Clima Futura @ VU*– communicating (unconvenient) science

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Abstract

In this paper we introduce Clima Futura, a game about climate change. The primary aim of Clima Futura is to gain experience with the parameters affecting climate change and to give access to climate change related research in a playful manner. The concept for the game has been developed as a submission for the yearly Dutch contest for the communication of science. In this paper we will give an overview of the scientific background of the game, the overall design of the game, and our approach for realizing the game, deploying a modular architecture which allows for extending the game with minigames contributed by the community of players.

Keywords and phrases: climate change, science communication, model-based simulation, serious games

Introduction

Over the last couple of years, climate change has come into the focus of public attention. Moved by television images of dislocated people in far-away countries, ice bears threatened by the corruption of their native environment, tsunami waves flooding the third world, and hurricanes destroying urban areas, the general public is becoming worried by what Al Gore has so aptly characterized as *an inconvenient truth*: the climate is changing and human affluence may be the prime cause.

In response to the *pathos* of the media, many civil groups do an appeal on the responsibility of individual citizens and start campains for an *ethos* of climate-correct behavior, by saving on energy-consumption or driving CO2-friendly cars. In the media, such campains are either advocated or critized by authorities from public government, and experts from a multitude of sciences, with conflicting opinions. As a result, the general audience, initially with genuine concern about the state of our world, gets confused and looses interest. And more worrisome, the adolescents, looking at the serious way adults express their confusion and ignorance, take distance and may decide that the *climate issue* is not of their concern.

At the Climate Centre of the VU University Amsterdam, we are not happy to observe that *pathos* and *ethos* overtake the public debate, and we actively wish to participate in the public debate bringing our multi-disciplinary scientific background into play. Moreover, since we *borrow the earth from our children*, as the old Indian saying goes, which Al Gore again brought to our attention, we feel that we must take an active interest in bringing the *climate issue* to the attention of the youth, in a form that is appropriate. From this background, we engaged in developing Clima Futura, a multi-disciplinary undertaking, bringing together climate experts from a variety of backgrounds with multimedia/game development researchers. The Clima Futura game addresses the issues of climate change, not altogether without *pathos* nor *ethos*, but nevertheless primarily focussed on bringing the *logos* of climate change into

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the foreground, in other words the scientific issues that are at play, and the science-based insights and uncertainties that may govern our decisions in the political debate. Given the state of our knowledge, the science of climate change itself may be characterized as an inconvenient science, and as such an interesting challenge to present by means of a game.

structure The structure of this paper is as follows. First, we will briefly discuss general issues of game design. Then we will describe the context, the science communication contest, the process of developing the concept for the game, and the actual design of Clima Futura. Before discussing the overall architecture of the game, we will characterize our *game event description format*, developed to allow for collaborative design, involving participants from a wide variety of disciplines. We will then outline the technical properties of our proposed game architecture, which accomodates extensions for special interest groups as well as contributions from the community of players.

Game play, simulation and exploration – (re)discovering design

Games are increasingly becoming a vital instrument in achieving educational goals, ranging from language learning games, to games for learning ICT service management skills, based on actual business process simulations, Eliens & Chang (2007). In reflecting on the epistemological value of game playing, we may observe following Klabbers (2006), that the game player enters a *magic circle* akin to a complex social system, where *actors*, *rules*, and *resources* are combined in intricate (game) configurations:

<div align="center">game as social system</div>

actors	rule(s)	resource(s)
players	events	game space
roles	evaluation	situation
goals	facilitator(s)	context

Leaving the interpretation of the elements of such a (game) system, indicated in the table above, to the reader, we may wonder what meaning

games have, and looking at the fantasy items and visual effects of current day video games, we may wonder not only what is the meaning of meaningful elements, having a logical place in the narrative, but also what is the meaning or function of the apparently meaningless elements. The answer is simple, involvement and more in particular emotional involvement due to the inborn playfulness of humans. In oppositio to the common conviction that *gaming is a waste of time*, many authors, including Gee (2003), express the opinion that gaming and game-related efforts provide a form of *active learning*, allowing the gamer to experience the world(s) in a new way, to form new affiliations, and to prepare for future learning in similar or even new domains. More importantly, due to intense involvement and the need to analyze game challenges, gaming even encourages *critical learning*, that is to think about the domain on a meta-level as a complex system of inter-related parts, and the conventions that govern a particular domain, which Gee (2003) characterizes as *situated cognition in a semiotic domain*. Without further explanation, we may note here that *semiotic domain* means a *world of meaning* that is due to social conventions and patterns of communication.

