UNDERSTANDING YOUTH LANDSCAPE PERCEPTIONS AND MAPPING LANDSCAPE VALUES VIA SOCIAL MEDIA

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Hydroelectricity is a ‘special case’ among renewable energies for its maturity, large scale, and extensive landscape impacts. To understand how locals perceive, use, and value the landscape is critical when considering hydro dam proposals. Previous research offers insight into local perspectives but conventional methods (e.g., survey and interview) show gaps in youth participation and engagement in these research activities. To fill this gap, we collect social media data to understand youth perceptions of the landscape. Results show that the most prominent landscape value in the Clean Energy Project (Site C) located in northern British Columbia area is aesthetics which is highly related to the river, riparian land, and mountains. In the Mactaquac dam area of New Brunswick, reservoir-based lifestyle is key to interpreting youth landscape perception. Landscape values are then mapped by kernel density estimation to show the spatial patterns. We find that different landscape values emerge in different places. This demonstrates that the approach of collecting and coding geo-tagged social media data is feasible and effective for landscape research.

LIST OF ABBREVIATIONS USED

GIS – Geographic Information System

Mactaquac - Mactaquac Generating Station

PPGIS – Public Participation Geographic Information System

Site C - Site C Clean Energy Project

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Chapter 1 Introduction

The development of renewable energy is intended to meet increasing energy demands with arguably less impact on the environment than conventional resources. Renewable energy has been criticized, however, as bringing social disruption in terms of landscape changes, displacement, health issues, and so on. Hydro energy proposals are more controversial than other renewable energies because by storing the water resource in a state of potential energy it holds back the flow, significantly changing and domesticating (*sensu* Lee, 1998) water bodies and the landscape around them. Thus, it is critical for decision makers to understand how people perceive and value affected landscapes, to adapt or discard hydropower-related proposals and/or design their associated stakeholder engagement. In recent decades, social scientists have attempted to understand social and cultural landscapes and to integrate these factors into landscape evaluation (Taylor, Zube, & Sell, 1987; Brown & Reed, 2000; Beverly et al., 2008; Zhu et al., 2010; Butler, 2016), where early research mostly focused on the economic and biophysical aspects (Litton, 1968).

To capture a more integrated concept of landscape perception, many research approaches (e.g., survey, interview, focus group, etc.) are used with several drawbacks such as high costs and demographic biases. Demographic bias is the most critical one: young people are less active in research activities (Lückman, Lagemann, & Menzel, 2013; Keilty, Beckley, & Sherren, 2016) and stakeholder or civic engagement processes

(Delli Carpini, 2000; Pasek, Kenski, Romer, & Jamieson, 2006; Sloam, 2012), instead often expressing opinions and attitudes, and documenting their lives, on social media (Quintelier & Vissers, 2008; Park, Kee, & Valenzuela, 2009). Using social media data as secondary data can overcome drawbacks such as high cost, low response rates, and inevitable influences from researchers in conventional approaches. Previous studies showed that data from image-sharing sites can contribute to landscape research but are far underutilized (Barry, 2014). The situation calls for improvements or alternative ways to conduct landscape research.

This thesis explores a photo-sharing social media site, *Instagram*, to see if it is effective to use such photos to reveal young people's landscape perceptions in places facing hydro-related disruption. Given the photo data are collected based on the geo-tag of each *Instagram* post, this thesis also demonstrates the capacity to map the landscape values in the study areas to show place-specific perceptions. The results will be discussed to inform decision makers about the potential conflicts and impacts that landscape changes under different proposal scenarios represent for youth. Most importantly, perhaps, this thesis looks at a new approach of using social media data, discussing the advantages and limitations compared to conventional methods.

1.1 Context

Due to climate change, energy security, and increasing energy demand, renewable energy is reported as generally acceptable and socially favored for future energy development (Wang, Nistor, Murty, & Wei, 2014; Corscadden et al., 2016), but also causes problems as well, such as landscape changes and health issues. Among various types of renewable energy, hydropower has played a dominant role in meeting Canada's electricity needs (Canadian Hydropower Association, 2008, cited in Wang et al., 2014). By 2012, hydroelectricity had become the primary energy source in Canada, comprising over 60% of its total energy generation (Canadian Electricity Association, 2013, citied in Wang et al., 2014). In some provinces, such as Ontario, Quebec, British Columbia, and Manitoba, the hydropower system has been expanding for decades, with developments that were also critiqued as overbuilding infrastructure and which caused many problems, for example, social disruptions among aboriginal people who vigorously opposed the hydro development (Karl, 2014).

Compared to other renewable facilities, such as wind turbines or solar panels that are mostly considered as localized visual interruptions on the landscape, hydro dam is a 'special case' in terms of its maturity, scale, and landscape impacts (Keilty et al., 2016). Hydropower has the longest history among renewable energies, and dams are reported as diverting rivers and displacing millions of people around the world (The World Commission on Dams, 2000). The size of individual dams is often bigger than other types of renewable energy infrastructure such as solar and wind. The consequent impacts on the landscape are not limited at the construction site and its viewshed only which is usually the case for renewable energies. Instead, dams cause extensive disruptions in relation to water impoundment or eventually river restoration. These significant changes can domesticate landscapes, bringing new visual resources, ecosystem, patterns of human settlements, as well as their altered lifestyles (Hough, 1990). In New Brunswick, for instance, the construction of the Mactaquac Generating Station (Mactaquac) forced local residents to relocate and to change the way they led their lives before the dam, and dramatically changed the nature of the communities and lifestyles the landscape fostered (Keilty et al., 2016).

Conflicts around hydropower proposals arouse researchers' interest in understanding how local residents perceive – whether accepting or opposing – such energy infrastructure. In Canada, decision making processes for hydro dam projects mostly focus on the economic, environmental, and energy security aspects (Corscadden et al., 2016). Gaps often exist, however, in terms of social impacts, particularly in the consideration of landscape. Questions such as how local people perceive, use, and feel about their landscape account less for the final decision than the economic benefits or ecological disruptions (Corscadden et al., 2016). In practice, social factors are criticized as difficult to quantify, assess, and incorporate because of their intangible and subjective nature (Tenerelli, Demšar, & Luque, 2016). Also, since individuals see landscapes through personal lenses of experience, individual values can differ widely on landscape issues. This fragmentation of perspectives can challenge collective decision-making, and even weaken the perceived importance of incorporating social issues in the related processes.

Despite the difficulties, in the area of landscape research, various approaches have been used in past decades to better understand people's landscape perceptions to inform scholars and decision makers. Surveys, interviews, and focus groups are widely used in conventional landscape research (Hunziker, 1995; Brown & Reed, 2000; Keating, 2012; Keilty et al., 2016). Photo elicitation has also become popular, which asks participants to take photos of landscape features (Sherren, Fischer, & Price, 2010), as well as Q-sort methodology that provides participants a set of landscape photos to rank (Kaymaz, 2012; Navrátil et al., 2013). Most recently, Brown and his colleagues have advanced public participation GIS (PPGIS) which asks people from different places to locate and sometimes rank landscape values on maps (Brown & Brabyn, 2012; Brown & Reed, 2012; Brown & Donovan, 2014; Brown, Weber, & de Bie, 2014). This method helps identify the perceived values of the landscape in specific places to analyze how the physical landscape changes, the cultural history, and other drivers can affect the values within a small geographic scale.

Although some of the approaches mentioned above are effective for understanding landscape perceptions and mapping values place-specifically, drawbacks also exist. First, the cost of data collection is high in terms of time and money, even for quite low sample sizes. Second, inevitable influences from researchers in face-to-face approaches like photo-elicitation can affect objectivity. Third, and most importantly, there is demographic bias in that younger generations are generally less active in public engagement (Checkoway, Allison, & Montoya, 2005; Lückman et al., 2013). In our research areas in particular, recent research shows the difficulty of reaching younger generations to understand their opinions toward decisions facing the landscape (Keilty et al., 2016; Sherren et al., 2016). This gap arises despite the fact that it is critical to fully understand young people's perceptions of current landscape, including how they view the physical features, how they use and value the landscape, because they will inherit the landscape in the future.

To collect data from social media sites as secondary data seems like a logical way to fill the gaps in youth voices and underestimation of social/cultural landscape values, as well as to overcome other drawbacks in conventional approaches. In general, social media has become the main platform for young people to express their opinions and feelings, and document their lives (Delli Carpini, 2000; Quintelier & Vissers, 2008; Park, Kee, & Valenzuela, 2009). Research that leverages social media data is growing, but there is less development in using data from photo-sharing sites. In landscapes studies, a few productive attempts have been made. For example, Barry (2014) collected photos from *Flickr* to understand public values about cattle grazing on park lands; and Martínez Pastur et al. (2015) used geo-tagged images posted on *Panoramio* to identity hot-spots of cultural ecosystem services. *Instagram*, however, is currently one of the most popular photo-sharing platforms among young people, yet has not been exploited for landscape research.

A new approach based on collecting photographic and textual data from *Instagram* may help to understand how landscapes are perceived, used and valued before and/or after installations, particularly by those young people who are less likely to willingly share.

1.2 Research Goals

This thesis is composed of two papers prepared for publication. It aims to address three main research goals: A) how do young people perceive the landscape in the study areas; B) what do results mean for decision makers considering hydropower proposals for the two cases; and C) is the demonstrated approach of using social media data effective in revealing young people's landscape perceptions or mapping landscape values? These goals will be achieved by two papers as two substantive chapters in this thesis, covering a handful of research sub-questions (Table 1).

In Chapter 2, we code photos and text-based captions for a year's worth of *Instagram* posts around hydroelectricity proposals to answer sub-questions A1-A3, including: how young people perceive physical features, how they use the landscape, and how they value it. We then visualize the coding results as conceptual diagrams to inform decision makers and other interested parties about potential conflicts under different proposal scenarios. Finally, we critically examine our approach to collecting and analyzing data from *Instagram* to reveal the youth perceptions of landscape.

In Chapter 3, with the geographic information collected for each *Instagram* post, we map landscape values to answer the sub-question A4 — how are landscape values spatially distributed in the study areas; and, question B — what can the decision makers learn from such value maps? From the methodological perspective, this chapter also discusses the feasibility and validity of using and filtering large volume of geo-tagged social media data for research purposes, as well as the respective advantages and limitations.

Table 1. Research goals achieved by the two substantive chapters.

Research goals	Chapter 2	Chapter 3
A: How do young people perceive the landscape?	√	√
A1: How do they perceive physical landscape features?	√	
A2: How do they use the landscape?	√	
A3: How do they value the landscape?	√	√
A4: How are the landscape values spatially distributed?		√
B: What can hydro decision makers learn from the results?	√	√
C: Is the method effective (advantages and limitations)?	√	√
C1: Revealing youth landscape perceptions?	√	
C2: Mapping landscape values?		√

1.3 Methods

1.3.1 Sites Rationale

We use two hydroelectric dam projects as our study cases, the prematurely aging Mactaquac Generating Station (Mactaquac), New Brunswick, and the in-progress Site C Clean Energy Project (Site C), British Columbia (Figure 1).

Figure 1. Maps of study areas, Site C, BC, and Mactaquac, NB, Canada (adapted from Natural Resources Canada, 2001).

The Mactaquac Dam was built in 1960s by the New Brunswick Power Commission and was originally expected to operate for 100 years. Due to a concrete expansion issue, the dam is expected to reach the end of its lifespan in 2030. In 2013, NB Power announced three options for the dam's future, including rebuilding, removing, and decommissioning the dam but keeping the headpond intact (NB Power, 2016a). This spring, NB Power suggested new approaches may exist to repair the dam so that it can continue to operate to its original lifespan (NB Power, 2016a). This project is quite sensitive in the Mactaquac area. During its construction in 1960s, 5300 hectares of largely agricultural land adjacent to the St. John River was flooded. Local people suffered from the dam construction including negative emotions and stresses caused by changing landscape views, loss of properties and livelihood, and forced relocation (Keilty et al., 2016). However, after half a century, the dam and the reservoir have become prominent and valued features of the landscape baseline in that area. People who were children during the construction time remember little of the trauma their elders experienced, and today largely hold positive feelings towards the current landscape, regarding its aesthetic beauty, their reservoir-related lifestyle, and the supports from the water landscape; so do the people who were born after the dam construction or migrated to this area as adults (Keilty et al., 2016). Removal of the dam may benefit the ecosystem, in terms of improving natural conditions, however, it is largely socially disfavored (Sherren, Greenland-Smith, Chen, & Parkins, 2016). Heated discussions around the dam future are ongoing and the preferred decision is due to be submitted in fall 2016 by NB Power to the NB Energy & Utilities Review Board: the latter crown agency is the regulator for the former crown corporation.

The Site C Dam is an in-process new project on the Peace River, British Columbia, in western Canada. The proposal was announced in 2010, followed by a series of actions, including project approval by the provincial government in 2014, and the beginning of construction in the summer of 2015. Firm opposition appeared and is ongoing despite the advanced stage of construction. The proponent, BC Hydro, justified the proposal by claiming economic benefits and increased employment, but the joint review panel report on the environmental impact statement stated that the negative effects on the ecosystem and the landscape in this area would be significant and irreversible (BC Hydro & Power Authority British Columbia, 2014). Most recently, a year after its construction began, the protests are still going (Amnesty International, 2016). Unless they are successful, the new dam will cause flooding over 3000 hectares of fertile farmland to create the storage reservoir (Hume, 2014). The local concerns focus on the loss of current natural landscape, the Peace Valley ecosystem, fishing populations after dam construction, agricultural traditions, and First Nations (Chen, 2015).

Site C is a demographically older and less densely populated location compared to Mactaquac, although both are similar in their proportion of young people. The Mactaquac area reported 97238 people in 2011 (census division of York county, including the provincial capital of Fredericton,), over 50% more than the Site C area at at 60082 (census division of Peace River region, including regional centre Fort St. John) (Statistics Canada, 2011). The population density in Mactquac was 12 people per square kilometer in that same year, compared with only 0.5 in Site C. There were similar average numbers of people per private dwelling across the sites, at 2.2 for Mactaquac and 2.3 for Site C, suggesting similar family sizes. The median age of the population in Site C at 40.2 was older than Mactaquac at 34.3. Yet, residents who were within the age range of 15 to 34 accounted for similar proportions: 26.9% in Mactaquac, and 30% in Site C (Statistics Canada, 2011).

The general landscape in the two areas are similar, though differences also exist. The Mactaquac area is generally flatter than Site C. Site C is located further north compared to Mactaquac, so that the winter in the former is usually longer and colder. The yearly average temperature in Site C was 2.3 °C from 1981 to 2010, and 5.2 °C in Mactquac. While the latter area had more yearly snowfall (189.6 cm in Site C and 237.1 in Mactaquac), snow stays on the ground longer at Site C due to the colder temperatures (147 compared with 109 days) (Environment and Natural Resources Canada, 2016a&b). Both areas have strong First Nations cultures (Mi'kmak and Maliseet in the East and Saulteau, Beaver (Dunne-za), and Cree in the West) and a long farming tradition traced back to 1700s for Mactaquac and 1900s for Site C (Lawson, Farnsworth, & Hartley, 1985; Pollon & Matheson, 2003; Treaty 8 Tribal Association, 2015). The dam locations are each within a short distance of a significant town (Fredericton, NB, and Fort St. John, BC), with an upstream area of farmland and small resource towns.

The different local attitudes and opinions toward the two dams, given their respective histories, provide an interesting opportunity to compare youth perceptions in the face of hydro-related landscape change. This work seems necessary and insightful for the decision-makers in the specific cases and in similar situations, as well as scholars of renewable energy and landscape perceptions and change.

1.3.2 Approaches

This thesis will use photos and text-based captions that were geo-tagged to the two study areas from a photo-sharing social media site, *Instagram*, via *Netlytic* from October 1, 2014 to September 30, 2015. Previous research revealed two important messages: 1) social media is a good data source to understand public opinions and discourses in many study areas (Autry & Kelly, 2012; Kirilenko & Stepchenkova, 2014; Joseph et al., 2015); and 2) it has a particular appeal to young people (Lenhart, Madden, Smith, & Macgill, 2007; Duggan & Smith, 2013). Building from these, we design our research approach to leverage *Instagram* posts. Given the large volume of social media data, the first level of data filtering work involves selecting only landscape photos from the raw dataset. To analyze the landscape photos, conventional inductive content analysis is used to code themes from the photos and captions based on a landscape perception model which was first built by Taylor et al. (1987) and has been widely used by later researchers. Three main themes are targeted, including physical landscape features, activities, and landscape values. Z-score testing is then applied to examine which theme categories are statistically related, helping build conceptual diagrams where themes are connected.

The approach that is used to map landscape values in this thesis is based on kernel density analysis which has been used in PPGIS studies. A more sophisticated filtering model is required to select landscape photos with geo-tags that match their contents, or in other words, photos that were uploaded and showed landscapes *in situ*. This process involves manual work to compare *Instagram* photos with the remote sensing images and street views on *Google Earth* in hot-spots of post density. Afterwards, kernel density estimation is applied to generate hot-spots of identified landscape values along the main water bodies in study areas, showing spatial patterns.

1.4 Limitations

Using social media data in this thesis overcomes some of the drawbacks in conventional methods mentioned above, though, limitations are revealed in other aspects. First, the dataset is only derived from young people who were using *Instagram* and geo-tagging their posts, which is not a comprehensive sample even of young people, given social media preferences, rural internet access and other barriers to participation. Second, the area of data collection is limited by the settings of *Netlytic*: the tool can only collect geo-tagged posts within a 5km radius around each given geographic point. Third, the filtering process cannot ensure that all invalid data are filtered out of the dataset. The large data size does not allow manual processing for each photo, so we only do so for those posted within potential hotspots, where the likelihood and risk of a systematic error or bias are higher. When using social media data, there is always this dilemma between the large volume of data and its precision. Additionally, errors can be introduced by the analyst due to a lack of personal familiarity with either area. In future, new semantic classifiers may be needed to establish automatic analysis models to solve these problems. These are the main limitations of this thesis, other concerns will be respectively discussed in Chapter 2 and Chapter 3.

1.5 Project Background

This thesis is a part of the research project titled "Energy Transitions in Canada: Exploring the social, cultural and ethical dimensions of a changing energy landscape", funded by the Social Sciences and Humanities Research Council of Canada. The grant is held by Dr. John Parkins (University of Alberta), with Dr. Thomas Beckley (University of New Brunswick) and Dr. Kate Sherren (Dalhousie University). This project aims to reveal social understanding of energy landscape changes across Canada to draw insights for future energy development: what is needed, desirable, and possible. Our team members have conducted research in British Columbia, Alberta, Ontario, and New Brunswick with multiple methods such as surveys, interviews, citizen jury, focus group, and Q-method. This thesis applies a new approach, using social media data to code and map landscape values, to contribute to one of the project's goals to understand individually held landscape values and how this can influence responses to energy proposals.

1.6 Organization of Thesis

This thesis is organized around two publishable papers. Each paper includes its own comprehensive literature review and detailed methods sections. Chapter 2 contains the first paper which aims to understand youth perceptions and use of the hydroelectric energy landscape. This part of the work codes *Instagram* photos and captions into three main themes, landscape features, activities, and values. Chapter 3 then furthers the work from conceptual to spatial mapping in which landscape values are located in the study regions. This directs the research to a geographic reality where we can foresee the potential changes of perceived landscape values and challenges for locals along the affected water bodies. The two papers both attempt to discuss the feasibility and effectiveness of digging data from social media and applying it in landscape research. Because my committee members are co-authors on both substantive chapters, the term "we" and "our" is used throughout the thesis for consistency with those chapters.

The term ‘social media’ is used as singular in this thesis, given common usage, rather than plural. Also, we need to explain the ethics and copyright issues that are raised by using social media data for research here. All the posts we collected from *Instagram* are public data, namely the user’s account and content are set as public for all visitors. Thus, by using public data, ethical review was not required in this thesis. However, to use the photos as examples, we have to respect the copyright owned by users (Instagram, 2016). We thus decided not to anonymize the photographers, instead citing usernames and the post links appropriately in American Psychological Association style (see figure 14 and 16). In addition, using these photos in this thesis may be justified under “Fair Dealing” (see Dalhousie University Fair Dealing Policy, 2013).

Chapter 2 Understanding youth perception and use of hydroelectric energy landscapes via social media

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2.1 Statement of Student Contribution

This paper is prepared for submission to the journal *Landscape Research*. Chen collected the data, conducted analysis, and wrote all sections of this manuscript. Dr. Sherren contributed to the research topic, methods for content coding, and writing process by editing this paper. Dr. Parkins contributed to editing as well. Both of them provided supervisory comments all through the process.

