Climate persuasive services: changing behavior towards low-carbon lifestyles

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ABSTRACT

ICT has reshaped our society, and with the current accelerating development of technology, and its wider distribution throughout the globe, they will continue doing so even more. These changes in society are important for sustainability. They affect the physical way the society and the environment interact, but they also affect the way people think, learn and behave.

We suggest that the persuasive power of ICT can be oriented towards climate change. For this purpose we define the concept of "climate persuasive services" as ICT applications that change personal attitudes regarding climate change and/or change behavior towards reducing greenhouse gases emissions. We consider mobile phones, pervasive sensors and social media as three key technological drivers for the development of climate persuasion applications.

We have analyzed the use of persuasion principles in existing web and mobile applications forming three clusters: tracking carbon footprints, sharing goals and making green behavior easier. Based on this analysis, we suggest a more planned use of persuasive principles, and propose six different opportunities for improvement.

Categories and Subject Descriptors

H.5 [**Information interfaces and presentation**]

K.4 [**Computers and Society**]

General Terms

Measurement, Design, Human Factors

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Keywords

Climate change, carbon dioxide emissions, media technology, social media, ICT, persuasion, captology.

1. INTRODUCTION

We live in a networked society. Information and communication technologies, such as desktop computers, mobile phones, laptops, software, Internet, and smart appliances, have transformed the way our society works [1].

At the same time in the last decades the world is experiencing many signs of environmental decay and collapse. We are depleting natural resources, changing the climate, polluting the air and the seas and driving many species to extinction. The world ecosystems are not feeling good [2], and we are the culprits.

As a response to these problems, the concept of sustainability emerged in the UN Conference on the Human Environment held in Stockholm in 1972, and from then it has slowly reached the political and social mainstream. The most cited definition of sustainable development comes from "Our common future" [3] report: "to meet the needs of the present without compromising the ability of future generations to meet their needs". This intra and intergenerational equity is reached by bringing together social, economic, and environmental factors.

One of the most pressing sustainability issues is global warming. This refers to the earth-wide climate system change, due to increased greenhouse effect created by human emissions. The warming of the global climate system is now unequivocal, with increases in global average air and ocean temperatures, melting of snow and ice worldwide, and rising average sea level [4]. Carbon dioxide is the most important anthropogenic greenhouse gas and the primary source of its concentration increase is fossil fuel use [4]. The use of fossil fuels is pervasive in our lifestyle, from fueling the cars and planes we use, heating or cooling our homes, or in almost every step in the process that brings food to our plates.

In this work we focus on mitigating climate change, because of its sheer importance for global sustainability, but also because it can

be seen as a representative example of environmental problems arising from the current societal system and lifestyle[1].

With these two changes in society (ICT development and sustainability) as starting points we want to analyze and find the nodal points where they meet. Many research questions emerge from there: How can this transformation potential of ICT be used towards sustainability? Can technology be used to change our attitude and behavior towards a low-carbon lifestyle? How is it used already? How can it be improved? We will use captology and persuasive principles to answer some of these questions.

2. THEORY

The aim of this work is to make an overview of persuasive ICT applications for sustainability, and in particular for climate change. Our objectives are:

- To place persuasion in a general framework of ICT and sustainability.
- To identify representative examples of ICT applications that use persuasive techniques towards reducing greenhouse gases emissions.
- To propose a definition of "climate persuasive services" based on captology theory
- To discuss how these services could result in behavioral change through the application of persuasive principles.
- To raise future research questions in this area.

2.1 Computers as persuasive technologies

Social influence tools as reciprocation, social proof, commitment, consistency, authority, liking, and scarcity [5] are important in the way individuals behave as part of their social context. They provide trigger features to make behavior more efficient. These features can be used to help changing attitudes and habits towards personal goals, such as stopping smoking or exercising more often.

Captology, the study of computers as persuasive technologies, brings together persuasion with the use of ICT. It provides a framework for studying the use of information and communication technologies for changing attitudes and behavior without coercion or deception [6].

In the case of climate change there are the clear goals of increasing awareness and reducing personal emissions. We will explore how ICT as persuasive technology can be used for that purpose.

