Massive-Scale Agency

by
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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

We are at a moment in time where technologies are developing at an accelerated pace, and information and communication technologies (ICTs) have advanced to a point where each of us carry a portal to insurmountable options for information access and social exchange. Our smartphones have become a necessary tool to the formation of our online and offline identities, and will continue to be an access point to several emerging technologies that will further affect the way we inhabit our surrounding environment.

With all the excitement that these technological advances may bring, we also find ourselves in a state of great uncertainty. The relationship we once had to the inner workings of our surrounding and ecological environments has deteriorated. This gap in knowledge, and the resulting poor behaviours as it pertains to environmental sustainability, have resulted in global warming, which continues to be the most pressing issue of our time.

ICTs have increased the speed of communication to real-time, and this capability for near-instant feedback introduces the potential to re-establish a close relationship with our immediate environment. This thesis seeks to investigate how ICTs can be used to create a digital platform that facilitates new forms of information representation that bridge the gap between the individual and man-made climate change. It explores design solutions that can be produced when combining the architect's skillset with tools and methodologies from other disciplines. Using various data collection methods including surveys, interviews, and user testing, a digital platform is created with the intention that its users may be able to gather their own evidence, realize where they are situated in the supply chain, and discover where there is room for individual agency through varying interventions.

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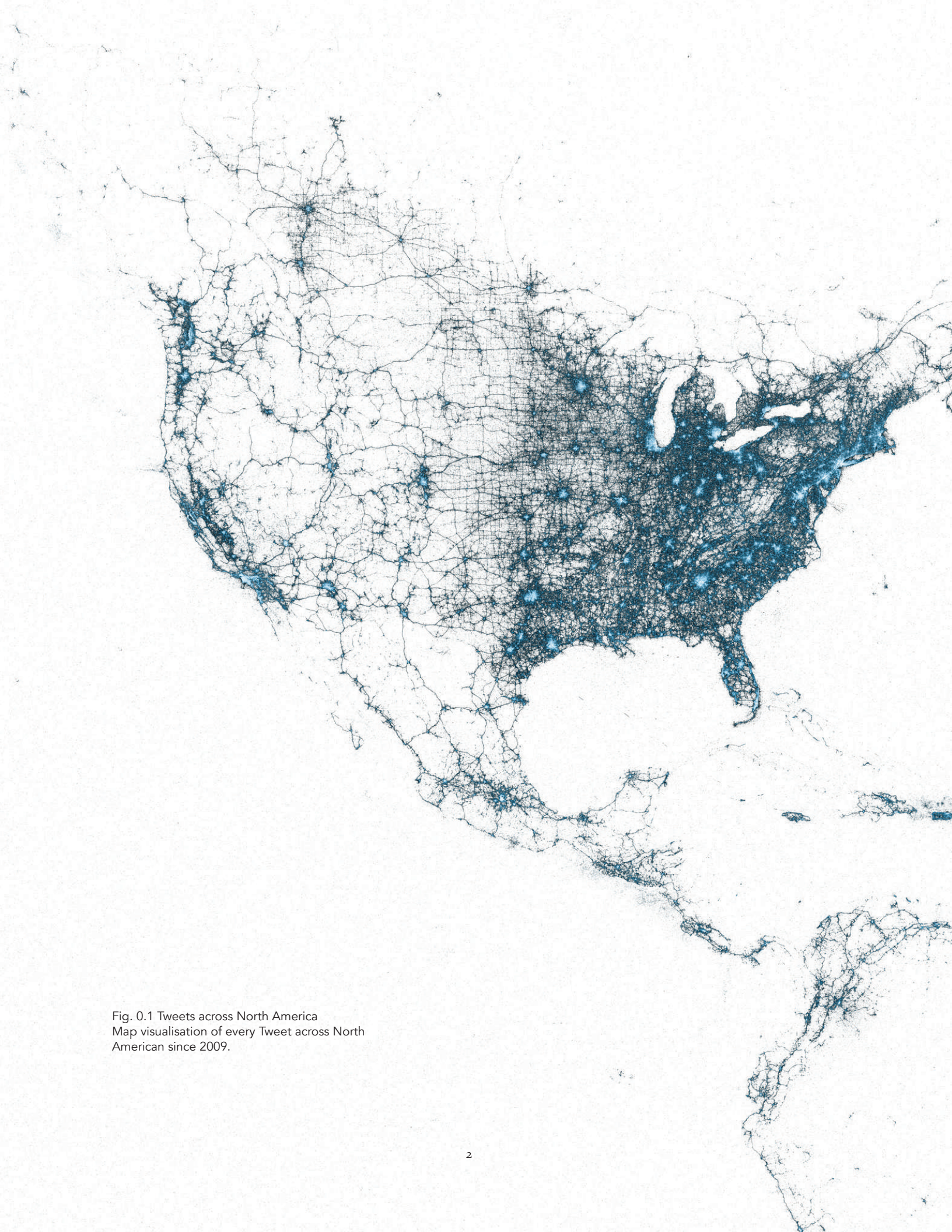
INTRODUCTION



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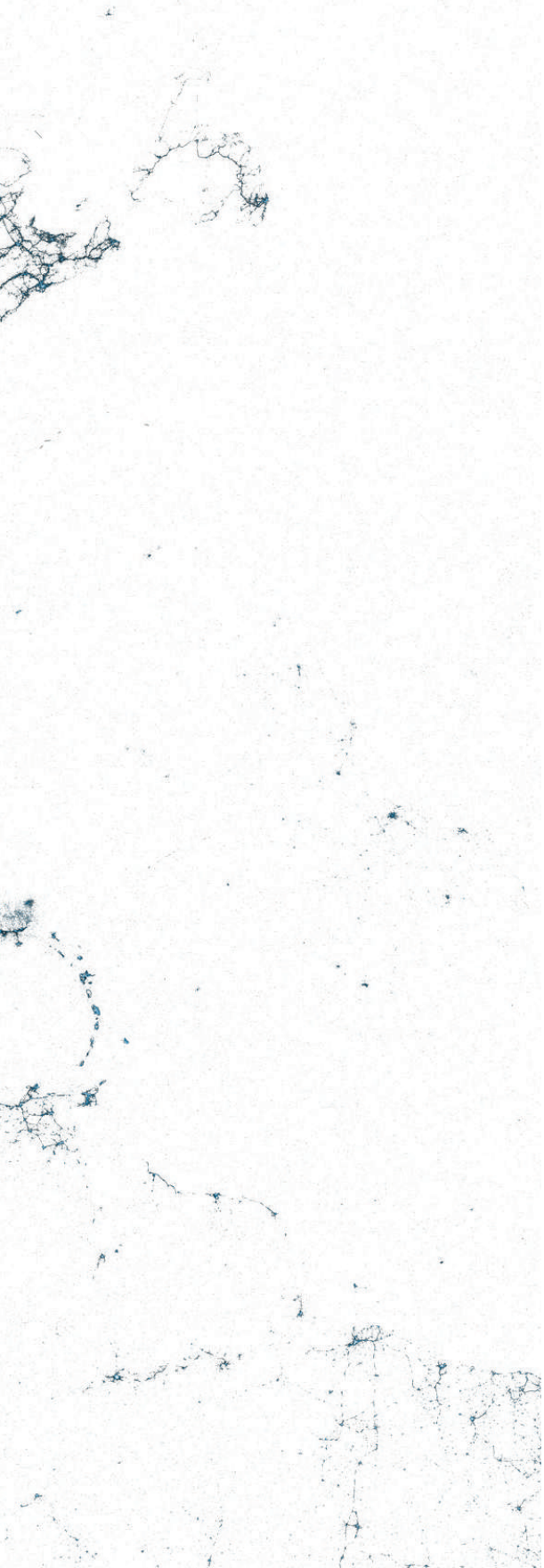


[1. Excitement]

We live on the brink of both excitement and fear. The excitement stems from the fact that we're at a moment in time where technologies are developing at an accelerated pace and the intervals between disruptive technological breakthroughs have shortened from centuries to decades. From just a few decades of development, information and communication technologies (ICTs) have advanced to a point where each of us carry a portal to insurmountable options for information access and social exchange. Our smartphones have become a necessary tool to the formation of our online and offline identities, and will continue to be an access point to several emerging technologies that will further affect the way we inhabit our environment.

With the proliferation of technologies that are able to sense, track and condense our every action, we have at our disposal an opportunity to discover the complexities of our supporting production networks in various perspectives that were previously an impossibility. By collecting and curating specific data from a personal level like those offered by fitness trackers such as the FitBit, to a societal level such as the traffic view on Google Maps, we are able to observe the effects of our behaviour at several different scales. Since these observations can be performed in real-time, the data they provide can also be used to construct feedback loops that are designed to drive toward desired objectives. For example, through Google Maps we can continuously adjust our movement in an attempt to avoid traffic, and through the FitBit we can change the frequency of our movement as a means to reach our desired fitness goals. This capability for real-time feedback introduces the potential to re-establish a lost relationship we once had to the inner workings of our surrounding environment. More specifically, while the methods of production for our material goods has increased in complexity, the average consumer's understanding of the inputs and outputs necessary to keep society afloat has decreased. This gap in knowledge, and the resulting poor behaviours

as it pertains to environmental sustainability, have ultimately resulted in a new-found state of global fear[1].

[2. Fear]

With all the excitement that these technological advances may bring, we also find ourselves in a state of great uncertainty. The issue of global warming continues to be the most pressing issue of our times and with good reason, given that it stands to be a very real threat to our capacity to survive on Earth.

Global warming occurs as a result of the sun's energy being trapped inside the earth's atmosphere due to an over abundance of greenhouse gases (eg. CO_2, methane, black carbon etc.). Experts advise that an atmospheric concentration of carbon-dioxide of 450 ppm is the designated threshold we must stay under in order to have a 50% chance of stabilizing the global temperature at 2 degrees above current values. For context, current CO_2 levels are at 410 ppm and rising, with a rate of increase of roughly 10 ppm every 4 years, as measured by the Mauna Loa Observatory.[2] As such, reaching the dreaded 450 ppm seems inevitable within the next couple of decades.

From a macro view of this problem, the solution appears to be simple. We have an excess of carbon dioxide in the air, therefore we need to lower it in order to avoid disastrous outcomes. Unfortunately for us, the problem is vastly more complex than it appears from afar. This is what Horst Rittel and Melvin Webber have defined as a wicked problem. While it has no definite solution, the mere act of attempting to solve the problem creates a new set of problems, and thereby serves to redefine the original problem[3]. Wicked problems demand constant re-evaluation since at no point will there be enough information to make a clear decision on how to solve them. Global warming can be categorized even further as an 'ultimate' wicked problem[4] due to the added complexity of time sensitivity, lack of central authority, irrational discounting and the fact that those seeking a solution are also the

source of the problem. Further compounding the complexity is the fact that this particular 'wicked problem' is deeply intertwined with the systems that sustain life on Earth, and is tightly woven around our cultural values.

There are a multitude of factors that contribute to global warming, and therefore solving it requires various types of solutions. Ultimately, these solutions must come from a mixture of both top-down and bottom-up sources. There are several timescales that we, as a society and as citizens, have to deal with. Firstly, there is the immediate reduction of carbon emissions by our designated 2050 goals. Secondly, there is the long-term issue of maintaining more sustainable levels for the generations to follow. For our immediate targets, although a majority of the solutions appear as though they must come from top-down strategies, our current situation makes it apparent that relying solely on them is insufficient. In order to accelerate a push into developing more sustainable infrastructures that our society can rely on going forward, we must cultivate bottom-up strategies, which are currently under-valued. They are powerful in their ability to significantly affect our mind-sets, both societally and individually. Bottom-up strategies have a potentially major impact in the development of key values that can instill individuals, who eventually make top-down decisions, with the drive to maintain sustainable ways of living. Bottom-up strategies must be developed in tandem with our top-down solutions to ensure a consistent progression towards sustainability both in the long- and short-term. As designers, this is the area in which we can develop tools to exact change and impart sustainable values.

As individual citizens, a major component that we have command over is our consumption of goods and services. While the intricate web of tangible-goods production appears as a well-oiled machine that magically offers us items from afar, the inner workings are messier, masking processes that have in reality pushed our ecological boundaries to their limits. Many such processes are

so negatively impactful on the environment that they would arguably be dismantled upon even the most summary evaluation, if not for the fact that they have anchored themselves within our social structures. As a result, the true impact of the products that we consume are often misunderstood or unknown and the way we've come to apply our values to these products either relieve us of any wrongdoing or convince us that there is no other way to live.

[3. How do we want people to live?]

Many people have differing views on how to tackle the issue, but what must be understood is that a panacea does not exist. While certain technological or political breakthroughs propel us forward, one breakthrough alone will never be enough to fully address the intricacy of the issue. Solutions from all sectors and scales have to be worked on in tandem in order to drive us to a new social structure where values shift into places that encourage an ecologically sustainable economy.

Various innovations in technology carry a promise that we can be rid of the issue once we figure out how to implement them. However, although investing in innovation is necessary, another large piece of the puzzle is focusing on optimizing our existing systems.[5] If we look past our fixation with the production of things anew, we can find that many readily available adjustments to our interaction with the built environment can have a significant impact on our overall quality of living. One poignant example of this is in Architecture00's submission to a competition, whose brief called for a new school addition in order to relieve hallway traffic. Architecture00 decided to apply their design thinking on how users were interacting with the existing building and found that simply rearranging and staggering the students' timetable would both alleviate the hallway traffic and eliminate the need to build. Architecture00 looked past the brief, thoroughly understood and assessed the issue, and proposed a solution that their research and judgment deemed suitable, despite it being contrary to the

expectations as initially outlined.[6]

This is not an argument for architects to stop building, or the idea that architects are not necessary; it is an argument for architects to expand their systems thinking. Whether we acknowledge it or not, the buildings that we design are political because they affect the lives of everyday citizens[7]. As such, although the commercial apparatus makes it difficult for architects to do so, there are opportunities for us to pay more attention to how users interact with the built environment.

[4. Focusing on people.]

Anthony Townsend specializes in the implications that technology has on cities and states that, "Every city has an economy and a culture that emerge from the decision and actions that people take each day.[8]" Within North America, the economy and culture that emerge is concentrated on individualism and consumerism. As long as the disconnect exists between both consumers to the products they consume and how micro-scale actions connect to macro-scale actions[9], the destructive system we find ourselves in will perpetuate and individuals will continue with business as usual. Even the seemingly small individual actions that are thought to be insignificant can become actions that contribute substantially to global emissions when performed at scale. What is needed, are carefully designed avenues for social information exchange that allow for the growth of a collective self-awareness. These avenues can shift our cultural values from being centred around passively consuming, to becoming actively involved with improving the operation of the built environment on a massive scale. Fortunately, such methods of information exchange are now within reach and their user experiences can be designed by architects.

With the advent of mobile technologies, we are witnessing a paradigm shift in how people inhabit physical spaces. There is no longer a strict production line in the creation of spaces where the users are relegated to the receiving end of design. Architects now

Fig. 0.2 Egyptian women protesting
Women protesting inequality during the 2010 Arab uprising.

have to also consider how users are becoming increasingly active players in the experience of a city by having access to platforms that allow for individuals to easily self-organize and band together for varying reasons[10]. This has created what Howard Rheingold would call a 'heated-up' urban metabolism[11] where spontaneous ideas can quickly escalate to large-scale interventions within a city at an astounding speed. Examples of this can be seen everywhere, from people organizing Arab Spring protests on social media platforms such as Facebook, Twitter, YouTube and Foursquare[12], to Pokémon fans stampeding through seemingly random or abandoned locations in the hope of capturing creatures that exist only in the digital realm. We suddenly have within our grasp the unprecedented ability to mass-coordinate people around a central concept on a whim, and with minimal effort.

In beginning the pursuit of nurturing any democratic and publically accessible and alterable infrastructure, the existing system must first be visualized in a way so that it may be generally understood by the viewer[13]. It is in this understanding of the existing system's operation that people may learn to gather their own evidence, realize their place in the supply chain, and see where there is room for individual agency. The ability to easily access big data and view it in relation to one's context is a design problem as the user experience must be carefully crafted in a way which fosters varying degrees of participation[14]. Although this type of design problem can be solved in many different ways by various types of designers, the required skills to tackle it within a collaborative team of varied disciplines are well within the skillset of an architect.

[5. Spatial agency.]

The common role of the architect is that of a designer of objects. While people look to architects for their expertise in the design of spatial environments, what is almost always expected of them is a newly created object, typically in the form of a building. However, the identity of an architect has always encompassed much more than what the profession has streamlined them into being. As ar-

chitects, we produce spaces for the other. In doing so, there exists a tacit understanding that we carry an ethical responsibility to the other[15], whether for the present or for future generations. This can manifest itself through various concepts and issues, but within the boundaries of this research, it refers to an ethical approach to sustainability, in the true sense of the word. It refers to studying and tackling issues pertaining to wider interactions between nature and society, and between humans and nonhumans[16]. Doing so as an architect-citizen in contemporary times asks of us to operate out of the usual boundaries of the profession, as the architect's standard tools and ways of working are insufficient in addressing the required urgency. This statement is not meant to deemphasize the importance of sustainable practices in our standard ways of working, as building sustainably and holistically remains of paramount importance in the long-term. Rather, it is meant as a motivation to explore design solutions that the architect's skillset can produce when combined with tools and methodologies from other disciplines. With this in mind, the architect can assume the role of the spatial agent in collaboration with others:

> Agents act not alone but as part of a mutual enterprise... Mutual knowledge is not determined by professional norms and expectations, but rather is founded in exchange, in negotiation, out of hunch, out of intuition. Mutual knowledge means abandoning the hierarchies embedded in most professional relationships and instead welcoming contributions from everyone in the spirit of a shared enterprise.[17]
>
> -Jeremy Till, Architecture Depends

An architect can begin to contribute to this shared enterprise through the process of "design thinking", where the solution is not prescribed before undertaking a method to thoroughly understand the problem at hand. The steps to design thinking, as defined by Stanford's d.school, are to empathize, define, ideate, prototype, and test[18], where all the phases can be repeated in various cycles until a suitable design solution is proposed. One notable follower of this methodology is Umbrellium, a design firm specializing in participatory design projects. When working with clients, Umbrellium does

Fig. 0.3 Umbrellium's 'Burble'
Umbrellium's Burble project is a citizen engagement spectacle where sensors, LEDs, and microcontrollers fill balloons that form a reactive structure that visitors can 'fingerpaint' onto.

Fig. 0.4 Umbrellium's Marling
Umbrellium's Marling is another citizen engagement project where an 'aurora' is created through the actions and sounds of participants, which are represented in the 'ceiling' of animated colour.

not follow a design brief as one typically does on more traditional design projects. Instead, they work closely with the community to carefully define the problem that they are trying to solve, discuss who should be included in the process, all while constantly questioning whether the proposed goals are indeed necessary. They then arrive at the intended solutions together with participation from all parties, thus developing a communal sense of ownership with respect to the final outcome. This open-minded approach can result in the broadening of the toolkit of the architect and conversely, enrichment of the problem solving processes of other disciplines as well. Within the context of today's planetary crisis, facilitating the mixing of various disciplines may give rise to new perspectives, perspectives that may ultimately provide the necessary alternatives to our current way of living[19].

With the accelerated development of ICTs, the dynamics of the public realm are undergoing changes that carry with them great potential for changing how we operate with the environment. Public spaces have historically been an excellent device for the exchange of information, whether in the form of conversation, or the sale of goods and services. Until recently, the concept of public space has always been tied to the physical, whereas now the flow of information can exist in both the physical and digital. Additionally, they are not mutually exclusive and one can greatly affect the experience and understanding of the other. With this in mind, there exists an opportunity for designing ICT-based tools that can turn spaces of consumption into spaces of decentralized power. The quickly developing ubiquity of the digital-public realm serves as a medium to the transferring of power from a physically imposed environment to one that is dynamically in possession of the citizens. As a spatial agent, the architect has the opportunity here to envision a framework for a new (social) spatial future[20], one that incorporates both the advantages of operating in both the physical-public and digital-public realms, and that encourages citizens to gather evidence, self-organize, and create solutions with regard to the planetary crisis.

While the definitions of design thinking have evolved throughout the decades, the process that has been formalized by the d.school at Stanford breaks it down to five modes of working: empathize, define, ideate, prototype and testing[1]. The process of design thinking carries differences from designer to designer, but these modes of working will provide a loose structure for the process that was undertaken during the course of developing this thesis.

The first two chapters provide the theoretical research that was completed in tandem with the subsequent three chapters, which form the practical design and testing portion of the thesis. Chapter 1 deals with where we place our values and Chapter 2 covers data and its potentials to enrich experiences. Chapter 3 covers the gathering of data for the thesis and Chapter 4 covers the prototyping and user testing processes. Chapter 5 summarizes the features suitable for the proposed iteration and addresses areas of further exploration.

CHAPTER ONE
WHERE CHANGE HAPPENS

"One day roughly 7,600 years ago, with glaciers melting and global sea levels rising, the Mediterranean Sea burst over the last rocky precipice separating it from a shallow lake north of what is today Istanbul. Thundering downward with the force of 200 Niagara Falls, this catastrophic deluge destroyed nearly everything in its immediate path and triggered history's first recorded displacement of climate refugees.

Ask people if they know this ancient calamity and most will say no. But ask if they've heard of Noah's Ark, the biblical rendering of this very flood, and most can recount not just the story but also its moral: the imperative of saving life on Earth from destruction by rescuing two of every animal.[1]"

-Paul Allen

Fig. 1.1 The storm

[1. Storytelling.]

The art of storytelling has always been at the core of our ability as a species to exchange information. From passing on important values and life lessons or preserving significant points in time, to simply expressing individual likes and dislikes or taking note of the mundane, stories are the means by which we develop an understanding of the world around us[2]. In *Made to Stick*, Chip and Dan Heath's exploration into 'sticky ideas', or ideas that successfully permeate society, show that storytelling is one of the key factors in making an idea 'sticky'[3]. Furthermore, sticky ideas also exhibit characteristics of being simple, unexpected, concrete, credible and emotional.[4] While the stories of global warming and climate change that demonstrate these characteristics have recently gained traction within the media, they have failed to develop a sense of agency in people. Current media messaging around climate change focuses primarily on 'doom and gloom' narratives, a methodology that, contrary to the desired objective, actually desensitizes the public and reduces the likelihood of evoking an emotional response[5].

While it is true that there are many examples of inspiring endeavours that point toward a shift to a new and sustainable economy, these transformations are not accumulating quickly enough to signal significant progress towards a better future. Thus, the lack of a 'critical mass' of positive stories has contributed to an overall negative outlook, which in turn has failed at encouraging public action. Further compounding the problem is that these negative stories are repeated en masse, thus strengthening their hold on the public.

This shortcoming is difficult to overcome, but there have been countless studies on various methods of communication that affect audiences more than those that seem to be used repeatedly in the media. In one of the seminal texts of the Situationists' movement, Guy Debord accurately foresaw mass media's impact

on society in *Society of the Spectacle*. Debord's understanding of how mass media and technology would be able to transform the consciousness of society[6] is apparent in his theses on the spectacle. He places the spectacle, a tool for social connection as mediated by the use of images[7], at the center of society's unrealism. He states that the spectacle (mass media) has no altruistic goal, encourages passivity, and appears to present reality while in actuality, it originates from the loss of global unity through misrepresentation[8]. Similarly, although the present representations of climate change's challenges in mass media inherently communicate a goal and common interest, the lack of connections to the individual or community results in apathy, pluralistic ignorance, or prisoner's dilemma.

Rather than a universal spectacle, what is required is a plurality of different messages[9] that appeal to different cultural types[10]. As different groups of people respond differently to the same story, one type of message will never be successful in reaching everyone. It is important that the stories about climate change begin to move away from overarching 'doom and gloom' narratives that paralyze, to engaging audiences with proven storytelling methods containing hopeful narratives[11] that mobilize. This is required of several outlets, as researchers have found that it is not one story or piece of information that sparks change, but the compounding of several stories and experiences over time[12]. Thus, it follows that there should be more of an effort to 'plant seeds' and to accumulate the number of disruptions to the current system[13] until a breaking point can be reached.

[2. Societal role of change.]

The term 'paradigm shift' was introduced in Thomas Kuhn's book *The Structure of Scientific Revolutions*. Kuhn uses this term to describe the periods in which scientific worldviews change radically in seemingly sudden leaps[14]. These leaps are triggered by anomalies within the accepted paradigm, often years or decades earlier than when the shift ultimately occurs. The same process

can also be said of major cultural paradigm shifts, where the work of a few pioneers triggers a chain reaction of other movements over decades, culminating in a tipping point where change finally occurs. Shifts of this scale can be seen in the 1792 pioneering book of Mary Wollstonecraft's, *A Vindication of the Rights of Woman,* that subsequently lead to women's suffrage[15,] or Virginia Woolf's body of work, which fuelled the self-liberation of women during the subsequent wave of feminism[16]. These examples illustrate that cultural shifts, while difficult to purposefully engineer or even imagine before they occur, do take place once the new paradigm influences a critical mass of actions.

Today, we are dealing with the urgency to move into sustainable ways of living, which requires its own major cultural shift. Our current systems of production are deeply interwoven with our cultural values and as such, a cultural shift can potentially be a great accelerator in achieving this goal[17]. While there are indications that we may already be undergoing such a shift, the determining factors of our success as a society will depend on our ability to re-evaluate our core values and to practice long-term planning[18]. In examining failed and successful past societies through his book *Collapse*, Jared Diamond found that those who overcame societal collapse when faced with environmental threats, such as deforestation, were able to make decisions that benefitted the group in the long-term even in the face of short-term sacrifices. They were also able to ask the difficult question of whether or not to hold on to the values that formed part of their identity when they proved to be the underlying cause of their environmental threat[19]. Within our own society, the dominance of our individualist values may seem unwavering, but under certain circumstances, other societies have shown that they are willing to make necessary personal sacrifices when the need arises.

It is often believed that people will not make personal sacrifices without a form of incentive, or extrinsic motivation. However, the opposite was observed in the aftermath of the 2011 Fukushi-

ma Daiichi power plant disaster. When asked to lower the use of air-conditioning to avoid brownouts without penalty or reward, Japanese citizens willingly did so despite the summer heat. This resulted in a decline in energy usage by 20% during peak hours all throughout summer[20]. This shows that it is possible for people to act against their own self-interest when the appeal to group identity is strong, and when the messaging concretely connects actions to clear goals. What is also important to note is the aspect of informed choice[21] and with it, the moral implications of actively choosing between self-interests and the well-being of the group. This is often the missing factor when making our everyday decisions and the full impact of our choices are either misleading or unknown.

[3. Passing on ways of living.]

Several societies through time have discovered sustainable ways of living in accordance to their own set of values and geography. This is especially evident in the isolated peoples of the New Guinea Highlands who have developed sustainable farming practices through trial and error over the course of 7,000 years, even in the face of environmental threats such as deforestation, erosion and soil fertility[22]. Their agricultural methods are so sophisticated and unique to their geography that villagers who leave to pursue a higher education often return to find that they are unable to cultivate their family gardens. This is due to having missed years of complex knowledge that could only have been obtained through physical observation and interaction[23]. In John Thackara's *How to Thrive in the Next Economy*, he argues that this traditional way of passing on knowledge is endangered by the emergence of new information networks[24]. While new flows of information are providing us with a seemingly large wealth of data access, we are losing, or possibly have already lost, a vital connection to the ecological environment that was learned intuitively through physical adaptation and interaction[25].

The importance of this connection lies in the ability for one to

Fig. 1.2 Save electricity
A selection of Japan's energy saving advertisements.

Fig. 1.3 Torches of Freedom

understand and place value on the ecological environment. As a result of this lost connection, we have too often optimized our systems in pursuit of increased economic value at the expense of both ecological and social value. In the separation of the urban and the agricultural, we have managed to isolate ourselves from the key underlying experience that gives us the ability to truly appreciate the worth and damage of the ecological environment. In its place, we have prioritized ideals of infinite growth and the continual consumption of new goods without realizing the devastating impacts that these demands carry.

[4. Consumer based living.]

The foundations of our consumerism can be traced back to the fifteenth century development of printing in Europe[26]. However, the coupling of consumerist marketing and our innate pursuit of happiness was amplified by the work of Edward Bernays, the nephew of Sigmund Freud. As a method for crowd control and mitigating civic unrest, the advertisement strategies of Bernays injected underlying ideals of success and acceptance into the act of product consumption[27]. Over the decades, this has developed into the belief that our material possessions are the extension of ourselves[28]. Furthermore, once we find that our existing material goods fall short of giving our lives meaning, we pursue newer material goods in the hope that they will succeed in providing meaning[29].

This presents a dilemma as messages of reduced or responsible consumption are ineffective and seen as personal attacks against one's core values[30]. This dangerous coupling is readily apparent in the images associated with the American Dream. While the concept of the American Dream is upward mobility for anyone regardless of background or origin, it has consistently been paired with the image of a newly built suburban home with a white picket fence. This proves problematic because it replaces the understanding of the suburbs as a government creation proven to be strenuous on ecological, economical and social resources[31], with

The coupling of values and consumerism is seen in the advertisements of cigarettes directed towards women. Edward Bernays hired women to smoke 'torches of freedom' in order to increase cigarette sales and eliminate the social taboo of women smoking in public.

an aspiration that virtually everyone strives to achieve. This form of misrepresentation, and the subsequent attachment of our values to tangible goods, occurs with many of the products and services that we consume on a daily basis, thus making the hope for behavioural change seem like an impossibility. Fortunately, many researchers have looked into effective ways to communicate to distinct cultures of consumption[32].

Within the culture of consumerism exists diverse cultures of consumption where each contain varying levels and types of concern for environmental and social issues[33]. Each of these groups respond to different approaches to narratives, such as communicating with an emphasis on convenience and status versus an emphasis on ethical concerns[34]. In addition to targeted messaging strategies, there also exists a growing trend in reflexivity, where a collective reflection and discussion on the values and practices of sustainable living is utilized[35]. Using similar methods, we could craft powerful narratives that can begin to separate products from the misrepresented ideals they are attached to.

[5. The stories we could tell.]

In communicating with people, it has been shown that initiatives are more effective when they provide:

- a minimum amount of necessary information
- a credible assessment of the threats at hand
- a sense of personal control with respect to their circumstances
- a clear goal with clear strategies to achieve it
- a sense of social support
- consistent feedback to signal their path to achieving their goal[36].

Additionally, these all need to be communicated with a narrative that encourages co-operation, emphasizes mutual interests, and highlights our common humanity across diverse cultural groups[37].

Fig. 1.4 The American Dream
A standard image representing the American Dream.

As John Thackara puts it, 'Change is more likely to happen when people reconnect – with each other, and with the biosphere – in rich, real-world contexts[38].'' In our world of growing ICTs, the technical capacity to facilitate social connection already exists. If used suitably, these communication technologies mainly serve to complement and enrich the ways in which humans can communicate with each other[39], both in real- and digital-world contexts. In many ways, we have already seen how these technologies and methods of communication have affected real-world social gathering, which in turn facilitates the development of local level initiatives. While our anthropogenic crisis ranges globally, societal change often starts at the local level[40].

CHAPTER TWO
DATA-POWERED STORIES

"The Easter Islanders' isolation probably also explains why I have found that their collapse... haunts my readers and students. The parallels between Easter Island and the whole modern world are chillingly obvious. Thanks to globalization, international trade, jet planes, and the Internet, all countries on Earth today share resources and affect each other, just as did Easter's dozen clans. Polynesian Easter Island was as isolated in the Pacific Ocean as the Earth is today in space. When the Easter Islanders got into difficulties, there was nowhere to which they could flee, nor to which they could turn for help; nor shall we modern Earthlings have recourse elsewhere if our troubles increase. Those are the reasons why people see the collapse of Easter Island society as a metaphor, a worst-case scenario, for what may lie ahead of us in our own future[1]. ... My remaining cause for hope is another consequence of the globalized modern world's interconnectedness ... we have the opportunity to learn from the mistakes of distant peoples and past peoples. That's an opportunity that no past society enjoyed to such a degree.[2]"

-Jared Diamond, Collapse

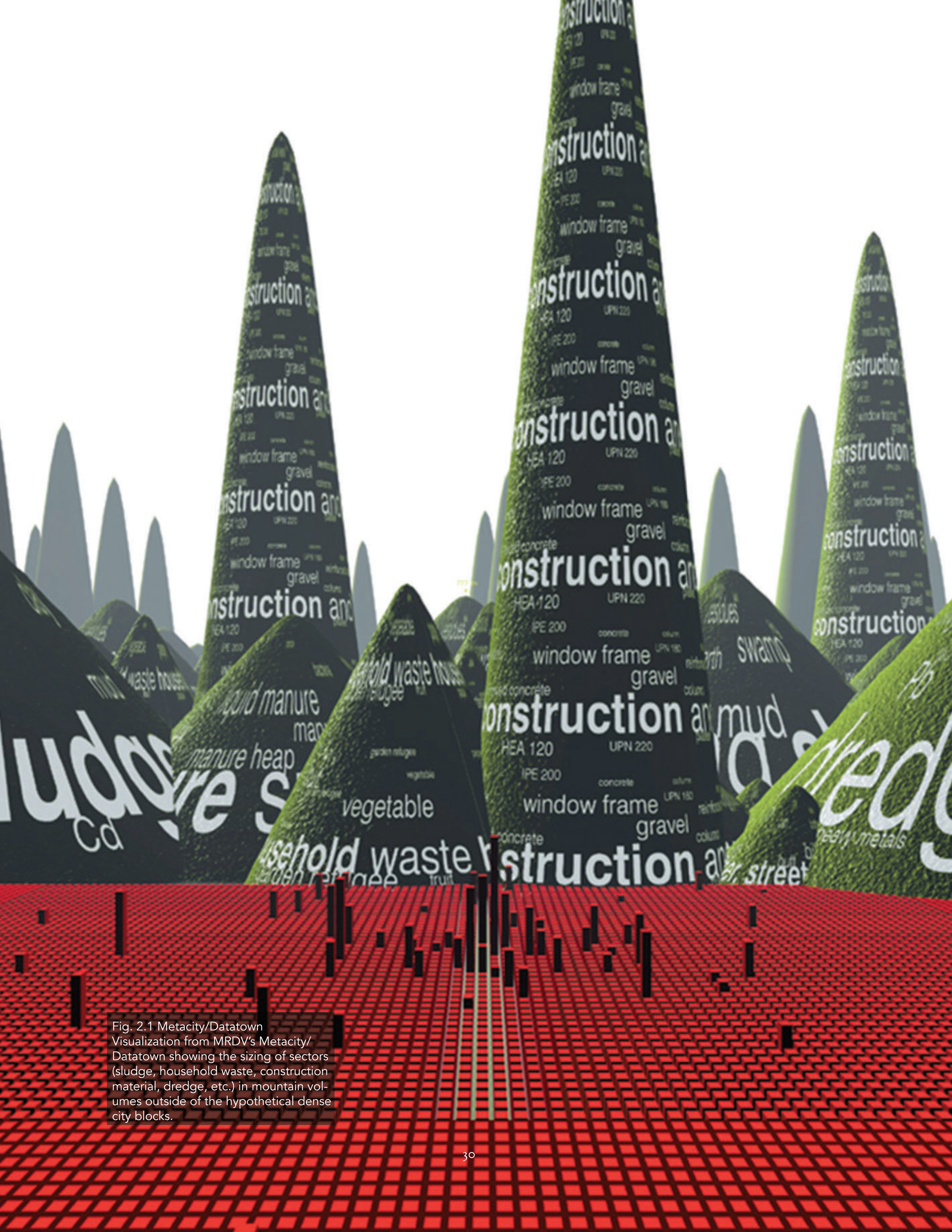


Fig. 2.1 Metacity/Datatown
Visualization from MRDV's Metacity/Datatown showing the sizing of sectors (sludge, household waste, construction material, dredge, etc.) in mountain volumes outside of the hypothetical dense city blocks.

[1. Uncertainty of data.]

The first step in the design thinking process is to empathize. As design thinkers, we do this by gathering data through various methods such as interviews, internet research, census data, etc., before attempting to define the problem to which a solution is formed. Without this important step to the design process, designers would be operating in the dark without any form of light. The first two chapters within this thesis represent a gathering of data in the form of theoretical background, data that will then serve as the foundation of the design process within the subsequent three chapters. Data, in its many forms, is critical to any design process as it is the basis of how we view the problems we seek to solve.

Data, in its purest form, can be seen as a set of quantitative or qualitative variables. Once sorted through and analyzed, it can begin to give us new perspectives of the world around us. In MVRDV's *Metacity/Datatown*, the representation of city data is pushed to extreme boundaries. Datatown is presented as a hypothetical city described only by the information required for its operation. In order to best approximate reality, all resources required to operate the city are represented as parameters that are based upon existing standards and guidelines. Its objective is to not only present a data visualization that connects hard numbers to physical reality, but to also reveal the laws of cause and effect of city systems[3]. Within the context of reducing carbon emissions, a similar attempt to relate abstract values with real world equivalencies would likely yield crucial observations. However, unlike the static nature of Datatown, visualizing the impact of human behaviour on the environment and making adjustments in response, would require a superior visualization method capable of incorporating dynamic and real-time feedback.

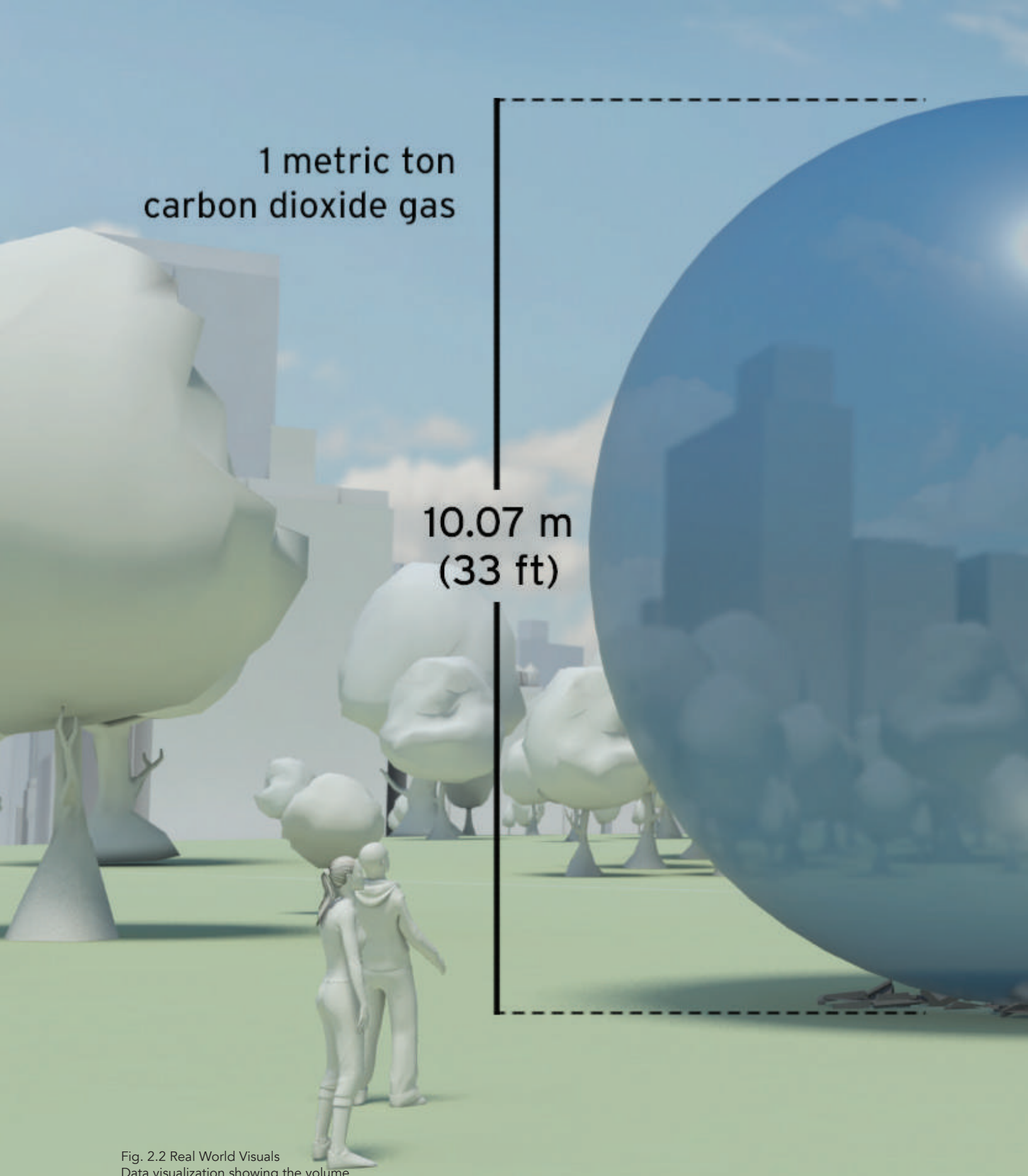
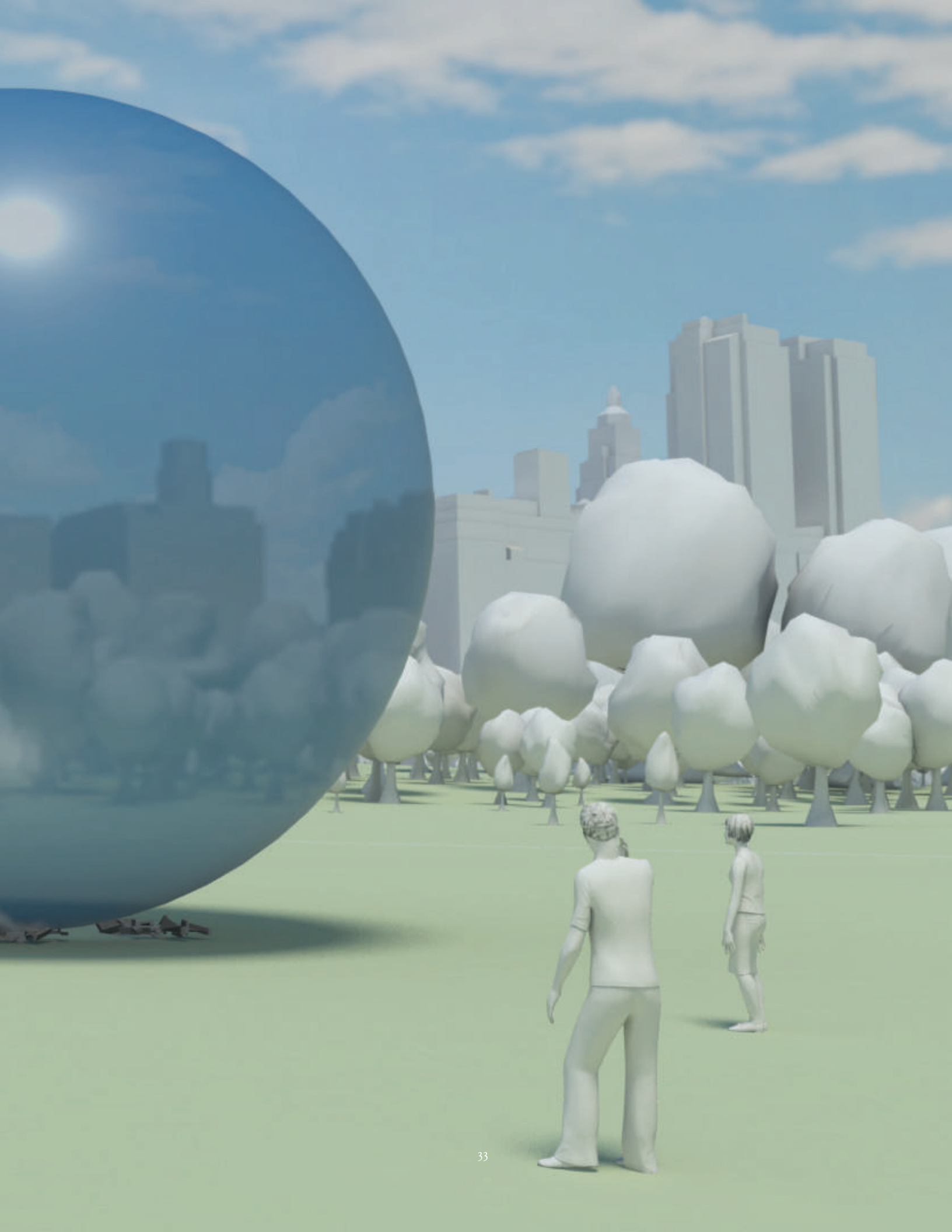


Fig. 2.2 Real World Visuals
Data visualization showing the volume of 1 metric tonne of carbon dioxide if it were visible.



An understanding of greenhouse gas emissions and how they are measured is a crucial first step towards lowering those emissions. Although the impacts of separate greenhouse gases differ, they can all be measured in their equivalencies to carbon dioxide (CO_2). For example, methane has 25 times the global warming potential of CO_2. Therefore, 1 kg of methane can be labelled as 25 kg CO_2e. While the embodied energy or operational emissions of certain goods and services are measured in units of carbon dioxide equivalents (CO_2e), it is difficult to understand just how serious a few grams, kilograms, tonnes, or Giga-tonnes of CO_2e are unless one has specialized knowledge. In Mike Berners-Lee's *How Bad Are Bananas?,* he creates meaningful connections to amounts of CO_2e by giving the estimated footprint of everyday products and services, from sending an email (4g CO_2e) to a leg of lamb (38kg CO_2e). He then anchors all these values by suggesting a realistic goal of emitting 10 tonnes of CO_2e per person per year, while noting that actual sustainability would require closer to 2 tonnes of CO_2e per person per year[4]. Placing the values alongside the 10 tonne goal immediately contextualizes exactly how damaging a return flight from London to Hong Kong is (3.4 tonnes CO_2e). Conveying impact can also be done in other, more visual ways. In the case of data visualization firm Real World Visuals, their methodology involves tying the abstract concept of carbon emissions with physical surroundings. This is done by giving volume to CO_2e in the form of bubbles that are subsequently placed in the environment according to the emissions of particular actions. As a result, the invisible carbon impact of an action becomes visible. However, while this visualization of the invisible brings us a step closer to understanding carbon emissions, the missing element is the indication of impact from limiting certain emissions in comparison to what is emitted in total.

These approaches to parsing and representing data are productive, but we should also be wary of the ways in which the visualization of data can prove to be counter-productive. Data is often viewed as information that is neutral, but it can also carry with

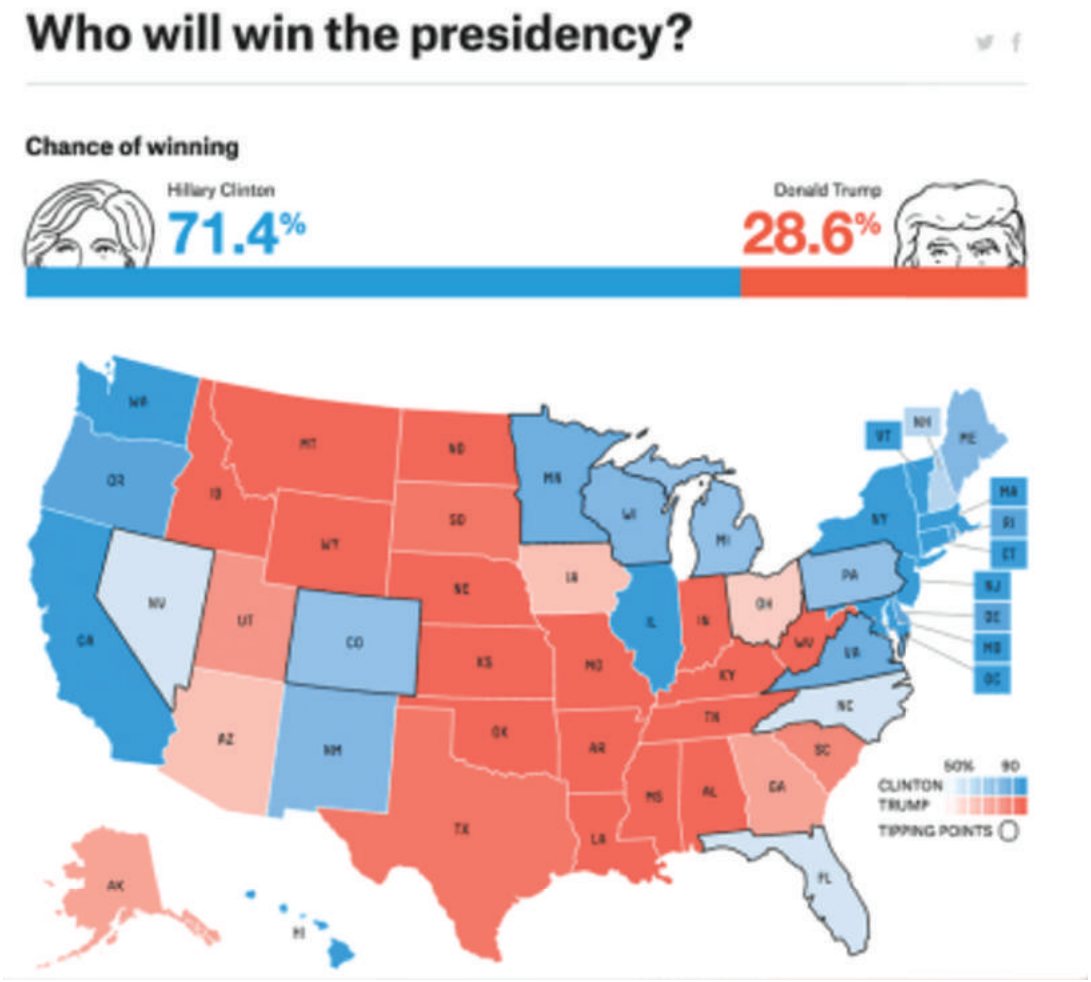


Fig. 2.3 Hillary vs. Trump
Data visualization of presidential election by FiveThirtyEight

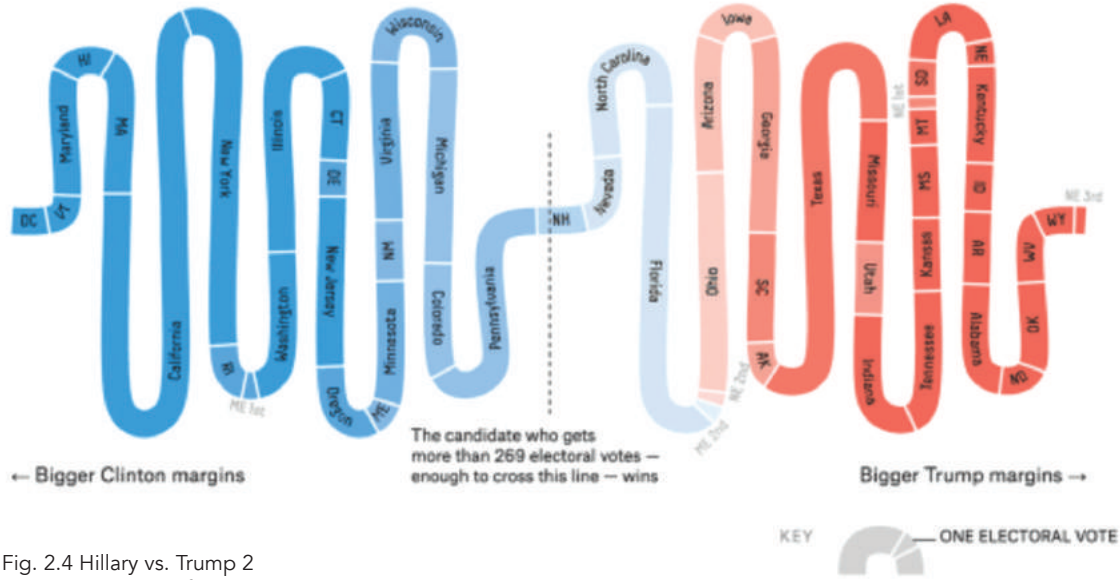


Fig. 2.4 Hillary vs. Trump 2
Data visualization of presidential election with emphasis on electoral votes by FiveThirtyEight

it many biases depending on how it is collected and represented[5]. The data visualizations we see in news stories or non-fiction books have all been collected, analyzed, and edited with the cognitive biases of the researcher/designer. As a result, the source of the collected data can greatly reflect the way they are perceived[6]. Several of the data visualizations that were published of the 2016 US presidential election illustrate how data visualization can be a medium for misrepresentation. The visualization from FiveThirtyEight managed to isolate the possible outcomes to seemingly one possibility. While the data for these visualizations were based on polling data, the very process of polling carries with it a degree of uncertainty. The visualizations failed to capture this margin of error and instead presented the single percentage as the hard value for each candidate's winning chances[7]. As datasets become more abundant and the demand for their visualizations grow, we must be mindful in the way we design our representations and analyses so that they may be as unbiased as possible.

[2. Current considerations.]

With growing speeds in computer processing and the continual development of information and communication technologies (ICTs), the capability of processing, analysing, and transmitting large amounts of data nearly instantaneously is a reality. We can see hints of these processes at work in our continuous notification streams on Facebook and Twitter. Sometimes these processes work discreetly in the background within our infrastructures. For example, in energy distribution, continuous streams of data from individual sources deliver load demands to energy providers in order to seamlessly balance power and avoid service interruptions[8]. Whether put into use discreetly or explicitly, this ability for real-time reflexivity can provide a wide variety of insights into both our supporting infrastructures and the patterns and trends that individuals fall into. It can also offer novel forms of interaction and information exchange in both physical and digital environments. As with any new opportunities, questions arise about whether these emergent technologies and access to big data will

serve to complement our lives or add unnecessary complexity to our existing issues.

The experience of the public space is already changing with accessibility to data[9]. As physical public space has served as an important mechanism for information exchange over the centuries, the ease of digital information access has shifted the order of inhabiting physical space. In opposition to the top-down design process of physical space, users that have access to urban data suddenly possess a bottom-up awareness of how to intervene within their physical environments. This pushes towards a more democratized shape of the city where users are able to affect their surroundings in ways that were not previously possible. While these are optimistic views of how urban informatics can positively alter our physical world experiences, it is of course a possibility that the opposite can also occur. As the philosopher Albert Borgman describes it, "There is a difference between information about the world, information for the world, and information as the world. Information can illuminate, transform, or displace reality.[10]"

While the access to real-time data can offer pertinent information about our world, it can also lead to the over-consumption of data. The over-consumption of data, as can be seen in the frequently written articles on people spending too much time on social media platforms, can prove to be a drain on our collective attention spans[11]. At a time when it is crucial to increase focus on our global crises, the pervasiveness of data and the ease with which it grabs our attention can lead to our further loss of engagement with our physical surroundings[12]. Taken a step further, there are many arguments around the isolating effects that the pursuit of data at increasing speeds can have. John Thackara calls it the 'desert of the real' and warns against the growing disconnection with living systems while we're too busy inhabiting the abstract world[13]. Paul Virillio states that the acceleration of communications into 'real time' effectively destroys the experience of the present by isolating it from its context in history[14].

In addition to the threat of desensitization and distraction, there exists a threat to general privacy, and as a consequence, issues concerning security. In order for personal data to be used effectively, it must be stored in databases. Unfortunately, data can be stolen from databases via cyber attack, thus opening up individuals to potential exploitation. In addition to this, within a signalling economy, although it may be explicit that participation is voluntary, there is the possibility of an unravelling of information that essentially makes the option an illusion[15]. In the theory of unraveling, a tipping point of participating users will psychologically force remaining users to participate as well. In this case, the option for privacy is essentially non-existent. Within reports of US consumers, there are already signs of powerlessness and futility with regard to corporations' efforts to mine their data[16].

The potentials that urban informatics bring are far reaching, while the possible dangers are not to be taken lightly. These questions will become increasingly more important to address when emergent augmented reality (AR) technologies become ubiquitous and the boundary between digital and physical realms becomes further blurred. As a precautionary measure, the implementation of these technologies must be coupled with adequate experiential design. Depending on how this is executed, the data we see can ultimately enliven our world, or isolate us even further[17].

[3. Telling stories with data.]

While telling stories is the universal method with which we choose to communicate with each other, it can be greatly enhanced by real-time data. Basing our stories on data has probably existed since the conception of storytelling itself, but this is the first period in time when we are able to enhance our stories with access to big data on urban operations processed in real-time. Looking back at what makes ideas stick, two of the core points to consider are building credibility and providing concrete connections within the stories we tell. If the use of real-time data is effectively integrated into our stories, we can quickly provide the credibility

and concrete connections necessary to effectively convey complex issues to audiences. Credibility can be established if data is properly used as a form of evidence to support statements made, and concrete connections can be forged by using data to illustrate how one or several factors in a system affect it or other systems. Credibility and concrete connections are in turn key factors in creating spaces of trust and understanding, and are vital in effectively communicating information about complex networks.

The use of real-time data can also serve as a foundation for supplying users with their own tools for observing and analyzing data, thus fostering participation and encouraging the user to draw their own conclusions about issues at hand[18]. Providing the means to evaluate an aspect of a system is crucial in that the user can develop their own rationale and motivations for participation[19], whereas the simple enforcement of rules would likely fall on deaf ears. When visualizing data, it is vital that the data be strictly utilized as a tool to represent reality as a placeholder for a real object, but not as the object itself[20]. This important aspect is often lost and the data, usually in the form of numbers, is taken as the true representation of reality, where in actuality it carries with it levels of uncertainty, errors and imperfections[21]. Furthermore, in using the tool of data as an abstraction, we have the tendency to forget that data can ultimately be traced to people[22]. The real-time data we typically use are human-made, either from measuring actual people, or a downstream effect of human behaviour. It was the belief of the Situationists that a city could not be understood as a system until we understood the experiential/emotional layer that was created by the experiences of the citizens[23].

Precedence for these approaches can be seen in the web application, *Friends in Space*. Designed by data visualization company Accurat, *Friends in Space* was a tool that allowed people to say hello to astronaut Samantha Cristoforetti on her expedition to the International Space Station.