2.2 Acknowledgements

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2.3 Abstract

Hydroelectric energy landscape change, in terms of the visual resources that shift and the resulting ecosystem conversion, has impacts on local settlement patterns, residents' perceptions, and their lifestyles. The younger generation that inherits these shifting energy landscapes is underrepresented in conventional public engagement processes. To fill this gap, we collected data from *Instagram*, where this demographic cohort dominates the medium. Photos showing landscapes were coded into theme categories, and conceptually linked based on co-occurrence. Focusing on two hydroelectricity project locations in Canada, the proposed Site C Dam, British Columbia, and the Mactaquac Dam built in 1960s, New Brunswick, main findings were discovered in both study cases: (1) river, riparian land, and mountains were commonly seen together; (2) specific features enabled different activities and shaped lifestyles; (3) aesthetics and place attachment were the most critical landscape values. Predictable changes to landscape features, such as river and farm properties, will directly affect young people in the Site C area with construction; whereas the Mactaquac will be impacted by lifestyle changes around the reservoir under the dam removal scenario.

2.4 Keywords

Content-sharing Social Media; Generation Y; Hydroelectric Dam; Instagram; Landscape perception; Social Impact Assessment

2.5 Introduction

Energy proposals that lead to water impoundment, such as hydroelectric dams, are different from many others in that a new visual landscape, ecosystem, and sometimes amenity emerges, which can in turn change local settlement patterns, residents' perceptions, and their lifestyles (Hough, 1990). Water landscapes are important in part for their relationship to various landscape features (Menárguez & Holgado, 2014). The appearance of energy facilities in a water setting thus causes an interruption to a continuous landscape (Parkhill, Butler, & Pidgeon, 2014; Filova, Vojar, Svobodova, & Sklenicka, 2015) such as flooded lands, new headpond features and surrounding parks and recreation areas. Such construction initiates a process of reforming visual resources and reestablishing ecosystems, which interacts with landscape and cultural changes, resettlements of local communities, and shifting economics and livelihoods. Human perceptions of landscape and human behaviors will change accordingly with the alterations of the physical landscape, and their experiences in it.

Younger generations will inherit the large-scale landscape changes caused by hydroelectric energy projects and likely will live longer with the consequences of those landscape changes. But this demographic is often underrepresented in conventional stakeholder engagement processes (Checkoway, Allison, & Montoya, 2005; Lückman, Lagemann, & Menzel, 2013; Keilty, Beckley, & Sherren, 2016). Though apathy has generally increased over the past 30 years, people under the age of 25 show the highest decrease of interest in politics and public affairs (Delli Carpini, 2000; Pasek, Kenski, Romer, & Jamieson, 2006; Sloam, 2012). Much of the engagement (e.g. discussion, activism) around public issues that do occur within this demographic cohort - Generation

Y or so-called Millennials who were born from early 1980s to early 2000s - happens on social media (Delli Carpini, 2000; Quintelier & Vissers, 2008; Park, Kee, & Valenzuela, 2009) where this generation also documents their lifestyles and other attitudes.

Such online documentation makes social media a valuable source of secondary data to help proponents and decision-makers anticipate the impacts of energy proposals on this important but largely invisible demographic. Text-based social media, such as *Twitter*, has been leveraged by decision-makers to share information, listen to opinions, and facilitate public discourse (Vieweg, Hughes, Starbird, & Palen, 2010; Autry & Kelly, 2012; Smith, 2014; Kirilenko & Stepchenkova, 2014; Joseph et al., 2015). Image-sharing social media sites, such as *Instagram* and *Flickr*, are thus far underutilized, yet provide rich insight for landscape research (Barry, 2014). Unlike *Twitter*, which is more explicitly political, messages carried by landscape images on social media often imply landscape perceptions, preferences, and lifestyles, which are all of importance for energy proposals (Chen, 2015).

In this paper, we capitalize upon the above characteristics of social media use with attention to *Instagram* photos and accompanied captions from two study areas facing hydroelectricity-related landscape change: the degrading Mactaquac Generating Station (Mactaquac), New Brunswick, and the in-progress Site C Clean Energy Project (Site C), British Columbia. We use a landscape perception model by Taylor et al. (1987) integrated by psychophysical, experiential, and cognitive paradigms, which are respectively related to physical features, activities, and landscape values. We apply conventional inductive content analysis to code *Instagram* data and z-score testing to measure the relationships among the coding themes. Based on these, we build perception diagrams to understand how the current landscapes were perceived by young people in terms of physical features, human activities, and landscape values. Further discussion is focused on how their perceptions may change in the context of energy proposals at each site based on our findings, and what challenges they may face with these changes.

2.6 Theoretical Background

2.6.1 Landscape and Landscape Perception

The term landscape has no universal definition. Early research started with a division between objective and subjective landscape. The English word landscape is an old Germanic term covering two distinct components: "(1) landscape as a tract of land regarding its physical shape, and (2) as a space with the presence of human beings' daily lives and points of view alongside the actual land" (von Maltzahn, 1994, p. 109). Early geographer Sauer (1974) also defined landscape as an association of forms, both physical and cultural. Ambrose (1969) pointed out that geographers at that time had been aware of the division between objective and subjective environment. The objective or physical aspect of landscape refers to the actual land, a mix of natural features (e.g., ocean, rock, soil) and built human features (e.g., bridge, building, road). The subjective or cultural landscape is perceived in the human mind, which can vary with each individual. Even the subjective elements, however, have to rely in part on the objective, in other words, has to be stimulated by what the actual land inspires for eye or experience (von Maltzahn, 1994; Stedman, 2003).

Based on this palpable division between objective and subjective landscape, previous landscape research was conducted with a main focus on one or the other. Litton (1968) discussed different landscape compositional types, which implied that landscape might be better described and inventoried as a visual and physical entity other than a state of mind. However, other researchers considered landscape as more subjective in the context of culture, society, and history so that the same landscape could embody different meanings for different people. Ambrose (1969) talked about the importance of human thoughts and behaviors in place research, in the cultural and historical contexts. Meinig (1976) identified ten different ways to see a landscape, most of which were based on the subjectivity of landscape. Greider and Garkovich (1994) also emphasized that physical landscape was imposed meanings by human culture which sought reflections of itself.

More recently, the line between objective and subjective landscape has faded with researchers viewing landscape as an integrated concept. A precursor in this integrated study area, Tuan (1979) explained his thoughts on landscape with a balanced and systematic description that landscape is a physical world necessary for human livelihood as well as a space for humans to act and contemplate. His definition of landscape encouraged those following to explore landscape in relationships and interactions between nature and culture, physical and psychological, and external and internal. A currently accepted definition of landscape given by the European Landscape Convention furthers the emphasis on relationships between physical place and human perception: "landscape as area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000, p. 2).

Many studies in the last decade have focused on identifying and interpreting such relationships between the natural elements and the cultural memes deeply rooted in the integrity of landscape (Soini, Vaarala, & Pouta, 2012; Kyle, Jun, & Absher, 2014; Menárguez & Holgado, 2014). Landscape perception research has also moved to a more holistic stage where physical landscape and values, human senses, and their experiences are systematically examined and discussed. Butler and Berglund (2014) defined landscape perception as "involving direct physical contact and experience with the simultaneous use of all senses" (p. 221). Dupont, Antrop, and Eetvelde (2014) similarly indicated this new transition in their observation that human beings and their senses are the bridge to connect the physical landscape when observing and experiencing it.

2.6.2 Landscape Perception Model

Understanding local and non-local landscape perception of landscape is critical for decision-making around a hydroelectric energy project. The landscape perception circle (Figure 2) explains that human perceptions of the current landscape can affect hydroelectric energy development proposals in terms of the social acceptability of such projects as sought through public consultation. Implementations of the projects can later reshape the landscape, and the new landscape will impact human perceptions in another project (this conceptual framework was adapted from Aggestam, 2014).

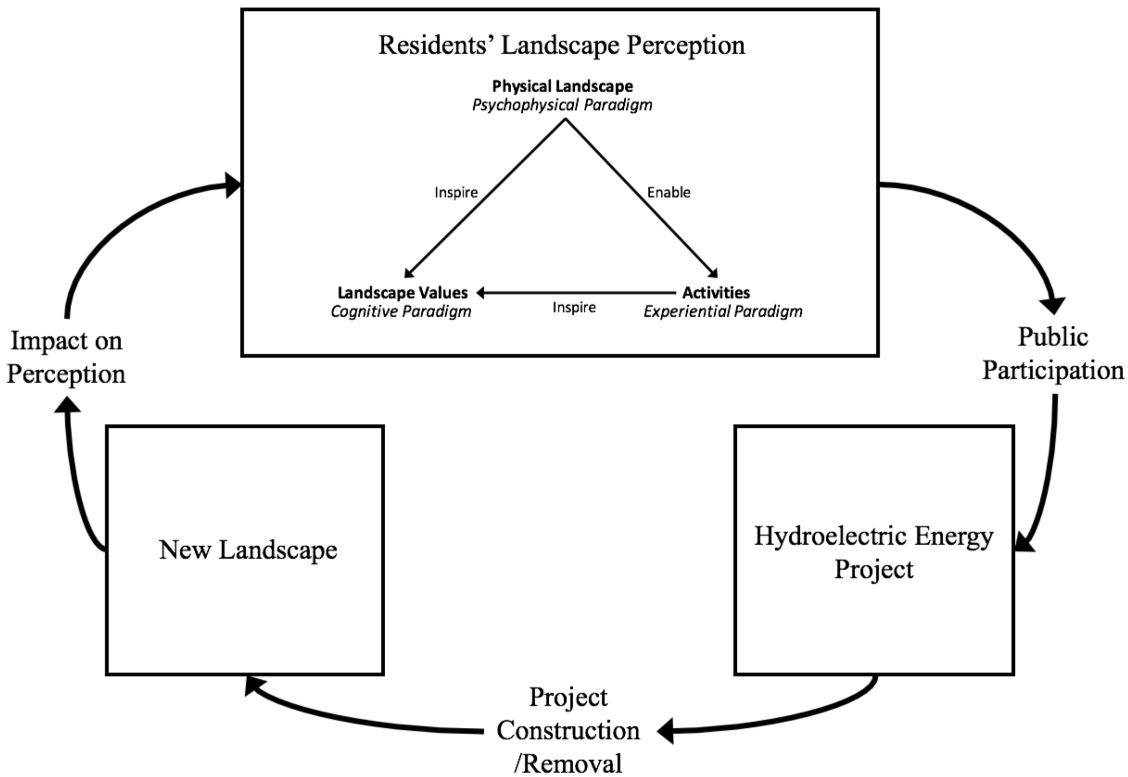


Figure 2. Landscape perception circle for hydroelectricity proposals (adapted from Taylor, Zube, & Sell, 1987, and Aggestam, 2014).

We build a landscape perception model based on the theory that was originally developed by Taylor, Zube, and Sell's (1987). Their work summarized previous work from the 1960s to 1970s when the area was relatively new, and explained landscape perceptions in four paradigms: the expert, psychophysical, experiential, and cognitive. This has become the groundwork for many of the latter landscape studies, such as landscape preference, aesthetics, symbolism, and sense of place (Jacobsen, 2007).

The *expert paradigm* demonstrates the evaluation of landscape from an expert perspective with considerations of artistic aspect, knowledge of ecology, and resource management (Taylor et al., 1987). Relying on experts who are well-trained to view landscape in a professional way, this paradigm was most prominent in the early years

(Litton, 1968), but less applied recently when the landscape evaluation is more linked to ordinary people's judgments (Jacobsen, 2007).

The *psychophysical paradigm* is widely accepted and the basis of many ranking and sorting techniques in landscape research, such as the Q-sort questionnaire (Kaymaz, 2012; Navrátil et al., 2013). It emphasizes a stimulus-response relation between physical landscape features and people's perceptions without conscious thought (Taylor et al., 1987). It aims to identify what aspects of physical landscape is valued. Such inherent value may be associated with the fact that a certain landscape feature enables people to do particular activities or offers specific meanings. Under this paradigm the focus is on landscape features, understanding which are preferred by people to view and show, and how commonly perceived features will enable activities and inspire values.

The *experiential paradigm* captures human perceptions of landscape from experiences in the landscape and the outcomes of such interactions (Taylor et al., 1987). In this sense, the focus is not the individual human or landscape feature, but the entire sensory immersion of human beings in the landscape, which can eliminate the dichotomy between human and environment (Carlson, 2012). Research methods based on this paradigm have been widely used in landscape perception research, such as field tours and on site interviews (Hunziker, 1995; Keating, 2012; Sherren et al., 2016). Analyzing human activities in the landscape under this paradigm considers how people use the landscape and identifies relationships between features and human experiences.

The *cognitive paradigm* derives from a more subjective perspective, where people perceive landscape by selecting features that have value to them (Taylor et al., 1987). This is a construct comprised of the visual aspects of a physical landscape and the specific activities enabled there. The cognitive paradigm explores *why* specific landscapes are valued. Research conducted on landscape values by implementing this paradigm not only identify the valuable landscape features, but also facilitate participants to think and explain why these are valued (Scolozzi, Schirpke, Detassis, Abdullah, & Gretter, 2015). Other landscape research related to landscape preference and symbolism was also developed on this paradigm (Jacobsen, 2007).

The model we built covers three of the paradigms (Figure 2). The psychophysical paradigm was used to interpret the physical landscapes perceived by the young people. These physical landscape features might enable human beings to do particular activities, represented by the experiential paradigm. Both physical landscape features and activities in the landscape can inspire landscape values, the rationales and stimulants that the cognitive paradigm represents. In brief, local landscape perceptions are an outcome of physical landscape, human interactions with it, and subsequent landscape values. The expert paradigm is an outsider perspective, which does not fit into our research to understand young residents' perceptions via coding their photos.

2.6.3 Hydroelectricity Landscapes and Youth Engagement

Hydroelectric dams are unlike other energy installations for the scale and nature of their landscape impacts – giving them more in common with impoundments for agricultural irrigation or flood control – and are thus subject to numerous concerns about the presence of utilitarian infrastructure in water landscapes. Rivers were the birthplaces of most ancient civilizations, providing appropriate conditions for livelihoods and transportation (Menárguez & Holgado, 2014). Studies show that the presence of water is always seen as positive by people (i.e. 'hydrophilia' as coined by Bernáldez, 1985; see also Lückmann et al., 2013; Filova et al., 2015). Changes in water landscapes, however, can cause local stress whereby hydroelectric energy facilities may often be initially stigmatized with causing the deterioration of nature, the environment, and the visual landscape (Parkhill et al., 2014).

Hydroelectric energy projects cause remarkable landscape and lifestyle changes (Atkins, Simmons, & Roberts, 1998), and thus require a full understanding of public perspectives on these changes, particularly among those who interact with the landscape. A more accurate identification of local interests will allow proponents to adapt proposals and decisions in relation to a fuller understanding of stakeholder values and needs (Aggestam, 2014; Butler & Berglund, 2014). Culturally, researchers note that shared values are diminished in contemporary society, replaced by greater cultural and values diversity, perpetuated by the information age where an understanding of such diversity may help to mitigate potential conflicts and tensions (Butler & Berglund, 2014). Conventional public engagement (e.g., public hearings, consultations, surveys), however, may not always be effective or efficient in this digital society due to the systematic demographic biases introduced by voluntary participation. Recent landscape research conducted in the Mactaquac area, New Brunswick, has shown the difficulty of reaching the younger generations to understand their opinions toward decisions facing the landscape (Keilty et al., 2016; Sherren et al., 2016; NB Power, 2016b).

Social media, as one of the main communication tools among young people, can provide rich insight on their thoughts and opinions. Today's young people prefer to use social media for information acquisition, exchange, and dissemination. This is not only limited to their private lives, but also public lives. One study indicated that Generation Y, born from 1977 to 1990, is more likely than older generations to use social networking sites (Cabral, 2011). They spend more time using online communication tools and are more comfortable doing so than older adults (Raacke & Bonds-Raacke, 2008). Social media sites such as *Twitter* and *Instagram* have a particular appeal to younger adults (Lenhart, Madden, Smith, & Macgill, 2007; Duggan & Smith, 2013). The activity of young people on such sites suggests that the gap in understanding about their landscape perceptions can be filled in part by analyzing social media data.

2.7 Methods

We leverage the age bias in *Instagram* users to consider online information close to two current hydroelectricity proposals as indicative of perceptions and lifestyles of young residents. We use thematic coding and statistics to generate perception diagrams that reveal young people's use and perceptions of the current landscape, and anticipate potential impacts under different hydroelectric energy proposal scenarios. That anticipation is based on the fact that specific landscape features will be changed by constructing or removing a dam and the associated reservoir. The new landscape formed by these changes will affect people's landscape perceptions in various ways. The alterations of the physical landscape, as well as perceived landscape, will bring various challenges and opportunities to young people in terms of lifestyle, cultural identity, and place attachment.

The first research question focuses on understanding the common landscape perception among young people in two study areas. Specifically:

(1) What were the physical landscape features commonly photographed?

(2) What activities were associated with those physical landscape features?

(3) What landscape values were identified in the photo captions, and how were they associated with landscape features and activities?

The second research question uses the above to anticipate how young people's landscape perception might change if the landscape changes based on current hydroelectricity proposals. Can our conceptual diagrams help us to anticipate the challenges for them to react to these changes and potentially adapt to a new landscape?

2.7.1 Study Areas

The Mactaquac Dam, New Brunswick, operated by NB Power, has the capacity of generating 668 MW of renewable energy, 12% of the provincial needs (NB Power, 2014). Since its construction in the late 1960s, the landscape in that area has been changed by flooding of the reservoir (Jacques Whitford Environment Limited, 2004). Many people opposed the dam at the time, but it was part of a rural modernization program by the government and was approved despite public concerns for communities and the ecosystem (Canadian Rivers Institute, 2011). Many residents lost their houses and land. Fifty years later, the utility is facing another choice due to the early end of the Mactaquac Dam's serviceable life in 2030. There are four options for its future: first, repowering the dam; second, retiring the dam but retaining the reservoir; third, removing the dam and restoring the river, and last, repairing the dam (NB Power, 2016a). These options have triggered public discussions about economic concerns, environmental impacts, and other social issues (Sherren et al., 2016). A decision is due in late 2016.

Compared with the situation of the Mactaquac Dam, the proposed Site C project is in progress to become a new dam in the Peace River catchment, flooding about 3000 hectares of fertile, low-lying farmland under the reservoir (Hume, 2014). The Joint

Review Panel report on BC Hydro's environmental impact statement about the Site C Dam revealed that the effect of the project on the landscape would be a significant adverse effect which would be irreversible (BC Hydro & Power Authority British Columbia, 2014). The environmental assessment report of the Site C project was approved by the Province of British Columbia on December 16, 2014 and its construction began in the summer of 2015 (BC Hydro, n.d.). This has caused heated discussions across the province and local stress. In early July, 2015, BC Hydro issued the construction notification letters for the Site C to aboriginal communities and regional governments, attached with an overview of its 10-year construction schedule (BC Hydro, 2015).

While the case studies differ in many ways, the general landscape is similar. Both dam locations are within a short distance of a significant town (Fredericton, NB, population 56,000; Fort St. John, BC, population 19,000), with an upstream area characterized by farmland and small resource towns (<5,000 people each). The Mactaquac area was cleared for farming starting in the late 1700s by United Empire Loyalists from the American Revolution, rewarded with land along the St. John River for their loyalty to England (Lawson, Farnsworth, & Hartley, 1985). The Peace River valley was the site of exploration and mineral prospecting in the late 1700s and 1800s and only cleared by farmers in the early decades of the 1900s (Pollon & Matheson, 2003). Both dams are the most downstream of three on their respective rivers.

The two dams are at different phases of their lifecycles. The landscape formed by the Mactaquac Dam and its reservoir has been appreciated for decades by local residents (Keilty et al., 2016). To remove the dam is the least preferred option in that area, but there is little debate outside the region. However, the Site C Dam plan has caused wide rejection within local communities, as well as negative mobilization in far-flung population centers such as the provincial capital of Victoria (Chen, 2015; Amnesty International, 2016). The opposite opinions toward hydroelectric energy facilities in New Brunswick and British Columbia represent the fact: residents largely want to keep the current landscape. Our research analyzed photographic and text-based data from both study areas to explain people's landscape perceptions at different phases of a hydroelectric dam project, and in different areas.

