

LIVING CLIMATE CHANGE

Design thinking and learning in complexity

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Abstract

As the world moves into an era of significant changes predicated by the challenge of sustainability, the future holds many questions, with serious consequences depending on the answers. Given the implications of these changes, the world's design community needs to be constantly challenged to respond. To support conversations on what life will be like in 20 or 30 years and thus make the climate change debate more tangible, IDEO, a global design and innovation company, is hosting the Living Climate Change project and website. Moving the debate away from what we have to give up toward what we can create, the project is born from the conviction that design has a role to play in addressing the global issue of climate change. The scenarios IDEO developed (in movie clips) show how we may choose (or be forced) to abandon the old ways and change our behaviour.

In partnership with IDEO, the Faculty of Industrial Design Engineering of the Delft University of Technology applied the Living Climate Change method in their education on sustainable design. Over a ten-week period, nine student teams were asked to develop non-linear future scenarios and present these in short movie clips. This paper presents the results of this activity, reflects on the methods used (expert involvement, storytelling, scenario building, movie making) and the learning that took place. The main conclusion is that the Living Climate Change activity turned out to be a valuable tool for the students, helping them come to terms with complex and interlinked topics and how these might change the world and the way we live.

Keywords

Design education, design thinking, sustainable design, climate change, constructivistic learning

1 Introduction

Climate change is an abstract problem for most people. This has, among other things, to do with the time scales on which the effects become noticeable. In geological terms, climate change is currently happening at breakneck pace. Hansen (2009, p. 161), for instance, explains that the human climate forcing by burning fossil fuels is ten thousand times more powerful than the natural forcing which takes place over long stretches of geological time. But from an everyday perspective the process is still extremely slow, leaving us (seemingly) with plenty of time for mitigation, and for adaptation to rising global temperatures, sea level rise and more extreme weather events (IPCC, 2007). As a consequence, for designers it is hard to meaningfully deal with climate change in day-to-day practice. Designers who try to incorporate climate change issues in their design brief quickly discover that (in order to prevent the brief from becoming too complex) the realistic response is to design for energy efficiency, i.e. reducing greenhouse gas emissions, shifting energy supply to include a larger portion of renewable energy resources, and increasing energy efficiency (Crul et.al, 2009). This is however a gross simplification which ignores questions of sufficiency, equity, product life cycles, and sustainability in general, and which fails to address rebound effects and other unintended side effects. The world of industrial product design is one predicated on growth - growth in sales, growth in market share, growth in product portfolio and growth in brand awareness. Addressing climate change (and sustainability in general) meanwhile, with a world heading for nine billion and emerging markets growing substantially, asks for 'limits to growth' (Meadows et al, 2004).

Unfortunately, sustainable practices in technology education too often amount to 'tinkering' practices, with sustainability goals being watered down and leaving the deeper problems unexamined (Elshof, 2009, Boks, 2006). This paper describes our attempt to address the full complexity of climate change in a practicum for designers and engineers of Delft University of Technology. Taking our cues from IDEO's Living Climate Change project (www.livingclimatechange.com), in 2009/10 we ran a Living Climate Change practicum in cooperation with IDEO, for third-year bachelor students of four different faculties: industrial design engineering, aerospace engineering, architecture, and mechanical engineering. In this paper we pose the question of how effective this practicum was for achieving the

intended learning outcomes. These stated that after this practicum, the students should be able to apply design thinking to a seriously complex problem such as climate change, translate their ideas into realistic future scenarios using narrative techniques, make competent use of expertise and scientific data, and develop storyboards and short video animations based on the future scenarios. We defined effectiveness as the extent to which the intended learning outcomes had been achieved; time needed by the students versus time allocated; and the appreciation and usefulness of the course as perceived by the students based on oral and written evaluations.

2 Theory

In current thinking about teaching and learning in academic settings, the so-called theory of constructivism plays an important role. This theory assumes that all knowledge is constructed at the basis of previous knowledge (Cobb 1994, Aalbers et al 2004). Also, current thinking urges academic teachers to distinguish explicitly between knowledge, skills and attitude, and to observe the synthesis of these three elements into solid academic competencies (Nedermeijer and Pilot 2000). Putting these two findings together, it becomes apparent that not just new knowledge is built upon previously-gained knowledge, but also that new skills must be developed on the basis of old ones, and that the student's continual attitude development must be safeguarded. In this, authenticity is key: students learn the most if the problems they are presented with resemble real-life problems and the context related thereto, and even more if the problems are of a kind they can intuitively imagine themselves tackling (Pilot and Bulte 2006; Tempelman and Pilot 2010).