An often heard criticism on educational games is, unfortunately, that, despite the good intentions of the makers, they do not get the target audience involved, or put in other words, are quite boring. This criticism, as we will argue later, also holds for many of the climate games developed so far, and the question is how can we avoid this pitfall, and present the impact of climate change and the various ways we can mitigate or adapt to the potential threats of global warming in an entertaining way, that involves the player not only intellectually but also on a more emotional level? Put differently, what game elements can we offer to involve the player and still adequately represent the climate issue?

Looking at the games discussed in *Playing Games with the Climate*[1], we see primarily games that either focus on (overly simplified) climate prediction models (*logos*), or games that challenge the player how to become climate-correct (*ethos*). In our approach, we not only aim to include (well-

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[1]www.worldchanging.com/archives/003603.html

founded) *logos* and *ethos* oriented game-playing, but also wish to promote an understanding of the *pathos* surrounding climate change, where we observe that the models taken as a reference are often gross simplifications and from a scientific perspective not adequate! To this end we will, as an extra ingredient, include interactive video as an essential element in game playing. This approach effectively combines a turn-based game-play loop, with a simulation-loop based on one or more climate reference models, with in addition exploratory cycles, activated by game events, which allow the player to explore the argumentative issues in the rethorics of climate change, facilitated by a large collection of interactive videos in combination with minigames. As we will discuss later, this approach imposes additional challenges for both the conceptual and technical design of our game, but in this way we can also contribute to the issue of *media literacy*, or "*mediawijsheid*[2]" as the Dutch Council of Culture calls it, that is making students aware of the impact of the media in presenting controversial issues.

The contest, the plan, and the process – building the team

The *Academische Jaarprijs*[3] (yearly national Dutch prize for scinetific communication) is a contest for bringing high-standing scientific research under the attention of the general public, including the younger generations! The VU University decided to submit their internationally well-renowned climate research as a candidate for the prize. Organized within the Climate Centre[4], in close collaboration with other Dutch universities, our climate scientists observed that:

> Regional climate change should not be seen only as a threat; changes to weather patterns could generate opportunities for large-scale innovations, and, developing a climate-proofing strategy now is likely to be more cost effective than taking drastic actions later.
> Kabat et al. (2005)

Since these issues are not only of scientific relevance, but ultimately concern the whole national as well as trans-national population, our university considered the topic highly relevant for the national competition in science communication. Looking for adequate means to communicate our scientific insights to the general audience, it took not long before the idea of a *game* came up. Both senior and junior staff of all relevant faculties were assembled to discuss the plan of a game, and an inventory was made of what games existed, followed by brainstorm sessions in which initial ideas were proposed.

Games we looked at included: *Planet Green*[5], offering ways to explore climate-correct behavior, the *ThinkQuest*[6] climate game, checking your knowledge for basic climate-related facts, the British *Climate Change Hero*[7] game, meant to improve the players knowledge about climate change factors, the German *Climate Simulator*[8], which allows for experimentation with climate change based on a simulation model, and the BBC game *Climate Challenge*[9], where the player must take decisions to tackle climate change and yet stay popular. But none of these games seemed to be satisfactory as a basis for our game, although each of them provided some inspiration, one way or another.

Rethinking our submission for the contest, we reflected on the criteria we were told the jury would look at:

- *relevance* – what is our message?
- *identity* – who are we?
- *impact* – why would anybody be interested?