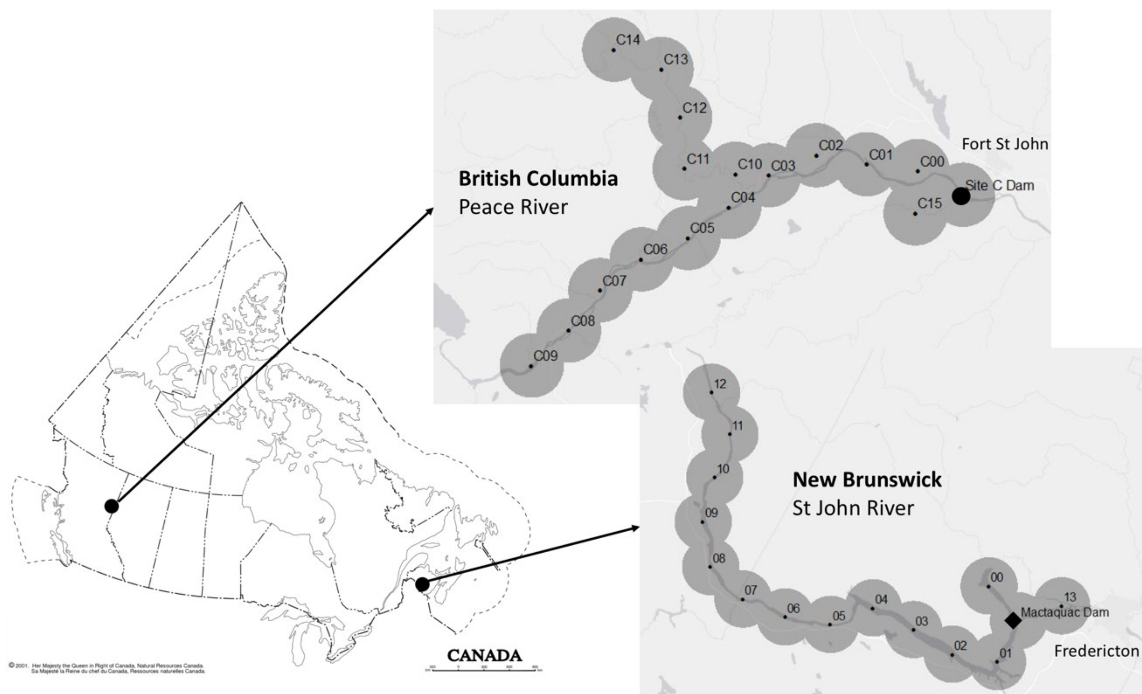


Figure 3. Maps of study areas, Site C, BC, and Mactaquac, NB, Canada (adapted from Natural Resources Canada, 2001), including the data collection point buffer zones in Site C (up right) and in Mactaquac (lower right).

2.7.2 Data Collection

Instagram photos and text-based captions were collected by geographic information via *Netlytic*, an online tool that can discover and collect conversations on multiple social media sites (Netlytic, 2015). *Instagram* is a popular platform for young people to show their personal lives and engage in public life. In September 2015, it had 400 million monthly active users (Statista, 2015). According to a survey conducted by the *Pew Research Center*, over 90% of the 150 million *Instagram* users are under the age of 35 (Smith, 2014). In April 2015, 55% of *Instagram* users were under age of 29 and 83% under 49, and the proportion of younger users on *Instagram* had grown (Duggan, 2015).

We chose 17 data collection points in the Site C area, British Columbia, and 15 points in the Mactaquac Dam area, New Brunswick, representing the planned and actual reservoir extent, respectively (Figure 3). *Netlytic* retrieved the links of *Instagram* posts which contain geographic information and were uploaded within a 5km radius around each point in two study areas, over the year from October 1, 2014 to September 30, 2015.

We selected *Instagram* posts in which the photos showed sufficient landscape of the study areas to interpret (see an example in Figure 4). The text-based captions for each photo were also retrieved for analysis. After data filtering (Figure 5), the Site C Dam had a final data sample of 319 posts and the Mactaquac had 1793 posts. We categorized posts (photos and captions) into four groups among which the photos showing natural landscapes or human activities were more frequent than that of built features or unknown-activity experiences in the landscape. Besides the young bias of *Instagram* use as discussed above which supports our research need, we confirmed that all of the users who contributed to valid data were young by looking at the faces showing in the photos or other 'selfies' from the same *Instagram* account.

Figure 4. An example of an *Instagram* post from the Site C dataset (michyday, 2015).

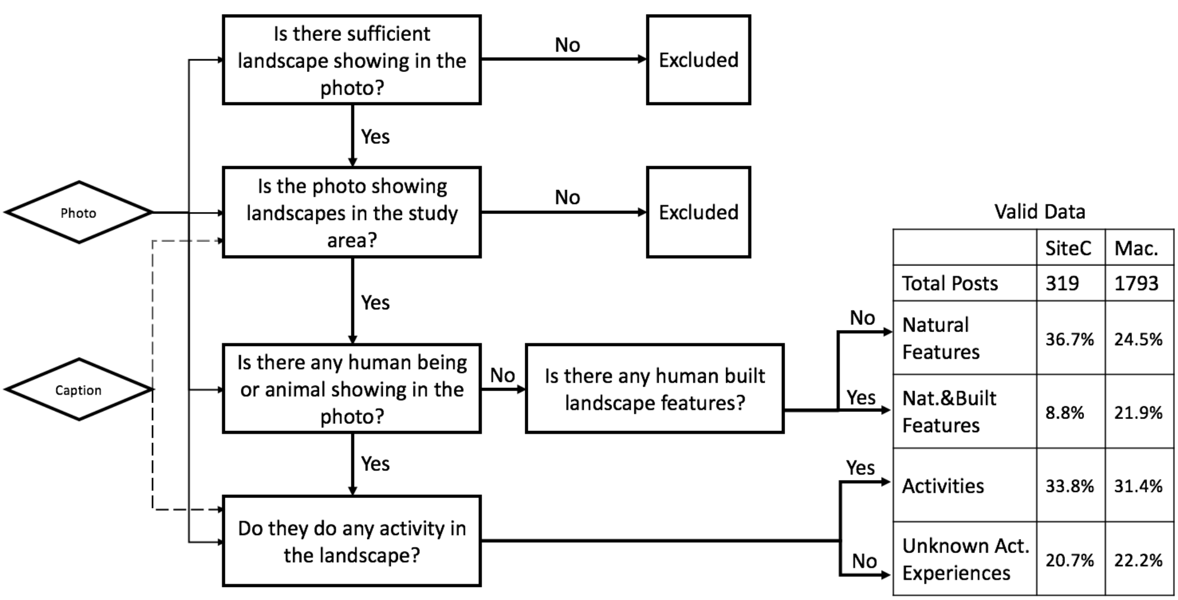


Figure 5. Flow chart for raw data filtering, including a summary of valid data for each of four photo types.

2.7.3 Category Development and Data Coding

We developed theme categories based on the landscape perception model: physical landscape features, human activities, and landscape values (Table 2). Conventional inductive content analysis was used to identify categories from the data itself (Hsieh & Shannon, 2005; Thomas, 2006).

Data coding was the process used to identify particular themes in the photos and assign them into relevant categories. In this paper, we used *NVivo 11* as the coding tool and divided the process into two parts, photo coding and text-based caption coding. Each *Instagram* photo was coded by physical landscape features (as many as identifiable), and human activities if evident in the photo. The caption for each photo, if any, aided the coding of the above. For example, activities could be clarified in texts and feelings about seasons could be identified by phrases like “I love winter” or “a horrible winter”. Captions were also used to glean landscape values by identifying specific keywords. For example, “beautiful”, “pretty” were the most frequently used keywords associated with landscape aesthetic value; “Home” was for sense of home; “community” was for community attachment; “miss” and “memory” were for memory; “life” was for lifestyle; and “Canada” or “Canadian” were for cultural identity. The coding work did not merely rely on identifying these keywords listed above, but also on the understanding of contexts. No limit was set for the number of categories into which each photo could be coded.

2.7.4 Measures

Coding results showed some of the themes co-occurred more frequently than others. Z-score testing (Li & Stepchenkova, 2012) was applied to examine the relationships among theme categories to discover the codes that co-occurred significantly more often than if randomly associated given the prevalence of each code. This helped to understand how they were perceived by young people and in what way the change of one feature can affect activities and values.

The z-score testing method followed the process explained in Li and Stechenkova's (2012) work:

$\boldsymbol{N}$= total number of photos
$\boldsymbol{f}_K$ = the number of photos in which object K occurs
$\boldsymbol{f}_L$ = the number of photos in which object L occurs
K and L are independently of one another, so
$\boldsymbol{f}_{KL}$ = the number of photos in which object K and L co-occur
$\boldsymbol{p}_{KL}$ = the possibility of co-occurrence of K and L= $\boldsymbol{p}_K\boldsymbol{p}_L$
$\boldsymbol{E}_{KL}$ = expectation of the number of photos in which K and L co-occur = $\boldsymbol{N}\boldsymbol{p}_K\boldsymbol{p}_L$
$\boldsymbol{Var}$ = variance = $\boldsymbol{N}\boldsymbol{p}_K\boldsymbol{p}_L(1-\boldsymbol{N}\boldsymbol{p}_K\boldsymbol{p}_L)$

$$\textbf{Z-score}=\frac{f_{KL}-E_{KL}}{\sqrt{Var}}$$

Z-score shows the difference between observation and expectation. A z-score higher than 1.96 indicates the co-occurrence of K and L in the same photo is at a significant level, which means the theme categories K and L are more likely to be simultaneously coded to the same photo. Z-score testing results helped to identify the significantly positive relationships among landscape theme categories. These relationships were diagrammed as networks using *Gephi 0.8.2* based on the coding and z-score testing results using the same method applied in Stepchenkova and Zhan (2013).

2.8 Results

The results of theme coding (Table 2) and z-score testing are summarized with landscape perception diagrams (Figure 6, 7, and 8). Theme categories are shown as dots scaled by the number of photos coded to each category (also shown as a number). Links between theme categories are shown for pairs with z-scores higher than 1.96, which statistically means they are significantly positively associated. The thickness of the lines is also scaled to the z-scores, also shown on the lines.

Table 2. Theme categories developed from collected *Instagram* images and captions, including in brackets the percent of photos from each site that were coded to each theme (Site C, Mactaquac).

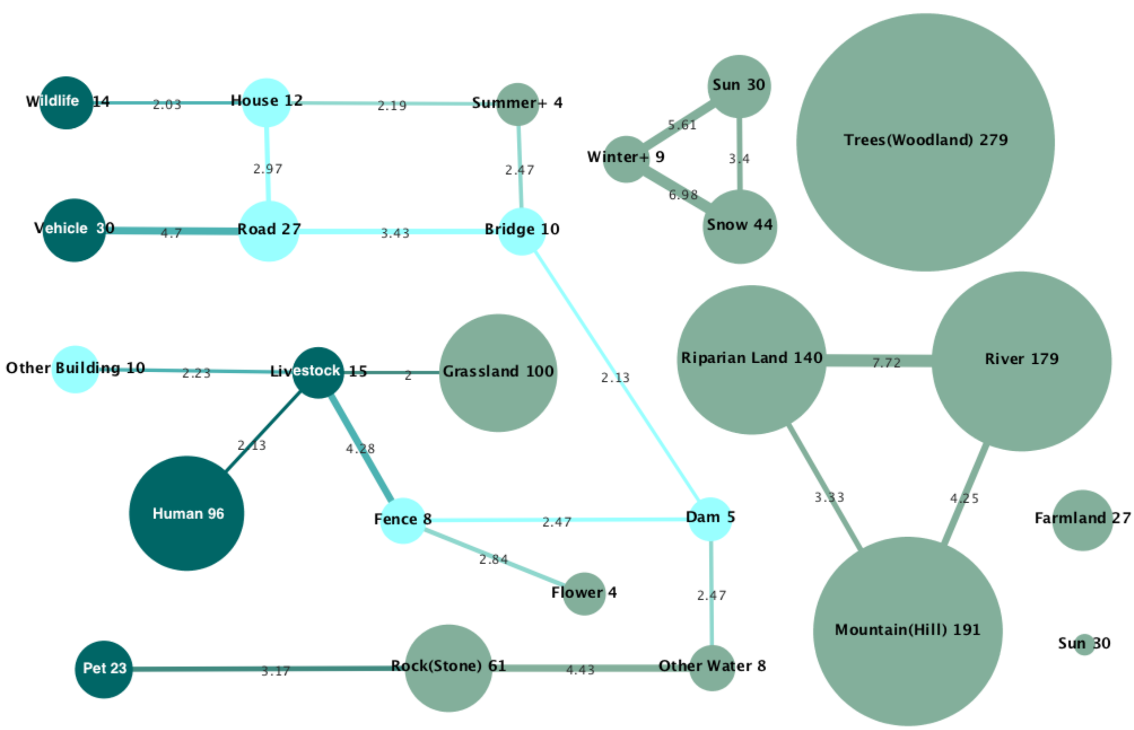
Physical Landscape Features		**Human Activities**		**Landscape Values**
Natural Features	Built Features	Hiking (7, 2)	Hunting (1, .3)	Aesthetics (22, 11)
Trees (Woodland) (88, 89)	Road (9, 11)	Boating (6, 5)	Photographing (1, .3)	Sense of Home (2, 3)
Mountain (Hill) (60, 32)	Vehicle (9, 9)	Driving (3, 4)	Zip Lining (0, 1)	Lifestyle (2, 2)
River (Reservoir) (56, 38)	House (4, 11)	Dog Walking (5, 2)	Skiing (0, 1)	Memory (1, 3)
Riparian Land (44, 34)	Bridge (3, 9)	Fishing (4, 1)	Building/Fixing (1, 0)	Cultural Identity (2, 1)
Grassland (31, 33)	Other Building (3, 7)	Swimming (1, 4)	Golf (0, 1)	Community Attachment (.3, .3)
Rock (Stone) (19, 13)	Fence (3, 4)	Celebrating (2, 2)	Kid Playing (.3, 1)	
Snow (14, 18)	Sign (1, 3)	Camping (2, 1)	Walking (.3, .2)	
Sun (9, 13)	Machine (1, 2)	Protesting (4, 0)	Soccer (.3, .1)	
Other Water Bodies (3, 14)	Dam (2, 1)	(Road/Field) Trip (1, 2)	Climbing (.3, 0)	
Farmland (8, 2)	Flag (0, 4)	Yoga (1, 2)	Tanning (0, .3)	
Orchard (0, 1)	Statue (0, 2)	Biking (0, 2)	Farming (0, .3)	
	Church (.3, .3)	Horse Riding (1, .1)	Volleyball (0, .3)	
Winter	Windmill (0, .1)	Sledding (1, 1)	Skating (0, .2)	
Positive Feeling (3, 3)	Human (30, 38)	Geocaching (1, 1)	Football (0, .1)	
Negative Feeling (0, .1)	Animals (16, 10)	Logging (.3, 1)	Baseball (0, .1)	
Summer Positive (1, 4)	Pet (7, 5)		Picnic (0, .1)	
Spring Positive (2, 1)	Wildlife (4, 4)			
Autumn Positive (.3, 1)	Livestock (5, 2)			

2.8.1 Landscape Features

Young people's perceptions of landscape feature in the two study areas (Figure 6a and 6b), The Site C area, British Columbia, and the Mactaquac area, New Brunswick, implies the physical landscapes perceived by the young people were quite similar. Trees were the most frequent feature showing in the photos (trees appeared in 87% of photos in the Site C dataset, and 89% in the Mactaquac dataset). In these photos, trees varied from an individual tree on the street, middle-sized woodlands, to large tracts of forest. However, trees had no preference of association with any other landscape feature, indicating that trees were ubiquitous. At both sites, riparian land, river/reservoir (i.e. the main channel of the river in yet-undammed Site C, or the reservoir in Mactaquac), and mountain/hill (again depending on topographic variation in the two sites) frequently appeared: for the Site C dataset, 44%, 56%, and 60% photos were respectively coded with riparian land, river and mountain; for the Mactaquac, 34%, 38%, and 32%. Unlike trees, which were isolated features due to ubiquity, these three features appeared together at both sites (for the Site C, z-scores between these features were higher than 3.33; for the Mactaquac, higher than 8.25). Among the *Instagram* photos collected, typical views showed the main river or reservoir with riparian lands and high-slope land nearby or mountains far away in the background, suggesting these three features were preferentially combined in photos. This was sometimes but not always because the features were physically adjacent. Other recognizable feature pairs that were preferentially linked in both cases make intuitive sense: road|vehicle, positive attitude towards winter|snow, livestock|grassland, rock|other water (generally small brooks).

Differences were also found between the young people's perceived landscapes of the two study areas. The overall structures of the two perception images indicate that many features in the Mactaquac area were significantly positively associated with each other (more pairs of features had z-scores higher than 1.96), suggesting they were highly integrated; landscape features in the Site C were less often connected. By looking through the *Instagram* photos, we noted the landscape in the Mactaquac area was flatter, which made physical features visually continuous; and there were more human settlements along the reservoir, which indicates the young people there had daily interactions with the landscape. The Site C area was more remote, often only reached during outdoor activities such as hiking.

a)



b)

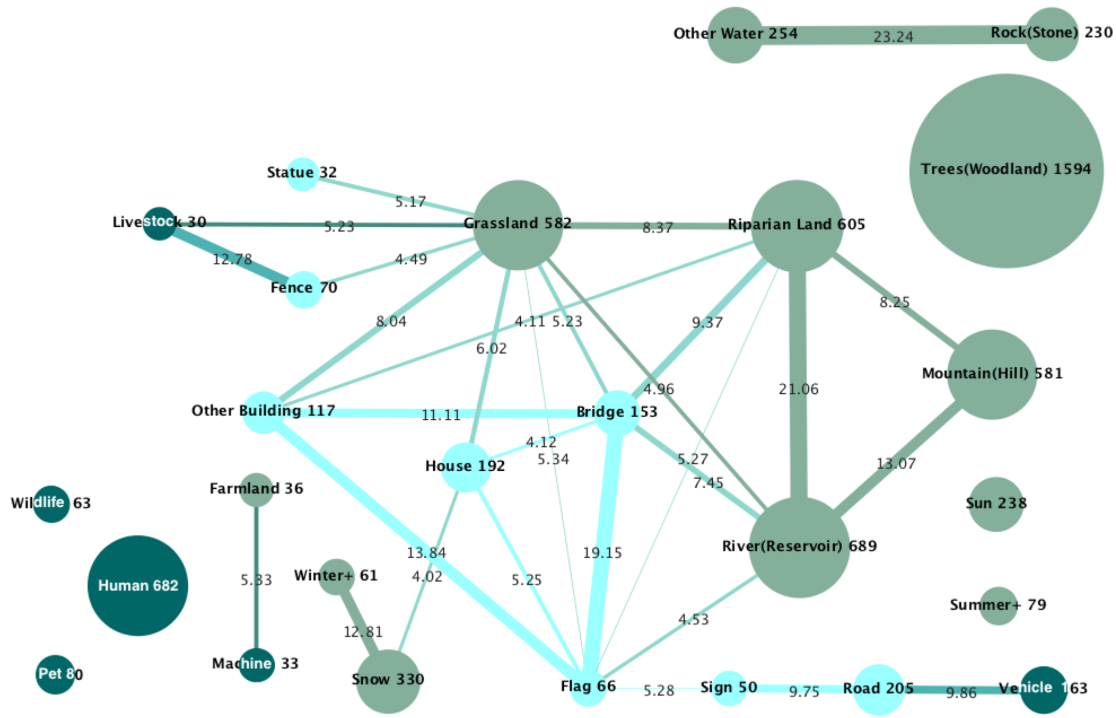


Figure 6. Landscape perception diagrams based on physical landscape features (movable features in dark green, natural features in green, and built features in light blue) coded for a year of *Instagram* landscape photos covering (a) The Site C area, BC, and (b) the Mactaquac area, NB. Numbers refer to coded posts and z-scores, thickness of lines refers to strength of association (z-score).