Within this theoretical framework, it is clear that design thinking presents a specific challenge: after all, design is an integrative activity that draws upon many different mental resources at the same time, in particular analytical and creative resources (see e.g. Eger et al 2004; Overbeeke et al 2004 and Roozenburg 2008 for the combined Dutch academic view). Dealing with 'fuzzy' i.e. vaguely-defined inputs, postponing judgment and searching for more than one possible solution are all essential elements of design thinking, not to mention dealing with the (often disconcerting) finding that solutions on one level of abstraction can become problems on a higher level. Sustainable development, where rebound effects often negate the gains of particular solutions (e.g. energy-efficient 'sustainable' lighting that is used to illuminate areas left dark before) presents perhaps the strongest case in point. Engineering students are known to take to such experiences badly, often showing 'lock-in behaviour' and insisting that their role as problem solvers is limited to the technological, and not the societal level (Mulder, 2006). A second common strategy for students is to simply

ignore certain elements of the problem description (in order to reduce its complexity). As the Living Climate Change practicum was to address climate change in all its complexity, the tutors were particularly keen on helping the students avoid these ‘knee-jerk’ reactions.

3 Educational Setting & Learning Objectives

The section gives an overview of the Living Climate Change project and the way we adopted it in the educational setting of the TU Delft. The intended learning outcomes are described and briefly discussed.

3.1 The Living Climate Change project

To support conversations on what life will be like in 20 or 30 years and thus make the climate change debate more tangible, IDEO, a global design and innovation company, is hosting the Living Climate Change project. The project was born from the conviction that design has a role to play in addressing the global issue of climate change.

Living Climate Change started in the summer of 2009 as a voluntary company-internal IDEO project. With the UN Climate Change Conference in Copenhagen in December 2009 to look forward to, IDEO wanted to engage the global creative and business communities in a discussion on climate change. In the year leading up to ‘Copenhagen’, climate change had a prominent position on most political, scientific and business agendas, but the design community had been unusually quiet. IDEO had several motivations for taking the lead in this debate. The Living Climate Change project:

- Provides a vehicle to make the all-too-abstract discussion around climate change more tangible and thus debatable in the public realm. Translating from the scientific and political expert language to everyday life experiences is urgently needed within this context in order to not just speak to the public’s intellect, but to evoke emotions. Living climate change attempts this by removing the false sense of ‘does not concern me’ and of ‘what can I possibly do’.
- Leads a constructive conversation, which enables us to discuss which solutions society might be able to come up with, rather than engaging in doom and gloom discussions.
- Is a way of showing the power of design thinking, a concept extensively explored by IDEO (Brown, 2009).
- Calls for experimentation. In the words of Johnson and Scholes (2005), ‘Organisations need to try out new ideas and see if they work and in so doing learn about the future as it changes...’ (p 231). By opening up the Living Climate Change project to the business

and creative communities, IDEO hopes to inspire more experiments, more action and 'doing', in order to enhance our understanding of the future.

The method IDEO chose for the Living Climate Change project was scenario building. Scenario building is described as 'envisaging a few different possible future outcomes for the situation under scrutiny' (Schwartz, 1996). The scenarios were developed in pairs, offering juxtaposed views of the future: one scenario showing how we 'make it' by managing the change towards a less carbon-intensive future, and the other showing how we 'don't make it' (i.e. we fail to transition in time) and are forced to manage the consequences. Both scenarios include opportunities for innovation, but also the need to sacrifice certain ways of life. The common thread in all scenarios is their focus on people's ordinary lives.