2.2 Framework

Our research around climate persuasion is part of a more general research of the convergence between ICT and sustainability. In this interdisciplinary area we have identified four main opportunity areas:

- **Persuasion**: Using ICT to increase awareness and change human behavior.
- **Optimization**: ICT applications that improve the efficiency of different systems, from electrical grids, houses to traffic.
- **Dematerialization**: Using ICT for eliminating or reducing the need of physical material in a given activity.
- **System changes**: Second order effects of ICT as it affects the way society works.

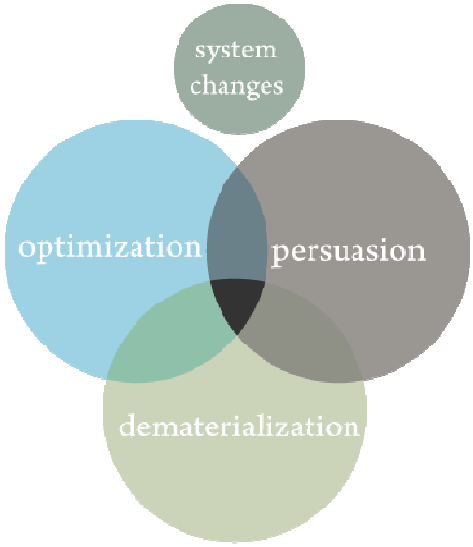

Figure 1. ICT and the environment; opportunity areas.

Persuasion has come to be one of our main research interests, and we suggest that changing behavior is a pre-requisite for reaching sustainability and mitigating climate change, and that ICT can play an important role in this.

2.3 Key technologies for climate persuasion

There are a number of technological trends that are central for the previously mentioned opportunity areas. For climate persuasion there are three technologies that we identify as key: mobile devices, pervasive sensors, and social media.

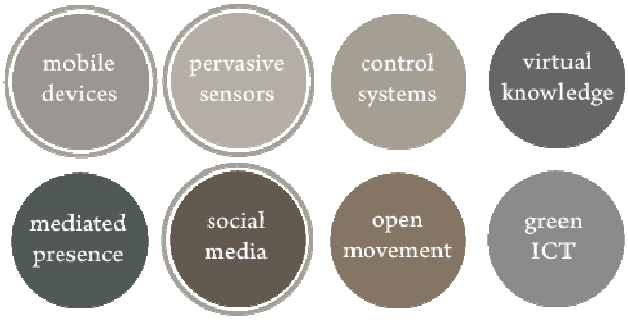

Figure 2. ICT and the environment; key technologies.

[1] In this text we will use the terms "global warming" and "climate change" as synonyms. With sustainability we will refer to solving the global warming problem. We use carbon dioxide to refer to all greenhouse gases emissions.

Mobile devices

Mobile phones enable pervasive use of applications, everywhere, every time, by (almost) everybody. More than 60% of the world population has a mobile phone, and many more have access to one[2]. It is the most widespread technology in the world. They are devices we always have with us, and are there when we need them. They can act as a pervasive concierge, coach and entertainer [7]. These advantages make mobile phones a powerful device of persuasion [7].

It is also worth mentioning that mobile phones have a small impact on climate change. One year's average GSM subscription including all life stages (from mobile production to base stations energy use) is calculated to be around 25kg CO_2, equivalent to driving an average car for one hour on a highway[3].

Pervasive sensing

Sensors are getting smaller, cheaper, and more pervasive. They are used in a wide range of environments from buildings to personal electronics and mobile phones, and for multiple types of data-sensitive application. Geographical position, local temperature, nutrient level in the soil, atmosphere pollution, speed, user heartbeat, sunlight intensity, and animal tracking are all examples of data that can be made available by the use of sensors.

Geographical information is an example of sensor data that has become widespread and central to many applications. Electronic devices, systems, and users are aware of where they are, what's near them, how fast they are moving, where their peers are, and how to get to a desired location.

Sensing the world around us will enable to be us more aware of the environment, of the people around us, to make our actions accountable and visible, and to help us manage our environments and ourselves. One main step in changing behavior is to measure it, and to be able to track changes. Pervasive sensing provides the means to do this.

Social media

Social media is changing the way we communicate with each other and the way social movements organize. We are using them for many activities, from managing business contacts, finding old friends from college, discovering new music, dating, sharing pictures, to developing software. Social media put real people behind the data, allow us to cooperate, compete, and be recognized by peers, and by such means it is a powerful persuasion tool.