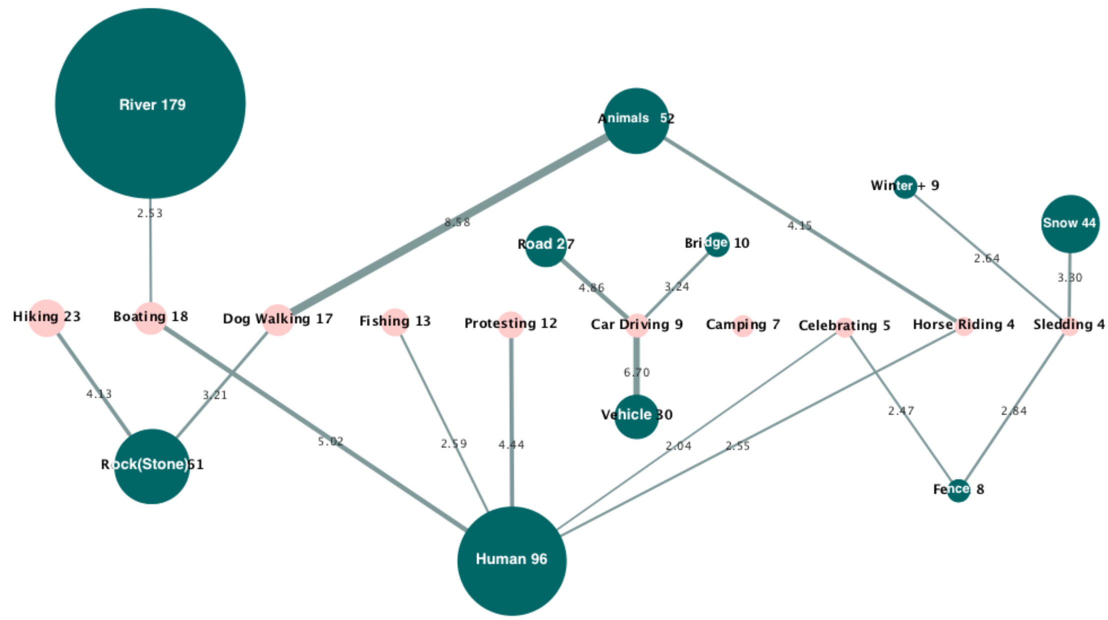
2.8.2 Landscape Features and Activities

The most popular activities identified in the study cases are recreational ones, and some of them were common in both areas, such as hiking, boating, dog walking, and camping (Table 2). Other activities like celebrating and car driving were also shared in the study areas. Each site also had unique activities that were only favored there, for example, protesting in the Site C area and yoga in the Mactaquac area. These anomalies are explained later.

The associations between visible activities and landscape features suggest that key features enable the same activity in both study areas (Figure 7a and 7b). The Peace River in the Site C area was significantly associated with boating (z-score=2.53), just like the reservoir in the Mactaquac case (z-score=8.83). In the latter area, boating was also highly associated with people's positive feelings toward the summer time (z-score=4.9). Young people frequently uploaded photos on *Instagram* showing them boating in the reservoir accompanied by captions about enjoying the summer time. Rocky landscapes significantly associated with hiking activity (for the Site C, z-score=4.13; for the Mactaquac, z-score=9.26). However, the photos showed that the two areas had quite different rocky landscapes: The Site C area was mostly in the mountains while the Mactaquac was near water bodies such as lakes and water falls other than the reservoir. The landscape of other water bodies with rocks was also popular for swimming in the Mactaquac area.

There were also different activities in the two areas. Young people in the Site C area did winter activities, such as sledding which had significant relations with snow (z-score=3.3) and people's positive feelings toward the winter time (z-score=2.64). However, in the Mactaquac area, summer activities such as swimming and biking were more frequent. Although there were activities in the Mactaquac area associated with winter or snow like yoga, thus pattern was mostly contributed by photos uploaded by a single yoga enthusiast and several of her followers who were doing yoga outdoors in the winter. Likewise, the Site C area had a unique activity: protesting. This derived from an organized river paddling event to protest the Site C project by local residents in July, 2015, right before the beginning of its construction. The event was a way for people to express concerns with the potential environmental problems and landscape changes the new dam would bring to this region.

a)



b)

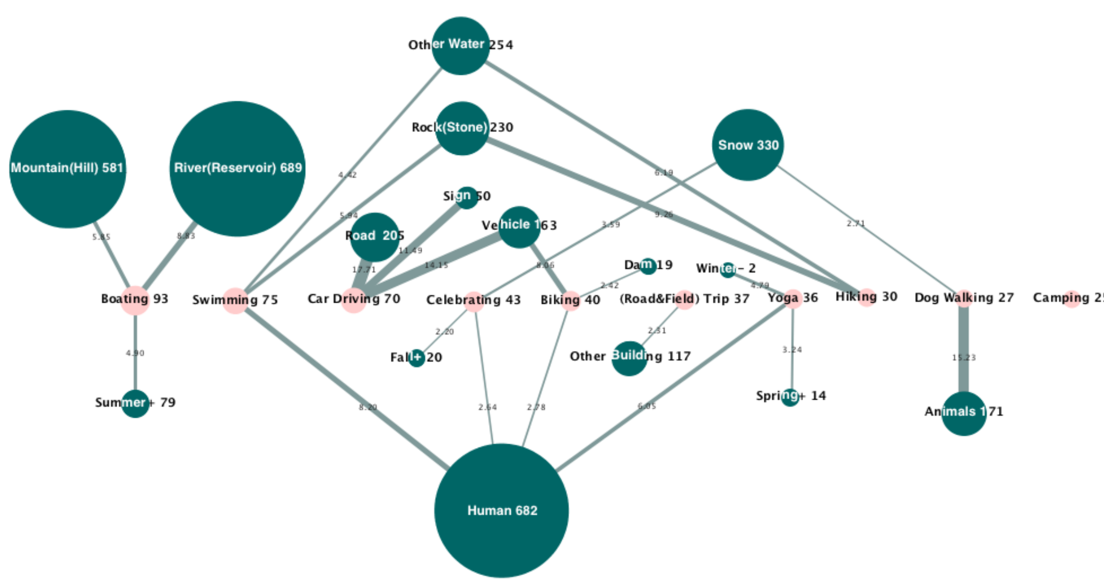


Figure 7. Landscape perception diagrams based on physical landscape features (dark green) and activities (light pink) coded for a year of *Instagram* landscape photos covering (a) The Site C area, BC, and (b) the Mactaquac area, NB.

2.8.3 Landscape Values

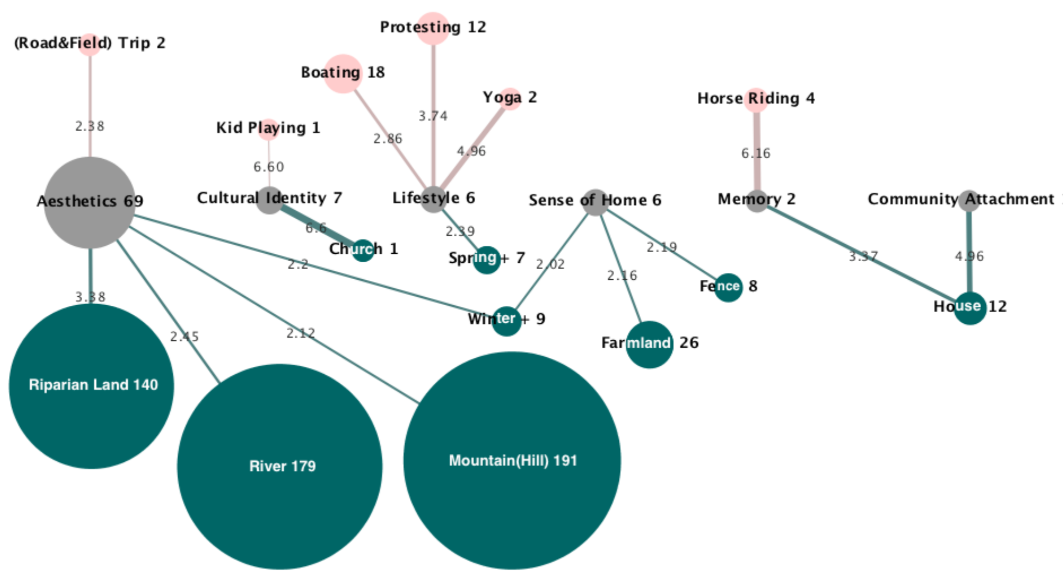
The six most important values discovered within *Instagram* captions were aesthetics, sense of home, community attachment, memory, lifestyle, and cultural identity in both study areas (Table 2). In the Site C area, the most important landscape value identified was aesthetic value, which positively associated with river, riparian land, mountain/hill, and people's positive feelings toward the wintertime (Figure 8a). Most of the photos coded with aesthetic value did not show significant association with any activity, implying that people might just stop by and take a picture, but without doing any particular activity in that location. The aesthetic value was also most frequently identified in the Mactaquac area, but had close relationships with sun (including sunsets and sunrises), and positive perceptions of the winter and autumn seasons (Figure 8b). Unlike in the Site C area, aesthetic value was not tied with the reservoir in Mactaquac. Instead, there was a significant correlation between aesthetics and hiking, which people in Mactaquac did more often near other water bodies, such as lakes and streams, rather than the reservoir.

Sense of home was another landscape value expressed by young people. In the Site C area, this sense was associated with people's positive feelings toward the winter time, farmland, and fences. Community attachment, as a similar concept, was linked to houses. Hence, farmland, houses, and fences combined at the core of people's attachment to the place. Several *Instagram* users wrote captions that their farm properties would be flooded by the new dam, and this could negatively affect their sense of belonging to the land. In the Mactaquac case, sense of home and community attachment were both associated with houses near the water.

More messages can be dug from significant associations with activities like car driving and celebrating. Many photos from the dataset showed a view of the photographers' familiar landscape on the road when they drove back home; and the captions usually emphasized their excited feelings of being home (e.g., "it's home!"). Celebrating events, such as festivals, birthdays, weddings, and so on, greatly evoked the landscape value of place attachment when the young people were with their family in their hometown or at home.

Landscape as lifestyle told different stories in the two study areas. Young people in the Site C area had more positive feelings about the spring time, perhaps not surprising given the length of winter so far north. Many photos showed they started to boat in the river when the winter ended, and appreciated the better weather and more opportunities to be outdoors. In the Mactaquac area, lifestyle was more associated with summer time and associated activities. Many of the photo captions implied that the young people viewed "summer", "lifestyle", and "headpond lake" as an integrated idea of their place value. In the long winter time, some people even uploaded summertime photos to express that they missed the "summer lake life" so much.

a)



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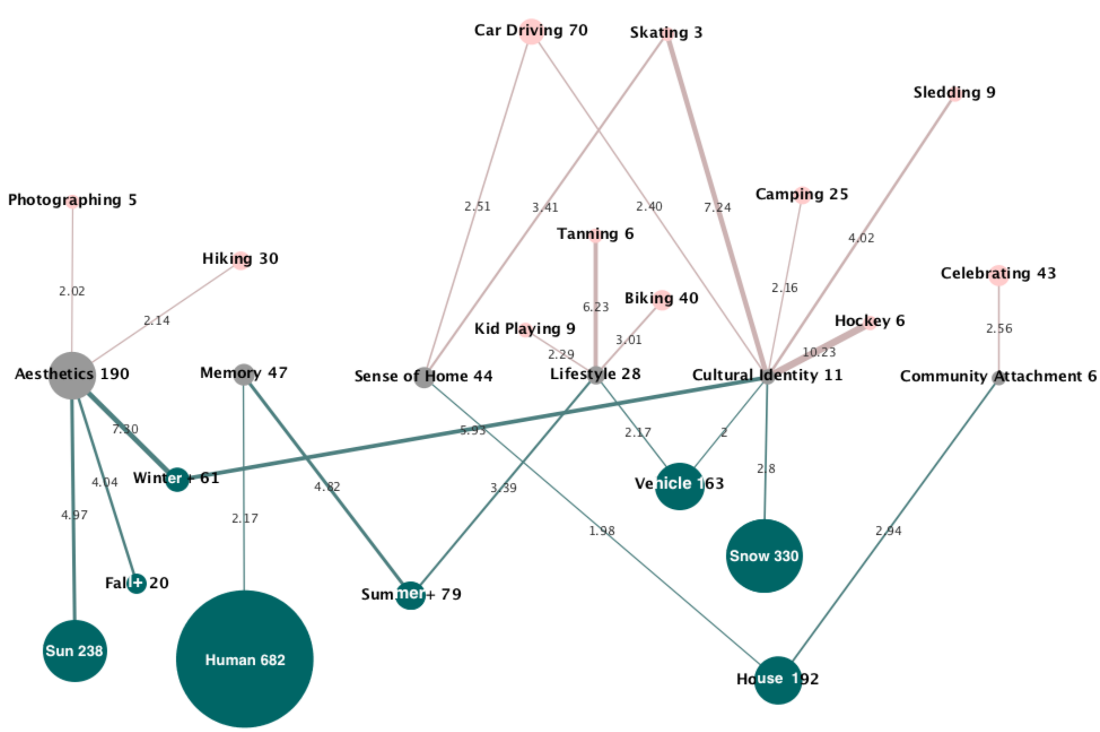

Figure 8. Landscape perception diagrams based on physical landscape features (dark green), activities (light pink), and landscape values (grey) coded for a year of *Instagram* landscape photos covering (a) The Site C area, BC, and (b) the Mactaquac area, NB.

2.9 Discussion

We collected data by geographic coordinates from a photo-sharing social media site, *Instagram*, to understand landscape perceptions of young people in new and old hydroelectricity landscapes. Specifically, we sought to understand: (1) young people's landscape perceptions in the study areas, regarding physical landscape features, human activities, and values; and (2) what would be the challenges for them in the future based on how their landscape and thus landscape perception would change under different hydroelectric energy proposals. In this section we summarize the key patterns identified, and focus on the implications of landscape change by looking at the features, activities and values that were significantly associated with features that will be affected by various hydroelectricity scenarios.

2.9.1 Changing Landscape Features

Humans' landscape perceptions, in part, can be depicted by their preference for particular landscape features which are often viewed as the basis of natural-social landscape (Tuan, 1979; Stedman, 2003). The frequency of *Instagram* users showing a certain landscape feature is a strong signal of such preferences. The psychophysical paradigm creates a lens through which key features – trees, and river with lands nearby – were seen and interpreted.

Trees (woodland) were the most commonly perceived physical landscape feature in both study areas in terms of appearance in photos, however, trees had no association with any other feature. Trees were the most ubiquitous feature in both areas so that it could be easily captured by people, which contributed to their unconscious perceptions of the wood-rich landscape (Taylor et al., 1987). The majority of photos collected from *Instagram* showed trees but few users mentioned their feelings about them in captions. Without articulation, though, the perception of trees is often positive since trees enable beliefs, such as nature being worth preserving and an indispensable part of daily life (Kaplan & Kaplan, 1989). Landscape views with trees may also have positive implications for sensual appreciation associated with health and well-being (Bernáldez, 1985; Kaplan, Kaplan, & Ryan, 1998). These sentiments are consistent with one of the most prominent motives for sharing photos online: people post and send photos on social media for gratification, including self-expression, showing positive feelings, and constructing identity (Charney & Greenberg, 2002; Hunt, Lin, & Atkin, 2014).

The loss of trees, as the most commonly and often positively perceived feature, would be anticipated to negatively affect young people's attitudes toward the landscape in both study areas, although both have logging histories. Certainly, tree removal commonly comes before the inundation of land by water for hydroelectricity (Panwar et al., 2010). Intermediate stages, where trees are removed but the landscape is not yet flooded, or conversely, a dam is removed but the exposed land not yet revegetated, can be confronting for locals. However, the deforestation rate may accelerate with more human settlements and road expansion near the dam, which can further enhance intensive logging in such forestry-based areas (Chen, Powers, Carvalho, & Mora, 2015). Especially in Site C, no assurance could be given that the tree loss could be compensated or restricted afterwards since more anthropogenic disturbances are foreseeable.

River, riparian land, and mountains/hills were identified together as a main cluster from the perception image of the Site C area, suggesting that these three features were often perceived as a whole. Their physical adjacency may partially contribute to the combination, but the psychophysical paradigm also suggests that river, riparian land, and mountain were perceived together because they enabled a similar aesthetic appreciation for viewers (Taylor et al., 1987). Water in landscape is usually preferred by people, and a natural and vegetation-covered edge in the waterscape will enhance appreciation (Kaplan et al., 1998). Our findings of landscape values, which will be discussed later, also revealed aesthetics that were inspired by the combination of the three features. Changes of any feature of the three will undermine this triangular construct in human perceptions. The Mactaquac case showed similar results, however, the three features were not independently grouped as one cluster, but were at the center of a larger cloud with another 14 features. This implies a more integrated and perhaps more vulnerable landscape view in Mactaquac: the topography is flatter which increases the accessibility of the water body and the visual connection of various landscape features (Hough, 1990).

Farmland is also prominent in both settings, including grassland and associated livestock, and will be subject to change in Site C following inundation. This is one of the key reasons for opposition to dam construction in terms of the potential loss of high quality land, agricultural economy, food security, etc. Numerous participants in public hearings expressed their central concerns for “losses to agriculture and the farming way of life” (BC Hydro & Power Authority British Columbia, 2014, p. 147). According to our parallel research on public information available through *Twitter* around the Site C project, some of the key opinion leaders identified were farmland owners, an agricultural union founder, and agricultural economists (Chen, 2015). They had made efforts to organize other farmers and to evoke public awareness of the negative effects the dam would bring, such as fertile farmland loss, self-identity loss, and degradation in agricultural industry (Chen, 2015).

2.9.2 Changing Activities

The experimental paradigm relies on the human-landscape relationship: that specific activities can be facilitated in particular landscapes (Taylor et al., 1987; Thwaites & Smikins, 2007). Stedman (2003) also pointed out how the physical environment can inspire and constrain human experiences in the landscape, which usually shapes meanings of the place. Mactaquac is a more inhabited landscape than Site C, too, due to good landscape accessibility and developed towns along the St. John River. Mactaquac photos not only showed recreational scenes (e.g., swimming in the reservoir) but also living (e.g., dog walking in neighborhoods) and working (e.g., farming, logging in forests). Potential landscape changes in this area were predicted to bring larger impact than the Site C on young people's feelings and usage of the landscape had permeated almost every facet of their daily life.

The river and reservoir were identified as key features facilitating boating in both study areas, but different kinds of boating were typical based on the running or still water that characterize each place. In Site C, river boating was a lifestyle but also a political choice. During the paddling event to protest the Site C project, the residents chose to boat the Peace River as a silent way to show the strong tie between them and their beloved river. Similarly, river and boating were also associated with young people's identity in Mactaquac, where the way they lived in the landscape was formed by the water. None of the photos in Mactaquac mentioned the dam decision itself, instead, they commented on how important the reservoir was for their "#riverlife" by posting photos showing recreational activities in the water. While water will remain in both landscapes under all scenarios, it is clear that the type of boating may have to change, significantly affecting summer lifestyles.

In Site C, fishing was one of the most common activities, and dam construction is likely to affect fish species and populations (Fearnside, 2014). This process has already occurred in Mactaquac, where salmon populations collapsed after dam construction, replaced by stocking with bass (Sherren et al., 2016). The environmental impact assessment of the Site C project revealed it would likely have loss of indigenous species. For the aboriginal people, especially, the changes to the water landscape will impact their fishing practices and cultural attachment to specific fishing sites along the river (BC Hydro & Power Authority British Columbia, 2014). Demonstrated in the same report, unfortunately, there was no evidence showing such lost habitat could be reestablished somewhere nearby, thus fishing as a popular activity in this area may experience permanent and irreversible impacts.

Also notable is the prevalence of a ‘car culture’ in both places, evidenced by driving as a significant activity, linked to features such as roads, vehicles, signs and bridges. Rooted in the western car culture, the vast majority of Canadians in a survey implied that cars were more important than televisions and telephones in their daily life (Canada NewsWire, 2003). Not only because of a lack in public transportation, young people also associate car access or ownership as a symbol of social status, thus it is critical for their self-actualization (O’Connor & Kelly, 2006). BC Hydro claimed that there would be benefits from highway improvements, though local residents are concerned that road construction and increased traffic volume will significantly affect their car-based lives (BC Hydro & Power Authority British Columbia, 2014). Such construction-related disruption is long over in Mactaquac, but any of the options it faces involves significant disruption to transportation, given that the dam serves as the only Saint John River crossing in the 70 km between Fredericton and Nackawic.