On the Living Climate Change website Tim Brown (CEO of IDEO) introduces the project in the following way: *"Design has a role to play in addressing the big challenges we face. As design thinkers we can shape the conversation by asking good questions, and then bring them to life by exploring possible solutions in an optimistic and real-world way. Climate change is of course one of those big challenges. Countries are moving towards reducing carbon emissions by as much as 80% by 2050. That's a massive change. How do we deal with it? One way is to rely on the policy makers and wait for change to come to us. Another way is for all of us to participate in imagining what life will be like in 20 or 30 years. Which behaviors will change? And which will be preserved? By starting with the human experience, we begin to point towards new possibilities and move the conversation away from what we have to give up, and toward what we will create. Living Climate Change is a place where we hope to explore the future through design thinking. ... No doom and gloom. No political agendas. Help us expand the conversation."* (www.livingclimatechange.com)

3.2 TU Delft practicum set-up

The practicum was modeled after IDEO's approach, with scenario building as the main method and the development of storyboards and movies as deliverables. The practicum ran over a period of nine weeks, from November 2009 – January 2010, with a workload of 2.5 ECTS (European Credit Transfer and Accumulation System), which amounts to 70 hours of student work. A total of 40 contact hours were planned in a workshop room with two TU Delft tutors present and available for questions and guidance. Nine teams of five students participated in the course, which was part of the minor Sustainable Design (a TU Delft elective 30 ECTS course). Pascal Soboll from IDEO spent approximately 12 hours with the students on three different occasions in the course of the practicum, explaining the Living Climate Change project and commenting on their work in his role of visiting critic. The

students who participated in the minor Sustainable Design had mixed TU Delft backgrounds, but they were all quite aware of environmental problems and strongly motivated to create sustainable solutions.

The assignment given to the students is summarized in table 1.

Focus on a future not too far away (2030 - 2040).
Define the path you want to follow. It is important you choose a topic/area/activity that you feel is relevant and interesting.
Get as close to being experts on your topic as you can - quickly! Find experts and talk to them. Look for recent scientific papers.
Develop hypotheses and questions. Ask yourselves, for instance, 'What if harvest failures due to climate change are the order of the day in 2040? How would that impact our food system and our dietary habits? How will we eat in 2040?', etc.
Instead of simply answering these questions, develop stories. Use personas in your stories and let them live in your imagined future.
Take your hypotheses, questions and stories to the experts. Put your ideas to the test and incorporate any changes.
You now probably have 'big stories'. It is time to narrow these down, and focus on a manageable 'chunk' of the future. Develop two storyboards for this (we make it by managing change/ we don't make it and manage consequences). These have to involve people (personas) and show a facet of life in the future.
Media selection. In parallel with the development of your storyboards, decide how you will animate the story (audio and video).
Start production.
Test your animations (dress-rehearsal).
Release!

Table 1. The assignment (step by step)

3.3 Intended learning outcomes

The Living Climate Change practicum had four intended learning outcomes, which will be discussed in some detail in this section.

- 'The students should be able to apply design thinking to a seriously complex problem such as climate change.' This learning outcome built on the student's basic knowledge of climate change (and sustainability in general), which was addressed and discussed in two earlier courses in the minor Sustainable Design. It also gave the students the opportunity to continue the development of their design skills – an ongoing learning

process, for both the design and the engineering students in the course. By addressing climate change directly and asking students think of realistic future scenarios, we wanted to make the 'big' issue of climate change come to life. This, we hoped, would help dispel the notion of helplessness or de-motivation we sometimes noticed, and inspire a positive, opportunity-seeking attitude. The involvement of IDEO served as a powerful motivator and provided the necessary authenticity.

- 'The students should be able to translate their ideas into realistic future scenarios using narrative techniques'. This learning outcome required the students to use basic scenario-building skills. The students had received no prior training in scenario building, but the tutors were confident that their design knowledge and skills would enable them to quickly grasp the essentials. In general, scenarios are distinguished from other methods by both systems thinking (in contrast to linear thinking) and taking into account multiple futures (in contrast to one future). (Mietzner, 2005).
- 'Make competent use of expertise and scientific data.' The tutors expected the students to have little difficulties finding their way to the right experts and scientific literature, as this had been part of their academic training for over two years.
- 'Develop storyboards and short video animations based on the future scenarios.' In the tutors' perceptions this was the most challenging learning outcome. It was quickly established that the students had hardly any experience in making storyboards or animations. After some discussion we decided to keep the movies as a deliverable, because we felt that these (irrespective of their visual quality) were an integral part of the assignment, for without them the students would be denied the opportunity to present their ideas and narratives in a coherent and persuasive way. Care was taken to create teams that had at least one student with some competence in this area. We asked the students to build on their drawing skills, and told them that crude movies (like basic stop-motion) were acceptable.