When we came accross a serious game in an altogether different domain, we nevertheless did find the inspiration we were looking for. In the ground-breaking *Peacemaker*[10] game, we found an example of how to translate a serious issue into a turn-based game, which covers both political and social issues, and with appealing visuals, not sacrificing the seriousness of the topic. By presenting real-time events using video and (short) text, Peacemaker offers a choice between the points of view of the

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[2]www.cultuur.nl/nieuws.html?nieuws_speeches.php?id=184
[3]www.academischejaarprijs.nl
[4]www.climatecentre.vu.nl

[5]planetgreengame.com
[6]library.thinkquest.org/5721/climategame.html
[7]www.devon.gov.uk/index/environment/climatechange
[8]www.deutsches-museum.de/dmznt/climate/climategame
[9]www.bbc.co.uk/sn/hottopics/climatechange
[10]www.peacemakergame.com

various parties involved, as a means of creating the awareness needed for further political action. With Peacemaker as an example after which to model our climate game, we started working on the design of a turn-based game, allowing the player to manipulate parameters of climate change over a period of time, against the background of a climate simulation model, and offering the opportunity to explore climate-related issues and opinions, using interactive video or by playing minigames. Clima Futura was born!
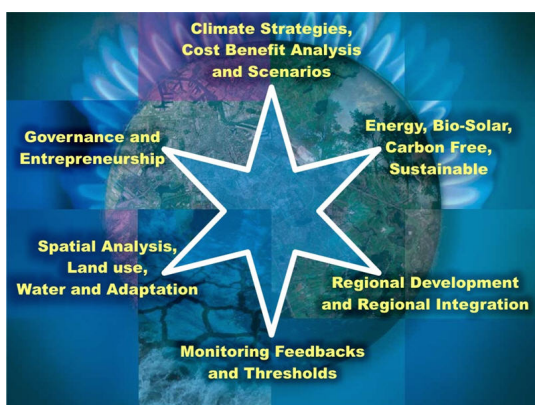
Fig 1. Climate Star

Final concept – Clima Futura

The Clima Futura game is targeted at an audience in the age of 12-26. Primary goals are to create involvement with the *climate issue*, and to provide information by allowing the player to explore cause and effect relations, using models based on scientific research in a continuously evolving field of knowledge.

Clima Futura is a turn-based game, with 20 rounds spanning a 100-year period. In each turn, the player has the option to set parameters for the climate simulation model. The game is centered around the so-called *climate star*, which gives a subdivision of topics in climate research, as indicated below.

- climate strategies – (1) emission reduction, (2) adaptation
- climate systems – (3) feedback monitoring, (4) investment in research, (5) climate response
- energy and CO2 – (6) investment in efficiency, (7) investment in green technology, (8) governement rules

- regional development – (9) campain for awareness, (10) securing food and water
- adaptation measures – (11) public space, (12) water management, (13) use of natural resources
- international relations – (14) CO2 emission trade, (15) European negotiations, (16) international convenants

Of the topics mentioned, not all may immediately be represented in the simulation model underlying Clima Futura, but may only be addressed in exploratory interactive video. The *climate star* is actually used by the VU Climate centre as an organizational framework to bring together researchers from the various disciplines, and in the Clima Futura game it is in addition also used as a *toolkit* to present the options in manipulating the climate simulation model to the player.

The result parameters of the climate simulation model are for the player visible in the values for *People*, *Profit* and *Planet*, which may be characterized as:

- *People* – How is the policy judged by the people?
- *Profit* – What is the influence on the (national) economy?
- *Planet* – What are the effects for the environment?

A generally acknowledged uncertainty within climate research surrounds the notion of *climate sensitivity*, that is the extent to which the climate and climate change is actually dependent on human activity. In practice, the actual assessment of climate sensitivity may determine whether either a choice for mitigation or adaptation is more viable. Cf. fig 2, plotting marginal costs and benefits (vertical) against stabilisation targets of atmospheric concentration of greenhouse gases (horizontal).
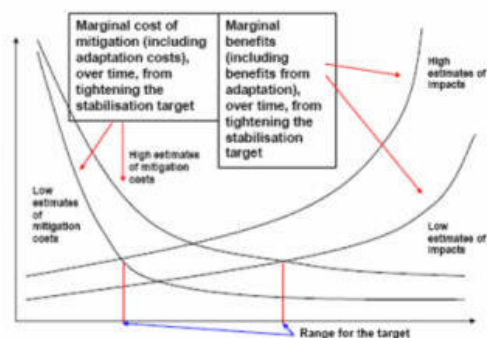

Fig 2. Tradeoffs Mitigation vs Adaptation

In the Clima Futura game we choose for using *climate sensitivity* as as a parameter for setting the level of difficulty of the game play, where difficulty increases with the value for climate sensitivity.