2.9.3 Changing Values

Landscape value was interpreted based on the cognitive paradigm which aimed to understand the reason why the place was valued (Taylor et al., 1987). By looking at the overall structure of young people's perceptions of landscape values, we found the values had more direct associations with physical features than with activities in the Site C area, suggesting that the landscape itself and its direct changes will most affect the values there, specifically (river- and farmland-related) aesthetics and place attachment. However, the Mactaquac case showed that the young people valued the landscape not only based on the physical features, but more because their lifestyles are shaped by features and activities, all of which were less vulnerable to change based on associated features.

Aesthetic value of the landscape was common in both study areas (a general bias of most photography), which might be driven by a preference for 'nature' (even in highly modified landscapes like Mactaquac) (Fox, Magilligan, & Sneddon, 2016). Parsons (2012) discussed that people perceive natural things as aesthetically valued. The stimuli identified for aesthetic value in both study areas were different, though all of them were natural features of the landscape. Site C case had its aesthetic value associated with river, riparian land, and mountains, suggesting the combination of these features directly facilitated the value. However, the Mactaquac did not show any evidence that values were evoked by the reservoir (instead, seasons and sun). Aesthetic values are thus more threatened at Site C as a result of dam construction, than at Mactaquac as a result of potential dam removal.

On the other hand, experience including being and doing activities in the landscape, can stimulate aesthetic appreciation as well (Bourassa, 1990; Hunziker; 1995; Keating, 2012; Nielson, Heyman, & Richnau, 2012). We can consider all the *Instagram* photographers as experiencing the landscape by being there for photo taking. Aesthetic value in the case studies seemed associated by time spent away from home: in Site C the only activity significantly linked to aesthetics was 'road trips', and even that not often, and for Mactaquac it was hiking.

Unlike the Site C, landscape values in the Mactaquac were more associated with lifestyle. Dakin (2003) demonstrated landscape as way of life because it is where people inhabit, embrace livelihoods, recreational activities, and attach to home. Young people's lifestyles were greatly stimulated by positive feelings in the summer time and activities like tanning, biking, and children playing, all pointing to a happy scene in summer. Much of this likely occurred near the reservoir, although it was not always visible: a large number of photos had captions commenting about people's "#lakelife" and "summer land". Landscape as memory in Mactaquac showed the same message, such as one commented on a landscape photo as "I miss the summer here".

Community attachment and sense of home were connected values, expressing a similar meaning of place attachment. *Instagram* users in both areas used keywords such as home, hometown, community, and family to express their feelings on properties, land, and the places. These values were mostly stimulated by houses, as a symbol of settlement. Previous research has indicated that community and home are two important contributors of a sense of place (Spirn, 1998; Duncan, & Lambert, 2004; Beckley, Stedman, Wallace, & Ambard, 2007) and property owners have a stronger attachment to a place (Meinig, 1976; Hough, 1990; Stedman et al., 2007). Tuan (1979) discussed that the fondness and attachment of a place could also be explained by people's familiarity of the place, incarnation of the past, and pride of ownership or of creation. The difference emerged from where sense of home was perceived by young people: in relation to fences and farmland in the Site C area, at risk of flooding, but to houses (at risk of losing lake views) in the Mactaquac area. Atkins, Simmons, and Roberts (1998) discussed that fences may imply ownership and prohibition to trespassers, which may indicate that young people in Site C had a stronger sense of farm property ownership, or at least a sense of safety or pride in that evidence of human occupation and labour (Tuan, 1977). Landscape changes related to property loss will affect the young generation's sense of home and community attachment in both study areas, and the farmland loss particularly for the Site C youth.

2.9.4 Implications for Case Studies

Based on our understanding of young people's current landscape perceptions in terms of landscape features, activities, and values, we then anticipated potential changes under different hydroelectric energy options.

For the Site C Dam, as the proposal was approved in 2014, and construction activities have been conducted from the summer in 2015, the predicted landscape changes will mostly affect the river and riparian land, as well as fishing conditions. Other foreseeable changes include the loss of high quality agricultural land, adjacent transportation and riparian settlements which will cause community relocation and disruption (Atkins et al., 1998). Changes to these features will directly affect young people's perceptions of aesthetic value and place attachment. Many *Instagram* photos showed a beloved view combined with the river, riparian land, mountains, and farmland, among which one user commented it as "the last view of our Peace River". Sense of home and community attachment will be negatively affected by loss of familiarity and properties. Tuan (1977) indicated that the loss of people's settlement would cause demoralization since it implies the ruin of the world they understand.

The Mactaquac Dam is approaching the end of lifespan early and facing four options. The first three, to repair, reconstruct and to decommission the dam, would mostly keep the current landscape. This may minimize the impact on young people in that area in the long term. The option of removing the dam would cause huge landscape changes due to the river restoration and ecosystem remediation. River and riparian land, identified as commonly perceived elements in this area by young people, would be visually unpleasant during much of that period. The reservoir which has been the carrier of the cherished "#lakelife" would disappear. Such changes would negatively affect young people's perceptions of the landscape at various levels, living, working, and recreational. The aesthetic and lifestyle value would be greatly undermined. Notwithstanding acknowledged ecological benefits of river restoration, antagonism is often seen in areas facing dam removal projects (Fox et al., 2016). Likewise, recent research in the Mactaquac area showed that collective discussions supported keeping the reservoir intact (Sherren et al., 2016). Though young people have so far been under-consulted in that decision process, saving the reservoir seems likely to be the key to saving their lifestyle, as well as associated meanings and values of the landscape, and the place.

Challenges for the young generation exist in both areas. They may live in the new landscape for the longest time in the future. Atkins, Simmons, and Roberts (1998) discussed that long-lived landscapes can be accepted unquestioningly by people, but uncertainty and unfamiliarity of landscape will cause uncomfortable and threatening feelings (Atkins et al., 1998; Kaplan, Kaplan, & Ryan, 1998). The process of interacting with a new physical landscape, getting familiar with it, relating it to cultural memes, finding new meanings, and forming connections may last for a long time. Some people may choose to move to another place to escape the changes to cherished landscapes. Moving to a new home under duress will undermine people's identity, even with adaptations (Million, 1992; Collignon, 2001). Such migration at young or middle ages may cause moving-back actions later, something seen among participants in recent research in the area (Sherren et al., 2016). A further challenge in Peace River will be the inevitable difficulty of facing future options given limited infrastructure lifespans, though they are unlikely to be faced as soon as in the Mactaquac area.

2.9.5 Implications for Social Impact Assessment via Social Media

Social media has contributed much to forming new patterns of social life, especially for young people who have been used to sharing their private life and engaging in public discussion online. This social trend brings plenty of opportunities to use social media data to assess social impacts, research about which typically uses methods such as interviews and surveys (e.g. Barry, 2014). Our research, using *Instagram* posts, suggests several strengths: (1) a large amount of available data at low to no cost; (2) capturing young people's voices, who are often absent from conventional public engagements; (3) doing so without interventions that can introduce bias in any research; and (4) often with geo-tagged information to provide the chance to identify popular viewpoints in the landscape and understand landscape values in a spatial context.

Each of these benefits has a converse challenge that also suggests cautions in the use of social media data. First, while many conventional studies relying on participatory photography or mapping are challenged by the effort to collect willing participants and quality data (Matteucci, 2013), social media methods can produce an overwhelming amount of data, and require substantial filtering processes to identify 'valid' data, which must be done manually. Data noise from the potential heterogeneity of social media use requires careful examination (see Appendix C). Individuals also participate variously on social media, which may require sampling to manage. The participants in social media and content sharing sites also self-censor in the image they present, which introduces additional biases that may not suit all settings. Biases are also introduced by socio-economic and communications biases associated with the use of such technology, although the smartphones that drive most of it are now near-ubiquitous. While we based our data collection on the geographic tag of each *Instagram* post, however, the tag might not indicate where the landscape in the photo was; instead, it could be where the user posted this photo (e.g. where cell coverage or internet was available) or simply situated based on the assigned coordinate of a place name input by the user. Thus, we did additional manual filtering work to determine whether the landscape was in the research areas. For example, we identified palm trees which were supposed not to grow in the Mactaquac area, but with manual examining, they turned out to be plastic trees installed near the reservoir. Mapping hotspots from such data would be subject to similar problems. As aforementioned, another limitation was using our datasets to imply impacts for young people. Finally, although not all *Instagram* users are young people, the fact that the vast majority are justifies our research assumption (supported by additional checks). This weakness is the nature of social media data: it is impossible to know their ages, jobs, incomes, real names, and whether they are local when using massive volume of social media data.

2.10 Conclusion

To better anticipate impacts and adapt or abandon hydroelectric energy proposals to suit local communities, a full understanding of the young generation's landscape perceptions is critical. Conventional public engagements are ineffective and inefficient in catching young voices. We collected photographic data and text-based captions from a social media platform (*Instagram*) where predominantly young people document personal and public lives. We were interested in interpreting the commonly perceived landscape, including physical features, human activities, and landscape values. A landscape perception model with three paradigms that were separately applied in previous research was adapted to interpret landscape perceptions. We anticipated that significant landscape changes, specifically of the river and riparian land (including houses and low-land farms), will directly affect landscape values of aesthetics and place attachment in Site C, while mostly affecting lifestyles in Mactaquac. These potential changes will bring particular challenges to the young generation in terms of losing familiar landscape, adapting to the new one, potentially migrating to other places, and facing more change at the end of the lifespan of energy facilities. This paper showed a new and insightful way to analyze social media data in landscape perception research. This work is also limited by the general challenges of using secondary 'big data': the paradox between a larger amount of data and the precision of each piece. We believe this is a feasible way to fill in the gap caused by changes in civic engagement among young people towards the online realm. Research in the future can seek more opportunities to capture and automate the analysis of valid data.

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Chapter 3 Using geo-tagged social media data to map landscape values

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3.1 Statement of Student Contribution

This paper is prepared for submission to the journal of Landscape and Urban Planning. Chen collected the data, conducted analysis, and wrote all sections of this manuscript. Dr. Sherren contributed to the research topic, methods for spatial analysis, and writing process by editing this paper. Dr. Parkins contributed to editing as well. Both of them provided supervisory comments all through the process.

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3.3 Abstract

Landscape values indicate how humans perceive and evaluate the landscape. In our study areas where two hydroelectric proposals have the potential to dramatically alter the landscapes, particularly the river (reservoir) and riparian land, an understanding of the spatial patterns of landscape values, especially the social and cultural values which are intangible and underestimated in energy planning processes, can inform decision makers to anticipate public concerns and adjust or abandon project proposals accordingly. Leveraging social media, intangible landscape values can be revealed. Such data also has the advantages of reaching young people and collecting large volume of data with low cost. We collected photos and captions that were geo-tagged to the study areas on social media site *Instagram*, and built a filtering model to extract valid data for kernel density estimation. The density maps reveal that: (1) different values occurred in different places; (2) aesthetic value was most widespread; (3) town areas, especially the old ones, and popular viewpoints were most likely to be attractors for multiple values. People tend to accept and appreciate familiar landscapes, thus proponents should make particular allowances for locations of key values and multiplex values.

3.4 Keywords

Geographic Information; Hydroelectric Dam; Landscape Values; Spatial Analysis; Social Media; Instagram

3.5 Introduction

Proposals involving landscape changes, especially hydroelectric dams that lead to water impoundment, call for a better understanding of landscape values held by local residents to inform the conversations about future development options. Generally, energy proposals are often seen as disrupting and threatening people's perceptions of landscape, place attachment, and senses of self that are associated with physical and social environments (Devine-Wright, 2009; Collins & Kearns, 2010). Physical landscape changes can result in uncomfortable feelings like anxiety, threat, and a sense of loss and displacement (Atkins, Simmons, & Roberts, 1998; Kaplan, Kaplan, & Ryan, 1998; Devine-Wright, 2009). At the same time, community-based support networks are also disrupted (Devine-Wright, 2009). In hydroelectricity proposals, the disruptions can be more critical than others because water bodies (e.g., rivers and lakes) are attractors for many landscape uses and values, such as recreation, aesthetics, educational use, and spiritual values (Beverly, Uto, Wikes, & Bothwell, 2008). Visually, water landscapes play a role in connecting various landscape features (Menárguez & Holgado, 2014), which are disrupted by the appearance of a hydroelectric dam (Parkhill, Butler, & Pidgeon, 2014; Filova, Vojar, Svobodova, & Sklenicka, 2015). Culturally, water bodies like rivers, lakes, and oceans were the birthplaces of human civilization, providing appropriate conditions for settlement and trade (Menárguez & Holgado, 2014), evident today by towns scattered along rivers. Socially, water bodies can be the carriers of people's livelihoods and lifestyle. In some agricultural regions, for instance, the way farmers lead their lives is tied to fertile soil and sources of irrigation, and their social networks rely on a stable settlement pattern around such resources (Atkins et al., 1998).

Thus, changes in water landscapes can cause intensive local stress due to many overlapping meanings and negative effects along multiple dimensions. This also explains why hydroelectric energy facilities are often unwelcomed and stigmatized early on as representing the deterioration of nature, landscapes, and way of life (Parkhill et al., 2014).

Only recently have social and cultural factors been integrated into energy planning processes, despite the multi-dimensional values of affected landscapes. Instead, landscapes have been discussed and assessed with a focus on economic and ecological perspectives. In practice, energy projects that involve landscape changes are often driven by government from an outside expert perspective or proponents who have strong interest in economic benefits (Brown, 2006; Vouligny, Domon, & Ruiz, 2009; Butler, 2016). Their desires to gain social license encourage them to elevate the economic benefits to balance potential negative effects. For their part, ecologists and environmentalists monitor the potential anthropogenic disturbances in natural environments. It seems to be more difficult to integrate social and cultural dimensions to such processes, although they are necessary to tell the full story (Plottu & Plottu, 2012).

One of the reasons why social values are ignored in energy proposals is because use values 'win out' over non-use values when proposals are expected to affect different values or uses in different ways: the less tangible ones can simply be overlooked. This is despite the fact that social and cultural perspectives of non-use values and immaterial benefits of the landscape are increasingly understood to be indispensable in landscape management (Brown, 2006). Use values of the landscape can be estimated by indicators such as loss of productive land, real estate values, volume of transportation, development of tourism, employment, and so on. Non-use values, however, have no associated market prices (e.g., aesthetic value), which makes it difficult to measure how important a particular value is for an individual. Also, social landscape values can be positively affected for some people and negatively affected for others. Even one person may consider the landscape from different perspectives. For example, people may accept a new road because the potential negative impacts on landscape aesthetics can be compensated by having cleaner and less noisy surroundings compared to the old one (Henningsson et al., 2015). Such hidden trade offs often causes the less tangible values to be overlooked.

Another challenge to integrating social and cultural values is human subjectivity, which makes such values difficult to quantify and assess (Tenerelli, Demšar, & Luque, 2016), at least in ways that can be directly compared with economic and ecological data. When values vary from person to person and place to place, fragmentation makes those scattered voices easy to dismiss in the collective decision-making process, for instance pejoratively as NIMBYism (Not In My Back Yard) (Devine-Wright, 2009; Brown and Weber 2012). Subjectivity is impossible to completely overcome in social science, but the various methodological approaches that do exist for cataloguing the issues tend to trade off richness (e.g. qualitative methods) and generalizability (e.g. surveys). Much work has been done on monetary assessments (e.g., contingent valuation) that simply measure all landscape values in prices to disclose respondents' willingness to pay for particular landscape values (Hanley, Colombo, Kriström, & Watson, 2009; Sauer & Fischer, 2010; Dachary-Bernard & Rambonilaza, 2012). Newer approaches seek to map multi-dimensional values, including aesthetic, recreation, life sustaining, learning, spiritual, historic, future, therapeutic, and cultural values alongside the economic and ecological ones (Brown, 2006; Raymond & Brown, 2007a; Brown & Weber, 2012; Brown & Donovan, 2014). Many other researchers have been inspired by Brown's work to fully understand comprehensive landscape values (Beverly et al., 2008; Zhu, Pfueller, Whitelaw, & Winter, 2010).

Finally, a last challenge to incorporating social and cultural values is the bias that can be introduced or simply perceived as a result of research or stakeholder participation. When applying active participation approaches (e.g., survey, interview, etc.) in social science research, it can be difficult to attract the necessary respondents (Reed & Brown, 2003), and the high cost per response limits the number of participants (Brown & Weber, 2012). In addition, influence from researchers cannot be avoided when participants only answer the provided questions and may be further affected by interview dynamics (e.g., power, gender, etc.). More importantly, there is other demographic bias in the samples because the younger generations are less actively engaged in public participation or research activities (Pasek, Kenski, Romer, & Jamieson, 2006; Sloam, 2012; Sherren, Beckley, Parkins, Stedman, Keilty, & Morin, 2016).

Using social media data to map landscape values presents opportunities to overcome the challenges mentioned above. It has seen limited use thus far in cultural ecosystem services, planning, and landscape studies (with recent exceptions see: Barry, 2013; de Vries et al., 2016; Martínez Pastur, Peri, Lencinas, García-Llorente, & Martín-López, 2015; Richards & Friess, 2015; Tenerelli, Demšar, & Luque, 2016). Social media users document their lifestyles and attitudes which may indicate thus-far hidden information for cultural and social values of the landscape. Mapping landscape values by geo-tagged social media data can expose and aggregate otherwise hidden values held by scattered individuals and thus help integrate lay planning perspectives into expert-orientated processes. Compared with conventional approaches (e.g., interview, survey, and focus group, as well as public participation GIS), using social media as secondary data has its own strengths, such as cost-efficiency for data collection, convenience given precise geographic information for each datum, and reduced subjectivity because the data are not gathered by direct contact between researcher and participant. Using social media data also changes demographic biases: first, it gives access to the 'silent majority' rather than the groups who have stronger interests in any specific proposal and who are more likely to speak up in formal processes; second, it most effectively reaches the younger generations who are hard to attract to research or stakeholder processes (Delli Carpini, 2000; Quintelier & Vissers, 2008; Park, Kee, & Valenzuela, 2009).

In our previous work, we have shown that it is feasible to use *Instagram* photos and captions to understand people's perceptions of physical landscape features, human activities and experiences, and landscape values based on a year of *Instagram* images geotagged to two Canadian hydro proposals (see Chapter 2). In this paper, we will use these geo-tagged *Instagram* posts collected in the two study areas, the degrading Mactaquac Generating Station (Mactaquac), New Brunswick, and the in-progress Site C Clean Energy Project (Site C), British Columbia, to map landscape values. We will probe two questions: (1) if and how social media data from *Instagram* can be used to map landscape values; and (2) what insights and implications such landscape value maps present for the two hydroelectric projects.

3.6 Background

3.6.1 The Evolution of Landscape Value Assessment

The majority of early landscape studies were carried out far from daily life, such as in a forest, thus the values of place were firstly understood based on pure physical features and ecological benefits (Plieninger, Dijks, Oteros-Rozas, & Bieling, 2013). Litton (1968) started his forest landscape study by systematically categorizing the feature components on a visual and physical basis. Taylor, Zube, and Sell (1987) then explained in their *expert paradigm* that the evaluation of landscape was derived from visual aesthetics and ecology, which assumes that the landscape had great intrinsic values. More recently, in the research area of ecosystem services, landscape is assessed by how its ecological integrity contributes to human well-being, often ignoring social-cultural implications (Plieninger et al., 2013; Tenerelli et al, 2016).

For early settlers and modern developers, they often assess and emphasize landscapes by economic value. From this perspective, people value a place because it provides economic benefits through extractive resources, agriculture, tourism, or other commercial activity (Brown & Weber, 2012). Especially in regions with agricultural, forestry, tourist, mining, or industrial traditions, the landscape and natural resources provide incomes and employment opportunities (Besser, Mclain, Cerveny, Biedenweg, & Banis, 2014), and the resulting infrastructure often accrues meaning as a result of those livelihoods and traditions (Keilty, Beckley, & Sherren, 2016). To gain support from local communities, proponents and developers look to economic development and potential employment to balance local concerns about ecosystem and landscape disruptions.