In the last years, the rise of mass social media tools such as Facebook, that increases the social impact to millions of users, has taken the possibilities of persuasion to a new level [9].

[2] This is the estimation from Informa Telecoms & Media in December 2008 http://www.informatm.com. For individual countries data can be consulted in the Millennium Development Goals database at http://unstats.un.org/unsd/mdg/Data.aspx

[3] This was an example in Jens Malmodin presentation of the life cycle analysis work at Ericsson. For more detailed information check the published LCA [8] or any other of his publications.

3. EXISTING EXAMPLES

With the previously mentioned key technologies as a starting point we present a sample of applications that uses persuasion principles for the purpose of climate change.

In opposition to more strict definition of Fogg, where persuasion is based on intentions, not on outcomes [6], we include examples that promotes low-carbon behavior using persuasive principles, even if climate change mitigation was not designed as a goal of the application.

They are clustered around three themes: tracking carbon footprint, sharing goals and making green behavior easier. It should be noticed that there are also other categories of applications that are worth exploring. The different clusters and examples are linked with the persuasion principles [5] at play, following Fogg's Captology framework [6].

3.1 Tracking carbon footprint

Being able to monitor personal carbon dioxide emissions is a first step towards reducing them. Measuring is needed to know the initial level of emissions and to track the generated change in behavior. There are some applications taking these measurements a bit further, facilitating the measurement, linking the results in social networks, and comparing the results between peers. They exploit mainly the following persuasion principles:

Principle of Self-Monitoring

Tracking their own behavior helps people to achieve a goal or outcome, in this case tracking greenhouse gas emissions with the goal of reducing them.

Principle of Reduction

Making the tracking of the emissions as effortless as possible to increase the persuasion to use the application, and then to achieve the goal.

Principle of Social Comparison

The users have a greater motivation to reduce emissions when they are given information about how their performance compares with their peers.

Principle of Social Facilitation

Not only comparison, the mere fact that they know they are being observed via the social media application, and/or they can see that other users are performing the same behavior together with them, helps the users to perform better.

3.1.1 Dopplr

Dopplr is an online service for frequent travelers. It lets you share your future travel plans with fellow travelers. It also reminds you of friends and colleagues who live in the cities you're planning to visit. You can use the service with your personal computer and mobile phone[4].

Dopplr is interesting because the system uses the accurate travel information their user's input for calculating their carbon footprint. This is a background process, meaning that the user do not need to make an effort to get environmental data, but it is just

[4] http://help.dopplr.com/faq/basics/

an added value to their main purpose, and explicitly not planned persuasive. As they put it:

> *"For a while there have been carbon calculators on airline websites and environmentalist websites, but generally they have been about directly showing the impact of an individual action, rather than the patterns and trends influencing the actions in the first place.*
>
> *That's why I thought it was an essential component from the start of Dopplr as a social tool for intelligent travelers to optimize their path through the world – […]*
>
> *It's not enforcing any particular course of action - it's the weighing scales, not the diet.*
>
> *What we all do with this information is up to us."*[5]

Even if not designed as a persuasive application, Dopplr has many characteristics that can change the user's behavior. It is a *tailored* application, providing personal accurate information of carbon dioxide emissions. All the data is available for *self-monitoring*, but it is also possible to share with other users and to watch other user's emissions and *compare* them with yours.

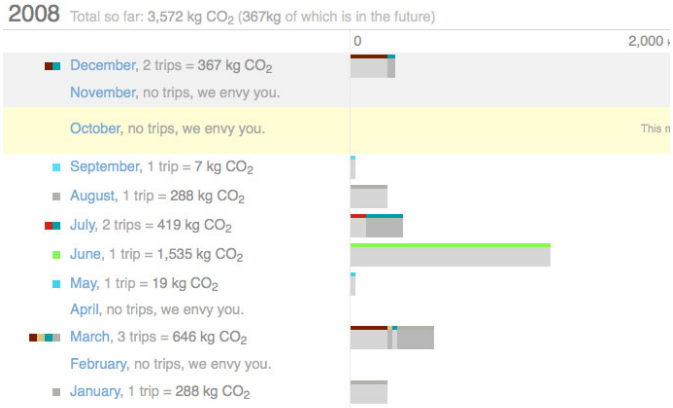

Figure 3. Screenshot of Dopplr CO_2 information.