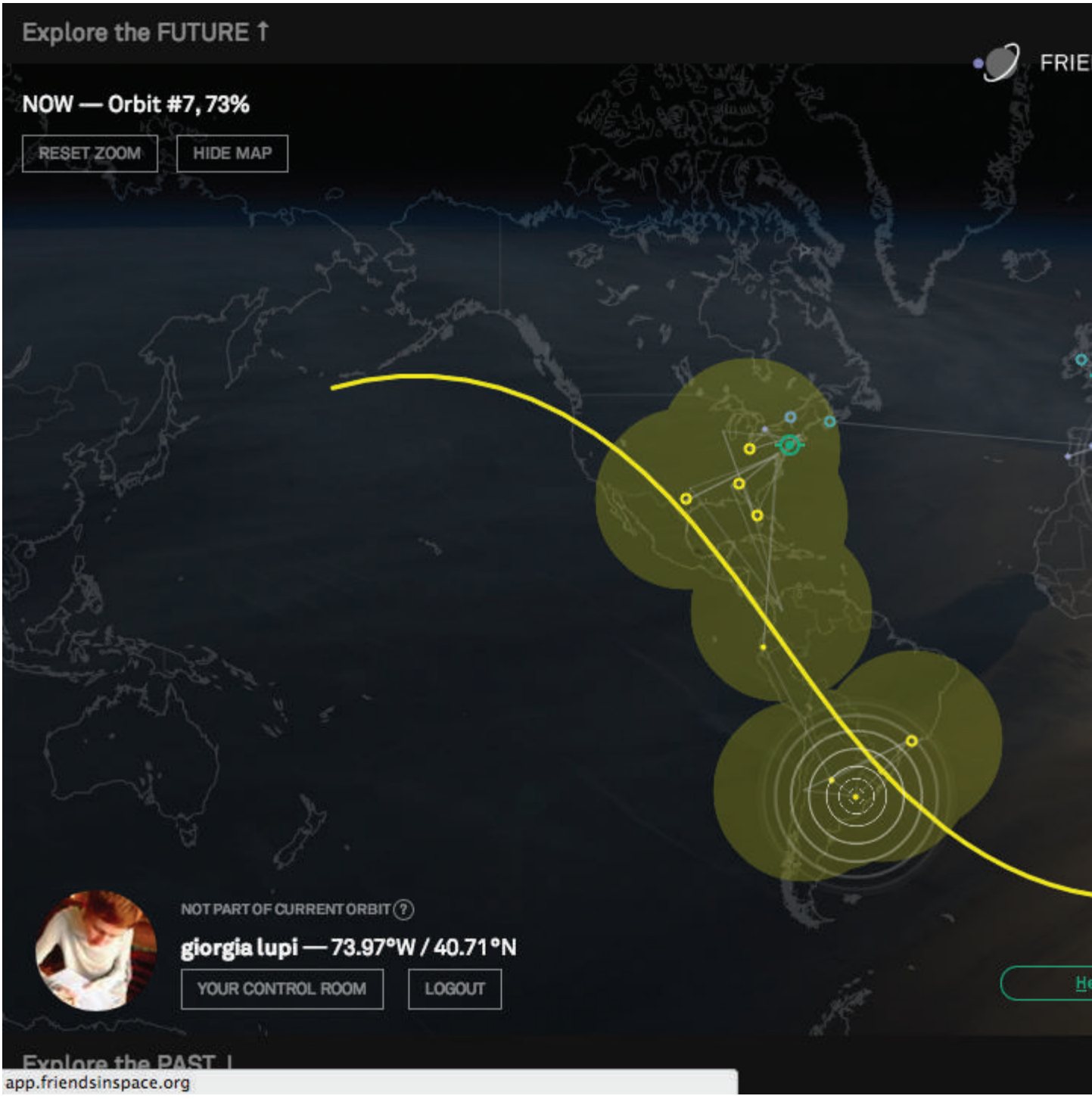
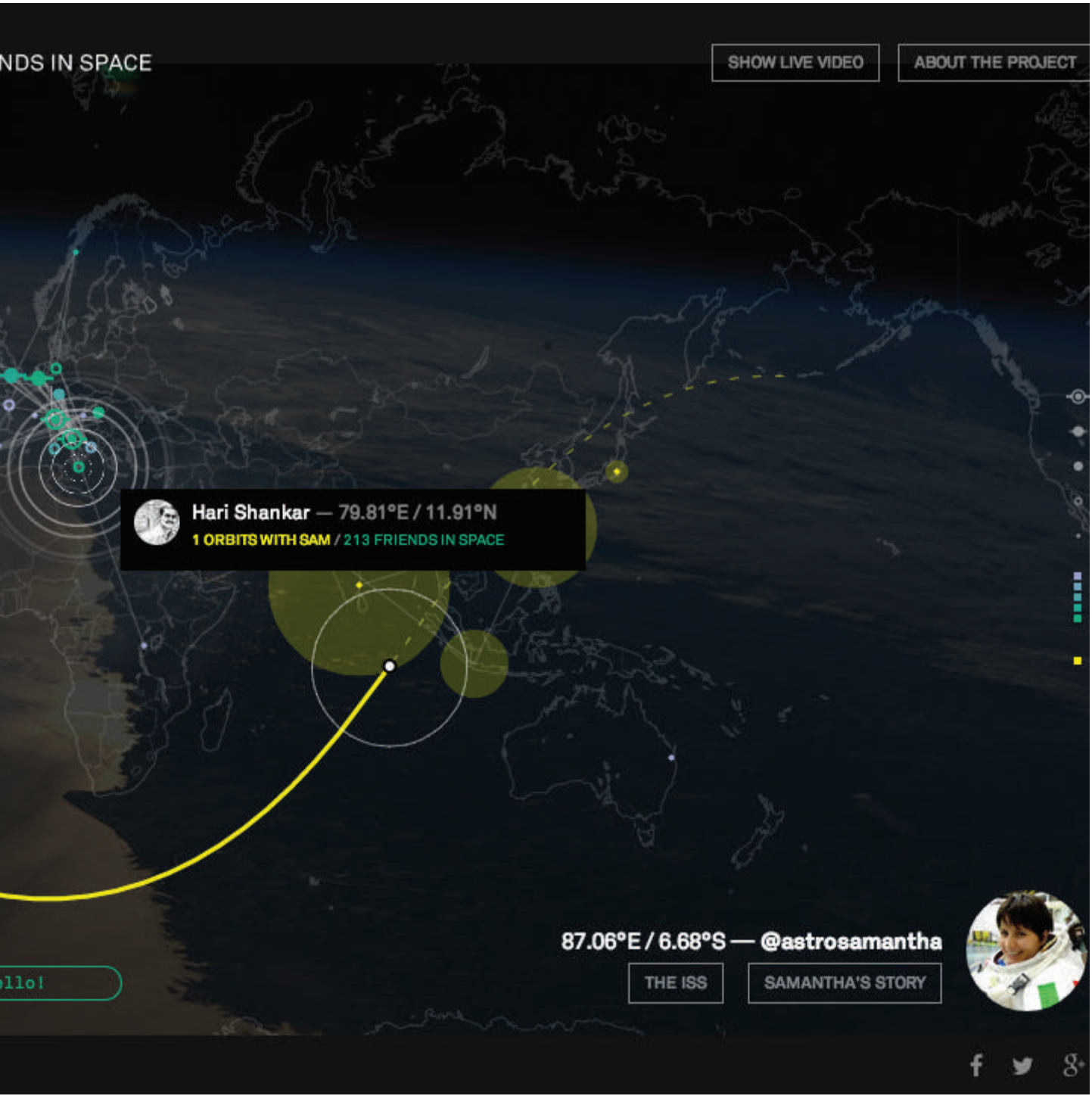


Fig. 2.5 Friends in Space
Interactive map showing the travel path of Samantha Cristopforetti in relation to the friends who have digitally said hello to her.


NDS IN SPACE
SHOW LIVE VIDEO
ABOUT THE PROJECT
Hari Shankar — 79.81°E / 11.91°N
1 ORBITS WITH SAM / 213 FRIENDS IN SPACE
87.06°E / 6.68°S — @astrosamantha
THE ISS
SAMANTHA'S STORY

Despite having access to all data imaginable pertaining to the expedition, the designers at Accurat decided to concentrate mainly on the potential connections between Samantha and the civilians that she was passing over. This was done by offering users the ability to wave to her, an innately personal gesture, on top of a backdrop of her real-time trajectory.

While using real-time data can be a valuable method in forming a level of credibility, there also exists the issue of ensuring effective communication when targeting a diverse range of social groups. Since one's perceptions of risk are formed by the social norms inherent to one's group, the effective concrete connections vary among social groups. A method of soliciting information may be successful with one group, but prove alienating to another[24]. To address such issues, any tools we design should incorporate feedback processes that enable dynamic changes to the approach of user interaction. This can facilitate greater reach and begin to build trust in communication[25].

[4. Informed behaviour.]

Out of the many wicked problems that we face, it is characteristically difficult to measure an individual's contributions to issues such as poverty or terrorism. In the case of global warming however, an individual's contribution of carbon dioxide equivalents can theoretically be measured down to the last gram[26]. Although the documentation of carbon footprint does not exist down to the granularity of each specific product that we consume, it is still possible to inform individuals of their environmental impact by creating a repository of best estimates. Patches of this accounting already exist in varying degrees within focused research projects and silos of information kept by businesses. By attempting to aggregate these pieces of existing knowledge and by updating it with the latest research, a foundation for a tool aimed at giving consumers informed choice can be created. The access to such a tool can also reveal to us exactly how incomplete our understanding is of the overall effects of our current supply chains, and possibly create a demand for more transparency.

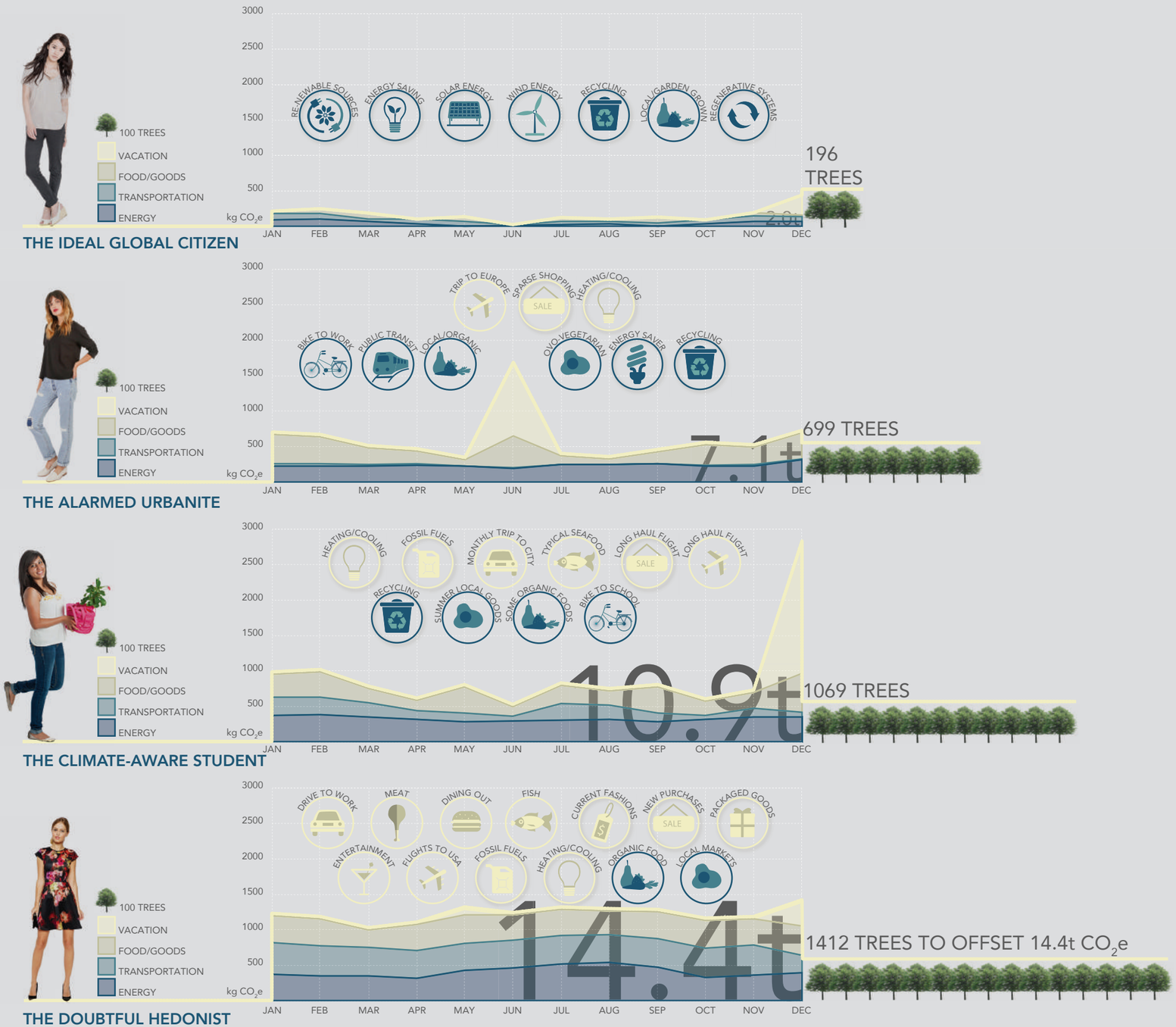


Fig. 2.6 Hypothetical user groups
An overview of the types of decisions that can be made over a year by four separate personas. To illustrate the impact of their total carbon footprint, the amount of trees required to offset their emissions is included. The number of trees are under the assumption that they are newly planted and will be upkept over the course of 20 years.

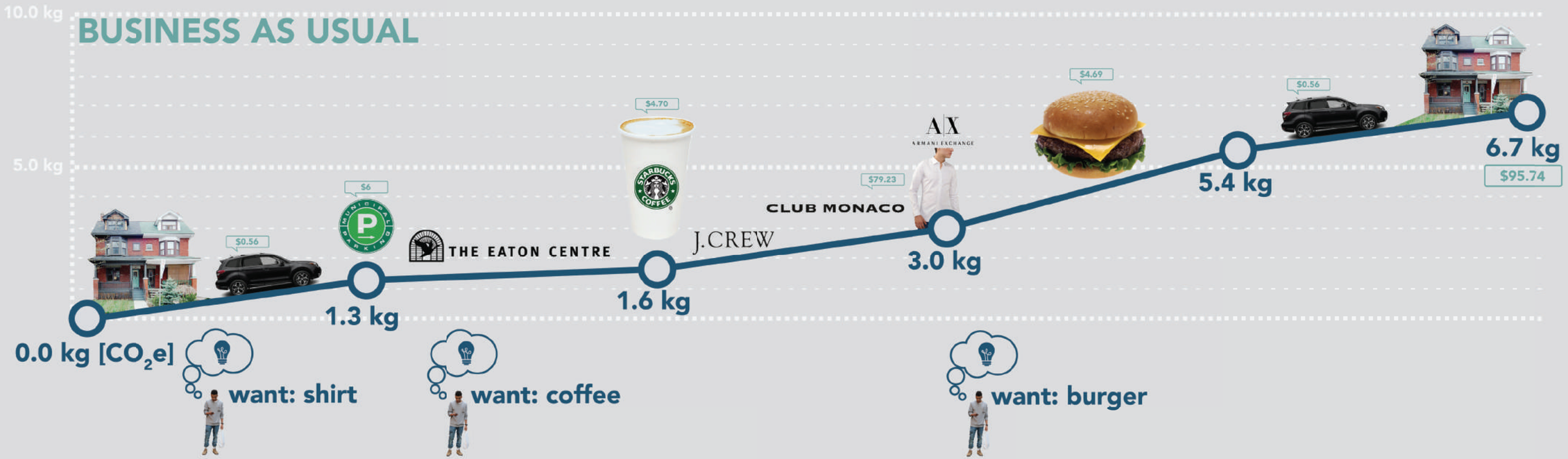


Fig. 2.7 Business as usual
How the emissions from purchases can add up over the course of a day out without being aware of alternate options available.

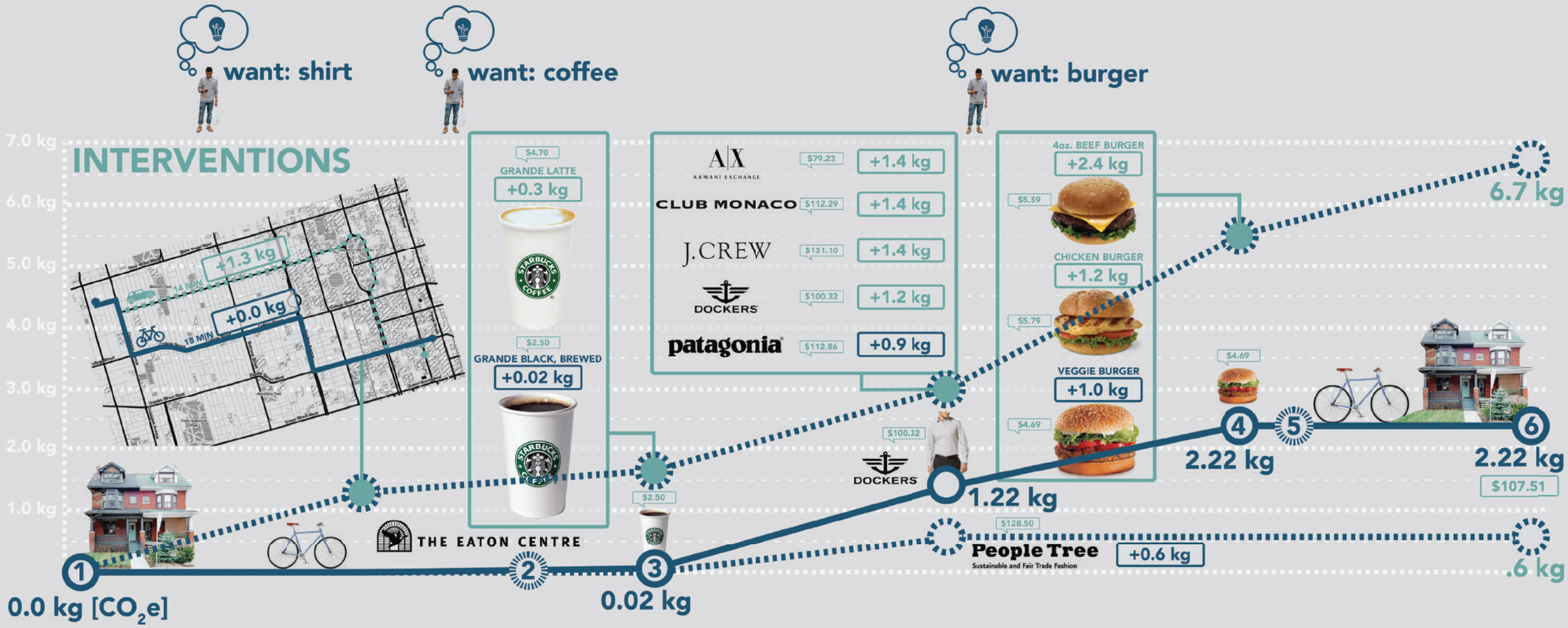


Fig. 2.8 Interventions
Potential difference in the emissions from purchase decisions if alternate choices were known.

FOOD & DRINK

1 kg CARROTS

0.25kg CO_2e LOCAL, IN SEASON

0.3kg CO_2e AVERAGE

1kg CO_2e SHIPPED BABY CARROTS

ASPARAGUS

0.125kg CO_2e 250g PACK, LOCAL & SEASONAL

3.5kg CO_2e 250g PACK, AIR-FREIGHTED FROM PERU IN JANUARY

1 kg TOMATOES

0.4kg CO_2e ORGANIC, TRADITIONAL VARIETY, LOCAL IN JULY

9.1kg CO_2e AVERAGE

50kg CO_2e ORGANIC, ON THE VINE, IN MARCH

Fig. 2.9 Food & Drink
Examples of differences in emissions from produce items depending on source and time of year.

ENERGY CONSUMPTION

SHOWER

0.45kg CO_2e 15 MINUTES, EFFICIENT GAS BOILER, AERATED

1.25kg CO_2e 15 MINUTES, TYPICAL ELECTRIC SHOWER

1.7kg CO_2e 15 MINUTES, 11-KILOWATT ELECTRIC POWER SHOWER

LAUNDRY LOAD

0.6kg CO_2e, 30°C, DRIED ON LINE

0.7kg CO_2e, 40°C, DRIED ON LINE

2.4kg CO_2e, 40°C, TUMBLE DRIED IN VENTED DRYER

3.3kg CO_2e, 60°C, DRIED IN COMBINED WASHER-DRYER

LIGHTS

90kg CO_2e, LOW ENERGY BULB, 1 YEAR

500kg CO_2e, 100W INCANDESCENT BULB, 1 YEAR

Fig. 2.10 Energy Consumption
Examples of differences in emissions from energy-based actions.

CLOTHING & JEWELLERY

PANTS

3kg CO_2e NYLON PANTS

6kg CO_2e COTTON JEANS

SHOES

1.5kg CO_2e CROCS

8kg CO_2e SYNTHETIC

11.5kg CO_2e AVERAGE

15kg CO_2e ALL LEATHER

NECKLACE

0kg CO_2e HANDED DOWN OR MADE FROM SEASHELLS & DRIFTWOOD

200kg CO_2e $1000CAD GOLD

400kg CO_2e $1000CAD GOLD & DIAMONDS FROM MINES IN DEVELOPING COUNTRIES

Fig. 2.11 Clothing & Jewellry
Examples of differences in emissions from clothing based on source material.

It is unlikely that a single governing entity would be capable of amassing all the data required for such a project. Realistically, it would have to be gathered via crowd-sourced efforts and subsequently verified by a validation method. Accessing the silos of information within businesses and other organizations would introduce the need for partnerships, which would likely prove difficult as the data would likely contain reasons to discontinue the use of the business' products. Although it is understood that current carbon counting values are best measures, there needs to be an effort to uncover the leaks that take place in carbon emissions estimates. There is a question to the quality of the best estimates that are developed by consulting companies and researchers. Various models are used in making these estimates. As supply chains are highly convoluted and various sectors intertwine, each model has their separate advantages and disadvantages. Two examples of these models are process life-cycle analysis and environmental input-output analysis. The process life-cycle analysis works its way up through the steps required in creating a product and produces an estimate. This method is almost always an underestimate as there are always leaks in the lifecycle that get unaccounted for. The environmental input-output analysis works its way down from the macroeconomic view and utilizes a method of calculation that can account for the rippling effects that industries have on other industries, thereby generating a complete estimate. As a result, one can obtain a crude estimate of a product's carbon emissions just by its pricing. However, this method discounts importing versus domestic goods, which is a key weakness[27]. The general accounting of carbon emissions across the board is imperfect and requires more understanding of systems to provide increasingly accurate values at more granular levels. Nevertheless, the best estimates that we have today are enough to create a starting point in signalling the areas that we need to focus on the most.

Working on the assumption that this data can be developed, the use of such data within a digital platform can work towards circumventing many of the cognitive biases that prevent us from acting on the issue today. One of them is overcoming the lack of an informed choice

where we are unaware of the full risks that we are assuming with the actions we make[28]. Another is using the data to defeat the 'tragedy of the commons.' By offering the ability to observe a data stream of our individual actions within a collective group, we can follow each other's steps towards improving our operations and create spaces of trust and open communication[29]. This ability to see the effects of our actions can also reveal the progress we have made compared to the ways we still need to go, which could counter our tendency in resulting to single action bias[30]. While these cognitive biases would have to be overcome as individuals, having the capability of observing the effects of our actions as a group can also potentially facilitate a collective, double-loop learning. Within this process of learning, there can be single-loop learning or double-loop learning. Single-loop learning occurs when direct feedback provides confirmation of our assumptions about the effects that an action may have. Double-loop learning begins when unintended consequences from our actions are realized and a re-evaluation of our underlying values begin[31].

In the face of today's reality, there is a necessity for us to make connections across our standard social groupings and commit to developing solutions and sharing best-practices. Prominent proponents of the public sphere as being places where strangers can confront and come to terms with each other include Hanna Arendt, Richard Sennett and Jurgen Habermas. Although there are variances in their exact positioning on the subject, their main argument for the public sphere is that it is a place where participants can set aside their individual interests and come together to focus on a common interest[32]. Today, this notion of the public sphere can be extended and enhanced by the digital sphere if the experience is designed with the goal of action in mind. These ideas can be seen in the local food platform The Food Assembly. The Food Assembly essentially enhances the experience of a farmers' market with an online ordering platform. Anyone can start a local assembly where they recruit members to join. The assembly then works together to seek local food producers to offer their goods over the online platform. At a designated time and location, they assemble and producers can offer their products

to their customers directly. In this model, the food producers can set their own pricing to get a fair return and only need to harvest/ produce what is requested to eliminate waste[33]. On this platform, the important feature is that there is plenty of opportunity for citizens to become actively involved in the common purpose of encouraging the consumption of local products, thus allowing them to feel a sense of belonging that strengthens the community[34].

There are many opportunities available for us to create interfaces that allow for more informed choice in the everyday decisions that we face. What we do lack is the awareness to these possibilities. Local level initiatives start everyday, but it is easy for them to get lost in the over stimulating barrage of articles and distracting media that seem to refresh themselves every minute. What we must continue to do is push social collaboration and sharing:

> Design for sustainability, it is turning out, is not about designers telling other people how to live. It's about the co-creation of tools and enabling platforms that make it easier to share resources – such as energy, matter, time, skills, software, space, or food. Developing grand visions for futuristic new systems is an important part of the mix – but so, too, is nurturing a continuous wave of small adjustments[35].
>
> -John Thackara

Thus, by constantly developing systems where participants can find ways to improve their routine activities, we continue to build upon a repository of best practices, which will become localized practices due to the importance of physical context. With the tools we have at our disposal, we have the responsibility to create a sort of public space that emphasizes the importance of being present and exchanging knowledge learned in a specific place[36].

[5. Finding potential.]

The collection of data is important for both initial research on where the possible areas of intervention are, and for maintaining a continuously updated baseline that we can measure against to track progress towards achieving our goals. Through the experiential design of data,

Fig. 2.12 Food Assembly Map
Locations of several 'food assemblies' across the UK.

Fig. 2.13 Food Assembly Values
The Food Assembly's core concept of physically connecting people through ease of accessing food with technology.

there are plenty of opportunities to build meaningful connections between diverse groups, which will lead us away from the distractions that data potentially creates and into initiatives that encourage us into taking increasingly more action:

> Working with data means designing ways to transform the abstract and the uncountable into something that can be seen, felt and directly reconnected to our lives and to our behaviours, something that is hard to achieve if we let the obsession for the numbers and the technology around them lead us in the process.[37]
>
> -Giorgia Lupi

In beginning to make sense of the complexity of global warming, drawing concrete connections between our everyday actions and the role that they play within the existing system can offer a sense of an informed choice, which is critical in facilitating behaviour change. By facilitating links between already existing silos of information and visualizing the effects of our actions in the urban context, the greater picture of the existing systems we rely on will become more comprehensible. In response, we can adjust ourselves accordingly in hopes that others will follow.

Finally, the tools that we create with data must keep in mind the importance of enabling a sense of agency and action. Although individuals tend to feel hopeless in the face of larger businesses and corporations, we have to remember that total impact is a product of population and impact per person[38]. Businesses can and do respond to public pressure[39]. What needs to be kept in check is that the improvements made are truly shifts in underlying ideals and not merely cosmetic adjustments. Considering this, as participants within larger social groupings and networks, these tools should allow for an overall ease of access to each other's data in order to enable accelerated learning from the trials and errors of our collective actions. The story of the Easter Islanders' collapse may be a foreshadowing of a worst-case scenario of our future, but with our access to ICTs, we have the capacity to quickly learn from each other's mistakes and adapt accordingly[40]

CHAPTER THREE
DATA GATHERING

TOTAL CO_2 EMISSIONS PER COUNTRY PER CAPITA [2011]

450ppm CO_2
POINT OF NO RETURN

Fig. 3.1 Carbon Diagrams

[1. Initial Studies.]

During the first pass of information gathering, defining the problem, and ideating, the scale of research and design was kept broad. Information gathering of carbon emissions was done at a global scale, a country scale for a few selected countries with a focus on Canada, and at the city scale for Toronto. In the carbon studies, the data gathering process relied solely on various publicly accessible sources such as Statistics Canada, NASA Earth Observations, and The World Bank, among others. For the complete version of the carbon studies, please refer to Appendix A. As the research statement at this point was focused on the representation of information, various precedent studies in different medium were done according to their reach and levels of participation. The complete list of precedents looked at can be found in Appendix B.

The statement of the problem early on in the process was as follows: How can emerging and existing technologies be used in order to establish new forms of information representation that can serve to bridge the gap between the individual and man-made climate change and subsequently influence decision making in their everyday lives?

Based on this definition of the problem, several ideations arose as possible solutions. The main foundation was that a platform would be created where the carbon emissions of products and services consumed would be tracked and displayed in order to form a baseline for various other functions, such as the ability to view an individual's progress, or a social grouping's progress in aiming to lower their carbon emissions. This platform would be digitally connected to various physical objects that could signal individuals to their continual progression towards their defined goal. The complete range of explorations and the initial design proposal can be found in Appendix C.

Fig. 3.2 Ideation 1
Pre-testing design proposal of user interface.


TOMATOES
TOMATOES ARE CURRENTLY NOT IN SEASON IN YOUR LOCATION. FIND ALTERNATIVES:
HOMEGROWN 25 g/g
Learn how to grow your own tomatoes for the coming season.
LOCAL 150 g/g
The farmer's market nearest you is this Saturday. Check out their offerings.
GREENHOUSE 347 g/g
Ontario offers greenhouse tomatoes this time of year. Find out more.
CALIFORNIAN 9 kg/g

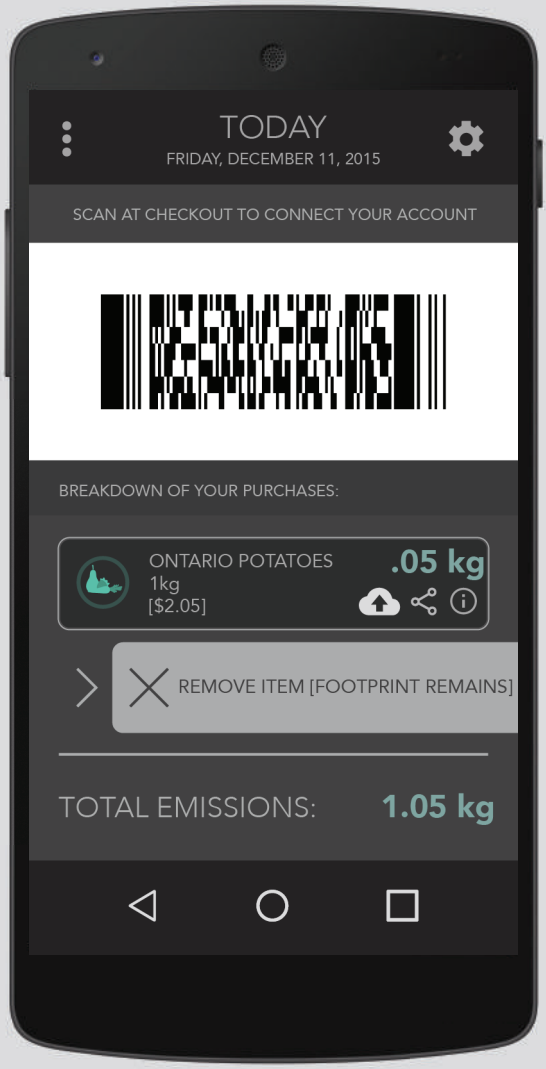

TODAY
FRIDAY, DECEMBER 11, 2015
SCAN AT CHECKOUT TO CONNECT YOUR ACCOUNT
BREAKDOWN OF YOUR PURCHASES:
ONTARIO POTATOES
1kg
[$2.05]
.05 kg
REMOVE ITEM [FOOTPRINT REMAINS]
TOTAL EMISSIONS:
1.05 kg

Fig. 3.3 Ideation 2
Image from pre-testing design proposal showing possible futures from global warming.


Tim Hortons
TASSIMO
FALLSVIEW CASINO
NIAGARA FALLS
EXTREME RAINFALL
IF ALL TORONTONIANS CONTINUALLY EMIT AT YOUR RATE, WE WILL SEE INTENSE DOWN-POUR, CAPABLE OF PARALYZING THE CITY FOR WEEKS.
milestones
GRILL + BAR
TASSIMO
the barcode brews it better
FALLSVIEW
CASINO RESORT
APRIL 29 & 30
IL DIVO
JACARDIA
BUILT TO MOVE
MERRELL
Soft Moc
PAVEL'S
YEARLY EMISSIONS
20.7t
CO_2e

[2. Empathy 2.0.]

The second pass of empathizing in the design thinking process involved running a general survey within Toronto to build upon the ground work completed during the first phase. It also involved conducting interviews with field experts within and exterior to the field of architecture. While the outcomes of ideation developed during the first phase were based on a body of collected data from publicly available databases and studies, the goal of the second phase was to find out which of the proposed solutions would potentially gather the most participants. The survey respondents were questioned on whether they cared about issues such as global warming and to what degree. They were also questioned about the motivations behind their purchases, and types of situations that would encourage a change in those behaviours. The interviews with field experts were held to research the types of projects being worked on within different disciplines, and how they explicitly or implicitly deal with the issue of global warming. Interviewees were also questioned about their general views of what could or should be done, and how they would collaborate with architects if they had the opportunity.

The general survey consisted of 22 questions and was designed with consultation from the Survey Research Centre at the University of Waterloo. It was ensured that the questions would achieve their purpose and that none of the questions were leading. The survey was run through the surveying service Pollfish. The original goal was to obtain a sample size of 260 respondents from within the city of Toronto. Based on Toronto's population of 2,826,500[1], this would have given a margin of error of ±6% with a confidence level of 95%[2]. The demographic groups were broken down in age groups between 14 and 55+ years. Quotas of age requirements for the respondents were set to be representative of the age demographic of the city.

When the survey was deployed, a few problems were encountered

that affected the outcome of the survey. Due to the service being based in Greece, there was an issue with the sorting by postal codes, which assumed all postal codes to be numeric. As a result, the automatic filtering system nullified almost every respondent based on the Canadian alphanumeric postal codes. Upon catching this, the service found that there were 1569 completed surveys, giving a minimum margin of error of ±2.5% for the multiple choice questions. Of the completed surveys, there were 402 respondent entries that were useable for next phases of prototyping and testing. This was found after filtering out the surveys with unusable responses for questions with open answers. This amount gives a 95% confidence level with a margin of error of ±5%. While this is less than the original target, the quota in achieving a representative age group was not met.

The field experts were interviewed in tandem to the survey process at their convenience. The structure of each interview had 3 parts, each with 5 prewritten questions in advance. The first part dealt with their general opinion on global warming while focusing on audience engagement, what they thought should be done, and any methods of engagement that they thought were underutilized. The next section focused on their field of work and the challenges they face in engaging their main audiences. The final section focused on what they thought were important facets of their profession that architects could learn from. Although the interviews were conducted with predetermined questions, there was room for interviewees to comment on areas that they thought were important to expand on and address.

The full survey questions and results can be found in Appendix D and full transcriptions of the expert interviews can be found in Appendix E.

INTERVIEW HIGHLIGHTS

INTERVIEW HIGHLIGHTS: USMAN HAQUE [UMBRELLIUM]

Interview highlights for Usman Haque, from the firm Umbrellium. He was interviewed for specializing in citizen engagement.

Current focus:

I am trained as an architect, and arguably, the work that I'm trying to do I still consider within the discipline of architecture. But the work encompasses more than just buildings and involves, on the one hand, projects that basically research the way that people relate to each other and the spaces around them, and how they become a part of the process of making decisions about, and ideally contributing to, their city. On the other end of the spectrum, the work I do is actually in technological infrastructure deployment, in sometimes technology products, and sometimes actually in the city itself. In that case, it's surely about building an internet of things, networking technology and stuff like that.

In your opinion, what are the changes most urgently needed today, with respect to global warming?

I think that what I would like to see more of in that context is more about the tools to action rather than just tools for information. In other words, there's quite a lot of work going on in, for example, deploying a bunch of sensors or building maps and visualizations, all of which is well and good and is necessary for certain things. But unless that stuff is all harnessed for the purpose of making decisions and enacting them, executing those decisions, all it is is spectacle without that. And so my question would be, first of all, how do we get more people involved in the evidence gathering process themselves? ... when I'm calling for more people to be involved in the amassing of evidence, it's because actually, we all have to be part of that process of a collective making sense. It can't just be the domain of some people with respect to others just kind of following along. Because I think the outcome of doing that that way, is not necessarily better evidence in a strict kind of empirical science sense. The outcome is a greater sense of responsibility and agency and involvement and kind of dedication and investment in an outcome, which is basically the sustainability of the human species. So it's not really about the data so much for me.

INTERVIEW HIGHLIGHTS

What do you view as the greatest barrier to fighting global warming for people on an individual level?

... I think that the biggest barriers are these kind of systemic logical conflicts, almost. And that's where I see potential roles for designers playing a really interesting part in actually somehow bridging these things that are – they're kind of complex. ... I think that there's been this kind of discourse of design over the last ten years or so, twenty years maybe, about design being about simplifying things or that being a task for design and I really want to push back against that. I think that, first of all, the idea that designers have some clarity that others don't, I think, needs to be challenged. But secondly, I think that the issues that we face are so complex that trying to make a simplified one-liner, linear kind of description, or trying to translate something like that is potentially actually harmful, not just not beneficial. And, so I think that in the context of what I was saying, like trying to get people together to discuss their own complex issues, what I'm not looking for is that a designer helps translate between them. I'm talking about a designer being able to provide a forum or a context or an environment for conversation where those people can kind of build up their own trust of each other.

What can you see architects doing in order to encourage people to get over the prisoner's dilemma that is entangled with climate change?

The interesting thing about prisoner's dilemma of course is that if both parties know that each other is cooperating, it turns out to be a net benefit for them both to cooperate. It's just that the lack of knowledge between the parties leads them to not cooperate. So, my proposition would be not just for a building to become net zero, but actually think about how can your building connect with the buildings around it or with the other – with the context that you're in. So it's not just net zero, but it's actually contributing wider to everything else. Even if you don't know whether they're going to reciprocate, just to do that anyway because that itself had kind of an on going cumulative effect of countering that prisoner's dilemma issue. Because the more people that do it, the more people will do it.

Fig. 3.4 Mini-Burble
Umbrellium's citizen engagement spectacle.

INTERVIEW HIGHLIGHTS

INTERVIEW HIGHLIGHTS: JEREMY TILL [ARCHITECTURE DEPENDS]

Interview highlights for Jeremy Till. He was interviewed for advocating for an emphasis on social issues within architecture.

Current focus:
Architect, writer and educator. Head of Central Saint Martins and Pro Vice-Chancellor of University of the Arts London.

In your opinion, what are the changes most urgently needed today, with respect to global warming?
I can't even begin to answer that question because it's just too massive because the whole thing is so interconnected. But I suppose the main thing is an absolute political will to make it happen and the trouble is politics are so compromised by the market at the moment. ... So until there is actually a market imperative for global warming, nothing's going to happen I'm afraid.

What do you view as the greatest barrier to fighting global warming?
Lies. Quite simply that we have a campaign led by vested interests to suggest that global warming is either fiction or else not as serious as it really is. The facts are completely uncontroversial, there's no doubt about that and so until those facts are absolutely explicitly accepted by every single party, we're not going to make progress.

What would you say is an action that individuals make that has the largest carbon footprint, yet is easiest to fix?
Well, you can do very immediate things at a domestic level. But that is only really putting sticking plaster on a gaping wound. And I'm not saying you shouldn't do that. I think that people should be responsible by basic environmental controls and basic fabric changes and you know, that's all fine. But it is also all tied up in a kind of sense of – we need a systemic change to the way that we value things and privilege things. As long as we are in a cycle of endless consumption, global warming is going to increase because consumption lead to extraction. ... In order to re-evaluate what systems of growth mean, and an economy and a culture which is based on the premise of endless growth is an economy and culture which is heading for oblivion.

INTERVIEW HIGHLIGHTS

What is the potential role of the architect in operating beyond the profession's traditional boundaries of a project (e.g. the software of a project)?

Good question because I think that's also kind of a professional question as to what constitutes architectural knowledge. Professions initially were set up as keepers of architectural knowledge and architectural knowledge was always seen to be both expressed and then validated through the building. Whereas my argument and Tatiana's and everyone I work with is to argue that architectural knowledge has a much broader set of social and spatial consequences. But the profession would find that really difficult to accept now because it's so bound to the idea of architecture simply being to do with a building. The whole award system, for example, is completely obsessed by the validation of refined objects. Why is that? ... And I'm not saying people aren't going to be designing buildings. People are going to keep on designing buildings but I think there is the opportunity for people to do other things beyond.

Are there any approaches to outreach strategies that you think we should be focusing on, but are under-utilized?

I think that the whole thing of collection of bottom-up processes, particularly within the western political system at the moment. But since we're in a massive democratic deficit, and since we're in an age in which politics as a democratic system has more or less been taken over by politics as an ideological and neoliberal system, the only alternative is through the collective of local-scale initiatives.

INTERVIEW HIGHLIGHTS

INTERVIEW HIGHLIGHTS: ANTONY TURNER [REAL WORLD VISUALS]

Interview highlights for Antony Turner. He was interviewed for specializing in making carbon emissions tangible through visualizations.

Current focus:
I am a company director ... and for the last 20 years my background has been in helping people understand climate change and sustainability generally, particularly in the business community. In the last five or six years, my interest has moved to cross into using data visualization again to help communicate the carbon climate challenge, and other invisible environmental challenges and issues.

In your opinion, what are the changes most urgently needed today, with respect to global warming?
I think that a genuine public understanding of the severity and necessity for speed of action is very critical. I think that the public's understanding is still very patchy and it lags behind the policy makers generally, and the business community as well.

What do you view as the greatest barrier to fighting global warming?
I could say it's the invisibility of the gasses. ... I think just being able to see greenhouse gas emissions being carbon dioxide coming from power stations, coming from vehicles, coming from transport, coming from our homes, that's one of the, really the biggest barrier I think to engaging with the problem.

What are the challenges that you're dealing with in catalyzing engagement in your audiences?
Our specialty is targeting unengaged audiences. We've just done a blog about this actually. We call it a push audience. So most data visualizations, most graphs, if you look at a bar chart or any kind of abstract visualization like a bar chart or a pie chart or something, it is abstract. And its primarily designed for people who are already familiar with that data and they work very well. ... but it's not the best thing to use if you want to say, grab people and say, "Hey have a look at this. You know. This is something you should think about. This is something you should be engaged with." And that's the audience that we're looking at. It's also true to say that decision makers in the world are generally very time constrained

INTERVIEW HIGHLIGHTS

people. And so, it makes sense if you're trying to get in front of decision makers, policy makers, people at a senior level in government or business, to have some very powerful, simple graphics that illustrate what you're trying to say.

...

So these things – it's surprising how little things that you can do. You talk to somebody, you just get somebody to understand something and you never know what they're going to do with it or how that's going to work. So, we have to keep getting the message out. But not in a shout-y way, I mean that's the trouble. I have friends who are activists and campaigners and I think there are times when activism and campaigning is really important. But also, we have to learn communication methods which are more inclusive and accepting of other people's views and non-confrontational. So our speciality, I suppose, is non-confrontational, honest imagery that helps people kind of get that first message to go, "Ok, yeah this is real." That's what we do.

Fig. 3.5 New York's Daily CO_2
Real World Visual's visualization of the space the total daily carbon emissions of New York City would occupy if it were a visible substance.

INTERVIEW HIGHLIGHTS

INTERVIEW HIGHLIGHTS: CHRIS NEWMAN [SYLVANAQUA FARMS]

Interview highlights for Chris Newman. He was interviewed for specializing in sustainable agriculture through permaculture.

Current focus:

My original professional background is as a software engineer... and I was a consultant, and basically the consulting life was extremely stressful... so my wife and I decided to move up what we thought would be a retirement project with farming and just move it up to right now.

In your opinion, what are the changes most urgently needed today, with respect to global warming?

I think the biggest thing that agriculture can do, and the things I'm working on is reducing reliance on meat, reducing the disconnect between food production systems and nature. So the idea is that right now when people want to create a farm they take all those trees, they'll take the forest, and they'll bulldoze all of it. Then they'll plant a grain field that's this horribly unnatural thing that has to be put on life support with a combination of synthetic fertilizer and sprays. Just all these things that require these inputs that in the way they are produced are huge drivers of climate change. They produce huge amounts or carbon, they cause soil to wash out, they cause chemicals to leach into the watersheds and sometimes poison the ground water. And when you get rid of all those trees you have to irrigate, in a lot of cases that starts to draw a lot of resources out of the ground. ... So I think if I had to put it into one big thing, it's that our agriculture systems today are overly market oriented. I don't think you can ever get away from the market and tell people this is what there is. I think that's ideal but unrealistic, but I think that agriculture at least needs to put ecological needs on par with the needs of the market, and to get rid of the things that are causing agriculture to drive climate change.

What do you view as the greatest barrier to fighting global warming?

I think the weight of the issue is the fact that so many people who are environmentalists, who are trying to have this discussion around climate change don't have their hands in the dirt. They are not farmers. They are not the people who wake up at 4am and stay up until 10 o'clock to try and till the land. And it's difficult

INTERVIEW HIGHLIGHTS

for people like that to have any real credibility with people who should be on the side of helping the agriculture to address its drivers of climate change. ... We need to not be such snobs about it, and we need to come at people who are on the ground, whose livelihoods are affected by climate change, and whose decisions can more directly affect climate change. We need to find more of a way to empathise with them. We need to understand where they are coming from. ... And for most people it's people doing various levels of agreeing with each other. It's exceedingly rare to get people in a think tank in New York to talk to a California almond farmer. It's extremely rare to get these people in the same room talking about the same issues. You just get people talking past each other. And as much as I'm a technologist in favor of the good things social media has done, I think it has made it extreme easy for people to get into their separate ships shooting at each other instead of getting in the same boat, and we all need to be shooting at climate change.

Fig. 3.6 Permaculture at Symbiont Gardens
Example of permaculture farming, which is an eco-system based agricultural method that Chris Newman works towards achieving.

INTERVIEW HIGHLIGHTS

INTERVIEW HIGHLIGHTS: IAN MONROE [OROECO]

Interview highlights for Ian Monroe. He was interviewed for his focus on engaging individuals to act against climate change through an online platform.

Current focus:
Teaching courses on scaling up climate solutions at Stanford. Realizing that one of the big missing pieces is engaging all of us as individuals to take part in the collective action solution brought him into launching Oroeco. Helping run a couple finance companies that are focused on investing in climate solutions and showing that that could just be a more profitable way to invest.

In your opinion, what are the changes most urgently needed today, with respect to global warming?
Well, the --- realization is we essentially need to change everything and that every decision we make as individuals, institutions and governments, have climate consequences, some obviously more extreme than others.

What do you view as the greatest barrier to fighting global warming?
I think one of the greatest barriers is just there are entrenched financial interests that don't want to see things changed because they're making money from the current system that we have. And one of the obvious ones is the fossil fuel lobby makes money from selling fossil fuels: oil, gas and coal. One that is maybe less obvious and less talked about is that there's also big agriculture lobbies that are connected to the unsustainable land use practices and agriculture systems that are also contributing to climate change in a big way. The biggest one really being industrial meat, particularly beef, because methane emissions from cows for beef and dairy is such a big part of the climate puzzle as well. And so that's one of the fundamental barriers is just the economic incentives around a few people who are making a lot of money basically off of the current energy and agriculture systems that we have and then all the rest of us, and really even folks working at fossil fuel companies, have an incentive to not have an unliveable world which is the trajectory we're currently on given our climate pollution trajectory. So beyond that, I'd say another barrier, getting to the much more personal level, is just I think an inherent hesitation for all of us to see ourselves as part of the problem.

INTERVIEW HIGHLIGHTS

It's a lot easier to point fingers at fossil fuel companies and dirty ag companies and ineffective governments that are often swayed by corrupt money moving from those industries, dirty industries that keep things how they are. But a whole lot of climate change is this collective action problem connected up to everything that we as consumers decide to eat, decide to do for our transportation choices, decide to do for home energy choices, clothing, etc. And, you know, nobody wants to be told that they're part of a problem and it's also – even if you realize that your choices are part of the problem, it's hard to start to think that your choices will actually make a difference if you do it unilaterally. You feel like you're just a drop in the bucket, so one of the challenges is how can we not only inspire us all to get engaged to take action at an individual level, but also show that all those actions collectively can add up to make a difference. That those drops in a bucket really can add up to a sea of potential.

What would you say is an action that individuals make that has the largest carbon footprint, yet is easiest to fix?
Relative to your climate impact that's really flying, how much you're eating red meat in your diet, how much you're driving and how efficient your home is.

Do you think that the architects or engineers should also collaborate more closely with the end users?
Certainly, I think that is another really important piece, is just the behavior side and what buildings actually do versus what they're projected to do. And that has been something that's been missing I think, from LEED certification projects. Other than academics being involved in tracking that stuff, I've seen several studies come out saying that actually a lot of energy efficiency design in buildings underperform because users use buildings differently than architects and engineers expect. User-centric design folks, behavioral psychologists, ideally I think are involved in the process as well.

SURVEY HIGHLIGHTS

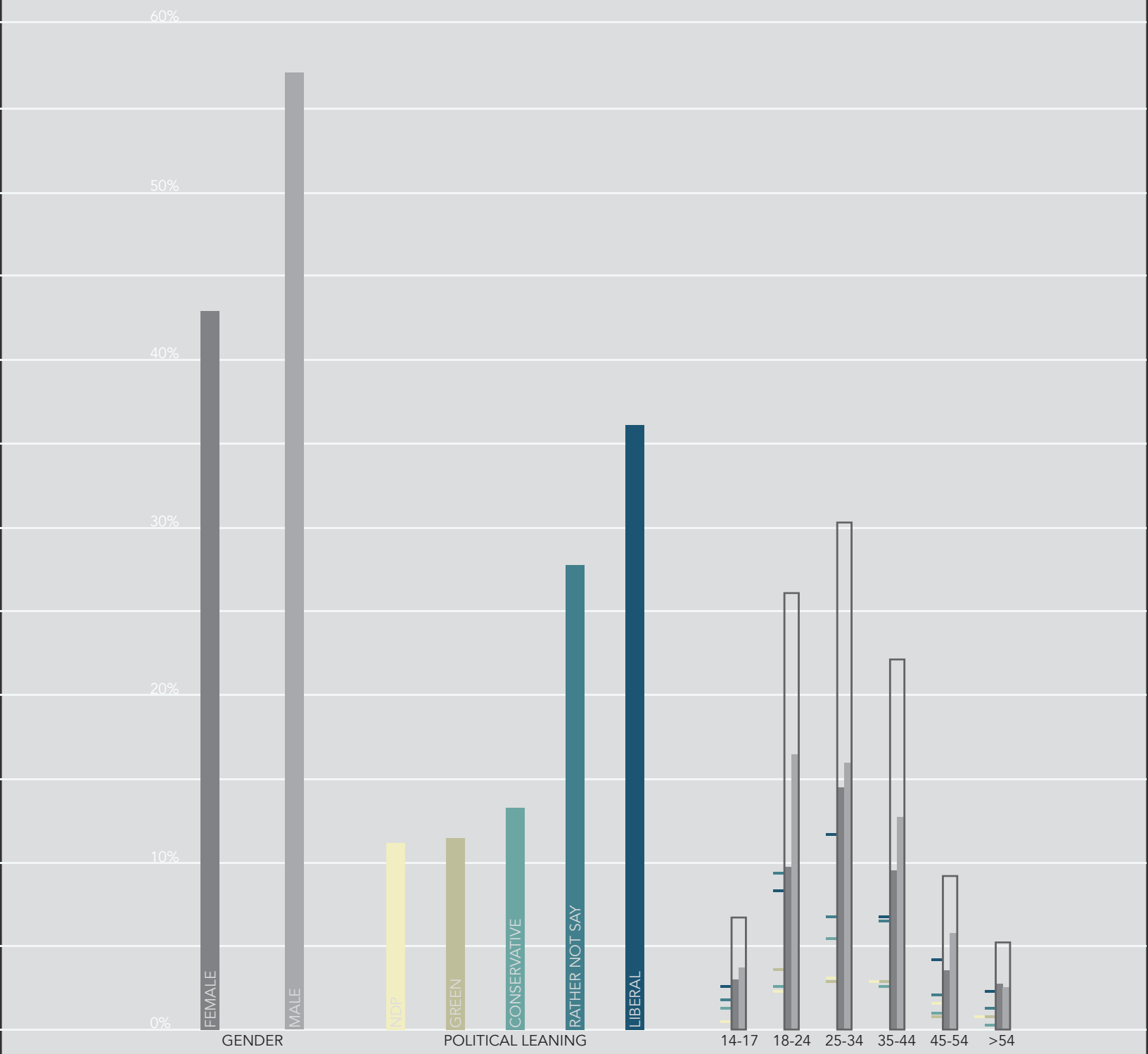
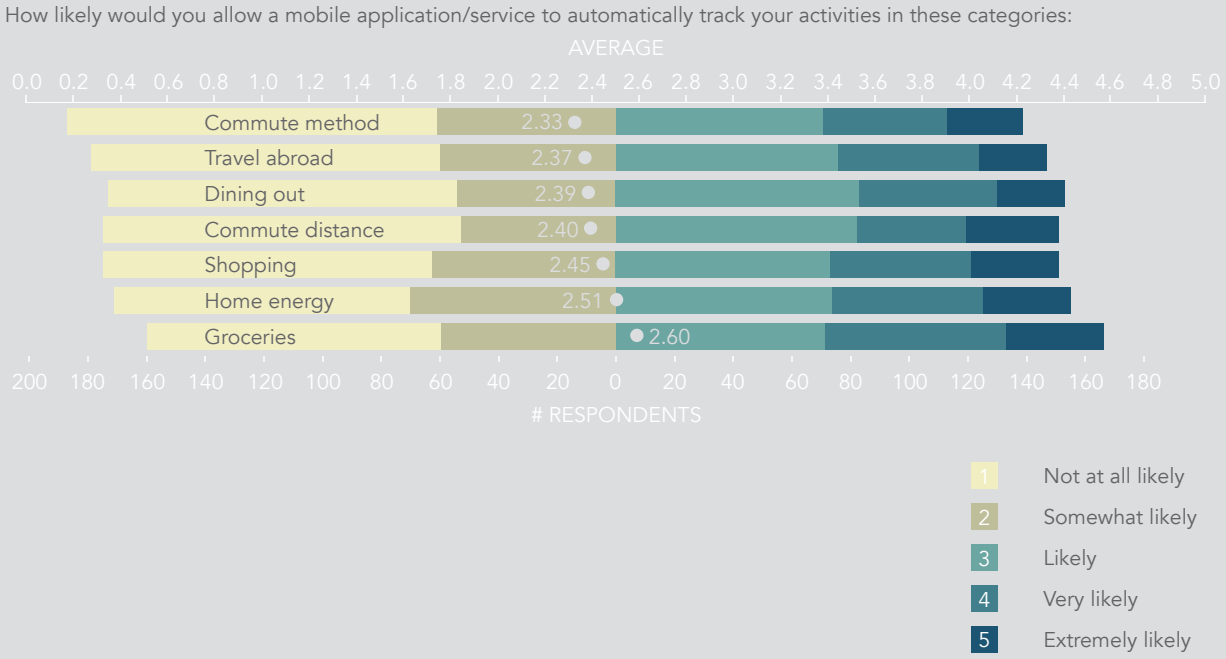
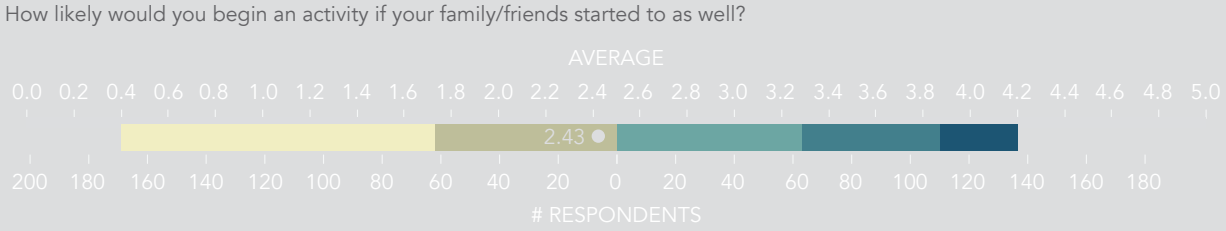


Fig. 3.7 Survey Diagram 1
Breakdown of survey respondents by gender, age groupings, and political leaning.

SURVEY HIGHLIGHTS





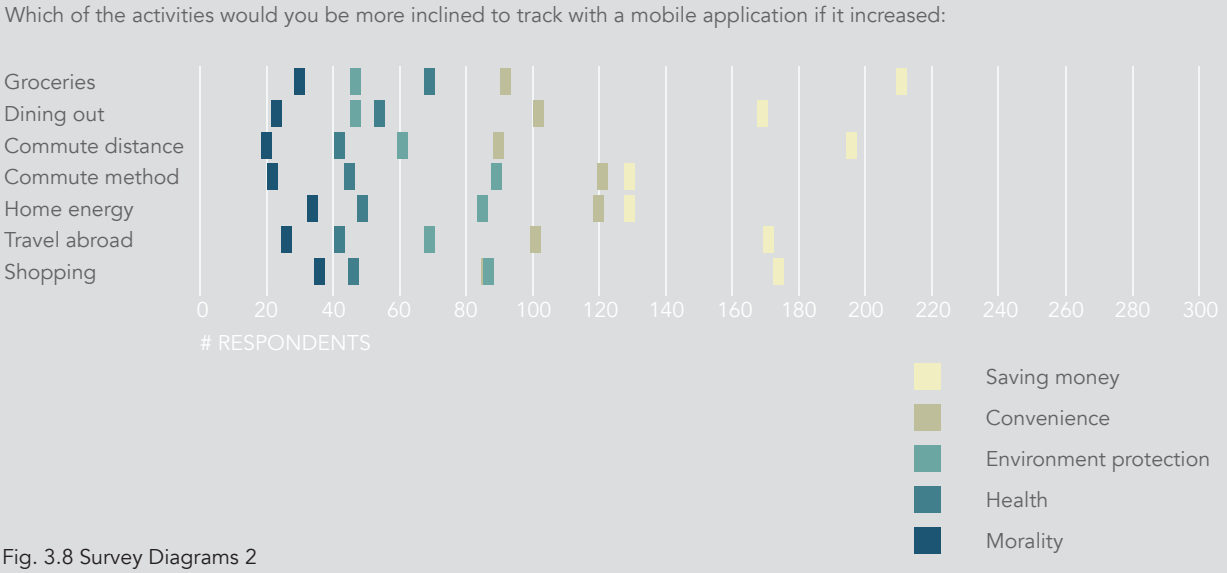
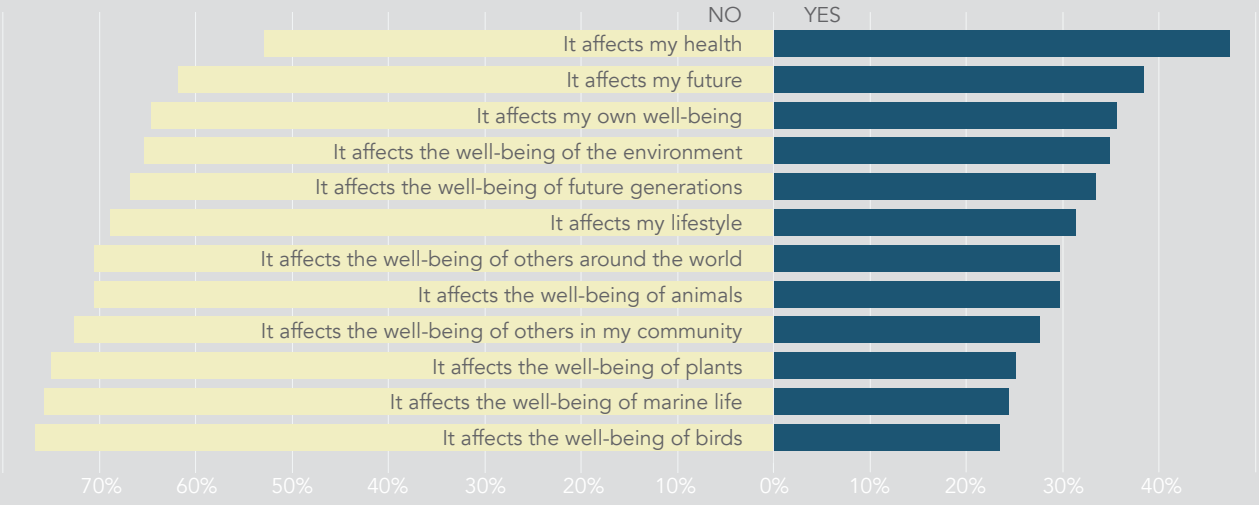


Fig. 3.8 Survey Diagrams 2
Results from questions 7, 8, and 9.

SURVEY HIGHLIGHTS

Please select all the situations that would encourage you to avoid purchasing an item/service



Please select all the reasons that would motivate you to make significant changes to your daily routine in order to prevent climate change:

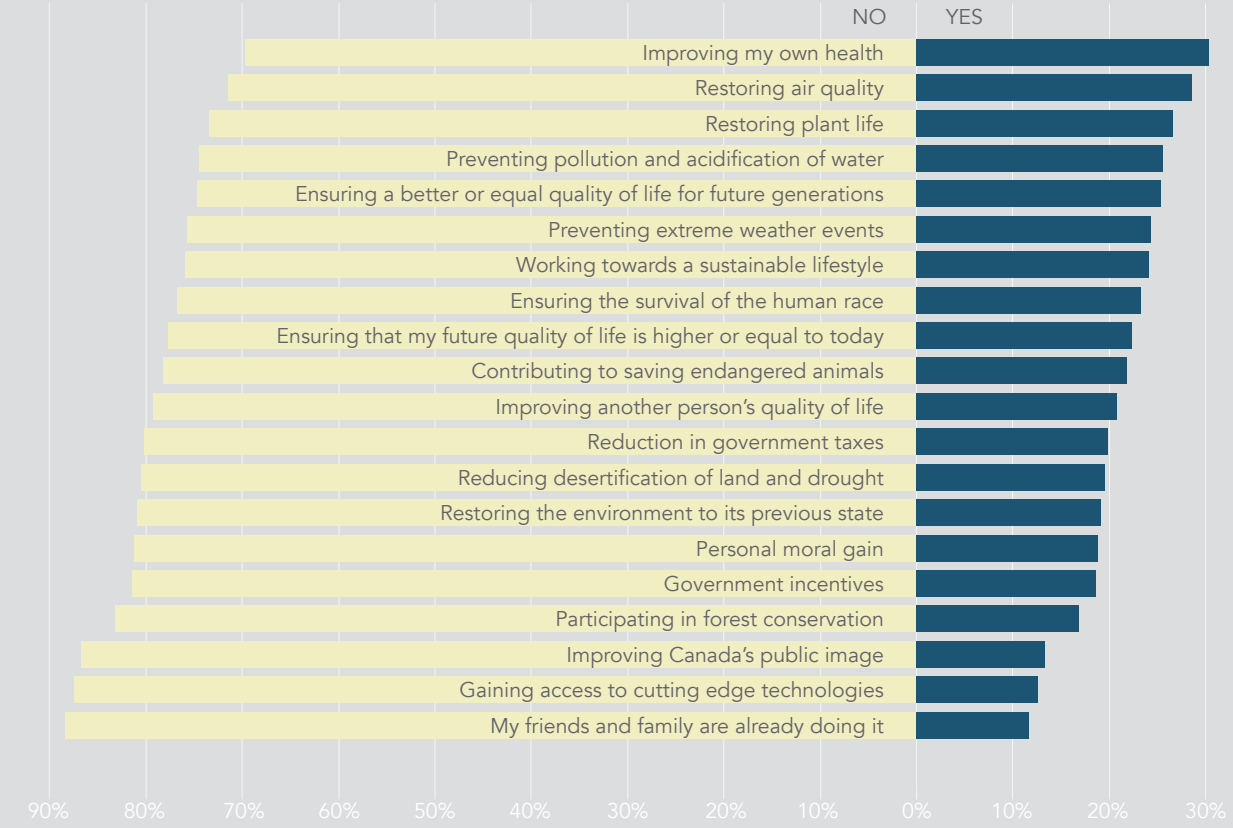


Fig. 3.9 Survey Diagrams 3
Results of questions 18 and 21.

