Raising Awareness about Extreme Rainfall through Gamificiation

Abstract
Due to climate change, extreme rainfall events will occur more in Amsterdam in the future. At the moment, Amsterdam's citizens are not aware about the damage these extreme events could cause. Because water management during these event ask for a shared responsibility, the tragedy of the commons implies on this issue. In this research, the influence of gamification and persuasive design on the citizens awarenss will be investigated by testing the game Heroes of Rain. Before the game, a survey has been carried out, which has been compared with the experiences of testing the game. While testing the game, it was noticed that the players started a conversation and their awareness increased. This corresponds with the theory that information exchange raises awareness, because games need to apply on real life.

Introduction

As many people might already know, there is a change happening in the earth's climate, the changes are making societies more vulnerable. Due to this climate change, extreme events are more likely to happen, however, exact effects differ at a regional scale (IPCC, 2014). In the Netherlands, the temperature increased with 1.7 degrees during the 20th century (PBL, 2012). The amount of precipitation increased with 21 per cent and together with the total amount, the intensity of rainfall increased as well (IPCC, 2012; PBL,2012). This can be noted from the fact that 7 of the 10 most extreme showers since 1951 happened over the last 20 years (Kluck et al. 2013).

Precipitation is at the moment the highest in the coastal provinces, the Veluwe and the South of Limburg (Wijngaard et al. 2009). From 1951 till 2009 extreme rainfall increased the most in coastal provinces (Buishand et al. 2011; PBL, 2012) and there are scenarios for the future that state that this increase in heavy rainfall events in the coastal provinces will continue in the future (KNMI 2011; PBL 2012).

On the 28th of July, 2014, such a heavy rainfall event occured in Amsterdam and caused 70 million euros of damage to private properties (Amsterdam Rainproof, 2015). Because there are many paved areas in Amsterdam and there are little elevation differences, the drainage system had to handle this extreme shower (Kluck et al. 2015). Amsterdams drainage system is accounted for 20 milimeters per hour (Kluck et al. 2015) and is therefore not able to handle a shower with a higher intensity (e.g. the cloudburst of the 28th of July, 2014). Therefore, the rainwater has to be stored in public and private areas.

However, awareness about these extreme rainfall events is relatively low among the citizens of Amsterdam. The managament of Natural hazards like extreme rainfall events is considered as a 'commons problem' by scientists (reference). Waternet, the company that takes care of the whole water cycle in Amsterdam, set up the programme Amsterdam Rainproof, in order to raise awareness for this topic and to tackle the commons problem.

At the moment, gamification and serious gaming are becoming more popular methods to raise awareness and engage people (Thiel, 2015). Gamificication is used as method to influence behaviour, enhance motivation, improve engagement by applying game metaphors (Marczewski, 2012). It has been used for a long time as for example grades in schools and parents rewarding children for preferred behaviour (Nicholson, 2016). It is also called serious gaming, gaming with real data. In this paper, gamification will be analysed together with persuasive design, a way of design which attempts an action or behaviour (Fogg et al. 2007), i.e. becoming aware of the extreme rainfall events.

Therefore, the main research question of this paper will be: *How do persuasive design and gamification affect the level of awareness and engagement of citizens of Amsterdam about and in the common's problems of extreme precipitation?*

This research question has been divided into separate subquestions.

1. How does the commons problem apply on heavy rainfall events?
2. What influence does gamification has on awareness and engagement?
3. What influence does persuasive design have on awareness and engagement?
4. What was the awareness before and after the game?

Methodology

In order to be able to answer the research questions above, several methods have been used. First of all, a literature study was carried out to provide an insight what awareness and engament are, how persuasive design works, what the commons problem is and how it applies on natural hazards and what gamification is. Then this information has been applied to the case study of Amsterdam Rainproof. During the building of the game, several surveys were taken about awareness and engagement about heavy rainfall events and analysed. After the game has been built, the game was tested and the surveys were taken another time. The reactions of the people who played the game and te results of the second survey were analysed and then compared with the results of the first survey. These surveys will try to measure awareness and engament. Measuring awareness through surveys, have been found a good method to measure awareness according to research from e.g. the South-East Digitial Television (2012) European and Enami & Safipour (2013).

Results

Tragedy of the commons

Garrit Hardin (1968) defines the tragedy of the commons as a problem where nobody thinks about the limits public space has, because they believe in 'freedom of the commons (i.e. public space)'. They only try to get as much profit from that space, although they exhaust that space. Commons problems mostly can be prevented with governance, the implementation of boundary rules who can use it, how much and when (Ostrom, 2008).