3.1.2 PEIR[6]

PEIR (Personal Environmental Impact Report) is a sensing application developed at UCLA that allows you to use your mobile phone to explore and share how you impact the environment and how the environment impacts you.

It doesn't rely on demographics for calculating the carbon impact, but it uses location data from mobile phones to calculate a dynamic report of the environmental impact. It detects if the user is walking or driving and calculates the CO2 and particulates depending on the car model, the weather, the road type, the time of the day[7].

PEIR uses advanced *self-monitoring* but it also provides the possibility for sharing and *comparing* with other users, including via Facebook.

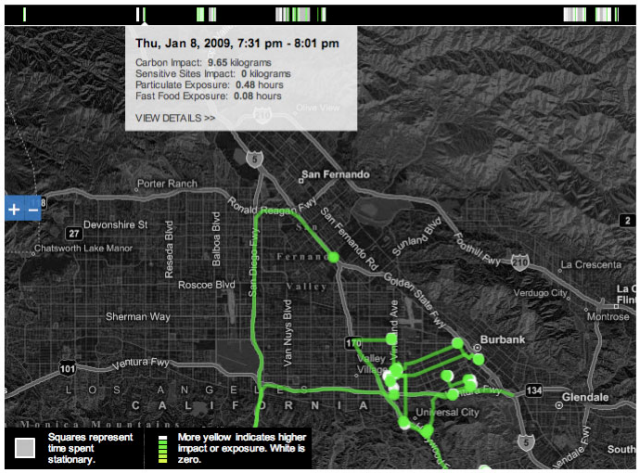

Figure 4. PEIR's web application screenshot.

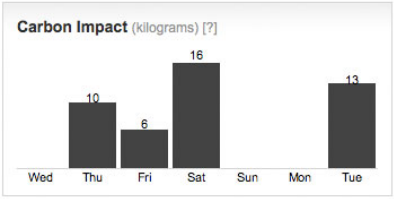

Figure 5. PEIR's web application screenshot.

3.1.3 Green virtual pet[8]

The green virtual pet is a prototype that connects the user's carbon behavior with a virtual pet that is always "living" in the user's mobile. The pet feels better when the users emits little carbon dioxide and worse when the user emits more. In the prototype the pet was a polar bear on an iceberg, and the water level changed depending on the user's emissions.

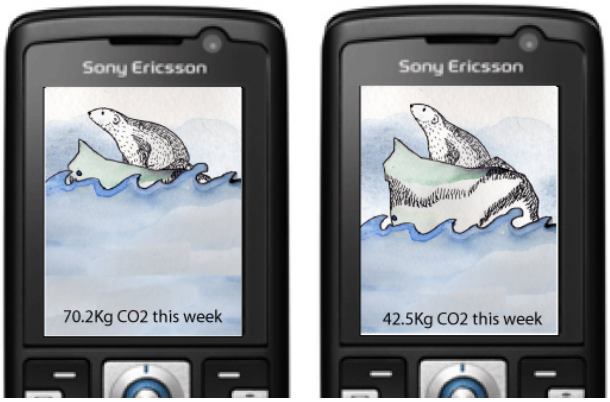

Figure 6. Green virtual pet concept.

[5] Matt Jones. http://blog.dopplr.com/2008/04/22/calculate-the-carbon-impact-of-your-travels-with-dopplr/

[6] http://peir.cens.ucla.edu/

[7] PEIR uses EMFAC model http://www.ysaqmd.org/EMFAC.php

[8] From the master thesis: ICT applications for a sustainable urban lifestyle. http://www.itsagreenmobileworld.com/research/Zapico_Palmgren_2008.pdf

3.1.4 *Mobgas*[9]

Mobgas is a EU Commission project that allows keeping track of personal carbon emissions. The user configures a standard day and needs only to log the "deviations", such as flying, or taking an extra car trip into the system. Having *self-monitoring* in the mobile phone enables to use it the moment the behavior is performed. An archive of emissions can be accessed online, together with a user ranking for enabling *comparison* and *competition* between users. Finally, tips for reducing emissions are provided.