SURVEY HIGHLIGHTS

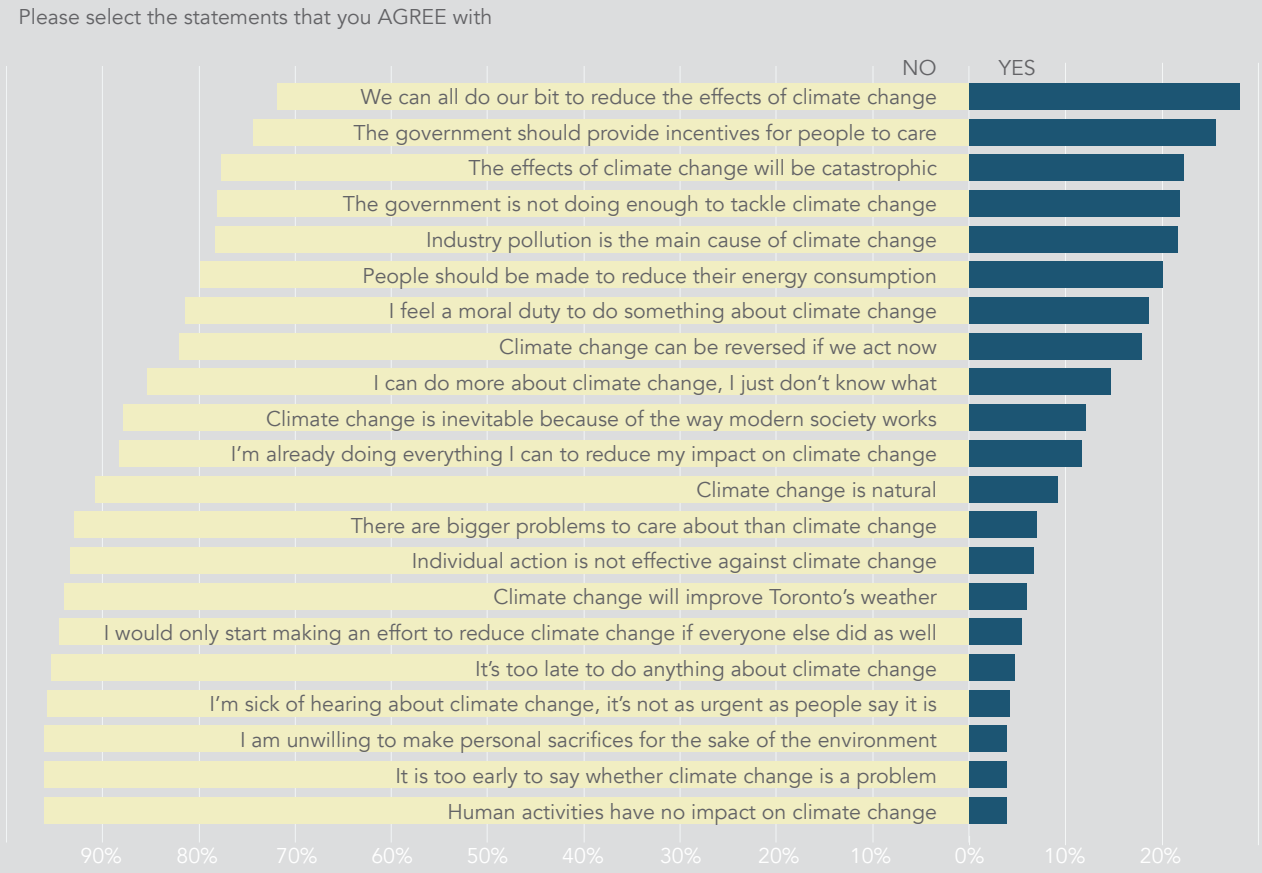


Fig. 3.10 Survey Diagram 4
Results from question 19.

[3. Reflections on methods.]

The general survey was an informative and convenient tool, but there were many drawbacks with the process. The obstacles that came with running the survey through an exterior service include: costs, accuracy, a limited respondent pool, and holes in the available data. The service that was used deployed the surveys online and were completed on desktop or via mobile phone. Since the survey appears through various online applications or games, it is difficult to pinpoint the type of social groupings respondents are coming from. The service does offer demographic data that can be quite thorough, from the usual categories that include education, age bracket, employment, etc. to more service specific data such as a developed 'persona'. However, these are voluntary categories and therefore the information for each respondent is not complete, which makes it difficult to form an overall picture of the type of people who responded to the survey. Although the questions asked participants for a reflection about why certain acts were performed over others and for what reason, their actual actions and thought processes might differ from what they report. A more accurate reading of behaviour would be from actually tracking the actions of an individual, which would lead to more accurate conclusions.

The field expert interviews were also an eye-opening process as it gave insight into what other professionals were doing in a more candid setting, which is very different from research sourced from written texts. Although there was only time to speak with each person once, it would be useful to enter a collaborative relationship with persons in other disciplines where conversations about the process are on-going, progressively focused and cumulative. As the interviews were conducted earlier on in the process, there was more ground to cover and the questions were kept general. If there were continued conversations, there could potentially be more feedback in relation to the design and input from various disciplines could be considered.

Despite the obstacles, the surveying tool was a great way to get base data to work with and would be a quick way to periodically gauge changes in user opinion if used in regular intervals on a regular basis. Additionally, the conversations with field experts were informative and if continued, could potentially result in interesting collaborative ideas.

[4. Redefinition.]

The results of the second phase of information gathering pointed towards a potential area of focus in consumer purchases of produce items. The previously designed platform included tracking various sectors such as transportation choices, produce purchases, and clothing purchases. Although the platform would ideally cross all sectors, including all of them in the prototyping would be too broad. Within the boundaries of the thesis, it was found from the survey results that people would be most willing to track their weekly groceries and make decisions based on health and costs. Ongoing research also shows that several areas where consumer choice can greatly impact carbon emissions savings are related to food consumption[3]. Additionally, several writings on user engagement emphasize the importance of providing options in order to give people a sense of control over their situation. Taking all these points into consideration, the design of a platform geared towards the individual would be most effective if it focused on our relationship with food.

The most significant findings from the survey that effected the next phases in the design process include people's willingness to change, issues of most concern, willingness to track purchases and in which sector, motivations for change, and attitudes towards global warming.

Interviews with field experts lead to further questioning of issues related to engaging users, and questioning our food production structures. With many of the food-based initiatives that already

exist within the city, it seems as though many improvements on the way we consume our food can already be made just by connecting people with and informing people of these initiatives. For example, the tool Food by Ward, created by the Toronto Food Policy Council, illustrates where fresh food deserts lie within the city[4]. This tool highlights all the food initiatives and fresh food resources already available to residents. At the same time, it is apparent where fresh food resources are lacking. Another study run by the Metcalf Foundation illustrated potential opportunities and roadblocks to scaling up urban agriculture. Their study indicates that while many local food and urban agriculture initiatives already exist, they lack a required presence with general public[5]. The effects that urban agriculture can have on one's carbon emissions can be significant seeing how Torontonians currently rely heavily on imported produce[6]. Encouraging demands for scaling up urban agriculture and alternative methods to growing edible produce is becoming an important issue as crop yields become lower due to the effects of global warming[7]. Coupled with efforts to communicate information on how this affects an individual's or social grouping's carbon emissions, these strategies would result in a better understanding in how these separate parts can affect the greater picture.

Information gathered from the survey, interviewees, and exterior research determined a redefinition of the problem for the next phases in design thinking to investigate: How can the use of emerging and existing technologies be leveraged in order to establish new methods of communicating data that can readily reveal the connections between the individual, our existing structure of food production, and man-made climate change in such a way that would provide individuals with both an informed choice, and a sense of agency to shift their investments into alternative forms of sustainable economies?

[5. Ideation 2.0.]

The findings from this stage of the data gathering process informed where the potential area of emphasis for the prototypes should be. Although none of the options investigated resulted in an obvious frontrunner, the focus on purchasing food had the most cumulative weight in terms of the potential effect that individuals have. The information gathered from the survey process also resulted in a small database that was used to generate a basemap for the prototypes. From this, the user testing process could contain a degree of realistic grounding, even if the sample size was relatively small. Three pared down prototypes were made, each testing a different method of relaying information about the user's carbon emissions. With the goal of producing working prototypes that users could test, practical lessons of which of the features were realistically achievable with limited technical skill and the lack of a real database were quickly learned. Although it was not a major obstacle for the thesis research, it further highlights the need to form partnerships with other disciplines in order to produce solutions that lie outside of standard disciplinary boundaries.

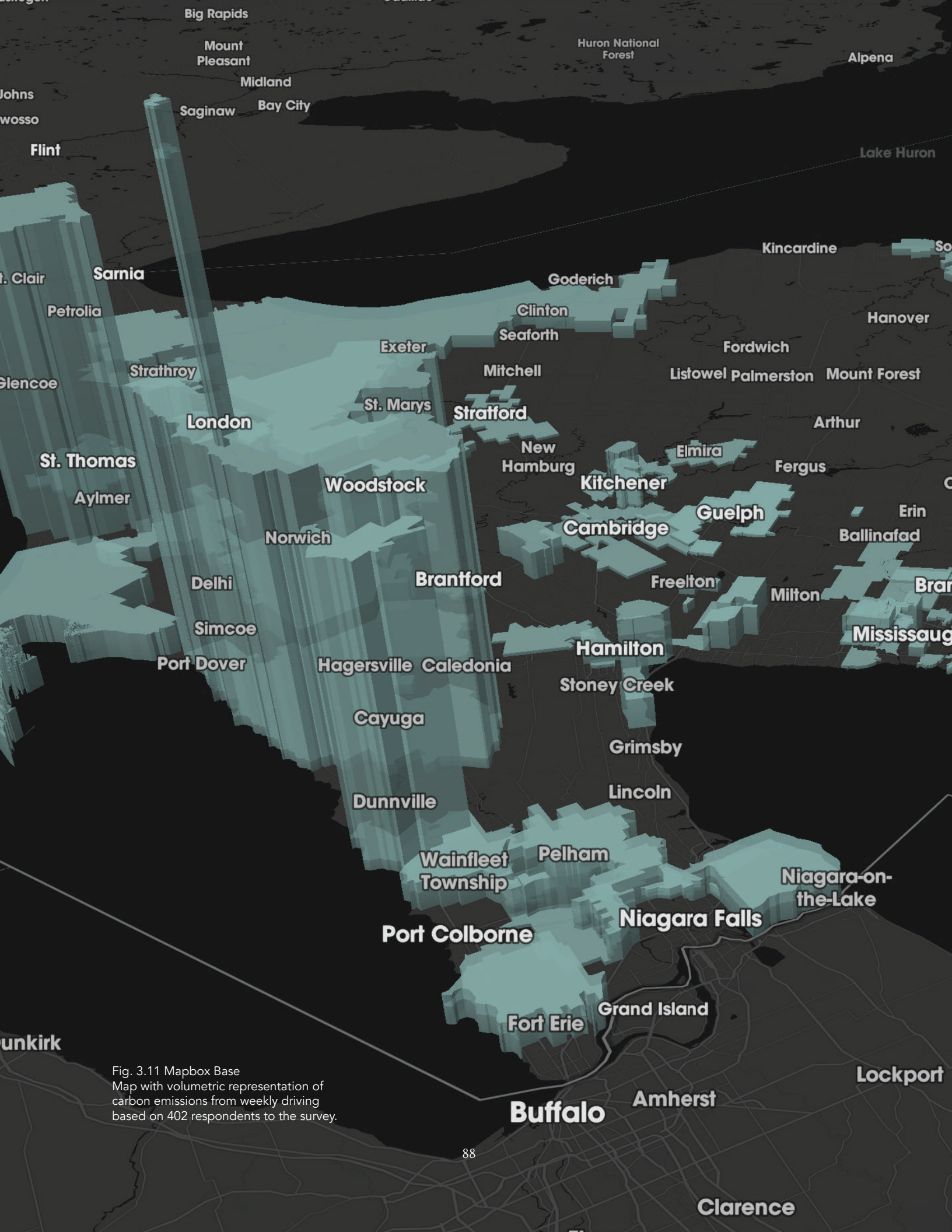
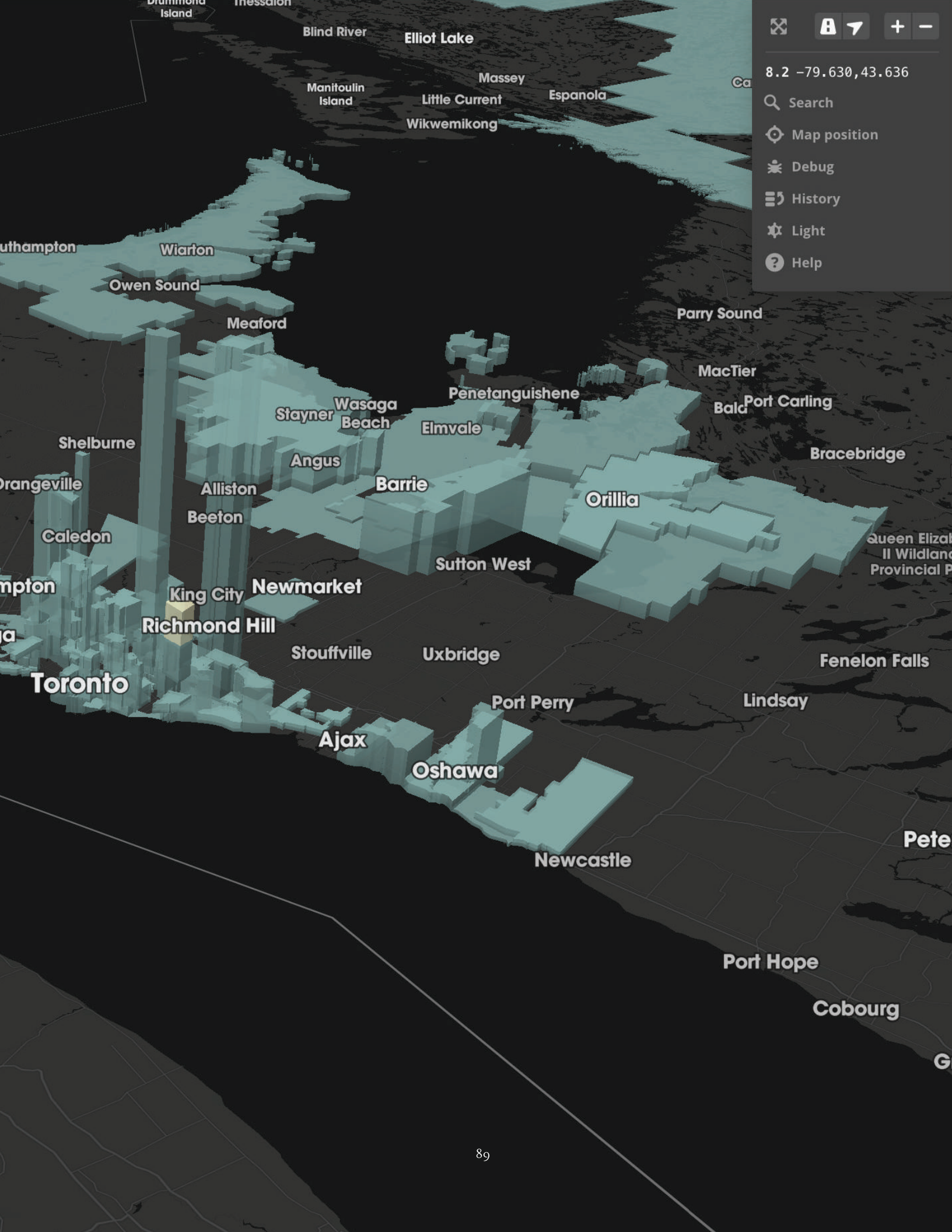


Fig. 3.11 Mapbox Base
Map with volumetric representation of carbon emissions from weekly driving based on 402 respondents to the survey.


Drummond Island
Thessalon
Blind River
Elliot Lake
Massey
Manitoulin Island
Little Current
Espanola
Wikwemikong
8.2 -79.630,43.636
Search
Map position
Debug
History
Light
Help
uthampton
Wiarton
Owen Sound
Meaford
Parry Sound
MacTier
Penetanguishene
Bala
Port Carling
Stayner
Wasaga Beach
Elmvale
Shelburne
Bracebridge
Angus
Orangeville
Alliston
Barrie
Orillia
Beeton
Caledon
Sutton West
King City
Newmarket
Richmond Hill
Stouffville
Uxbridge
Fenelon Falls
Toronto
Port Perry
Lindsay
Ajax
Oshawa
Newcastle
Port Hope
Cobourg

CHAPTER FOUR
SOCIAL SCALE 1:1

Fig. 4.1 Social Carbon Network
Map visualization of a social network and the amount of carbon emissions through driving that they contribute to the city and the social network.

[1. Prototyping.]

Three of the previous explorations in user interfaces were chosen for development in the prototyping phase. The chosen methods were selected for their potential in offering value for the user, addressing the issues of user engagement and agency, and addressing the previous research on potential areas of intervention. There was also a consideration of limited technical skills and access to data within the boundary of the thesis. The first prototype centred around a number-value based approach where estimated values of the user's carbon emissions were presented. The second involved presenting the same estimated value with spatial context and integration with hypothetical social networks. The last focused on developing community values by concentrating on informing the user of their actions along with those in their social groupings and physical neighbourhood. The users are then informed of initiatives that are present near their location that they can take part in.

All three of the prototypes calculate the user's carbon footprint with the user's number of kilometres travelled in a week by car. This was decided as the point of reference since commuting by car is very common and easily relatable to the general public. This is then compared with different values and/or visualizations within the prototypes, which were based on survey data or data from public sources.

Prototype 1:

In the first prototype, the value of the the user's carbon footprint is shown to them as a number value with a meter, the complete meter value being the average Canadian's emissions from driving based on the number of kilometres driven per year[1]. The emissions value differs from one car model to the next, but to simplify the process, the calculations were based on the US Environmental Protection Agency's estimate of the average annual CO_2 emissions from a typical passenger vehicle[2]. The second menu then

takes the user to number-value comparisons of their emissions to those of the average Torontonian, neighbour, and friend. Values for the average Torontonian comes from Statistics Canada[3], while values of the average neighbour is based on a study of emissions from neighbourhoods within Toronto[4]. The value of the friend is purely hypothetical and is predetermined to be calculated as a value lower than the user's in order to observe their response.

Prototype 2:

The second prototype prompts the user for their driving distance and location through postal code. It then provides their number value with a similar meter to the first prototype. Users can then see how the amounts of people's carbon emissions is distributed within the city, in a volume. This visualization is based on the completed survey where respondents also provided their weekly driving distances. The values differ by height only and are grouped by postal code, therefore the volumes are a result of the elevation value and postal code area. In the next menu, the user can see members within their social network, the total emissions of the group and how much each person is contributing to group's value. The subsequent menu then offers actions that the user can alter in other areas of their daily life and see the volumetric difference that that action would have on their emissions from driving. The purpose of this is not only to provide a variety of options that could lower the user's footprint, but also highlight the fact that actions from other areas can also make up a significant amount of one's emissions.

Prototype 3:

The final prototype prompts the user to input their driving distance, location, an item they regularly purchase from a list of edible produce, and a grocery store that they frequent from another list. In addition to being able to see the emissions value based on their driving distances, they can also see the emissions value of the grocery item from their selected store. The grocery item

emissions are presented as a CO_2e value and then converted into the corresponding number of kilometres driven by car. The emissions values of their driving distance and grocery item can then be compared in a unit familiar to the user. In the next menu, the user can see where members purchase that same grocery item and the corresponding emissions values when purchasing that item from various sources. The connecting lines also vary in colour according to relatively higher or lower emissions values between sources, quickly indicating which member's source offers that item at the lowest or highest emissions value. Although grocers can carry a produce item from various sources and have varying emissions values in-store, this was simplified by choosing one estimated value that the grocery store carried. These values were calculated from general estimates of produce items based on their growing method and shipping distance[5]. The third menu offers information on local alternative sources for produce. These are mainly community gardens that the public can access on occasion, and locations of nearby farmers' markets based on data from Food by Ward[6]. Although the items of produce may or may not actually be offered from all these locations, it was treated as if they were available. Hypothetical 'urban farmers' were also added into the network of existing sources to see if the user would buy produce by local, micro-scale producers. From these locations, the user can see the differences in pricing and emissions if they were to buy from these alternative sources.

PROTOTYPE ONE

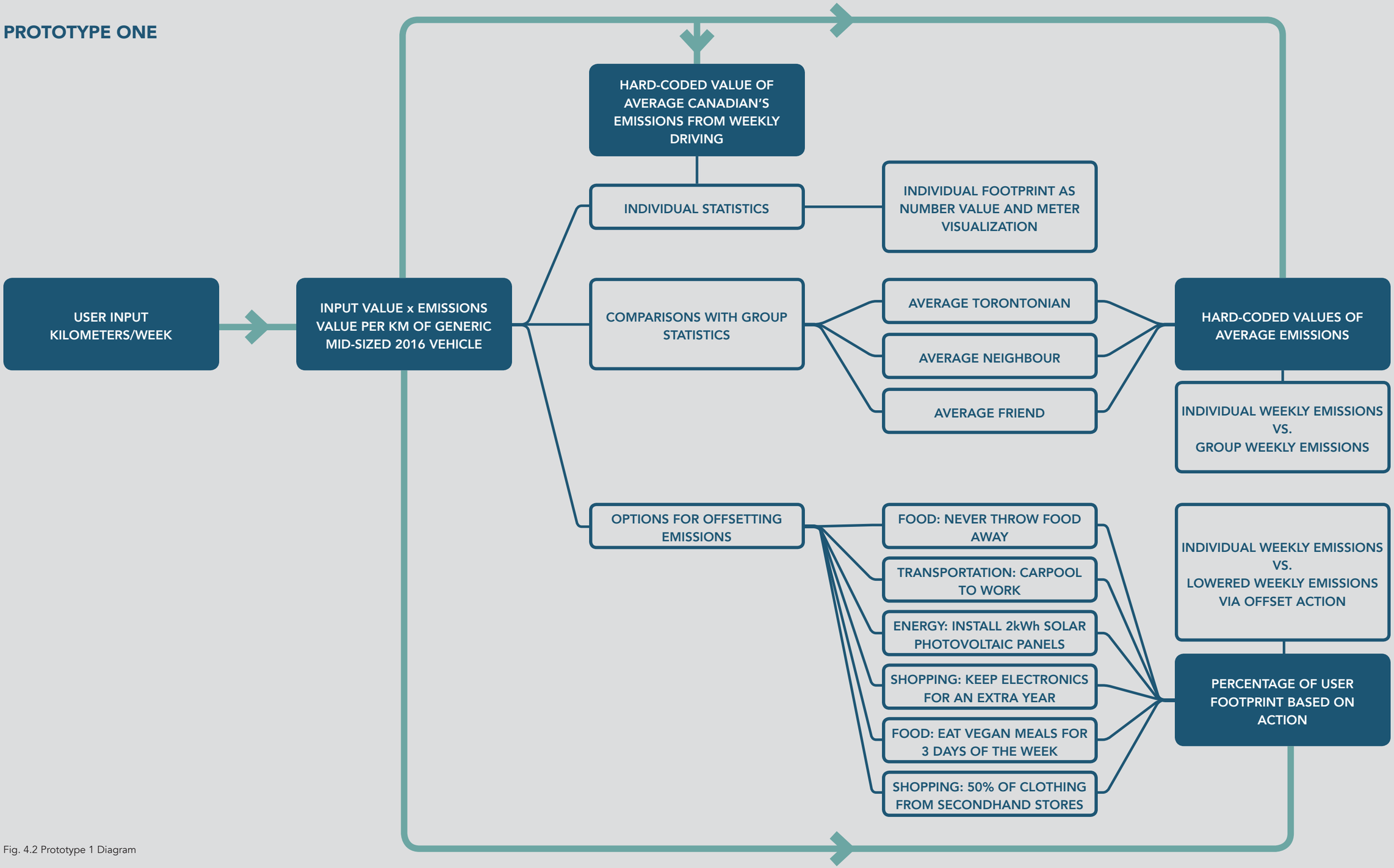


Fig. 4.2 Prototype 1 Diagram

Fig. 4.3 Prototype 1 User Interface
Sequence of user interface layouts of first prototype tested.

PROTOTYPE TWO

HARD-CODED VALUE OF AVERAGE CANADIAN'S EMISSIONS FROM WEEKLY DRIVING

USER INPUT KILOMETERS/WEEK

USER INPUT POSTAL CODE LOCATION

INPUT VALUE x EMISSIONS VALUE PER KM OF GENERIC MID-SIZED 2016 VEHICLE

INDIVIDUAL STATISTICS

COMPARISONS WITH SOCIAL NETWORK

MAP OF TORONTO'S EMISSIONS WITH INDIVIDUAL CONTRIBUTION HIGHLIGHTED

INDIVIDUAL FOOTPRINT AS NUMBER VALUE AND METER VISUALIZATION

MAP OF TORONTO'S EMISSIONS WITH SOCIAL NETWORK'S CONTRIBUTION HIGHLIGHTED

FRIEND 1: KAITLYN

FRIEND 2: ANTHONY

FRIEND 3: COLE

FRIEND 4: ALEXIS

FRIEND 5: OLIVIA

% OF GROUP TOTAL IN NUMBER VALUE, AMOUNT OF EMISSIONS IN CO_2e AND VISUAL METER IN RELATION TO GROUP TOTAL

HARD-CODED VALUES OF SOCIAL NETWORK'S EMISSIONS [PRESET % OF USER'S INPUT]

MAPBOX API

OPTIONS FOR OFFSETTING EMISSIONS

FOOD

TRANSPORTATION

ENERGY

SHOPPING

MAP/VOLUME VIEW OF POTENTIAL EMISSIONS SAVED ACCORDING TO CHOSEN ACTION

NUMBER AND % VALUE OF EMISSIONS AVOIDED AND VISUAL METER IN RELATION TO PERSONAL TOTAL

PERCENTAGE OF USER FOOTPRINT BASED ON ACTION

GENERATED MAP BASED ON DATABASE OF VOLUMETRIC EMISSIONS BASED ON KILOMETERS DRIVEN PER WEEK FROM 402 TORONTO SURVEY RESPONDENTS

MAP OF SURVEY RESPONDENTS' VOLUMETRIC EMISSIONS WITH EMISSIONS CONTRIBUTION FROM 5 MEMBERS OF SOCIAL NETWORK HIGHLIGHTED

PRE-GENERATED MAPBOX MAPS SHOWING DIFFERENCE IN EMISSIONS IN VOLUME

Fig. 4.4 Prototype 2 Diagram

Fig. 4.5 Prototype 2 User Interface
Sequence of user interface layouts of second prototype tested.

PROTOTYPE THREE

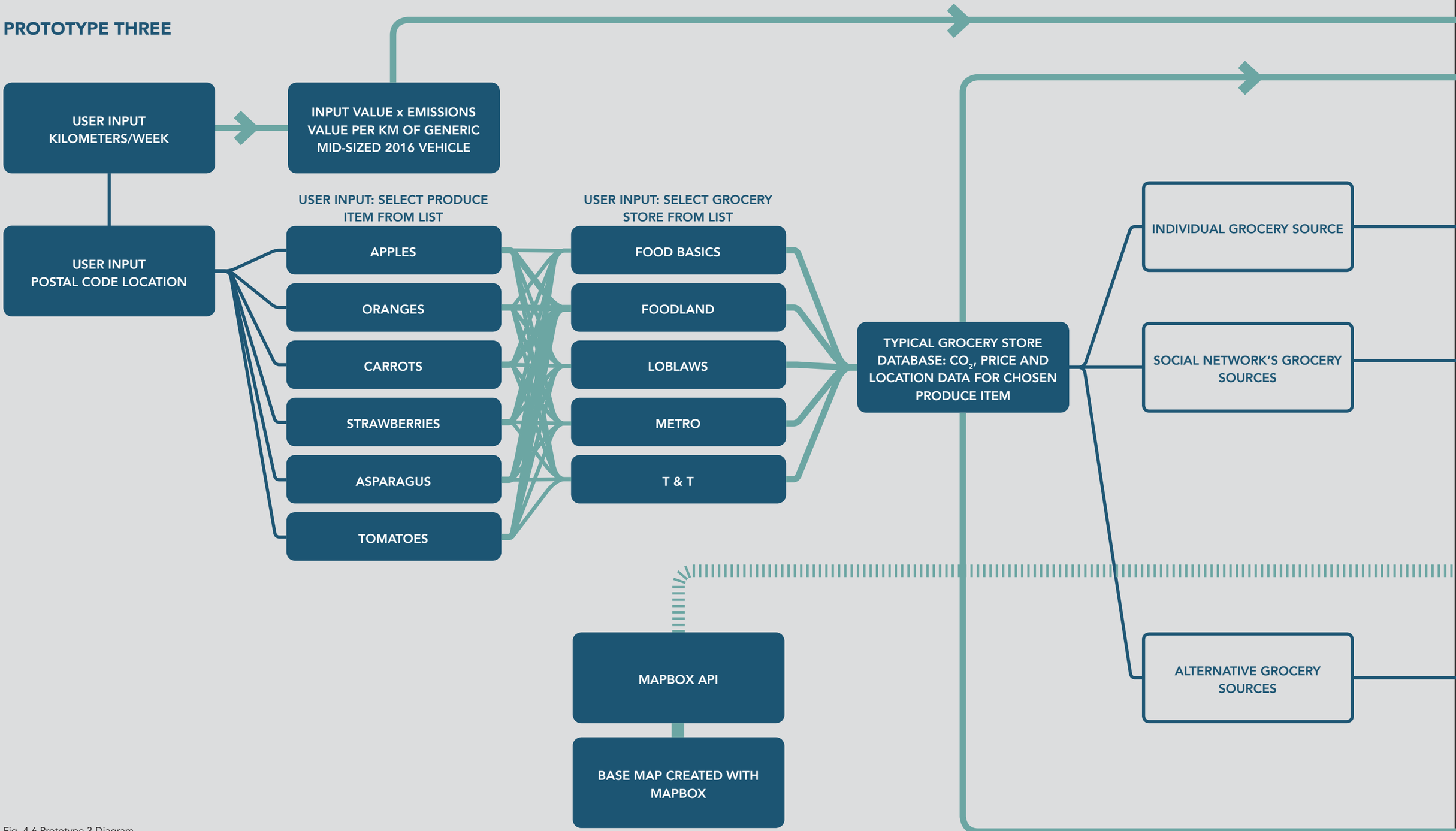
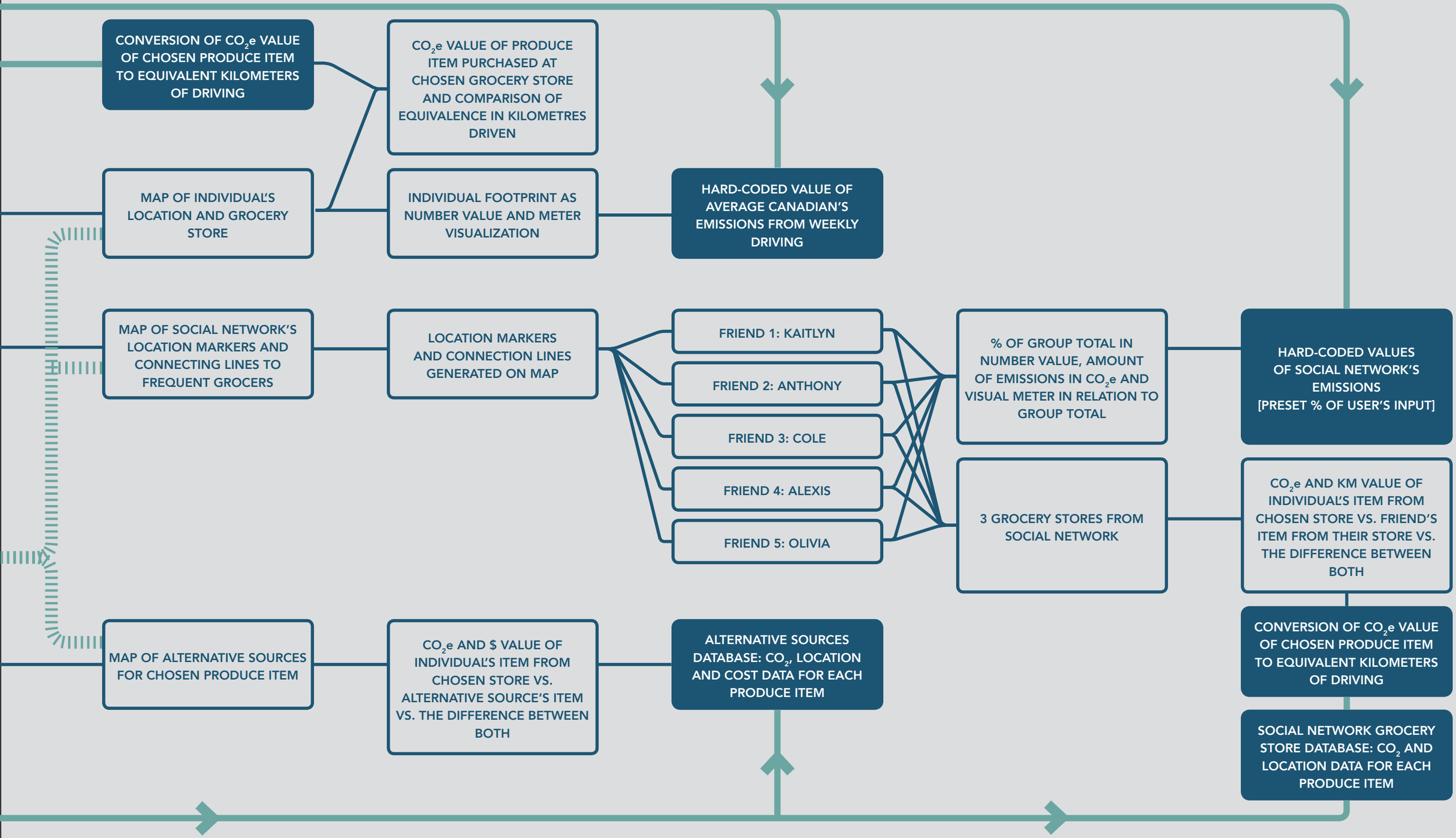


Fig. 4.6 Prototype 3 Diagram


CONVERSION OF CO_2e VALUE OF CHOSEN PRODUCE ITEM TO EQUIVALENT KILOMETERS OF DRIVING
CO_2e VALUE OF PRODUCE ITEM PURCHASED AT CHOSEN GROCERY STORE AND COMPARISON OF EQUIVALENCE IN KILOMETRES DRIVEN
MAP OF INDIVIDUAL'S LOCATION AND GROCERY STORE
INDIVIDUAL FOOTPRINT AS NUMBER VALUE AND METER VISUALIZATION
HARD-CODED VALUE OF AVERAGE CANADIAN'S EMISSIONS FROM WEEKLY DRIVING
MAP OF SOCIAL NETWORK'S LOCATION MARKERS AND CONNECTING LINES TO FREQUENT GROCERS
LOCATION MARKERS AND CONNECTION LINES GENERATED ON MAP
FRIEND 1: KAITLYN
FRIEND 2: ANTHONY
FRIEND 3: COLE
FRIEND 4: ALEXIS
FRIEND 5: OLIVIA
% OF GROUP TOTAL IN NUMBER VALUE, AMOUNT OF EMISSIONS IN CO_2e AND VISUAL METER IN RELATION TO GROUP TOTAL
3 GROCERY STORES FROM SOCIAL NETWORK
HARD-CODED VALUES OF SOCIAL NETWORK'S EMISSIONS [PRESET % OF USER'S INPUT]
CO_2e AND KM VALUE OF INDIVIDUAL'S ITEM FROM CHOSEN STORE VS. FRIEND'S ITEM FROM THEIR STORE VS. THE DIFFERENCE BETWEEN BOTH
CONVERSION OF CO_2e VALUE OF CHOSEN PRODUCE ITEM TO EQUIVALENT KILOMETERS OF DRIVING
SOCIAL NETWORK GROCERY STORE DATABASE: CO_2 AND LOCATION DATA FOR EACH PRODUCE ITEM
MAP OF ALTERNATIVE SOURCES FOR CHOSEN PRODUCE ITEM
CO_2e AND $ VALUE OF INDIVIDUAL'S ITEM FROM CHOSEN STORE VS. ALTERNATIVE SOURCE'S ITEM VS. THE DIFFERENCE BETWEEN BOTH
ALTERNATIVE SOURCES DATABASE: CO_2, LOCATION AND COST DATA FOR EACH PRODUCE ITEM

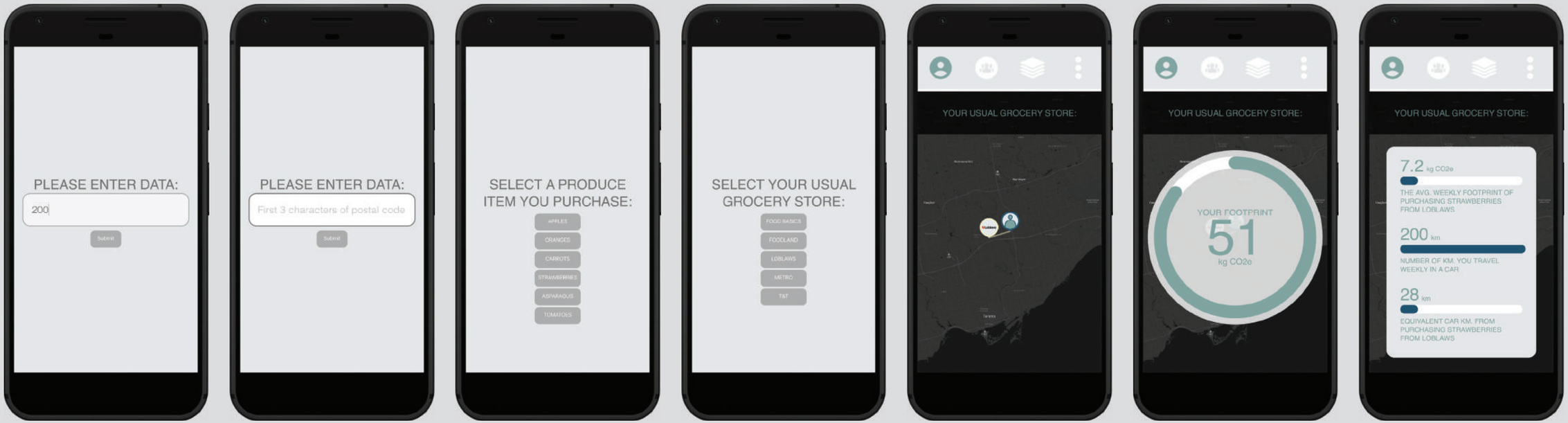


Fig. 4.7 Prototype 3 User Interface A
Sequence variation layouts of third prototype tested.

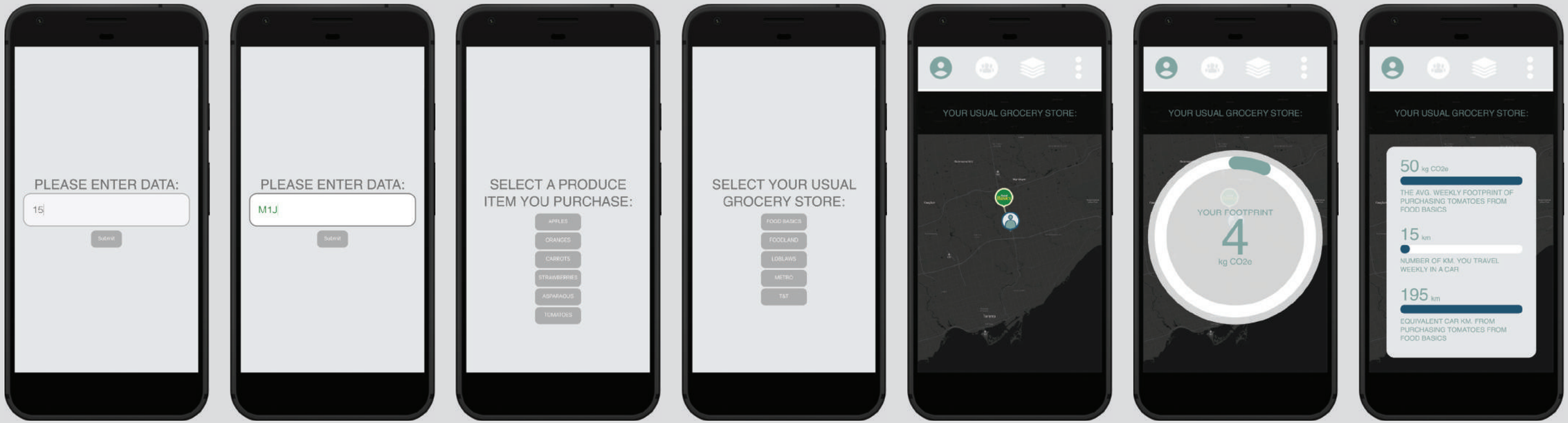


Fig. 4.8 Prototype 3 User Interface B
Sequence variation layouts of third prototype tested.

[2. Testing.]

Each user was recruited randomly in public areas with no knowledge of their background to avoid possible biases from recruiting at a university campus or from a predetermined pool of available users. In the end, three users participated in the full user-testing session that consisted of walking through the prototypes, a question and answer period before, during and after each prototype, and completing the previous survey.

The pre-testing questions mainly dealt with the base data needed to run the prototypes. Users were also questioned on their general knowledge of carbon emissions and global warming, and what they thought their impacts was in relation to other people or groups. Questioning during the module testing mainly dealt with what their immediate reactions and thoughts were on the features of the prototypes. The post-testing questions dealt with which module tested they found most impactful, and which features they could see being useful in their daily lives. The complete list of questions used in the user testing process can be found in Appendix F.

[3. Reflections on user testing.]

There are many improvements to the process that should be made if this was repeated for further research. First, it would be ideal to run testing sessions with a focus group of about 5-10 people to test real-time interactions within a social setting. There were also limitations to the user testing as to how it was conducted. It would have been more effective to have access to a larger database base values to generate more accurate visualizations. However, this would require more time and effort to build. Also, the sessions were quite long and took from 45 minutes to an hour. It would most likely be easier to find participants if the process was shortened and more focused, perhaps on just one prototype. Since only three people were tested, it is important to take note of the small sample size while using it as a basis for further development. Var-

ious sources for interface testing state that only five users need to be tested to gain significant insight into user experience and design. But since the prototypes also try to address issues of how well certain social groups may respond to different stimuli of information, it would be ideal to test the interface on different social groups to gain insight on which features work better than others in that regard. However, for the purposes of the thesis, the next phase in the process will proceed on the results from the three tested users.

[4. Findings.]

The three tested users were all in separate professional fields and fell within the age groups of 18-24 or 25-34. They each had varying degrees in the understanding of a carbon footprint, or of the size of their own carbon footprint. Even when one user reported having a high alert on issue of global warming, there were obvious areas of uncertainty as to what their actual impact as an individual was and how it compared to people in other countries or cities. There was also a gap in knowledge between the impact of all the items that the users came into contact with. While there was concentrated knowledge of the impact in one category such as car travel or electronics, there was no knowledge of the impacts of products in other categories such as clothing or edible produce.

User 1:

The first user responded well to the second and third prototypes. Although having a general understanding of carbon emissions and that we have a need to lower it, the visualization in the second prototype made an impact on the overall picture of how much a few people in the city can emit. While being adamant on having next to no car travel time for regular commuting, the first user found the impacts of certain produce items to be eye-opening and surprising in how much they contributed to their overall emissions.

User 2:

The second user stated at the beginning of the session that global warming was not an important issue to them and was not aware of what a carbon footprint was. However, they responded well to the second prototype and was interested in seeing the differences in carbon emissions from the city. This method got across the idea that perhaps an effort should be made to lower their carbon emissions. The first and third prototypes seemed to present the information clearly, but not being the purchaser of groceries in the household, the information seemed to be less engaging.

User 3:

The third user considered themselves more engaged with the issue of global warming. Although familiar with the concepts of carbon footprints and carbon emissions, there was uncertainty in the the weight of emissions for different categories of products and also a misconception of how well our city was doing in regards to carbon emissions. They found the first prototype to be the most useful as it was a quick way to gauge process and would find the third prototype useful as a tool to seek out closer alternative sources for their produce items.

The full results of the user testing sessions can be found in Appendix F.

USER ONE: TESTING HIGHLIGHTS

Gender:	Male	**Occupation:**	IT
Age Group:	18-24	**Postal Code:**	M1W 1B1
Household Income:	$60k-79k	**Children:**	0
Education Level:	Bachelor degree	**Marital Status:**	Single
Ethnicity:	Asian	**Supporting Party:**	NDP

WOULD YOU BUY GROCERIES FROM ALTERNATIVE SOURCES?

YES

HOW LIKELY WOULD YOU BEGIN AN ACTIVITY IF FAMILY/ FRIENDS DID AS WELL?

VERY LIKELY

HOW LIKELY WOULD YOU ALLOW AN APP TO TRACK YOUR GROCERIES?

EXTREMELY LIKELY

I feel a moral duty to do something about climate change.
The government should provide incentives for people to care about the environment.
We can all do our bit to reduce the effects of climate change.

TRUSTED SOURCES ABOUT CLIMATE CHANGE:

FAMILY/FRIENDS

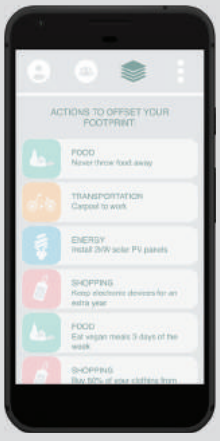
MOBILE APP

ENERGY SUPPLIER

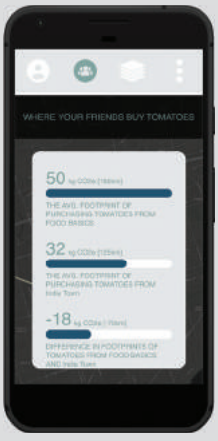
MAIN MOTIVATION:

SAVING MONEY

MOST LIKED FEATURE



MOST SURPRISING



MOST IMPACTFUL

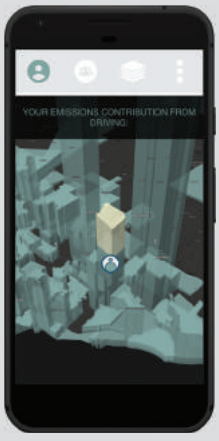


Fig. 4.9 User 1 Summary

USER TWO: TESTING HIGHLIGHTS

Gender:	Female	**Occupation:**	Administration
Age Group:	25-34	**Postal Code:**	M2K 1B1
Household Income:	-	**Children:**	0
Education Level:	College Diploma	**Marital Status:**	Single
Ethnicity:	Asian	**Supporting Party:**	-

WOULD YOU BUY GROCERIES FROM ALTERNATIVE SOURCES?

YES

HOW LIKELY WOULD YOU BEGIN AN ACTIVITY IF FAMILY/ FRIENDS DID AS WELL?

MODERATELY LIKELY

HOW LIKELY WOULD YOU ALLOW AN APP TO TRACK YOUR GROCERIES?

VERY LIKELY

We can all do our bit to reduce the effects of climate change
The government is not doing enough to tackle climate change
I can do more about climate change, but I don't know what

TRUSTED SOURCES ABOUT CLIMATE CHANGE

GOVERNMENT

ENVIRONMENTAL ORG.

NEWSPAPER ARTICLES

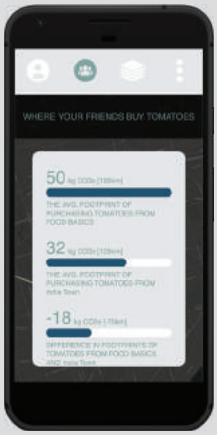
CLIMATE SCIENTIST

MAIN MOTIVATION:

SAVING MONEY

MOST LIKED FEATURE

MOST SURPRISING



MOST IMPACTFUL

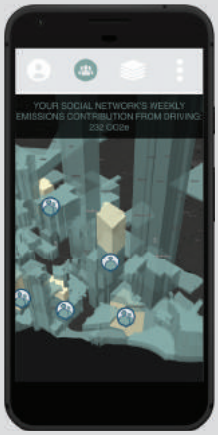


Fig. 4.10 User 2 Summary

USER THREE: TESTING HIGHLIGHTS

Gender:	Male	**Occupation:**	IT
Age Group:	25-34	**Postal Code:**	M2K 1E8
Household Income:	$80-$159k	**Children:**	2
Education Level:	High School	**Marital Status:**	Single
Ethnicity:	Asian	**Supporting Party:**	-

WOULD YOU BUY GROCERIES FROM ALTERNATIVE SOURCES?

YES

HOW LIKELY WOULD YOU BEGIN AN ACTIVITY IF FAMILY/ FRIENDS DID AS WELL?

NOT AT ALL LIKELY

HOW LIKELY WOULD YOU ALLOW AN APP TO TRACK YOUR GROCERIES?

VERY LIKELY

We can all do our bit to reduce the effects of climate change
People should be made to reduce their energy consumption if it reduces climate change
The effects of climate change will be catastrophic

TRUSTED SOURCES ABOUT CLIMATE CHANGE

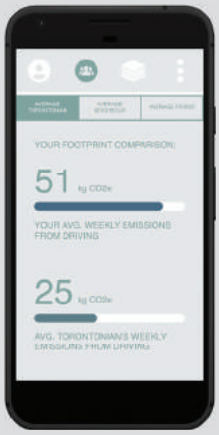
FAMILY/FRIENDS

ENVIRONMENTAL ORG.

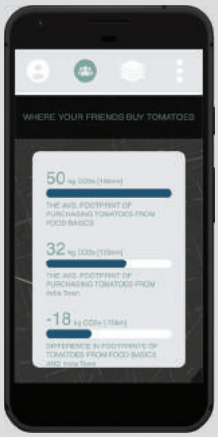
MAIN MOTIVATION:

SAVING MONEY

MOST LIKED FEATURE



MOST SURPRISING



MOST IMPACTFUL

Fig. 4.11 User 3 Summary

[5. Next steps.]

The process of user testing was a valuable experience as it provided direct feedback on the interface from potential users. This insight provided from immediate reactions from the users is typically not a standard experience that architects would have access to in the design of larger buildings. This data is appreciated in that it provides concrete direction in how the design of certain experiences should be tweaked in order to achieve the set goal.

Keeping in mind the aforementioned imperfections of the data collection process, the findings accumulated thus far will be incorporated into the adjustments made for the final proposed iteration for this thesis.

CHAPTER FIVE
PROPOSED ITERATION


INSULATION RATING IS LOW
+87.7kg
CO_2e
INVEST IN INDUCTION STOVE
-7.3t
CO_2e
WASHING DISHES IN HOT WATER
+20.7kg
CO_2e
how can i save energy?

Fig. 5.1 Home Energy Saving Tips
Rendering of application experience at home. Several options to lowering emissions while saving energy are revealed.

[1. Continual Ideation.]

The process within this thesis progressed from the first design thinking stage of empathizing, to the testing phase only once. However, the cycle of designing and re-designing through prototyping and testing can easily be repeated several times, even after establishing and implementing the framework of the interface. With the capacity to easily reach users after interface has been built, a continuous stream of feedback from, and the observed behaviours of the users allow for ongoing interface adjustments in order to maintain user engagement.

[2. Tested features.]

The contextual map visualizations and product emissions comparisons were found as the most engaging features of the three prototypes. Based on this, there is potential value in working on developing visualizations where the positioning of nearby residents can be seen by each other. Users would be able to take note of each other in terms of efforts made in lowering emissions through product choices, or supporting local initiatives that require increased presence within the city. A database of products and their embodied emissions would be a worthwhile project as it would serve as the foundation of the proposed interface, and it could additionally provide a basis for many other types of eye-opening comparisons.

[3. Additional features.]

The methods in designing user experiences explored within this thesis was limited, but there are many additional avenues that the interface can expand into. Although the proposed interface took an emphasis on food and local food production, the basis of the interface that gives an estimate of an individual's carbon footprint would be most effective if it was inclusive across all sectors. The database containing this information could also act as the foundation for other interfaces with concentrations in other areas, such as tackling the issue of sustainable clothing production.

Further features of the proposed interface would be to concentrate on facilitating community gathering in 'real-life'. From experience, we know that our individual efforts to simplify our lives are more likely to gain traction within a community that supports through positive reinforcement[1]. Although digital platforms can offer a sense of community online, they should also be used to compliment real world connections, and cannot replace the basic human need for physical interactions. Therefore, in order to create a well-rounded system that aims to aid us in shifting our value structures, there needs to be an element of real world gathering where we can extend our experiences and knowledge through physical interactions. This can be done by expanding the feature of promoting local urban agriculture, where users can use the digital platform to inform themselves of where existing urban agricultural producers are, and also have the ability to declare an interest in certain types of produce that are not adequately supplied. The ability for others to see desired products can possibly create interest in new urban farmers who would become suppliers based on the level of demand. In order to exchange goods, a digital platform where users can pre-order from local producers and meet in impromptu locations at predetermined times, similar to the model of The Food Assembly[2], would add flexibility to the usual farmers' market. The model of the farmers' market is more restrictive in terms of scheduling and the online purchasing model would be able to inform suppliers exactly how much product needs to be harvested or supplied on the day of exchange.

Fig. 5.2 Urban agricultural network
Rendering of application revealing locations of several types of alternative sources for groceries.


+4.8kg
COMMUNITY GARDENER
-7.2kg
URBAN FARMER
YOUR USUAL
TOMATO GROCER'S
20.7t
CO_2e
where can i buy tomatoes?

[4. Integration.]

The proposed interface would also benefit from forming partnerships with other existing platforms in private and public sectors that already track specific behaviours. Existing platforms include energy use by services such as Nest or one's energy supplier, commuting distances and modes of transportation by applications such as Citymapper, and food consumption by applications such as MyFitnessPal. For example, the carbon footprints in the prototypes were calculated by having the user manually input their driving distances. This would be quite tedious in practice, especially when commuting data can already be mined through Google Maps. Acquiring data streams from several different sectors that already track our behaviours discreetly would form a more accurate picture of our complete carbon footprint.

When using environmental input-output analysis, the basis for calculating the estimates of carbon emissions is based on the variable amount of dollars spent in particular categories. Developing partnerships with financial institutions and businesses could also be an effective method in achieving the goal to manage emissions on an individual level. For example, a feature could be applied where the pricing of products is adjusted to include their ecological and social costs. This way, users can see and compare the true cost of products upon scanning their UPC code. If this was implemented as a proactive feature where users are charged according to fluctuating resource requirements of products depending on their demand, it would require regulations for the participation of all vendors to ensure equal market opportunities. Another feature that could be available is generating the carbon footprint value from dollars spent according to sector by analysing data from financial institutions. These institutions already keep data on the amount of money spent, and sort them according to category. This data could be utilized with environment input-output analysis to generate an overall carbon footprint value.

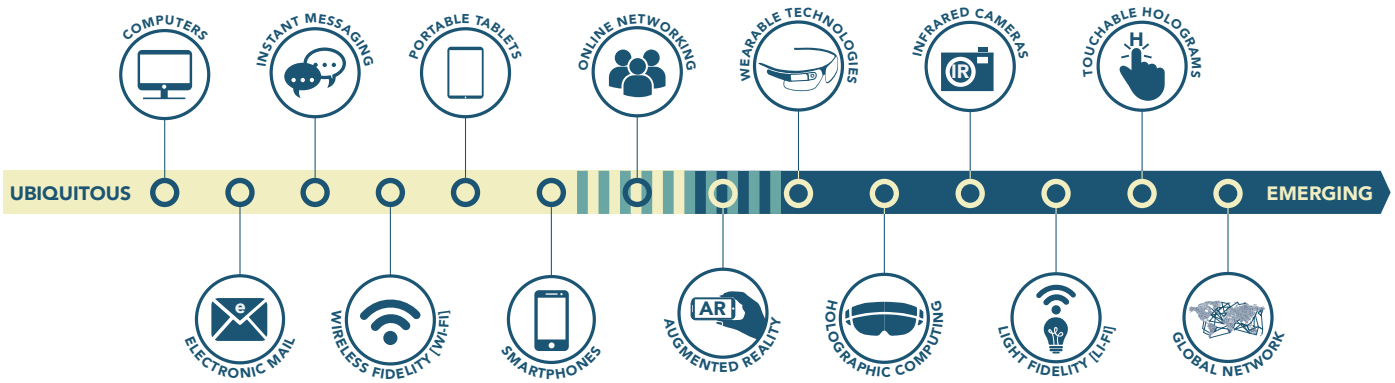


Fig. 5.3 Emerging Technologies
Diagram of ubiquitous and emerging technologies.

Fig. 5.4 Enchanted Objects
Proposed 'enchanted objects' that are connected together in an 'internet of things' in order to provide glanceable progress within the proposed platform.

Fig. 5.5 Local Meetings
Rendering of application showing members in local social network available for exchanging goods.


YOUR CURRENT YEARLY EMISSIONS:
6.8t
CO_2e
GOAL: 9t
WILL BE OFFERING: BASIL
RASHID'S YEARLY EMISSIONS
6.2t
CO_2e

Fig. 5.6 Urban Digital Artifacts

In the coming years, we are also likely to see more integration of augmented reality (AR) in our everyday interfaces. Although the timeline of its development is difficult to predict, the potential disruption that AR will have on interaction with digital platform interfaces will provide opportunities to experiment and design the way we go about our daily lives. This will be enhanced by the emerging ubiquity of products digitally connected through the 'internet of things' (IoT). If executed correctly, the use of AR technology combined with the growing connectivity between our everyday items, there is potential in building upon systems that manage awareness of our carbon emissions either discreetly or explicitly, depending on user preferences. The importance in the design of such systems is to work past the gimmickry that occurs with newly adopted technologies and develop systems that are able to continuously engage its users.

[5. The intended outcome.]

While continuing design iterations with existing and emerging technologies, it is important to avoid distraction from dealing with the novel ways we can experience interfacing with digital platforms. Focus must be maintained on the interface's usefulness as a tool for the user. If the platform can establish a reliably secure and convenient way to collect user data on items of purchase, it can potentially become a valuable resource to guide users along on their preferred paths to living more sustainably. Although it cannot be assumed that such a tool would be used ubiquitously, even if it is able to establish a footing within a few social groupings, it can potentially accelerate the development of local initiatives that are cognizant of our global urgencies by facilitating informed choice. Additionally, focusing on the importance of real-world community gatherings will compliment the development of a carbon tracking tool. Providing options for physically-present cultural exchanges with a focus on urban agriculture, coupled with a digital information resource of behavioural impacts can possibly intensify the push towards a new economy based on sustainable values.

Proposed variation of citizen engagement event through proposed platform. Lives are given carbon values and users can leave online artifacts in a display of community involvement.


YOUR CURRENT YEARLY EMISSIONS:
6.8t
CO_2e
GOAL: 9t
team sea lions
245t
MARK'S
YEARLY EMISSIONS
15.7t
CO_2e
ANONYMOUS'
FRIEND REQUEST
REQUEST
CO_2e
how is my team doing?

Fig. 5.7 Group emissions goals
Rendering of application revealing a social network's progress towards achieving an emissions goal. Each member's emissions contributions are visible.

CONCLUSION

[1. On future iterations.]

The explorations and research processes conducted within this thesis begin to look at how routine experiences can be designed or intervened upon with the intent of offering people an informed choice with respect to how the products and services they consume affect the stabilization of the greater networks we are all situated in. As discussed, a successful way to reach a maximum amount of people is to convey data through focused storytelling methods directed towards various cultural groups. While the final design iteration within the thesis contains a limited amount of the investigated communication methods and may appear generic, a truly successful platform would require constant development and continual feedback from users. Building on more culturally and socially focused strategies would be an emphasis of subsequent iterations. As it currently stands, the initial strategy is to offer a tool where users can collect evidence by making their own observations of their surrounding environment. They can then choose to create their own narratives by selecting the types of data to share within their own social groupings.

[2. On process.]

The growing possibilities of how we can design experiences using urban informatics are exciting as they offer an infinite amount of additional ways we can experience our physical surroundings. As such, the process of gathering feedback from the end users even after implementation is critical since the goals of the designer's intentions can never be assumed to be perfectly executed or permanently applicable through time. The end goal of continuous user engagement changes due to users' limited attention span, therefore an interface that seeks to continuously engage must also be responsive and shift accordingly to the needs of its users. In the immediate objective of relaying the intricacies of our relationship with carbon emissions, there are levels of uncertainty that need to be clearly communicated and the inconsistencies from seemingly infinite sources need to be vetted and sifted through. The under-

standing of this from the everyday citizen's perspective requires more exploration on effective representations of data where both the design and the users' needs are balanced to facilitate a gradual interest in unravelling complexities.

[3. On filling voids.]

The methods of user engagement explored within the thesis involve various ways of telling stories with data from a hypothetical database that contains the CO_2e value of any service or product that one may consume. Although such a comprehensive database does not exist and would take time to build, the aggregation of existing silos of data could provide a framework of what such a database would look like and immediately prove to be useful. Realistically, the pursuit of developing of an interface such as the one proposed would initially have to rely on a crowd-sourced method of gathering these existing data and research projects. There is great difficulty in accounting for all the resource emissions[1] contained in every available item and the direct causality between a certain product and its exact ecological effect may never be achieved. However, even building from a resource of rough estimates brings us closer to a clearer picture of the relationship between our individual actions and how they relate to the ecological systems that support us. Additionally, it provides the basis of a much needed quantitative point of reference to where we stand as individuals and how far our efforts take us.

