Transparent Media Driving Spaceship Earth

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Abstract. In our everyday life, we are surrounded by events and phenomena that are difficult to explain or comprehend. Despite significant advances in many scientific fields and abundant availability of data on many aspects of our life, it is still a challenge to communicate slow and complex global processes to the average citizen. In this chapter, we study problems of explaining such processes in the media and look into the future for solutions. We take climate change as a case study and look into how the media can communicate the importance of the issue to the population, and transform simple awareness and high-level knowledge into rational action directed towards solving the problem. We observe signals in technology, media and society

to present possible outcomes for the future development of media, and provide our optimal path for development.

Keywords: Media, Big Data, climate change, reporting

1. Introduction

The idea of Earth as a spaceship was presented first in the end of the nineteenth century in Henry George's book *Progress and Poverty* to describe the limited resources on Earth. The human race is the passenger on an isolated spaceship which is travelling through space, and it has to manage the resources it has on board. Later on, the term was used to illustrate the seriousness of climate change and the importance of conserving the fragile atmosphere protecting the passengers on the ship.

Climate change is a typical example of a slow and complex process going on perpetually in the background of everyday life. It has diverse roots in all parts of society and the economy, and its consequences on environment are challenges for the whole of mankind. One way to view the feedback loop of climate change is shown in the information–impact loop of Fig. 1. Even though the loop in Fig. 1 is labelled with terms relating to the environment, the same principle can be applied to slow processes in other disciplines.

Fig. 1. describes an information-impact loop. For more immediate processes the loop is iterated more frequently, whereas, with slow processes such as climate change, the time scales are so long that the loop does not function properly.

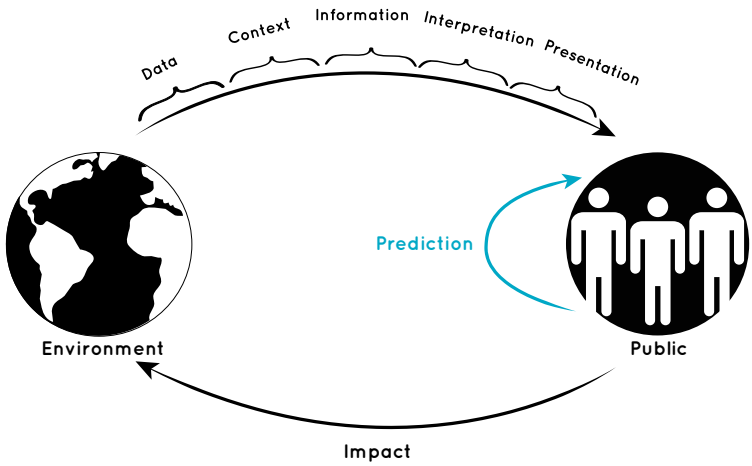

Fig. 1. ***Information–impact loop. Information relating to the environment is delivered to the public by the media. This information, in turn, affects people's behaviour, and, further on, it has a second-wave impact on the environment. When it comes to slow and complex processes, due to the limited human lifetime, this loop becomes discontinuous but can be enhanced with predictions.***

Living in the digital age, we are surrounded by a sea of information, and the rate of continuous data production is faster than ever. New information technology tools make it easier to derive knowledge and understanding from information. The current trend of increasingly accumulating data is also evident in the growing amount of available open data. Many governments and other groups are opening their data, i.e., sharing the data in a standardized format. Yet there are still few economic incentives for private companies to open their data: enclosed data is often a valuable business advantage. Smartphones provide vast quantities of data to individuals concerning their behaviour in the digital, and increasingly also in the real, world. We witness the rise of mobile media access, social media interactions, as well as the movements such as 'quantified self'. In general, data is becoming a more essential part of societal discourse, business and media. That is why some refer to the period since 2001 as the Big Data era.

Media and reporting are facing a particular set of challenges and opportunities in this era. Namely, the newly available data changes the role and the definition of a journalist and redefines the rules of reporting. It also disrupts the business models of current media, which poses a challenge to traditional media. On the other hand, greater amounts of open data combined with new technology enable faster and more precise news reporting, the incorporation of relevant social and personal aspects to news, and novel ways of storytelling.

In this article, we discuss in detail the challenges and the opportunities that big data afford the media through a particular example of climate change reporting. Namely, we first go into current media issues that are relevant for reporting complex processes such as climate change. After that, we identify current technological and societal trends that we think provide opportunities for resolving identified issues. Finally, we describe desired possible future scenarios. We choose to describe the desired future scenarios inspired by the conclusion from Curran (2010) that "one should not only passively predict the future of journalism, but also seek to actively shape the future to have a better outcome."

