalists in front of extreme weather event scenery. The players, however, can rarely assume game-play and strategies through these interdiscursive elements alone, but rather need to consult statistics. In addition, a game-internal wiki supports the player in their decisions and describes the relationships and interventions without providing any information on how these influence any indicators or game-mechanics.

FOTW is more multi-faceted than other games, since environmental quality is comprised of several indicators (complex) which are either abstract (eco-toxicity: index for soil quality or water stress) or concrete (carbon dioxide concentration). These indicators all exist in relation to each other and can be viewed in the

statistical section of the game. In addition, environmental quality is also subject to unaffected external factors, which is rarely the case in other games: climatic conditions change (sometimes to the benefit of the player) when soil fertility in Europe increases due to the increase in average temperatures. The exploitation of clathrates can eventually lead to methane eruptions.

What makes FOTW complex and challenging is the direct and indirect influence and interdependency of indicators. An increase in electric vehicles and mobility leads to increased energy consumption, which in turn increases exploitation of coal, leading to increased greenhouse gas emissions (direct/indirect-multivariate). Even obvious negative interventions can have positive impacts: A collapse of the South-American rainforest leads to increased area for agricultural activity (side-effects present: interventions produce un-intended side-effects). The presence of interdependent relationships among indicators requires the player to further investigate system mechanics in order to better understand game mechanics and consequently set the appropriate interventions: the expansion of school education in Africa will decrease child mortality and result in decreased birth rates, which in turn will lead to an aging population. A challenging task for players is also prevalent goal-conflicts and resulting side-effects (interventions produce un-intended side-effects):

The decrease in greenhouse gas emissions resulting in decreased productivity and standard of living (Human Development Index), means that greenhouse gas emission reductions will lead to loss of financing for future interventions and responses. The many interdependent relationships of indicators prevent equilibrium situations where no side-effects in systems occur. However, the game does not explicitly depict these relationships. The player is required to consult statistics by investigating interdependent relationship based on data in the statistics screen. Against this background, the intervention "e-mobility" describes: "massively cuts back dependency on oil. Increase in electricity in proportion." The high amount of prior knowledge needed, the learning by trial and error, combined with a highly complex world climate model developed by the Oxford University Climate Dynamics Group define FOTW as a Serious Game.[22]

The interventions improving environmental quality are comprised of different sectors (e.g., energy or agriculture), and relate to science or technologies as well as climate-policy instruments (e.g., awareness raising campaigns or greenhouse

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22 On this category see also Fromme, Johannes/Biermann, Ralf/Unger, Alexander: "'Serious Games' oder 'taking games seriously'?," in: Hugger, Kai-Uwe/Walber, Markus (eds.), *Digitale Lernwelten. Konzepte, Beispiele und Perspektiven,* Wiesbaden: VS 2010, pp. 39-57.

gas emission taxation). Therefore, climate change is addressed in a holistic way on the level of interventions (quality of intervention). The game clearly differentiates among technological as well as value and behavioral changing interventions in the areas of curative (e.g., flood protection against tsunamis) as well as preventive impact (facilitating a change of values for cutting consumption or increasing e-mobility).

The authors identify the representation of climate policy and politics as problematic: All relevant interventions are ordinated by the World Government (environmental politics and negotiation: regulated: simple or not represented; via, for example, top-down decisions). The level of approval for selected interventions is only represented by symbols of "green hearts" in each world region, respectively, which can be easily managed via other simple interventions.

The complexity of the game presupposes that the climate change narration is ambiguous: In many scenarios, the industrialization of Africa leads to political stability which in turn successfully concludes the scenario even though environmental quality decreases. Similarly, the deforestation of tropical rainforests provides additional agricultural productivity through increased access to land for biofuels. The most effective form of narration is the emblematic comparison of atmospheric carbon dioxide concentration and increase in temperature between the game rounds. This mechanic lets the player identify CO_2 as the central factor for climate change. However, a distinct differentiation of protagonists in a climate change narration is not possible simply due to the fact that relationships among indicators are not easy to identify.