In natural hazard management, cooperation to cover losses lacks in many places over the world, because individuals do not feel responsible. Everyone has benefits by contributing in risk management, but this contributing does not create direct gains (Weichselgartner & Obersteiner, 2002). However, when a natural hazard occurs, a big part of the community experiences the losses. Thus, community engagement can reduce vulnerability and the community will be more resilient against natural hazards (Abramovitz et al. 2001; Thompkins & Adger, 2004).

Awareness and engagement

Awareness means '*knowledge that something exists; understanding of a situation or subjects at the present time, based on information or experience*' according to the Cambridge dictionary (Cambridge Dictionary, 2016a). Awareness in this case is the knowledge, obtained from information or experience that heavy rainfall events in Amsterdam will occur more in the future and will cause problems and damage.

Engagement is something different from awareness, it is more, Cambridge Dictionary (2016b), describes engagement as '*the fact of being involved with somehting*' engaging someone is '*to interest someone in something and to keep them thinking about it*'. In this case, engagement means that the citizens also rainproof their houses.

Gamification and awareness

By using gamification in awareness raising, desired behaviour is rewarded, what shows which behaviour the player should have (Lawley,2012). If the learning process has been gamified right, the learning process can be enhanced and people will get aware (Lawley, 2012).
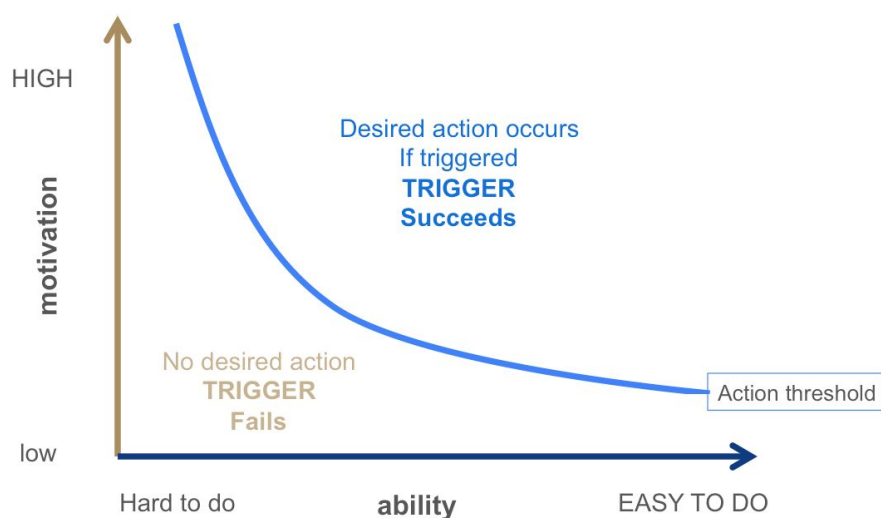
This can also be decribed in the seven doors model that shows the way from not being aware to long lasting behavioural change (Robinson, 1998). In order to raise awareness and to engage people, all seven steps must be completed. A game must show all elements, from providing knowledge about the problem, explain how the player could act in real life to showing that it was a succes (Liu et al. 2011). The positive feedback loop the model creates, will cause the change in behaviour (Liu et al. 2011). The model is not a closed circle, because the behaviour of the player already changed. However, the player can convince others to play, which means that they are the 'educator', and more people will get aware and will be engaged (Sayers, 2006).

Persuasive design and awareness

Gamification does not work on its own, according to Lawley (2012), in order to get the desired effect, the game must also include good game design. Persuasive design is a way of designing that can influence peoples behaviour (Fogg, 2009). The FBM model by Fogg (2009) includes three components: motivation, ability and triggers to reach target behaviour. According to this study, people have mostly a small level of ability and motivation, the task for designers is thus to increase the motivation and ability. However, most of the time, it seemed that making the behaviour less difficult (increasing ability) increased behaviour performance the most (Fogg, 2009). The third factor is the trigger, which is either a spark, facilitator or a signal, when timed well calls to action (Fogg, 2009).

Behaviour = ability + motivation + trigger

HIGH

motivation

Desired action occurs
If triggered
TRIGGER
Succeeds

No desired action
TRIGGER
Fails

Action threshold

low

Hard to do   **ability**   EASY TO DO

Heroes of Rain game and awareness

Before the game had been made, a survey was carried out among citizens of Amsterdam. This section will shortly explain the main findings. 32 per cent out of 76 respondents thinks that it rains more often and more intense and 74.7 per cent had never heard of Amsterdam Rainproof. 73.3 per cent has never had any damage from heavy rainfall events. 70 per cent replied to the question 'Do you think heavy rainfall events are bad?' with 'not bad at all' or 'not so bad'. Besides that, 78.8% had never taken rainproofing measures before. Also, 43.8 per cent did not hold the resident of a house as responsible to make the house rainproof.