In Section 2, Current Issues in Reporting, we identify five problems in reporting slow and complex processes, using climate change as an example. In Section 3, Current Trends in Media and Technology, the reader is introduced to the current issues and trends in media and novel technological advancements that are likely to change the reporting of slow and complex processes. Data processing and visualization techniques, data journalism, hybrid media, augmented reality, and digital maps are trends and technologies that can help people to conceive the digital world and navigate in the sea of information. Based on the assumption of increased media transparency, in Section 4 we present visions of the future. These visions illustrate how new technologies and media trends can help people to achieve better knowledge, understanding and reasoning of the slow and complex processes onboard Spaceship Earth. This is very likely to inspire actions to change the direction of such processes, in our case climate change. In Section 5, we offer final discussion.

We stress that novel media can be used to concretize complex phenomena. With respect to the case of climate change, the media has the potential to educate people about sustainability and the limitations of the Earth. We describe a new type of media that can actively engage people to take action for the environment and to become proactive actors in sustainability. On a more general level, a described scenario can lead to increased global consciousness.

2. Current Issues in Reporting

Using climate change as an example of a slow and complex process, we have identified five main issues in traditional reporting which act as *bottlenecks for* comprehending the problem and relevant causalities. There are several, partly overlapping, issues that make climate change a good example.

2.1. Shifting Baselines

Climate change as a process is slow. The changes that occur in the lifetime of an individual are so small that they are hard to notice in everyday life. This problem is described as 'shifting baselines'. People do not have reliable personal and emotional recollections of the baselines from the previous generation, so they do not experience changes themselves but learn about them from reports and studies in a less engaging manner.

A good example of shifting baselines is the sport fishermen on Key West, Florida, shown in Fig. 2, happy about their catches despite the fact that the average size of the fish has decreased 88 percent since the 1950's (McClenachan, 2009).

Fig. 2. ***The catches of the sport fisherman have decreased over 88 percent since the 1950's. Still people look as happy in the photos. Pictures from McClenachan (2009).***

2.2 Slowness of Feedback Loop

The impact of the choices an individual makes today becomes visible in several years' time. Linking the visible impacts to the consequences reliably takes several years on top of that. For example, it took almost a decade to scientifically prove that increased floods are a consequence of anthropogenic climate change (Pall, Aina, Stone, Stott, Nozawa, Hilberts, et al., 2011).

2.3. Cumulative Actions

One reason for the sluggishness of the feedback loop is that the contribution of an individual action is small: cumulative actions matter, and actions cumulate slowly. It is impossible to prove causality on an individual level, even though the causality might be clear on a population level. Collective behaviour leads to the bigger impact. The majority of CO_2 production is a result of the lifestyle choices of numerous individuals in Western countries. Still, people do not appreciate their own contribution to this development.

2.4. Conflict of Interests

There are groups that openly claim that no climate change exists. There will always be such groups, but the amount of media attention and political power they have is crucial. Many industries have huge lobbying and economic power, and their interest lays in short-term economic gains rather than the sustainable use of natural resources and the atmosphere. Right-wing think tanks promote the belief that there is no climate change or that its consequences are minor. These think tanks are often funded by industries for whom the solutions to climate change will be harmful (for example, Koch Industries) (Brulle, 2013).

2.5. Media Bias

Current media reporting on climate change diverges strongly from scientific consensus. Media tend to report the most shocking scenarios. The search for a catchy headline often hinders the reporting of the most relevant news with the most informative value. The different interest groups, discussed above, also affect the reporting.

There are many ways the media misrepresent facts about the climate change. The following list contains some types of bias that influences media.

- **Corporate bias:** Some media houses have an economical interest for not reporting climate change truthfully. This is especially true for media houses that are owned by corporations whose business would suffer from people reacting to climate change.
- **Mainstream bias:** Media tends to report on issues that are currently mainstream. Climate change becomes relevant for the media only when something related to it is happening.

- **Sensationalism bias:** Shocking and sensational news sells better than informative and profound articles. Media also tends to exaggerate.
- **Concision bias:** It hard to show all aspects of climate change in a concise way.

Fig. 3 shows how climate change reporting in media differs from the scientific consensus.