More recently, researchers integrate social, cultural, historic and other hidden values into landscape value frameworks (Brown & Reed, 2000; Dakin, 2003; Gómez-Sal, Belmontes, & Nicolau, 2003; Duncan, & Lambert, 2004; Beckley, Stedman, Wallace, & Ambard, 2007; Raymond & Brown, 2007a; Vouligny et al., 2009; Zhu et al., 2010; de Vries et al., 2016). This trend is consistent with the most widely accepted definition of landscape that was given by the European Landscape Convention as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000, p. 2). Inspired by Rolston and Coufal's (1991) forest landscape typology, Brown and his colleagues have developed and applied an integrated landscape value typology that includes spiritual, intrinsic, historic, future, and cultural landscape values (Brown & Reed, 2000; Brown, Smith, Alessa, & Kliskey, 2004; Alessa, Kliskey, & Brown, 2008). Their work inspires many other researchers to use and adapt the typology in study of place and landscape values (Beverly et al., 2008; Zhu et al., 2010; Butler, 2016). Other established landscape value typologies, independently from Brown's work, show a similar integrated ethic. Gómez-Sal et al. (2003) classified landscape values into ecological, productive, economic, cultural, and social dimensions, which was more concise but roughly grouped some distinctive values regarding human life and development into the social dimension. Vouligny et al. (2009) evaluated landscape from a more comprehensive system including 19 attributes, among which detailed dimensions were shown, such as sense of home, memories, tranquility, particularities, and community. Butler (2016) studied various landscape value typologies utilized in previous research and synthesized them into a six-category list: economic, natural significance, aesthetic/scenic, recreation, cultural significance, and intrinsic. This is believed by Butler (2016) to be a relatively developed and synthetic typology.

Although comprehensive landscape value typologies were established, to understand perceived social and cultural values at an individual level is still problematic. As discussed earlier, since they are difficult to assess, and thus difficult to incorporate into broader analytical frameworks, they are often dismissed by decision makers. Individuals evaluate landscapes based on personal knowledge and their experience of nearby spaces, communities they foster, assessments of utility, feelings of belonging, established lifestyles, and many other factors (Zube, 1987; Vouligny et al., 2009). The same landscape may thus be perceived as valuable in different ways for different people. Attempts are made to assess these individual values through such methods as contingent valuation and public participation GIS (PPGIS). While contingent valuation is widely used, given many of the hidden landscape values (e.g., heritage, symbolic, and identity) cannot be defined in monetary format, defining all values in prices limits the capacity to express the differences which emerge in multiple dimensions of the landscape (Plottu & Plottu, 2012). That is to say, we may only know people are willing to pay more for one value than another, but we are not able to understand why and how the differences are derived. To understand how landscape is perceived differently in different places, some researchers are mapping where specific landscape values occur and why (e.g., PPGIS). Mapping landscape values help reveal place-specific perceptions, attitudes, and preferences among different stakeholders and land use groups (de Vries et al., 2016; Plieninger et al., 2013). This is also a feasible approach to spatially aggregate varying and scattered individually perceived landscape values, while revealing diversities among people, communities, and places.

3.6.2 Mapping Landscape Values and the Use of Social Media Data

Early approaches to mapping landscape values were manual, based on capture through paper maps, followed by improvement to do the mapping exercises online, but still showed problems. For instance, Brown and Raymond (2007) used their adapted 12-category landscape value typology in a mail survey to ask participants to stick variously-sized paper dots, representing differing importance of each particular value, on a real map. The geographic information was then digitized into statistical and spatial analysis software. This was a costly and cumbersome process. With the development of online tools, i.e., *Google Maps*, this method has been much improved (Brown & Weber, 2012). With online mapping tools, participants are required to open a web link and click & drag the virtual dots onto the map. All the geographic information associated with each landscape value is automatically digitized. In recent years, this concept of PPGIS has contributed to studies of landscape values, forest landscape planning, and public land assessment (Brown & Reed, 2012; De Meo, Ferretti, Frattegiani, Lora, & Paletto, 2013; Brown, Weber, & de Bie, 2014). However, challenges still exist with this method, including standardizing the scale and precision of capture, as well as respondents being promoted with a specific limited set of values. There are also barriers to participate by aged populations and those without good internet source.

Unlike PPGIS, other methods track responses of mobile participants as they move through space to map landscape values. Bergeron, Paquette, and Poullaouec-Gonidec (2014) applied on-site and mobile interviews to understand place-specific values. Participants answered questions when they were at different sites on a fixed route. The advantage is that people can immerse themselves into the landscape, rather than just thinking about it when looking at a map. Drawbacks include the difficulty to eliminate influence from interviewers and the limitation of constructed questions. Sherren, Fischer, and Price (2010) used photo elicitation to catch the spatially-varying values of graziers in New South Wales, Australia. Participants were asked to photograph significant features on their properties and the photos, and their respective viewsheds, were mapped to understand attachment to trees. Both of these approaches were expensive and time-consuming and only feasible for small samples.

To overcome the drawbacks of small sample sizes, self-selection bias (e.g. demographic), cumbersome methods and researcher interference, some researchers make use of data from social media sites. Barry (2014) collected photos from *Flickr*, an online photo-sharing site, to understand public values, interest, and perceptions about cattle grazing on park lands. Richards and Friess (2015) retrieved geo-tagged photos and from the same site to map cultural ecosystem service usages. Martínez Pastur et al. (2015) used geo-tagged images posted on the *Panoramio* site to identity hot-spots of cultural ecosystem services. These examples show the effectiveness and efficiency of using social media to collect photographic data with large *n*, low cost, and precise geographic information, to study landscape-related issues. Yet challenges and cautions remain in the use of social media data. The overwhelming amounts of data captured through social media are often ‘noisy’ which calls for careful filtering. The variety of reasons and ways people use social media requires a systematic strategy of sampling, which means researchers must have a good understanding of online ‘participants’, and if and how they can contribute to the valid data sample. A demographic bias also exists that ‘participants’ may be limited by accessibility of the internet access and capacity with tech hardware (e.g. smartphones) and software (e.g. apps), as well as their selection of an increasing range of social media tools. Although web-based mapping methods such as PPGIS have been applied for years by many researchers, social media sources are also promising, bring the advantages of catching youth voices, reducing data collection cost and influences from researchers, thus are worth further exploration of data from underexplored sites such as *Instagram*.

3.7 Methods

To contribute to improvements in mapping social and cultural factors for landscape evaluation, and to leverage the strengths of social media, we collected a year of photos and text-based captions on *Instagram* that were geo-tagged to two current hydroelectricity proposals. We used thematic coding and spatial analysis to generate landscape value maps that reveal hot-spots of place-specific perceived values. The method we applied to process and analyze geo-tagged social media data, described in detail below, demonstrate some of the strengths and weaknesses of using big data in applied research.

3.7.1 Study Areas

Our study focuses on two hydroelectric proposals in Canada, the Site C Dam, British Columbia, and the Mactaquac Dam, New Brunswick (see Figure 3, p. 30). The Mactaquac Dam is operated by NB Power, having the capacity of generating 668 MW of renewable energy, 12% of the provincial needs (NB Power, 2014). Since its construction in the late 1960s, flooding 5300 hectares of land adjacent to the St. John River, the landscape in that area has been changed. However, local residents have come to appreciate the reservoir-generated landscape, even those who originally opposed the dam and/or lost their riverfront properties at that time (Keilty et al., 2016; see Chapter 2). Fewer than fifty years later, the utility is facing another choice due to the projected early end of the Mactaquac Dam's serviceable life in 2030. Since 2013, three options have been under consideration for its future, including rebuilding with or without power on the current site, or removing all structures to restore the river to natural status (NB Power, 2016a). This year, NB Power announced that new approaches may allow the dam to be repaired so that it can generate power to its original 100-year service life, but the viability of this fourth extended life option has not yet been confirmed (NB Power, 2016a). All options have inspired heated public discussions, informally and through formal stakeholder processes, around associated economic, environmental, and especially social issues (Sherren et al., 2016). The most ecosystem-beneficial option, to restore the river, is actually least favored among locals because they have come to love the reservoir's amenities (Keilty et al., 2016; see Chapter 2). Local opinions are of great importance this time because the original dam construction was stigmatized as a top-down decision by the government and approved despite public concerns for communities and the ecosystem (Canadian Rivers Institute, 2011). While NB Power has conducted open houses and online surveys to share information and elicit opinions, both are subject to demographic bias and other self-selection; little rigorous social science has been undertaken that seeks to aggregate the disparate voices and stories, and what has been was not funded by the utility (Sherren et al., 2016; Keilty et al., 2016; NB Power, 2016b). According to our recent work conceptually mapping landscape features, activities and values, we have identified that reservoir-based lifestyle is key to understanding local attachments to the place (see Chapter 2).

The approved Site C Dam project has begun construction in the Peace River catchment, although there remains considerable resistance from local Aboriginal communities and scholars (Amnesty International, 2016; Mccarthy, 2016). Unless some last ditch protests are successful, the dam will flood about 3000 hectares of fertile, low-lying farmland under the reservoir in the near future (Hume, 2014). Compared with the Mactaquac case, the Site C Dam is located in a remoter area with fewer communities and sparser population. The Joint Review Panel report on BC Hydro's environmental impact statement about the Site C Dam indicated that the effect of the project on the landscape would be a significant adverse effect which would be irreversible (BC Hydro & Power Authority British Columbia, 2014), but only from the visual and biophysical perspectives. This project has also met with opposition within local communities, as well as social mobilization in far-flung population centers such as the provincial capital of Victoria (Chen, 2015). Our previous research reveals the current landscape with the composition of river, riparian land and mountains is widely appreciated as aesthetically valuable and that the farmland along the river is at the root of their senses of belong to the place (see Chapter 2).

While the case studies differ in many ways, the oppositions toward the hydroelectric energy proposals are driven in part by the same reason: to keep the current landscape. The general landscape in the two case areas are similar. Both dam locations are within a short distance of a significant town, with an upstream area (originally) characterized by farmland and small resource towns. Also, both dams are the most downstream of three on their respective rivers.

3.7.2 Data Collection

We use *Instagram* as our secondary data source. *Instagram* is a popular photo- and video-sharing social media platform and had 400 million monthly active users in September 2015 (Statista, 2015). Its geo-tagging system allows users to assign photos with geographic information of where the picture was taken or where it was posted. We collected photos and text-based captions which were geo-tagged to the areas within 5 km radius of a range of data collection points via *Netlytic* (2016) during a one-year period, from October 1, 2014 to September 30, 2015 (Figure 9; see data collection points in Figure 3, p. 30).

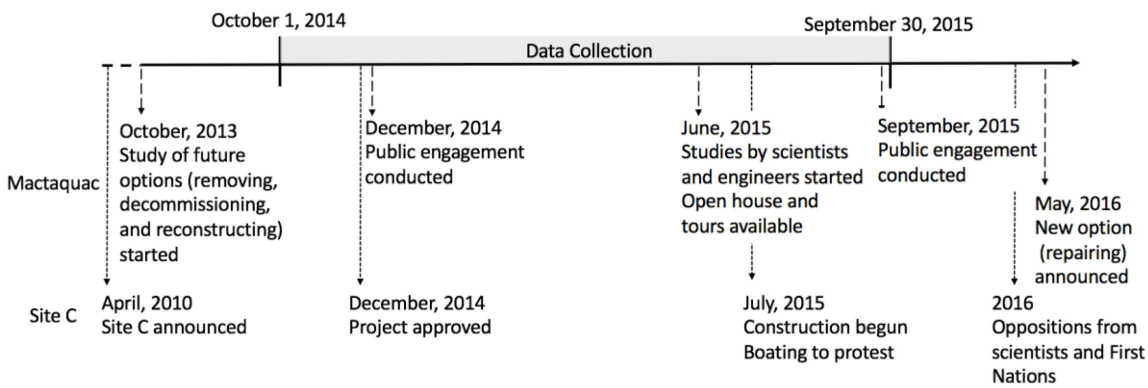


Figure 9. Timelines for two projects during data collection period.

We selected geo-tagged *Instagram* posts in which the photos show sufficient landscape of the study areas to interpret (see Figure 5 in Chapter 2, p. 32), which excluded indoor photos and people close-ups. After data filtering, the Site C Dam had a data sample of 316 posts and the Mactaquac had 1786 posts (the data sizes are slightly smaller than those in Chapter 2 because some of posts lost geographic information when retrieving data from *Netlytic*). We categorized posts (photos and captions) into four groups among which the photos showing natural landscapes or human activities were more frequent than those of built features or unknown-activity experiences in the landscape.

3.7.3 Filtering Model

To understand place-specific landscape values, we needed to eliminate or at least minimize the bias caused by the *Instagram* geo-tagging system. In other words, we needed to select photos that were driven by landscape and posted *in situ* or places nearby to ensure the geographic information matched the view in each photo. In the geo-tagging system, *Instagram* also provides default coordinates for place names, such as Mactaquac Provincial Park, which users can assign to photos uploaded elsewhere. To extract such valid posts for further analysis, we first categorized possible drivers for different types of geo-tagged posts (Figure 10):

a) if a single user posted multiple photos tagged at the exact same geo-point or at least close enough geo-points, it was more likely driven by Wi-Fi accessibility at home, in hotel or restaurant, and system default place names (Figure 10, top left);

b) if a single user posted multiple photos tagged with different geo-points, it had a good possibility of being landscape-driven, but not exclusively (Figure 10, top right);

c) if different users posted multiple photos by the exact same geo-point, it could be due to Wi-Fi accessibility or using the default place names (Figure 10, lower left); or,

d) if different users posted photos with different geo-points, it was more likely because of the landscape (Figure 10, lower right).

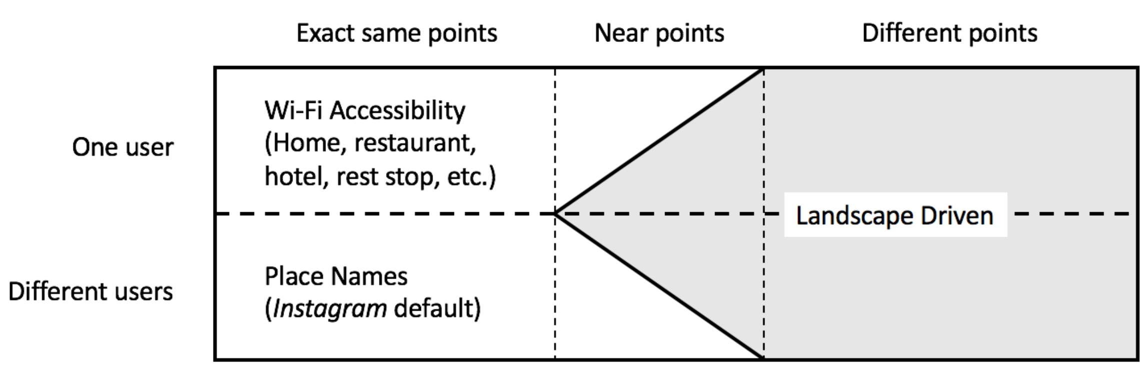


Figure 10. Categories of geo-tagged photos in various scenarios (shaded area represent the valid data, but a part of the unshaded area in the center may also contains valid data).

The shaded areas represent the valid data that we need, however, some of the data in type a and type c can also be landscape-driven (Figure 10, center) which need a filtering strategy to distinguish them from those posted due to Wi-Fi accessibility and system default place names. A somewhat qualitative filtering model was built to filter *Instagram* photos that were posted due to Wi-Fi accessibility and system default place names out of valid datasets (Figure 11). In step one, we excluded photos posted by the same user using the same (or very close) geo-point in Excel. In step two, all filtered data was imported into a spatial analysis software, *ArcGIS 10.2.2*, where point density estimation was used to identify photo posting hot-spots (>10 photos within a 500-meter radius). We then manually viewed the landscape within hot-spots on remote sensing maps and street views via *Google Earth* to determine whether these densely posted photos were because of reasons other than landscape views or features. For instance, posts were removed if the site was a hotel or restaurant that did not match photo contents. Given the large volume of social media data, we could not manually check every geo-point, but only the hot-spots where photos were more likely to be posted due to Wi-Fi accessibility or tagged as the default place names.

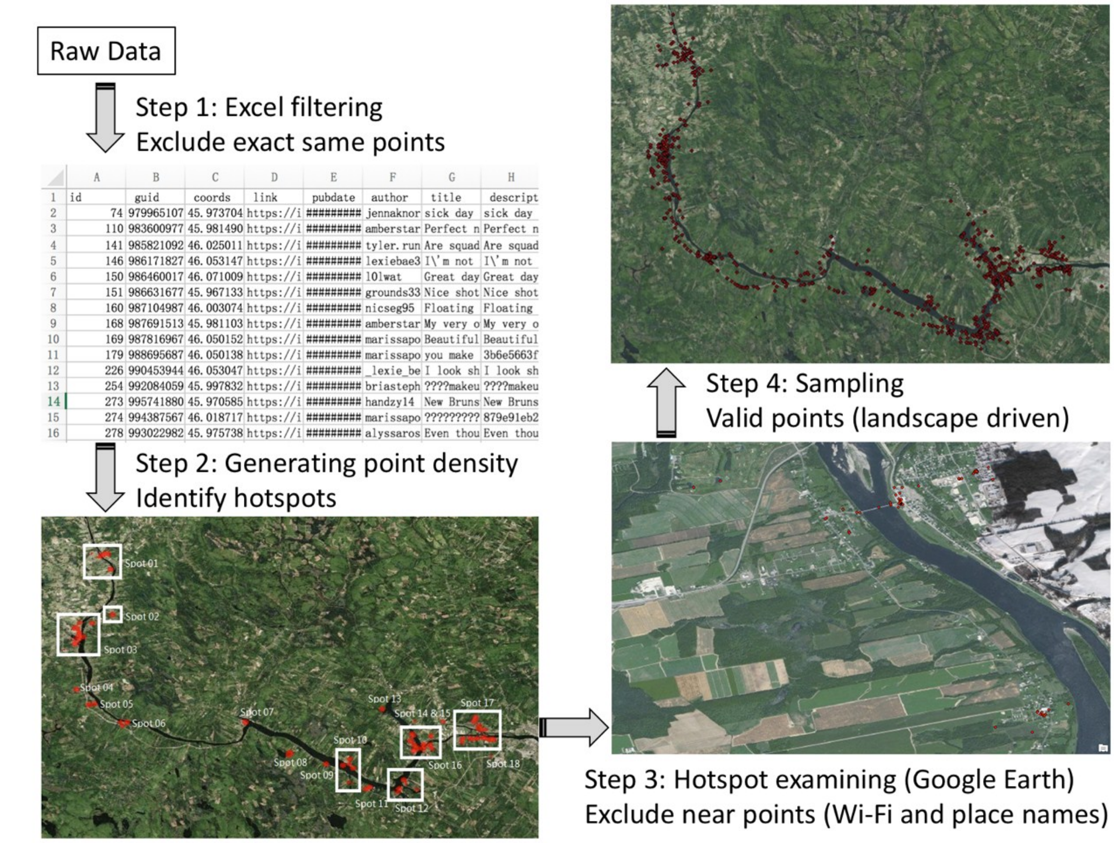


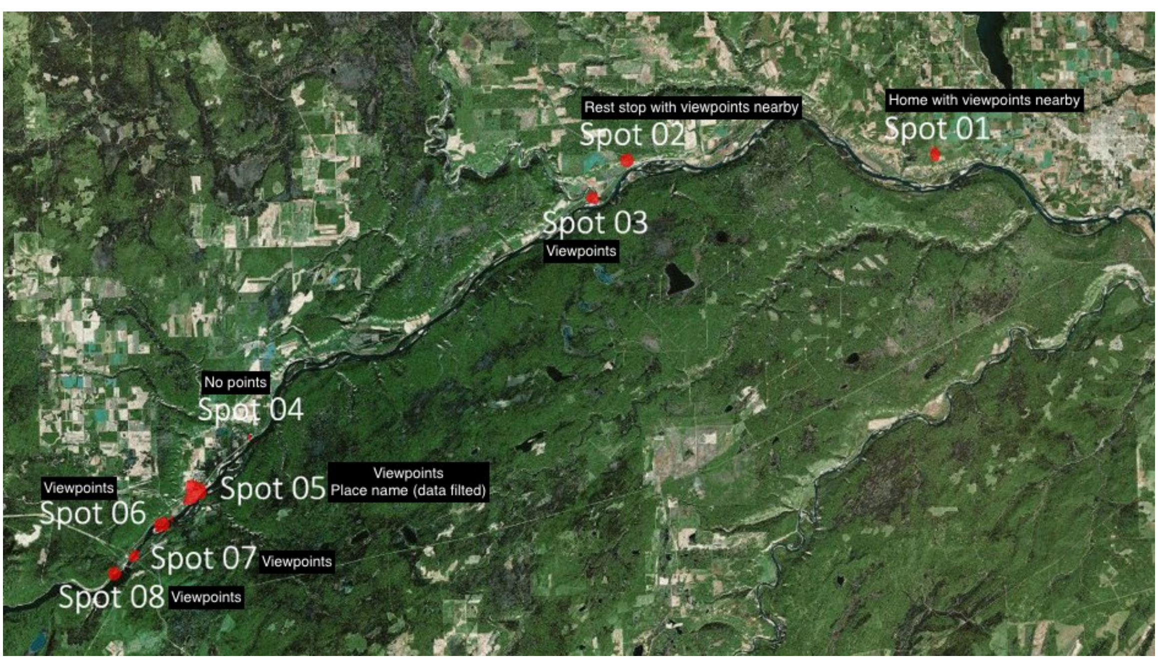
Figure 11. Data filtering model (using Mactaquac dataset as an example).