What must be kept in check is the quality of the data and how it is handled. Several resources of data must be aggregated from different sources and incorporated into a new dataset. This presents an issue of assessing the varying levels of quality and reliability of data sources. Errors and inconsistencies are almost guaranteed to exist and they must somehow be vetted with standards in place. They must also be presented to the user in a transparent way where the uncertainties and gaps in data are understood. The solutions to this will be difficult to achieve and must also be constantly re-evaluated with the user in mind, since there is a level of

trust that must be maintained between the user and the proposed system. In response to this issue, the software's structuring must be designed in ways that make it responsive to unforeseen revelations of unreliability in certain data sources.

[4. On pushing values.]

The source of our planetary crisis is very much based on the values that we, as a society, choose to perpetuate and overcoming them will depend on whether we are able to re-evaluate those values and reinvest ourselves in truly sustainable ways of living. As architects, the values that we design with are integrated into our creations and they affect those that they are imposed upon, whether implicitly or explicitly. The approaches to design within this thesis research may seem unconventional by utilizing methods from separate disciplines, but it was with the objective of discovering anti-disciplinary solutions that break away from standard modes of operation within architecture. While developing adaptive solutions from standard approaches is certainly worthwhile and necessary, our particular situation asks of us to also develop solutions that stem from explorations outside of our normative constructed boundaries in the hopes that progress towards a better future can be accelerated. Whether as professionals or citizens, it is in these zones outside our comfort level where we can begin to ask ourselves whether the values we currently hold on to as a society are counter-intuitive to our survival. Once we are able to do this, we can begin to readjust ourselves accordingly in order to adopt new values that will allow us to continue flourishing.

What ultimately was designed in the thesis is a tool that people can use to gather their own evidence about the network of carbon emissions and how it relates to everything we purchase, with an emphasis on edible produce. This tool incorporates varying degrees of involvement depending on the interest level of the user, which is necessary to involve larger audiences since requiring the same level of interaction across the board is usually more limiting. This can be seen in the options from quickly checking a num-

ber that offers progress at-a-glance, to the more involved part of the community where efforts could be made to develop alternate sources of produce from a bottom-up perspective.

Looking towards the longer term, this tool also begins to look at how a preliminary social framework could be established in order to facilitate a supportive community that encourages continual progress towards our carbon targets at an individual level. By encouraging social gatherings in the context of tackling a common goal, we can nurture the seeds that may lead to new economies that are based on low-carbon economic activities that allow people to flourish[2]. The emphasis on people and their ability to flourish within our sustainability solutions is often an overlooked component yet is vital to achieving our carbon targets. Although the issue of sustainability is often categorized as an environmental issue first, it is very much a social problem first and an environmental issue second. As stated by John Ehrenfeld in *Sustainability by Design*, "If we fail to address the unsustainability of the modern human being, we will not be able to come to grips with other aspects of sustainability. [3]" In light of this, social networks that support one's efforts to transitioning to sustainable lifestyles must be built and nurtured in place of the common methods of prescriptive solutions that regularly demand reductions with no alternative choice.

[5.]

In the words of Bernard Tschumi:

> Architecture is a form of communication... of knowledge. Architecture is a way to understand our world, and also possibly to have some effect on it. It doesn't have to necessarily be through buildings – it has to do with ideas that involve our immediate environment, our physical space. Any way to use that physical environment, that architectural context, as a means to discuss issues I think is very appropriate[4].

The communication and sharing of knowledge pertaining to our

surrounding environment in the context of global warming has been the basis of all the proposed solutions. There is an endeavour to reconnect people with their surrounding and ecological environments in the hopes that the gained knowledge will lead to action in the form of small changes and interventions. The accumulation of these small interventions that anyone can partake in has the potential to be transformative on a systems level[5]. The challenge may seem insurmountable, but most of what we need to achieve a sustainable way of living is already within our reach, should we choose to work together:

> We are all shaped by our countless and cross-cutting individual identities—as citizens of a nation, residents of a local region, members of cultural groups, workers in an enterprise, members of civil-society organizations. Our multiple identities, as Amartya Sen has brilliantly emphasized in Identity and Violence, allow us each to connect not just to one place or culture or region or religion but to multiple facets of our world. Each of us is, at least potentially, a node of a truly global network in which we help to weave together diverse traditions, areas of knowledge, and cultural pursuits on the global tapestry. We are each the potential shapers of a global society that can share values and address common global challenges.[6]
>
> -Jeffrey D. Sachs, Common Wealth.

With various tools for connectivity at our disposal, we have the ability to quickly share and learn from each other's endeavours. By creating welcoming platforms where we can all bring our unique perspectives and bases of knowledge to the table, we will be able to increase our efforts in working towards and eventually achieve a far more sustainable way of living.

ENDNOTES

ABSTRACT

[1] Rebecca Spector, "Fully Integrated Food Systems: Regaining Connections between Farmers and Consumers," in The Fatal Harvest Reader: The Tragedy of Industrial Agriculture, ed. Andrew Kimbrell, (Washington: Island Press, 2002), 289.

[2] Dietmar Offenhuber and Katja Schechtner, eds., Inscribing a Square: Urban Data as Public Space (New York: SpringerWien, 2012), 64.

[3] John Thackara, How to Thrive in the Next Economy: Designing Tomorrow's World Today (Thames and Hudson, 2016), chap. 10, Kindle.

INTRODUCTION

[1] Rebecca Spector, "Fully Integrated Food Systems: Regaining Connections between Farmers and Consumers," in *The Fatal Harvest Reader: The Tragedy of Industrial Agriculture*, ed. Andrew Kimbrell, (Washington: Island Press, 2002), 289.

[2] Brian Kahn, "We Just Breached the 410 PPM Threshold for CO_2," *Scientific American*, April 21, 2017, https://www.scientificamerican.com/article/we-just-breached-the-410-ppm-threshold-for-co2/.

[3] George Marshall, *Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change,* (New York: Bloomsbury, 2015), 95.

[4] Marshall, *Don't Even Think About It,* 95.

[5] Luc Vallee and Jean Michaud, "To Reduce Carbon Footprint, We Must Improve Energy Efficiency," *The Globe and Mail,* June 18, 2016, https://www.theglobeandmail.com/report-on-business/rob-commentary/to-reduce-carbon-footprint-we-must-improve-energy-efficiency/article30508632/.

[6] Architecture00, 2017, http://www.architecture00.net/architecture/.

[7] Jeremy Till, *Architecture Depends* (Massachusetts: MIT Press, 2013)

[8] Anthony Townsend, "The Killer App for Technology-infused Cities Isn't Efficiency, It's Sociability," in *Inscribing a Square: Urban Data as Public Space,* ed. Dietmas Offenhuber and Katja Schechtner, (New York: SpringerWien, 2012), 64.

[9] Townsend, The Killer App for Technology-infused Cities Isn't Efficiency, It's Sociability," 64.

[10] Howard Rheingold, "Life is Not Completely a Game," in *Space Time Play: Computer Games, Architecture and Urbanism: The Next Level,* ed. Friedrich von Borries, Matthias Böttger, and Steffen P Walz, (Basel: Birkhäuser, 2007), 213.

[11] Rheingold, "Life is Not Completely a Game," 214.

[12] Dietmar Offenhuber and Katja Schechtner, eds., *Inscribing a Square: Urban Data as Public Space* (New York: SpringerWien, 2012), 77.

[13] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 28.

[14] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 62.

[15] Till, *Architecture Depends,* 173.

[16] Till, *Architecture Depends,* 183.

[17] Nishat Awan, Jeremy Till, and Tatjana Schneider, *Spatial Agency* (London: Routledge, 2011), 32.

[18] Hasso Plattner, *An Introduction to Design Thinking* (Institute of Design at Stanford, 2010), 2-11.

[19] Marshall, *Don't Think About It,* 233.

[20] Till, *Architecture Depends,* 182.

CHAPTER ONE

[1] Paul Allen and Peter Kareiva, "Paul Allen, Peter Kareiva Call on Hollywood to Make More Films About Climate Change," *Variety,* April 26, 2017, http://variety.com/2017/voices/columns/paul-allen-hollywood-climate-change-1202395252/?hootPostID=026cb68dc56a82d1b9433f986b352429.

[2] George Marshall, *Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change,* (New York: Bloomsbury, 2015), 105.

[3] Chip Heath and Dan Heath, *Made to Stick: Why Some Ideas Survive and Others Die,* (New York: Random House, 2007), 13.

[4] Heath and Heath, *Made to Stick,* 254.

[5] Marshall, *Don't Even Think About It,* 150.

[6] Rich Gold, *The Plenitude: Creativity, Innovation, and Making Stuff* (Cambridge, MA: The MIT Press, 2007), xxi.

[7] Guy Debord, *The Society of the Spectacle* (New York: Zone Books, 1994) Chapter 1.

[8] Debord, *The Society of the Spectacle,* Chapter 1.

[9] Per Espen Stoknes, *What We Think About When We Think About Climate Change* (White River Junction: Chelsea Green Publishing, 2015), 132.

[10] Lisa Dilling and Susanne C. Moser, eds., *Creating a Climate for Change* (Cambridge: Cambridge University Press, 2007), 257.

[11] Marshall, *Don't Even Think About It,* 57.

[12] Dilling and Moser, eds., *Creating a Climate for Change,* 98.

[13] John Thackara, *How to Thrive in the Next Economy: Designing Tomorrow's World Today* (Thames and Hudson, 2016), chap. 10, Kindle.

[14] Thomas S. Kuhn, *Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 2008), 95.

[15] "Women's Suffrage in the United States," Wikipedia, accessed August 08, 2017, https://en.wikipedia.org/wiki/Women%27s_suffrage_in_the_United_States#Emergence_of_the_women.27s_rights_movement.

[16] Rebecca Solnit, *Hope in the Dark* (New York: Nation Books, 2004), 135.

[17] Dilling and Moser, eds., *Creating a Climate for Change,* 258.

[18] Jared Diamond, *Collapse* (New York: Penguin Books, 2014), 522.

[19] Diamond, *Collapse,* 523.

[20] Marshall, *Don't Even Think About It,* 69.

[21] Marshall, *Don't Even Think About It,* 69.

[22] Diamond, *Collapse,* 279.

[23] Diamond, *Collapse,* 281.

[24] Thackara, *How to Thrive in the Next Economy,* chap. 10.

[25] Thackara, *How to Thrive in the Next Economy,* chap. 10.

[26] Dilling and Moser, eds., *Creating a Climate for Change,* 258.

[27] BBC, *Century of the Self,* directed by Adam Curtis (London: BBC Two, 2002).

[28] Tim Jackson, *Prosperity Without Growth: Economics for a Finite Planet* (London: Routledge, 2009), 98.

[29] Jackson, *Prosperity Without Growth,* 100.

[30] Jackson, *Prosperity Without Growth,* 153.

[31] Vishaan Chakrabarti, *A Country of Cities* (New York: Metropolis Books, 2013), 33.

[32] Dilling and Moser, eds., *Creating a Climate for Change,* 255.

[33] Dilling and Moser, eds., *Creating a Climate for Change,* 263.

[34] Dilling and Moser, eds., *Creating a Climate for Change,* 261.

[35] Dilling and Moser, eds., *Creating a Climate for Change,* 263.

[36] Dilling and Moser, eds., *Creating a Climate for Change,* 73.

[37] Marshall, *Don't Even Think About It,* 42.

[38] Thackara, *How to Thrive in the Next Economy,* chap. 10.

[39] Nigel Thrift, "Cities Without Modernity, Cities with Magic," in *The Cybercities Reader,* edited by Steve Graham (London: Taylor & Francis, 2004), 98-100.

[40] Dilling and Moser, eds., *Creating a Climate for Change,* 301.

CHAPTER TWO

[1] Jared Diamond, *Collapse* (New York: Penguin Books, 2014), 119.

[2] Diamond, *Collapse,* 525.

[3] MVRDV, *Metacity/Datatown* (Rotterdam: 010 Publishers, 1999), 214.

[4] Mike Berners-Lee, *How Bad Are Bananas?,* (London: Profile, 2010), 7.

[5] Mark Shepard, ed., *Sentient City* (New York City: Architectural League of New York, 2011), 190.

[6] Shepard, ed., *Sentient City*, 194.

[7] Mark Wilson, "Why We Had No Idea Trump Would Win," *Co.Design,* November 11, 2016, https://www.fastcodesign.com/3065750/why-we-had-no-idea-trump-would-win.

[8] Timothy McGovern, "Real-time Data for the Real World," *O'Reilly,* November 1, 2016, https://www.oreilly.com/ideas/real-time-data-for-the-real-world.

[9] Dietmar Offenhuber and Katja Schechtner, eds., *Inscribing a Square: Urban Data as Public Space* (New York: SpringerWien, 2012), 63.

[10] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 16.

[11] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 15.

[12] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 16.

[13] John Thackara, *How to Thrive in the Next Economy: Designing Tomorrow's World Today* (Thames and Hudson, 2016), chap. 10, Kindle.

[14] Paul Virilio, "The Third Interval: A Critical Transition," in *Rethinking Technologies,* edited by Verena Andermatt Conley (Minneapolis: University of Minnesota Press, 1994), 4-5.

[15] Scott R. Peppet, "*Unraveling Privacy: The Personal Prospectus and the*

Threat of a Full-Disclosure Future," Northwestern University Law Review 105, no. 3 (2015): 1157, http://scholarlycommons.law.northwestern.edu/nulr/vol105/iss3/4.

[16] Natasha Lomas, "The Online Privacy Lie is Unraveling," *TechCrunch,* June 6, 2015, https://techcrunch.com/2015/06/06/the-online-privacy-lie-is-unraveling/.

[17] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 17.

[18] Shepard, ed., *Sentient City,* 87.

[19] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 61.

[20] Giorgia Lupi, "How We Can Find Ourselves in Data," filmed March 2017 at TEDNYC, New York City, NY, video, 11:13, https://www.ted.com/talks/giorgia_lupi_how_we_can_find_ourselves_in_data.

[21] Giorgia Lupi, "Data Humanism, the Revolution Will Be Visualized," *Medium,* February 1, 2017, https://medium.com/@giorgialupi/data-humanism-the-revolution-will-be-visualized-31486a30dbfb.

[22] Lupi, "How We Can Find Ourselves in Data."

[23] Offenhuber and Schechtner, *Inscribing a Square: Urban Data as Public Space,* 88.

[24] George Marshall, *Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change,* (New York: Bloomsbury, 2015), 140.

[25] Marshall, *Don't Even Think About It,* 117.

[26] Marshall, *Don't Even Think About It,* 192.

[27] Berners-Lee, *How Bad Are Bananas?,* 194.

[28] Marshall, *Don't Even Think About It,* 71.

[29] Diamond, *Collapse,* 429.

[30] Marshall, *Don't Even Think About It,* 196.

[31] Tim Campbell, *Beyond Smart Cities: How Cities Network, Learn and Innovate* (United Kingdom: Taylor & Francis, 2012), 41-42.

[32] Martijn De Waal, "The Urban Culture of Sentient Cities: From and Internet of Things to a Public Sphere of Things," in *Sentient City: Ubiquitous Computing, Architecture, and the Future of Urban Space,* edited by Mark Shepard (Cambridge, MA: Architectural League of New York, 2011), 190-195.

[33] Thackara, *How to Thrive in the Next Economy,* chap. 5.

[34] Marshall, *Don't Even Think About It,* 71.

[35] Stuart Walker and Jacques Giard, eds., *The Handbook of Design for Sustainability* (New York: Bloomsbury Academic, 2017), xxv.

[36] Thackara, *How to Thrive in the Next Economy,* chap. 10.

[37] Lupi, "How We Can Find Ourselves in Data."

[38] Diamond, *Collapse,* 524.

[39] Diamond, *Collapse,* 485.

[40] Diamond, *Collapse,* 525.

CHAPTER THREE

[1] "Toronto Population 2017," Country Digest, accessed August 15, 2017, http://countrydigest.org/toronto-population/.

[2] "Summary of Solutions by Overall Rank," Drawdown, accessed September 04, 2017, http://www.drawdown.org/solutions-summary-by-rank.

[3] "Sample Size Calculator," Creative Research Systems, accessed May 24, 2014, https://www.surveysystem.com/sscalc.htm.

[4] Catherine McIntyre, "This Mapping Tool Shows How Accessible Food is in Your Neighbourhood," *Torontoist,* April 14, 2016, http://torontoist.com/2016/04/this-new-mapping-tool-shows-how-accessible-food-is-in-your-neighbourhood/.

[5] Joseph Nasr, Rod MacRae, and James Kuhns, *Scaling up Urban Agriculture in Toronto: Building the Infrastructure," (*Metcalf Food Solutions, 2010), http://metcalffoundation.com/wp-content/uploads/2011/05/scaling-urban-agriculture.pdf.

[6] Rod MacRae, Joe Nasr, James Kuhns, Lauren Baker, Russ Christianson, Martin Danyluk, Abra Snider, et al., "Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries? Part II, Policy supports and program design," *Journal of Agriculture, Food Systems, and Community Development,* advance online publication, http://dx.doi.org/10.5304/jafscd.2011.022.002.

[7] Anthony J. McMichael, John W. Powles, Colin D. Butler, Ricardo Uauy, "Food, Livestock Productions, Energy, Climate Change, and Health," *The Lancet*, volume 370, Issue 9594, October 12, 2007, https://doi.org/10.1016/S0140-6736(07)61256-2.

CHAPTER FOUR

[1] "Canadians Driving Less, Driving Smaller," Statistics Canada, October 07, 2016, http://www.statcan.gc.ca/pub/11-402-x/2010000/

chap/trans/trans01-eng.htm.

[2] "2008 Canadian Vehicle Survey Update Report," Natural Resources Canada, last modified October 10, 2010, http://oee.nrcan.gc.ca/publications/statistics/cvs08/chapter2.cfm?attr=0.

[3] "Greenhouse Gas Emissions from a Typical Passenger Vehicle," United States Environmental Protection Agency, last modified November 21, 2016, https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle-0.

[4] "Table 6: Households' Greenhouse Gas Emissions from Private Vehicle Operation, By Census Metropolitan Area, 2007," Statistics Canada, last modified December 19, 2012, http://www.statcan.gc.ca/pub/16-001-m/2010012/t006-eng.htm.

[5] Jared R. VandeWeghe and Christopher Kennedy, 2007, 'A Spatial Analysis of Residential Greenhouse Gas Emissions In The Toronto Census Metropolitan Area,' *Journal Of Industrial Ecology* 11 (2): 133-144, doi:10.1162/jie.2007.1220.

[6] Mike Berners-Lee, *How Bad Are Bananas?,* (London: Profile, 2010), 25-48.

[7]"Food by Ward Resources," Toronto Food Policy Council, accessed February 21, 2017, http://tfpc.to/food-by-ward/food-by-ward-resources.

CHAPTER FIVE

[1] Tim Jackson, *Prosperity Without Growth: Economics for a Finite Planet* (London: Routledge, 2009), 150.

[2] "How the Food Assembly Works," The Food Assembly, accessed March 05, 2017, https://thefoodassembly.com/en/p/cost.

CONCLUSION

[1] Tim Jackson, *Prosperity Without Growth: Economics for a Finite Planet* (London: Routledge, 2009), 73.

[2] Jackson, *Prosperity Without Growth,* 130.

[3] Stuart Walker and Jacques Giard, eds., *The Handbook of Design for Sustainability* (New York: Bloomsbury Academic, 2017), 64.

[4] Dan Hill, "New Spatial Intelligence, or the Tree Allowed to Grow Freely, but to Man's Pattern," in *Sentient City: Ubiquitous Computing, Architecture, and the Future of Urban Space,* edited by Mark Shepard (Cambridge, MA: Architectural League of New York, 2011), 167.

[5] John Thackara, *How to Thrive in the Next Economy: Designing Tomorrow's World Today* (Thames and Hudson, 2016), chap. 10, Kindle.

[6] Jeffrey D. Sachs, *Common Wealth: Economics for a Crowded Planet* (New York: Penguin Group, 2008), chap. 14, Kindle.

BIBLIOGRAPHY

Allen, Paul, and Peter Kareiva. "Paul Allen, Peter Kareiva Call on Hollywood to Make More Films About Climate Change." *Variety*, April 26, 2017. http://variety.com/2017/voices/columns/paul-allen-hollywood-climate-change-1202395252/?hootPostID=026cb68dc56a82d1b9433f986b352429.

Architecture00. 2017. http://www.architecture00.net/architecture/.

Awan, Nishat, Jeremy Till, and Tatjana Schneider. *Spatial Agency: Other Ways of Doing Architecture*. 1st ed. London: Routledge, 2011.

Berners-Lee, Mike. *How Bad Are Bananas?* London: Profile, 2010.

BBC. *Century of the Self*. Video. Directed by Adam Curtis. London: BBC Two, 2002.

Campbell, Tim. *Beyond Smart Cities: How Cities Network, Learn and Innovate*. United Kingdom: Taylor & Francis, 2012.

Chakrabarti, Vishaan. *A Country of Cities*. New York: Metropolis Books, 2013.

Country Digest. "Toronto Population 2017." Accessed August 15, 2017. http://countrydigest.org/toronto-population/.

Creative Research Systems. "Sample Size Calculator." Accessed May 24, 2017. https://www.surveysystem.com/sscalc.htm.

De Waal, Martijn. "The Urban Culture of Sentient Cities: From and Internet of Things to a Public Sphere of Things." In *Sentient City: Ubiquitous Computing, Architecture, and the Future of Urban Space*, edited by Mark Shepard. Cambridge, MA: Architectural League of New York, 2011.

Debord, Guy. *The Society of the Spectacle*. New York: Zone Books, 1994.

Diamond, Jared. *Collapse*. New York: Penguin Books, 2014.

Dilling, Lisa, and Susanne C. Moser, eds. *Creating A Climate for Change*. Cambridge: Cambridge University Press, 2011.

Drawdown. "Summary of Solutions by Overall Rank." Accessed September 04, 2017. http://www.drawdown.org/solutions-summary-by-rank.

The Food Assembly. "How the Food Assembly Works." Accessed March 05, 2017. https://thefoodassembly.com/en/p/cost.

Gold, Rich. *The Plenitude: Creativity, Innovation, and Making Stuff*. Cambridge, MA: The MIT Press, 2007.

Heath, Chip, and Dan Heath. *Made to Stick: Why Some Ideas Survive and Others Die*. New York: Random House, 2007.

Hill, Dan. "New Spatial Intelligence, or the Tree Allowed to Grow Freely, but to Man's Pattern." In *Sentient City: Ubiquitous Computing, Architecture, and the Future of Urban Space*, edited by Mark Shepard. Cambridge, MA: Architectural League of New York, 2011.

Jackson, Tim. *Prosperity Without Growth: Economics for a Finite Planet*. London: Routledge, 2009.

Kahn, Brian. "We Just Breached the 410 PPM Threshold for CO2." *Scientific American*, April 21, 2017. https://www.scientificamerican.com/article/we-just-breached-the-410-ppm-threshold-for-co2/.

Kuhn, Thomas S. *The Structure Of Scientific Revolutions*. Chicago: University of Chicago Press, 2008.

Lomas, Natasha. "The Online Privacy Lie is Unraveling." *TechCrunch,* June 6, 2015. https://techcrunch.com/2015/06/06/the-online-pri-

vacy-lie-is-unraveling/.

Lupi, Giorgia. "Data Humanism, the Revolution Will Be Visualized." *Medium*, February 1, 2017. https://medium.com/@giorgialupi/data-humanism-the-revolution-will-be-visualized-31486a30dbfb.

Lupi, Giorgia. "How We Can Find Ourselves in Data." Filmed March 2017 at TEDNYC, New York City, NY. Video, 11:13. https://www.ted.com/talks/giorgia_lupi_how_we_can_find_ourselves_in_data.

MacRae, Rod, Joe Nasr, James Kuhns, Lauren Baker, Russ Christianson, Martin Danyluk, Abra Snider, et al. "Could Toronto provide 10% of its fresh vegetable requirements from within its own boundaries? Part II, Policy supports and program design." *Journal of Agriculture, Food Systems, and Community Development*. Advance online publication. http://dx.doi.org/10.5304/jafscd.2011.022.002.

Marshall, George. *Don't Even Think About It: Why Our Brains Are Wired to Ignore Climate Change*. New York: Bloomsbury, 2015.

McGovern, Timothy. "Real-time Data for the Real World." *O'Reilly,* November 1, 2016. https://www.oreilly.com/ideas/real-time-data-for-the-real-world.

McIntyre, Catherine. "This Mapping Tool Shows How Accessible Food is in Your Neighbourhood." *Torontoist*, April 14, 2016. http://torontoist.com/2016/04/this-new-mapping-tool-shows-how-accessible-food-is-in-your-neighbourhood/.

McMichael, Anthony J., John W. Powles, Colin D. Butler, Ricardo Uauy. "Food, Livestock Productions, Energy, Climate Change, and Health." *The Lancet*, Volume 370, Issue 9594. October 12, 2007. https://doi.org/10.1016/S0140-6736(07)61256-2.

MVRDV. *Metacity/Datatown*. Rotterdam: 010 Publishers, 1999.

Nasr, Joseph, Rod MacRae, and James Kuhns. Scaling up Urban Agriculture in Toronto: Building the Infrastructure." *Metcalf Food Solutions, 2010*. http://metcalffoundation.com/wp-content/uploads/2011/05/scaling-urban-agriculture.pdf.

Natural Resources Canada. "2008 Canadian Vehicle Survey Update Report." Last modified October 10, 2010. http://oee.nrcan.gc.ca/publications/statistics/cvs08/chapter2.cfm?attr=0.

Offenhuber, Dietmar, and Katja Schechtner, eds. *Inscribing a Square: Urban Data as Public Space*. New York: SpringerWien, 2012.

Peppet, Scott R. "Unraveling Privacy: The Personal Prospectus and the Threat of a Full-Disclosure Future." *Northwestern University Law Review* 105, no. 3 (2015): 1153-1204.
http://scholarlycommons.law.northwestern.edu/nulr/vol105/iss3/4.

Plattner, Hasso. *An Introduction to Design Thinking*. Institute of Design at Stanford, 2010. https://dschool-old.stanford.edu/sandbox/groups/designresources/wiki/36873/attachments/8a846/ModeGuideBOOTCAMP2010.pdf?sessionID=573efa71aea5050334122449 1c862e32f5edc0a9.

Rheingold, Howard. "Life is Not Completely a Game." In *Space Time Play: Computer Games, Architecture and Urbanism: The Next Level,* edited by Friedrich von Borries, Matthias Böttger, and Steffen P Walz, 312-215. Basel: Birkhäuser, 2007.

Sachs, Jeffrey D. *Common Wealth: Economics for a Crowded Planet*. New York: Penguin Group, 2008. Kindle.

Shepard, Mark, ed. *Sentient City*. New York City: Architectural League of New York, 2011.

Solnit, Rebecca. *Hope In The Dark*. New York: Nation Books, 2004.

Spector, Rebecca. "Fully Integrated Food Systems: Regaining Connections between Farmers and Consumers." In *The Fatal Harvest Reader: The Tragedy of Industrial Agriculture,* edited by Andrew Kimbrell, 289. Washington: Island Press, 2002.

Statistics Canada. "Canadians Driving Less, Driving Smaller." October 07, 2016. http://www.statcan.gc.ca/pub/11-402-x/2010000/chap/trans/trans01-eng.htm.

Statistics Canada. "Table 6: Households' Greenhouse Gas Emissions from Private Vehicle Operation, By Census Metropolitan Area, 2007." Last modified December 19, 2012. http://www.statcan.gc.ca/pub/16-001-m/2010012/t006-eng.htm.

Stoknes, Per Espen. *What We Think About When We Try Not to Think About Global Warming*. White River Junction: Chelsea Green Publishing, 2015.

Thackara, John. *How to Thrive in the Next Economy: Designing Tomorrow's World Today*. Thames and Hudson, 2016. Kindle.

Till, Jeremy. *Architecture Depends*. Massachusetts: MIT Press, 2013.

Toronto Food Policy Council. "Food by Ward Resources." Accessed February 21, 2017. http://tfpc.to/food-by-ward/food-by-ward-resources.

Townsend, Anthony. "The Killer App for Technology-infused Cities Isn't Efficiency, It's Sociability." In *Inscribing a Square: Urban Data as Public Space,* edited by Dietmar Offenhuber and Katja Schechtner, 63-64. New York: SpringerWien, 2012.

United States Environmental Protection Agency. "Greenhouse Gas Emissions from a Typical Passenger Vehicle." Last modified November 21, 2016. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle-0.

Walker, Stuart, and Jacques Giard, eds. *The Handbook of Design For Sustainability*. New York: Bloomsbury Academic, 2017.

Wikipedia. "Women's Suffrage in the United States." Accessed August 08, 2017.https://en.wikipedia.org/wiki/Women%27s_suffrage_in_the_United_States#Emergence_of_the_women.27s_rights_movement.

Wilson, Mark. "Why We Had No Idea Trump Would Win." *Co.Design*, November 17, 2016. https://www.fastcodesign.com/3065750/why-we-had-no-idea-trump-would-win.

Vallee, Luc, and Jean Michaud. "To Reduce Carbon Footprint, We Must Improve Energy Efficiency." *The Globe and Mail,* June 18, 2016. https://www.theglobeandmail.com/report-on-business/rob-commentary/to-reduce-carbon-footprint-we-must-improve-energy-efficiency/article30508632/.

VandeWeghe, Jared R., and Christopher Kennedy. 2007. "A Spatial Analysis of Residential Greenhouse Gas Emissions in The Toronto Census Metropolitan Area." *Journal of Industrial Ecology* 11 (2): 133-144. doi:10.1162/jie.2007.1220.

Virilio, Paul. "The Third Interval: A Critical Transition." In *Rethinking Technologies*, edited by Verena Andermatt Conley. Minneapolis: University of Minnesota Press, 1994.

APPENDIX A
CARBON STUDIES

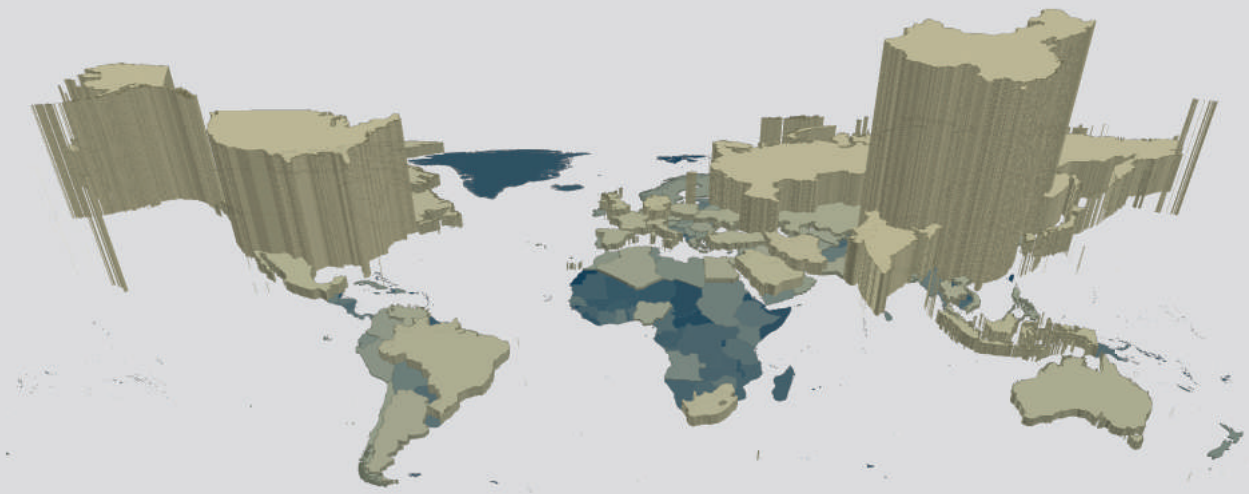


Fig. A.1 Infographic of total carbon dioxide emitted by country.

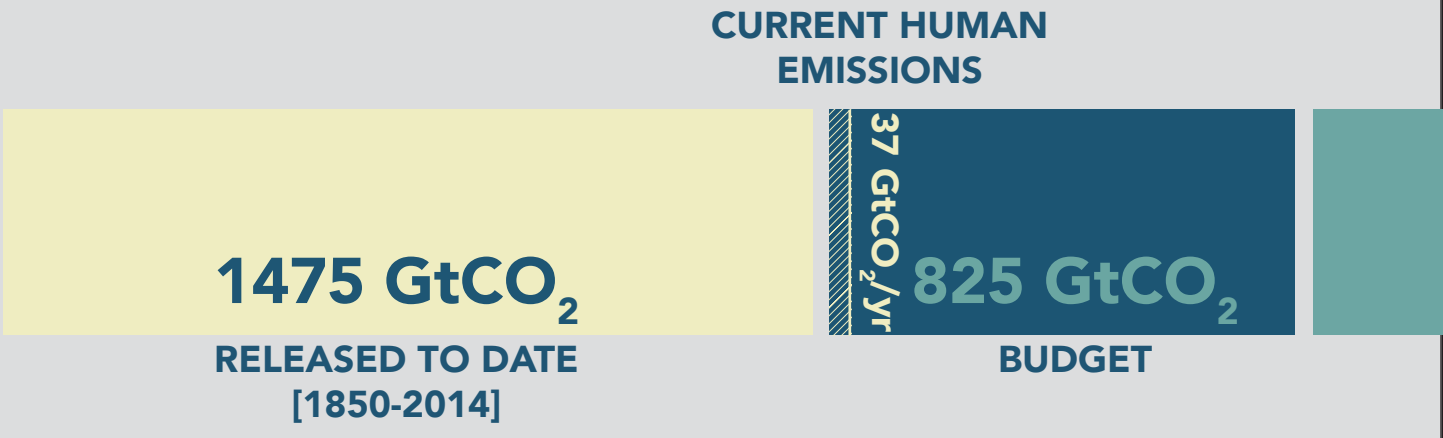


Fig. A.2 Infographic of total carbon dioxide released to date and available reserves potentially to be emitted.

TOTAL CO_2 EMISSIONS PER COUNTRY PER CAPITA [2011]

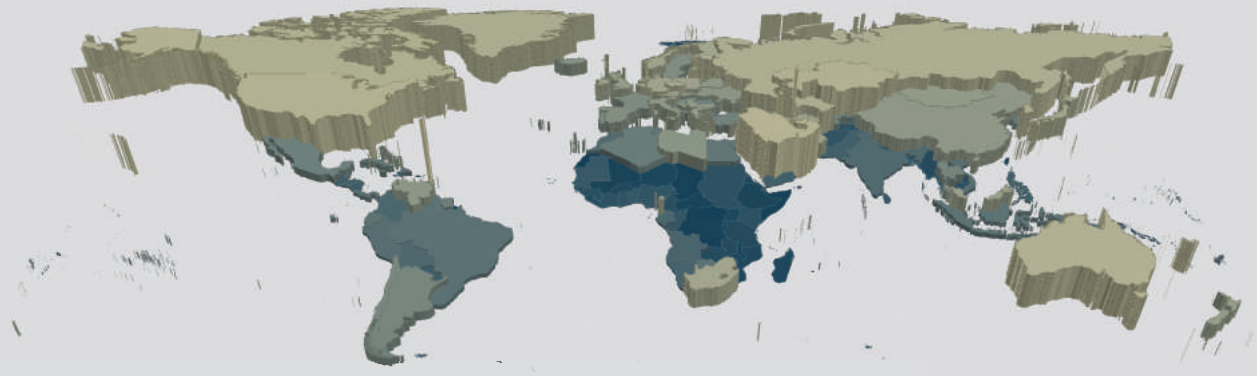
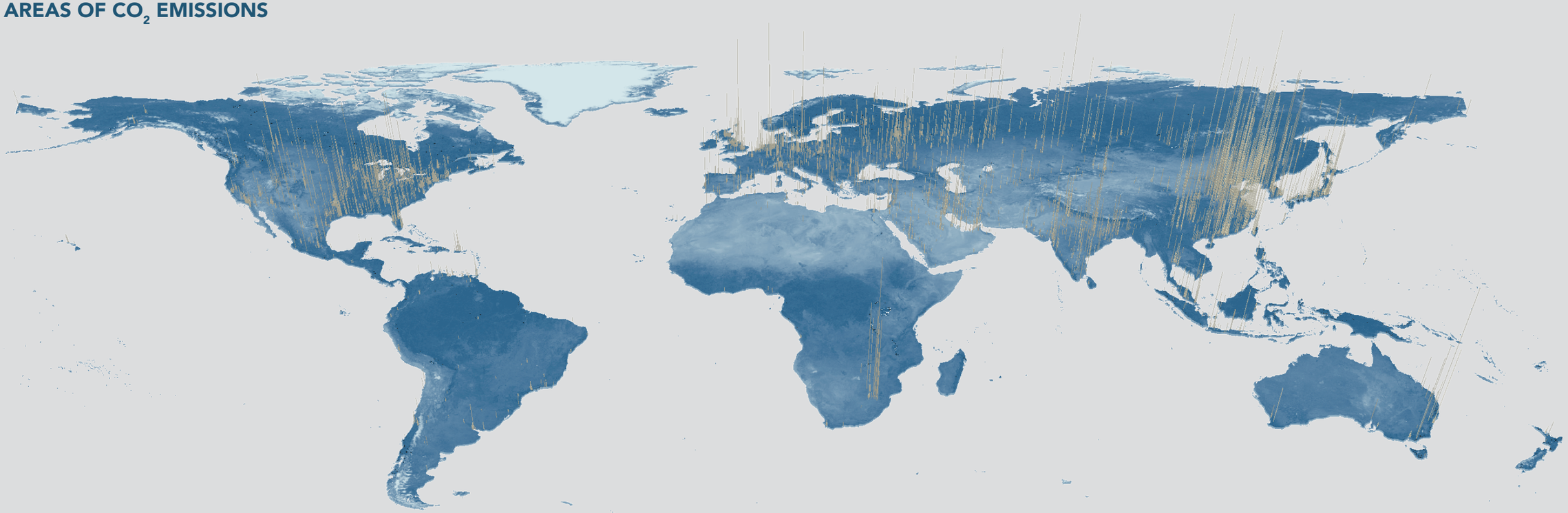


Fig. A.3 Infographic of total carbon dioxide emitted per country per capita.

2785 $GtCO_2$

AVAILABLE RESERVES

AREAS OF CO_2 EMISSIONS



450ppm CO_2
POINT OF NO RETURN

2t CO_2/capita
KYOTO PROTOCOL
GOAL

4.6t CO_2/capita
2011 AVERAGE
[AND RISING]

1ppm ATMOSPHERIC $CO_2 \approx 7.8$ $GtCO_2$
GLOBAL POPULATION [2014]: 7.2 BILLION
REACHING THE KYOTO PROTOCOL GOAL WILL RELEASE 14.4 $GtCO_2$/yr

Fig. A.4 Infographic of carbon emission targets and current rates of emission.

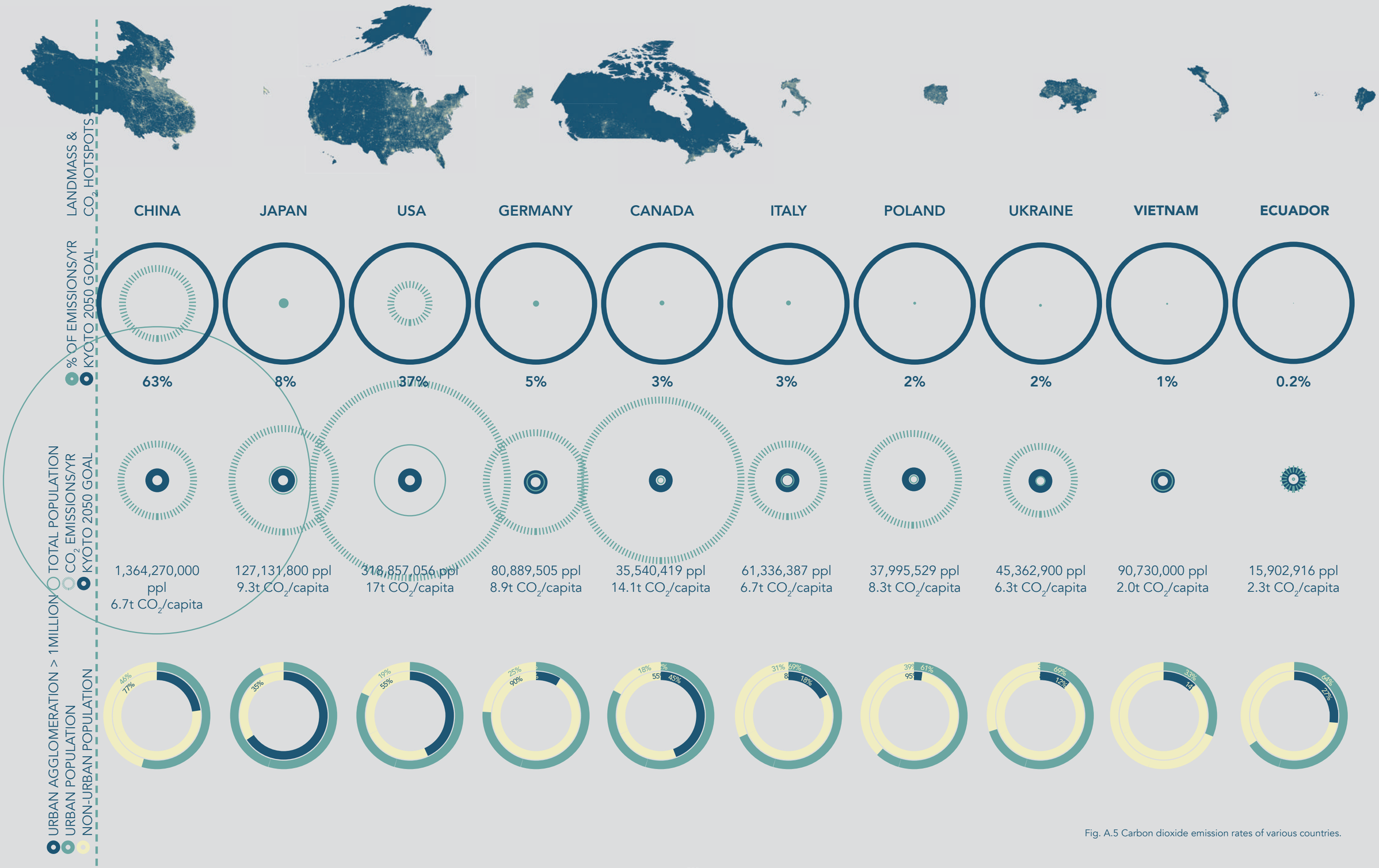
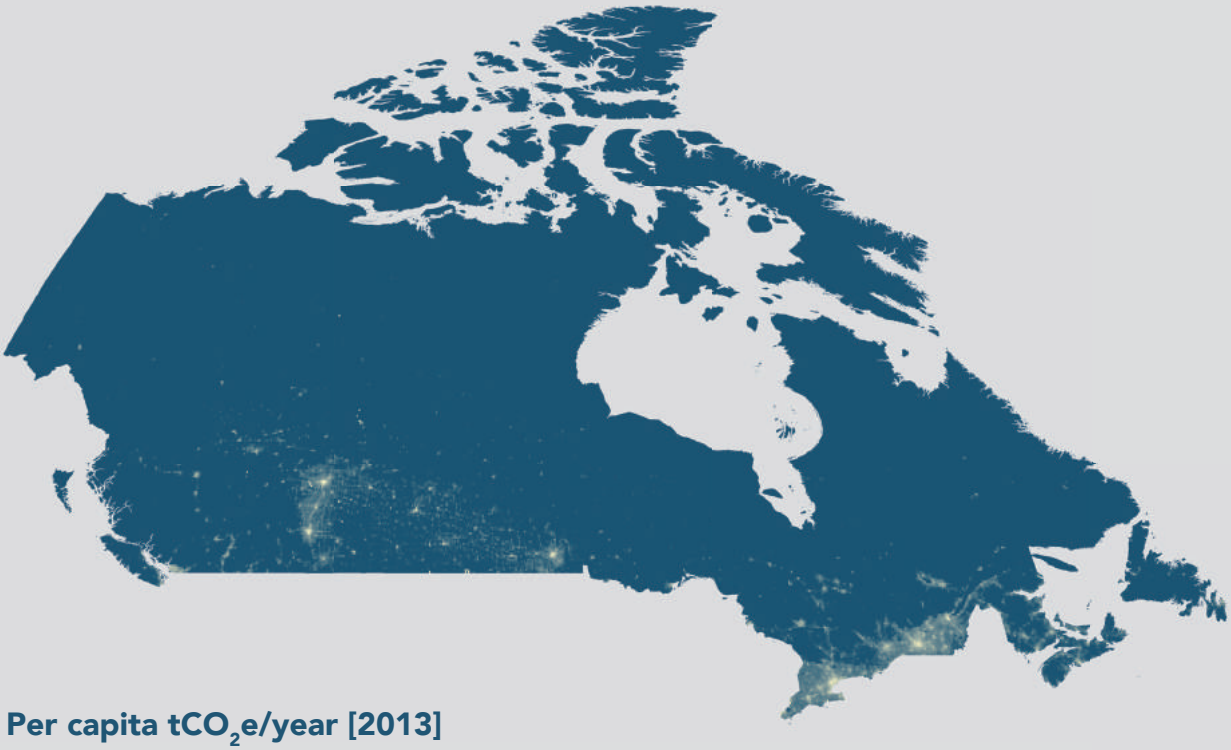


Fig. A.5 Carbon dioxide emission rates of various countries.



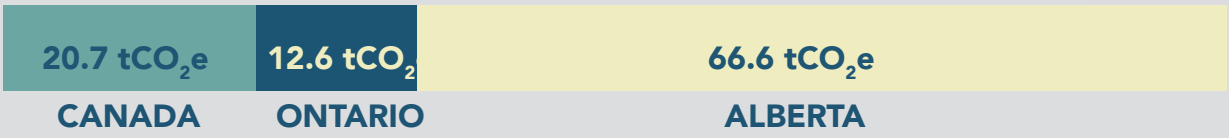


Fig. A.6 Carbon dioxide emission rates for Canada.

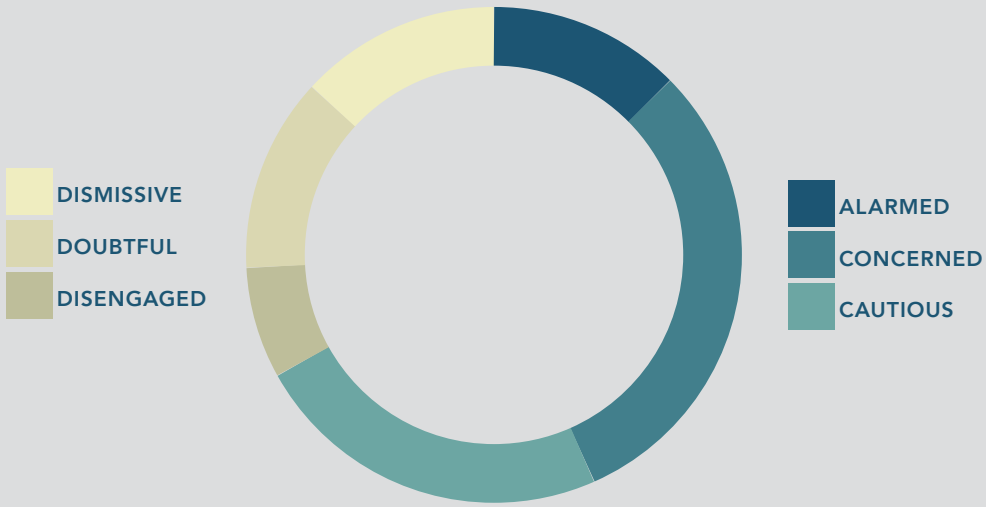


Fig. A.7 North American views towards climate change by user segmentation groups.

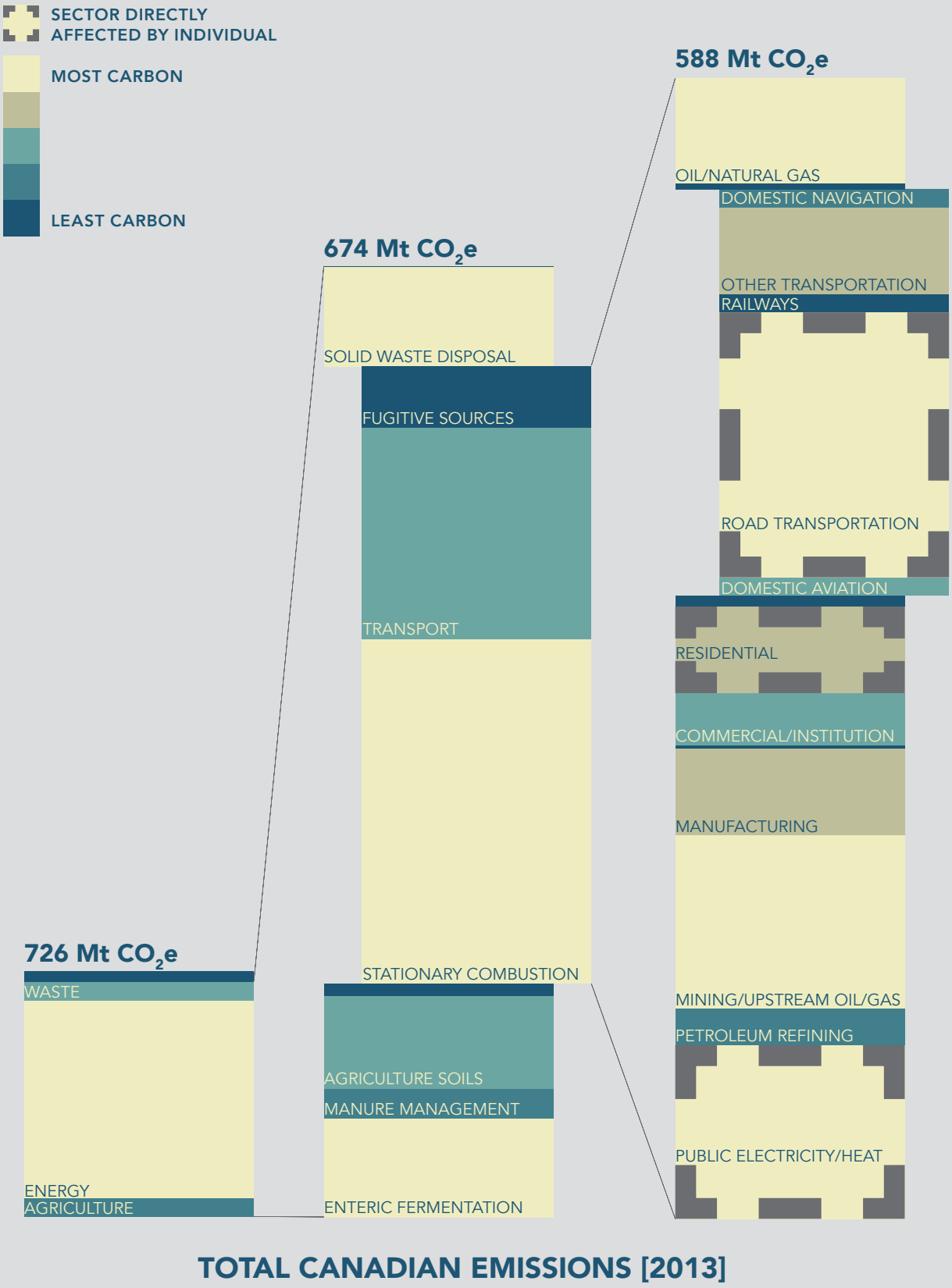
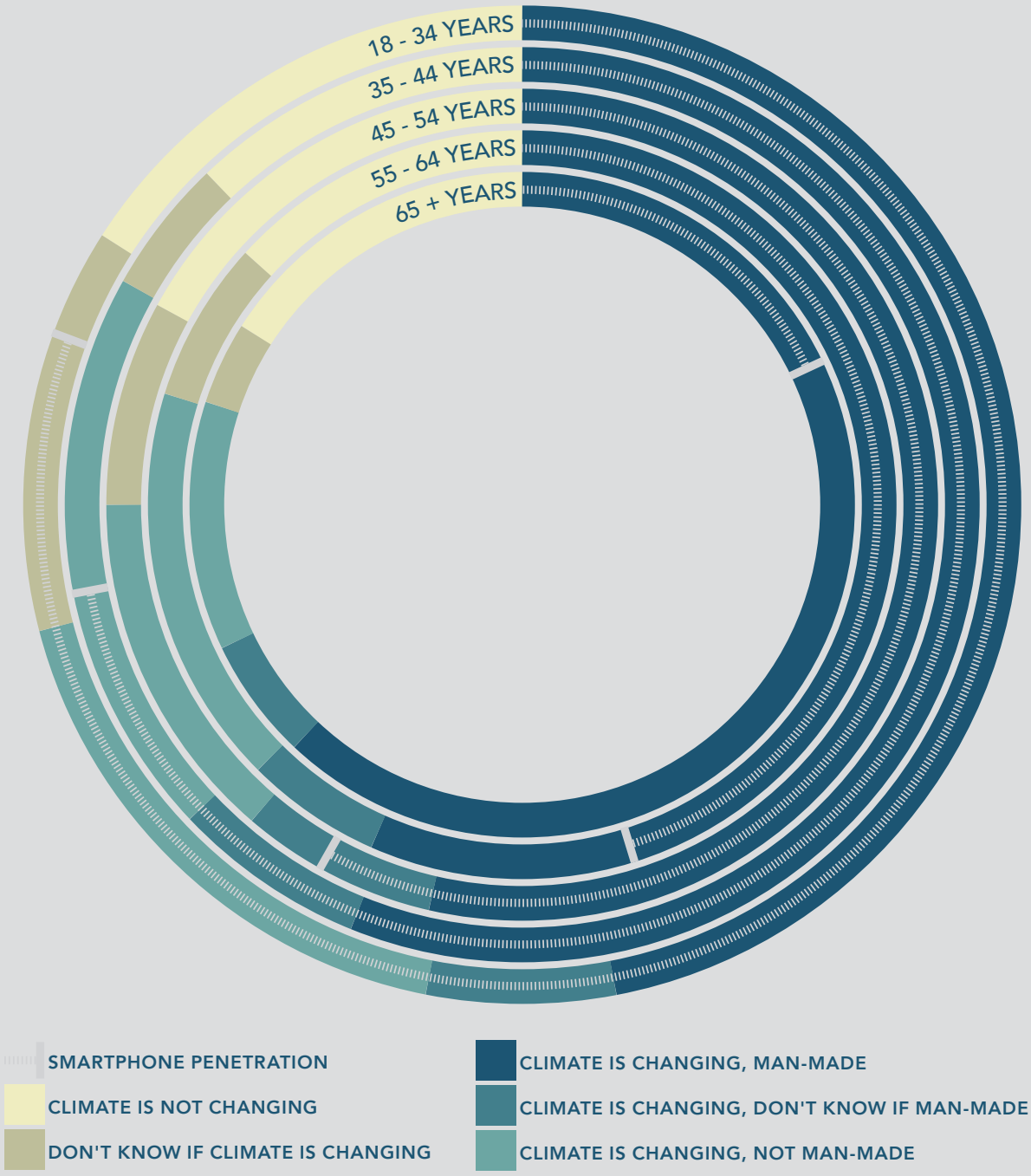
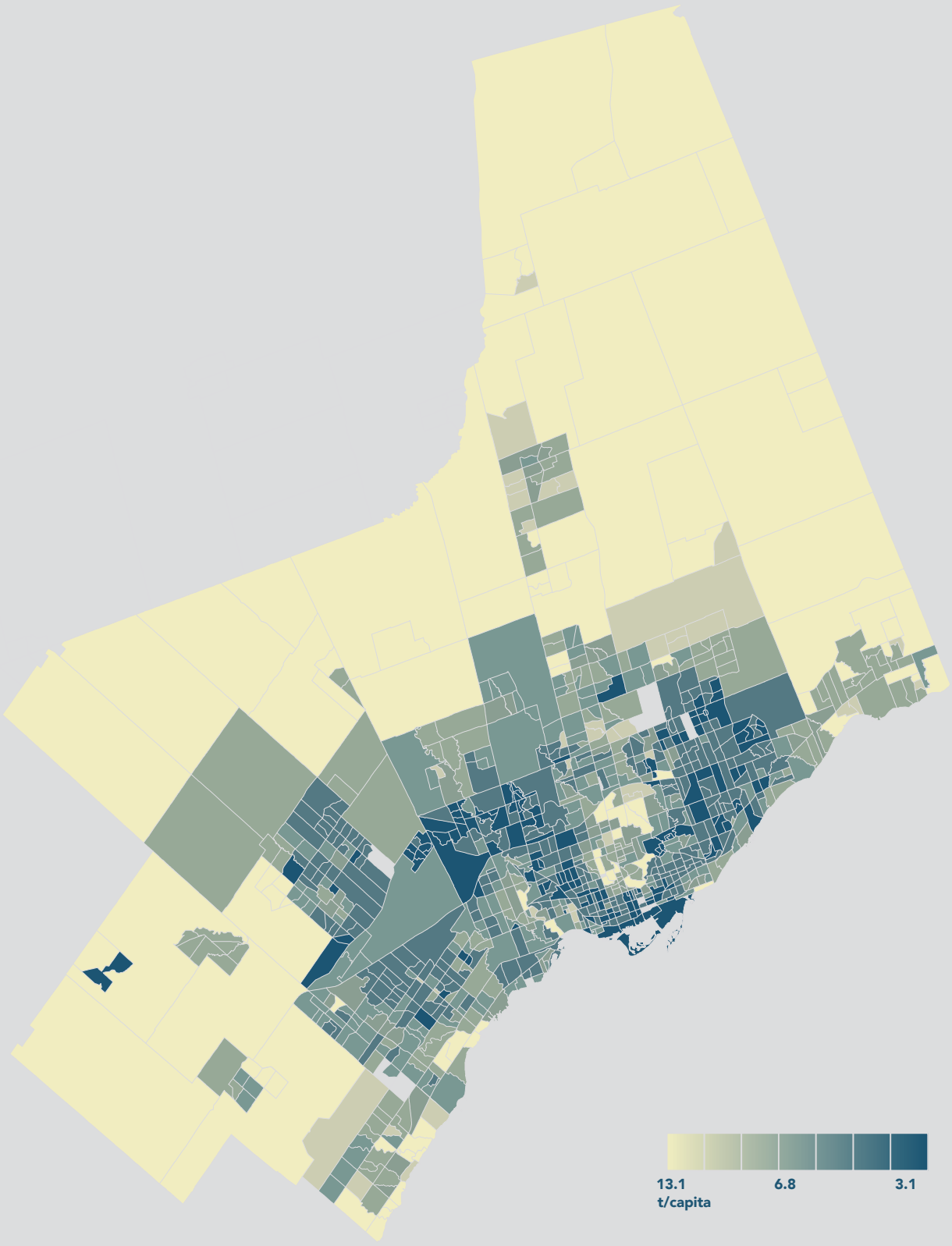


Fig. A.8 Breakdown of carbon emissions within Canada.



TORONTONIAN VIEWS TOWARDS CLIMATE CHANGE BY AGE GROUP

Fig. A.9 Torontonian views towards climate change by user segmentation groups.



TORONTO'S ANNUAL GHG EMISSIONS BY AREA [2007]

Includes total building operations, electricity use, building fuel use, total transportation, transit, and combined residential activities.

Fig. A.10 Carbon emissions levels of geographic areas within Toronto.

QUANTIFIED INDIVIDUALS

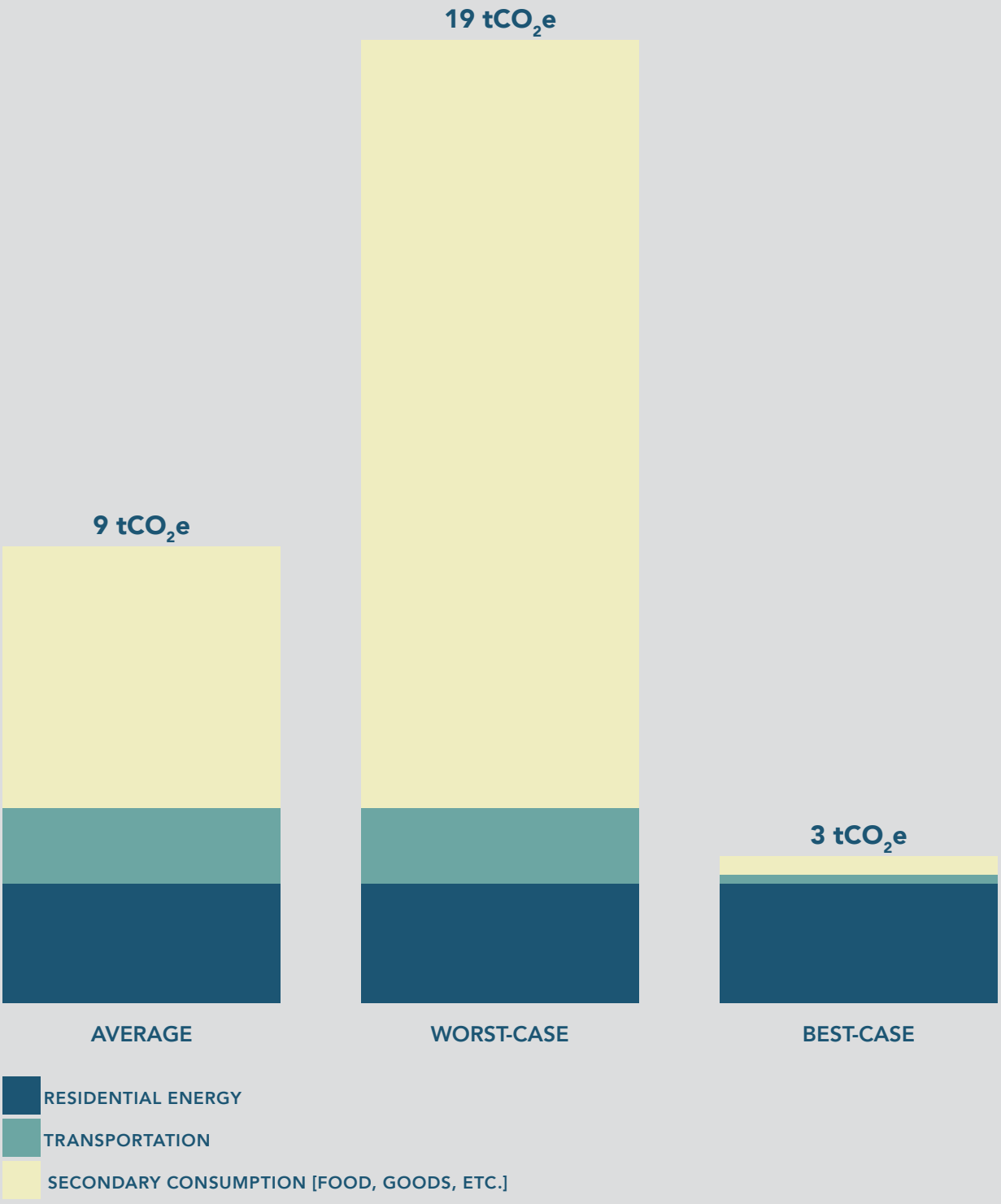


Fig. A.11 Possible areas of individual intervention pertaining to carbon emissions.