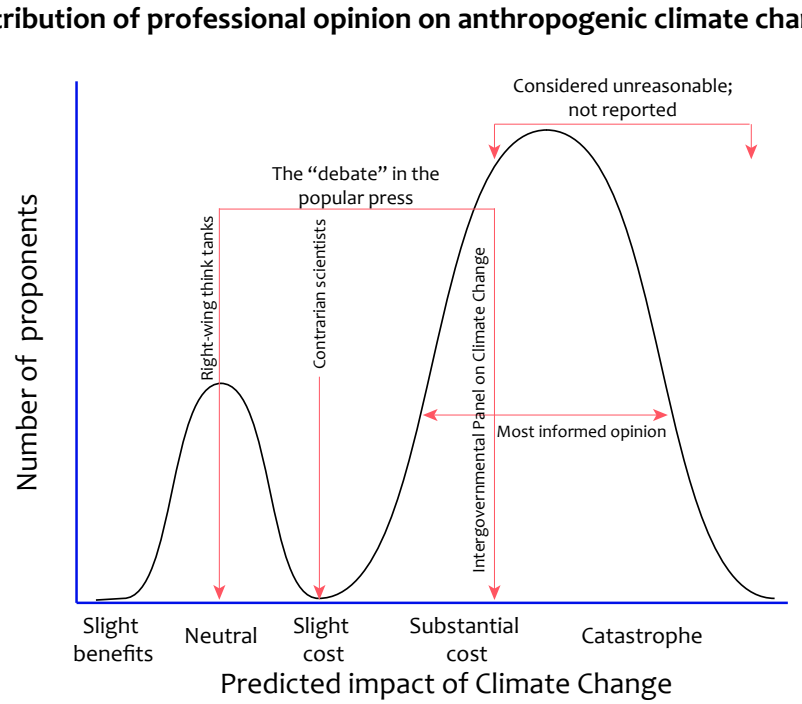

Fig. 3. ***Distribution of professional opinion on anthropogenic climate change. Figure shows that media tend to report only some kinds of opinions. Picture from Tobis (2010).***

3. Current Trends in Media and Technology

3.1. Data to Journalism

As we capture more and more aspects of our (digital) lives, we are bound to have exponentially increasing amounts of data. While this presents an opportunity to have better measurements and improve our decision-making, such development also calls for advancements in technology and human competences. In 2012 data science was dubbed "The sexiest job of 21st century" (Davenport and Patil, 2012), and, as we ac-

cumulate more data, the demand for the workers able to analyze it increases (McAfee and Brynjolfsson, 2012).

In terms of technology, in spite of the recent progress in affordable tools to analyze big data (McAfee and Brynjolfsson, 2012), we are far from being able to deal with all the data. One of the key concerns is that most of current data is unstructured, in different formats and hard to verify. Lack of technological standards and sharing practices causes chaos and uncertainty, which results in a flood of data and information asymmetry. While there is no immediate expectation of standardizing data formats or creating interoperability with concepts such as Linked Data, some universal modes to deal with data are bound to emerge with the increased need to process it.

Effectively using multiple data-sources is essential for several reasons; understanding and describing the dynamics of complex situations, finding solutions to complex problems, and making those approachable and understandable to laypeople all require several types of data. Since non-experts generally focus on static, easily observed components of complex systems (Hmelo-Silver, 2004), good visualization can give viewers a deeper understanding of the behaviours and functions of a system.

Data journalism, i.e., using digital data to find and tell stories, makes it possible to display a vast amount of information in a compact way. It has gained importance in recent years and is often referred to as a significant new tool for journalists. Data journalism provides additional possibilities for deepening a story, adding verification and context, engaging the audience and enhancing the presentation (McCandless, 2009). It is, as well, a tool for the diagrammatic way of conceiving, wherein the information attached to the written story is an essential part of the message (Thrift, 2011).

We assume that a surge in competence of data analysis and some availability of tools is bound to spill into 'general public', going beyond data scientists and journalists. We have already seen examples such as Wikileaks (wikileaks.org) that represent the involvement of unlikely groups in reporting. Some organizations successfully use crowdsourcing to involve the general public in a range of tasks, from contributing to innovation to discovering new planets, as NASA does (Gustetic, 2014). Much crowdsourcing activity is based on data which the organizations decide to make publicly available.

We can assume increased participation of organizations and individuals in the more global and complex processes, through the available data, technology and competence. Co-creating also has the possibility of engaging the crowds. This would mean increased transparency in reporting, as well as better understanding of complex problems that are usually hard to comprehend for a single individual. To paraphrase, crowdsourcing lets us see 'the wisdom of crowds' in action.

New technologies cause traditional news reporting to become increasingly automated (Oremus, 2014), and crowdsourced (reddit.com; twitter.com). This is causing a journalist's job profile to slowly shift from being the first to report something to explaining what certain developments actually mean in the bigger picture, as well as verifying data. Many major news outlets have restructured their workforce in order to

reflect these changes, which are in turn having a direct impact on transparency, data handling, and accountability on a general level (Gray, Chambers and Bounegru, 2012).

Data journalists can create relevant reports and infographics, which are interactive, up to date, transparent and even personalized to the reader. This requires using programming to automate the process of gathering and combining information from various sources in order to find connections between hundreds of thousands of documents. More traditional journalistic expertise, such as instinct for news value and design skills, is also required.