To give an example of game play, we let the player start in 2007, the year the IPCC[11] (Intergovernmental Panel on Climate Change) report was published. In each subsequent round, the player may choose to undertake action. For example, when the player decides to enforce restrictions on CO2 emissions, s/he may choose option (1) in the climate star, which can be reached through *climate strategies*. The result will then be visible, after some period of (game) time, in either one of the result parameters, *People*, *Profit*, and *Planet.*
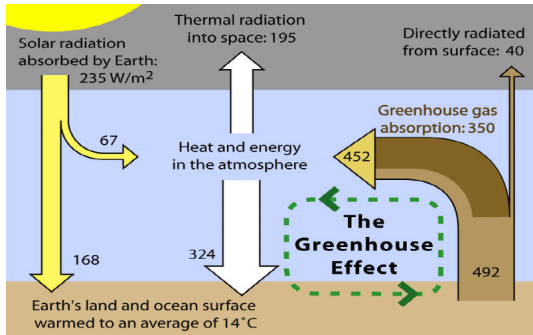

Fig 3. The Greenhouse Effect

The climate simulation model[12] underlying Clima Futura is primarily based on the Climber 2.0 model, which is used for scientific simulations of climate change, based on the division between land and sea, the density of vegetation, sea temperature, and the amount of CO2. See fig 3. Economic costs and benefits of climate policy options are calculated by means of an integrated assessment model coupled to the climate model. Additionally, an alternative model, the MERGE[13] model is used, which gives a flexible means to explore a wide range of contentious issues: costs of abatement, damages from climate change, valuation and discounting. MERGE contains submodels governing domestic and international economy, energy-related and non-energy emissions of greenhouse gases, non-energy emissions of greenhouse gases, as well as market and non-market damages due to global climate change.

[11] www.ipcc.ch

[12] en.wikipedia.org/wiki/Climate_model

[13] www.stanford.edu/group/MERGE

As an aside, the choice of models[14] is in itself a controversial scientific issue, as testified by J. D. Mahlman's article on the rethorics of climate change *science versus non-science*[15], discusssing *why climate models are imperfect and why they are crucial anyway.*
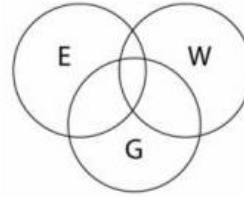

Fig 4. Game play, Simulation, Exploration

In summary, see fig. 4, the Clima Futura game combines the following elements:

1. game cycle – turns in subsequent rounds (G)

2. simulation(s) – based on climate model (W)

3. exploration – by means of interactive video (E)

Each of the three elements is essentially cyclic in nature, and may give rise to *game events*. For example, game events may arise from taking turns after 5-year periods, due to alarming situations in the climate simulation, such as danger of flooding an urban area, or accidental access to confidential information in the exploration of video material. In addition, Clima Futura features *mini-games*, that may be selected on the occurrence of a game event, to acquire additional information, gain bonus points or just for entertainment. Examples of mini-games, are *negotiation with world leaders*, or a climate-related variant of Tetris. Clima Futura also features *advisors* that may be consulted, to gain information about any of the topics of the *climate star.*

After a first round of design, which resulted in the Clima Futura Design Bible, that we will discuss later, we created a trailer to announce our game and to invite our target audience to play it: *Can you save the world*? The trailer begins with a descriptive part, displaying the affluence of our society, but indicating climate-related problems, including economic threats to (third world) countries and animals endangered in their natural environments. This announcement of doom is

[14] www.grida.no/climate/ipcc_tar/wg1/308.htm

[15] www.gfdl.noaa.gov/∼gth/web_page/article/aree_page1.html

followed by an indication of the political dilemmas, and opposing world leaders. The *climate star* is then introduced as a means to gain scientific insight, which is a sine qua non for saving the world, and so, in conclusion, play Clima Futura, and save the world! Let is be well-understood, though, that despite the *pathos* of the trailer, which breathes *doom and gloom*, our actual intent is to provide information about climate research (*logos*), as a means to arrive at more responsible decision making, not exclusively driven by *pathos* and (blind) *ethos*!