RESUMÉ

From the perspective of sustainability sciences and with respect to game-mechanics all three selected games clearly reference environmental problems and climate change. The more games such as URBAN EMPIRE try to engage in a more holistic approach to human development (e.g., a sustainable development approach) representing environmental indicators next to other ones, such as safety, the less environmental problems are at the center of the discourse. Interdependent relationships of environmental problems are very prominently addressed in FOTW: This is the case for both winning conditions as well as the complexity and differentiated representation of environmental quality in the game (e.g. atmospheric carbon dioxide concentration, biodiversity loss, etc.) which makes FOTW a game best

reflecting the current expert discourse.[23] URBAN EMPIRE and ANNO 2070 represent environmental quality indicators on par with other indicators for winning conditions. Due to the complexity of environmental expert discourse, all three games fundamentally reduce this complexity in its game-mechanic as well as narration.

The most relevant aspect of learning in digital games is playful problem solving; the logic of intervention influences gaming experience and fun, the immersion, as well as a better understanding of contexts and connections. Solving environmental problems in digital games relies more on understanding root causes in climate change debates, which are equally relevant to the scientific discourse,[24] than un-intended side-effects. With regards to the possibilities of players to respond to problems in the form of interventions, all three games have slightly different approaches. All three games, however, strongly rely on curative interventions, which often represent technological solutions (cleaner production processes or renewable energy provision).

This conveys a sense of necessity for technocratic approaches as the only possible solution to the player. FOTW and URBAN EMPIRE offer players different preventive interventions to choose from. However, the two games do not provide additional information on whether preventive over curative interventions are more effective in the long term. Only FOTW addresses the impact of societal values, as well as changes of mindsets and goals for satisfying basic needs in relation to economic growth and rising production of goods in its game-mechanic. Against this background, the game indicates a societal development path away from consumer-oriented capitalism towards a model of "life styles of health and sustainability"[25] which represents one of the most urgent challenges for addressing global environmental challenges such as climate change.[26] ANNO 2070 and FOTW provide simply top-down interventions without account for diverse interests and side-effects on other stakeholders. Only URBAN EMPIRE makes it possible for the

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23 Steffen, Will/ Richardson, Katherine/Rockström, Johan et al.: "Planetary Boundaries: Guiding Human Development on a Changing Planet," in: *Science* 347 (2015), p. 1259855.

24 Blanco, Gabriel/Gerlagh, Reyer/Suh, Sangwon et a.: "Drivers, Trends and Mitigation," in: Edenhofer, O. et. al (eds.), *Climate Change* (2014), pp. 351-411.

25 LOHAS: transition towards a life style based on activities on less resource intensive consumption and instead built on more social relationship building see also Schommer, Peter/Harms, Thomas/Gottschlich, Hendrik: *LOHAS Lifestyle of Health and Sustainability*, Heilbronn: Ernst & Young 2007.

26 Jackson, Tim: Prosperity without Growth. Economics for a Finite Planet, London: Earthscan 2009.

political dimension to be addressed in multi-party and negotiations systems in an environmental discourse via the city council.

In conclusion, based on the manifestation of different criteria and binary disposition from the analytical framework, the authors differentiate between two groups of games: 1) Agenda games, which portray different options for interventions and, therefore, potentially foster awareness raising and change of behavior. 2) Realistic games, which makes it easier to understand foster system mechanisms of environmental problems. The authors are aware that these two types are ideal positions which are indeed perceived to some extent as hybrid forms in the selected games.

Table 2: Categorization in Agenda and Realistic Games based on Binary Disposition II in the Analytical Framework (righthand column)

style		aspects	Anno 2070	Urban Empire	FOTW
agenda games		narrative representation	░		░
		aesthetic elements—aesthetic implementation	░		
		intervention—quality of intervention		░	░
		intervention—logic of intervention		░	░
		intervention—environmental politics and negotiation		░	
	realistic games	expert discursive explanatory notes & texts			
		systemic representation—influence on environmental quality	░		
		representation of environmental quality—complexity			▓
		representation of environmental quality—level of abstraction			▓
		systemic representation—influence on environmental quality			▓
		systemic representation—causality of indicators	▓		▓

Despite the fact that games like URBAN EMPIRE or ANNO 2070 do not adequately reflect the complexity of real-world environmental problems, they effectively simulate intervention logic, understanding, and systemic representation. FOTW primarily focuses on best simulating system mechanics and understanding while at the same time following a drastic aesthetic representation facilitating reflection by

players. The authors would like to contribute to the discourse on environment and serious games design by providing an analytical framework which practically identify environmental discourses and has been tested successfully on three games. The analytical framework and consecutive systematization of games into realistic and agenda games can be of importance for didactics and guidelines when using digital games for school teaching: School teachers could specifically select games to portray certain aspects of environmental discourses.

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