Current state of the art examples show only a glimpse of what we can expect from data journalism, as the field is constantly developing. There is yet a lot of room for improvement and innovation, with journalists and news companies shaping standards and starting to cooperate with each other and with scientists.

3.2. Trends in Technology

When it comes to media and reporting, the Internet itself continues to disrupt the landscape. For the first time the Internet has enabled sharing of information in a many-to-many manner and with open data; it allows anyone to be a producer of content and literally to reach anyone else with a connection to the Internet. In such a situation, vast amounts of data and discussions are available online, and it becomes a challenge to navigate such a sea of information. We see emerging startups that try to tackle the challenge by providing adaptive content delivery channels (for example, pulse.me and Paper by Facebook).

Another media challenge for users is comprehension and linking of the pieces of information available in different formats and through different services. In this case, we also see startups trying to tackle the challenge by creating and, importantly, inviting the audience to also create iconographic, mapped, and video digest reports (such as meograph.com). Considering the situation described above, we identify a couple of trends in technology that are most likely to disrupt media and reporting in the future: (1) contextual computing, (2) next-generation user interfaces, and (3) information visualization.

The adaptive (personalized or situation-dependent) media content delivery channels are part of a recent, larger trend in ICT contextuality. Big data, in particular user graphs and digital maps, enable such development: geotagged pieces of information can be delivered to a user's mobile device (or any ubiquitous type of device) when they become relevant. Contextual data enable smart service delivery. In the near future, contextual computing is expected to take the leading position from mobile technologies.

Georgia Tech researchers Abowd, Dey, Brown, Davies, Smith and Steggles (1999) defined and discussed the applications of contextual computing more than a decade ago. Traditionally, four main contexts are defined for an individual:

- **Social:** consists of social circles of a user
- **Personal:** includes deep-rooted beliefs, health situation and emotional aspects

- **Interest:** preferences, choices of a user in diverse circumstances
- **Behavioural:** product of user past, current actions and habits

There are already companies maintaining large social graphs (such as Facebook), or behavioural graphs (such as Amazon recommendations), or combinations of those (such as Netflix) for their customers. For the purposes of our article, we would like to introduce the fifth relevant context:

- **Environmental:** factors via which a user is affecting the environment and climate change (for example, Tesla and Nest users' data)

Obviously the four previously described contexts are influencing the environmental context. However, we think that a necessary feedback loop about the environmental consequences of individuals' actions is lacking at the moment, and this is what introducing the environmental context can alleviate. For instance, if you know how your energy consumption influences the climate, one might hope that you would change your behaviour. Or, if you know that some of your friends are influencing your environmentally unsustainable actions, you might even choose to change the social context. We find that the current trend of establishing such an environmental context and thus the missing feedback loop is one of the most relevant challenges when it comes to the future of reporting complex phenomena.

Combining data from different contexts offers amazing possibilities to enhance individuals' lives. Linked Data, which we introduced at the beginning of the section, enables the combination of different contextual data in original ways. Thus, we already see a rise in applications which combine a number of different contexts for an individual and augment the user experience in completely novel ways. Data collected by applications have the potential to create mobile applications that are 'aware' of what the user is likely to be doing at any given moment, even if they are not actively using any device. The applications can even take a proactive role of predicting possible future user actions and warnings in case of need.

Coming back to media, we have already given examples of media startups that embrace an advanced utilization of the context of interests, either by itself (pulse.me) or in combination with social and personal contexts (Scoopinion.com and Paper) in order to enable precise delivery of relevant information. Individuals can achieve profound understanding of complex phenomena with repetitive learning. Contextual technologies also can be used in engaging learning where the application gives pieces of information to the user in the time and place where the user can find the information relevant and interesting.

Next-generation user interface (UI) technologies include augmented reality (AR), gesture interfaces, tangible interfaces, and many others. The promise of such UIs is that the interaction with a single computer interface is replaced by multiple interfaces in combination with real objects, thus blurring the lines of traditional reality and virtual reality. Reality is augmented or completely immersed in computer UI. It is

clear that the starting point in actualizing such advanced technologies is the design and sophisticated visualization.

Some of the aforementioned next-generation UI technologies, such as AR, have been developed in recent years and presently reach first consumer applications. Others, such as tangible interfaces, have been in R&D for a decade already, but are still waiting for breakthrough applications to appear in the consumer market. It is inevitable that such novel UI will drive a large transformation in the *society*, which will greatly affect fields such as media and reporting. Media will be perceived as more seamless, and thus it has the potential to make users more engaged. The ubiquitous computing environment will expand the borders of what we perceive as media, resulting ultimately in more time people spend interacting with it.