4 Practicum results

The results of the Living Climate Change practicum (18 movies of roughly 2 minutes each) covered a wide range of topics, ranging from the 'green' 2028 Amsterdam Olympics, to water shortages in China, to large-scale bee farming, to smart systems for helping us manage our kitchen gardens and alleviate food shortages, to a resurgence of a secondary economy of repair and recycling shops, to a new look at tourism after massive sea level rise. The results were graded on a scale from 0 – 10, with grade 6 being the minimum result required to pass, 7 meaning decent work, grade 8 meaning good work and grade 9 outstanding. The nine teams scored between 6,8 and 9,5 with an average across the nine

teams of a grade 8. This is a high score, but not surprising given the enthusiasm and motivation of the students and tutors. In order to give a more detailed idea of the outcomes of the practicum, one pair of scenarios is described and illustrated in more detail: 'Spaghetti Bolognese' (available through <http://www.youtube.com/watch?v=9R7jWIKywcl>).

- Don't make it: this movie shows the forced adaption to frequent food shortages; crop failures are caused by droughts and extreme weather events. All fresh food is preserved (canned) and stockpiled in case of shortages. Supermarkets therefore only sell canned food, and year-round availability of basic crops (for instance onions) is no longer guaranteed (figure 1). Meat has been banned altogether. Instead, people buy meat replacements. Artificial flavorings are used to capture some of the 'old' taste of beef, chicken, etc (figure 2). Naturally, a lively black market in homegrown crops has sprung up. Manure and food waste are considered valuable commodities, these are collected and used for the production of biogas to powers vehicles (replacing fossil fuels).

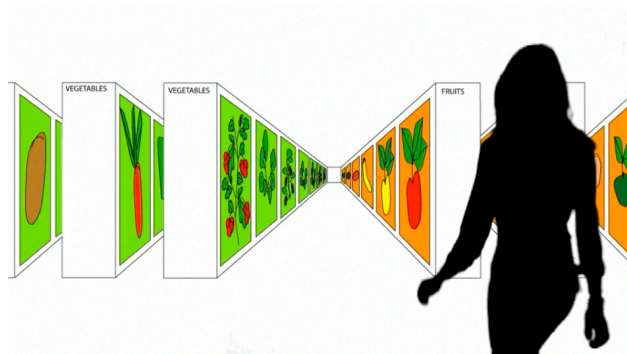


Figure 1: Supermarkets only sell canned food



Figure 2: Artificial flavorings for meat replacements

- Make it: the movie explains how new values regarding food come into place to alleviate the effects of climate change. Almost all food is now grown locally, for instance in urban farms, and a nutrient retrieval system is in place with the aim to close the (local) nutrient cycle, thus reducing the dependence on fossil fuels for transportation and artificial fertilizer. All citizens are obliged to participate in this system. In fact, you cannot buy food unless you bring back nutrients (i.e. compost) to the store (figure 3). Meat is still available but it is rationed through a 'meat credit system', leading to a lively credit transfer among people (figure 4).



Figure 3: food is grown locally (the bucket contains compost to be exchanged for food)

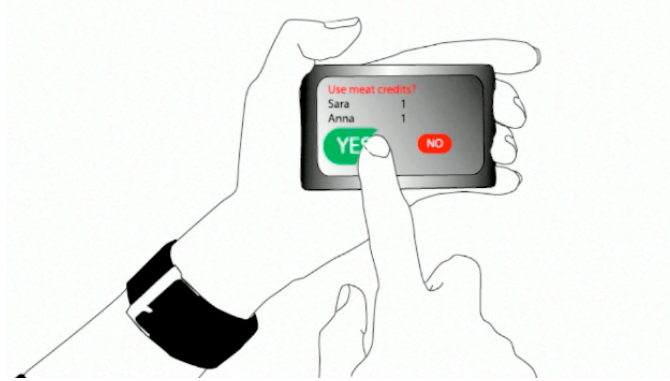


Figure 4: transferring meat credits

In June 2010 this team was given the 'Living Climate Video Challenge' award (<http://www.design21sdn.com/challenges/23/entries/9555/gallery>).