This spatial filtering process resulted in the removal of 13% and 14% of photos, respectively, in the Site C and Mactaquac datasets. In the Site C dataset, hot-spot No. 05 contained 24 photos tagged as the same geo-point for Hudson's Hope but was far away from the viewpoints (Figure 12a), which were filtered during step 3. In the Mactaquac case, 198 photos were excluded because they were tagged at default place names, posted at home but showing views elsewhere (e.g. tropical holidays), and at Wi-Fi accessible locations such as gas stations where the real photo location could not be assured (Figure 12b). After data filtering, the remaining data was considered valid for generating landscape value maps (Table 3).

Table 3. Data volumes during filtering process.

	Site C		Mactaquac	
Geo-tagged landscape photos	316		1786	
Step 1	Exact same points excluded			
	300		1729	
Step 2	Generate hot-spots			
	Photos within hot-spots	Photos without hot-spots	Photos within hot-spots	Photos without hot-spots
	189	110	1182	547
Step 3	Photos that do not match geo-location removed			
	165		984	
Valid Data	275		1531	

a)



b)

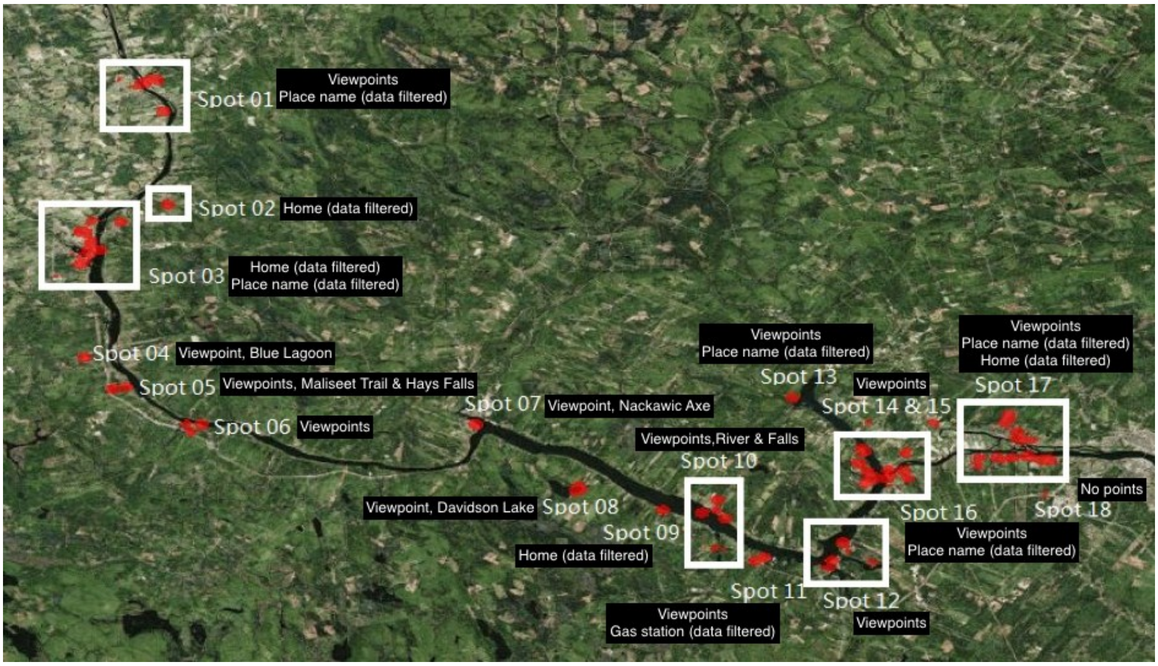


Figure 12. Drivers for geo-tagged photo sharing on Instagram in a) the Site C area, British Columbia, and b) the Mactaquac area, New Brunswick.

3.7.4 Landscape Value Coding and Mapping

We coded all valid photos and captions in *NVivo 11* into landscape values (see details in Chapter 2). Landscape values were only coded from text-based captions excluding emojis which can have unclear meaning. We used semi-inductive content analysis (Hsieh & Shannon, 2005; Thomas, 2006) and identified six social and cultural landscape values from the captions both by sample words (Table 4) and a full understanding of the contexts.

Table 4. Sample words for landscape value coding.

Landscape Values	Sample Words
Aesthetics	beautiful, beauty, pretty, view (as in "nice view', 'good view', 'wonderful view')
Sense of home	home, family, house
Community attachment	community, hometown
Lifestyle	Life (as in 'summerlife', 'riverlife', 'lakelife'), lifestyle
Memory	miss, memory
Cultural identity	Canadian (generally related to characteristic winter)

Valid data was imported into *ArcGIS 10.2.2*, where each post contains the geographic information and coding results for different types of landscape values (recorded as Boolean: 1 if the value was coded and 0 if it was not). We used kernel density estimation to first generate the post density map for all valid data to show where photos were uploaded on *Instagram*; and then generated density maps for each landscape value to identify hot-spots where each value was highly appreciated. The cell size selected for kernel density estimation was 500 meters and the search radius was 5000 meters, which were heuristically determined by the geographic nature of the study areas, and drawing on empirical insights from previous studies (Raymond & Brown, 2007b; Alessa et al., 2008; Brown & Donovan, 2014).

We used the 2011 Canadian Census of Population census block data to compare hot-spots with population density (Statistics Canada, 2011) to analyze whether they were driven simply by increased observation or by the specific landscape in that place. We converted population density to an integer raster layer with the same extent and cell size as the photo density raster, and conducted band collection statistics. The resulting correlation matrix showed the degree of linear relationship (and thus independence) between the two variables, to help assess the effectiveness of using geo-tagged social media data to map landscape values under the process established above; highly correlated data would suggest that population density would be a simple proxy.

3.8 Results

This section discusses separately the thematic coding of landscape values, the maps of those hot-spots, and how the value hot-spots correlate with population density. The subsequent discussions section interprets the results in light of the literature and our research questions.

3.8.1 Landscape Value Coding

The coding results (Table 5) show that six landscape values were identified from text-based captions of *Instagram* photos. In the Site C area, aesthetics was the most common landscape value, coded from 22% of the 275 posts which were often co-tagged with hashtags like "#Peace River", "#Peace Valley", and "#British Columbia". The caption below is an example:

> "Beauty day. #Peace Valley #Peace River #beautiful #scenery #lovethis #sunshine #instagood #instagreat #doubletap #perf #home #myfave" (*Instagram* user bobinster10, 2015).

This post also reveals another value, sense of home, which was coded to 4 posts out of the total. Due to a smaller data size in this remote area, landscape values such as community attachment, cultural identity, lifestyle, and memory, were also only identified in a few posts, which affects some of the mapping and statistics that follow.

Aesthetics was also the most coded value in the Mactaquac area, at 11% of the total dataset. That percentage is lower than that in Site C, however, other values such as sense of home, lifestyle, and memory were identified in more posts. For instance, lifestyle was coded to instances when people in this area described their lives as tightly associated with the reservoir, such as the following caption for a water view picture:

> "First day of summer vacation 2015 #maternityleave #mactaquac #livingthelife" (*Instagram* user ashleyjsprague, 2015).

This caption also indicates the importance of summer time for locals, when they often recreate in water bodies. Pleasant memories from the summer also made the landscape valuable, perhaps explaining why there were many users posting photos of summer scenes in the winter, saying, for example: "Summer sunsets are the best" (*Instagram* user abbygailxo, 2015).

Table 5. Coding results of landscape values (all geo-tagged posts were imported for kernel density estimation, but some of them have no caption so that no values are coded).

Landscape Value	Site C		Mactaquac	
	Posts	Percent	Posts	Percent
Aesthetics	61	22.2%	168	11.0%
Sense of Home	4	1.5%	32	2.1%
Community Attachment	1	0.4%	6	0.4%
Cultural Identity	7	2.5%	8	0.5%
Lifestyle	5	1.8%	20	1.3%
Memory	2	0.7%	39	2.5%

The two cases have similarities in that aesthetics was the most prominent value, while it was less dominant in Mactaquac. In this area, lifestyle associated with the water bodies and summer activities, as well as summer memories suggest a more complete story of how landscape was valued by people, consistent with previous work (Chapter 2).

3.8.2 Landscape Value Maps

The above coding results were mapped to places using the hot-spot methods discussed earlier (Figure 13 and 17). In the Site C area, aesthetic value was mostly concentrated in three locations, Hudson's Hope upstream, Attachie in the middle, and downstream close to Fort St John (Figure 13a). The latter two areas have specific viewpoints, with access off the highway, including components of river channel, riparian land, and mountains in the background (Figure 14a and 14b; also shown in Figure 12): Hudson's Hope is particularly famous for the view of rocks in the water (Figure 14c). The maps of other landscape values are less robust due to the small data size, but several observations can still be made: (1) sense of home was mostly perceived in established town areas, whereas community attachment only appeared in Hudson's Hope, the largest and the oldest settlement within the data collection zone; and, (2) cultural identity has a similar distribution as aesthetics but less wide spread. Looking by place, the area near Fort St John has sense of home as the primary value; the middle part between Attachie and Farell Creek is dominated by landscape values of aesthetics, sense of home, cultural identity, and lifestyle; and, the Hudson's Hope area had the widest range of values evident.

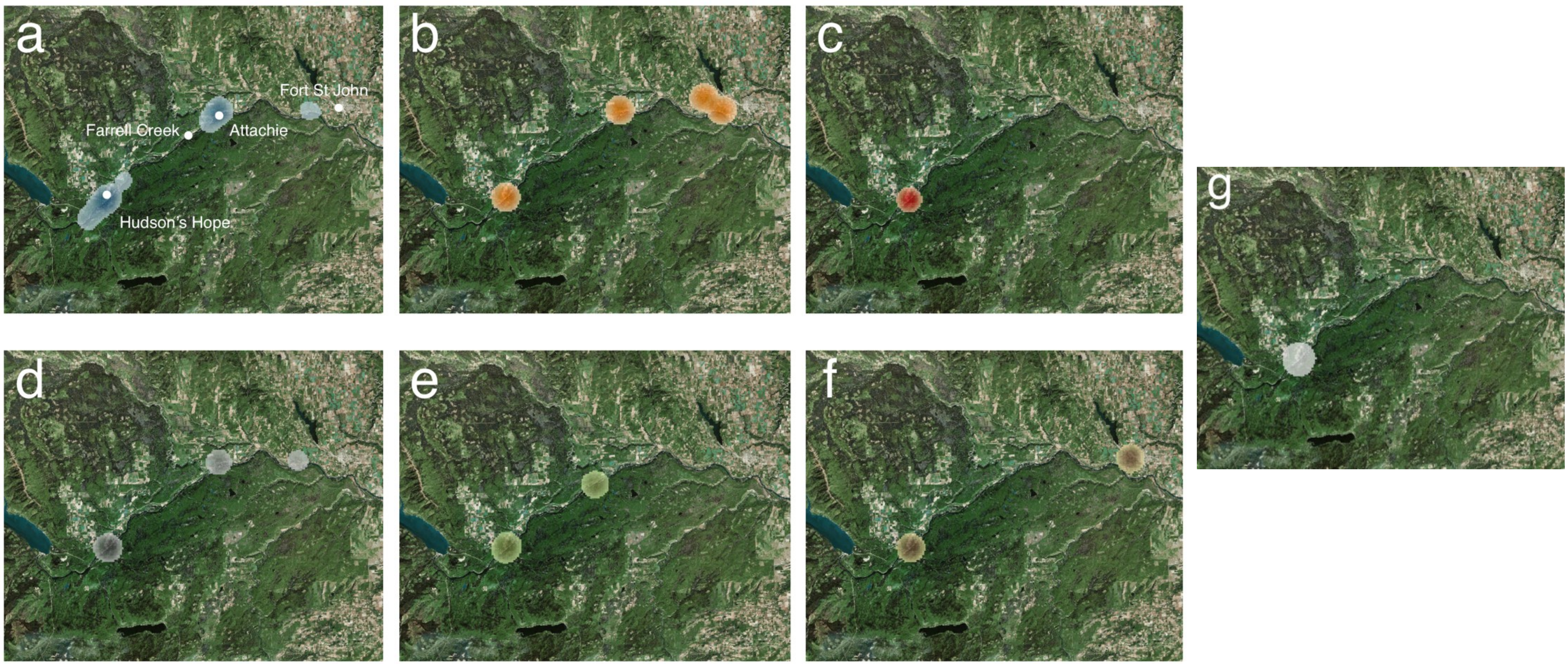


Figure 13. Landscape value maps of the Site C area, a) aesthetics, b) sense of home, c) community attachment, d) cultural identity, e) lifestyle, f) memory, g) hot-spot overlays of all values.

Figure 14. Viewpoints in the aesthetically valued areas in the Site C, a) place close to Fort St John (scott_neo, 2015), b) place around Attachie (beckysue100, 2015), c) Hudson's Hope (parkamus, 2015).

Based on a larger data size in the Mactaquac area, we have richer results for interpretation (Figure 15). Landscape aesthetic value was revealed in extended areas along the reservoir rather than places merely around the towns. Particularly, it extended from places near the dam and provincial park to 20 kilometers up. Numerous places along the Mactaquac reservoir were perceived as aesthetically valuable, for instance, the Mactaquac Beach and river views (Figure 16a and 16b), as well as the nearby falls, lakes, and trails (see details in Figure 12). Unlike the general poor accessibility in Site C, these viewpoints could be visited and appreciated on a daily basis because there were more human settlements and the landscape is flatter for extended horizons. Community attachment was highly associated with towns along the reservoir, including Fredericton, Keswick Ridge, Nackawic, Meductic, Woodstock, and Hartland. However, sense of home spread to adjacent rural areas. Among those towns along the reservoir, the new town of Nackawic (officially incorporated in 1976) is a blank spot for all values except community attachment, which is different from other towns that are attractors for multiple values. Lifestyle and memory values were more widely perceived over a large area in this area than that in Site C, considering the numbers of photos coded. These two values were highly related to water bodies including the reservoir, lakes, and streams (Figure 16c). The geographic distributions of lifestyle and memory values overlap the town areas, but also occur in less densely populated places.

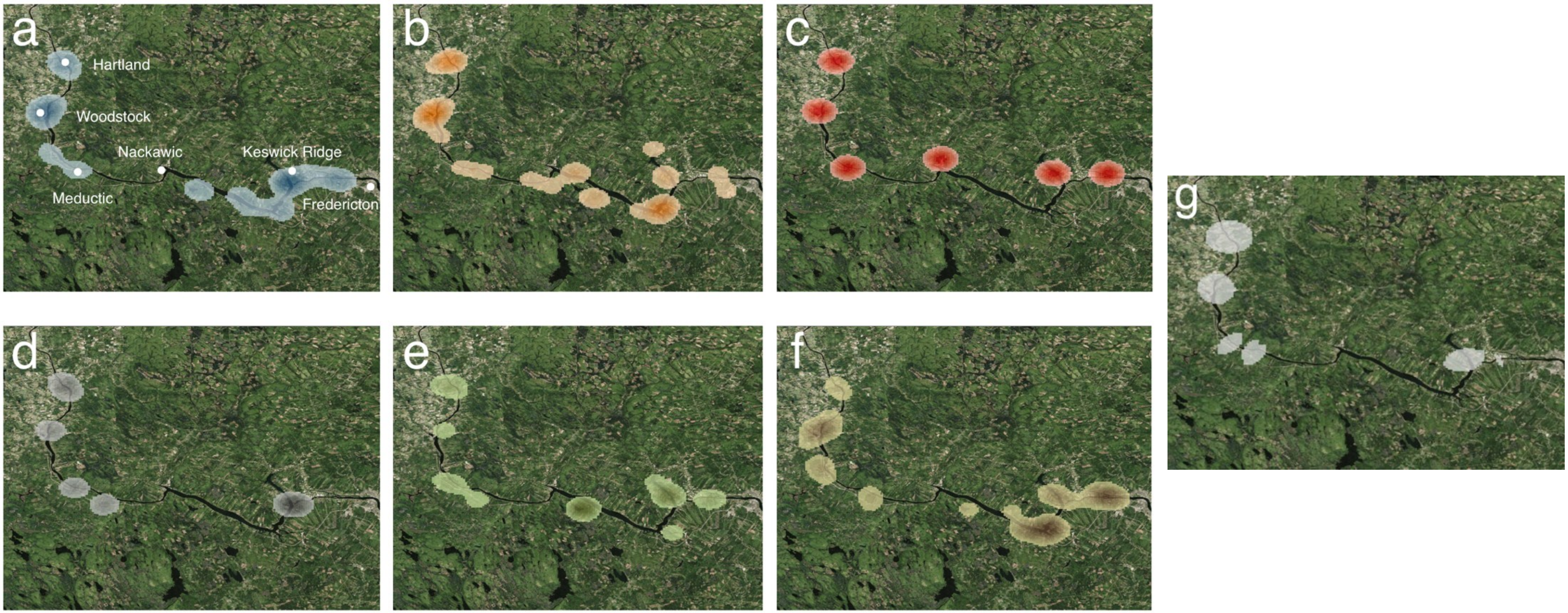


Figure 15. Landscape value maps of the Mactaquac area, a) aesthetics, b) sense of home, c) community attachment, d) cultural identity, e) lifestyle, f) memory, g) hot-spot overlays of all values.

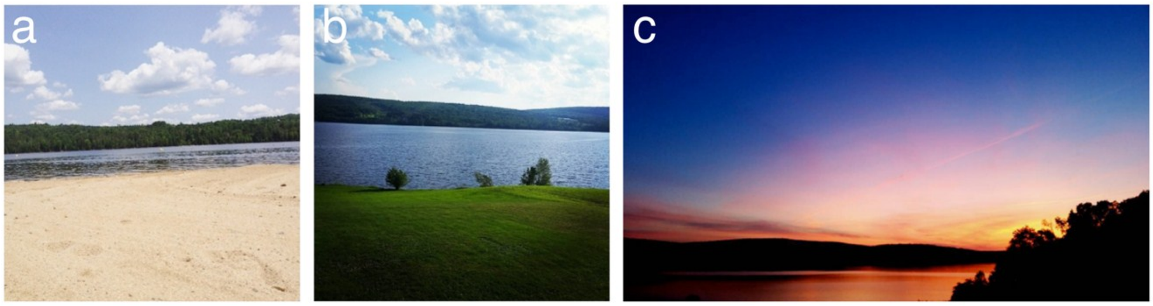


Figure 16. Viewpoints in the aesthetically valued areas in the Mactaquac, a) Mactaquac Beach in the Provincial Park (dirtfae, 2015), b) A typical headpond view (darcysargeson, 2015), c) A river view with caption of "riverlife" (darcysargeson, 2015).

The two cases show similar spatial patterns of landscape values: (1) different values occurred in different places; (2) aesthetic value was most prominent and widely spread; and, (3) towns and popular viewpoints were most likely to attract multiple values. The differences also exist: the more accessible and populated Mactaquac landscape led to (1) values more widely spread along the reservoir; and, (2) lifestyle and memory values more commonly occurring.

Correlations of different values were also examined (see Appendix A). The results show that some of the values are more associated with each other, such as cultural identity and community attachment in Site C, and memory and aesthetics in Mactaquac. Aesthetics and cultural identity were a pair of highly related values perceived in both study areas. However, the results might be biased because of the smaller data size of the Site C case than that of Mactaquac.

3.8.3 Landscape Values vs. Population density

We also measured Pearson correlations between *Instagram* post density and census block population density in the study areas (Table 6; also see Appendix B). The results, 0.2 for

Site C and 0.25 for Mactaquac, both indicate weak increasing linear relationships, which means the hot-spots of photo posting areas were not mostly driven by population density or associated likelihood of Wi-Fi convenience. Or in other words, there are other reasons people were encouraged to share geo-tagged landscape photos on *Instagram*, such as the landscape viewpoints. In the filtering process, when examining post hot-spot sites on *Google Earth,* popular viewpoints that were located out of dense population areas were identified (Figure 12), such as the view off the highway at a rest stop in Site C, and lakes, falls, and trails in nearby places along the reservoir in Mactaquac.