If games are combined with AR technology, we see enormous possibilities for connecting people to their surroundings and for raising their awareness of reality. For example, there already exist games in which people can see how their community will look in a hundred years, assuming that current behaviours and rate of carbon emission continue or given a particular set of changes in their collective behaviour (Klopfer and Sheldon, 2010). Games as a learning method are drawing interest in science education (Rosenbaum, Klopfer and Perry, 2007), and they could be particularly useful in educating kids and students about climate change.

Finally, data visualization is crucial to helping users understand the message contained in the data. Information has to be in an easily conceivable format so that the user doesn't get bored or too perplexed. Considering the wealth of data available nowadays, it is visualization technologies that have promise to help navigate that abyss. The power of visualization is not only in presenting the data, but it often helps as the first step insight into what kind of analytics could best be performed. Besides representing complex datasets in ways that take into account the limitations of human cognitive capability, visualization also can be applied to existing and seemingly simple concepts to bring a new viewpoint and thus enhance human understanding from diverse perspectives. The fact that some of the most valued visualizations up to today originated in the nineteenth century (Tufte, 2001) shows that this field has unused potential to improve and catch up with the trends in the Big Data era.

4. *Visions of the Future*

Based on the trends and signals presented in the previous section, we construct a scenario around how climate change reporting might develop in the future. Our scenario is based on an assumption of increased transparency and awareness turning into action more frequently.

4.1. Living in a Transparent World

Currently the EU and USA have initiatives to open a large amount of government data to the public and standardize it so that third parties can use it. Governments opening up the data would further advance transparency trends. Government-provided data can be even more useful when combined with other sources and types of data. It is not reasonable to expect that data-sharing practices will change overnight, but the recent willingness of some corporations to share their data indicates that the direction is also the same for companies. Increase in transparency is expected, especially in the non-core areas of the business, such as sustainability and climate change data.

However, research points out that unless the process includes mechanisms that would allow others to access the data easily, process it and actually act on findings, opening data would only increase the bureaucracy inside organizations providing the data, while having no effect of accountability (Wong and Welch, 2004). Thus, technology and data in itself do not solve the problem if a system facilitating accountability of those reporting the data is not in place. Therefore, we assume that, in the future, transparency of data would be accompanied by the right environment to use the information and actually make a difference by reporting it through media to individuals. Potentially, transparency in data and media would address the problems of shifting baseline, slow feedback loop and cumulative action. Provided that data would be open, it would be easier to track down individual actions and simulate consequences, based on a rich data from the past.

We predict that by 2020, sustainability reporting will still not be widespread, or standardized in any manner. The data that companies share generally come in the form of written reports and summary presentations, which highlight some figures. However, they resemble a public relations gesture rather than an accountable report. Some large companies may employ open standards (e.g., XBRL GRI) suggested by bigger audit companies, as those standards are starting to gain popularity.

As reporting spreads, however, it is likely companies will realize that climate change is also affecting their performance by disrupting their operations in the regions affected by environmental disasters. Such business incentives can be the most powerful ones in convincing companies to act, as it hits their bottom line. Another side of data availability is an increasing pressure on companies, from NGOs and customers, to share more details about their activities related to environment and act on that information.

While at the moment there is a certain pressure on companies from society, it still comes from smaller groups especially working on the issue. As data and services based on the data become available, the engagement of wider audiences is to be expected. NGOs and other interest groups would have more opportunities to investigate the impact of the business on the environment and to develop a new set of tools to analyze this data. While it may still be impossible to pinpoint the exact impact of

business activities in certain regions, it would be possible to check companies' claims to some extent.

Already by the beginning of the next decade we should see a new breed of companies devoted to transparency. These pioneers will operate on the principle of complete transparency, giving away large parts of their data on the regular basis in a standardized format. The goal of such companies is to showcase their business practices by inviting interested parties to scrutinize their data on the subject of climate change. These companies believe that the future trend would be towards openness of information on all levels (government, corporate and individual), thus making the move early on would bring them a first mover advantage later.

In the long term, transparency of companies is bound to become commonplace. The combination of external pressure, the opening of data by the government, economic viability, and general attitude change towards sharing information, would drive a revolution in transparency. Already today companies in highly industrialized areas, such as China, are looking for cleaner sources of energy and environmentally friendly manufacturing practices. Thus, by 2030, we expect to see a number of giant corporations being transformed drastically in order to keep up with new trends. Transparency would be a globally accepted trend. Global awareness of the importance of preserving Spaceship Earth for generations to come will lead to increased competition in certain domains, while also forming interesting partnerships. For instance, cooperation between largest data centre owners, such as Google, and energy utility companies, lead to discovering new ways to utilize the energy that before was wasted in data centres.