5 Conclusions

How effective was this practicum? In this practicum effectiveness was defined as the extent to which the intended learning outcomes were achieved, the time needed by the students versus time allocated, and the appreciation and usefulness of the course as perceived by the students based on oral and written evaluations.

5.1 Coping with complexity

For designers, coping with complexity is nothing new. Design is by definition complex and involves the integration of technological, physical, economical and other constraints. The step-by-step assignment (table 1) was meant to help the students frame the problem at hand. They were asked to focus on a region and an aspect of daily life (for instance preparing a meal, visiting a sports event, going on a touristic outing, buying stuff). Next, they had to decide which of the possible effects of climate change they wanted to address. The result was a short statement framing the problem and the approach the team wanted to take: "We want to focus on how future water shortages in China (due to melting Himalayan glaciers) may affect people's daily lives".

By framing, the students reduced complexity without over-simplifying (see for instance Dorst, 1995). It also allowed them to pursue a topic that was in line with their personal view on climate change. All teams developed this 'problem statement' for their scenarios, although some needed several attempts to arrive at a fruitful one (i.e. a statement that allowed for rich exploration).

5.2 Developing scenarios

The next step, and arguably the most difficult one, was to predict how the effects of climate change would impact the chosen practices in 20-30 years time and to design two plausible and juxtaposed scenarios. Understanding the potential impacts of climate change required the students to do background research and consult experts (see also paragraph 5.3). Developing the scenarios required a creative leap: What are the general storylines? Who are the main characters? Where are the stories situated? How can we visualize these best? How do we make the stories interesting and realistic? In the first weeks of the practicum most time went into answering these questions. Based on our observations (during tutoring) we saw the student teams use several approaches:

- Extrapolation of existing trends in order to get a feel for the future 20 or 30 years from now; for instance with regard to sea level rise, glaciers melting, the consumption of resources.
- Exaggeration for narrative effect; for instance assuming massive sea level rise, global resource and commodity shortages, extinction of species.
- Use of metaphors and analogies. In the Spaghetti Bolognese scenario, for instance, the bucket with compost is a metaphor for the local closed-loop nutrient cycle.
- Use of humor. This is always a good technique to make a story entertaining, and the students made good use of it.
- Creating open ends (by not filling in every detail) in order to create a sense of curiosity and a starting point for new ideas. Figure 5 for instance makes us wonder: how does this 'food bio-printer' work, and what are those canisters for?



Figure 5: Open ends: what are those canisters for, exactly? (Movie: 'Eating the Future')

- Layering: many teams started with a relatively simple story, and then added layers of complexity in order to make the story more realistic and to address the diverse effects of climate change. In one scenario ('To Bee') the story starts with the simple image of a bee pollinating a flower, and then goes on to explain the large scale effort to breed bees, as

climate change and pesticide use have led to near-extinction of the species. Another layer of complexity is added when it becomes clear food is now grown locally, leading to less abundant harvests and a rigorous rationing scheme.

- Juxtaposition of scenarios. The students struggled quite a bit to develop two related storylines that looked at the same topic from different angles (make it, don't make it). It was tempting to simply negate a positive scenario in order to arrive at two contrasting stories, but this usually resulted in a utopian and a desperate story and made for rather dull and unrealistic storytelling. The solution was to introduce subversive elements in the 'make it' scenario, and positive elements in the 'don't make it' story. The students needed to realize that people are very good at adapting to new circumstances. New behaviours quickly become routine. Situations that seem absurd or uncomfortable today may be the norm in 20 or 30 years. And whatever future we find ourselves in, some people will always try to sabotage 'the system'. Not all teams managed to translate these insights into their narratives, but those that did consistently received higher grades.
- The human element. For many student teams this was perhaps the hardest part: how to find the right human touch-points, how to give a good feel for what living with climate change will be like. The teams were clearly more comfortable thinking about technological solutions, and this comes through in most (if not all) movies. However, after several prompts by the tutors, most teams managed to introduce a bit of the 'messiness' of real life into their narratives, for instance when the smart management system for the kitchen garden (Foodmanager 3000) gets hacked by an eight-year old in order to double his quota for pineapples ('Eating the Future' scenario).