3.2 Sharing goals ("you do, me too")

Climate change can be seen as a typical tragedy of the commons problem [10], where an unregulated common resource creates an incentive for each user to increase their share without limit, finally bringing ruin to all. Global warming follows this pattern; the common good (atmosphere, climate) is misused for the individual sake (driving, flying or eating fruit transported from the other side of the globe).

Persuasive applications can be used to break this dilemma, promoting collaboration for a common good. Using social media, climate goals can be set in public and shared by many users, users can help each other in how to change and make it happen together. By doing this there are some strong persuasion principles at play:

Principle of Social Facilitation

The users are more likely to perform well and achieve the goal of reducing emissions when they know they are being observed via the social media application, and/or they can see that other users are performing the same behavior together with them.

The simple act of sharing the goals with the public awake the "commitment and consistency" principle [5], and the users are more prone to stick to that goal.

Principle of Reciprocity

If the rest of the users have complied with the goal of reducing emissions, the pressure for also complying will be bigger.

Principle of Social Comparison

The users have a greater motivation to achieve the goal of reducing emissions when they are given information about how their performance compares with other similar peers.

Principle of Normative Influence

Social media can add peer pressure to increase the possibility that the user will adopt the goal. The principle of "social proof" [5] plays a big role. If so many people are also committing to these goals and complying, I should too.

Principle of Social Learning

The users will be more motivated to reduce their emissions if they can use the application to see how other users are reducing theirs (and being rewarded for it).

Principle of Competition, Cooperation and Recognition

The applications can use competition, cooperation and public recognition, to motivate the users towards certain behaviors and to achieve the goal of reducing emissions.

3.2.1 *43 Things*[10]

This is one of the first tools for online goal sharing. Users can create goals, share them with their peers, write about their progress, observe other people working toward the same goal and see their tips, even cheer up other users' goals.

"People have known for years that making a list of goals is the best way to achieve them. But most of us never get around to making a list. […] Make a list on 43 Things and see what changes happen in your life. Best of all it's a way of connecting with other(s) […]"[11]

43 Things site is being used by users wanting to reduce their carbon dioxide emissions. Users *commit* to the goals in public, *share* their learning process, and cheer each other *recognizing* the effort.

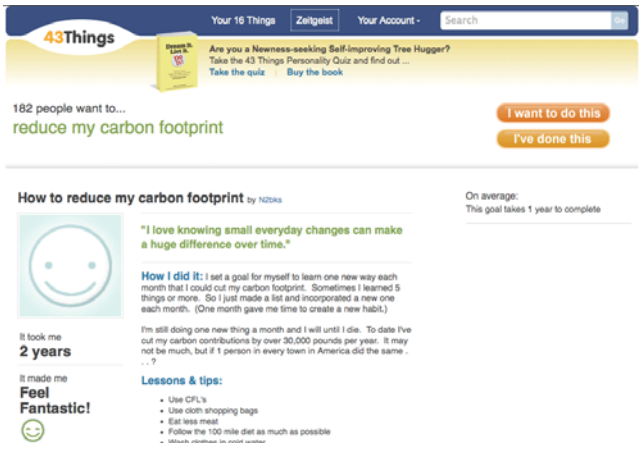

Figure 7: 43 Things: Reduce my carbon footprint.

3.2.2 *We are what we do*[12]

The central idea is to show that small actions by a lot of people can generate a big change. In this site they give you small actions, information of how and why they are important and advice on how to perform them. Once you've completed the action it can be marked as done and the action's counter increases. If you fly less maybe it doesn't matter so much, but if other 3049 people did it too, it is a big change.

This application create a *normative influence* by showing how many other people have done right. They are helping to solve the common problem, and a user should *learn* from them and *reciprocate* in their effort.

[9] http://mobgas.jrc.it/

[10] http://www.43things.com

[11] http://www.43things.com/about/view/faq

[12] http://www.wearewhatwedo.org

Figure 8. We are what we do[13].

3.2.3 *One million acts of green*[14]

A Canadian site that wants to persuade its users to do actions to reduce their environmental impact. It provides help on how to do the action and then it calculates the greenhouse gases saved by it. It is again based on *normative influence* and social proof but it also generates a mass cause-effect between behavior changes and greenhouse gases emissions.