After that, four more in-depth interviews have been done with citizens from Amsterdam. Three of them do not own a house and do not hold themselves responsible for rainproofing their house. However, they would like to have more information about what they could do as a tenant to make their house more rainproof. The houseowner had had damage before, and thinks rainproofing houses is a shared responsibility, secondly, the houseowner said that he lacks knowledge about rainproofing his house.

During the event FabCity, the game 'Heroes of Rain' has been tested among visitors of the event. The aim of the game is to rainproof your house in five minutes, which you can do with answering quiz questions about rainproofing, climate change and Amsterdam Rainproof or with the 'trial and error' method. After testing the game, everybody from the test audience (8 people) started a conversation, either with their test partner or with the researchers about the topic of a water resilient city.

Discussion

The results, explained in the previous section showed that almost half of the respondents showed thinks they are not responsible for water damage in their house during heavy rainfall events. Also, a majority of the respondents answered that they have never taken any rainproofing meassures. This illustrates the tragedy of the commons problem as explained in Hardin (1968). In the game, the commons problem has been tried to be tackled by adding boundaries and providing ownership rights to the virtual houses. Ostrom (2008) stated in her study about managing the tragedy of the commons that giving the citizens ownership rights and creating boundaries will make people more responsible for their land.

Secondly, the seven doors model has been applied in the game Heroes of Rain was well. The quiz element, as described by Robinson (1998), is the first door, i.e. knowledge. The second door is desire, it is the desire for a different future, to make people able to pretend a different future (Robinson, 1998). The players can pretend a differnt future, because the game Heroes of Rain simulates this different future. After that, the player experiences in the game that he has the ability to install rainproofing measures (by trial and error or the quiz) and that it pays off, this are the third and fourth door. Then the player sees that it is actually quite easy and gets stimulated and rewarded in the fifth and sixth door (Robinson, 1998). When the game ends, the player sees that he reduced damage of the Copenhagen cloudburst and sees that it was a success.

The persuasive design elements that have been used in the game are the following: the ability of the game is high, which means that it is simple to install rainproofing measures. Besides this, there are not many choices, therefore, figuring out what to do is simple as well. This will work in reaching the target behaviour (i.e. finding out that rainproofing in virtual and real life is easy), because in persuasive design, making it easier to reach the target behaviour will make it more likely that the people reach that target behaviour (Fogg, 2009). The trigger that is needed to make the player take action is a spark in this user experience. The spark is the trigger that raises motivation in this case, for the game, the spark is fear, because the game works towards the Copenhagen cloudburst.

A persuasive game should be realistic and interesting, according to the study of Amir and Ralph (2014). Secondly, enjoyment and exitement play a major role in convincing a player to take action and aquire the learning outcomes (Ginnakos, 2013). Multiplayer games have more interaction than single player games (Soute et al. 2010) as a result of this, the players experience peer pressure (Liu et al. 2011). The interaction and peer pressure can enhance the learning effect.
Before the game, the results of the survey stated that the citizens from Amsterdam were not aware about the possible damages of extreme rainfall and the solutions for the problem. After the game they started a conversation about what they had experienced and what they could do to make their properties more rainproof.

However, measuring awareness is difficult. After the game, the players all started a conversation with either us or the other players. Telling each other what they have already done will help more in getting people aware then telling people what they should do (Tannenbaum, 2013). People do not want to be different, so if in the conversation somebody says 'I rainproofed my house' it will be more then norm and it will be more likely for others to do so too (Tannenbaum, 2013). Conversations are exchanges of information and therefore they raise awareness (Dullemond et al. 2010).. According to the Game-Based Learning Elevation Model (GEM), a serious game will meet the learning outcome (i.e. raising awareness) if the player can reflect on the topic in the private world (Kiili, 2004).

Recommendations for further research are going on with testing this game, because more measurements will make the findings more accurate and precise. Doing the same survey after the game as the survey in the beginning and comparing these results can also provide better and more results. However, this research could be seen as a pilot study that tests the possibility and chance of succes of this method of raising awareness among citizens in Amsterdam about extreme rainfall events.

Conclusion
Currently, the citizens of Amsterdam are not aware about the damage extreme rainfall could bring to their properties, as found out with the survey. The game works via the 7 doors to engagement cycle

and Fogg's behavioural change model for persuasive design. The game is increases the ability for people to rainproof their house and has a spark trigger, which motivates them to play the game. After the game, there was noticed that the players started discussing what they had just done in the game. This is the reflection of the game in the private world. Comparing the observations we got during the testing of the game with the models and literature, there could be said that gamification and persuasive design used in this form have a positive influence on the awareness of the citizens of Amsterdam.

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