5.3 Use of expertise

The tutors were too optimistic in assuming that the students would be able to handle expert information and scientific data competently. The students' academic attitudes and skill sets were clearly in need of development. We were struck by their uncritical use of internet sources and by their being unable to distinguish good from poor internet information. As far as we're aware, they didn't read books or journal papers, but they did readily absorb information from films and documentaries (for instance 'An Inconvenient Truth' by Al Gore). Also, it took quite a bit of pushing from the tutors to make the students contact experts (from knowledge institutes or other universities). In making them call people for interviews, we obviously forced them to step out of their comfort zones. However, once they had connected to an expert they were often enthusiastic about what they'd learned.

5.4 Storyboards and video animations

Even though the students had never developed storyboards before, it turned out they had little problems making these. They could easily build on their drawing skills, and their knowledge of comic strips (figure 6).

Developing the narrative, however, proved to be much more challenging. In paragraph 5.2 the approaches used by the students are explained in detail. Coming up with stories was not very difficult, but giving these stories a life-like quality, with characters they could identify with, was hard. The other major challenge was to build two contrasting scenarios around the same storyline without falling into the 'black and white' trap.



Figure 6: Example of storyboard (Movie: 'Eating the Future')

5.5 Time spent

The students were not required to record the hours spent, but during evaluation they reported very long hours (much more than allocated; up to 60 hours) learning and using the relevant software for movie production. As tutors we would have preferred to see the students spend more time on background research and the development of the narratives, and would have been happy with less proficient movies (which we repeatedly told them), but obviously the students chose to spend their time developing their movie-making and presentation skills. Although there was quite a bit of complaining about the time-consuming

nature of the movie-making process, we had the impression that the students actually enjoyed acquiring these new skills and felt proud of what they had achieved in the end.

5.6 Appreciation

It was no surprise that this practicum was highly appreciated by the students. In particular, they valued the opportunity to meet and work with IDEO.

5.7 Overall conclusions

In terms of achieving the intended learning outcomes this practicum was effective. Taking into account that we had a team of highly motivated students, this practicum offered them (perhaps for the first time) a method for relating the potential effects of climate change and other sustainability topics to their own everyday lives, and imagining how their lives might change in the future. This sometimes led to lively debates in the teams, with the students engaging in (much needed) cultural critiques, for instance related to our consumption culture. The students also learned that the future, no matter how dire it may look, would offer opportunities for innovation, for fun, for making life meaningful. We can only hope that this positive message will stay with them throughout their future professional lives.

The presence of IDEO served as a motivating force, but perhaps even more importantly, it also legitimized the students' engagement with the topic of climate change. IDEO leading the way made it 'ok' or even 'cool' to work on climate change.

The practicum was less effective in that it all teams spent more time than allocated, in particular for movie production. This raises the question whether such skills shouldn't be taught as regular part of the bachelor design curriculum. Also, the third year bachelor students were more inexperienced with academic inquiry than we had expected. We hadn't foreseen this and hadn't planned on giving specific guidance here.

6 Recommendations

The Living Climate Change practicum was a one-off. A repetition of the same practicum in a similar set-up is unlikely for various reasons, and so we would like to ask ourselves what we have learned that may be useful for other sustainability courses in technology education.

- Authenticity is a key quality to look for in such courses. Working with people from business, with design professionals and with experts in the field gives a course the necessary grounding in reality, a feel for the 'state of the art' in a certain field, and it helps legitimize the students' efforts. Whenever possible, such collaborations should be encouraged in sustainability-related courses.

- Building plausible future scenarios is a very good way to engage in strategic topics and to address complex, abstract and intangible problems (like sustainability). It is recommended that scenario development becomes a part of engineering and design students' basic skill sets.
- Given the importance of multimedia presentations in today's demanding corporate environment, it is important that design students learn the basics: how to develop a good narrative, how to make a storyboard and how to animate these storyboards. The inordinate amount of time spent in this practicum on acquiring these skills raises the question whether such skills shouldn't be taught as a compulsory part of the bachelor design curriculum.

Finally, this practicum highlighted the need for constant renewal in education: with the many challenges facing the world today it is important that the engineers and designers we educate have a 'long view', i.e., that they are able to move beyond everyday small problems and look at the bigger picture. This will make them better equipped to deal with a dynamic and ever-adapting world. As a consequence, our education needs to be equally adaptive and dynamic, and we need to seek innovative ways to engage students with topics of global importance (i.e. the Millennium Goals: <http://www.un.org/millenniumgoals/environ.shtml>).

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