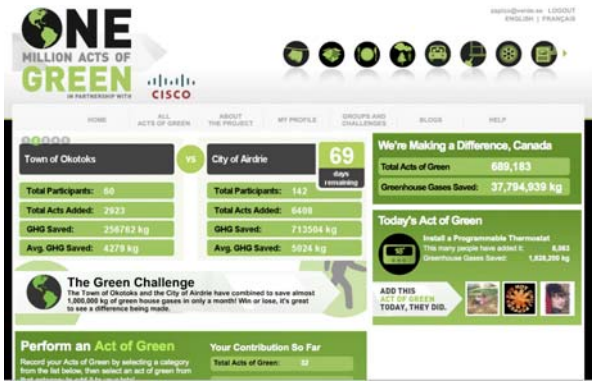

Figure 9: One million acts of green website.

3.2.4 *Eco-island*

Eco-island [11] is a game-like application developed by Waseda University, and it is designed from a persuasive approach. A family sets a common goal of carbon dioxide emissions that is linked to the water level of the island they inhabit in the interface. They need to cooperate to keep their island above the water level. If a member emits too much, other family members need to reduce their emissions to compensate, exploiting *cooperation* and *reciprocity*. There is also a system of trading between different islands, using a virtual currency.

Figure 10: Eco-island concept.

3.3 It's easy to be green

Choosing the low-carbon alternative instead of following the normal behavior requires effort from the user side. Helping in the decision and eliminating the extra effort by making the low-carbon behavior easier, increases the success of persuading.

Principle of Tunneling

Guiding the users through the process of different habits and persuading along the way.

Principle of Reducing

Making the act of reducing carbon emissions easier can persuade to change the user behavior towards low-carbon alternatives.

Principle of Praise

Used in combination with reducing, giving praise (text, images, sounds, symbols) to low-carbon behaviors can be perceived as encouraging.

Principle of Kairos

Offering suggestions at the opportune moment, where and when the user is making a decision.

3.3.1 *Turn off the house*[15]

The 'House-off' Switch is a conceptual switch that allows a user to turn off all non-essential electronic items in their home from a central switch. Push the button to turn your house on when you get home; push it again to turn it off when you leave. At the same time that it reduces the work for doing this task, it gives you a symbolic praise of doing the right thing.

[13] http://www.wearewhatwedo.org/actiontracker/action.php?action=1358

[14] http://green.cbc.ca/

[15] http://www.jackgodfreywood.co.uk/switch.htm

Figure 11: Turn off the house concept.

3.3.2 Public transportation

Personal car use is one of the actions with most impact in the individual carbon footprint. Choosing public transportation instead of a private car is usually more difficult; from not knowing which bus line to take or when it arrives, to not having cash to pay for it. There are ICT applications that help to make public transportation an easier choice, and therefore persuading to use it. One example is making payment effortless and fast using the mobile phone to pay with near field communication[16]. Another is to use mobile phones to easily plan the route and schedule[17].

3.3.3 Mobile flight offsetting

Nokia's we:offset[18] is a mobile application for Nokia telephones that allows you to offset your traveling directly from your mobile phone. It works in collaboration with Climate Care[19], that compensates emissions by investing in a variety of projects, from renewable energy, efficiency gains, to avoiding deforestation.

When the GPS-enabled mobile phone detects that a user has left an airport and appeared in a different one, the application calculates the carbon dioxide emission, presents it to the user, and has a shortcut for offsetting it (*reducing*). Finally the application shows a thank you message (*praising*).

4. CLIMATE PERSUASIVE SERVICES

We have gone through a variety of different services and the way they use persuasive techniques in a more or less planned way. We propose how a more conscious use of captology [6] and persuasion principles could help designing applications that are more effective creating behavioral change towards reducing greenhouse gas emissions.

For that we define the concept of "*Climate Persuasive Services*" as ICT applications that change personal attitudes regarding climate change and/or that change behavior towards reducing greenhouse gases emissions.

Climate Persuasive Services must use persuasive techniques in a planned way; as defined by Fogg, captology is based on intentions, not on outcomes [6]. The main persuasive goal of the service can vary, from promoting public transportation to reducing energy use or cut meat consumption. But there must also be an overarching purpose of reducing greenhouse gases emissions.