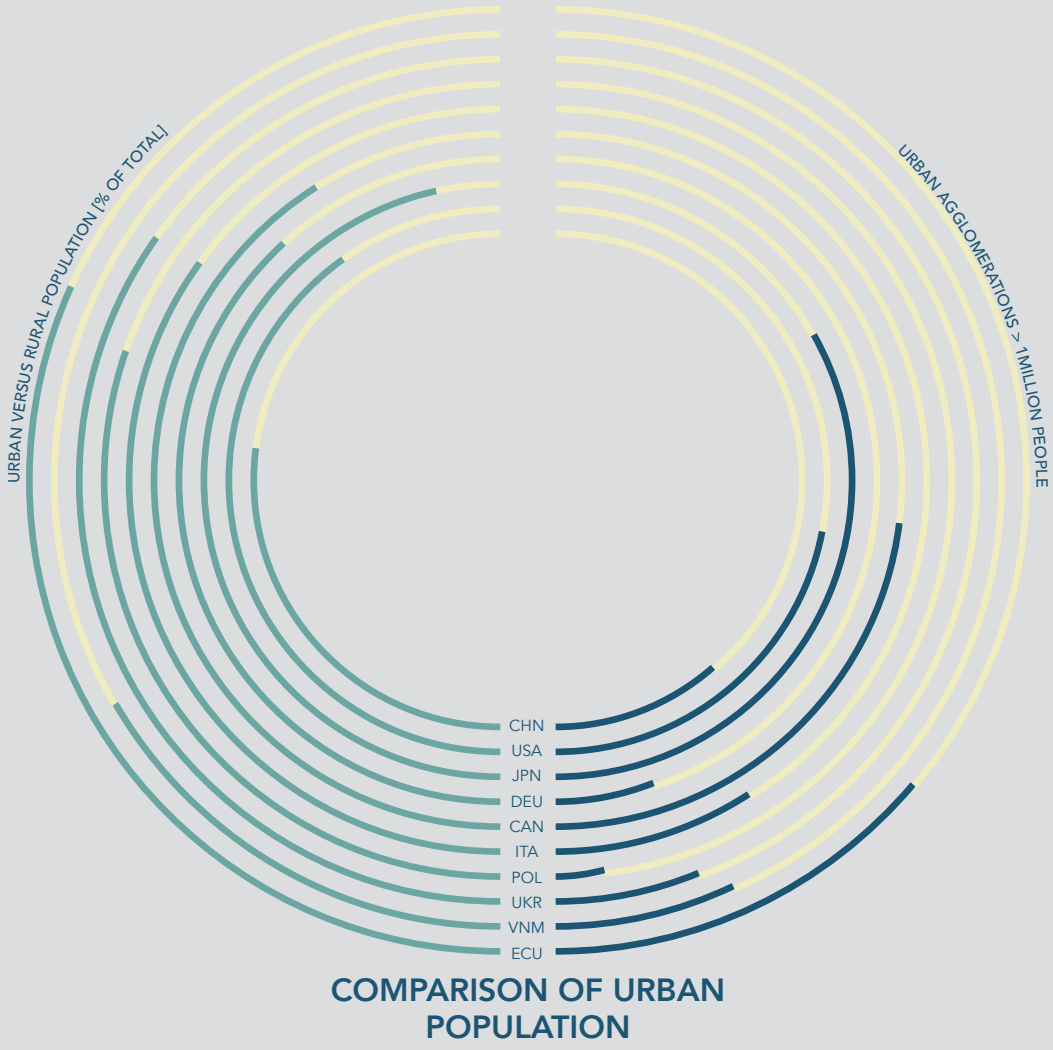


Fig. A.12 Urban population comparisons of various countries.

CHANGE IN CHLOROPHYLL CONCENTRATION [2002 - 2015]

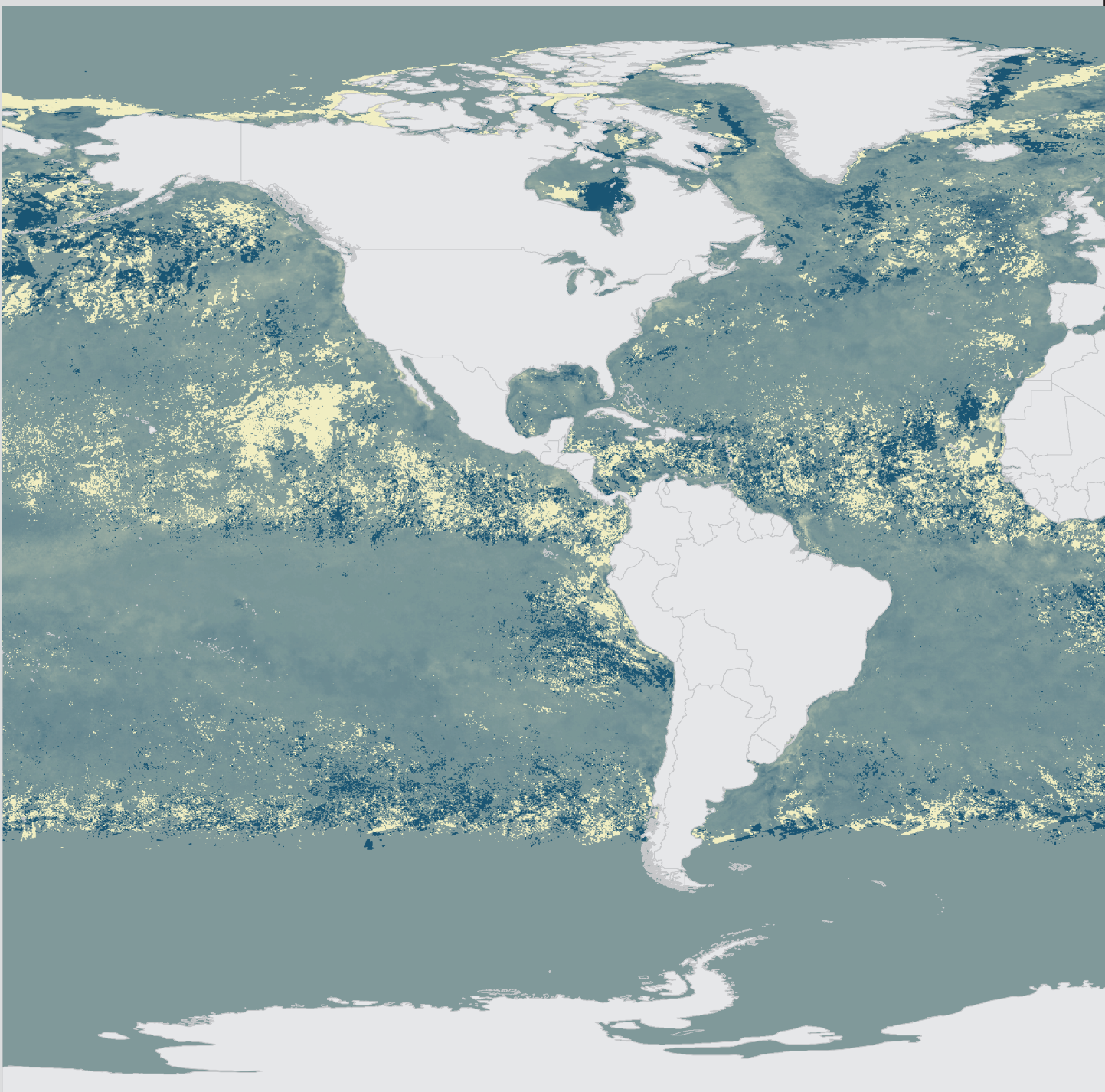
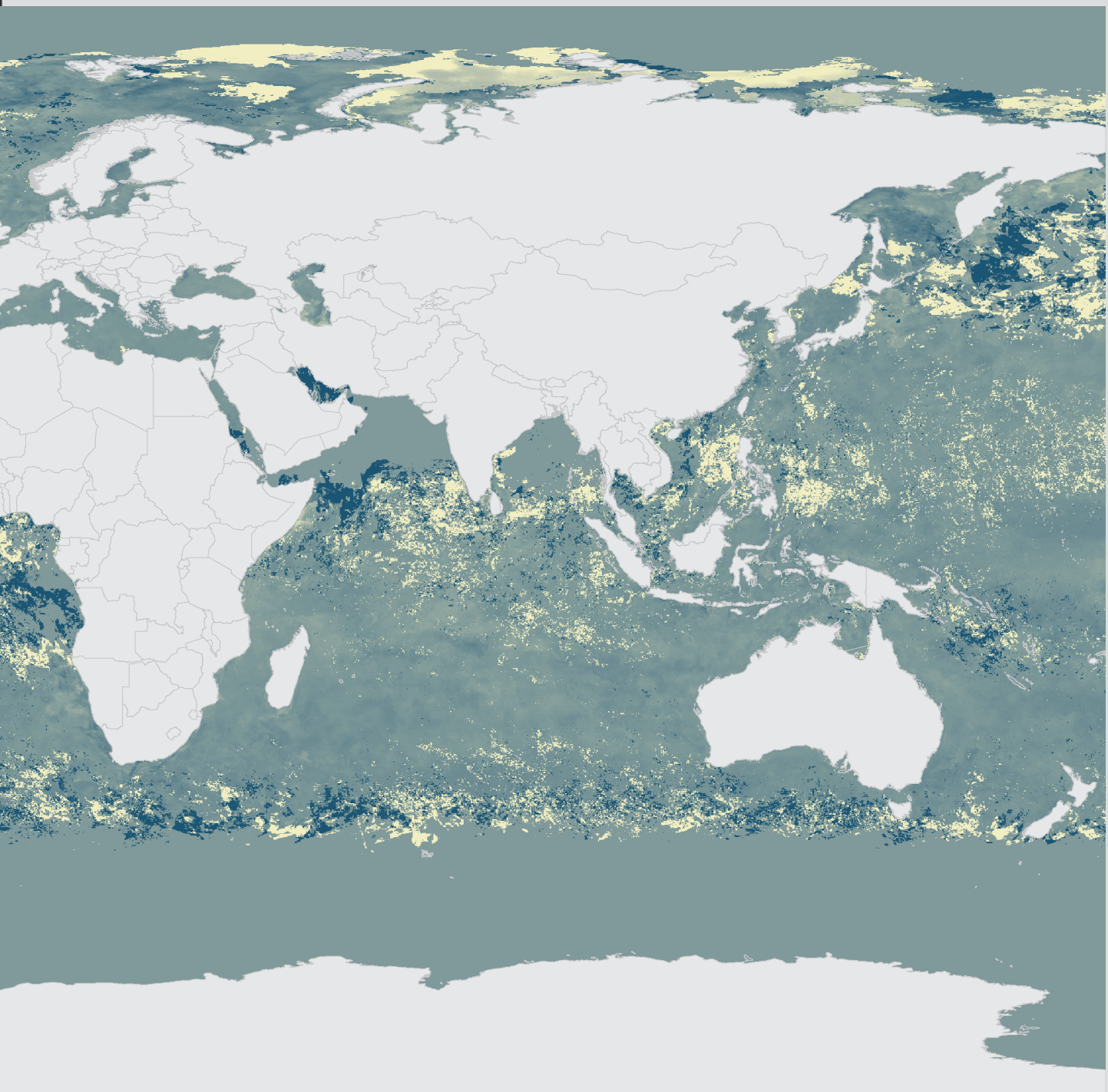


Fig. A.13 Worldwide change in chlorophyll concentration.



LESS CONCENTRATED MORE CONCENTRATED

CHANGE IN RAINFALL [1998 - 2015]

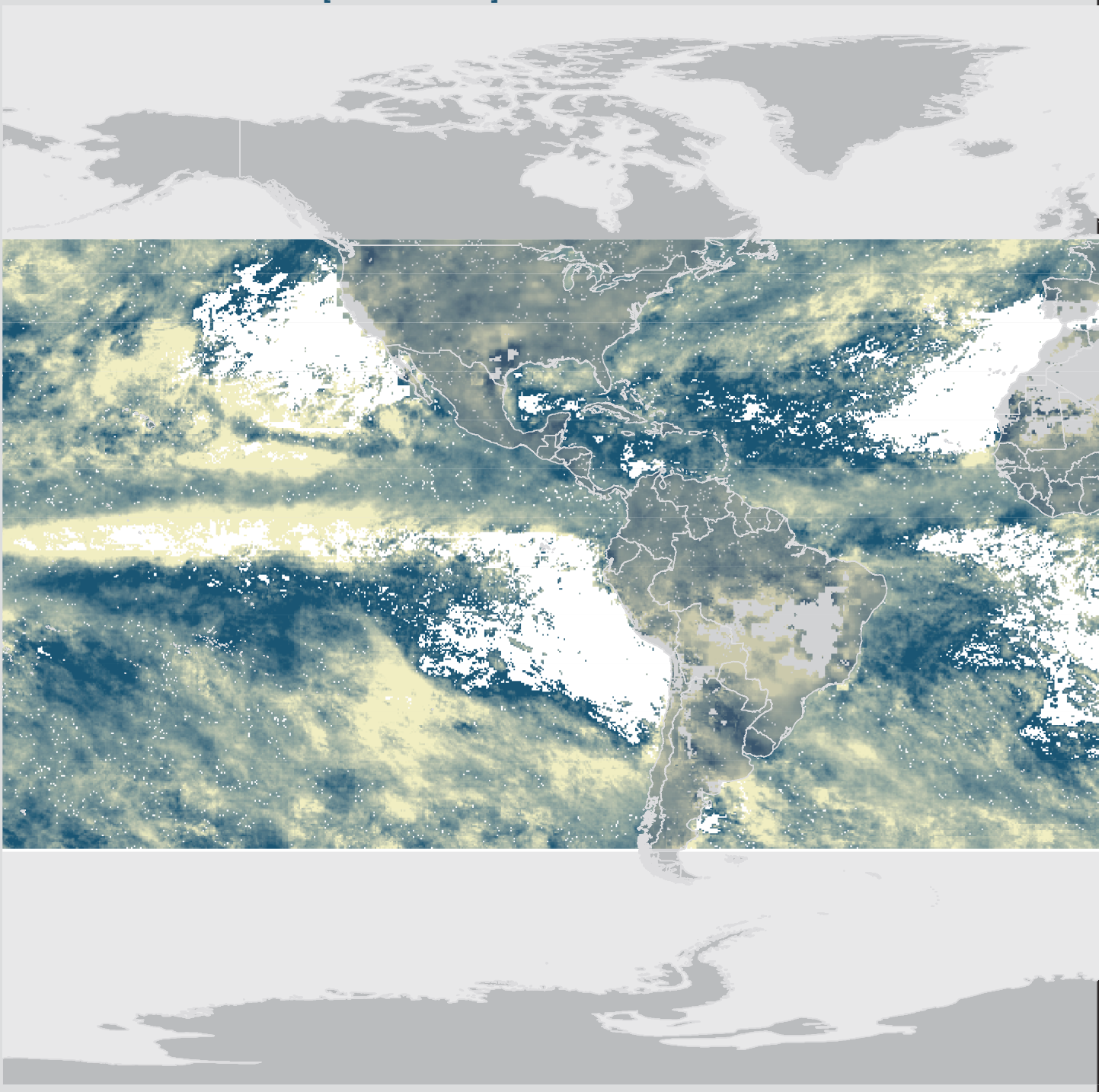
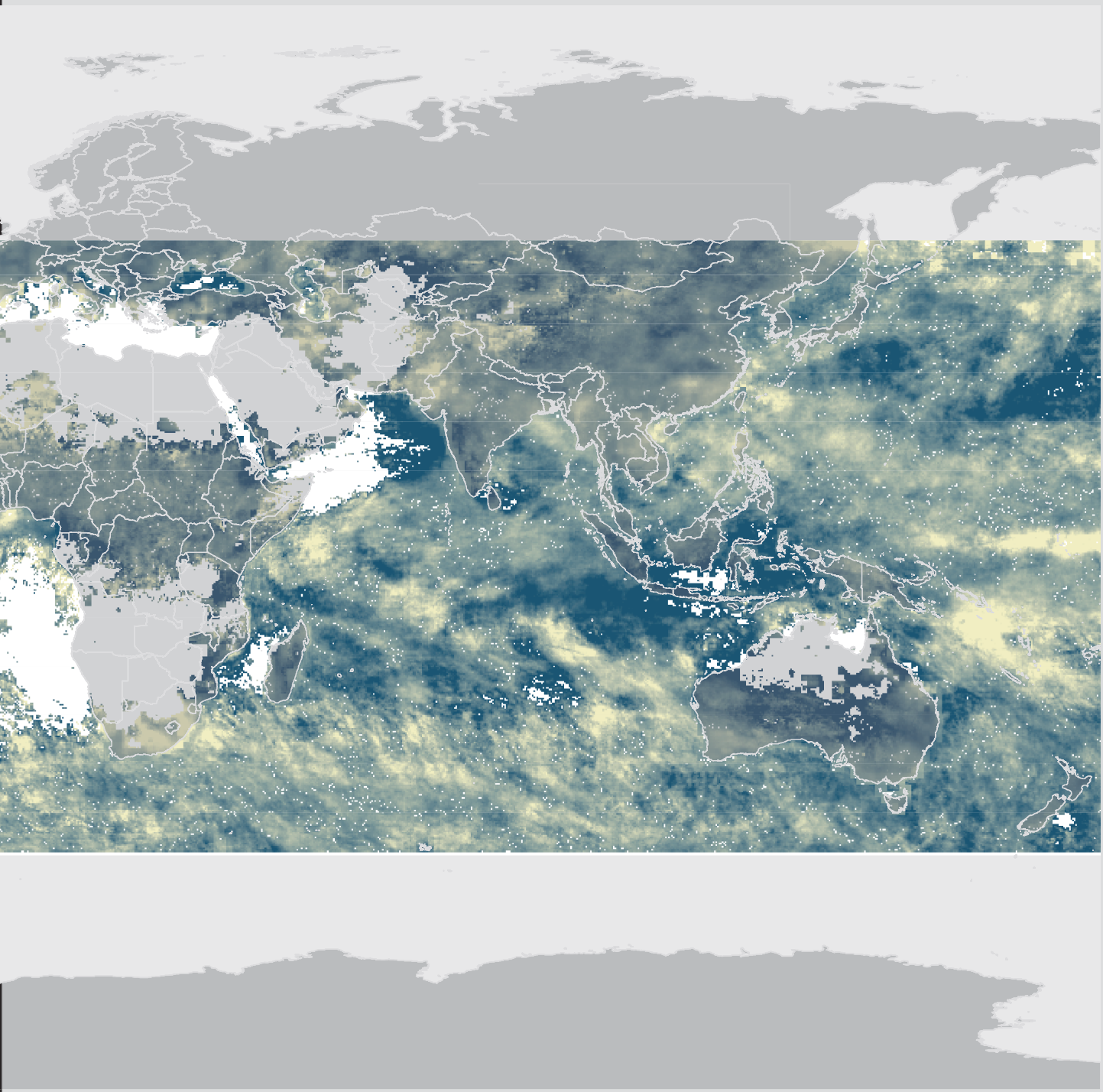


Fig. A.14 Worldwide change in rainfall.



UP TO -2000mm CHANGE

UP TO +2000mm CHANGE

CHANGE IN LAND TEMPERATURE ANOMALIES [2000 - 2015 NIGHT, JANUARY]

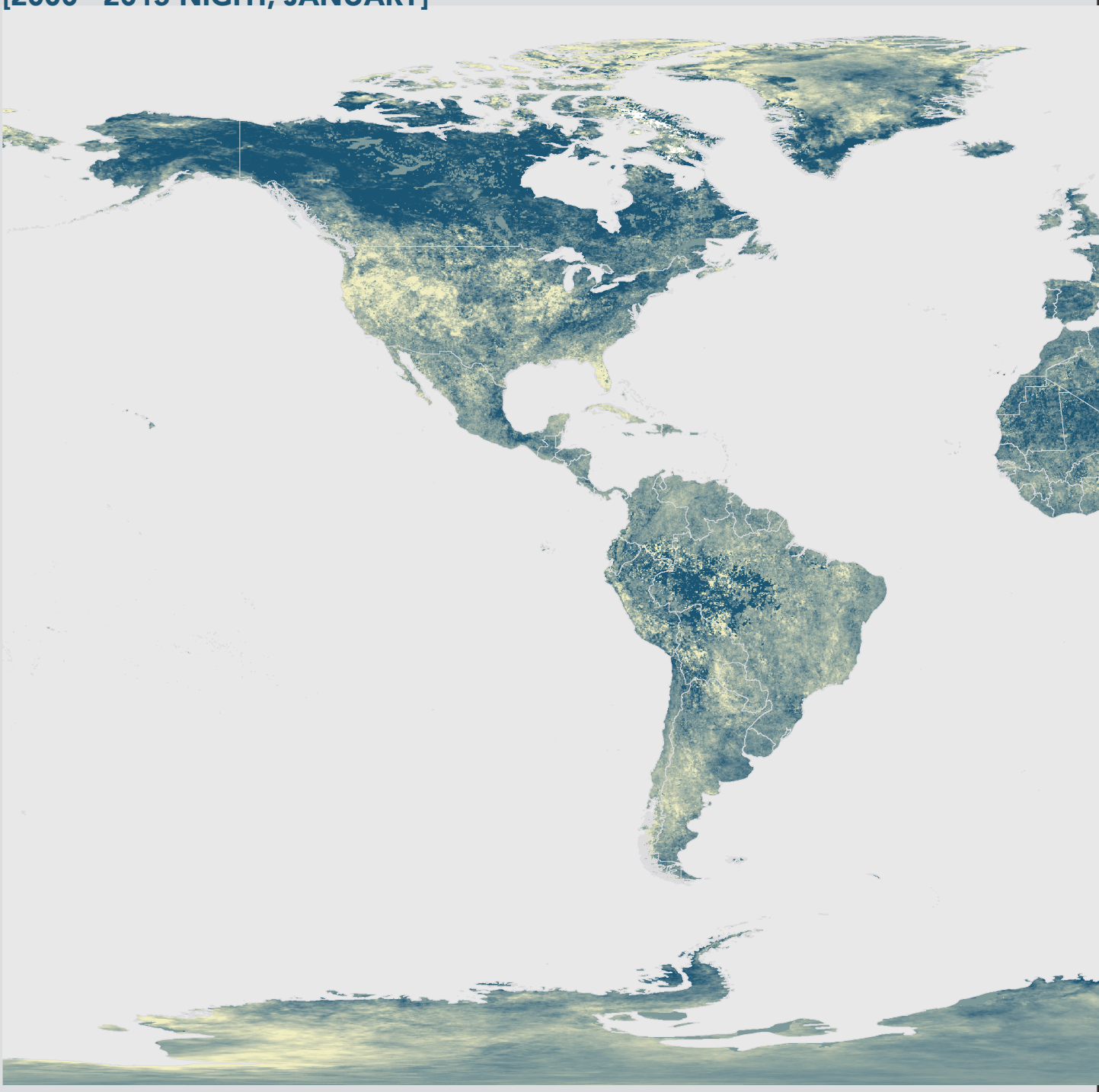
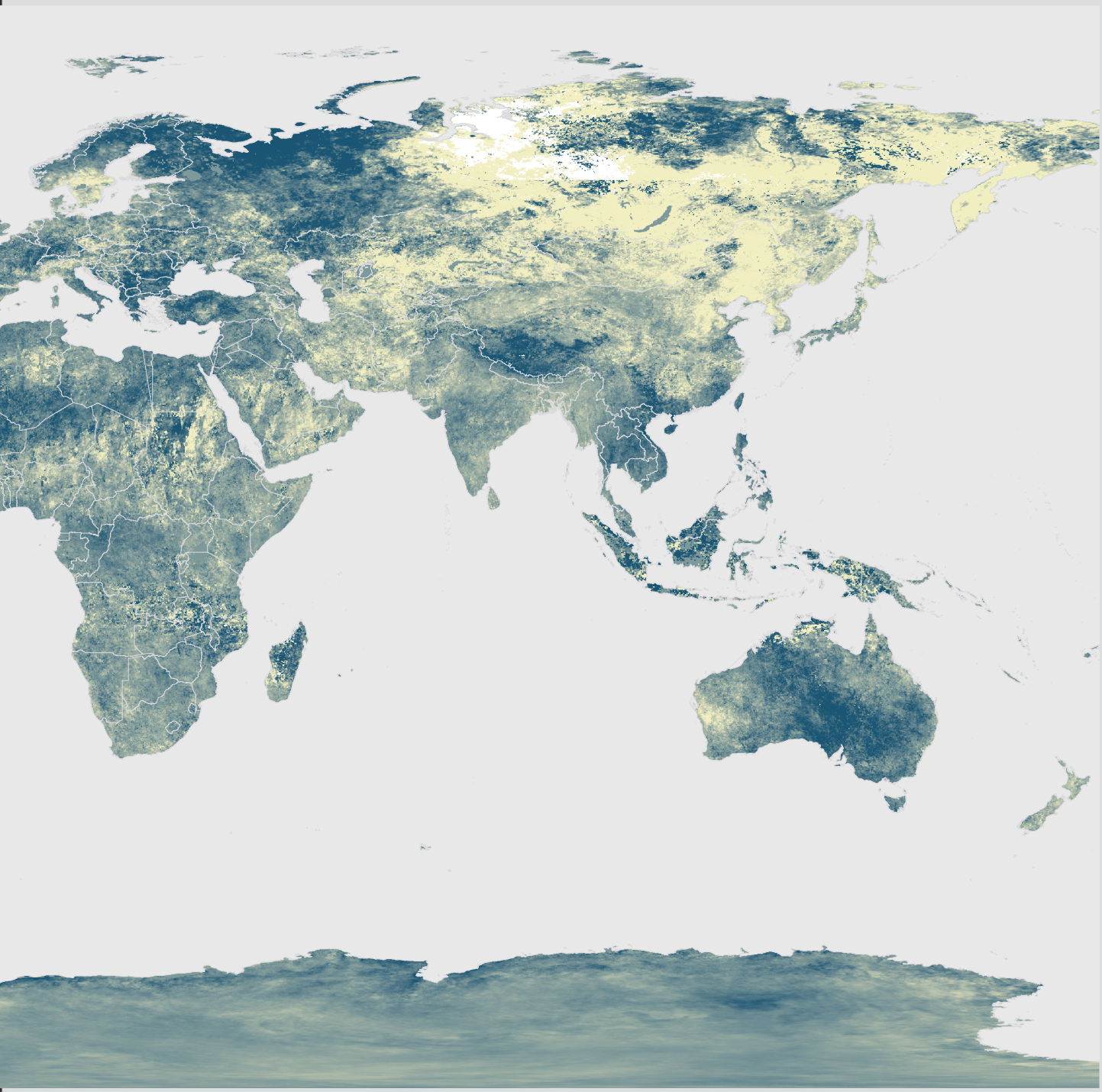


Fig. A.15 Worldwide change in winter land temperature change anomalies.



UP TO 24°C WARMER

UP TO 24°COOLER

CHANGE IN LAND TEMPERATURE ANOMALIES [2000 - 2015 NIGHT, JULY]

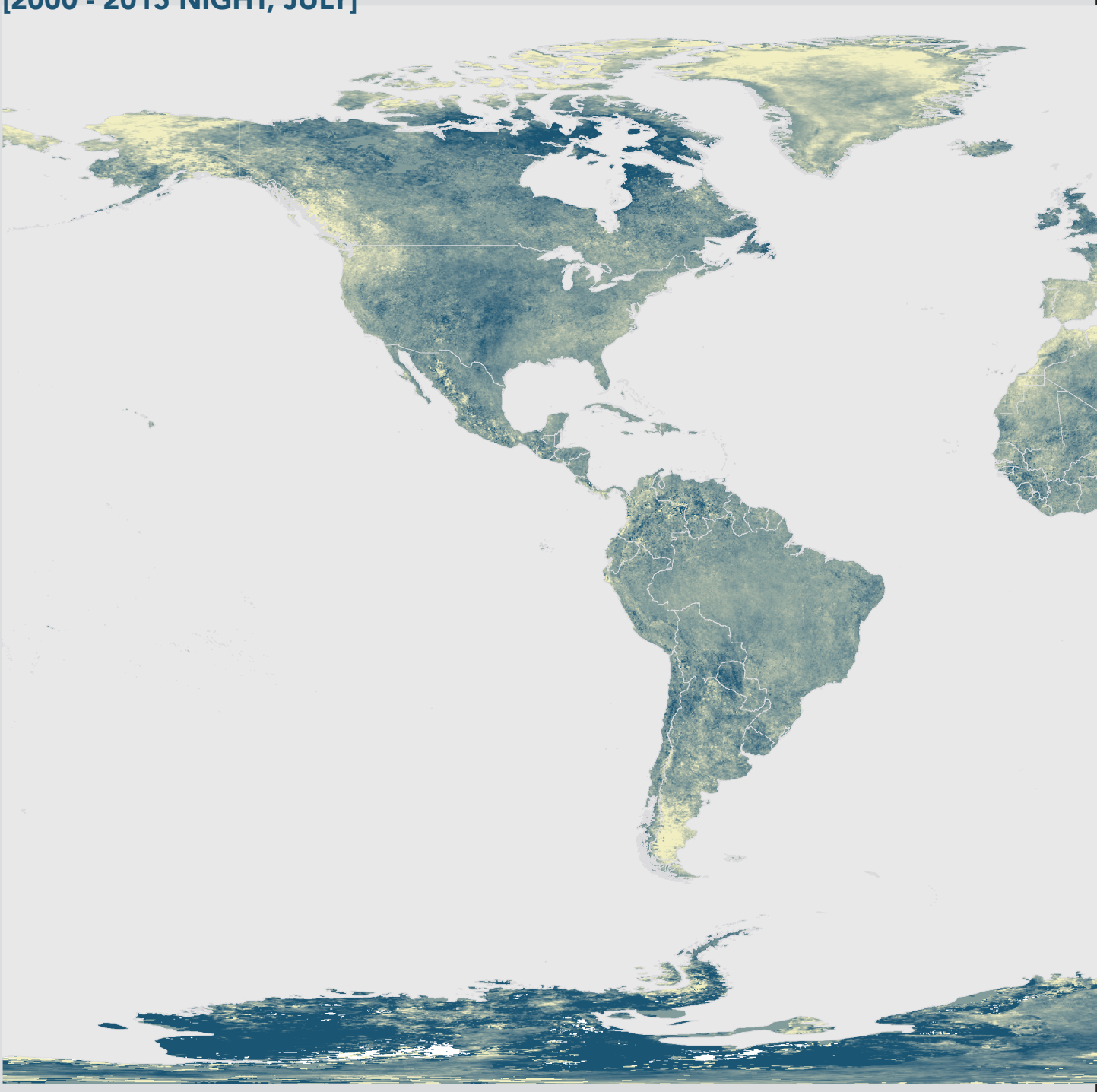
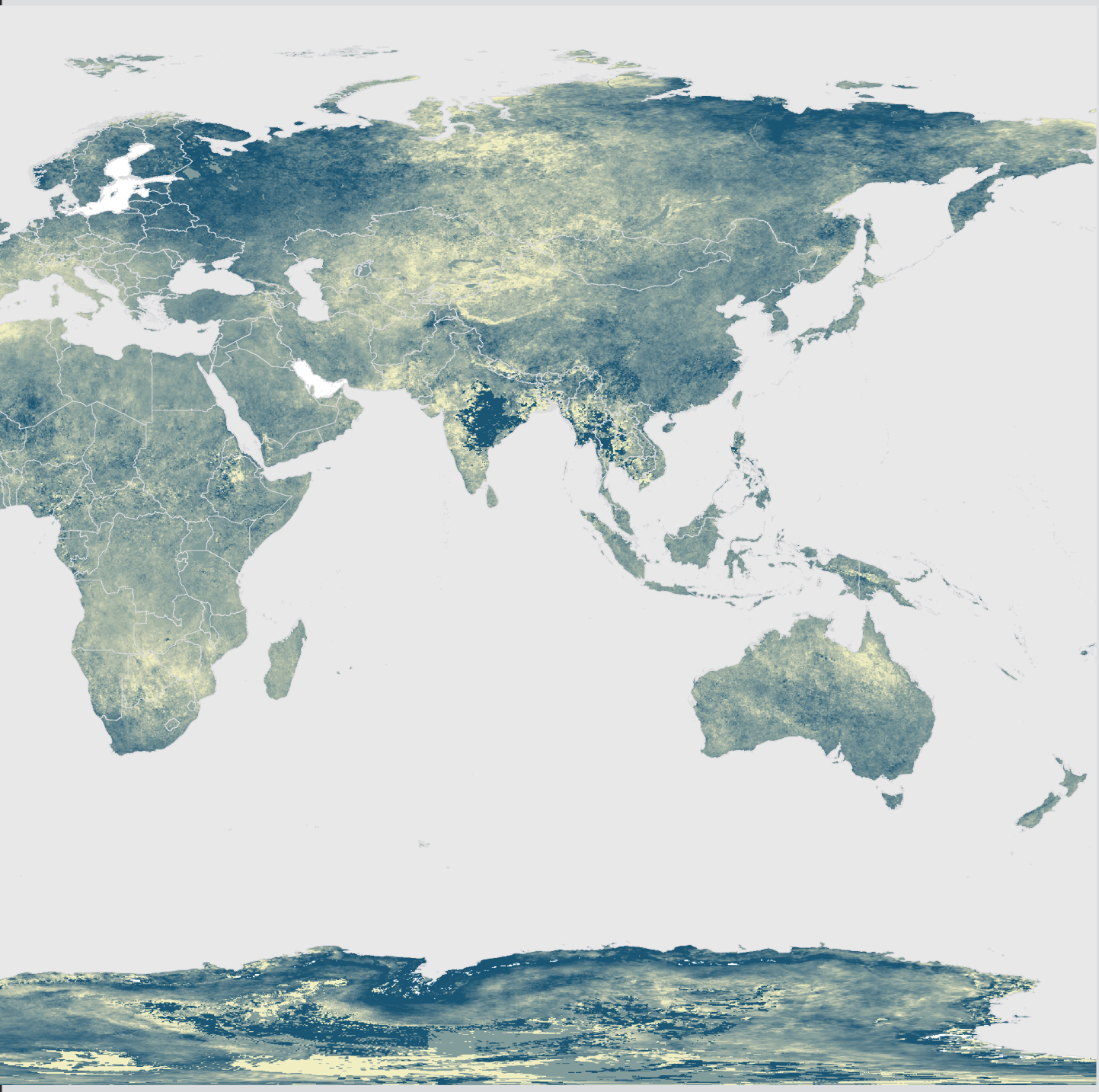


Fig. A.16 Worldwide change in summer land temperature change anomalies.



UP TO 24°C WARMER

UP TO 24°COOLER

CHANGE IN GLOBAL LEAF INDEX [2000 - 2015]

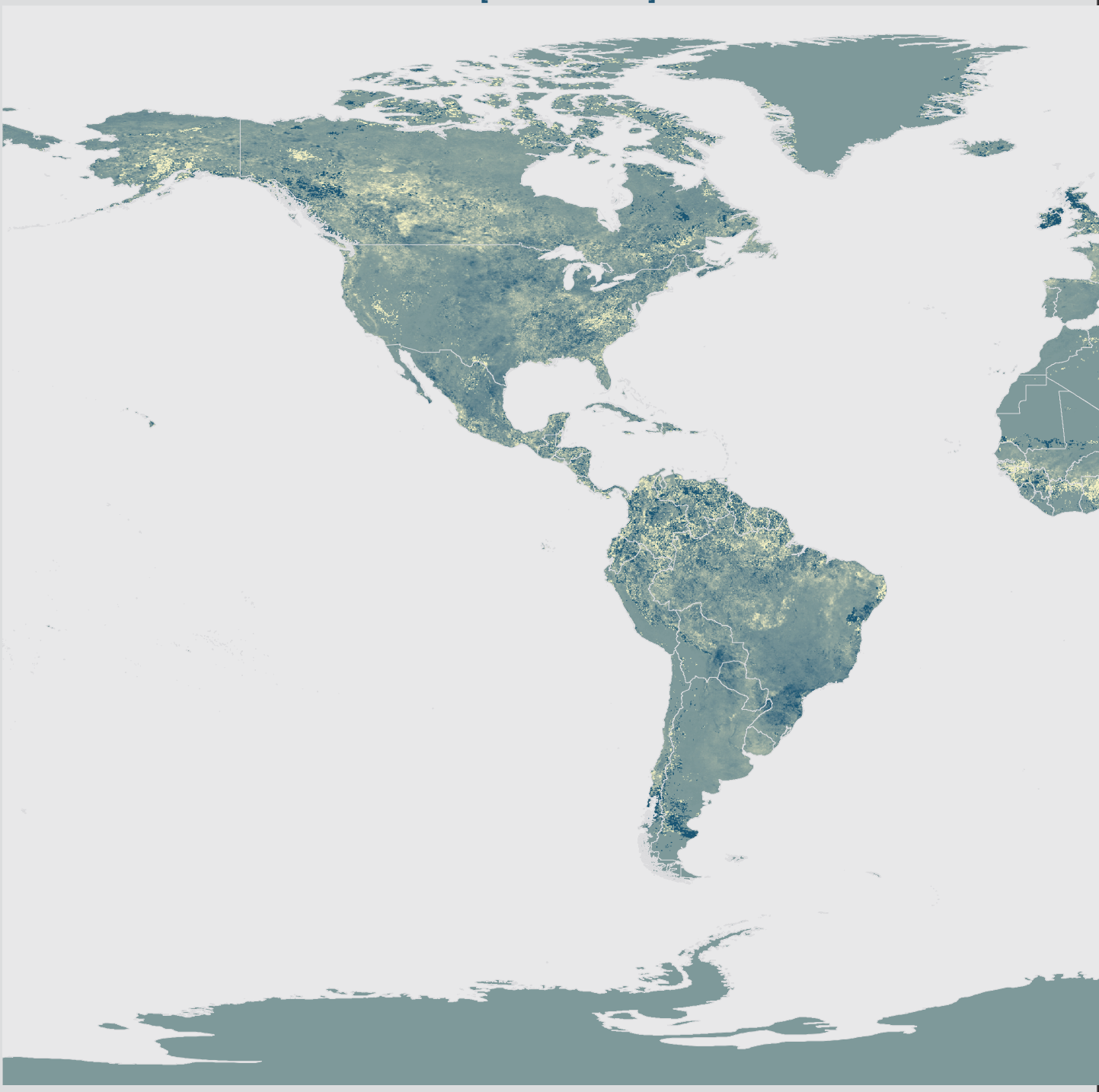
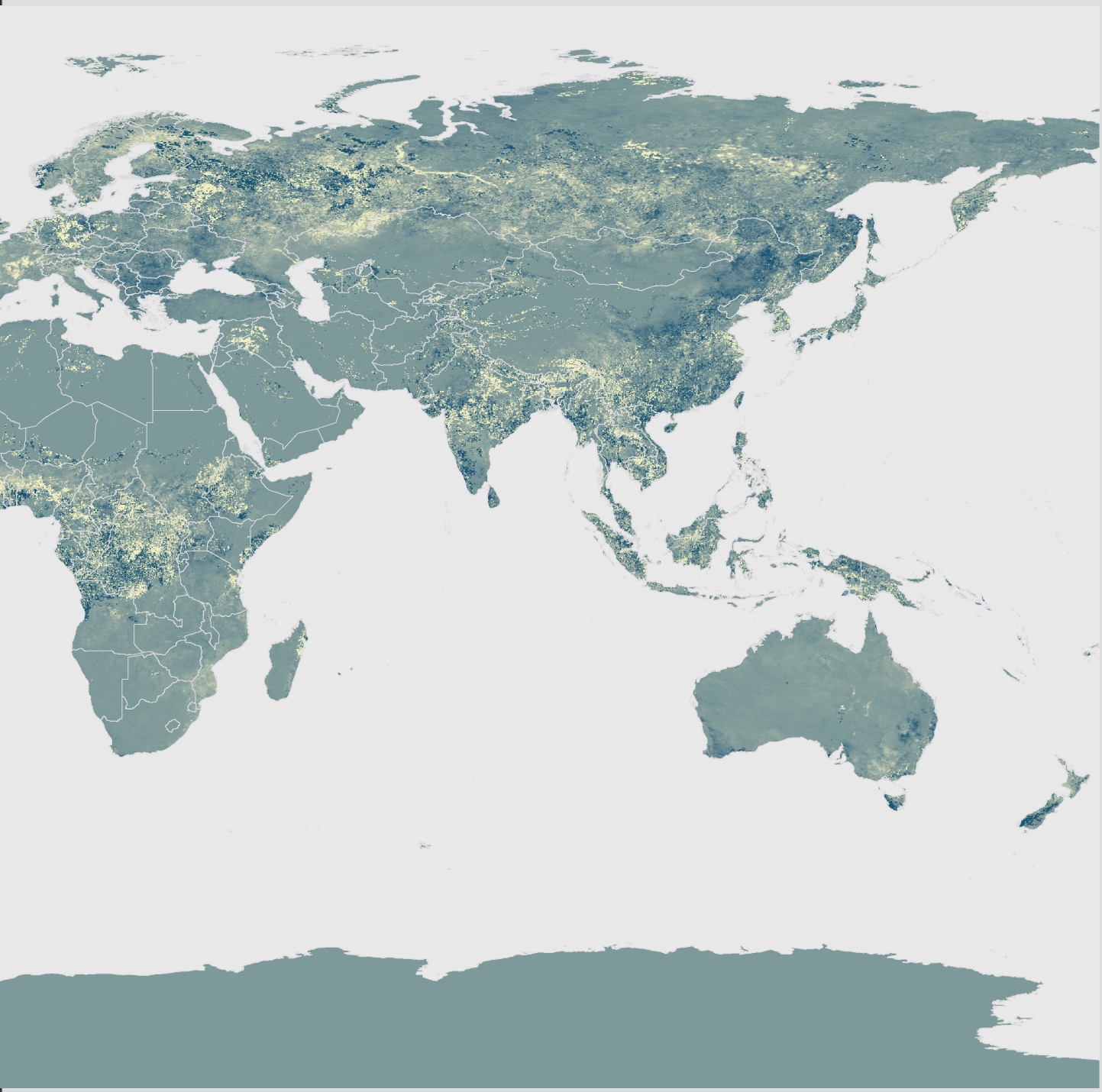


Fig. A.17 Worldwide change in leaf cover.



LOSS OF LEAF COVER

GAIN OF LEAF COVER

CHANGE IN NET PRIMARY PRODUCTIVITY [2000 - 2015]

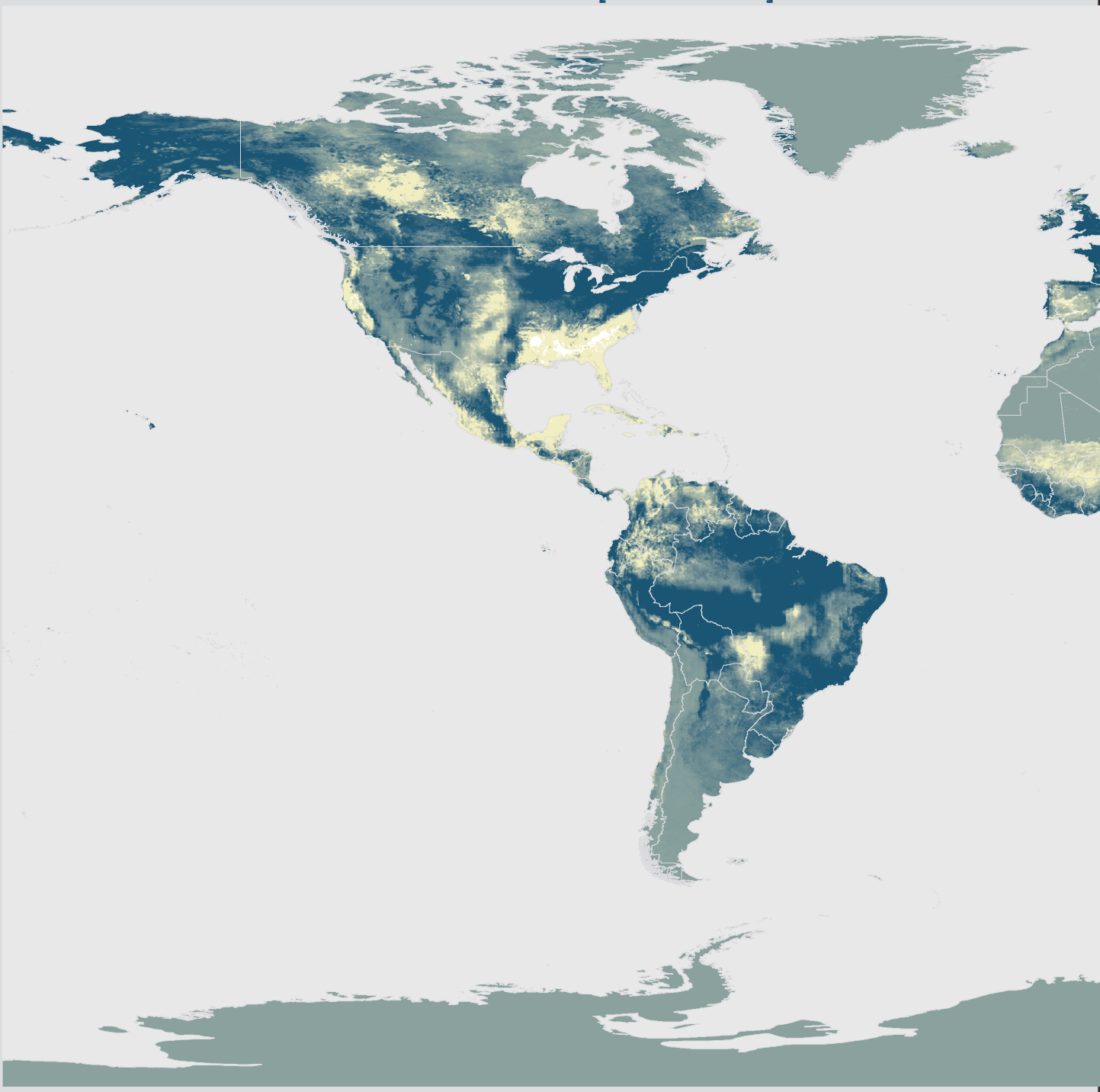
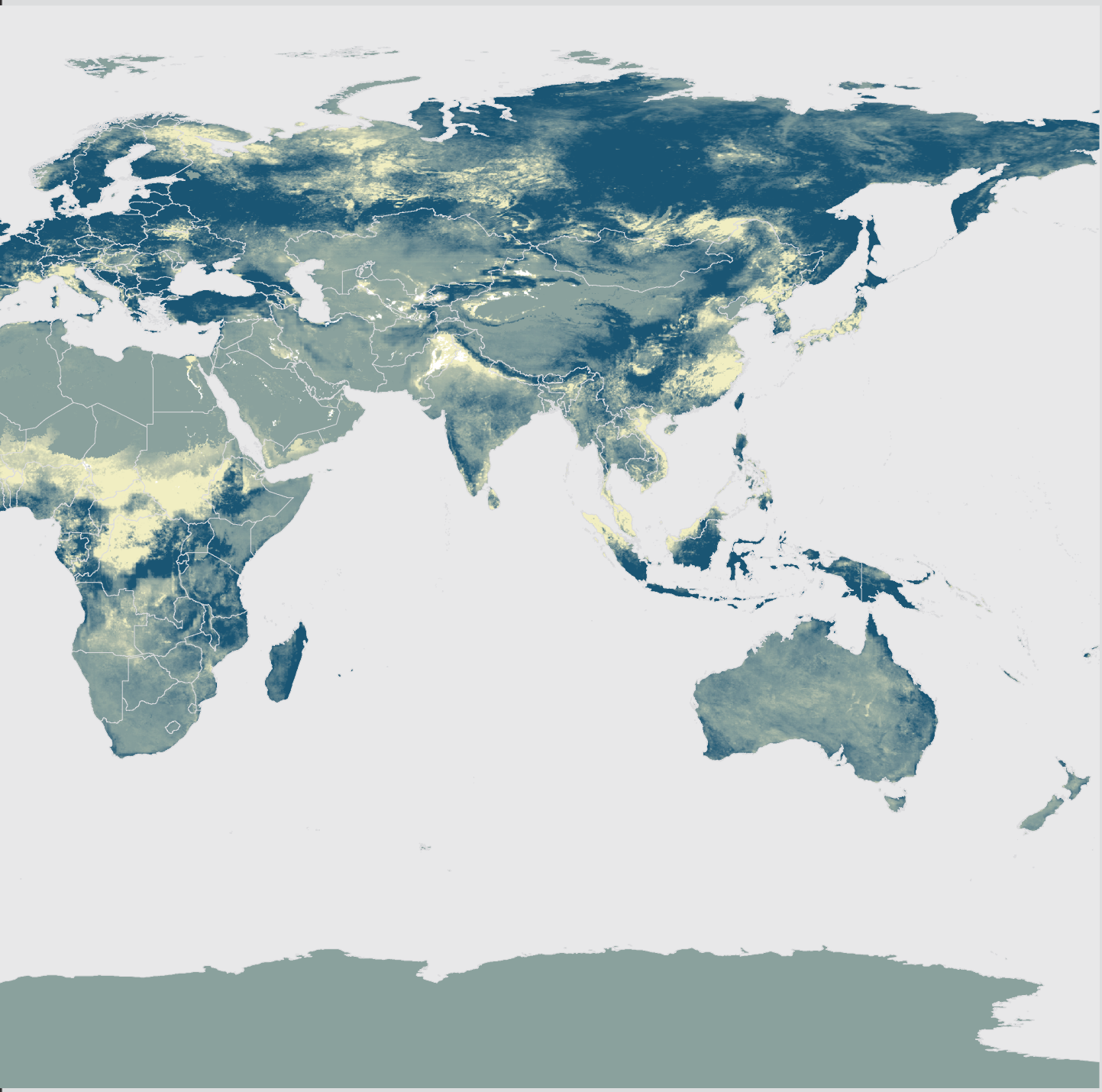


Fig. A.18 Worldwide change in net carbon absorption productivity.



LOSS IN
CARBON ABSORPTION

GREATER RATE OF
CARBON ABSORPTION

GLOBAL URBAN FOOTPRINT [GUF]

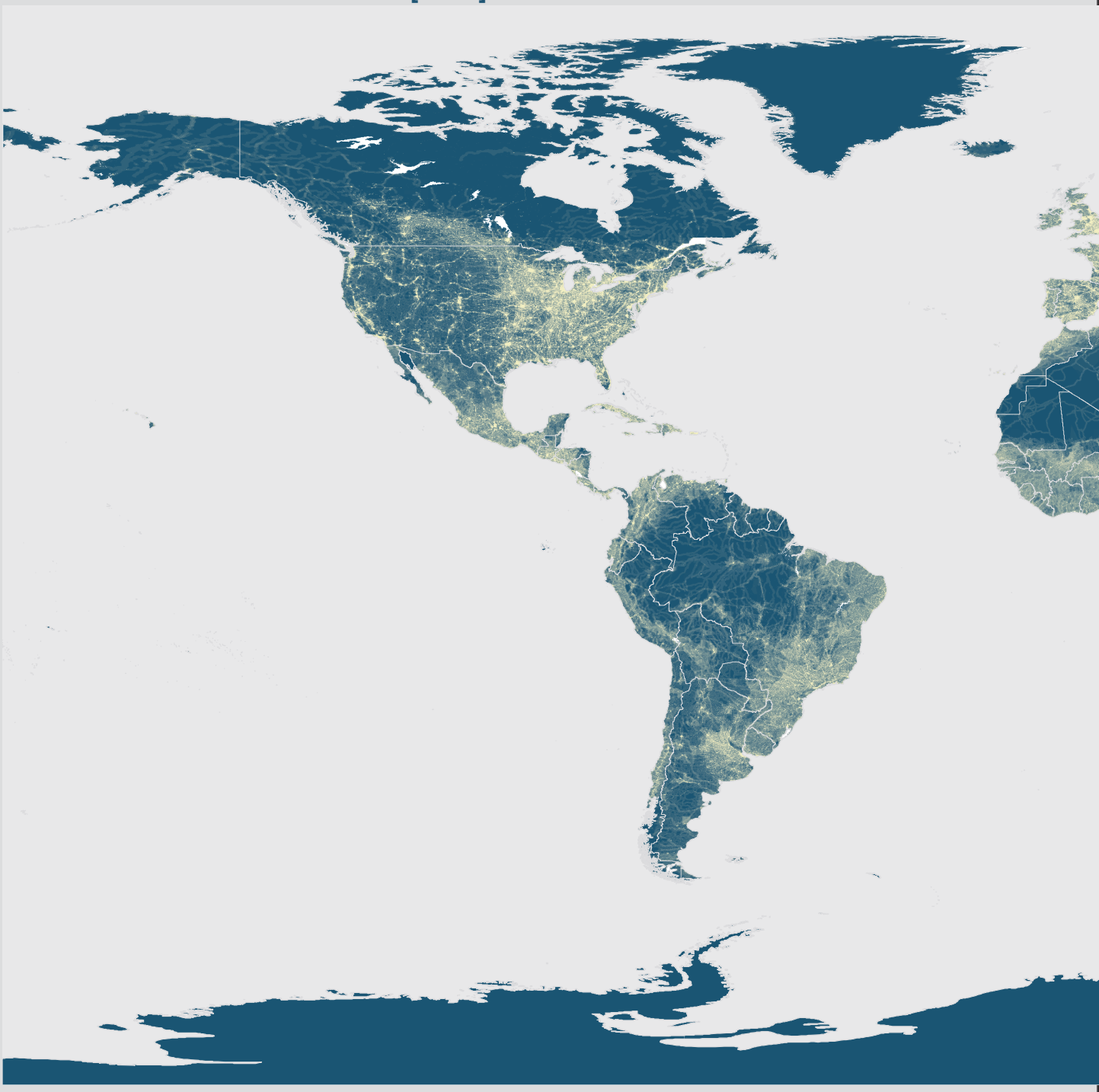
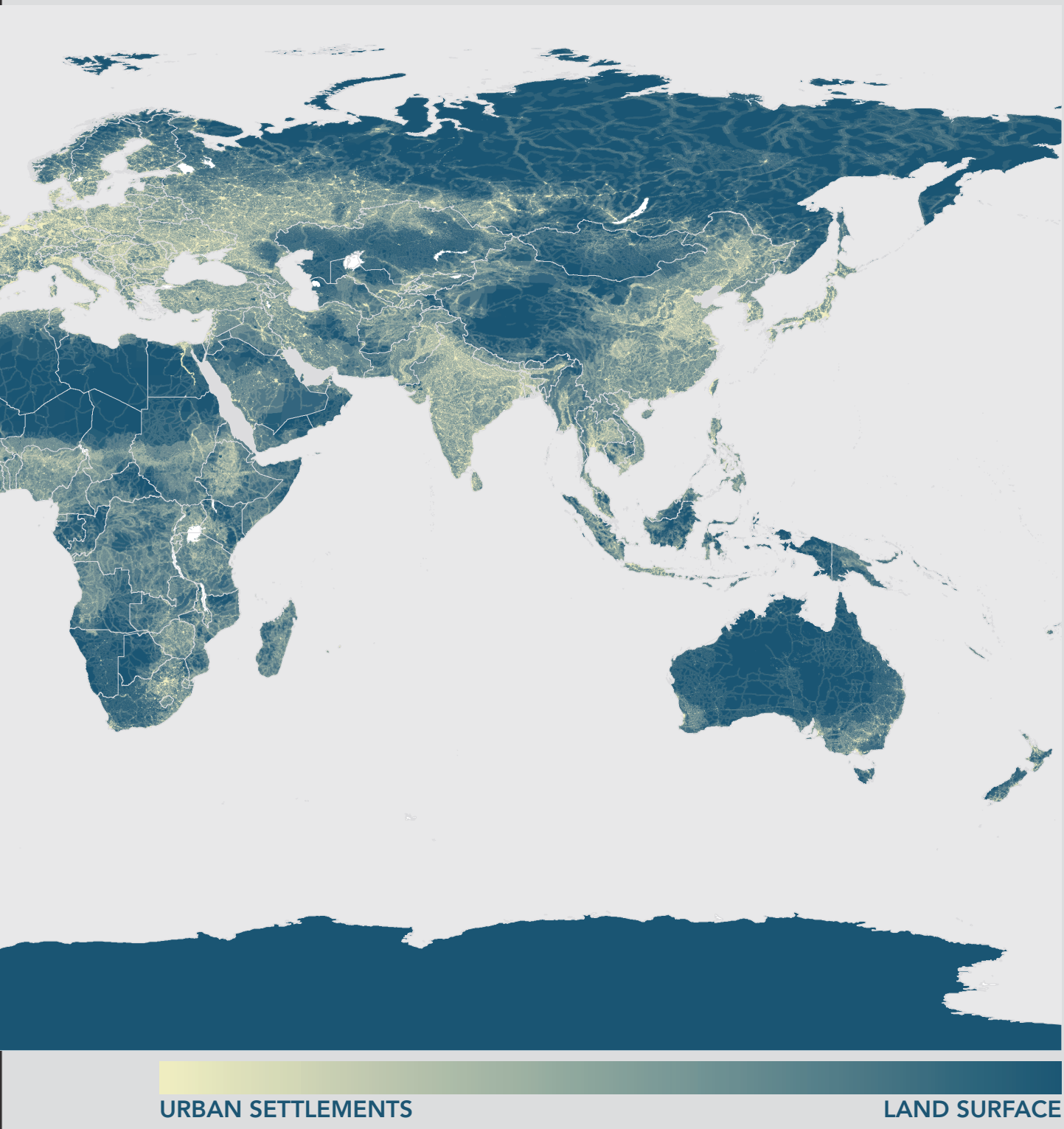


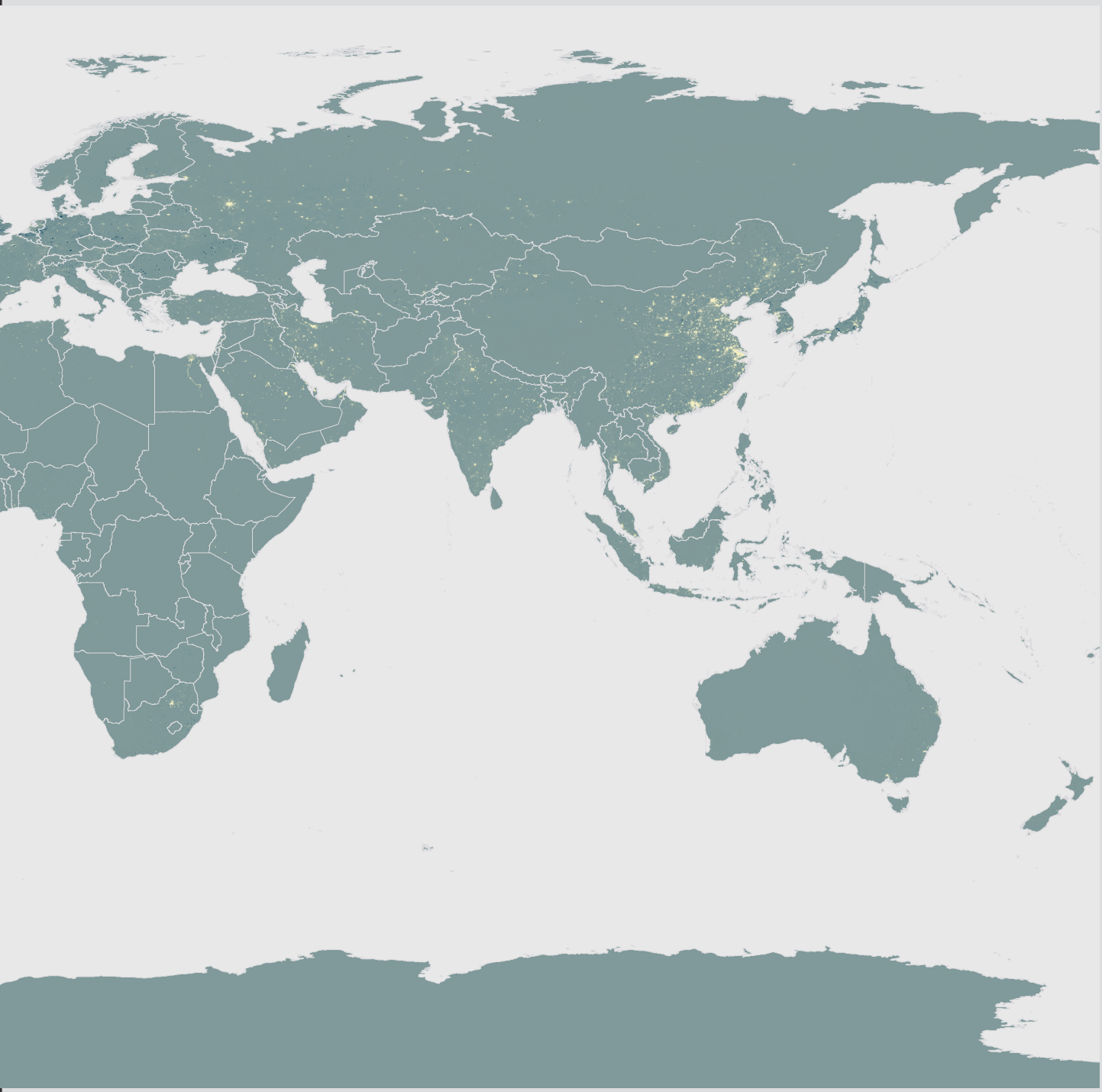
Fig. A.19 Worldwide mapping of urban settlements.