The game event description format – scenario(s)

Having decided on the general structure and elements of the Clima Futura game, a turn-based game loop, a climate-model driven simulation, exploratory video, and mini-games, the problem is how to connect these elements in a meaningfull way, and design a coherent collection of game events. This problem is further aggravated by the need to find a way to design in a collaborative fashion, necessitated by the sheer amount of disciplines and people involved.

To enable collaborative design we developed a game event description format, which standardizes the way game events are to be described, and for which we also developed an online form, structured as outlined below:

- name of event – give a meaningful name
- event-id – for administrators only
- type – (generic/specific) game/model/video
- cause – game play/simulation/exploration
- feedback/information – give a logical description
- player actions – indicate all (logical) player options
- description of visuals – for feedback, information and player options
- additional information – give a url with references to additional informatin and visuals
- relates to event(s) – give id's or descriptions of related events

Before enforcing the game event description format, our ideas about the design of Clima Futura were gathered in a collection of narratives and brief descriptions, in what we called the *Clima Futura Design Bible*. Using the standardized game event description format, we hope to arrive at a more uniform way of describing the narratives, the perspectives from which these narratives can be experienced, the challenges or problems a player must solve, the resources available to the player, such as capital, knowledge and political power, the rewards, possibly using bonus credits for succesfully playing a mini-game, as well as the visuals, which will where possible be derived from the collection of videos we have available.

In addition to the game event description format, we also provided a minigame description form, containing a field to indicate the event that gave rise to the minigame, a field for a description of the minigame in words, as well as a field for the visual depiction of the minigame. Together, the game event and minigame description formats, provide a means to develop an online hyperlinked design document, that may serve as a reference for further design, development and coding. For the elaboration of the design, we are developing storyboards, which characterize in a visual way the major (dramatic) elements of narratives, structured using a subdivision in:

<div align="center">scenario(s)</div>

- context – general setting, situation
- problem – event(s) to occur, problem to solve
- S-R situation(s) – stimulus/response (one or more)
- climax – action must be taken
- resolution – find solution or result

Although the actual workflow that we will deploy during development is at the moment of writing not clear, we will strive for developing templates that allow for a quick realization of the designs captured by the game event and minigame description format(s), along with the storyboards for visual design.

Towards a modular architecture – participatory deployment

In the beginning, we envisioned the realization of our climate game as a first-person perspective role-playing game in a 3D immersive environment as for

example supported by the Half Life 2 SDK, with which we gained experience in creating a *search the hidden treasure*[16] game in a detailed 3D virtual replica of our faculty. However, we soon realized that the use of such a development platform, would require far too much work, given the complexity of our design. So, instead of totally giving up on immersion, we decided to use *flash* video[17], indeed as a poor-man's substitute for real 3D immersion, which, using *flash*[18] interactive animations, has as an additional benefit that it can be used to play games online, in a web browser. Together with the Flex 2 SDK[19], which recently became open source, *flash* offers a rich internet application (RIA) toolkit, that is sufficiently versatile for creating (online) games, that require, in relation to console games or highly realistic narrative games like Half Life, a comparatively moderate development effort. To allow for component-wise development, we choose for a modular architecture, with four basic modules and three (variants) of integration modules, as indicated below.
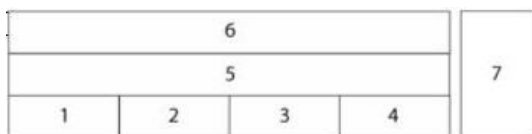

Fig 5. Clima Futura Architecture

1. climate model(s) - action script module(s)

2. game play interaction - event-handler per game event

3. video content module - video fragment(s) and interaction overlays

4. minigame(s) - flash module(s) with actionscript interface

5. Clima Futura - integration of modules 1-4, plus server-side ranking

6. adapted versions – educational, commercial

7. multi-user version –with server-side support

In addition, we would like to develop a facility that allows players not only submit their own video material, but also to build or modify their own minigames, which might then be included in the collection of minigames provided by Clima Futura.