Another trend closely tied to mass-transparency is the ability to contextualize real-time data and make it relevant to the user. Ubiquitous computing, together with advancements in computing mechanisms (quantum and neuromorphic computing), would make processing and rapid delivery of relevant data a reality. Such developments, together with new-generation user interfaces would blur the lines between real and augmented virtual worlds.

Novel technologies can be used to easily relate current natural disasters to ongoing climate change. Consider, for example, a future journalist working on an article on lahar mudflows in Indonesia. Using suitable applications and software, the journalist can easily create an educative and visual description of why and how the heavy rains and consequent mudflows are now more common in certain areas and how it is related to the increased CO_2-level. Based on earlier disasters and economic models, the journalist can easily create estimates on how the disaster will affect Indonesia's economy in the future and estimate other consequences such as indirect victims due to decreased social conditions. All this can be created within two hours of the onset of a mudflow and added as an appendix to the article. The journalist can spend most of his effort on analytical work, which is then supported by these models. Information combined and delivered in this way has a potential to connect a complex and global issue, such as climate change, with concrete actions and consequences, driving the action among people.

4.2. The Future of Journalism

Personalized assistants will be the primary means of delivering journalistic content and other information to people. They can be software implementations or a full OS in a phone, smart watch or other wearables. Due to advancements in artificial intelligence (AI), such digital assistants provide well tailored content important to the user, giving individuals access to personally and contextually relevant information in real time, while even predicting certain events.

2014 marks the year where news of an earthquake in LA was first reported by an algorithm, only three minutes after it happened (Oremus, 2014). The tendency towards algorithm-assisted reporting will free reporters primarily from the more tedious side of their jobs, letting them concentrate their limited resources on more relevant part of their jobs. Liberating journalists from hunting breaking news and sensations would improve problems with media bias that is based in sensational live news and create space for investigative and explanatory journalism emphasizing problems that matter. This in turn has a potential to bring more of a spotlight on conflicts of interests among climate change proponents, businesses and political parties.

As algorithms improve, more and more of the news we consume on a daily basis will be compiled and delivered automatically, changing the journalistic ecosystem in the long term, as professionals will mainly concentrate on delivering social, economical, historical and political context for topics of public interest. This in-depth journalistic work is done mainly with hybrid media combining data, video, and even gaming. As the systems we deal with in our everyday lives become more complex and the world becomes more connected, it will require a diverse set of tools and the cooperation of scientists and journalists to untangle the connections. We see signals of this already today as data-oriented journalism becomes more relevant (FiveThirtyEight.com, theguardian.com/data); we can also observe a rise in explanatory media (vox.com), which is especially popular in new media channels (like 1veritasium's and CGPGrey's channels on Youtube).

High quality journalistic content will be of utmost importance, with more emphasis on research and putting data in social, cultural, political and economical contexts. This is especially important as new legislative and political decisions involve longer chains of reasoning, more data and more participation, information and communication technologies become more connected, creating wide spreading information networks in which a user is navigating, and supply chains of consumer goods become longer and harder to track. With climate change reporting, the CO_2 production is well-known from all parts of the supply chains, industrial processes, and different lifestyles. Even when the CO_2 production is not directly measured, it can be reliably determined by interested parties, such as NGOs, from various linked data sources.

4.3. Technologies Enabling Action on Spaceship Earth

The current trends in technology provide clear signals of what to expect in decades to come. In a context of media reporting complex issues, two technological trends stand out specifically: gathering of data and augmented/virtual reality (AR/VR).

Building a business based on the data collected from the users of Internet services has become a huge business. Companies like Google, Facebook and Twitter, thrive on providing user data to third parties (such as advertisers), which they collect by offering users free Internet-based services. Now there are some signals that suggest that data collection will cross boundaries of individual Internet services and cover other aspects of our life. Google recently acquired Nest (Google Inc., 2014), a company producing home thermostats and smoke detectors. Google is also interested in getting its services into cars, while innovative car manufacturers like Tesla collect all possible data about a vehicle, as well as driving patterns of its owner. IBM's vision of the smarter home envisions connecting all home devices into the network (IBM Corporation, 2010).

In terms of explaining complex problems, such data collection presents unprecedented possibilities, as it has the potential to reveal insights that were inconceivable before. In short term, many companies would develop their own data analysis tools for different types of big data. Additionally, there would also be some open source alternatives, available to consumers and smaller entities that could harness the power of the data and bring a change.

The other trend concerns the introduction of contextual technologies such as AR, which have a potential to revolutionize the delivery of media content to the user. From user perspective, these changes are bound to bring advancement in contextual technologies to make it easier for users to make decisions and faster to find relevant information based on the user's current context. In terms of media this means the delivery of more targeted information to the users and the use of context and contextual data as a tool to help people engage with the message.