URBAN SETTLEMENTS LAND SURFACE

CHANGE IN CO_2 EMISSIONS [1997 - 2010]

Fig. A.20 Worldwide change in carbon emissions.



UP TO 100 kgC/m²/year
INCREASE

UP TO 100 kgC/m²/year
DECREASE

APPENDIX B
PRECEDENT STUDIES

ANALYSIS STRUCTURE

For the analysis of the precedents, three themes are broken down into elements by experts in each of the respective subjects. The first is how sticky or effective the ideas are relative to how they are presented. The elements used are those created by Chip and Dan Heath, both experts in the field of business and entrepreneurship.

The second concerns the elements of storytelling. These elements are sifted from a longer list of twenty-two guidelines by a storyboard artist at Pixar. These twenty-two guidelines are often used by filmmakers, writers and artists of all kinds in order to pursue a more effective story.

The third is in the field of participatory design. Usman Haque, a seasoned professional in designing participatory systems using the latest of technologies, outlines a list of necessary elements to evoke a drive to participate in a certain system.

The precedents have also been analysed to see how far reaching its audiences are. Although in many cases this is very difficult to measure, a benchmark can almost always be found. For example, the amount of likes an application receives may not necessarily show how many times they are downloaded, but it could indicate a ballpark figure on the magnitude of people using it.

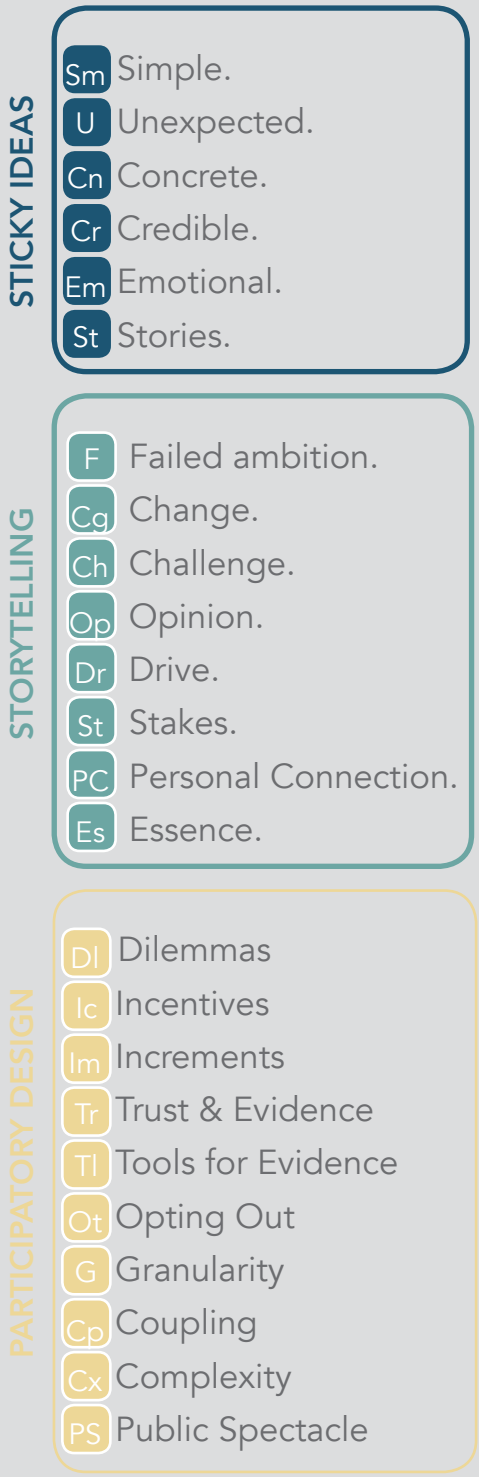
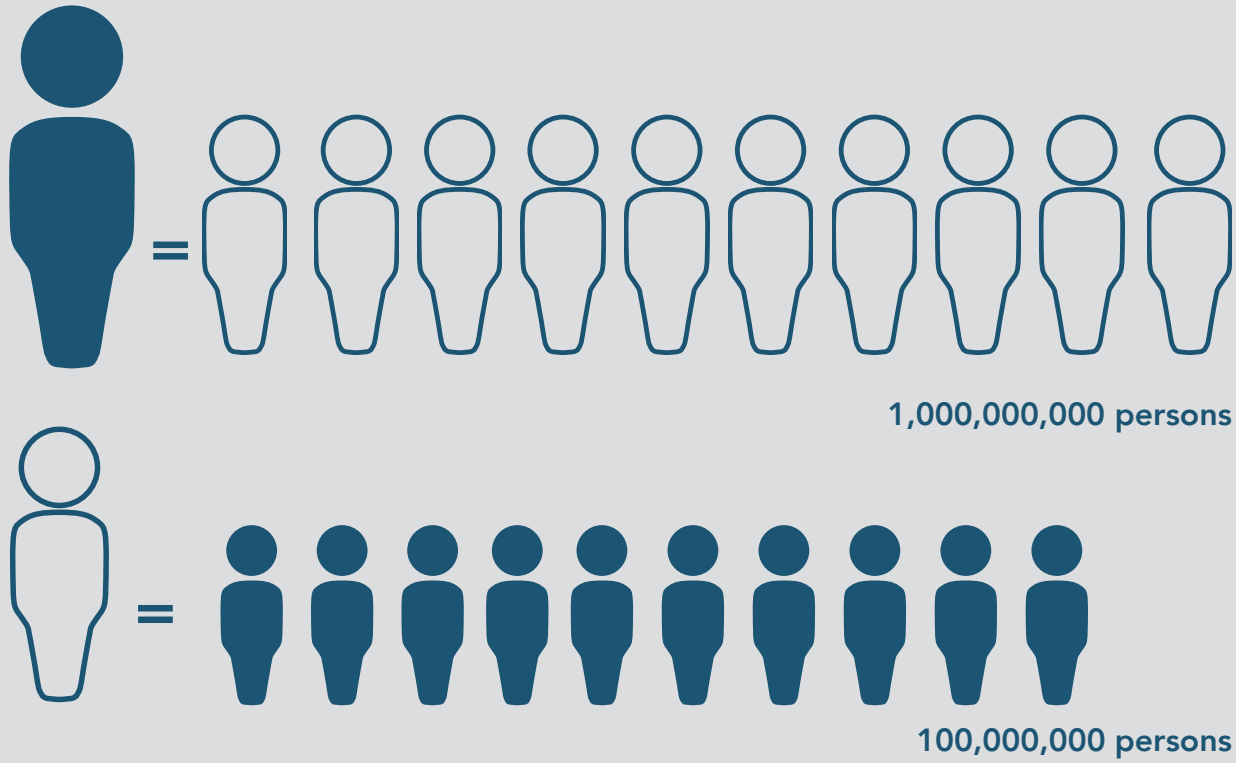


Fig. B.1 Precedent analysis legend.


1,000,000,000 persons
100,000,000 persons
10,000,000 persons
1,000,000 persons
100,000 persons
10,000 persons

SUBURBAN DEVELOPMENT

Suburban development is widely known to be a toll on the cities they surround and of society in general. Unfortunately, they continue to grow globally at a steady rate and will only continue as the world population grows. According to the World Bank, 3.29 billion people worldwide currently reside in a non-urban environment. Given the problems and externalities related to cost and the environment, the immensity of that number (almost half the world's population) is revealing of how big an issue it is.

AFFECTS: 3.29 BILLION PEOPLE WORLDWIDE

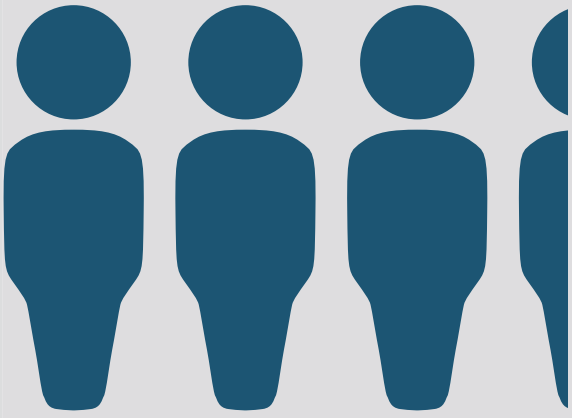
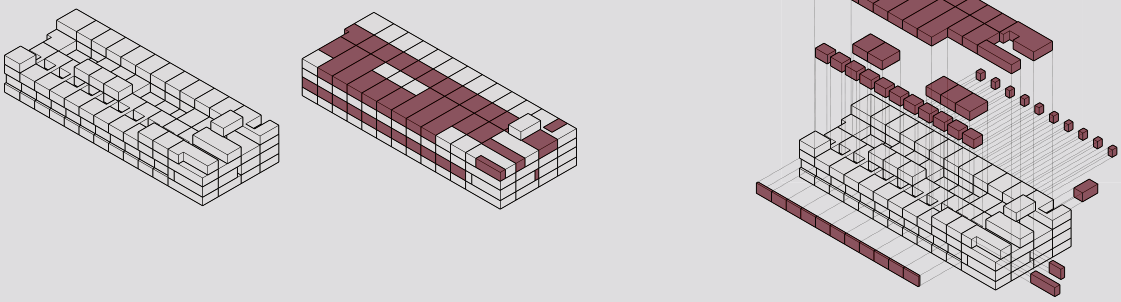


Fig. B.2 Reach analysis of suburban develeopment.

BORNEO/SPORENBURG

Borneo/Sporenburg is a prime example of how suburban development should and could be designed. However, based on the number of people it directly affected (inhabitants of the area), it would hypothetically take 598,181 similar projects to affect the same amount of people that are living in suburban developments worldwide.

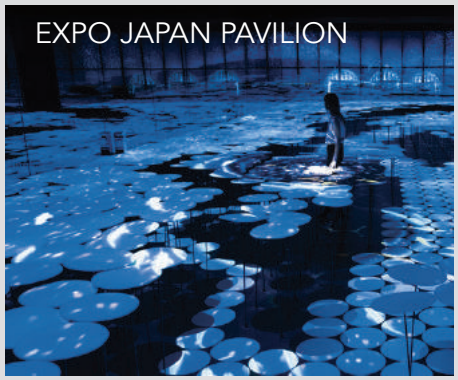


AFFECTS: APPROX. 5.5 THOUSAND PEOPLE

Fig. B.3 Example of suburban development: Borneo/Sporenburg.

EXHIBITS/DESTINATIONS

Exhibits and destinations inteded for showcasing new ideas are known to be an attractor of audiences. These audiences are most likely open to learning and experiencing what is there to be offered. To put into perspective the number of visitors in relation to the population of the suburbs, it would take 165 Japan Pavilions; 210,897 LIVE Singapore exhibits; 73,111 Istanbul-o-matik exhibits; or 253,077 Invisible Istanbul experiences to offer information exposure to all of the suburban population.



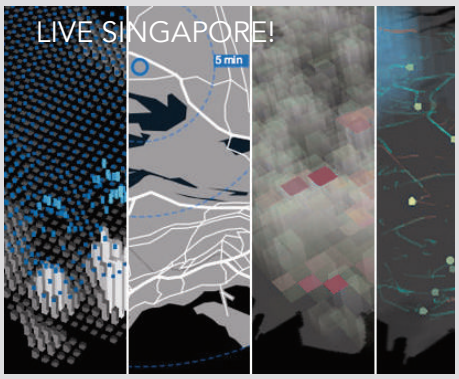


Fig. B.4 Reach analysis of exhibitions.

POTENTIAL VISITORS: 20 MILLION

ESTIMATED VISITORS: 15.6 THOUSAND

ESTIMATED VISITORS: 45 THOUSAND

ESTIMATED VISITORS: 13 THOUSAND

COMICS/STORYBOARDS

Undeniably, the advent of the storyboard has improved the quality of storytelling has vastly improved in the field of filmmaking and animation. The comic book, already a polished form of the storyboard, has been effectively communicating stories for decades and growing in popularity. These two sources are worth delving into at a later date in terms of how ideas are revealed to an audience.

Fig. B.5 Vertical suburbia - Yes is More.

Fig. B.6 Storyboards from Pixar's *Up*.

GAMES

The act of gamification is an interesting method to involve participatory action. The popularity of sandbox games are evidence to this. There is currently a movement dedicated to gamify global issues such as climate change, but none reach the level of success that can potentially be had. These games, which deal with urbanism and the harshness of climate, are worth looking at deeper.

In comparison with suburban development, it would take 25,703 Never Alone games; 2,057 Cities: Skylines games; or 47 Minecraft games to reach an audience the size of suburban population.

COPIES SOLD:
128 THOUSAND

COPIES SOLD:
1.6 MILLION

COPIES SOLD: 70 MILLION

Fig. B.7 Reach analysis of video games.

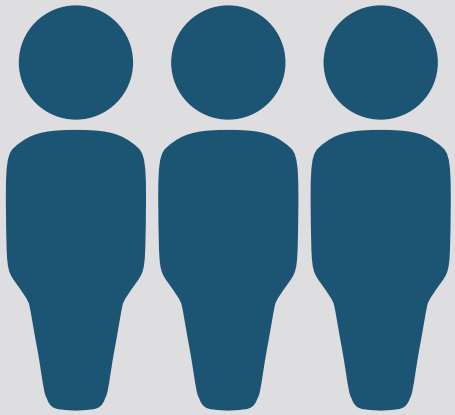
FILM

Film is a very widespread medium that has a great potential to reach global audiences. Unfortunately, documentaries often only capture a small portion of those audiences, but they definitely have the potential given the right circumstances and quality of message/ storytelling. In the case of these films, the viewership is difficult to determine due to the amount of media outlets today, but some are measured in its potential viewership according to the platforms they are offered on.

While it would take 433 Inconvenient Truths or 50 Cowspiracy films, it would potentially only take 1 Racing Extinction film to reach all suburban populations if it reached its viewership potential on its worldwide release. Two are these films are further analysed in terms of their whole system and integral moments to see what makes them effective. In today's digital world, it seems that a strong multi-modal platform supporting the film is almost as important as the film itself.

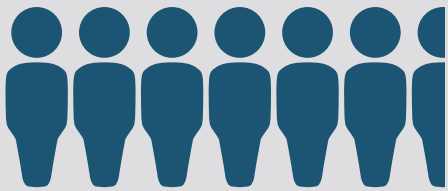
ESTIMATED VIEWERS:
7.6 MILLION

?



POTENTIAL VIEWERS:
3 BILLION

?

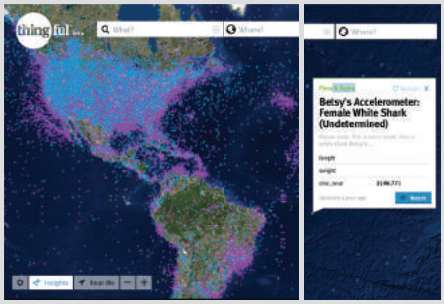


POTENTIAL VIEWERS:
65.5 MILLION

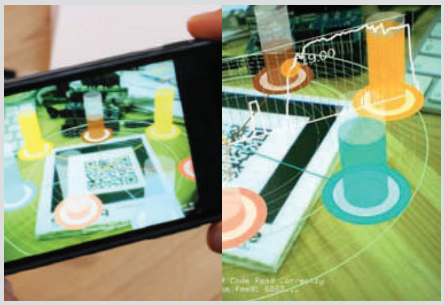
Fig. B.8 Reach analysis of films.

APPLICATIONS

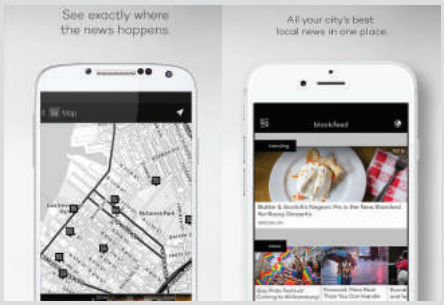
Only a few decades ago, the idea that everyone would be carrying their own portable computer was an absurd idea. Today, the widespread amount of applications for a variety of portable computing devices is unavoidable. The importance of digital platforms and its potential to create social change and movements has been proven. We witnessed that fact with the role that Facebook and Twitter played in the Arab Spring. As technology continues to develop, it is important to realize and apply its potential. Four applications are further analysed to see how data is received and perceived by its users.



thingful®



porthole
powered by pachube

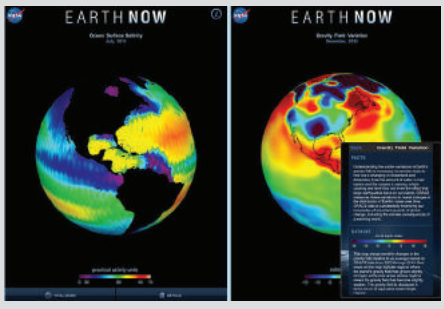


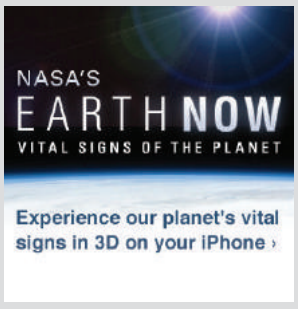
blockfeed

APPROX. DOWNLOADS: 5 THOUSAND

WHAT was THERE

LIKES: 91 THOUSAND





APPROX. DOWNLOADS: 500 THOUSAND

Fig. B.9 Reach alanysis of applications.

DOCUMENTARY FILM: RACING EXTINCTION

Fig. B.10 Storytelling analysis of documentary film *Racing Extinction*.

DOCUMENTARY FILM: COWSPIRACY

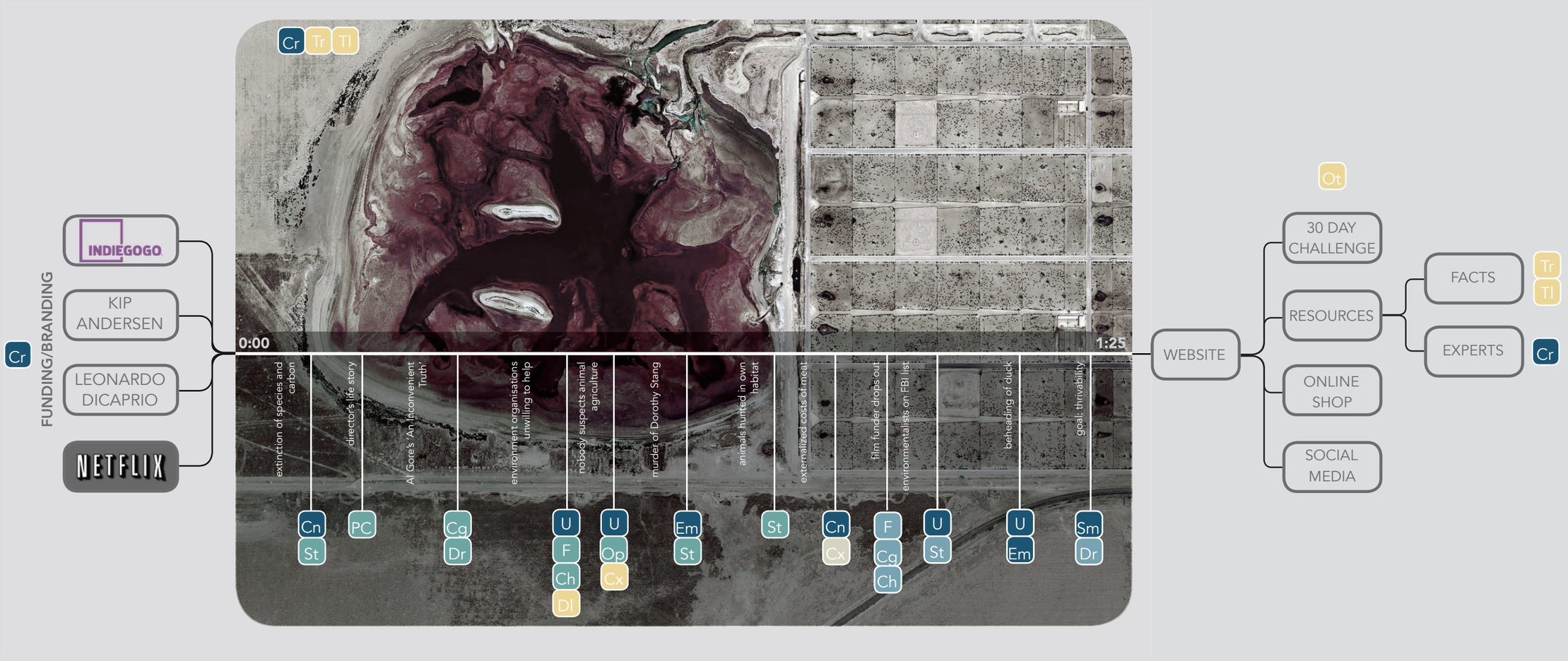


Fig. B.11 Storytelling analysis of documentary film *Cowspiracy*.

APPLICATION: BLOCKFEED

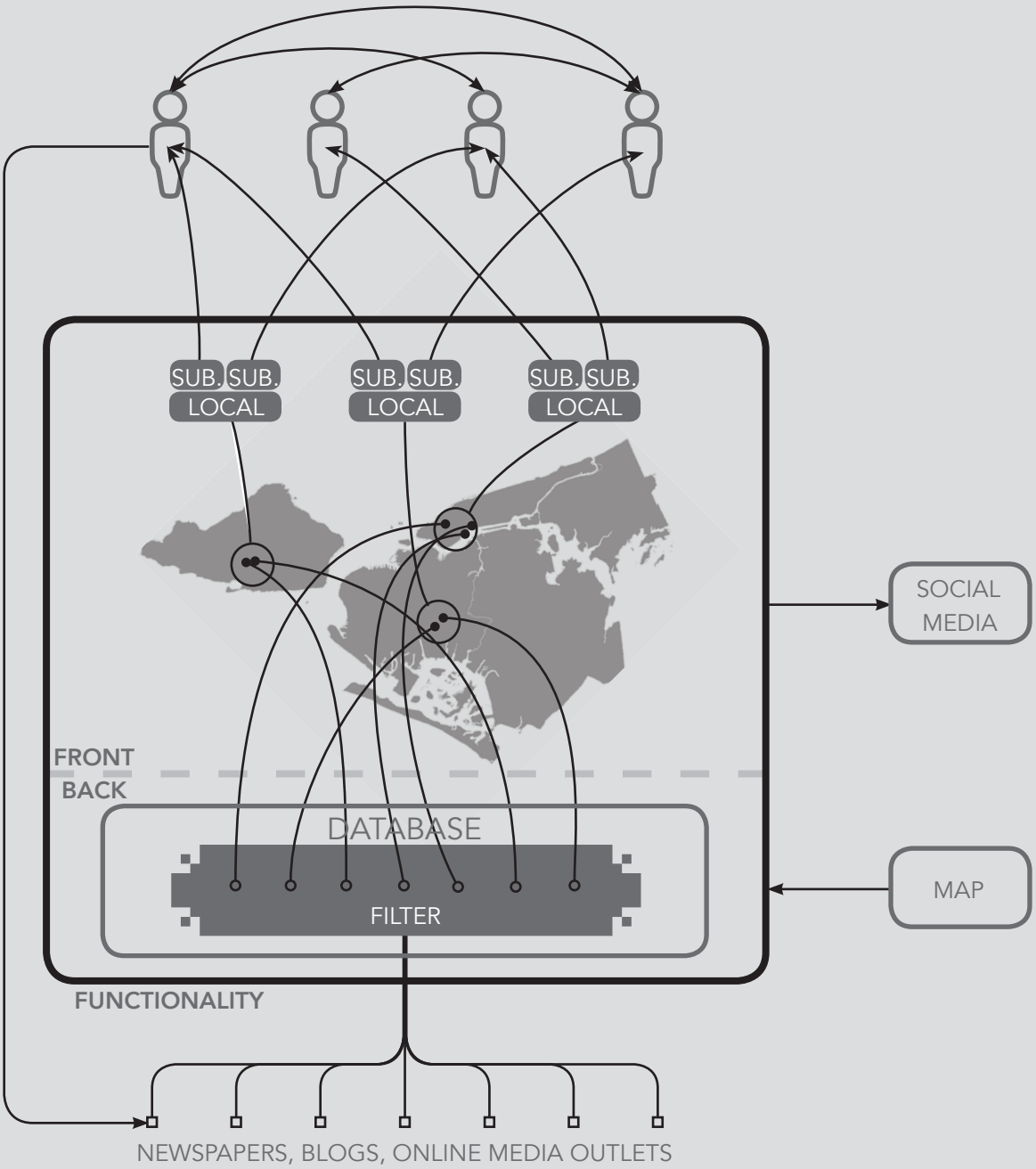


Fig. B.12 Design anlysis of application *Blockfeed*.

APPLICATION: WHAT WAS THERE?

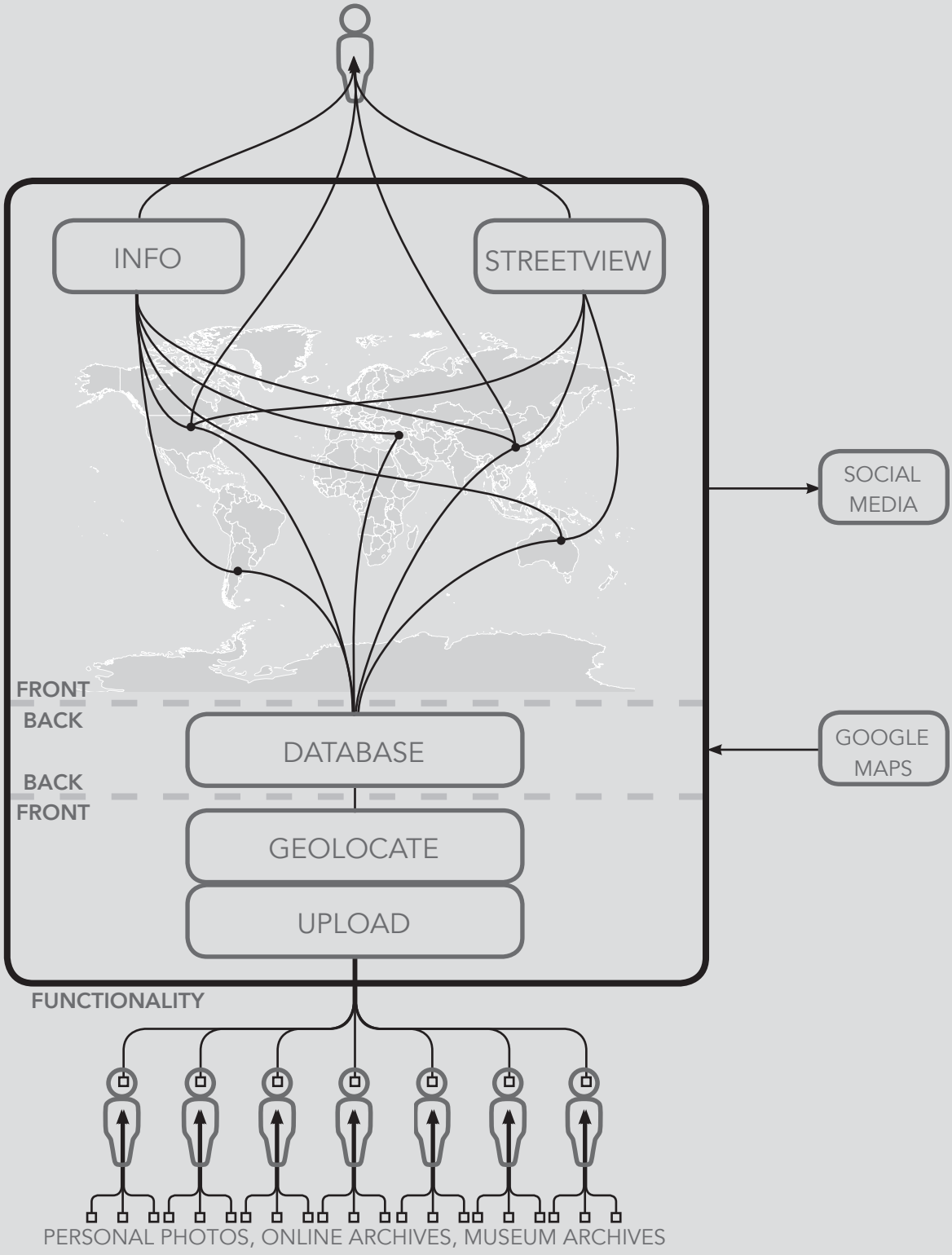


Fig. B.13 Design analysis of application *What Was There?*

APPLICATION: THINGFUL/PORTHOLE

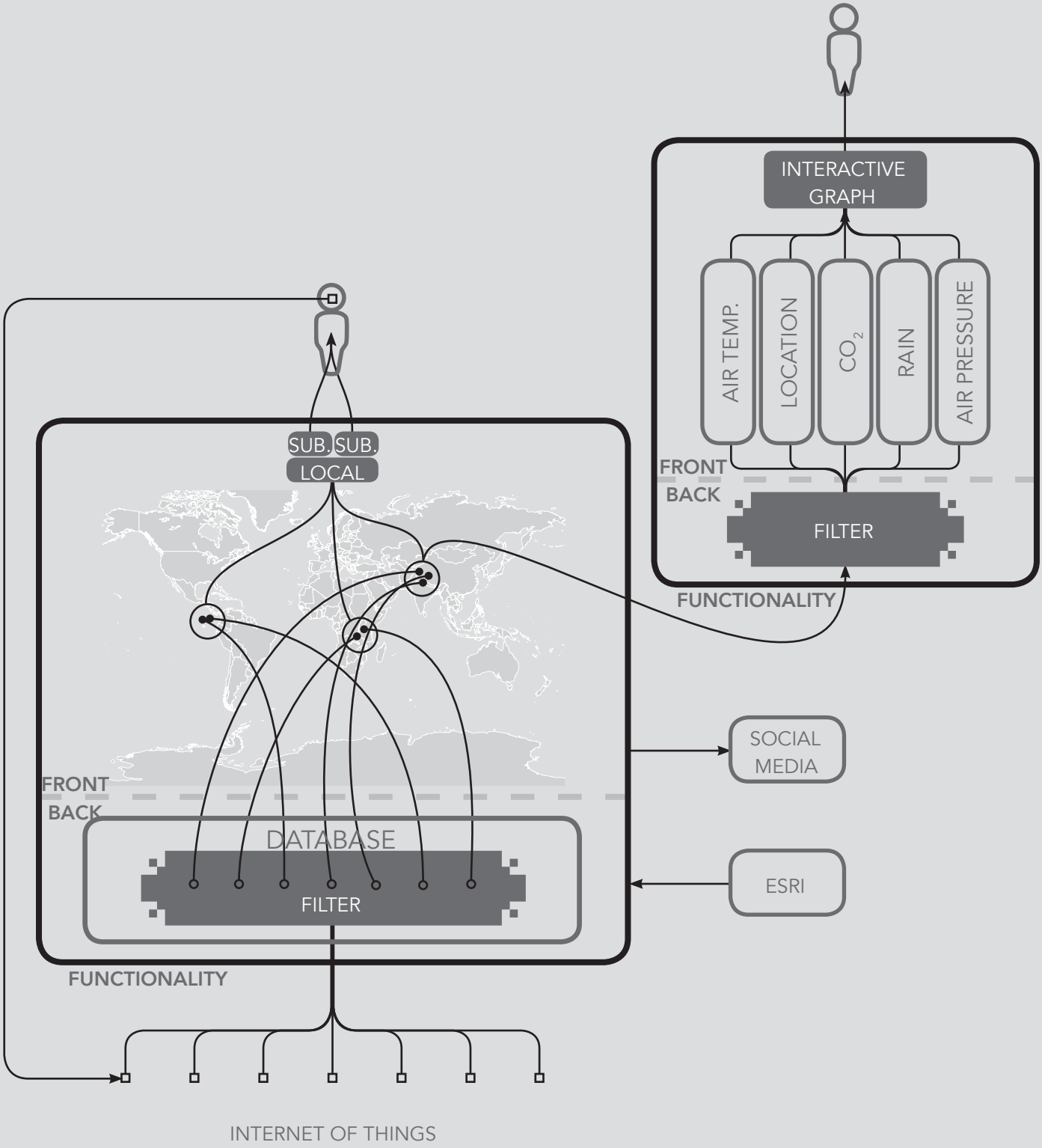


Fig. B.14 Design analysis of application *Thingful/Porthole*.

APPLICATION: EARTH NOW

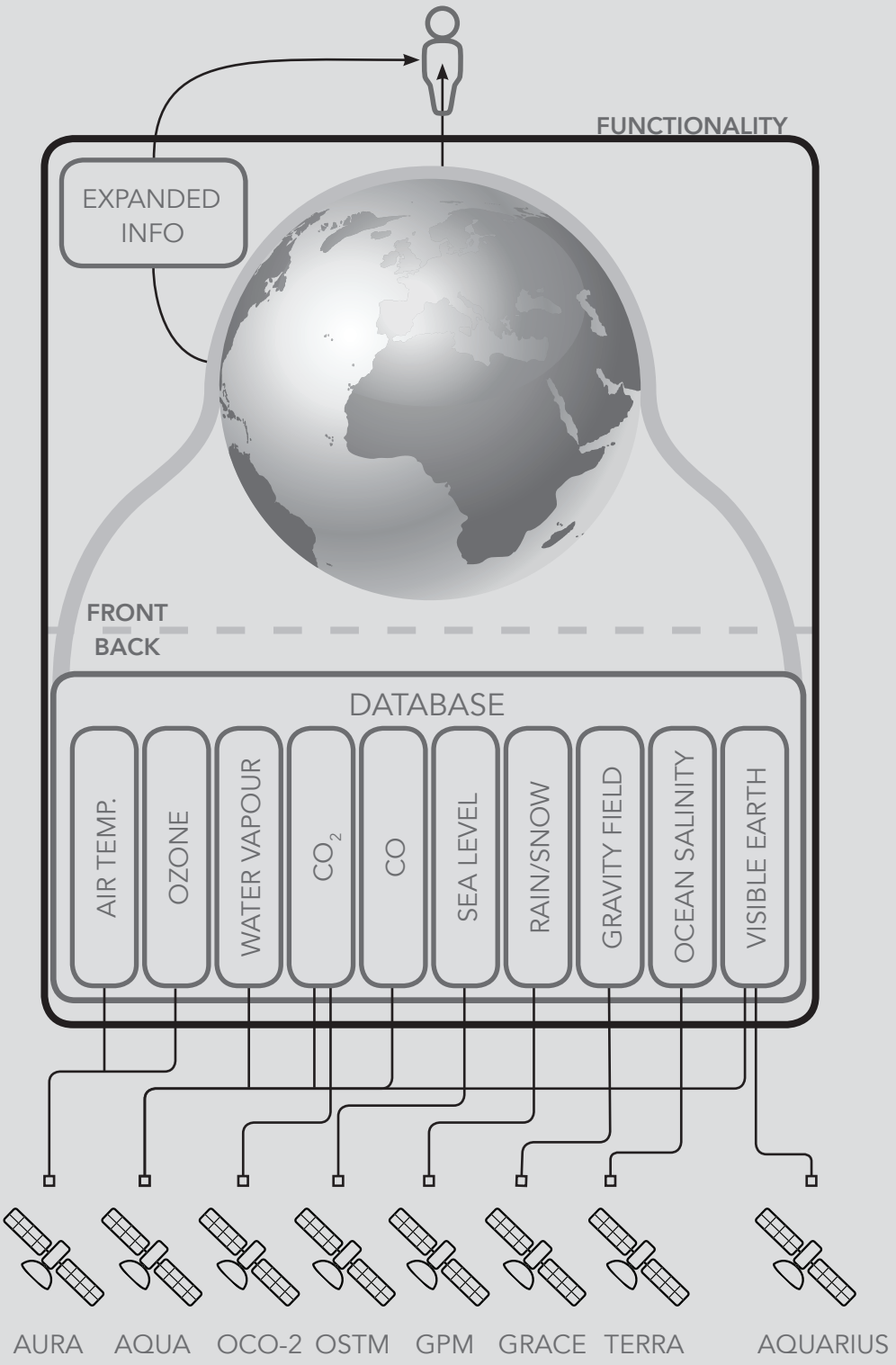
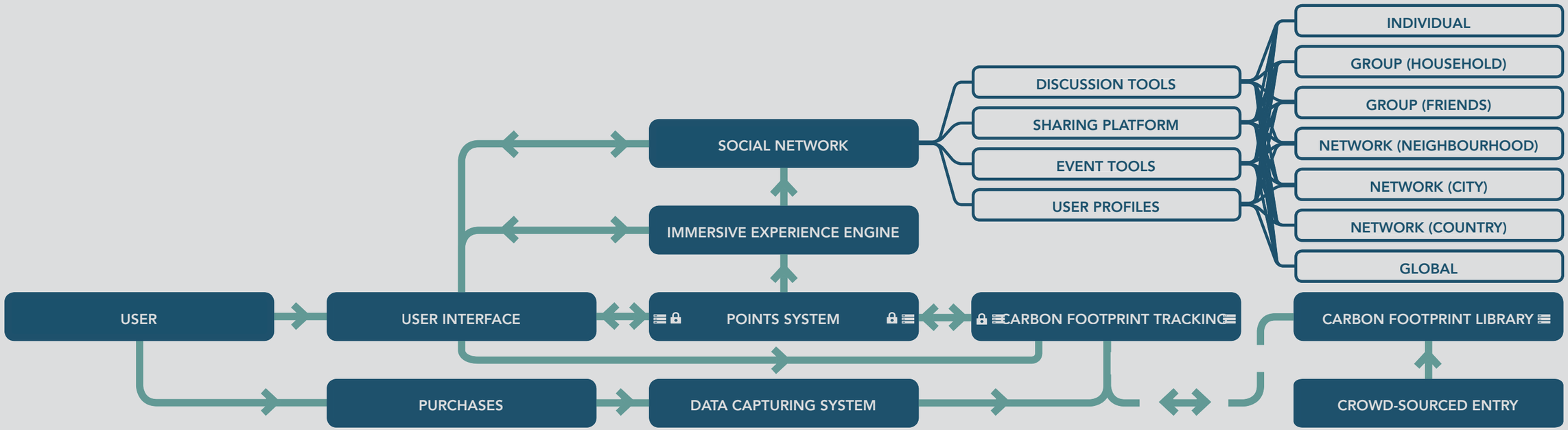


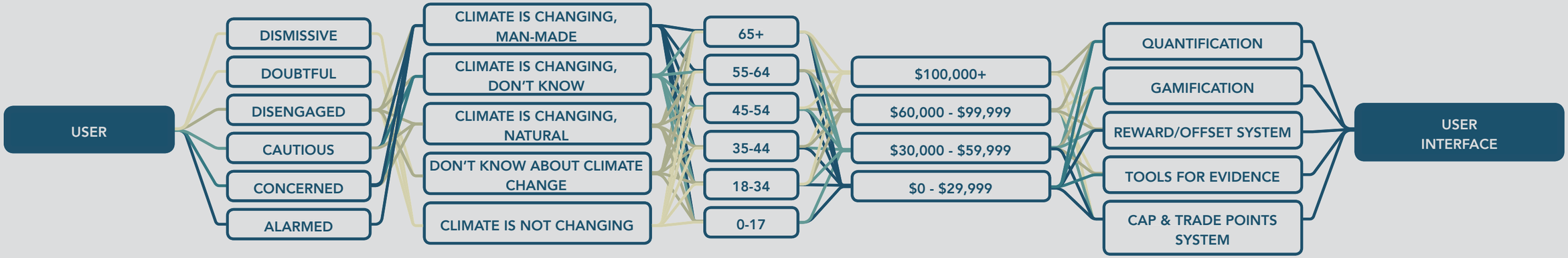
Fig. B.15 Design analysis of application *Earth Now*.

APPENDIX C
PRE-TESTING DESIGN



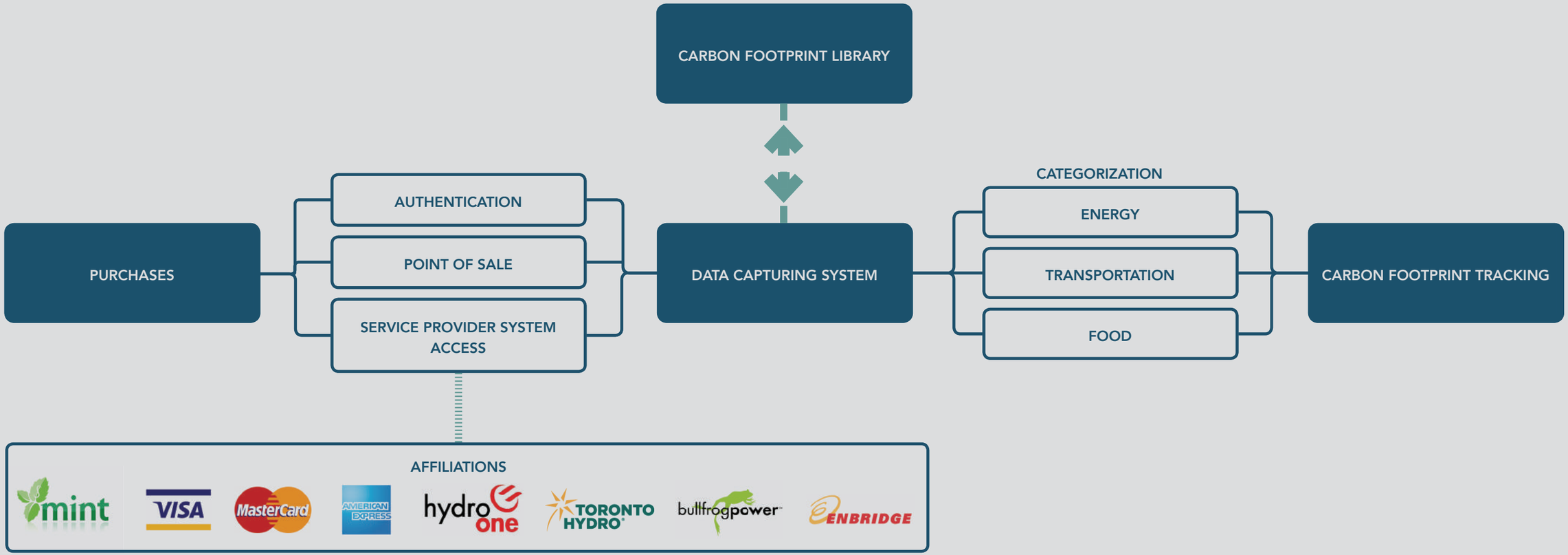
OVERALL SYSTEM

Fig. C.1 Flowchart of the overall system processes.



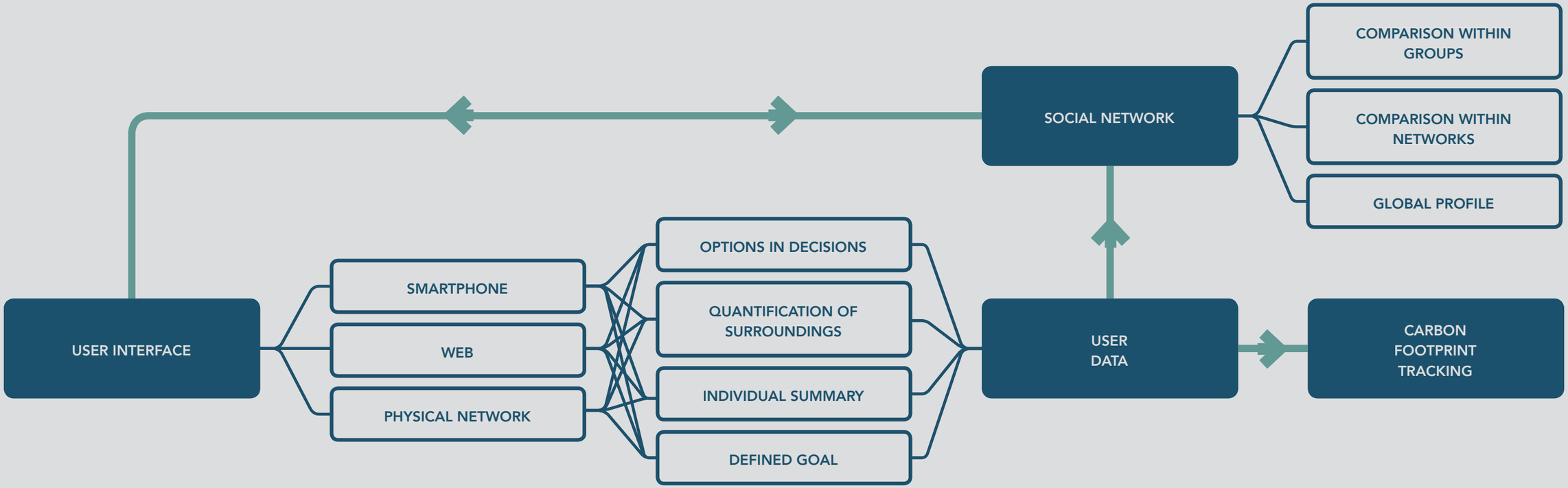
USER SEGMENTATION

Fig. C.2 Flowchart of the user segmentation filtering process.



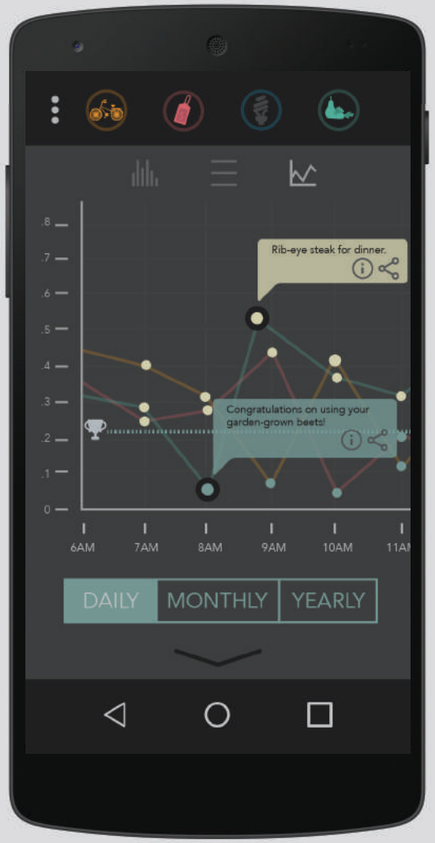
CARBON TRACKING

Fig. C.3 Flowchart of the carbon tracking process.



QUANTIFICATION

Fig. C.4 Flowchart of the quantification process.



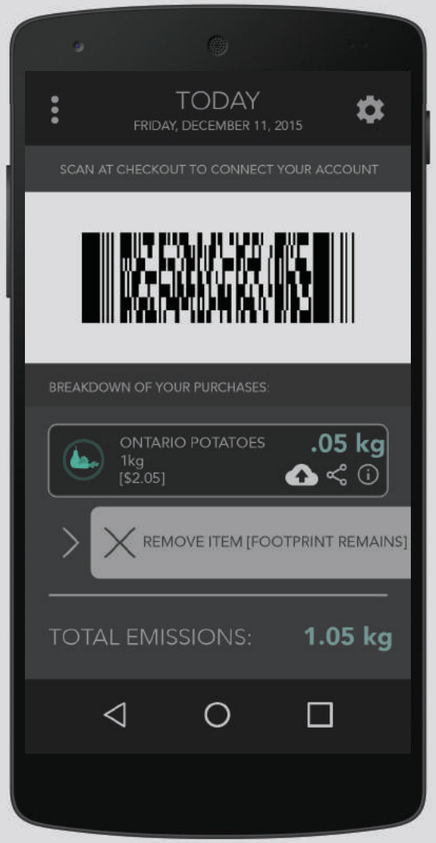
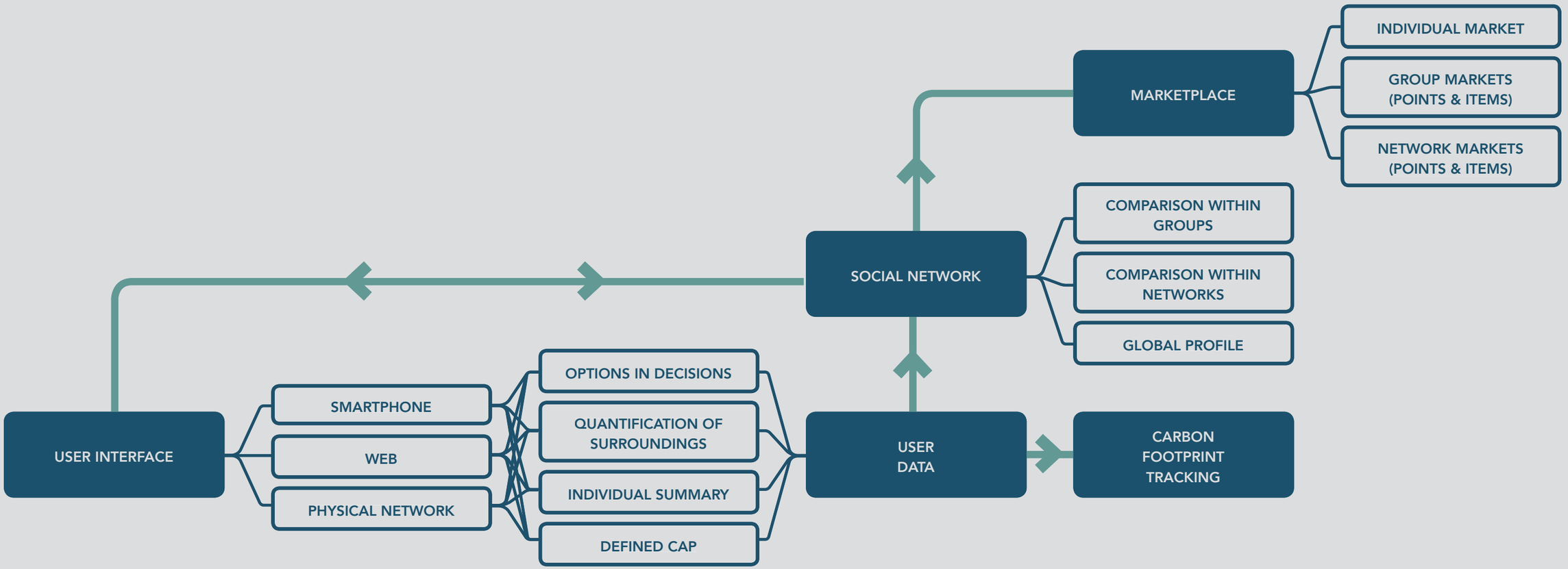


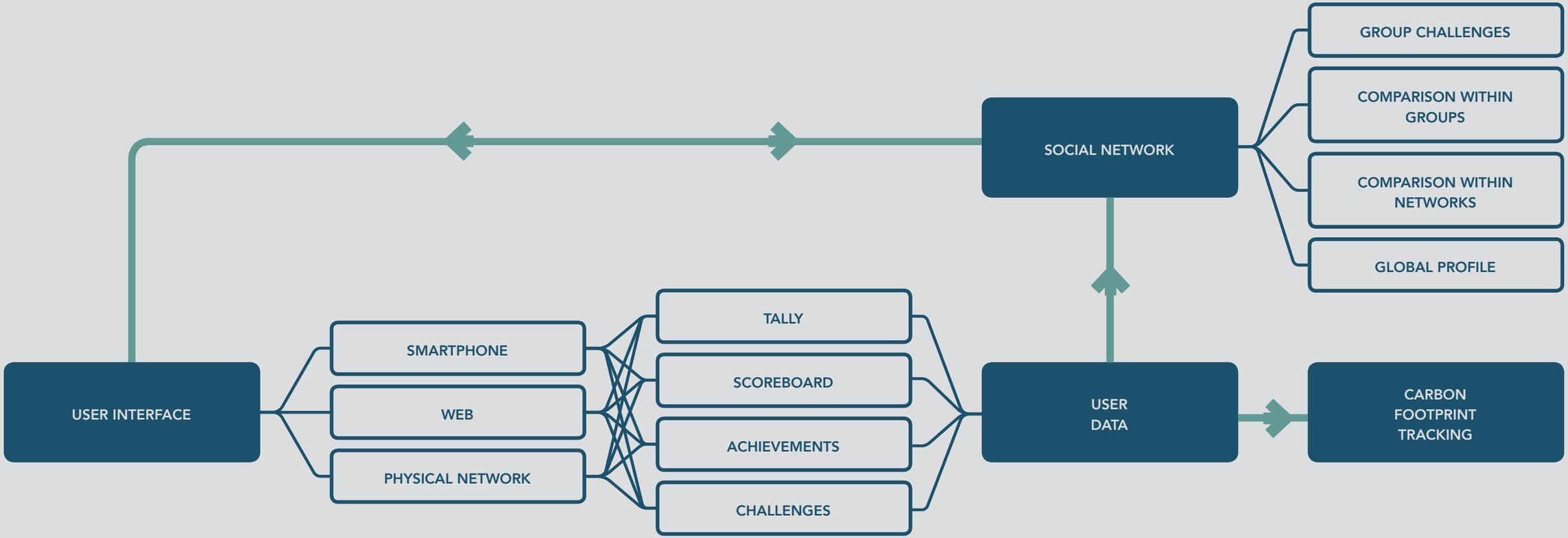
Fig. C.5 Selected user interface layouts.



CAP & TRADE POINTS SYSTEM | THE ALARMED URBANITE

Fig. C.6 Flowchart of the cap & trade points process.

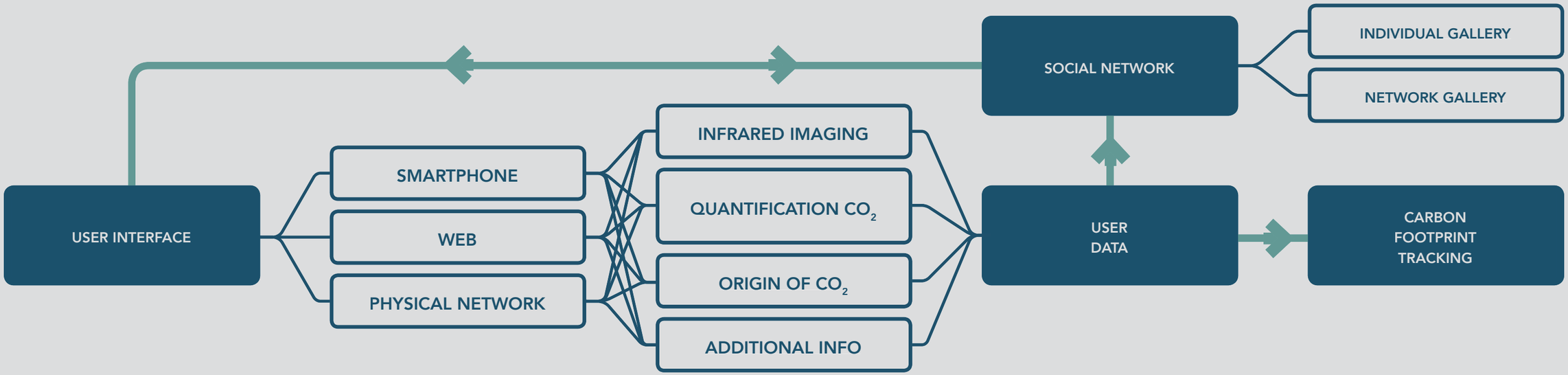
Fig. C.7 Selected user interface layouts while clothes shopping.



GAMIFICATION | THE CLIMATE-AWARE STUDENT

Fig. C.8 Flowchart of the gamification process with an example target user group.

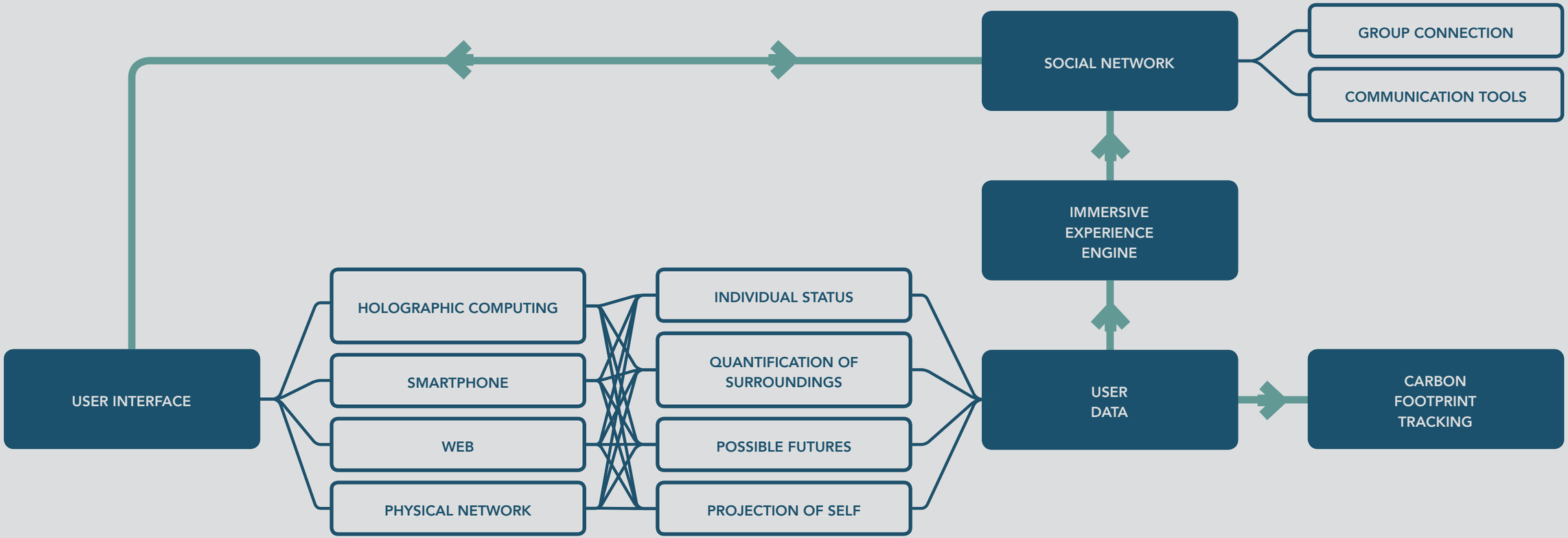
Fig. C.9 Selected user interface layout with the gamification process.



TOOLS FOR EVIDENCE | THE DOUBTFUL HEDONIST

Fig. C.10 Flowchart of the tools for evidence process.

Fig. C.11 Experiencing the system as a tool for evidence.



IMMERSIVE VISUALISATION

Fig. C.12 Flowchart of the immersive visualisation process.

Fig. C.13 Experience of using immersive visualisation tools through a smartphone.

Fig. C.14 Experience of using immersive visualisation tools with augmented reality hardware.