The reviewed existing applications have examples that can be defined as Climate Persuasive Services (as Eco-Island) while other that do not (as Dopplr). From both we can identify some general characteristics and opportunities that are important for the design of future Climate Persuasive Services. From these, we have some suggestions of important features and improvements:

Effortless, accurate, individual CO_2 data

Many of the applications mentioned base their carbon dioxide calculations, not on the individual behavior, but on statistical data. This can discourage the user and create a loss of credibility. Using specific data based on the individual behavior, as in PEIR or Dopplr, is recommended to exploit the *tailoring principle*. The increased accuracy of using behavioral data specific to the user for calculating carbon dioxide emission helps also to strength the self-monitoring principle. This has to be done in an easier way, effortless for the user, using the *principle of reduction.* Pervasive sensing technology can be used to create dynamic behavioral data. Data streams from electricity consumption, transportation routes or food shopping patterns, can be gathered without user effort.

Feedback for more responsibility

Augmenting the credibility of the data, by having real feedback of the behavior of the peers, can improve the *reciprocity principle* and help breaking the tragedy of the commons. If committing to a goal is not coupled with a mechanism to know if the goal has been achieved or not, the trust of others in the action can be jeopardized. As for enhancing tailoring, this can be solved by sensing technologies feeding real behavioral data into the system.

Normative influence

Many "green oriented" applications use a heavily niche-oriented design and concept. Using instead the power of *social proof* and *normative influence* could have a more powerful effect. Make the green behavior look normal, not the normal behavior look green [12].

Exploit a mass principle of cause and effect

Global warming can be seen as a big problem caused by many very small decisions. Linking the *cause and effect* between individual acts and emissions, and enhancing this with the power of social media to show the total impact, can provide a boost for persuasion and increase *reciprocity*.

Make it fun

Many applications could make more use of game-like functionality, triggering the principles of *competition, cooperation and recognition*. Social media provides many options for this.

Make it mobile

As mentioned throughout this article, mobile phones are a powerful, pervasive technology for persuasion. Some of the applications analyzed make use of them, for collecting data, helping in behavioral choices, or as an interface. But we think that

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[16] NFC payment is widely extended. One example is the Japanese Mobile Suica system. http://www.jreast.co.jp/mobileSuica/index.html

[17] For instance Google Transit application: http://www.google.com/transit

[18] We:offset. http://www.nokia.com/A41039027

[19] Carbon care. http://www.climatecare.org

there are many more possibilities in using mobile phones, together with mobile sensors and with mobile social media tools. There are also many possibilities for exploiting the *principle of kairos*, providing suggestions at opportune moments. It could be used for breaking habits and to help the user when needed, in the decision moment.

5. CONCLUSIONS AND FUTURE WORK

Throughout this text we have seen that there are many existing ICT applications that use persuasive techniques towards climate change, even if some of them are not designed for that purpose, and some even explicitly negate their persuasiveness.

With our definition of climate persuasive services we wanted to create a theoretical base from where to identify and analyze these applications, and to help in designing new ones. We have found some cases where there are clearly persuasive techniques in action. We however observe that there are many possibilities for improvement with a more consciously planned use of persuasion principles.

Our purpose has been to overview this exciting area of interdisciplinary research, and to generate a common ground for future questions. Some of the future questions we can suggest following the steps in this text are:

Quantitative results are needed. For instance, doing a series of cases with real users of particular applications, tracking their carbon dioxide emissions and behavioral change would be beneficial. It would be optimal to do these cases with different focus groups of different age, cultural and geographical contexts. How is the real impact in personal emissions? Does it make a quantifiable difference? How does it differ from different users with different lifestyles and awareness levels?

It would be important to study the impact of trustworthiness of the system and the data in persuading the users. How does the transparency of the data affect the persuasion? Which level of transparency is needed?

More theoretical research is also needed, linking in a deeper way the theories of captology and persuasion with environmental awareness and climate-change behavior.

Finally it would also be interesting to study anti-climate persuasive technologies, ICT applications that promote behavior changes towards lifestyles with higher carbon dioxide emissions.

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