New-generation user interfaces are particularly important when it comes to delivering contextual news. Technology offers the potential to have different contextual services that would combine the data and AR, from finding out about the ingredients and health characteristics of food products at the supermarket to the applications about carbon footprint and energy efficiency in our daily actions. A combination of unprecedented data-gathering tools and story-enhancing technologies such as AR has the potential to open society's eyes to a shifting baseline and the impact of one's actions on the environment.

In the short term, society starts changing even though the changes are slow *at this point*. Very much like companies, the majority of the population has yet to pass the stage of awareness and switch to action. Availability of data, tools for analyzing the data, skills of reporters and climate change watchers to analyze the data, and quality of media reporting would be expected to improve in the next five years.

In the long term, for Spaceship Earth and explaining climate change, technological change would bring new forms of reward for green behaviour, through new types of green NGOs and specialized organizations. A membership of such an organization would be considered an honour to those special individuals who have contributed the most to increasing awareness, influencing other people's environmental habits or opening up the truth about some high-carbon footprint companies. Many investigative data journalists would be among the members of these organizations.

In the upcoming technology-savvy generation, kids from early school days learn about the concept of Spaceship Earth and how to be environmentally friendly. Availability of the data and tools to analyze it would ensure that discussion is based on facts and scientific arguments, rather than on speculations, prejudices or emotions. Because of the described improvements and novel means of reporting on their habitual actions, people, in general, will be much more environmentally aware and responsible. It is a new norm of behaviour for people to be open about their own environmental-footprint, and most of the social networks now add such a field on personal profiles. It is also considered to be a negative sign if someone is hiding such information from their profiles. Sophisticated means are established to calculate such an attribute from different data sources for an individual.

4.4. The Fifth Context: Environmental Impact

The next step is to look at how all the aforementioned tools and technologies could be combined to create a heightened awareness for the environment in the general public. The combination of open data from government and pioneer companies, as well as scattered data from other corporate players, NGOs, scientists and media to investigate the impact of human activities on the climate in greater detail than ever. This sets a foundation for the new ways of reporting complex problems.

In addition to businesses, there is a worldwide Wikipedia-type project called 'Datapedia' going on that is aiming to collect all the openly available data in one location and offering a platform that users can build links between the data.

By 2030 climate science and modelling has advanced to the stage where the reliable forecasts of the weather trends can be created up to one year. There are commercial companies offering such forecasts. Warnings about floods and hurricanes can be given up to half a year in advance. As well, there are plenty of popular-science applications and games about the climate data.

At the same time, an active minority concerned with sustainability and climate change is gaining momentum. While this is largely limited to the more privileged layers of society, consisting of higher-income, highly educated young professionals, for them climate change consciousness is mainstream. Availability of data and tools has strengthened crowdsourcing movements, digging through the data and connecting activities and events related to the climate change. Such activism creates the base for new sources of information and new services for people to track climate change and put pressure on companies, governments and fellow members of society to take action.

Games and culture are a great way to distribute information in a casual and engaging way. Ingress (http://www.ingress.com/) is a popular AR game today that actively creates awareness of monuments that are converted into portals in the game-layer and require the player to regularly visit monuments in their surroundings in order to participate in the game. Similarly AR games that involve the environmental context can help users to understand effortlessly and engage with such complex themes as the carbon cycle, heat deflection, water distribution, light pollution and its impact on the flora and fauna surrounding us in our everyday lives, and how it has changed over the last century due to human activity.

Another application of the aforementioned technologies is called 'Atmosphere game'. It is a popular way to educate people about the mechanisms of climate change. Advanced climate sciences and increased computation power have enabled atmosphere models that can be used to create educative games. In the Atmosphere game, the user can simulate climate predictions by changing the parameters of human activities: oil price, environmental taxes, national GDP growth goals etc., and then observe the consequences in the form of average temperature, pictures of changed local climates, and local economical parameters such as food prices.

Interactive media is needed to create educative journalistic work of these more complex phenomena. The reader needs to have the possibility to put these mechanisms into action. For example, in political reporting the reporting can be enhanced by the economics game, in which the reader can change something and see the predicted consequences of his or her decisions. There has been an increase in availability of these simulations and prediction tools in the last ten years, and they are becoming more essential way of how Western citizens perceive the world. Reality and virtuality are colliding and becoming one self-fulfilling prophecy. This has increased and continues to increase the weight that science has in public debate, yet misinformation is still common within these games, which can become dangerous and misleading.

Our best chance to counter misinformation is widespread user participation, crowdsourcing and accessibility due to user friendly tools, and the trend of media production turning into a common knowledge that everyone has access to. We recommend investing heavily in freedom of speech, net neutrality, raw open data and other movements that enforce the free flow of information and actively enable user participation.