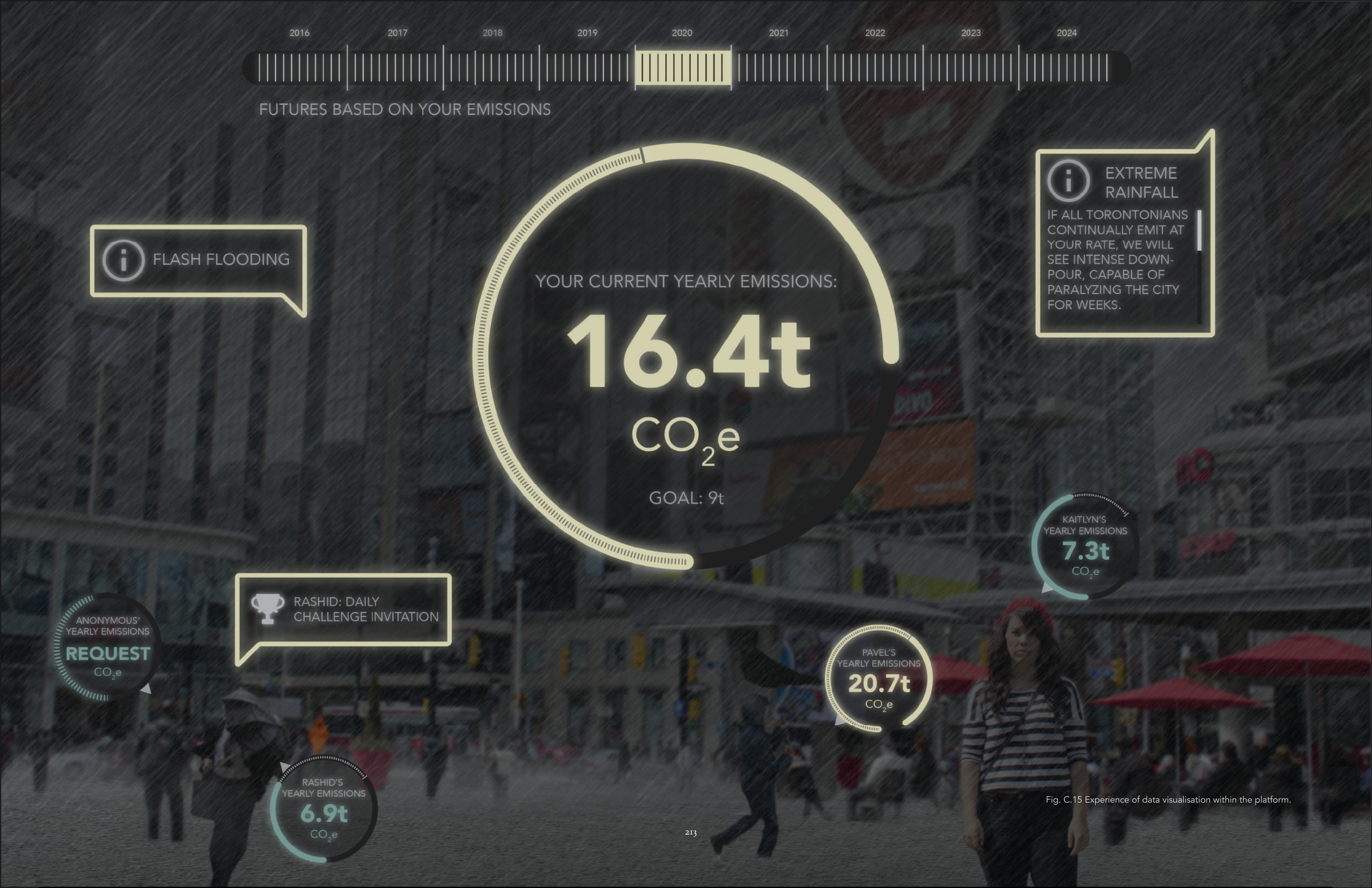


Fig. C.15 Experience of data visualisation within the platform.

APPENDIX D
SURVEY RESULTS

Fig. D.1 Demographics

Demographics

Total responses
1576

Age groups
14 - 17 (12.91%), 18 - 24 (26.72%), 25 - 34 (29.83%), 35 - 44 (15.9%), 45 - 54 (8.65%), 14 (0.06%), > 54 (5.92%)

Gender
Male (57.52%), Female (42.48%)

Fig. D.2 Question 1

Q1
TYPE: SINGLE SELECTION

Which political party are you most likely to support?

#	ANSWERS	PERCENT	COUNT
A1	Liberal	28.17%	444
A2	Conservative	14.47%	228
A3	NDP	8.82%	139
A4	Green	13.01%	205
A5	Rather not say	29.38%	463
A6	Other	6.15%	97
A7	PDP		
A8	Pink		
A9	Tdp		
A10	APC		
A11	Pdp		
A12	pgg		
A13	Communist		
A14	brawn		
A15	Left		
A16	none		
A17	Duterte Administration		

POWERED BY Pollfish

Fig. D.3 Question 2

Q2
TYPE: OPEN-ENDED

What are the first 3 characters of your postal code?

#	ANSWERS
A1	php
A2	M4l
A3	m1w
A4	N0E
A5	L8L
A6	P6B
A7	J6w
A8	h1n
A9	M4e
A10	H3R
A11	M2J
A12	H2n
A13	h1n
A14	M1k
A15	R3t
A16	M3A
A17	L2M

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Fig. D.4 Question 3

Q3
TYPE: RANKING

Please rank the following issues in order of importance to you:

#	ANSWERS	1	2	3	4	5	6	7	MEAN
A1	Healthcare funding	225	202	180	147	160	168	164	3.8
A2	Pension	185	199	192	170	186	174	140	3.8
A3	Education	220	176	163	155	156	163	213	4.0
A4	Renewable energy	124	188	192	224	198	167	153	4.0
A5	Impacts of climate change	162	175	175	187	194	177	176	4.1
A6	Aboriginal funding	185	149	160	163	185	195	209	4.2
A7	Immigration policy	145	157	184	200	167	202	191	4.2

TOTAL UNIQUE RESPONDENTS 1576

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Fig. D.5 Question 4

Q4
TYPE: NUMERIC OPEN-ENDED

Roughly how many kilometres do you regularly drive or ride as a passenger in a car in an average week?

#	ANSWERS
A1	5
A2	150
A3	75
A4	5
A5	20
A6	90
A7	0
A8	10000
A9	1
A10	30
A11	20
A12	12
A13	1616
A14	0
A15	40
A16	20
A17	400

Fig. D.6 Question 5

Q5
TYPE: MATRIX, MULTIPLE SELECTION

For each of the following activities that you do regularly, please indicate your reason/s for doing them.

#	ANSWERS	I DON'T DO THIS	IT SAVES ME MONEY	I HAVE A MORAL OBLIGATION TO DO IT	IT IS HEALTHY FOR ME	OTHER PEOPLE ARE DOING IT TOO
A1	Walking or cycling to work	497 - (36.87%)	258 - (19.14%)	174 - (12.91%)	343 - (25.45%)	76 - (5.64%)
A2	Taking public transport	400 - (31.08%)	433 - (33.64%)	211 - (16.39%)	113 - (8.78%)	130 - (10.10%)
A3	Seeking fairly traded products	429 - (34.24%)	279 - (22.27%)	337 - (26.90%)	113 - (9.02%)	95 - (7.58%)
A4	Buying energy efficient light bulbs	275 - (20.75%)	426 - (32.15%)	310 - (23.40%)	187 - (14.11%)	127 - (9.58%)
A5	Buying organic food	369 - (28.41%)	194 - (14.93%)	230 - (17.71%)	366 - (28.18%)	140 - (10.78%)
A6	Buying local food	244 - (18.42%)	326 - (24.60%)	340 - (25.66%)	290 - (21.89%)	125 - (9.43%)
A7	Recycling	194 - (14.10%)	258 - (18.75%)	490 - (35.61%)	243 - (17.66%)	191 - (13.88%)

TOTAL UNIQUE RESPONDENTS 1576

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Fig. D.7 Question 6

Q6
TYPE: SINGLE SELECTION

Choose an activity that you do NOT currently take part in:

#	ANSWERS	PERCENT	COUNT
A1	Recycling	13.03%	147
A2	Vegetarianism	41.22%	465
A3	Stopped using gas vehicles	13.92%	157
A4	Eating in-season produce only	10.37%	117
A5	Using a smart service, such as Nest, to make your energy consumption more efficient	11.35%	128
A6	None of the above. I take part in all the listed activities.	10.11%	114

TOTAL UNIQUE RESPONDENTS 1576

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Fig. D.8 Question 7

Q7
TYPE: SINGLE SELECTION

How likely would you begin that activity if your family/friends started to as well?

#	ANSWERS	PERCENT	COUNT
A1	Not at all likely	28.00%	282
A2	Somewhat likely	18.97%	191
A3	Moderately likely	21.95%	221
A4	Very likely	17.58%	177
A5	Extremely likely	13.51%	136

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.9 Question 8

Q8
TYPE: MATRIX, SINGLE SELECTION

How likely would you allow a mobile application/service to automatically track your activities in these categories?

#	ANSWERS	NOT AT ALL LIKELY	SOMEWHAT LIKELY	LIKELY	VERY LIKELY	EXTREMELY LIKELY
A1	Groceries	316 - (28.88%)	224 - (20.48%)	267 - (24.41%)	171 - (15.63%)	116 - (10.60%)
A2	Dining out	366 - (33.46%)	225 - (20.57%)	266 - (24.31%)	136 - (12.43%)	101 - (9.23%)
A3	Daily commute distance	352 - (32.18%)	196 - (17.92%)	275 - (25.14%)	151 - (13.80%)	120 - (10.97%)
A4	Daily commute method	377 - (34.46%)	204 - (18.65%)	264 - (24.13%)	144 - (13.16%)	105 - (9.60%)
A5	Home energy consumption	330 - (30.16%)	224 - (20.48%)	265 - (24.22%)	163 - (14.90%)	112 - (10.24%)
A6	Travel	363 - (33.18%)	197 - (18.01%)	260 - (23.77%)	158 - (14.44%)	116 - (10.60%)
A7	Shopping	336 - (30.71%)	203 - (18.56%)	263 - (24.04%)	164 - (14.99%)	128 - (11.70%)

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.10 Question 9

Q9
TYPE: MATRIX, MULTIPLE SELECTION

Which of the activities (listed on the left) would you be more inclined to track with a mobile application if it increased...

#	ANSWERS	SAVING MONEY	CONVENIENCE	ENVIRONMENT PROTECTION	HEALTH	MORALITY
A1	Groceries	644 - (46.60%)	292 - (21.13%)	141 - (10.20%)	205 - (14.83%)	100 - (7.24%)
A2	Dining out	468 - (35.56%)	385 - (29.26%)	158 - (12.01%)	206 - (15.65%)	99 - (7.52%)
A3	Shopping	544 - (41.18%)	316 - (23.92%)	226 - (17.11%)	138 - (10.45%)	97 - (7.34%)
A4	Daily commute distance	390 - (29.17%)	336 - (25.13%)	284 - (21.24%)	218 - (16.31%)	109 - (8.15%)
A5	Daily commute method	402 - (29.76%)	345 - (25.54%)	272 - (20.13%)	184 - (13.62%)	148 - (10.95%)
A6	Travel	481 - (36.52%)	318 - (24.15%)	231 - (17.54%)	178 - (13.52%)	109 - (8.28%)
A7	Home energy consumption	493 - (35.52%)	262 - (18.88%)	316 - (22.77%)	183 - (13.18%)	134 - (9.65%)

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.11 Question 10A

Q10
TYPE: MULTIPLE SELECTION

From the following list of environmental issues, select up to three issues that concern you the most:

#	ANSWERS	PERCENT	COUNT
A1	Air pollution	12.46%	289
A2	Flooding	3.84%	89
A3	Litter	5.78%	134
A4	Pollution of rivers/seas	8.06%	187
A5	Water scarcity	7.07%	164
A6	Poor waste management (landfills)	6.12%	142
A7	Traffic/congestion	7.12%	165
A8	Radioactive waste	5.35%	124
A9	Overpopulation	8.06%	187
A10	Hole in ozone layer	5.26%	122
A11	Global warming	15.31%	355
A12	Genetically modified food	7.16%	166
A13	Species extinction	6.99%	162
A14	Other	1.42%	33
A15	Light pollution. I can't see the stars...		
A16	Enciroment		
A17	Animals born to be eaten - Meat Consumption		

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Fig. D.12 Question 10B

#	ANSWERS	PERCENT	COUNT
A18	BEE Extinction, specifically		
A19	Death		
A20	na		
A21	Sink holes		
A22	cost of living		
A23	Roads and sidewalks in winter are never cleaned		
A24	I'M NOT AWARE		
A25	corrupt, criminal governments, corporations and banks are a massive problem		
A26	I dont really worry about anything		
A27	HYDRO PRICE TOOOOO HIGH		
A28	DSAwwq		

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.13 Question 11

Q11
TYPE: SINGLE SELECTION

Please rate your level of understanding of climate change.

#	ANSWERS	PERCENT	COUNT
A1	Poor	9.19%	96
A2	Fair	12.44%	130
A3	Average	30.62%	320
A4	Good	31.29%	327
A5	Excellent	16.46%	172

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.14 Question 12

Q12
TYPE: SINGLE SELECTION

Burning oil produces carbon dioxide.

#	ANSWERS	PERCENT	COUNT
A1	True	57.76%	599
A2	False	14.08%	146
A3	I don't know	28.16%	292

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.15 Question 13

Q13
TYPE: SINGLE SELECTION

Climate change is mainly caused by human activities.

#	ANSWERS	PERCENT	COUNT
A1	True	65.63%	678
A2	False	18.20%	188
A3	I don't know	16.17%	167

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.16 Question 14

Q14
TYPE: SINGLE SELECTION

For the next decades, the majority of climate scientists expect a warmer climate to increase the melting of polar ice, which will lead to an overall rise of the sea level.

#	ANSWERS	PERCENT	COUNT
A1	True	62.10%	639
A2	False	13.02%	134
A3	I don't know	24.88%	256

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.17 Question 15

Q15
TYPE: SINGLE SELECTION

Nuclear power plants emit carbon dioxide during operation.

#	ANSWERS	PERCENT	COUNT
A1	True	37.06%	381
A2	False	25.39%	261
A3	I don't know	37.55%	386

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.18 Question 16

Q16
TYPE: SINGLE SELECTION

The last century's global increase in temperature was the largest during the past 1000 years.

#	ANSWERS	PERCENT	COUNT
A1	True	51.70%	531
A2	False	13.24%	136
A3	I don't know	35.05%	360

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.19 Question 17

Q17
TYPE: SINGLE SELECTION

For the next decades, the majority of climate scientists expect an increase in extreme events, such as droughts, floods and storms.

#	ANSWERS	PERCENT	COUNT
A1	True	59.20%	608
A2	False	12.95%	133
A3	I don't know	27.85%	286

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.20 Question 18A

Q18
TYPE: MULTIPLE SELECTION

Please select all the situations that would encourage you to avoid purchasing an item/service:

#	ANSWERS	PERCENT	COUNT
A1	It affects my own well-being	8.56%	358
A2	It affects the well-being of others in my community	6.98%	292
A3	It affects the well-being of animals	8.01%	335
A4	It affects the well-being of the environment	8.90%	372
A5	It affects the well-being of others around the world	7.80%	326
A6	It affects the well-being of future generations	8.90%	372
A7	It affects my future	10.11%	423
A8	It affects my lifestyle	8.32%	348
A9	It affects the well-being of marine life	6.74%	282
A10	It affects the well-being of plants	6.77%	283
A11	It affects the well-being of birds	5.98%	250
A12	It affects my health	11.79%	493
A13	Other	1.15%	48
A14	Made by children		
A15	I don't know		
A16	all of the above		
A17	If effectits my loved ones		

Fig. D.21 Question 18B

#	ANSWERS	PERCENT	COUNT
A18	Non		
A19	It's expensive		
A20	It effects the well-being of animals (ex. Meat products, leather, gelatin)		
A21	It's overly expensive		
A22	money		
A23	The cost.		
A24	CO2 is not bad, it is a building block of life, More Co2 means more plants which give off oxygen, the real problem is the criminals in corporations, banks and governments using their fake Pseudoscience as real data		
A25	Jsnsjs		
A26	Price		
A27	Price		
A28	It cost much		
A29	Please explain		
A30	Unethical practices		
A31	Jjkmngh		
A32	Hyjduududejejjejejr		

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.22 Question 19A

Q19
TYPE: MULTIPLE SELECTION

Please select the statements that you AGREE with:

#	ANSWERS	PERCENT	COUNT
A1	We can all do our bit to reduce the effects of climate change	9.54%	298
A2	Climate change is inevitable because of the way modern society works	4.77%	149
A3	People should be made to reduce their energy consumption if it reduces climate change	7.08%	221
A4	Climate change will improve Toronto's weather	2.56%	80
A5	Climate change is natural	3.30%	103
A6	I would only start making an effort to reduce climate change if everyone else did as well	2.27%	71
A7	The government should provide incentives for people to care about the environment	8.61%	269
A8	It's too late to do anything about climate change	1.99%	62
A9	I'm already doing everything I can to reduce my impact on climate change	4.23%	132
A10	I'm not sure if climate change is happening	1.67%	52
A11	Climate change does not exist	1.31%	41
A12	Human activities have no impact on climate change	1.63%	51
A13	Industry pollution is the main cause of climate change	7.27%	227
A14	It is too early to say whether climate change is a	1.60%	50

POWERED BY Pollfish

Fig. D.23 Question 19B

#	ANSWERS	PERCENT	COUNT
	problem		
A15	I feel a moral duty to do something about climate change	6.66%	208
A16	I am unwilling to make personal sacrifices for the sake of the environment	1.60%	50
A17	There are bigger problems to care about than climate change	2.63%	82
A18	The government is not doing enough to tackle climate change	7.68%	240
A19	I can do more about climate change, I just don't know what	5.19%	162
A20	Individual action is not effective against climate change	2.98%	93
A21	The effects of climate change will be catastrophic	7.24%	226
A22	I'm sick of hearing about climate change, it's not as urgent as people say it is	1.89%	59
A23	Climate change can be reversed if we act now	6.31%	197

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.24 Question 20A

Q20
TYPE: MULTIPLE SELECTION

Please select all the sources that you would trust to give you information on climate change:

#	ANSWERS	PERCENT	COUNT
A1	Government	10.94%	264
A2	Your energy supplier	6.34%	153
A3	Environmental organizations	15.08%	364
A4	Family members	7.37%	178
A5	Newspaper article	10.69%	258
A6	Climate scientist	18.48%	446
A7	Non-fiction books	5.97%	144
A8	Close friends	7.17%	173
A9	Mobile phone app with information from reviewed sources	7.54%	182
A10	My favourite radio station	4.89%	118
A11	Articles posted on my Facebook feed	3.31%	80
A12	Other	2.24%	54
A13	Gase		
A14	Hhh		
A15	Teachers		
A16	God		
A17	0408		

POWERED BY Pollfish

Fig. D.25 Question 20B

#	ANSWERS	PERCENT	COUNT
A18	My mind :v		
A19	None		
A20	News		
A21	Internet		
A22	none of these		
A23	Nobody really. Everyone has an agenda and data can be interpreted to promote any view.		
A24	None of the about as it is all Pseudoscience		
A25	112		
A26	Trusted Websites		
A27	All of them		
A28	God or the pope		
A29	Alt media		
A30	School		
A31	Independent news research		
A32	Only the government Turley knows but they lie		
A33	Scientists		
A34	Uu		
A35	No one		
A36	Academia		
A37	you tur		

TOTAL UNIQUE RESPONDENTS 1576

POWERED BY Pollfish

Fig. D.26 Question 21A

Q21
TYPE: MULTIPLE SELECTION

Please select all the reasons that would motivate you to make significant changes to your daily routine in order to prevent climate change:

#	ANSWERS	PERCENT	COUNT
A1	Government incentives	4.13%	189
A2	Personal moral gain	4.00%	183
A3	Improving my own health	6.60%	302
A4	Improving another person's quality of life	4.88%	223
A5	Contributing to saving endangered animals	5.36%	245
A6	My friends and family are already doing it	2.95%	135
A7	Gaining access to cutting edge technologies	3.26%	149
A8	Reduction in government taxes	4.66%	213
A9	Participating in forest conservation	4.50%	206
A10	Working towards a sustainable lifestyle	5.57%	255
A11	Preventing pollution and acidification of water	6.03%	276
A12	Reducing desertification of land and drought	4.77%	218
A13	Preventing extreme weather events	5.09%	233
A14	Restoring air quality	7.04%	322
A15	Restoring plant life (ie. more trees, etc.)	6.34%	290
A16	Ensuring that my future quality of life is higher or equal to today	4.77%	218

POWERED BY Pollfish

Fig. D.27 Question 21B

#	ANSWERS	PERCENT	COUNT
A17	Improving Canada's public image	3.06%	140
A18	Ensuring the survival of the human race	5.47%	250
A19	Ensuring a better or equal quality of life for future generations	6.03%	276
A20	Restoring the environment to its previous state	4.55%	208
A21	Other	0.94%	43
A22	Gase		
A23	To see the stars again		
A24	All the above		
A25	My father		
A26	I dont know		
A27	Helping Animals		
A28	Chris		
A29	Nothing as Pseudoscience is a real danger to life on the planet		
A30	Lorns		
A31	Na		
A32	ALL OF THEM		
A33	There is nothing the corrupt, criminal government can do, I don't trust them as far as I can throw them		
A34	Better and faster transportation system		
A35	Nothing		

TOTAL UNIQUE RESPONDENTS 1576

Fig. D.28 Question 22

Q22
TYPE: MULTIPLE SELECTION

Please select the statements you know to be FALSE:

#	ANSWERS	PERCENT	COUNT
A1	The global carbon dioxide concentration in the atmosphere has increased during the past 250 years.	14.84%	230
A2	The majority of climate scientists expect the climate to change evenly worldwide.	16.65%	258
A3	Carbon dioxide is harmful to plants.	21.10%	327
A4	At the same quantity, carbon dioxide is more harmful to the climate than methane.	16.06%	249
A5	Today's global CO2 concentration in the atmosphere has already occurred in the past 650,000 years.	17.10%	265
A6	A majority of climate scientists expect a warmer climate to increase water evaporation.	14.26%	221

TOTAL UNIQUE RESPONDENTS 1576

APPENDIX E
INTERVIEW TRANSCRIPTS

USMAN HAQUE [UMBRELLIUM]

1. Please give a brief overview of your professional background and what you are currently focused on.

I am trained as an architect and arguably, the work that I'm trying to do I still consider within the discipline of architecture, but the work kind of encompasses more than just buildings and involves, on the one hand, projects that basically research the way that people relate to each other and the spaces around them and how they become a part of the process of making decisions about and ideally contributing to their city and on the other end of the spectrum, the work I do is actually in technological infrastructure deployment in sometimes technology products and sometimes actually in the city itself. And in that case, it's surely about building an internet of things, networking technology and stuff like that.

2. In your opinion, what are the changes most urgently needed today, with respect to global warming? Changes we, as citizens that designers can have an effect on, need to focus on in the short term.

I think that what I would like to see more of in that context is more about the tools to action rather than just tools for information. In other words, there's quite a lot of work going on in, for example, deploying a bunch of sensors or building maps and visualizations, all of which is well and good and is necessary for certain things. But unless that stuff is all harnessed for the purpose of making decisions and enacting them, executing those decisions, all it is is spectacle without that. And so my question would be, first of all, how do we get more people involved in the evidence gathering process themselves because right now with climate change we're in this kind of a somewhat – well it's actually an unprecedented situation where the very notion of truth and reliability and trust, which are some of the very foundations of civilizations, are being challenged by the political structures that we find ourselves in. And so, if you look at policy in the US for example, which has made a dramatic shift under Trump actually questioning whether climate change is even a phenomenon at such a high level, the

stuff that's needed has suddenly become much more lost. And so, you know, right now when it comes to climate change, as ordinary citizens, we're kind of presented with having to trust the opinions of either, yes in some cases they're scientists, in some cases it's a politician or it's a religious figure or it's a media figure, or it's like – with climate change we're almost being tossed with having to weigh up other people's evidence even whether or not there's a scientific consensus. It's almost as if ordinary people are just going to be left out of that whole battle and it's like, "Well, whose opinion do you actually trust?" And so personally, I'd be really keen to see more people involved in questioning those standards of evidence and becoming part of the evidence gathering themselves, so not just blindly having to trust someone. Because there are experiments that one can do, that one can understand better what's actually going on, some datasets that one can delve into as an ordinary member of the public and be much better informed. So I'd like to see that on the one hand and on the other hand, I'd like to see more of a kind of decision making and actions that can come about from that evidence. So in other words, you know, unfortunately one logical consequence of the environmental debate is when you look at just how energy intensive living is, just breathing is energy intensive. Just breathing actually has a negative effect on the carbon footprint of the planet. But with human intelligence, we can actually counteract our own negative effects and actually ameliorate the carbon situation. But only if we intentionally do it. So if we follow a lot of the environmental debate, it's all that reduce, you know, "Reduce what you're doing," "Stop doing this," "Stop doing that," and I don't see enough yet of, "Oh, but you can do this and this actually improves." It doesn't just mitigate or it doesn't just stop harming, it can actually improve the situation. So I'd like to see more of that. People amassing their own evidence and kind of not having to blindly trust others and then secondly actually moving to a point where they are able to kind of build stuff that actually improves the situation.

Do you think there would be an issue of reliability if people were gath-

ering their own evidence and drawing their own conclusions without technical knowledge?

It's definitely a massive issue and it's not – I think that the very terms of evidence need to be reframed. By which I mean that, you know, if you are looking for, as evidence, a clean dataset, objective so-called dataset, which is perhaps the enlightenment model of knowing the universe, you want as much data as you can, then arguably yes, you have to all be kind of indoctrinated in the same clean way of collecting data and making sure to do all the stuff that scientists have to do to make sure that their data is consistent. But in some cases, it's not purely the data that's important, in other words it's not just about the individual numeric data points that you're collecting. It's actually about that process of measuring yourself and seeing stuff go up and down rather than just being a static value. Or it's about understanding how complex measuring is, how much personal opinion actually has to go into the process of amassing evidence. How important context and how important choosing when, why, where, and how you're going to measure something. All of these are so vital to it. And so I guess, when I'm calling for more people to be involved in the amassing of evidence, it's not because we're going to have a better perspective on everything, it's because actually, we all have to be part of that process of a collective making sense, if you see what I mean. It can't just be the domain of some people with respect to others just kind of following along. Because I think the outcome of doing that that way, is not necessarily better evidence in a strict kind of empirical science sense. The outcome is a greater sense of responsibility and agency and involvement and kind of dedication and investment in an outcome, which is basically the sustainability of the human species, if you see what I mean. So it's not really about the data so much for me.

3. What do you view as the greatest barrier to fighting global warming for people on an individual level?

Prisoner's dilemma factors in a lot here right? It's that idea that, "Why should I do anything if my neighbour is not doing anything?" or "Why should I bike to work when everyone else is in the comfort of their car?" or etc., etc. And so I think that the biggest barrier are these kind of systemic logical conflicts, almost. And that's where I see potential roles for designers playing a really interesting part in actually somehow bridging these things that are – they're kind of complex. So, for example, we could easily solve the pollution issue in every city by banning all cars and stopping factory production. That would pretty much wipe out the problem of black carbon, actually within a few weeks. Now, of course we can't do that because there's many good reasons for having cars, you know, from a certain perspective. There's good reasons from the perspective of a parent who's trying to get their child to school on time before getting to work, from the perspective of somebody's who's just trying to go about their daily life. So it's a really complex issue and getting people to be able to stand up to these challenges together I think, is a really interesting task for designers. So in other words, enabling a cyclist and a driver to be part of developing some kind of proposition together, understanding and hopefully even possibly empathizing with each others' respective positions and not just their positions but their kind of, their own complex network of constraints and desires. I think that's where – that's a barrier that designers can kind of help work through. And so, if I can expand on that for a bit, I just wanted say that I think this might tie back to your previous questions as well, but I think that there's been this kind of discourse of design over the last ten years or so, twenty years maybe, about design being about simplifying things or that being a task for design and I really want to push back against that. I think that, first of all, the idea that designers have some clarity that others don't, I think, needs to be challenged. But secondly, I think that the issues that we face are so complex that trying to make a simplified one-liner, linear kind of description, or trying to translate something like that is potentially actually harmful, not just not beneficial. And, so I think that in the context of what I was saying, like trying to get

people together to discuss their own complex issues, what I'm not looking for is that a designer helps translate between them. I'm talking about a designer being able to provide a forum or a context or an environment for conversation where those people can kind of build up their own trust of each other.

Sort of like a public space.

Potentially public. The question of what public even means anymore is a – we can get sidetracked on this. I know what you mean but I don't think it's necessarily a public space. It's just, it's a space of trust, really.

4. What is your opinion on the effectiveness of using methods of general audience engagement as a measure against global warming (e.g. media that is directed at a general audience as opposed to targeting specific user groups)?

From my previous answer, you probably understand that I'm a bit skeptical of pure fact. I don't think facts help anything, you know. In a sense, facts are used by those to back up whatever it is they already believe. This is a sweeping statement of course, but I think especially in the socio-political context that we increasingly find ourselves, pure fact is not really the answer. So whether those facts are geared towards one group, or a larger group or what have you, I think is kind of less important than how to get different groups involved in some kind of co-located interaction together. I think that the idea, the importance of conversation for me is not just that it's the idea of sharing stuff. The idea of conversation is building a shared model together, it's a kind of act. And by the way, this is why I find processes like barn-raising so interesting. Historically, this idea of people coming together to build something together with lots of different expertise and so I would be looking for something, some kind of process like that. I don't know exactly what that is and maybe I've tried to explore it in different ways in different parts of my own work, but I don't have

an all-encompassing narrative yet to explain what it would look like. But that seems to me to be the important thing, is kind of like mixing up the kind of messy groups, if you see what I mean.

5. What would you say is an action that individuals make that has the largest carbon footprint, yet is easiest to fix?

Well, driving for sure. Every mile that you can stop driving is pretty impressive. And especially because the research shows that much of the kind of driving that we do is quite short journeys. So that would be one thing that is quite interesting, but I think the other way to flip it – I mean that's if we look purely at the reduce mechanism, which reduces carbon impact. But things like, I mean it sounds kind of hippy but, things like planting trees actually is so easy to do and becomes a carbon sequestering mechanism itself. So its not just that it doesn't cause carbon, it actually extracts from the atmosphere. So that seems to me to be a good argument for doing something quite easy like that.

6. What do you see as a missing factor in the design of media used by people/agencies that aim to communicate information to the general public in order to convince them to become more engaged with mitigating global warming? In what ways might we bridge that gap to increase its effectivity?

One of the standard tools for communicating information is the data visualization and it's so frustrating to me that so many data visualizations are basically static images that smooth out and basically hide all of the complexity that is actually involved. And so, if you have to do data visualizations, and I would really strongly encourage people not to, but if they have to then I would at the very least want to be thinking of, "How do you expose all the data that you had to exclude from this data visualization to make it look pretty?" How do you make sure to show that curatorial process through which you decided this dataset was the one to visualize and not this other one? Why did you choose NASA's data rather

than the European Space Agency's or what have you? Or what happens if you can show multiple sources of data? How can you communicate through the visualization tool the stuff like using logarithmic scales and the dynamic range of data? You know, sometimes what you can do is chop off the bottom and the top so that it all fits on the graph. How can you make sure that you're communicating all of that and how the pictures changes if you're able to reconfigure your visualization to include all this other data? That would be a purely media-oriented wish of mind.

It's difficult because the data visualization is to simplify in order for people to actually pay attention. If it's too complex they won't look at it, but at the same time it's really hard to just generalize something so complex in the end.

7. Please give a general overview of what Umbrellium does and how it differs from other firms.

The work we're trying to do is to build tools of citizen empowerment, but which I mean to look at, first of all, how do you get groups of people working together, which in itself is a challenge and then secondly, the notion of empowerment is this idea of people exceeding what they thought was possible. And so the work can be in some cases very short term, you might even say spectacular, kind of getting thousands of people involved at the same point. Or on the other hand it might be stuff that's, you know - the more interesting stuff for me is the long term stuff, which is much more subtle. Where we actually work with communities over sometimes a couple of years, two or three years, and effectively kind of co-create projects that emerge only gradually over time. But which actually becomes the fabric of everyday life if you see them. I'm not sure how we differ from other firms except that, I suppose that our – first of all, all the kind of main-designers on the team – there's three of us, we're all trained as architects and we kind of, for us it is part of the practice of architecture. But I supposed that one way that we differ from a lot of other straight

design firms is that we don't really pitch to briefs. In other words, very often the traditional model might be client wants xyz comes here and a bunch of people pitch a proposition that resolves some of those issues and instead what we tend to say is, "We actually have no idea what we're going to do. Here's the work we've done in the past and all of this has come about by working with a community and building up trust over some time and having lots of conversations and building stuff together and figuring out actually what is the right thing to do for this particular context collaboratively." So we don't actually have a pitch beyond that. So I think that's a little bit different from other firms.

That sounds like a great process because having the brief kind of locks you into a certain solution, but does that make it harder to find clients or people to fund your work? Because it requires so much trust.

I would say we definitely probably lose 90% of the incoming business that comes in because, you know, an advertising firm would be, "Ooh. Can you do some flashy lights for us?" Well, that's not really what we do, but there's some guys down the road that do that really nicely.

8. What are the challenges that you deal with in achieving the level of interaction you're aiming for in your interactive installations? What are some examples of some fool-proof approaches you use that achieves audience engagement?

One of things I've realized over the years is that you actually can't – if you have an idea of how something is going to work, you know, "If everybody does this, then it'll all be really perfect and it'll all be doing this kind of stuff." You can't use that as a way to explain to other people why they should be part of it. In other words, you can't just say, "Oh, you know if we all do this thing together, then it's going to result in this magical interaction or this kind of magical moment." Because that in itself is not enough to convince people to get involved. So, very often what you have

to do is, you kind of have an idea in mind of what might emerge when everyone is involved or lots of people are doing something. But really the task is to figure out how to do that micro-interaction that entices people to get involved just for a short time, just briefly just to experiment and then figure out how to kind of aggregate all of those together into something. In other words, in might not be that everyone knows exactly what they will be contributing to in the end as a sort of much larger general experience.

9. In what ways can architects improve their design process with the use of emerging technologies and data-based processes that is often under-utilized or overlooked?

Well, definitely check out the work of Gordon Paskin and Cedric Price who were doing a whole lot more with a whole lot less technology back in the 60s and 70s. And, I guess, for me it's not a technology question. It's not. It is not a – technology in and of itself is not an opportunity. In some cases, it can just be a barrier to thinking so what I would be wanting to challenge architects to do is just kind of to be constantly challenging themselves about every aspect of who's making the decisions about the design at every stage. By which I mean that of course you always have the designer of the building, of the system, of the something, so somewhere there is a designer which may be a whole group of people or what have you. But somebody ultimately has to make the decisions about things. So what I'm really interested in is how you might, you can make decisions that actually open up more decisions to other people if you see what I mean. So if I was to say something like you - this is a really stupid one-line description but – you might make a decision to put a light switch in where you flick it up and it goes on and you flick it down and it goes off. That would be an opportunity for me to sort of question, "Well why should it be up for on and down for up? Can somebody else make that decision about whether it's up or down for off?" And then challenge that again and say, "Well what if up and down was not on and off but, you know, you have to flick it up twice for on

and twice down for off." Or something like that. Again, just sort of throwing out that decision for somebody else to think about what the script is that captures the input to the output. And you can kind of cascade them downwards to many different levels in the design process. That's what I'd be really interested in seeing how architects bring that more into the process of design rather than thinking about how technology's going to specifically solve that. Because I think it can lead too easily down to just parametric blob form technology driven architecture rather than humane and human-environmental, kind of conversational interfaces if you see what I mean.

10. What can you see architects doing in order to encourage people to get over the prisoner's dilemma that is entangled with climate change? Is it enough to strive to build net-zero buildings, or is there more that they can do outside their standard mode of operation?

The interesting thing about prison dilemma of course is that if both parties know that each other is cooperating, it turns out to be a net benefit for them both to cooperate. It's just that the lack of knowledge between the parties leads them to not cooperate. So, my proposition would be not just for a building to become net zero, but actually think about how can your building connect with the buildings around it or with the other – with the context that you're in. So it's not just net zero, but it's actually contributing wider to everything else. Even if you don't know whether they're going to reciprocate, just to do that anyway because that itself had kind of an on going cumulative effect of countering that prisoner's dilemma issue. Because the more people that do it, the more people will do it, if you see what I mean.

It's kind of like a gamification of living in your house.

Not exactly gamification I think. It's more a question of thinking about the selfish reasons to be selfless almost, if you see what I mean. Because I have nothing against selfishness in the sense

that there's no reason for us not to worry about ourselves and do things for our own selves, but it just turns out that quite often, by doing selfless things then it is actually beneficial for ourselves. I think that, you know, dealing with the air quality is a good example. If you improve your own air quality you also happen to improve your neighbour's air quality, probably not as much but it has a net benefit on your neighbour's as well, even if they don't do anything. And so you can kind of act selfishly and by accident almost help others around you. So I find that paradigm quite interesting to explore.

11. Mitigating climate change will require constant engagement and perseverance with dealing with increasingly difficult problems. How does Umbrellium's approach to participatory systems and citizen empowerment deal with this issue?

I think that my take on this is that I don't know what the right answer is to tackle climate change. I don't think there's any single right answer. I also don't think if we leave it in the hands of technocrats and politicians, that they're going to have the right answer. Because historically, it's that combination of quite linear thinking that's kind of gotten us into the mess that we're in. Which means that probably, one of the best ways to try and figure out how to get ourselves out of this mess is if we are all involved in building and thinking about and kind of imagining that future and how we're going to make it come about. So that means, what I see my role as being within this kind of system is to kind of think about how can I design – how can I do these projects where essentially what we're doing is designing for people to be able to trust each other, to kind of build into their own lives a sense of responsibility for the decisions they're making about the future, about the sense of accomplishment they have from working with their neighbours. Neighbours in a very sort of general sense. And how can people have a bit more agency in this process, a bit more kind of belief that they can have an impact. And so, what I think I'm trying to say is that it's not that I think it's that we're going to

figure out through this process, how to deal with climate change, it's more that one of the aspects of dealing with climate change has got to be a sense of solidarity that I think is kind of shaky. And so that's the thing I'm trying to focus on.

With what methods does it try to create or nurture citizens' motivation to continually engage with an issue that seems to be easily forgotten in day-to-day life?

One of the aspects of our methodology of working is – so when we start the project, the project might have sort of idea or a goal in mind. Now typically, when you're doing this kind of project, people tend to want to keep that goal quite static, because then you can evaluate your progress towards that goal. We do something a little bit different though. We, from the very first meeting when we're meeting with the local community, we challenge that goal. We say, "What if it's not this goal. What if we should be working towards something else. Let's reimagine what that goal should be." And going through that process we also say, "Who else should be involved in questioning what this goal is." And that kind of sets up the program for the next encounter. What we've noticed that this does is that it makes people feel much more closely involved in and kind of owning the project because they're not just part of a process of an assembly line of just delivering the outcome. They're not just slotted into a place. They're actually having some effect in discussing what the outcome should even be at all stages. So, that has probably been the most useful methodology for us to get people to care about a project. Basically getting them involved in deciding why we should even be doing it in the first place.

JEREMY TILL [ARCHITECT/WRITER]

1. In your opinion, what are the changes most urgently needed today, with respect to global warming?

That's too big of a question. That's like kind of – I can't even begin to answer that question because it's just too massive because the whole thing is so interconnected. But I suppose the main thing is an absolute political will to make it happen and the trouble is politics are so compromised by the market at the moment. As we can see so clearly in the States. That the political will is always going to be overwhelmed by market imperatives. So until there is actually a market imperative for global warming, nothing's going to happen I'm afraid.

2. What do you view as the greatest barrier to fighting global warming?

Lies. Quite simply that we have a campaign led by vested interests to suggest that global warming is either fiction or else not as serious as it really is. The facts are completely uncontroversial, there's no doubt about that and so until those facts are absolutely explicitly accepted by every single party, we're not going to make progress. The fact that what Trump is going to do or has done already is just an indication of that all. The fact that in Canada the Tarsands are still being exploited to a most appalling extent because of commercial interests. And as long as commercial interests are tied up with the environment, we're going to be absolutely screwed.

3. What is your opinion on the effectiveness of using methods of general audience engagement as a measure against global warming? (e.g. facts & figures shown through the media, directed to a general audience vs. targeting specific groups)

Well, I think it's all well and good to have general engagement with the public, but it's ever going to reach a mass audience. And so you can get influential films or movies coming out. I think Gore is doing another one, I think he's doing a kind of follow up

to the first one. Those I think are very compelling. When you get a major figure like Al Gore to a major movie which hits a broad public, I think that works quite effectively. Whether one can do it through town hall meetings and whatever, you only get a reach of a very limited group of people. Public pressure, I'm afraid, as has been shown in Trump and in Brexit, public pressure isn't the major force in decisions are made at the moment. They're being made through vested interests. And it's scary.

4. What would you say is an action that individuals make that has the largest carbon footprint, yet is easiest to fix?

Well, you can do very immediate things at a domestic level. But that is only really putting sticking plaster on a gaping wound. And I'm not saying you shouldn't do that. I think that people should be responsible by basic environmental controls and basic fabric changes and you know, that's all fine. But it is also all tied up in a kind of sense of – we need a systemic change to the way that we value things and privilege things. As long as we are in a cycle of endless consumption, global warming is going to increase because consumption lead to extraction. And so it is actually a – yes I think that there are clearly major things going on in countries like Germany and interestingly now in China in sense of renewables. But strangely I think that is only a kind of a shift of technologies and it's not a shift in culture. In order to re-evaluate what systems of growth mean, and an economy and a culture which is based on the premise of endless growth is an economy and culture which is heading for oblivion.

5. What do you see as a missing factor in the design of media used by people/agencies that aim to communicate information to the general public in order to convince them to become more engaged with the issue?

Well without meaning to be too damn political, as long as the media is controlled by right wing corporations, we are never going to

get the full facts coming through. So as long as Murdoch is controlling Fox and News International – I mean I'm not even taking Breibart into this, I'm talking about the dominant of the certain sector of media is distorting what is getting through as a set of comparing arguments. And it's only when you really get – I mean I was amazed that Paris did get the effect it did and I think it's mainly because there was a sort of almost human dimension to the way that – which is beyond the media, so that Paris happened beyond, outside of the media information campaign. It happened on a face to face thing where you got real human consequences being exposed to politicians and that made a difference.

6. On scarcity, how can architects begin to reverse the design of scarcity when, in practice, the profession seems to be positioned to perpetuate it. What are the first steps an architect must take to begin to engage with the construction and conditions of scarcity in the context of global warming?

You'd have to read the chapter in our book about that. But to sort of summarize it, it's to do with – it's a sort of shift as to what design – what constitutes design. And if design is only constituted and given credibility through the production of objects, whether its buildings or new widgets or whatever and if one's identity as a designer is so closely attached to notions of newness and of refinement and so closely attached to objects, then we are going to be in an endless cycle. The perpetuation of the production of objects. Whereas if you say, well let's use design intelligence is other ways. Let's use design intelligence to redistribute what is there already. Let's use design intelligence to upcycle. Let's use design intelligence to – all the words I've used – optimization, adaptation – I forget all the words we use but we came up with about six or seven. They're quite basic terms, but in each of them what one's talking about is not the attachment to the object but a consideration of what comes before the object ie. the processes of production and what comes afterwards ie. the processes of occupation in the case of buildings or use in the case of objects.

So I think that those are designerly issues. But they don't have an identity in terms of an apparent visual kind of signature. And so design then shifts or architecture then shifts its value system at a way that people identify themselves and that's a real problem. So some of the stuff I can't stand is when you get people saying they're sustainable architects building buildings in Abu Dhabi, which is de facto a non-sustainable thing to do. So the fact that it just reduces, but only by a token amount, the energy footprint of a skyscraper in Abu Dhabi is not dealing with issues of global warming.

But aren't architects stuck in a kind of apparatus where they're kind of driven by the clients that they get?

Yes, absolutely, which is a very difficult dilemma. I'm a comfortable, well-paid academic who has the privilege and enormous obligation to be a critic and it's easy for me to say, "Well you shouldn't build in Abu Dhabi." But the reality is that people are going to build in Abu Dhabi and that those buildings in Abu Dhabi are not generated by any wider social, environmental, or ethical responsibility. They are generated by the short term demands of a development and the architects at that level are simply dressing up capital. And in doing that they might dress it up as really green. They might persuade somebody that, you know, a couple of solar panels on the top is helping but it's trivial. And therefore I think it's architects – I don't blame architects. They're not contributing to global warming, but they are part of the processes by which global warming is perpetuated. Now of course, architects should, if they are even within that system, they should do everything they can to reduce environmental footprint. They should do everything they can to make sure there's a kind of ethical responsibility in the way that buildings are procured. But there's only so much they can do. And I think it's a kind of displacement to say that architects are to blame. I don't think they're to blame at all.

I guess we're just trying to make the best of the current situation

that we have.

7. In your writings and lectures, you advocate for operating with the 'software' in addition to the 'hardware' of a project. How do you see architects begin to incorporate your concepts of redistribution and optimization within given design briefs and under pressure from client needs?

Well I suppose in my own idealistic – I don't know if it's idealistic because there are people who are doing it but I argue in Scarcity and elsewhere that actually the problem often starts with writing the brief. So architects often come into the process too late to actually have a fundamental say over what is produced. And increasingly they're coming in later and later into the whole project and so they are brought in by the stage at which the project is pretty much determined. And so all that the architects can do is to sort of spatialize capital. Or aestheticize it. So I think that there are ways though, by which there are examples of architects operating in parallel fields whether it's planning or urban design or even systems design where you're applying a spatial sensibility to the processes and in that dealing with the software. I think that's a very empowering thing to do and I kind of – I have to say in my position as an educator that the architects and architectural students are fantastically good at understanding all those kind of connections.

8. How do we, as architects in practice, advocate for the upscaling of more unorthodox approaches and the redefining of scarcity in order to engage societal and economic change? What can architects do to upscale existing bottom-up efforts – is it through design or does it require stepping out of our standard boundaries?

I think it requires stepping outside the standard boundaries if the boundaries are simply associated with the production of objects. But I don't think it means stepping outside the boundaries if boundaries are seen as wider forms of spatial brackets of social

production. I think it is perfectly possible, when I go back to the whole thing about the discussion around the brief and in engagement around the discussion of the brief right at the first stages of any project, and I think that using spatial intelligence at that and I think, if I'm being optimistic about it all, you also get not only environmental benefit out of that but potentially economic benefits. Most people who write briefs are complete idiots. They're just driven by --- for example, if you go into any airport around the world and it's just full of the same brands. Why is that intelligent? Well the reason for that is that the people who rent out airport spaces are stupid. And they're just minimizing risk and going for standard business models because that's the way they've been told to operate. If I take a place like I'm sitting at the moment in Central Saint Martins, we're part of this huge new development with a very, very canny developer who happens to be an architect who hasn't let a single train into the whole of King's Cross and it's the most overwhelmingly popular place in London. That's a trivial example but it shows that you can think through even those basic development strategies in more inventive manners.

9. What is the potential role of the architect in operating beyond the profession's traditional boundaries of a project (e.g. the software of a project)? If architects traditionally deal with object of building and construction, how does dealing with the 'software' of a project fit into the profession and how do we begin to expand our territory to include that process in our designs?

Good question because I think that's also kind of a professional question as to what constitutes architectural knowledge. Professions initially were set up as keepers of architectural knowledge and architectural knowledge was always seen to be both expressed and then validated through the building. Whereas my argument and Tatiana's and everyone I work with is to argue that architectural knowledge has a much broader set of social and spatial consequences. But the profession would find that really difficult to accept now because it's so bound to the idea of architecture

simple being to do with a building. The whole award system, for example, is completely obsessed by the validation of refined objects. Why is that? There's a few alternative award systems, but nearly every – a lot of those or the competition systems. You know the competition system is absolutely corrupt because all it does is to make aesthetic judgements on seedy eyes, which is crazy. So there needs to be I think a kind of redefinition of what constitutes architectural knowledge and that could only really happen through – it either happens through the professional bodies or by completely stepping away from them and given that professional bodies' have recently behaved so disgracefully in the political arena, maybe you'd just have to step away from them. In as much as that, what the AIA did over Trump was mind boggling. Absolutely mind boggling that the day after he was elected they came out and supported him immediately. It's disgraceful. So how can you look to the professions as arbiters and defenders of architectural knowledge.

I would always argue that it has to start with education because it's the next generation, not present generation. So I think the discussions have to start in education, but education is also in a difficult situation because of processes of pre-judication in validation in which the professions still have nominal control over the systems of the architectural education. And that's a real problem because you basically get people who are thirty years out of school coming to validate the people who are going to be at the top of their profession in thirty years' time. So you got a kind of sixty-year temporal gap. Often the people who are coming to look at schools are using their own experience to validate and accreditate schools so schools are somewhat caught because of professional accreditation system. If the schools were allowed an expansive view of what constitutes architectural education, then the next generation could go out with that expansive view and enact it more. And I'm not saying people aren't going to be designing buildings. People are going to keep on designing buildings but I think there is the opportunity for people to do other things beyond.

10. Mitigating climate change will require constant attention and perseverance towards changing our unsustainable behavioural tendencies. What can an architect do to facilitate this need? With what methods can they try to create or nurture people's motivation to continually pursue this goal?

Well I think that's sort of – that's a difficult one because in a way, that sort of suggests that architects can act as pure agents of change in relation to an issue which is not an architectural issue ie. it's a political and economic issue. So they can use an agency in terms of their professional expertise, they can use their own agency in terms of their individual agency as political beings and they can act as responsibly as possible on the delivery of environmentally responsible buildings. Whether they can act as a sort of change in people's behaviour systems, I'd be less convinced. Particularly when you think about it, I don't know what it's like in Canada and the US, but in the UK the --- when you think about in relation to buildings and building costs, over 50% of building costs in the UK, I'm sure it's the same in North American, are not associated with architectural design. They are associated with mechanical engineering design. All of those systems are designed by engineers, they're not designed by architects. If you look at the building I'm in, it's got the most appalling mechanical ventilation system, which is so wasteful. So, so wasteful. And it's got a ridiculous system of lighting, which is meant to be automatic but no one knows how it works so the light's on all night, etc., etc., etc. So this isn't an architectural problem. I could say as an architect head of this institution, "Do something about it," and I do it on a monthly basis. But nothing I actually do, it's out of my hands. So I think one has to be realistic about the agency of architects within a much more complex set of relationships.

11. If you had to teach urban planners or architects, what do you think is important for them to learn about operating in the context of global warming and finding agency in the design process?

I think there are basic technical things that everybody should know about, but they're often over elaborated. Designing environmentally is not difficult. It's a very kind of, almost common sensical set of principles and I think it's – I was going over my old notes from years ago when we were talking of very early environmental design in Cambridge by one of the pioneers and it was turned into this ridiculous set of complexities of scientific nonsense. Whereas I can sit down with a group of students now and I can give them the principles of sustainable design in about two hours. So there is that and there is a very basic kind of set of generic, environmental principles about just being sensible to reducing environmental footprints. But beyond that, I think it's to understand the wider set of networks which goes into the making of any built environment and to understand the flows and the ecological flows and the networks and the systems of production and the wider socio-political context of the production of buildings and know how to intervene into those processes well.

12. Should architects expand their roles beyond focusing on achieving sustainability/carbon neutrality in the design and construction of buildings, or would that be stepping into territory that would be better suited to other professions? With the abundance of specialized roles, how could the perspective of the architect contribute to other approaches to achieving the systematic changes required to a sustainable state of operation?

Yes, but also being an optimist, I would say that architects are generally smarter in understanding spatial networks and relationships. And therefore can make the connections in a more informed and agile manner.

13. How would you propose we, as a society, begin to evolve our current educational, governmental and commercial institutions to encourage a conscious consumerist system?

You can't answer that question. You can't answer in one thing educations, commercial, and governmental. I mean, clearly in the end, it's a political issue. Until the politics of climate change can change, nothing's going to change. And the politics unfortunately, are so compromised by commercial imperatives. At that level, as I've said before, the agency of individual architects or even collective architects is sort of pretty marginal, I'm afraid.

You don't think there could be a tipping point of enough bottom-up strategies that could address the problem?

I think it's interesting about what's happening in some of the North American situations where you get alliances of either cities or states coming together to enact their own environmental strategies, I think that's very interesting. That is happening at the same time as Trump is going to embark the Pennsylvania coal mines because one of his crack cabinet members owns them, so you're sort of caught always between a corrupted top-down and an enlightened bottom-up and the battlements in those various systems. Yes, I mean I'd like to think that a collection – and if you look at the transition terms in the UK which is a collection of bottom-up processes, and collective processes coming from small communities – absolutely fantastic. But as long as we've got the dominance of commercial imperatives at a higher level, global warming's never going to change. And it's only when there's absolutely clear evidence that it's - I mean there's completely clear evidence but it is economically suicidal in the medium to long term. It's when that medium term comes shorter, that's the only time it's going to change. And I think we're pretty close to that. We only need a few more really serious climate disturbances on the East and West coasts in North America to make it clear that that's, you know – we only need New York to be hit on an absolutely --- regular basis in terms of flooding or for the flood in California to get so bad that it's understood as an ecological imperative to change. And I don't know – we're in a very, very dangerous situation because we're past the tipping point but how far past it

we don't quite know. And the kind of – the commercial imperatives are still only operating in a sort of long term vision that it's all going to be solved by bio-technology.

14. Are there any approaches to outreach strategies that you think we should be focusing on, but are under-utilized?

I think that the whole thing of collection of bottom-up processes, particularly within the western political system at the moment. But since we're in a massive democratic deficit, and since we're in an age in which politics as a democratic system has more or less been taken over by politics as an ideological and neoliberal system, the only alternative is through the collective of local-scale initiatives.

ANTONY TURNER [REAL WORLD VISUALS]

1. Please give a brief overview of your professional background and what you are currently focused on.

I am a company director, I'm not a scientist and for the last 20 years my background has been in helping people understand climate change and sustainability generally, particularly in the business community, and in the last five or six years my interest has moved to cross into using data visualization again to help communicate the carbon climate challenge and other invisible environmental challenges and issues. Like air pollution and so on, water resources and so on.

2. In your opinion, what are the changes most urgently needed today, with respect to global warming?

I think that a genuine public understanding of the severity and necessity for speed of action is very critical. I think that the public's understanding is still very patchy and it lags behind the policy makers generally and the business community as well. But I think all sections of society need to be more, I've used the term for many years, carbon literate. I think, you know, we need to become carbon literate. Climate change itself is extremely complex and because of the time spans and the time lags and the complexity, I think it's particularly difficult to communicate. But I think that actually helping people to understand, you know, the carbon landscape of our industrial society, that is really important. And a key part of that of course, is the invisibility of these gasses that we're putting into the atmosphere everyday. So, I mean, that's the kind of enough of one thing. I there's a secondary issue, which is around the, and that's prevalent and has emerged more in the last sixth months with the, particularly with the US presidential election situation where we can see the power of small groups of operators who are able to seed doubts in a very big way and I think that the global NGO and climate change community thought that that was kind of under control but what we're seeing now in the American election sort of is actually that that is not the case. You

know, that still shapes and influences important decision makers like the current head of the EPA in America who, yesterday again saying that he doesn't think that it's real. And that's very worrying.

3. What do you view as the greatest barrier to fighting global warming?

I could say it's the invisibility of the gasses. If you could see when, when I was a child you saw trucks going up a hill and there would be a lot of black stuff coming out the back. You could see that it was nasty and dirty and smelly and so on. And trucks got a lot cleaner and so on. We've now got this challenge with diesel cars and air pollution where combustion engines are being cleaned up to an extent that they don't, you can't see anything coming out but trouble is you've still got a lots of invisible stuff like nitrous oxides or particles which are very damaging to people. So, I think just being able to see greenhouse gas emissions being carbon dioxide coming from power stations, coming from vehicles, coming from transport, coming from our homes, that's on of the, really the biggest barrier I think to engaging with the problem.

4. What is your opinion on the effectiveness of using methods of general audience engagement as a measure against global warming?

I think it is a ___ it's a complicated story with weird time frames. I've been trying to help people understand climate change for 20 years now and I would say I've got it right at all. I think that what the NGO committee has learned that the kind of shock tactic of showing polar bears on ice sheets and flooding etc. that itself is, you know, a. it's not enough and b. often it makes people just not engaged. But I think more nuanced ways of communicating, you know, some of them do work, and I don't think there's any magic silver bullet. I don't know if I can say much more than that.

5. What would you say is an action that individuals make that has the largest carbon footprint, yet is the easiest to fix?

Probably the easiest to fix at an individual level is the decision to purchase green electricity. The next easiest now, is probably to purchase and electric car, if that suits your driving habits. People can decide to either not take air flights or take shorter or fewer air flights. So that's another thing, but even deep green people like, sometimes, a bit of winter sunshine. So, but when I first started, I don't think there were many things individuals could do really. But I think the emergence of suppliers like eco electricity and good energy in the UK, you can immediately cut 2 or 3 tonnes off your household carbon footprint just by switching to one of those suppliers. And in the last year or two, making the shift to an electric car. Particularly if you put solar on your roof that you could charge it up with, that makes a difference. I think the reality is though, is that we have to realize that we're in a culture that a lot this, you know, the emissions are part of the bigger societal framework. And so, it isn't easy for people to, at a personal level – I'll put it in a different way. I think it's disingenuous to sort of say to people, oh, unplug your charger or something like this. I think it's better that we put our efforts into getting policy makers to decarbonize energy sources and support offshore wind and other methods and new battery storage technologies and things like that. But of course the other thing is energy efficiency. That's really difficult to get across to people. How do you help make houses more efficient? Again, I think the big problem is energy is an invisible, energy is not only invisible but also, it's also abstract. So it's both abstract and invisible, so I know that there is hope that having smart meters is going to help people understand the energy use in the buildings. And of course it does, and people take notice of those but there's lots of evidence that people get bored very quickly even with nice smart meters, so they lose their impact.

6. What do you see as a missing factor in the design of media used by people/agencies that aim to communicate information to the general public in order to convince them to become more engaged with mitigating global warming?

A missing factor. Well, I could again say the missing factor is the invisibility of these things. We've done, we've got a blog on our website that shows the emissions of a VW golf. So the average weekly emissions of a VW golf, diesel, petrol, electric, because they do an electric version, and then electric if you use Eco-tricity. And I mean, it's a massive difference, you know, it's very striking. And of course there's the additional benefits with the electric that you're not locally polluting the road outside your kid's school. So I do think that making stuff visible is a missing factor. But then I would say that.

7. Please give a general overview of what the Real World Visuals does.

A data visualization business that looks at invisible environmental stuff and impenetrable numbers and turns that into something that is engaging for people who are, wouldn't normally be engaged. Whether it's carbon emissions, air pollution, water volumes, or whatever. We can make this stuff, it's really making it real. You talk to most people about carbon emissions and actually, there's a sort of part of the brain that, in an abstract way, thinks that it is real maybe, but there's also part of the right brain that I think rejects that. So it's kind of making people go, ah yeah that's real. And hopefully then, they'll ask more questions and start to get engaged. For us, success with our visuals, whether it's imagery, image sets or animations or whatever, success is when the audience goes away with more questions of their own and with a desire to seek answers to those. And that's when they can go to a more detailed kind of informational source. Our aim is to get across the basic, simple, core message with this concrete visualization method.

8. What are the challenges that you're dealing with in catalyzing engagement in your audiences? What are some examples of the approaches you use? Are certain audiences targeted differently from others?

Our specialty is targeting unengaged audiences. We just done a blog about this actually. We call it a push audience. So most data visualizations, most graphs, if you look at a bar chart or any kind of abstract visualization like a bar chart or a pie chart or something, it is abstract. And its primarily designed for people who are already familiar with that data and they work very well. You know a good graphic will help someone who's familiar with that data, to see, to gain insights, to see outliers, to see trends, etc. And that's really useful, but it's not the best thing to use if you want to say, grab people and say, "Hey have a look at this. You know. This is something you should think about. This is something you should be engaged with." And that's the audience that we're looking at. It's also true to say that decision makers in the world are generally very time constrained people. And so, it makes sense if you're trying to get in front of decision makers, policy makers, people at a senior level in government or business, to have some very powerful, simple graphics that illustrate what you're trying to say. For instance, we were commissioned by the UN in Southeast Asia to make a film, which was to be shown at the beginning of a conference about resource efficiency and it was in a conference attended by environment ministers from China, and Australia, and Japan, and lots of other countries in Southeast Asia. But they were launching a report that was about 250 pages or something and they knew there was a good chance that quite a lot of those ministers wouldn't get past the first page or two. They'd be very lucky if they read the executive summary. So what they wanted to do was have something that they could show everybody which basically told the story in a very graphic, visual way. So we created a 3-minute film using the data from that report. So that audience was quite specialist, it was policy makers and environment ministers and so on, but it was an audience that needed to be grabbed and said, "Hey, have a look at this." You know, and that hopefully would make them open up that report and go, "Okay, yeah. I need to find out more about this. That's interesting." "Why's our resource efficiency much better than China or why is Japan doing this or why is Afghanistan being like this, etc." So that was the

idea.

9. How do you quantify the effectiveness of your visualization campaigns? Is there a way that you can measure whether or not your target audiences are responding as expected?

We've done very little of that kind of quantification. We've done some pilot work with Plymouth University. We are very keen to do more of that. We know anecdotally and from clients that what we do, when it's done right and when it works well, it's effective. Nevertheless, it would be great to collaborate with a university to do some proper research where they could use our images, maybe conventional images, picture type images and then sort of no images or something like that with different focus groups and monitor the different responses to different questions and so on. It would take a bit of designing that sort of process, but we would really like to collaborate something like that, and we haven't so far.

10. What are the advantages/disadvantages of the approaches you are taking towards visualizing data?

I suppose you can say that the disadvantage is that it costs more money to create nice imagery, than if you don't. The advantage is that you're more likely to get people's attention and reach a wider audience and get a better response from the target audience if you take the effort to communicate it in the right way. We think our visual methods can be really helpful in that.

Who funds your work?