For the actual production, we will use additional components, including *game physics*[20], a *relation browser*[21], and an *earch*[22] component. In particular, both physics and in-game building facilities seemed to have contributed to a great extent to the popularity of Second Life, Eliens et al. (2007b). In creating *digital dossiers*[23] for contenporary art, we have deployed concept graphs, that is a relation browser, to give access to highly-related rich media information about art in an immersive manner. Finally, given the topic of Clima Futura, being able to visual models of the surface of the earth seems to be more than appropriate. It is interssting to note that our technology also allows for the use of *flash* movies directly by invoking the *youtube* API[24] as a web service, which means that we could, in principle, build minigames around the evergrowing collection of *youtube*, or similar providers.

Providing flexible access to collections of video(s) to support arguments concerning controversial issues has been explored in Vox Populi[25], Bocconi (2006). The Vox Populi system distinguishes between the following types of argument(s):

- topic-centered – common beliefs, use of logic, examples

- viewer-centered – patriotisms, religious or romantic sentimentality

- speaker-centered – the makers are intelligent, well-informed, sincere and trusthworthy

These argument types are related to what we have previously characterized as, respectively, *logos*, arguments based on logic, reason and factual data, *pathos*, arguments that appeal to the emotion(s) of the audience, and *ethos*, which in essence does an appeal on the belief in the trustworthiness of the speaker. In Vox Populi, video fragments are annotated with meta-information to allow for searching relevant material, supporting or opposing a particular viewpoint. based on the users'

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[16]www.cs.vu.nl/~eliens/game
[17]www.adobe.com/products/flash/video
[18]ww.adobe.com/devnet/flash
[19]www.adobe.com/products/flex/sdk

[20]www.fisixengine.com
[21]http://der-mo.net/relationBrowser
[22]www.flashearth.com
[23]www.few.vu.nl/~dossier05
[24]www.youtube.com/dev
[25]homepages.cwi.nl/~media/demo/IWA/

preference, either a *propagandist* presentation can be chosen, epressing a single point of view (POV), a *binary commentator*, which shows arguments pro and con, or an *omniscient presenter* (mind opener), which displays all viewpoints. Although a research topic in itself, we would like to develop a *video content module* (3), that provides flexible access to the collection of video(s), and is media driven to the extent that video-material can be added later, with proper annotation. Together with in-game minigame building facilities, it would be in the spirit of a participatory culture, to provide annotation facilities to the player(s) of Clima Futura as well, to comment on the relevance and status of the video material, Jenkins (2006).

Conclusion(s) – looking back

Now, at the time of writing, we are busy preparing the presentation of Clima Futura for the jury of the scientific communication contest. We decided to have three central presenters (anchors) and an expert-panel (choir), that may comment on detailed scientific or technical issues. The presentation, in which we will stress the multi-disciplinary approach, covers the following topics, in the order of listing:

presentation

1. philosophy – pathos, ethos, logos
2. trailer – drama, apocalyptic, appeal to player
3. climate star – scientific issues & game play
4. game development – architecture and project plan

Although it too early to look back, we may on reflection ask attention for another potential pitfall, that endangers any educational game, once aptly expressed by Sartre in his criticism of *l'esprit de serieux*. Indeed, we may become too serious! In concluding our account of the design and development of Clima Futura, we may refer to an *ontology of humour*, Dormann et al. (2007), that may be taken as a guideline to avoid the common pitfall of *serious games*. In brief, Dormann et al. (2007) distinguishes between three theories of humour, that each denote a particular function of humour: *relief theory*, which explains humour as a reduction of stress, *superiority theory*, which asserts that humour has a social function, as a means to enforce the norm of a group or culture, and *incongruity*

theory, which relates humour to the discovery of hidden meanings. We leave it to the imagination of the reader to establish in what way the various types of humour may be put to effect in the *climate issue*!

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