5. *Discussion*

Having presented a viable and preferred future, in this section we take a look at our assumptions and alternative possible scenarios. After that, we summarize the main conclusions about the future for each of the issues identified in the present-day reporting.

First, let us recall the trends that we identified as relevant for the discussion on future of media: data journalism, contextual computing, next-generation user inter-

faces and information visualization. All of these trends are currently evident, some of them in root phase, for example, contextual computing, and others having already reached a developed phase, such as data journalism. However, we consider that all these trends have great potential to grow and transform from their current form, and, importantly, they are interdependent. Namely, contextual technologies build on top of available (open) data and high-quality visualization. At the same time, next-generation user interfaces are imagined to provide a novel platform that will likely transform contextual technologies as we currently see them on top of mobile devices. Information visualization is as old as the tradition of data collection amongst humans. Nevertheless, such a large amount of (Big) Data is available today that the visualization techniques need to catch up. Analysis of the current business and entrepreneurship scene and research literature suggest that those are the trends with the largest potential to change the media as we know it. Having taken a short look back at how the Internet itself has disrupted the printed news media, we conclude that the global media disruption is still taking place, along with the development of the trends that we identified.

As for the alternative future scenarios, it is obvious that there are many factors at place, some of them more likely and some of them less. As Curran (2010) has shown, a large portion of predictions in research literature have proven to be wrong. He also discusses the moral point that one needs to take to try to actively influence the future of media by discussing a desirable and possible future. This is the approach we adopt in this article, in particular since the stakes with regards to climate change are so high that we believe everyone on the planet needs to take the best action they can starting now. Considering how crucial a role media plays in general human actions, in this article we suggest an actionable future for it. We think that our described scenarios belong to the area of a future that is most probable. To justify this, we use the scientific predictions regarding climate change, those same predictions that, due to the current media situation, a large part of the population is not aware of, let alone those who do not believe that the climate change is happening at the first place.

According to some of the most recent scientific articles and agency reports (Hegerl, Hoegh-Guldberg, Casassa, Hoerling, Kovats, Parmesan, et al., 2010; Knox, Hess, Daccache, and Ortola, 2011; Oreskes, 2007; Stocker and Qin, 2013), we can expect some strong-to-catastrophic consequences of climate change in the near future. The report conclusions by the Intergovernmental Panel on Climate Change (IPCC, 2013) are unequivocal on global warming in the atmosphere, ocean and the Earth's surface and cryosphere. The analysis attributes these changes to humans. Unless human activities with regard to carbon and greenhouse emissions drastically change now, we expect to witness many more such events in the near future. Thus, our predictions on different approaches in future media reporting on climate change and complex processes in general will be reinforced by such events. At the same time, as we describe above, the technology will offer a possibility for transformation, which media needs, or will be forced to accept.

To summarize, we identify following answers to the current issues in reporting:

1. **Shifting baselines:** In the future Big Data will provide enough historical data for the slow processes to be actually easily observed on different levels. Geotagging of images and other content will enable people to see how locations and places have evolved. When time passes, we will get more data about the slow trends, such as fish getting smaller.
2. **Feedback loop is slow:** Human behavioural data is accumulating at a rapid pace. Social media can be considered a huge sociological experiment producing such data. In the age of context, this data becomes essential when delivering information about slow processes. To tackle this issue, prediction mechanisms based on such data and context will be used. It is easy to imagine applications that warn a user about what will happen if he continues with the current trend of his action. Because of the increase in contextual technologies, the virtual world will be an essential part of people's everyday lives. Smart phones will guide behaviour by bringing more relevant facts to their attention.
3. **Cumulative actions matter:** As a consequence of the data collected everywhere (sensors, smart meters, CO_2, social discussions...), and contextual computing, reporting individual influences and cumulative nearby community (neighborhood) influences will be easy. To distinguish the drops in the ocean, people need to be instantly reminded and shown the consequences of their actions. Interactive and engaging applications, such as games combined with environmental data will help reach this goal. We see a future where the energy distribution systems are completely redesigned, and everything produces data. Inhabitants of future smart cities will share their environmental impact data over social networks where everyone has a personal environmental influence index.
4. **Conflict of interests:** In the future, we expect companies to be working towards being carbon-free. Sophisticated systems that track and measure environmental indicators will be developed. The media pressure will, thus, be high, and companies contributing to climate change will be subject of public criticism.
5. **Media bias:** Future technologies, such as Augmented Reality and next-generation user interfaces, combined with large amounts of data and contextual technologies, will make reporters great storytellers. Thus they will be much more adept at spreading messages about complex processes that were difficult to present before or avoided.

To conclude, we think that a combination of the trends we presented will enable reporting complex processes in the future. In particular for climate change, media and reporting will introduce currently missing information flow, which we name as the environmental context, presented by the blue line in Figure 1.

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