It's varied completely. We've had work which has come from research funding, sort of start-up type research funding. Predominantly though, it's from organizations which can be businesses, business and trade associations, individual businesses who want to tell a good story. We've done quite a bit of work now for UNEP

and we're doing another film for UNEP in South America. We've done work for universities, Plymouth and Urie? And we've also done work for some NGOs and NGO collaborations. It's a wide variety really. So we've actually done work for Bill McKibben of 350.org. I've met him at a conference in the States and he really liked our approach and so when he did his Do the Math tour, we did graphics for him for each of the places that he was talking from, in Seattle and New York and different cities. But we've also done graphics for Shell, which we used to get across the amount of CO2 they were going to be putting underground with carbon capture and storage. And we quite like the fact that we can work for that broad a spectrum of customers. Our job is not to say necessarily, it's good or bad or whatever. It's to present their data in a way that makes sense, that's obviously for the ultimate good of the planet.

Is it easy to obtain the data? Are there missing holes sometimes?

Sometimes there are. It's generally, with companies who like our approach and they say, "We want to tell our stories," and then they say, "Don't worry, we've got the data." Then when we actually look at the data it's pretty poor and some of it's anecdotal. So, I think now though, we're very clear to prospective clients that we need to have data and we need to have an idea of the story they want to tell. We need to have both those things. Well, we don't need to know the story they want to tell, but we need some ideas on that. When we have projects where there's a lot of data but they're unclear to exactly where to tell the story, then we ask for a scoping budget. So we have a budget that pays for us to scope the work. But nowadays, there's lots of data out there and generally I think the quality of data is pretty good.

11. Mitigating climate change will require constant attention and perseverance, how does your company's approach to visualising global warming data deal with this issue? With what methods does it try to create or nurture the audience's motivation to continually be engaged?

As I've said before, we're at the start of the engagement process. I think we're a cog in that engagement process. One of the challenges is that we have ideas on how things can be done as part of a big process but that's not our job to do that. I think it's particularly a case, for instance, with universities. We've developed a university campus energy and carbon tool where we can take data from the estates department for all the buildings and show the real time and the daily carbon footprint of, visually, of all the buildings or groups of buildings on one or several campuses. And that's quite a cool tool and in fact, we're now reworking that to sort of do a third, a version 3, which would allow the universities to put in their own data. We're looking at rolling that out. So it has to sit within a bigger campaign. It was to sit within a longer term process which is not in our hands. It's in somebody else's hands. So that can be frustrating. We create something that we think has lots of potential to do lots of things and it's kind of used once or twice and then it's put on the back burner. Or it sits on a very out of the way webpage that nobody can reach. So that's annoying, but that's generally not in our, it's out of our control.

Is there anything you can do to fix that?

If we had, if we were for instance responsible for a complete campaign as a university or something like that, but we don't have the resources to do that. In my previous consultancy we could have done that, but really I think the trick is probably to be, is to look for more collaboration, possibilities. So if we can collaborate with a bigger sort of training stroke campaign provider, that had a one-year or two-year or three-year program, we could iteratively be involved. Get involved in the early stage to get things moving and to launch things and as different challenges emerged and different ideas came forward, we could be part of providing visual comms ideas as part of the ongoing campaign. That would be a way to do that. But we are a small organization. We're small. We don't' have a lot of resources and I think for the size of the organization we

have done quite a lot.

The larger organizations don't fund these sorts of projects yet.

They've got to see it as important and I think one of the challenges we have, actually is that we – I think sometimes, conventional/ traditional comms people don't quite get what we do. And that's, sometimes it's been a puzzle. I think that there is a tendency to see us as just another kind of graphics company and that they have to keep us in a box and that sort of thwarts any sort of creativity. And that really is what you need. It doesn't happen all the time, but it can be a problem.

12. If you had to teach urban planners or architects, what do you think is important for them to learn about operating in the context of global warming and finding agency in the design process?

We do work with architects, in fact we work particularly with one architect. We're just now doing some imagery for him and they have quite an innovative housing system that they're promoting using straw bale and straw bale piles and natural fiber panels. So the actual material, the building, is a carbon store or sink. So we think there's a lot we can do with the architectural world because they already are collating the energy performance of potential buildings in design. And also, more and more, they are pulling in data around the embedded carbon footprint of the building materials that are being used. So, BIM, it's called. BIM systems, in theory, could, we could really help visualize buildings, proposed buildings and changes to buildings in a very automated, cool way that would really help architects get across this information to planners and developers and others. So I have been pursuing that with some of the big building companies, but we haven't so far done anything specific. We have been successful in showing this, the benefits of using timber in buildings. We did a series of films for the Timber Trade Association campaign called Wood for Good. Those were very successful. We're doing some now with

Why Design for their new building products as well, so there's plenty of scope in that world. It's just a big world.

13. In what ways can architects collaborate with individuals from your fields of expertise in order to better address global warming and sustainability?

It gets back to this core principle of visualizing carbon numbers. If you have carbon numbers occurring anywhere, so if you're an architect and you're putting forward a design for new buildings, it's pretty likely that you're going to be giving information about that, around the energy use and the the inbuilt carbon property of that building. So why not show it visually if that's easy to do and if that's going to make people aware of that, particularly if it's a low carbon building. Because what you can then do, you can show a big pile of bubbles and say, "That's the amount of emissions that you would have if you didn't have this cool stuff that we've designed into the building." And then you have a second image, which is the building with the little tiny pile of bubbles and say, "But, that is what you're getting." I think there's a lot of power in that imagery that we can do. What we're working on, really is to automate the creation of that kind of imagery as much as possible. So we can take 3d models directly from architects and very inexpensively create really cool visual stuff for them.

You're taking mass and turning it into volume itself, but there's a lot of tricks in doing it and doing it well and making it work properly. We've learned those over the last 6 years. So, we are going to be shortly launching some tools and as a sort of toolkit. We've got quite a cool real-time visualizer that you can put in any amount as an annual amount. So 2 tonnes, 5 tonnes, 5 million tonnes. And it shows, it just turns that into an automatic sort of fountain of bubbles with the spec on how many bubbles are being emitted and what size they are as a real fountain of bubbles. And so it's a little mini attention grabber, really. So that's the amount of CO_2, that is that annual footprint as a real-time stream. We rather like

real-time streams. We think they're – people like them. They grab people. And that kind of thing is very shareable, you see, so if you make something that is a cool gif film that somebody can just share with their mates and send them out and say, "Hey, this is quite cool." And so on. So more and more, we're trying to do stuff which is very shareable, short, simple and elegant that leads to interactive tools that you can play with and explore data with more depth.

Have you considered using augmented reality?

We have and we have done, we've turned it on our head. The thing about augmented reality is that you can go into an unreal landscape, but what we think you can do, and we've trialed this already, is that you can actually put the data into a landscape through your phone or iPad or whatever. So, for instance, you could hold your phone up to your building and if there was some kind of signal that you can get that would tell you what the emissions were of that building right now, you could actually get a stream of bubbles, or a pile of bubbles, literally, that would be super imposed on the image to show you the actual values of the carbon footprint right now of that building. Or whether it's a building or a car or whatever, a power station or something. So that's kind of doable now really, we know how to do that. We have trialed that kind of thing. We prefer to put augmented data in reality rather than the other way around.

14. How has global warming affected your profession? In your opinion, what needs to change within your profession in order to achieve the necessary changes for mitigating global warming?

The effects of global warming are very subtle and seeing the difference between global warming, climate change or normal weather differences is very difficult. And that's why – I mean we have storms. I live by the sea in Devon, so I was down on the beach at lunchtime. Two miles up the railway track, because the

railway goes past our beach two miles up there, two years ago, three years ago, the line was broken by the storms. And for three or four months, we couldn't use the railway. Now that, to me, is a sign of the changing climate. More extreme weather events. Stronger storms, higher rains, etc. But I think it's not people like me living up a hill in a nice country who are going to so affected. It's people in already over stretched parts of the world who are living off the land who are the ones now being affected. We can see that now with these crises in Africa and the Middle East. Comfortable people like me aren't really being affected so far. In 50 years or something, we're now starting – scientists are now starting to find ways to measure the amount of ice that's coming off the Greenland icecaps underneath, not the surface ice, but the underneath ice. Because it seems like there's a lot more than they had thought. And so up until now the predictions have been about a metre maybe, a metre sea level rise by the end of the century. But I wouldn't be surprised if in two or three year's time, we find new data coming out that says we'll have that by 2050 or something if we carry on like we are. So I think it's, of course for some people in the world, it's already hitting them really hard. In the comfortable Western world, it's our children and grandchildren who are going to find the - going to be the ones who are living in that kind of really disrupted world.

15. How would you propose we, as a society, begin to evolve our current educational, governmental and commercial institutions to encourage a conscious consumerist system?

It's a huge question. I mean, we have really, really deep-seated institutionalized cultural norms which get in the way. My suspicion is that the current industrial consumer based society is going to have to quite radically change if we are going to seriously cope with these – you know, mitigate and decarbonize our societies. And I don't really see sign of any political buy-in to that kind of radical change. Our governments only have four- or five-year tenure. So structurally, we're not really set up to think about longer

term issues like this. So, it's a big question. I don't know what the answer is. I think carbon literacy should be taught at schools, it should be taught at universities, it should be something that is – it should be part of something that we understand. I suppose in a way, it's starting to happen. There's a lot more engagement now than there was ten years ago, twenty years ago when I first got involved in this twenty years ago. But still, the pace of cultural change is much slower than we need, I think.

Do you see it accelerating with all the initiatives that are happening today?

Well I was determined for London, until last year when we had this Brexit vote in the UK and we had this kind of craziness going on in America. And I think both those things are going to set us back on this path, you know. Essentially, to solve global issues we need global collaboration and if we, politically, are shifting towards more of an isolationist culture, then we're not going to solve the global issues. So the events of the last year, with Brexit and the US election, I think have put a – I'm hoping that that's a temporary blip in greater global collaboration. I think one thing that is definitely a positive is the massive technological advances and the – I'm just looking at a report from --- Energy that shows that really, offshore wind now – I mean land wind has been on par with or lower with conventional fossil fuel power stations. But offshore wind is approaching well and offshore wind has really massive potential. Continual potential in Europe, other parts of the world, Japan and American as well. I would say that falling cost of PV, the falling cost of batteries for electric cars, the increasing range of electric cars with more powerful batteries and the realization of the financial sector of the risk of the fossil fuel world. So these are all positive things. Thank God.

On planting seeds.

Seeds have to be planted if they can. When I started CarbonSense,

which was my consultancy about ten years ago, after a year or two we started to get very busy and I needed people to work for us. And I'd been approached by a young man who was studying at Schumacher College at Dartington at Devon and he was interested – he wanted my opinion on a scheme he had to try and get Dartington to change from burning oil for the burners into burning woodchips. And I went to talk to him and gave him some advice and so on. Actually, when I started to get busy I thought, "He's a good guy." I wondered if he would like to come and help with working for me. To cut a long story short, he came and worked for me. He put on hold his Masters and he was brilliant. He had never worked in an office or done that kind of thing at all before. He's had a very varied background and whatever I set him up to do, he excelled at. Even if it had a lot of responsibility. So after three years or so, he was actually approached by somebody from the Carbon Disclosure Project and he went to work for them. As quite a junior person to start with, he quickly went through the ranks and then a few years later, he was made chief executive of their New York office. When Obama was watching advice on climate change, he called in half a dozen NGOs and one of them was the Carbon Disclosure Project. So Tom had quite a few meetings with Obama and his advisors in helping him see the importance of climate change. And then I had a call from Tom three years ago and he said, "I've been approached by Christiana Figueres of the UNFCCC. She wants a special advisor for liaising particularly with the business community," and so on. "Do you think I could do it?" And I said of course you could do it. So he went to work for her. So really, he was the power behind – he was a key person behind Christiana Figueres in the run up to the Paris talks which got the global agreement. So that started with one seed and one young guy who didn't know much about these things. I helped him to understand that, see how you could communicate, use his natural skills and personal charm to effect and so on. I'm very proud of the fact that he's actually her right hand man. So these things – it's surprising how little things that you can do. You talk to somebody, you just get somebody to understand something

and you never know what they're going to do with it or how that's going to work. So, we have to keep getting the message out. But not in a shout-y way, I mean that's the trouble. I have friends who are activists and campaigners and I think there are times when activism and campaigning is really important. But also, we have to learn communication methods which are more inclusive and accepting of other people's views and non-confrontational. So our speciality, I suppose, is non-confrontational, honest imagery that helps people kind of get that first message to go, "Ok, yeah this is real." That's what we do.

IAN MONROE [OROECO]

1. Please give a brief overview of your professional background and what you are currently focused on.

All of my professional background has been focused on scaling up solutions to climate change. Initially in international development in renewable energy spaces, I studied earth systems science, climate change, renewable energy technology and international development economics at Stanford for undergrad and grad school and then since then I've worked in over two dozen countries throughout Asia, Africa and Latin America on scaling energy and climate solutions and eventually got invited back to Stanford and started teaching courses on scaling up climate solutions, which something I'm still doing and in the course of that, also realized that one of the big missing pieces is engaging all of us as individuals to take part in the collective action solution. To what is the massive collective action problem with climate change. That's what brought me into launching Oroeco and also seeing the missing pieces in terms of information and incentives in the right places in the financial world and now also spun off into helping run a couple finance companies that are focused on investing in climate solutions and showing that that could just be a more profitable way to invest. It's been a fun journey. I've been doing a lot of things I didn't expect I would do.

2. In your opinion, what are the changes most urgently needed today, with respect to global warming? On an individual level?

Well, the --- realization is we essentially need to change everything and that every decision we make as individuals, institutions and governments, have climate consequences, some obviously more extreme than others. But really, climate change is this massive, collective action problem that's connected to our energy system and our agriculture and land use practices and really it's all about getting information and incentives in the right places to move to a zero carbon economy and even get beyond net zero emissions to actual negative emissions where we're drawing down the

excessive greenhouse gases that have already built up in the atmosphere. And to get that to happen, really it's just a matter of having information and incentives in the right places. Information in terms of what actually makes a difference. What are the big choices versus the small and incentives basically getting at who's paying for it? What economic drivers can actually push us in towards virtuous cycles of improvement rather than continued cycles of pollution and disruptions. And putting a price on carbon at the government level is a big piece of the picture and making sure it's applied to every industry. Another big piece of the picture is engaging all of us as citizens to realize that climate is an urgent threat to everyone everywhere in the globe and that governments can only do so much. A lot of it needs to be coming from citizen engagement and can also come from investor engagement moving the massive pools of tens of trillions of dollars out of climate problems into climate solutions. I also spend a lot of time working on that.

3. What do you view as the greatest barrier to fighting global warming?

I think one of the greatest barriers is just there are entrenched financial interests that don't want to see things changed because they're making money from the current system that we have. And one of the obvious ones is the fossil fuel lobby makes money from selling fossil fuels: oil, gas and coal. And they want to continue selling fossil fuels as long as possible and make as much money as possible doing that. And solving climate change means that we have to stop using fossil fuels entirely. So there's just a fundamental disconnect there in terms of economic incentives. One that is maybe less obvious and less talked about is that there's also big agriculture lobbies that are connected to the unsustainable land use practices and agriculture systems that are also contributing to climate change in a big way. The biggest one really being industrial meat, particularly beef, because methane emissions from cows for beef and dairy is such a big part of the climate puzzle as well. And so that's one of the fundamental barriers is just the econom-

ic incentives around a few people who are making a lot of money basically off of the current energy and agriculture systems that we have and then all the rest of us, and really even folks working at fossil fuel companies, have an incentive to not have an unliveable world which is the trajectory we're currently on given our climate pollution trajectory. So beyond that, I'd say another barrier, getting to the much more personal level, is just I think an inherent hesitation for all of us to see ourselves as part of the problem. It's a lot easier to point fingers at fossil fuel companies and dirty ag companies and ineffective governments that are often swayed by corrupt money moving from those industries, dirty industries that keep things how they are. But a whole lot of climate change is this collective action problem connected up to everything that we as consumers decide to eat, decide to do for our transportation choices, decide to do for home energy choices, clothing, etc. And, you know, nobody wants to be told that they're part of a problem and it's also – even if you realize that your choices are part of the problem, it's hard to start to think that your choices will actually make a difference if you do it unilaterally. You feel like you're just a drop in the bucket, so one of the challenges is how can we not only inspire us all to get engaged to take action at an individual level, but also show that all those actions collectively can add up to make a difference. That those drops in a bucket really can add up to a sea of potential.

4. What do you see as a missing factor in the design of media used by people/agencies that aim to communicate information to the general public in order to convince them to become more engaged with mitigating global warming?

So I think one of biggest missing factors initially is just communicating climate at a personal level. There's still, I think in Canada you guys are a bit smarter about this. In the US there's still a lot of silly discussion about whether or not there's even scientific incentive on whether climate change is real and human caused and an urgent threat to address. So engaging – just getting out there

how much really there's absolutely zero debate in the scientific community about whether climate change is real and caused by humans and is a huge urgent threat. But going beyond to that to then making climate personal, here's what climate change means not just in terms of degrees of temperature rise globally 50 years from now or 100 years from now but making it into terms that are meaningful for each person. So here's what climate change means in your backyard for people and places you love. Here in California, here's what climate change means for drought and wildfire and floods and sea level rise. And when you start talking about climate on those personal terms and connect it to the changes that people are seeing everyday, that makes climate I think much more real and much more urgent. So you make it something that's here now, about people and places that you love and things that you just personally care about and that's one of the biggest missing pieces. To just engage people to care about climate change to begin with and have it bubble to the top of the long list of all sorts of other priorities that everybody has. And then beyond that, that's just the how do you get people concerned. And then the next question is how do you get people actually feeling empowered and engaged to take action at a personal level and at a political level and also how their dollars can influence on the spending and investment side. And there I think you just need to be telling the stories of the solutions and telling stories of solutions that feel like they're not too hard to do. That are not something that necessitates that everybody become an activist because the vast majority of people don't want to be activists. They want to be doing what is considered normal and what is something that is convenient and easy and ideally saves money or is different and better in some other way. So communicating as much as possible, all those different solutions that are out there, and there are a lot that just are better choices overall for climate and for other factors that people care about.

And I think also it's really important to feel like you're part of a community that's acting with you. That you're not that crazy

person out there alone on a soapbox with a megaphone. There's a percentage of the population that wants to be that person, that leader that vocalizes it, but the vast majority of people really want to do what they feel is normal and what's supported by what their friends and family are doing and I think that's one of the things we really need to engage much more effectively with climate action is getting to that personal level of how taking action on climate fits in with who you consider you are and what you think is most important and how it relates to your happiness and one of the most common themes to what leads to personal happiness is how you feel you are respected by whoever you consider your peer group to be. Whether it's a bunch of African villagers or a bunch of billionaires. So coming up with climate solutions that give you that social sense of belonging I think is a really important part of the puzzle.

5. Why did you pursue the specific approach that your mobile app is based on? Were there other approaches that you decided not to pursue?

So, I'll start by saying Oroeco is still very much a work in progress and we probably actually only gotten maybe 5% of what we want to do with it which mainly is just constraints on time and funding to actually build out what we have built out versus what we'd like to build out. So the approach that we're taking with Oroeco first is starting with the – we're essentially starting with the assumption that our users already care about climate change. There are pieces that we'd like to add in that get into that engaging people to care about climate change to begin with and making it more personal. That we haven't done yet. So our basic Oroeco user is already somebody we assume cares about climate change. So what we've seen is actually the average person who says they care about climate change often that is somebody who's a bit higher income than average and also somebody who considers themselves more of a global citizen to travel around a fair amount, particularly flying. As you probably know from doing any sort of carbon footprint calculator, Oroeco or otherwise, flying easily becomes the

largest chunk of your carbon footprint. It certainly is true for me. So, we're in this ironic state where a whole lot of the people who say they care about climate change actually are substantially worse than average in terms of climate impact. And so, bridging that gap between what we say we believe and what we actually do is what Oroeco is trying to get at specifically related to climate change and the first step with that is just measuring where you're at. There's that kind of cliché to say but very true statement that you can't manage what you don't measure. So you can't really reduce your carbon footprint very effectively is you're not tracking it and so that's the first piece of Oroeco. It's just tracking your carbon footprint. We're working on doing that in a more automated way. We actually used to be a bit more automated based on your spending habits more so recorded. Then the second part is not just where you are in terms of a number but how that number compares. So making your carbon footprint meaningful and also getting into this behavioural psychology of we all like to think that we're better than average, and when we see we're not, that hopefully inspires us to change a bit and improve. And so, that's another piece of Oroeco, it's not just tracking the carbon footprint of your diet and your transportation, your home energy, etc., but showing you how you compare to your Facebook friends if you want to connect to Facebook and how you compare to averages in your area. And then the next piece is not just showing you where you're at but showing you what you could do to get better. So we have about fifty actionable items based on your data for how you can improve your footprint and many of those things save you money at the same time. And then the initial pieces that we're continually trying to improve is to make that all fun and rewarding for taking those actions. And so we're working with both intrinsic and extrinsic rewards. So on the intrinsic side, which actually generally seems to be more motivating for people. You can see how you are doing versus your friends and improving by taking action and you can see just your progress over time and feel good about aligning your climate actions with your climate values. And then on the extrinsic side, we're visualizing that money savings that you can

do by taking a lot of actions that are related to energy efficiency in particular as well as actually diet related actions. And then we've been working with the PIPs reward platform to build in this virtual currency for doing good and there's a whole lot more that we've like to do as I've mentioned. And I think I probably want to get into this for what are the challenges around engagement, but certainly the more we can make actions really actionable on a daily level and rewarding for taking action on a daily level and the more we can make them integrated with social media and basically supported by the larger community to kind of enhance that intrinsic aspect of feeling rewarded for taking action, I think the more Oroeco will grow and be effective as a platform that is actually making a dent in the climate problem. But I will say one, getting back to the barriers piece and what is important to solve climate change, a piece that I forgot to mention that I think really is important is we as individuals can never do enough to just through shifting our lifestyle choices get to the point of per capita climate pollution that is actually the level we need to get to to solve climate change. Really the level we need to get to is actually negative even now, right, since we already have greenhouse gas emissions in the atmosphere that are higher than any time in recorded human history and probably levels that we want to draw down and the only way to get there is to have a willingness to essentially pay for removing the climate pollution that we're putting up and that has been put up in the past and so I think one of the biggest, important pieces for solving climate change is to shift the culture around climate and come up with the best effective managing campaigns to basically have us think about our climate pollution the same way that we think about our trash. That we just have an obligation to pay to get rid of it. And ideally you recycle as much of it into useful things as possible, but the same way we wouldn't – that we would feel bad about throwing a piece of trash on the ground, certainly in a public space where somebody saw us do it, we need to figure out how to get that same mentality around the climate pollution that we're putting out that's invisible all the time and not only invisible because it's a gas, but also because it's

happening in factories or farms halfway around the world that are connected up to our consumption choices. So I think that's one of our biggest challenges, that's effectively being willing to put a price on our individual pollution that's connected up to our personal consumption choices. And you can kind of get at that with a carbon tax at the point of pollution but you could get to that carbon negative world where we're actually driving down pollution that's already in the atmosphere. We really need to, even as individuals, be willing to pay a price to remove that. And there are plenty of different technologies that can draw down carbon, we just need to be willing to pay a price to actually do that. And that price has to be high enough that incentivizes those technologies to do what they can do. Just another rambling in another direction, but I think it is really an important piece and that's also why we have is, another piece of Oroeco, is carbon offsets that's part of it where users can go fully carbon neutral or carbon negative by supporting clean-cook stove projects that reduce emissions in East Africa.

6. What would you say is an action that individuals make that has the largest carbon footprint, yet is easiest to fix?

So, definitely as mentioned for a whole lot of people, and this really scales with income, but I think is also a bit generational and just changing environments. For a lot of people, flying is by far the biggest part of their carbon footprint if you're taking one long cross-country flight that almost automatically makes you worse than average and if you're doing multiple, somebody like me who's working internationally, that becomes pretty substantial. So, being willing to reduce your flying by doing more teleconferences, telecommuting, that's certainly one way to really substantially improve your impact. A lot of people aren't willing or able to do that because they're flying around the world to see family or have to do it for work and that's where, in particular, carbon offsets are really important. And certainly there are carbon offset projects out there that are not great. That are scams of

one sort or another so it's kind of – it is really important to make sure you're supporting offset projects that you're convinced are really making a difference as opposed to just giving extra money to something that would happen anyway. Ideally you'd support projects that have additional co-benefits beyond just the carbon side of things and that's why we, in particular, like clean-cook stoves because they also reduce environment pollution and give women and girls more time to study and work rather that be out in dangerous situations collecting firewood. But going beyond flying, I think there's obviously driving, taking public transit instead or carpooling, that piece of the transportation picture, particularly for folks who aren't flying as much, is pretty substantial. I think a lot of people don't realize diet is as substantial as it is and really what's talked about as sustainable food isn't actually what matters more in terms of sustainability. For climate change at least, eating local and organic has very little impact but eating less red meat, so specifically less lamb and less beef, has a huge impact. So really, just cutting beef out of your diet entirely is something that could be a huge win for reducing your climate footprint. Even just eating it one day less a week, shifting to chicken instead. If you want to go fully vegan, that's the most climate efficient. I've had a lot of people who aren't willing to do that, but it's a lot easier to just eat less red meat or cut it out of your diet. And cheese unfortunately as well, also has a relatively high carbon footprint and, again that's because of the methane emissions associated with cows. Another kind of myth busting around climate impact in diet is that, unfortunately, and something that is upsetting to me because I grew up on a little organic farm with sheep and cows. Grass fed beef and lamb actually is even worse in terms of climate impacts in a lot of systems than the kind of awful feedlots that we see in the news and that's just because for cows and sheep methane isn't a pollutant, it's what they naturally produce as they're digesting lignocellulosic material, mainly grass, and they unfortunately produce more methane when they're out around grazing, eating grass versus than in the feedlot eating grain. So they're happier and healthier, but they're producing more methane each day and

then they're also getting more exercise so they take longer to get to the slaughter weight. The slaughter weight that they're killed at tends to be lower as well. So it's basically more methane each day times more days alive times more animals needed to produce the same amount of meat and all that means that a grass fed burger that you're paying a lot of money for is actually probably about double the carbon footprint as the grain-fed burger that you get at McDonald's. There's myth around – it's certainly better for animal welfare, but unfortunately there's a disconnect between animal welfare and climate impact when it comes to beef and dairy. Basically there's no such thing as climate sustainable beef or lamb. But there are some cool veggie based alternatives like Beyond Meat and Impossible Burger. They're making burgers that taste entirely meaty but they're made out of plants which are pretty cool, coming on the market. Long story short, diet is also important and often underappreciated and then home energy, home energy efficiency and a lot of those home energy efficiency stuff just pays for itself and actually saves you money. From changing in light bulbs to putting in insulation. What are the most underappreciated things you can do on a regular basis to improve your impact? It's just washing with cold water instead of warm or hot water because it takes so much energy to heat water. That's a really easy way to do it. A lot of people are just used to washing with warm or hot water but actually detergents are now made to work just as well with cold and you're wasting a huge amount of energy using warm water. And then if you can, hanging up your clothes to dry rather than using a dryer also saves a lot of energy. So those are things that folks don't really think about that actually on average, there's an interesting base for looking at perception of energy savings versus reality of energy savings and the average American and probably Canadian would probably be in the same boat. They perceive that the amount of energy they save from washing with cold water is something like 1,000th of what it actually is. So it makes a much bigger difference than what most people think. Beyond that, it's great to use reusable mugs and bags and things like that that relative to your climate impact that's really flying,

how much you're eating red meat in your diet, how much you're driving and how efficient your home is.

How would you propose to convince someone to eat less meat if it's really engrained within their culture?

That is one of the hardest things to change for people because diet is so personal and so much integrated with what you're just used to doing. And what you think of as your family and where you belong. I'd say a lot of it, you can shift. Like chicken, for examples is a much more climate efficient meat than beef and pork is somewhere kind of in-between. And I think it's also important to realize that what any of us decides to eat makes a difference. So it's not like you have to go to the full extreme and become vegan, but if you decide to eat a few vegan meals a week when otherwise you wouldn't, that will make a difference. If you just decide to eat a chicken burger instead of a hamburger, that makes a pretty substantial difference. So I think that's the thing, just easing into it. For some people they like just making that commitment and doing it an extreme, but I think for most people it's about just having incentives to make daily choices that are at least somewhat better. And that's something we're working on, on integrating into Oroeco, is more, particularly the diet because diet is such a daily choice thing where assuming you're eating somewhere around at least three meals a day, each of those meals can be more or less carbon intensive and feeling like you're getting rewarded choosing the more sustainable meal each time is something we want to do.

7. If you had to teach urban planners or architects, what do you think is important for them to learn about operating in the context of global warming and finding agency in the design process?

I'll give you a personal story because I actually worked for one of the US's largest architecture and engineering firm that also operates in Canada. I worked in a group based in San Francisco

that is focused on renewable energy and waste sustainability. It had a group of architects as well but the architects and engineers were rather separate. So that I'd say is the main take-home, make sure that architects and engineers are working together from the get go. And ideally that architects have some idea of what engineering design makes a difference. So things like, LEED building certification, the more architects that are trained up on that, and thinking about that in their design, the better. When that doesn't work, I'll give you one little caveat. There was one project that they won that was a massive high profile complex in the middle east and the architects won the project by submitting a very spiffy looking design without consulting engineers really at all. And they won the project and then handed it over to the engineers and basically the project was a giant glass box in the desert. And they told the engineers, "Here, make this LEED Platinum Certified. So the highest level of sustainability LEED certification with something that's a giant glass box in the desert with massive air conditioning loads. And there's basically just no way to do it. That's an example of what can happen when there's a disconnect between design and engineering. I think given that the built environment is such a huge piece of our energy load, it's really essential that architects have at least some basic energy and water efficiency engineering background or they're working very closely and ideally both with engineers from the get go. And I think LEED certification becoming more and more popular is something that is helping with that. But we need a lot few giant glass boxes in the desert.

I agree with that but sometimes I do feel it's partially the clients that supersede our decisions as architects, even though we know we should be doing something, we're still under the control of the client.

Yes, and I'm not quite sure how to get the client's education better that way. Maybe by really marketing, because in this case the architects had marketed to the clients that this building we're designing is going to be LEED Platinum certified by the way so the clients didn't really care about it being as highly sustainable as

possible, they just didn't know that the architects basically hadn't actually talked to the engineers about how it would happen at the time that they sold them the project. So I think increasingly, clients do want this if you can make an economical argument that I think on average LEED buildings are getting higher occupancy rates and employee satisfaction and commanding higher leases for that reason. Client education definitely needs to be a piece of that puzzle as well because ultimately that's where the money is coming from and the architects need to win the project to do it in the first place. I'd add that into the equation for sure.

8. What are some good companies to offset your carbon emissions?

We work with a non-profit called Impact Carbon that does these clean-cook stove offsets. They more work with companies rather than individuals. So you can do it directly through Oroeco as an individual if you want to offset with Impact Carbon's offsets who are doing clean-cook stove projects mostly in Tanzania and Uganda. There's also My Climate that's more operating in Europe. But a lot of the offset companies have had a hard time just convincing people they should actually pay something extra for reducing their pollution. Terrapath is one that's been around for awhile now.

Do they offset it by the tonne?

Yes, you basically just say how many tonnes that you want to offset. What I'd really like to see are companies that are not just reducing emissions. Basically having offsets that pay for emissions reductions but offsets that pay for emissions removal. And I've yet to see any company that's really doing that yet. I guess you could argue that reforestation – effectively a tree does that or any plant does that when it grows. As long as then that reforestation stays there and the trees don't get chopped down or they don't burn down in a fire.

I guess that's the trouble with these methods, you don't know who's

taking care of it and whether it is properly taken care of.

All of these need to have some degree of third party verification. The ones that we incorporated into Oroeco through Impact Carbon are gold standard certified, which is a third party entity that's verifying that not only the offsets are actually valid but that they also provide additional social and environmental benefits. You could envision offset projects that actually make a community worse off, like take a bunch of land away from subsistence farmers and plant a bunch of --- on there or something. Terrapath is still up and operational and is a direct offset provider. I'm of course biased towards what we're doing with Oroeco. That's a whole long conversation if you want to get into what to look for and whether or not an offset provider is actually a good choice and really doing something that is additional versus something that would happen anyway. And you're just giving it some extra money.

That's the hurdle that I find I go through personally. I want to make sure that something is very effective, but then looking into it, everything is very convoluted and the information isn't always there. So it ends up being too much work and I can't see how everyone would be doing this.

I'd say one thing that would definitely be suspicious within the offsets is seeming to cheap. So anything cheaper than $10/tonne or so. That probably means that it's not something that actually is additional. It's just money that's flowing in on top of a project that would already happen or already has happened awhile ago. It's just digging a little bit deeper to see what folks are really doing and then who are the third party verifiers that are verifying that a project is actually legitimate.

9. From your time working with the architecture firm, --

I was working with the engineering firm, so we would collaborate with the architects but it wasn't as nearly a close collaboration as it should've been.

Do you think that the architects or engineers should also collaborate more closely with the end users?

Certainly, I think that is another really important piece, is just the behavior side and what buildings actually do versus what they're projected to do. And that has been something that's been missing I think, from LEED certification projects. For example, following through with verifying that the benefits really are there. I think certainly yes, ideally there's that continuous engagement in collaboration. I think the main question is who actually pays for that? And who's willing to see that through? Other than academics being involved in tracking that stuff, I've seen several studies come out saying that actually a lot of energy efficiency design in buildings underperform because users use buildings differently than architects and engineers expect. User-centric design folks, behavioral psychologists, ideally I think are involved in the process as well.

CHRIS NEWMAN [SYLVANAQUA FARMS]

1. Please give a brief overview of your professional background and what you are currently focused on.

My original, well I guess I'm still kind of current, professional background is as a software engineer; as a web developer and a backend database developer that kind of thing. And I was a consultant, and basically the consulting life was extremely stressful in Washington D.C., or I was in Washington D.C. Notoriously stressful environment, and it took a toll on my health. So my wife and I decided to move up what we thought would be a retirement project with farming and just move it up to right now. So that's how we got into farming.

In terms of the farm we've been doing it for almost four years now. This is our fourth full season I believe. It's kind of hard to believe that much time has passed already. I guess our background with that...we're new to farming, we didn't go to school for farming, we weren't formally trained in farming. We just picked up our education from a combination of Youtube, visiting other farmers, and just making lots and lots of mistakes. Some more costly than others. So we really just jumped in with both feet. We didn't do internships or try to apprentice somewhere, or go WOOFING, or anything like that. In hindsight maybe we should have, but we're fine now so it all worked out. That's kind of our background.

So in terms of what the farm is doing. We started out in the pasture based farming model that you may have heard about with Poly-phased farm with a lot of what Michael Palm has written about. Over time we've morphed the farm from this thing that restored my health and get me away from a professional environment that wasn't so great towards a...it kind of turned into a help save the world sort of thing. So that's where we started moving more into permaculture and ecologically oriented agriculture and doing some of the things we are doing like with green mason. I don't know if you heard about us through Medium or some other way, but there's kind of a peer to peer food app that we're working on

to help democratize both the supply and the demand of local food. So I can't get away from software engineering even when I want to. We're also doing work with the Axe-Keith Foundation, that's a personal project of mine, working with the Axe-Keith Foundation in Maryland to building the world's largest food forest on public land that's going to be 200 acres of food forest, scheduled to be developed over the next 13-15 years. So that's I guess the lay of the land for right now.

2. In your opinion, what are the changes most urgently needed today, with respect to global warming? On an individual level?

So I guess related to agriculture, there are a lot of things. I think the biggest thing that agriculture can do, and the things I'm working on is reducing reliance on meat, reducing the disconnect between food production systems and nature. What I mean by that is when somebody decides they want to plant a grain field, or a corn field, or a wheat field, or anything like that. Let's say in Virginia for example. Where you're at (Toronto, Canada) you guys are in a woodland area right? Pretty tall trees like Oak, Hickory, Pine, stuff like that? You guys aren't Tundra or anything, you guys have forests right? So the idea is that right now when people want to create a farm they take all those trees, they'll take the forest, and they'll bulldoze all of it. Then they'll plant a gain field that's this horribly unnatural thing that has to be put on life support with a combination of synthetic fertilizer and sprays. Just all these things that require these inputs that in the way they are produced are huge drivers of climate change. They produce huge amounts or carbon, they cause soil to wash out, they cause chemicals to leach into the watersheds and sometimes poison the ground water. And when you get rid of all those trees you have to irrigate, in a lot of cases that starts to draw a lot of resources out of the ground. We have no idea how much ground water is located in the over aquafers, but in most cases we know that we are drawing from those ground water sources faster than they are being replenished by rain water or ground water. Our way of farming where we decide that we

know better than nature I think is a key driver, whether it's leveling forests to create grain fields, or producing animals as cheaply as humanly possible. I think capital agriculture is a huge problem. Especially in America given how cheap beef is, the size of the American beef herd, the fact that beef herds, swine herds, and maybe to a lesser extent poultry herds around the world are increasing under this industrial model. Given the effects that methane has on the atmosphere, given the effects that their expiration has, CO2, CH4. Methane is horrible, and just given that we just have this addiction to meat which is biologically understandable but it's one of those things where the market is reacting to a biological need in a way that isn't holistically oriented. It's fulfilling people's desires to eat $1/lb ground beef everyday but it's saying nothing about what are the effects on the atmosphere, the soil, the water. So I think if I had to put it into one big thing, it's that our agriculture systems today are overly market oriented. I don't think you can ever get away from the market and tell people this is what there is. I think that's ideal but unrealistic, but I think that agriculture at least needs to put ecological needs on par with the needs of the market, and to get rid of the things that are causing agriculture to drive climate change.

3. What do you view as the greatest barrier to fighting global warming?

Politics, a combination of people's expectations, but I think at least in America you know who our president is now. God help us all. That's another thing I'll apologize for. There's a cognitive dissidence that goes on. If you go up to the Corn Belt and you meet farmers who do conventional agriculture they'll admit in a minute that weather patterns are changing and not for the better, but if you say climate change their ears close. And that's from people who make their living from the land, people who are screwed over by the fact that it's either raining way too much or not nearly enough. People who will lose thousands of acres of crops if the temperature inches up by 1 degree Celsius. These are the people who are existentially tied to the effects of climate

change. They will admit that they are happening but they will not have the discussion with you if there is even the slightest scent of politics, or detecting you're a liberal or anything like that. I think the weight of the issue is the fact that so many people who are environmentalists, who are trying to have this discussion around climate change don't have their hands in the dirt. They are not farmers. They are not the people who wake up at 4am and stay up until 10 o'clock to try and till the land. And it's difficult for people like that to have any real credibility with people who should be on the side of helping the agriculture to address its drivers of climate change. It gives them away that they are so far removed. I'm a pretty liberal guy, maybe center left, closer to the left. It's a lot easier for me to have a conversation with a Kansas wheat farmer or a pig farmer in Missouri or somebody like that, and talk to them about the effects of climate change because I've got a lot in common with them. And a lot of it is about trust. They don't think that I'm after anything of theirs, that I'm not trying to take their livelihood away from them because we draw our livelihood from the same thing. I don't want to call it elitism because you have to discuss climate change from what it is. You have to talk about the science behind it but I think for our part focus on the things you can change about yourself. With us being, I assume you're probably on the liberal side of the climate change issue just given what you do and the fact that we're talking. We need to not be such snobs about it, and we need to come at people who are on the ground, whose livelihoods are affected by climate change, and whose decisions can more directly affect climate change. We need to find more of a way to empathise with them. We need to understand where they are coming from. We need to stop the…there's a conversation where farmers are considered stupid. And I've even gotten into discussions about climate change, maybe veganism, or about the local food movement in general. Where I'll talk about things from the perspective of the farmer without portraying the fact that I went to a good school, that I majored in computer science, and that I write on Medium, and that I have progressive political viewpoints. But when I'm writing about things just as a

farmer I'll maybe not be so nice about something like vegetarianism I'll automatically get attacked as an idiot because I'm a farmer. Never mind the fact that I graduated Magna Cum Laude from a top 20 CS school, you're a farmer, you live in the south, you're stupid. That doesn't help the cause because you've got to convince those "stupid" people to embrace your ideas in order to...to persuade them. You got to persuade them with honey, you're not going to persuade them by beating the hell out of them. I think that's the biggest barrier, like everything, it's communication and the lack there of. It's hard. There's a lot of tribalism and people self-select who their friends are, who they associate with, who they talk to, who they debate. I see debates online, and on Facebook, and on Instagram, and on Reddit. And sometimes hacker news talks about climate change and their culture. And for most people it's people doing various levels of agreeing with each other. It's exceedingly rare to get people in a think tank in New York to talk to a California almond farmer. It's extremely rare to get these people in the same room talking about the same issues. You just get people talk past each other. And as much as I'm a technologist in favor of the good things social media has done, I think it has made it extreme easy for people to get into their separate ships shooting at each other instead of getting in the same boat, and we all need to be shooting at climate change.

4. What is your opinion on the effectiveness of using methods of general audience engagement as a measure against global warming?

I think it's important to have that kind of common score board, the challenge is in getting people to realize why it's important. You can tell from somebody like me, with a science background, or somebody who's more academically inclined about the whole 2-3 degrees Celsius threshold, and that'll resonate with use but for a lot of people it just doesn't. You've got a lot of people who as soon as you mention the NOAA they just turn off. This is just too science, I don't like math, I'm going to go back to doing what the hell I was doing. It almost goes back to what I was talking about

earlier. That you have to address people in different ways. You're not going to convince somebody who's at an East Coast New England think tank...you're not going to use their argument to convince a guy who's in the middle of the United States to change their views of climate change using the same argument. I think those things fall on deaf ears, and it goes back to that whole ability to empathise with those farmers on the ground. You can't talk to them in the abstract about the global mean temperature is going to rise by 2 degrees because there's always going to be somebody, and by somebody I mean Ted Cruz, taking isolated samples of data like the whole thing about there was no global increase in the temperature mean of the past 17 years, but it turned out that those statistics were completely pulled out of context. And that it basically accounted for what the temperature was before the latest El Nino, in which the temperatures dropped and came right back up, but they used that to claim that over the last 17 years there's a drop and increase, and that there's no difference, and that climate change is BS. You're going to always have people like that saying that and the amazing thing is that you'll have people who know that isn't true because they've seen their wheat fields drying up with no water. There's always going to be somebody who's going to present some other aspect of the science. It comes down to empathizing with people at where they live and having that conversation with them that their livelihood is under threat. And you see it. I don't have to tell you that the atmospheric temperature is this, and satellite data says this, and ground readings say this. No, look at your wheat field, it's rotting. You have to use more pesticides every year. The pest cycles aren't breaking. You can't rotate your crops fast enough. What do you think this is? Do you think it's climate change or a biblical plague? The effects are the same. This is the way you appeal to conservatives. Wouldn't you rather be in the driver seat on this instead of just hoping that OMG, I hope this works itself out somehow. The whole American spirit thing is that you see a problem you solve the problem. You shouldn't be afraid of science, you shouldn't be afraid of whooping the problem in the ass and kicking it in the teeth, and that's what this is, but you

know the problem is that it's exactly what you're saying about the general audience. Nobody is saying that! And everything I read from the New York Times, or the Post, or NPO, or going furthest to the left the Huffington Post ,or MSNBC. No one frames the debate in those terms, and since right now it is the political left unfortunately in the scientific community which is now unfortunately associated with the left because of that. Science should just be science, fact should just be fact. Now science is political. Now there's alternative fact. Now there's all this crap that goes along with it. Since the left owns it it's up the left to figure out that the general audience discussion isn't enough. It does not cross that line. It's not bridging that gap, and trust between people who are working on the ground and people in the ivory towers or elite liberal D-Bags or whatever. Somebody's got to bridge that gap, and it's not going to be them. It's got to be us. The general audience thing it makes us feel better but it's not enough, it's not going to work.

APPENDIX F
USER TESTING RESULTS

USER ONE

Pre-testing Questions

1. What is your postal code?

M1W 1B1

2. What are 3 produce items that you purchase weekly?

- Bananas
- Apples
- Tomatoes

3. Please list the sources that you would regularly purchase these items from.

Food Basics

4.What are your requirements for choosing these items (eg. Price/ health/source/etc.)?

Out of necessity.

5.Would you consider purchasing produce from alternative sources such as a hobby farm or neighbourhood gardens?

Yes, if it's safe.

Pre-Module Questions

1. What is your opinion on global warming and climate change?

With the rise in energy consumption, it's definitely an issue that needs to be addressed. It will be more under the microscope in the coming years, especially with all the tech we're using, all the electricity. We need to be careful with things.

2. What is your current understanding of what a carbon footprint is?

I don't know what that is.

3. How big do you think the impact of your carbon footprint is as a Torontonian in comparison to people from the rest of the world?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

I think we're in the middle. Being in a North American country, we are better with these things, with government rules and regulations. We're better with those. But I don't think we're completely great.

4. How big do you think the impact of your carbon footprint is from driving, compared to the average Canadian?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

I mainly get around using the TTC. I don't own a car and I Uber once in awhile. I'd like to think that if I'm getting around using the TTC, it's not as big as having my own car.

5. Which of your daily activities do you think contributes most significantly to your carbon footprint?

Public transportation

6. How much of a difference in carbon emissions do you think an individual can make just by making changes to their everyday routines?

Maybe eating less fast food, less McDonald's. That could be a way of individuals reducing carbon emissions, because people talk about how junk foods are not good for you. So if you reduce that to once in awhile versus every so often. At the price point, you can buy a coffee for a dollar at McDonald's, so you'll by it there versus just making it at home.

7. Do you ever think about the environmental impact of the food that you eat?

As of recently yes, because I went on a trip to a cottage, which is about 2-3 hours away and I just realize how much more nature and how natural the environment I was in made me think about how my food choices can be impacted.

Prototype 1 [Carbon Tracking – Hard Data]

1. Is the presented information clear?

It is clear.

2. Does the value of your emissions based on driving surprise you in anyway? How about when it is compared to the other averages?

No, not surprised. In comparison, it's understandable/expected.

3. What piece of information affected you the most?

I like the options, so that people are aware that these are options. Especially having a mobile app that could be a daily reminder of what I can do today to keep things low. I think it would be pretty good if people had an app to be more aware about it.

4. Before seeing this information, were you aware of the impact that driving had on carbon emissions? What was different from what you previously thought?

Yes, in my high school they would always say if a car was in the parking lot to pick up the kids, they have reminders of not idling cars for more than three minutes. Things like that, environmental tips.

Prototype 2 [Carbon Tracking – Spatially based Data with Sociability]

1. Does the data visualization make you more aware of the impact of your individual emissions than the previous one?

Yes.

2. Does seeing how your footprint value compare to other people in your social network affect you in anyway? How about in the city setting?

I thought it would be to a greater extent. As long as people are aware of how much they are using, that would be better.

3. Does seeing the footprint as a volume rather than a graph or number value change the way you understand the impact that an individual can make?

Yes.

4. Which piece of information from this module was most surprising/ engaging/provoking and why?

The way the map was set up and you can see everything.

Prototype 3 [Community-based Network]

1. Did seeing this information encourage you to think twice about considering where your produce comes from before you choose to buy it?

Yes.

2. Is the information on the carbon emissions of specific items that you're thinking about purchasing valuable to you? Would you like to continually access this type of information before you decide on purchasing something, whether it's produce or other items such as clothing, etc.?

Yes, I think if you could know, if this could show up in an app that there's something nearby that you could buy, then that would be good. I think if you wanted a huge target audience, you'd install it into Google Maps so that everybody knows.

3. Would having easier access to where these alternative sources for produce encourage you to purchase from them more often?

Yes.

4. What do you think would motivate you to buy from alternative sources more often?

Cheaper and less carbon emissions. I think you pretty much know if it's coming from a farmers' market it's been grown naturally more than with pesticides. My parents do complain about that all the time, how it's not naturally grown just by looking at the fruit or vegetable. If they have the option of something that's closer, pretty sure they would go buy more, since they do most of the groceries.

5. Which piece of information from this module was most surprising/engaging/provoking and why?

The tomatoes having such a high carbon emissions.

Post-testing Discussion Questions

1. Which method(s) of revealing information made the biggest impact on how you see the effects of your daily activities on global warming?

The 3d map.

2. How effective is revealing your total carbon footprint to you?

Extremely effective
Somewhat effective
Neutral
Somewhat not effective
Not effective at all

I think it's important because I didn't know what a carbon footprint was until now. Now that I have an understanding of it, every person should realize where they stand and how much they contribute to the emissions, how it's been distributed amongst everybody and where the most impact is coming from. If this was a community app, where people could be like, if everyone who comes to the library gets live updates of the emissions of this area and it was translated to several languages since there's many immigrants in this area, then they'd be more aware. Like you're making a public service announcement and then having the graphs showing where it's being done.

3. What would motivate you to make an effort to lower your footprint? Saving money on weekly purchases? How much would you have to be saving in order to consider changes to your regular purchases?

Probably saving money and installing things that could save energy. I think Toronto hydro makes you install some things where you know how much energy you're using in your house. It was a while back but they installed something in our house that would

tell you how much energy is being used at a constant level and knowing when the best cycle is to do the laundry, the cycle period at night or early in the morning so that you're not doing it in the peak hours for energy consumption. Things like that.

4. Is there any sort of data you would be more interested in seeing than what was shown to you today?

I think maybe one suggestion I would like to have is where you do have a thing that monitors how much energy you're using in your house, a personal one. So it's like how much energy your monitor used and what you did today and what you're saving. Like a monitored transaction that could say this where I could use less energy.

5. Would you recommend others to use a mobile application like this one? If so, who?

Yes, for people who I feel would actually care enough. I do know a couple people who would be really interested in this, people who are more interested in knowing where their food comes from. I do know a few guys or girls who are health freaks.

6. How important is it for you to see members within your social network also working towards lowering their footprint?

I feel like with anything it's all about execution. So if people do care enough about what they're using their energy on and if that person is with me every weekend, maybe carpool, which I usually do with my friends. Or eating healthier and not hanging out at McDonald's. I know a lot of people who are buying into veganism or vegetarianism who I'd never picture ever, so I think the social impact that people are eating cleaner, they would be more interested in something like that or to be more aware of where food is coming from.

7. Does the data visualization make the possible repercussions of global

warming more tangible/understandable than before?

Yes.

8. How accurately would your carbon emissions have to be tracked in order to encourage you to lower it? Would you want to know the footprint of everything you consumed, or would a broader total be enough (e.g. daily, weekly, or monthly emission total)?

If I knew my carbon emissions 24/7, all the time.

9. Does the information on the potential emissions savings that you can have by adjusting your decision making surprise you in any way?

Yes.

USER TWO

Pre-testing Questions

1. What is your postal code?

M2K 1B1

2. What are 3 produce items that you purchase weekly?

- Apples
- Cereal
- Milk

3. Please list the sources that you would regularly purchase these items.

Metro

4. What are your requirements for choosing these items (eg. Price/ health/source/etc.)?

Price

5. Would you consider purchasing produce from alternative sources such as a hobby farm or neighbourhood gardens?

If it was the same price, then it'd be great.

Pre-Module Questions

1. What is your opinion on global warming and climate change?

I don't care.

2. What is your current understanding of what a carbon footprint is?

I don't know what it is.

3. How big do you think the impact of your carbon footprint is as a Torontonian in comparison to people from the rest of the world?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

4. How big do you think the impact of your carbon footprint is from driving, compared to the average Canadian?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

5. Which of your daily activities do you think contributes most significantly to your carbon footprint?

Transportation

6. How much of a difference in carbon emissions do you think an individual can make just by making changes to their everyday routines?

Extremely large difference
Somewhat large difference
Somewhat moderate difference
Small difference
No difference at all

7. Do you ever think about the environmental impact of the food that you eat?

No.

Prototype 1 [Carbon Tracking – Hard Data]

1. Is the presented information clear to you?

Yes.

2. Does the value of your emissions based on driving surprise you in anyway?

A little bit.

3. What piece of information affected you the most? What piece of information would affect you more?

The comparisons.

4. Before seeing this information, were you aware of the impact that driving had on carbon emissions?

Yes.

Prototype 2 [Carbon Tracking – Spatially based Data with Sociability]

1. Does the data visualization make you more aware of the impact of your individual emissions than the previous one?

The first one was more clear.

2. Does seeing how your footprint value compare to other people in your social network affect you in anyway?

Yes.

3. Does seeing the footprint as a volume rather than a graph or *number*

value change the way you understand the impact that an individual can make?

The number is easier to understand.

4. Which piece of information from this module was most surprising/engaging/provoking and why?

The comparisons with the other people.

Prototype 3 [Community-based Network]

1. Did seeing this information encourage you to think twice about considering where your produce comes from before you choose to buy it?

Yes.

2. Is the information on the carbon emissions of specific items that you're thinking about purchasing valuable to you?

Yes.

3. Would having easier access to where these alternative sources for produce encourage you to purchase from them more often?

Yes. I would go to the alternative sources.

4. What do you think would motivate you to buy from alternative sources more often?

More organic. Health reasons.

5. Which piece of information from this module was most surprising/engaging/provoking and why?

The footprint of the tomatoes.

Post-testing Discussion Questions

1. Which method(s) of revealing information made the biggest impact on how you see the effects of your daily activities on global warming?

The second one with the 3d maps.

2. How effective is revealing your total carbon footprint to you?

Extremely effective
Somewhat effective
Neutral
Somewhat not effective
Not effective at all

3. Which methods were the most or least effective in motivating you to lower your footprint?

The first module. And if I knew I was saving money and lowering the carbon emissions.

4. Is there any sort of data you would be more interested in seeing than what was shown to you today?

More variety in food categories. Not just the fruits. The values for fast foods, chicken.

5. How important is it for you to see members within your social network also working towards lowering their footprint?

It would be interesting seeing the other friends.

6. How accurately would your carbon emissions have to be tracked in order to encourage you to lower it? Would you want to know the footprint of everything you consumed, or would a broader total be enough

(e.g. daily, weekly, or monthly emission total)?

I would only need a general total.

7. Does the information on the potential emissions savings that you can have by adjusting your decision making surprise you in any way?

Yes. I didn't know from before.

USER THREE

Pre-testing Questions

1. What is your postal code?

M2K 1E8

2. What are 3 produce items that you purchase weekly?

- Lettuce
- Tomatoes
- Cucumbers

3. Please list the sources that you would regularly purchase these items.

No Frills or Loblaw's

4. What are your requirements for choosing these items (eg. Price/ health/source/etc.)?

Freshness
Affordability

5. Would you consider purchasing produce from alternative sources such as a hobby farm or neighbourhood gardens?

Definitely if it was accessible.

Pre-Module Questions

1. What is your opinion on global warming and climate change?

I'm a big advocate against global warming. I like to be very conscious when it comes to global warming. I actually kind of feel that we're not doing enough as a civilization to try to something to prevent emissions and all that stuff.

2. What is your current understanding of what a carbon footprint is?

A carbon footprint is pretty much anything that I do that could contribute towards pollution.

3. How big do you think the impact of your carbon footprint is as a Torontonian in comparison to people from the rest of the world?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

I would say bigger as a result of not just looking at myself.

4. How big do you think the impact of your carbon footprint is from driving, compared to the average Canadian?

Extremely bigger
Moderately bigger
Same
Moderately smaller
Extremely smaller

5. Which of your daily activities do you think contributes most significantly to your carbon footprint?

The use of electronics from energy consumption.

6. How much of a difference in carbon emissions do you think an individual can make just by making changes to their everyday routines?

Extremely large difference
Somewhat large difference
Somewhat moderate difference

Small difference
No difference at all

7. Do you ever think about the environmental impact of the food that you eat?

No.

Prototype 1 [Carbon Tracking – Hard Data]

1.What do you understand from the presented information? Is it clear?

Definitely it's clear. I understand that my consumption from driving when it comes to emissions is a lot bigger than I anticipated.

2. Does the value of your emissions based on driving surprise you in anyway? How about when it is compared to the other averages?

Yes.

3. What piece of information affected you the most? What piece of information would affect you more?

My assumption versus the actual facts. Not realizing that I do make a bigger impact through my carbon footprint.

4. Before seeing this information, were you aware of the impact that driving had on carbon emissions?

Yes.

5. What was different from what you previously thought?

I never realized. What I factored in was picking up the kids, driving to work, maybe buying groceries, see a friend. It's really surprising, I felt that it would be a lot lower.

Prototype 2 [Carbon Tracking – Spatially based Data with Sociability]

1. Does the data visualization make you more aware of the impact of your individual emissions than the previous one?

It does visually, but to me I think it pretty much speaks the same thing.

2. Does seeing how your footprint value compare to other people in your social network affect you in anyway? How about in the city setting?

It does in a way where maybe I've realized that maybe my total drives up the overall then it gives me some perspective to what I need to do. And in reverse then maybe it would drive me to try to convince others to maintain theirs.

3. Does seeing the footprint as a volume rather than a graph or number value change the way you understand the impact that an individual can make?

Personally no, but I know visually a lot of people tend to go into that. But personally, as long as I have the numbers, that's the main thing.

4. Which piece of information from this module was most surprising/ engaging/provoking and why?

I think when you compare the other different activities that you can perform just to see the differences in comparisons. I think that was interesting.

Prototype 3 [Community-based Network]

1. Did seeing this information encourage you to think twice about con-

sidering where your produce comes from before you choose to buy it?

100%, for sure.

2. Is the information on the carbon emissions of specific items that you're thinking about purchasing valuable to you? Would you like to continually access this type of information before you decide on purchasing something, whether it's produce or other items such as clothing, etc.?

Realistically, it would definitely be something I'd pay attention to. I guess the question I have is what would drive me to continue this type of behaviour? Without like-minded people I might not have – let's just say for example I have ten friends and all ten friends really don't care, that might put me in a situation where I'm like, okay what's the point?

3. Would having easier access to where these alternative sources for produce encourage you to purchase from them more often?

Yes.

4. What do you think would motivate you to buy from alternative sources more often?

My children being exposed to this type of information would also sort of force my hand. Because really and truthfully, when I buy groceries, there only certain things I'll buy that are organic but solely for the ingredients that I'm putting into their food.

5. Which piece of information from this module was most surprising/engaging/provoking and why?

The amount of other alternatives where I can purchase the same food.

Post-testing Discussion Questions

1. Which method(s) of revealing information made the biggest impact on how you see the effects of your daily activities on global warming?

I think looking at the comparisons with these horrible tomatoes from Loblaws. Literally looking at the alternatives which are close by, if they could save you money versus my regular routine.

2. How effective is revealing your total carbon footprint to you?

Extremely effective
Somewhat effective
Neutral
Somewhat not effective
Not effective at all

Do you think it would affect the way you think about your decision making?

Yes.

3. Which methods were the most or least effective in motivating you to lower your footprint?

The most would be the whole comparison piece. I think in essence it would also be the least because of, with something like that who knows what the person is thinking or interested in. If you have a huge variety of different things you can compare to like even something as simple as a mobile device versus a tablet. Or the types of meat that I buy – Wagyu versus regular AA meat. I think that would probably be really insightful because depending on how I feel or maybe I'm at the grocery store about to buy something and compare it, I'll say wait a minute, I'm spending way too much. A huge variety would be beneficial.

4. What would motivate you to make an effort to lower your footprint? Saving money on weekly purchases? How much would you have to be saving in order to consider changes to your regular purchases?

The total impact. If this app just asked me a bunch of specific questions about specific detail and maybe categorizes them into subcategories and then gives me an overall total to see how much I'm actually impacting, I think that would probably open my eyes. Because looking at transportation alone and then compounding that with everything else, I'm actually worried that it's going to be bad. It would give me enough fear to realize I need to change my habit to make a difference.

5. How often do you think you would use a mobile application like the one shown to you today? What would you want to be done differently?

It would be based on the habit that I'm performing, so it could be very frequently, it could be infrequently. I buy groceries, I might take a look at this but then it could also be miniscule in deciding what means of transportation I'm going to take to go somewhere. That may be something I'd considering reviewing for. If there's something I do as a daily routine or weekly routine that would correspond to maybe a function that I could look at in the app then I can – give me a reason to go check it first.

6. Would you recommend others to use a mobile application like this one? If so, who?

If I could see the benefits and realize that this is something, it's going to take more than myself to get involved to really help out the environment, I would definitely share it with others. Who? My close family, friends, acquaintances. Depending on how impactful this app is to me, I might just even pitch it to anyone that comes by, but really it's just, how dependent have I become with this app?

7. How important is it for you to see members within your social network also working towards lowering their footprint?

Very important. One person can make a difference, but a whole group can really make change.

8. Does the data visualization make the possible repercussions of global warming more tangible/understandable than before?

Not necessarily because I think I know the cause and effect already and how bad it has been/continues to be unless we do something.

9. How accurately would your carbon emissions have to be tracked in order to encourage you to lower it? Would you want to know the footprint of everything you consumed, or would a broader total be enough (e.g. daily, weekly, or monthly emission total)?

A combination. It's good to see the grand total but then in order for me to work on it I need to break it down, break it apart to see where I can reduce some of that footprint.

10. Does the information on the potential emissions savings that you can have by adjusting your decision making surprise you in any way?

Yes, it does. You showing me one example like tomatoes and seeing what a big impact it has, it is definitely an eye opener. Same with seeing what effect keeping electronics for more than a year, I think it's a really good idea to see and compare that. It's just something that I would consider minute and small, could actually make that big of a difference. Unless people are shown something, how will they know? If I'm making the same mistake over and over again, I think calling me out on it is the right way to doing things.