Each landscape value density map was tested with the population density as well (Table 6). Community attachment and memory are the values most consistently related to population density, which can also be seen in the value maps where the hot-spots of these values were mostly located in the town areas (Figure 13 and 15). However, overall, none of the landscape values were significantly related to the population density. This may indicate that the filtering method is effective that we applied to eliminate photos which were geo-tagged as Wi-Fi accessible locations instead of the landscape *in situ*.

Table 6. Correlation testing results of landscape values and population density.

	Census Block Population Density	
	Site C	Mactaquac
All Valid Data	0.20	0.25
Aesthetics	0.20	0.36
Sense of Home	0.18	0.33
Community Attachment	0.29	0.36
Cultural Identity	0.27	0.18
Lifestyle	0.24	0.17
Memory	0.38	0.36

3.9 Discussion

We leveraged geo-tagged landscape photos and captions on *Instagram* to understand place-specific landscape values. This focuses on intangible values. We built a filtering model to systematically select photos that were driven by landscape viewpoints *in situ* rather than Wi-Fi accessibility or system default place names. While we focused on intangible values, seeking to fill gaps in available methods and protocols for integrating social and cultural landscape assessment, similar approaches could be used to map more tangible evidence in photos, such as landscape features or human activities. In this section, we discuss the key geographic patterns of different landscape values, and the drivers that might cause hot-spots of each value. Furthermore, the methodology is discussed to assess the viability of large-sized social media data for landscape study.

3.9.1 The Patterns and Drivers of Landscape Values

The landscape value maps show that different landscape values occurred in different places and had their own patterns in our study areas. This result supports findings by recent place-based research that landscape values are complex in space: different places can be perceived as valuable from different dimensions (Brown, 2006). Unlike early landscape work, which underestimated how spatial factors can affect people's perceptions of specific landscapes, place-specific approaches indicate that landscape values should be seen and analyzed as relationship values that connect people and place, which means that the person is a key factor in understanding landscape value formation (Brown & Donovan, 2014). Individuals often value landscapes differently on the basis of self-interest and experiences, instead merely of the objective features (Vouligny et al., 2009). In this study, particularly, the intrinsic value of different places, people's perceptions of the value (e.g., what is pretty? What is home?), their knowledge of and experiences in the landscape, and familiarity with the land can all contribute to the fact that different places were perceived to embody different values.

Aesthetic value was identified as the most widespread one in both study areas, but more dominant in Site C than in Mactaquac. In general, the dominance of aesthetic values across both cases may simply reflect the reason why many people take photographs and post them online – beauty – but its dominance in Site C may be related to its relatively natural and more dramatic ecosystem. According to previous research, landscape which is perceived to be in a natural state, is often appreciated as aesthetically valuable (Parsons, 2012; Fox, Magilligan, & Sneddon, 2016). Also, water features, indigenous land covers, and mountains might have great contribution to landscape values, such as the aesthetic factor (Brown & Brabyn, 2012; Vouligny et al., 2009). In our study, viewpoints distant to towns and without built features in view, such as river views and the view of rocks in the water in Site C, and the views of the reservoir, lakes, and falls in Mactaquac, mostly drove the aesthetic value of the landscape.

The concentration and prominence of aesthetic value in Site C compared with Mactaquac might be discussed from a trade-off perspective. Brown and Weber (2012) used their empirical results to illustrate that human society developments can balance the importance and distribution between natural/intrinsic values and more human-based values. In our study, compared to the less developed Site C area, Mactaquac had the aesthetic value much less prominent, but viewing the reservoir landscape more as the carrier and supporting resources for daily life. We have no comparable pre-dam data, thus may indicate that regional development has reduced people's appreciation for the landscape as a purely visual source for aesthetics. In Mactaquac, the distribution of lifestyle reveals a story of individual daily lives and recreational activities. The maps show locally appreciated "#riverlife" and "lakelife" in the 'lifestyle' hot-spots along the reservoir and near other water bodies, such as Blue Lagoon, Hays Falls, and Davidson Lake. Memory values distributed similarly with lifestyle, whereby it was tied to summer memories about the "riverlife". In our previous research, similar results can be found from Mactaquac residents' conceptual landscapes where lifestyle, water-based activities, and summer life sat at the central point (see Chapter 2).

Notwithstanding these patterns of lifestyle on the landscape, like other studies using photos online, accessibility also drives geographic patterns of revealed values to some extent. That is, an area may have the potential to hold a value, if people can get there to see it and experience it (and in our case, photograph, it) (Brown & Brabyn, 2012; Brown & Weber, 2012). This explains that the aesthetic value was focused in three spots in Site C, but was spread further along the reservoir in Mactaquac, since the latter area is flatter and less remote. There are few ways to overcome this in spatial studies, but conceptual mapping of features, activities and values (see Chapter 2) can help to identify 'untapped' areas of landscape value.

In both cases, sense of home was found spread around towns; however, the community attachment was strictly concentrated in towns. In our recent research where we analyzed landscape values from the conceptual aspect, it was difficult to distinguish the nuance between sense of home and community attachment (see Chapter 2). In this study, the value maps show the differences that sense of home was more shaped by the perception of individual's home and property, such as cottages, which were not necessarily located in the towns or populated areas (Hough, 1990; Stedman et al., 2007);

whereas the community attachment was adhered to towns where people gained the sense of being connected. These two values both significantly contribute to human sense of and their attachment to the place (Spirn, 1998; Duncan & Lambert, 2004; Beckley et al., 2007).

All of the six landscape values we mapped had spatial overlaps, such as town areas which might be partially caused by the fact that there were more people visiting or living in the places which results in more posts on *Instagram*. Despite this, our findings are consistent with a previous study that revealed communities are the attractors for landscape values, specifically for the social and cultural values (Beverly et al., 2008). Our overlaps were mostly in town areas where people live and work, which means they accessed the landscape frequently and were familiar with it. Such familiarity clearly affects the acceptance of landscapes and perception of landscape values (Tuan, 1979; Atkins et al., 1998; Kaplan et al., 1998). But not all towns were perceived the same in this analysis, and those differences were telling and suggestive of real sensitivity in our approach. The small mill-town of Nackawic, NB, was built in parallel with the Mactaquac Dam and the pulp and paper mill that was to use most of its power, to house new workers at that mill and those who were displaced as a result of the flooding it caused. Comprised predominantly of pre-fabricated houses, it is arguably not a beautiful place, but it has a strong community, and this is the only value revealed for it in the Mactaquac analysis. Interestingly, the old homesteads and settlements around Nackawic where many of tis families may have roots show as high in sense of home. By contrast, Hudson’s Hope, BC, is the third oldest community in British Columbia, much older than others on the Peace River, and revealed all six landscape values *in situ*.

Overlaps appear in places with landscape viewpoints or in recreational sites as well. It seems clear that the false separation of use and non-use values is unhelpful: many non-use values arise through use. For instance, the aesthetic value and lifestyle value were identified at places such as lakes and falls where people could do recreational activities in the Mactaquac area. This was also seen in our recent research where summer activities and lifestyle were conceptually associated (see Chapter 2). The appearance of humans and their activities will also greatly force landscape value shaping and changing (Brown & Weber, 2012). In addition, landscape values are not independent with each other; conversely, values are perceived correlated and some values are more likely to be co-located (Beverly et al., 2008; Zhu et al., 2010). The drivers, such as landscape viewpoints, attractions, access/activity sites, or dense populations may drive a cluster of relevant landscape values in the same place. Also, time in place may be a good predictor of multiple values, contrasting new towns like Fort St. John and Nackawic with old ones like Woodstock and Hudson's Hope.

All the landscape values discussed above have parallels within the sense of place literature. Perceived values reflect the affective bond between the physical environment and human beings' inside world, which is defined as the concept of topophilia (Tuan, 1974). Individuals may view the same landscape differently on the basis of different experiences, yet within groups demonstrate similar perspectives towards its suitability to live. Cresswell (2015) also discusses sense of place as human subjective and emotional attachment to a place, which may change and be lost under the pressure of time-space compression (Massy, 1993) as development increases and spaces homogenize. Massy (1993) discussed that how time-space compression – people increasingly moving and communicating across space – can influence their sense of place. The economic development in places can be a stimulus to accelerate such compression. However, more importantly, diverse in-migration and local integration of different groups can also increase the compression. The development and social change since dam construction in Mactaquac may explain why the key landscape value in Mactaquac was different from the Site C. This may also help to anticipate what will happen in the Site C area with the new dam, that is to say, with a sudden change in development and social differentiation.

3.9.2 Implications for Case Study Hydroelectricity Proposals

To better adapt, adjust, or discard the proposals in the study areas, decision makers should ensure that the plans which are often proponent- or expert-driven can be consistent with human values of the landscape (Raymond & Brown, 2007a). In Site C, if the proposed dam proceeds, physical landscape changes will dramatically affect the importance and geographic distribution of landscape values. One need only compare the sample images provided for the two sites to see how hydroelectricity development 'domesticates' the landscape. The landscape alterations may not be limited to facility constructions or water impoundment, however, the local development may shift as well as accelerate with more human settlements and road expansion, as well as changes in tourism opportunities and housing after the construction (Chen, Powers, Carvalho, & Mora, 2015; Brown & Weber, 2012), as has happened in Mactaquac (Sherren et al., 2016). Such changes will influence values at personal, social, and cultural levels. Although most decisions related to landscape change are passively accepted (Brown & Weber, 2012), firm opposition has been heard for years around Site C, showing conflict between local concerns from the residents and the social good claimed by planners for the whole area (BC Hydro & Power Authority British Columbia, 2014). Significant landscape value hot-spots, particularly those with multiple perceived values, should be paid particular attention in design and impact mitigation. The popular landscape view of rock pillars in the river at Hudson's Hope would be significantly affected by the flooding, perhaps entirely lost, as was Pokiok Falls in Mactaquac. Meanwhile, low-lying home and property loss would also happen. These will affect the importance and distribution of all values, particularly of aesthetics and sense of home in Site C.

The negative effects cannot be eliminated, however. Negative influences on one value may be compensated by forming or increasing other values. Referring to the hydroelectric development in Mactaquac, promoting the benefits of a reservoir-based lifestyle may help form new patterns of place-specific values. But, it is hard to say whether residents get the same benefit from the replacement landscape values. We can be sure that people in Mactaquac initially suffered from the changes, but adapted to that change over time to embrace reservoir living (Keilty et al., 2016). Now, the Mactaquac dam is facing different options for its future, among which to remove the dam is least favored, locally. The current landscape has been beloved for long time and all identified landscape values were found along the reservoir. It is rational to conclude that people tend to seek status quo and a more stable pattern of perceived landscape values. Thus, decisions that will least affect places with highly or multiply perceived landscape values would be most benefit for locals, from the consideration of social and cultural landscape.

3.9.3 Using and Filtering Social Media Data for Values Mapping

Spatial mapping of values has been widely applied in various fields and demonstrated as effective in showing geographic distribution and hot-spots, with some caveats (Brown, 2006). An additional goal in this exploratory work was to determine whether and how we can use social media data for this purpose. Particularly, can we robustly identify landscape values from *Instagram* posts? Can these identified values be seen to represent the perceived values *in situ*? Can the resulting maps inform decision makers?

The results generated through *Instagram* posts analysis can offer useful insights for decision makers to understand the potential conflicts between current perceived landscape values and expected alterations by energy proposals. Our experience suggests that there is great potential for using social media data in landscape research. First, just like conventional approaches, such as interview, survey, and photo elicitation, social media data can help reveal human attitudes and preferences for the landscape, including these intangible values (e.g., lifestyle). Second, collecting social media data as secondary data is a type of passive public participation, without interventions from researchers. Moreover, social media has additional power in collecting large volume of (often geo-tagged) data at low cost. And most importantly, it offers a new way to include the perspectives of young people in public discussions or research activities to offset existing demographic biases, since the main users of social media are young.

While the method in general is effective, drawbacks appeared in the data collecting and filtering processes. First, there are many ways *Instagram* posts can be geo-tagged, and not all are consistent with the original location where the photo was taken. The filtering approach taken to ensure a match was systematic yet cumbersome and imperfect, and in part relied on our knowledge of the study area landscapes, which may not be viable in all situations. The study areas were also reasonably small and rural, and thus the number of posts manageable; the approach used may have to be more automated in other settings, likely causing increased error. Future work should focus on how to improve the data collection and filtering models. How can we ensure the data retrieved have precise geographic information that matches the photo content? Additionally, the subjectivity of qualitative coding may be problematic with larger studies and more photos, requiring more analysts. Is it possible with new semantic classifiers to establish a model to automatically analyze photos? Such methods will of course not be error-free: any approach will be vulnerable to confounding situations like the perplexing plastic palm trees at a Mactaquac-area resort.

In general, the validity, reliability, and interpretability of social media data should be more critically examined. First, people use different social media sites for different reasons, such as *Twitter* for more public ends and *Instagram* for private life (Chen, 2015). Even for the same site, people can have different uses and online behaviors (Park, Lee & Kim, 2012), and this is not yet fully understood. The potential heterogeneity of use requires a good strategy of sampling, which means researchers must understand their 'participants' (see Appendix C). Second, not all demographic cohorts have equal access to the internet (Statistics Canada, 2006, cited in Beverly et al., 2008), meaning social media introduces biases related to age, income and education levels. Third, *Instagram* posts may not be able to reveal all landscape values. According to our coding work, identifying social and cultural values of the landscape using social media is easier than other values, such as learning and biodiversity. *Instagram* users are less likely to explicitly discuss about the education values or the biological features of the landscape on a photo-sharing site. This makes it potentially complementary with other approaches. Fourth, another concern is about online personality and sanitized self-image which may affect self-expression. While this is no different from the ways that people may change behavior to optimize appearances in a conventional interview, it is new, and worth investigating further. This problem may have larger influences on some sensitive topics like health, drug, crime, and so on, but it did not introduce noteworthy bias into our landscape research.

This study analyzed the geographic distribution of each coded landscape value from *Instagram* posts in the study areas, but the relationships between different values and physical landscape features have not been fully explored. More questions can be answered with work of this kind. How much do the water bodies contribute to different landscape values? Was a specific value mostly driven by a particular landscape feature? What values were highly co-located, and why? The answers will help us not only understand where and why the values are perceived by locals, but also how the values will relevantly change as a result of landscape-related planning decisions (Beverly et al., 2008).

3.10 Conclusion

Place-specific understanding of perceived landscape values is critical for decision makers to predict how the energy-related landscape changes will affect the spatial patterns of local values. Most impact assessment work has been focused on assessing the ecological and economic values of the landscape, respectively representing the lens from environmental experts and proponents or relevant-interested groups who will benefit from the projects. However, the intangible values related to individuals, society, and culture are often underestimated. Recently, though multifunctional dimensions have been increasingly studied, landscape value is still more considered as a general value without analyzing the geographic relationships between values and places. In this paper, we collected *Instagram* posts and coded landscape values were mapped. The results show that: (1) different values had different spatial patterns and many overlapped; (2) aesthetics dominated study areas and was highly correlated with landscape viewpoints (e.g., water bodies) instead of towns; and (3) old towns held more values. In general, hydroelectricity-driven landscape changes will undoubtedly affect the spatial patterns of landscape values. While residents typically seek stability this is not always possible; yet, decision-makers should pay more attention to preserving locations and viewpoints that were perceived with one concentrated or multiple values. This paper explored a feasible and insightful way to using geo-tagged social media data in spatial analysis to understand landscape values. Although this method can overcome many of the drawbacks that appear in conventional approaches, it has shortcomings in data collecting and filtering as well. Future work may improve data validity and reliability, as well as explore spatial relationships of values and features.

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Chapter 4 Conclusion

Around hydroelectricity landscapes, this thesis explored how young people perceive the landscape around sites of past or future hydroelectricity development: how did they see, use, and value the landscape? Chapter 2 asked how youth perceived the current landscape in terms of the physical features, activities, and landscape values. We coded the photos and captions collected from *Instagram* by geo-tags within two study areas, and calculated the relationships to find significant connections among different categories of features, activities, and values. Based on the results, we built conceptual diagrams to show aggregate landscape perceptions: how features were perceived by the photographers, what activities they did in the landscape, and how the features and activities facilitated the formation of values. These allowed for explorations of how the modification of specific features (e.g. water bodies and adjacent areas) would impact lifestyles and values. Moreover, since each of the *Instagram* posts we collected contained a geographic coordinate, we mapped the spatial patterns of the landscape values in Chapter 3. This thesis aims not only to understand how and why people conceptually perceive the landscape as a lived place, but where those concepts are anchored. Specifically, which places are most rich in landscape meanings and values, and do the photos help us to understand why? Methodologically, using social media data, we had to be cautious about the validity of the large volume of data for specific purposes. For Chapter 2 we simply had to remove photographs where landscape did not comprise a significant part of the frame. In Chapter 3, we built a multi-stage filtering model to select posts where photo content matched geographic information. After data filtering, we imported the geo-tags and landscape value coding results into *ArcGIS 10.2.2* to conduct kernel density estimation and generate hot-spots of landscape values. These density maps show the different spatial patterns of the six values as perceived in the research areas.

The results from Chapter 2 indicate that river (reservoir), mountain, and riparian land were perceived as important landscape features in both study areas. These three things were often viewed together largely because they had great likelihood of co-occurring in the same photos. This feature cluster had a significant association with landscape aesthetic values in the Site C area, where people valued the landscape more often from the visual perspective. This might be explained by the fact that the Site C area is more remote and less densely settled so that *Instagram* photographers had fewer social and cultural ties with the landscape. In the photo captions, people linked their Peace River, Peace Valley, or British Columbia identity with the aesthetics of the current landscape. Thus, it is reasonable to foresee that if the Site C dam is completed, the natural river and riparian land would be significantly affected, which would most negatively impact the aesthetic value and thus identity. In addition, property loss, including farmland and low-lying houses, would undermine the local sense of home and sense of place. In Mactaquac, none of the options for the dam future will cause significant or long-term displacement or relocation as the dam is already in place. For the residents in that area, under the scenario of dam removal, their sense of home or of place might be influenced by the changing view during and after river restoration. The story in Mactaquac was different from that of Site C, however, because the key value in the former lies in lifestyle, not simply aesthetics. The reservoir is important not only from the aesthetic perspective, but for how locals use the water body and how they have formed their lifestyle around it. We identified many posts showing the river view and their recreational activities in the water, accompanied with hashtags like "#riverlife" or "#lakelife". Photos of summer scenes were even uploaded in the winter time to reminisce about summer time when they could view the running water and do more outdoor activities. Thus, to keep the Mactaquac dam and its headpond would be the most preferred local option from the landscape perspective, whether it is done to produce power or not. To remove the dam would likely cause stress and difficulty for people to accept the new landscape in the future.

Chapter 3 was partly based on the work in Chapter 2. After understanding the general landscape perceptions at each site, we continued on to explore the spatial patterns of landscape values to see whether the landscape in different places would facilitate people to perceive it as valuable in different dimensions, especially in social and cultural contexts. The hot-spots of the six landscape values generated by kernel density estimation show that different values did occur in different places. Values overlapped mostly in town areas and landscape viewpoints in both study areas. Sense of home and community attachment were more concentrated in towns where people lived and connected with each other. However, aesthetics and lifestyle expanded to outskirts and landscape viewpoints far from human settlements. Generally, to support local landscape values, decision-makers should carefully consider the potential conflicts in areas with high concentrated value or multiple values. According to the results in Chapter 2, in the Site C area, places with high aesthetics should be given more attention by decision makers, as should the areas with high lifestyle value in Mactaquac.

Another methodological exploration in this thesis was whether and how social media data can contribute to landscape studies, overcome the drawbacks in conventional approaches, and fill the gap of youth participation. In Chapter 2, we discussed the effectiveness of capturing young people's voices through social media, as well as of analyzing *Instagram* photos and text-based captions to understand their landscape perceptions. Generally, the cost of collecting social media data as secondary data is lower than conventional approaches, and the data volume can be quite considerable. In addition, there is less influence from the researchers if using social media data because the photos were not taken for research purpose nor were the information in captions facilitated by survey questions or the conversations with researchers. However, drawbacks exist as well. Manual work is substantial while ensuring the precision of a large volume of social media data. Demographic biases of social media participation, internet access and information literacy may affect the results. The different ways that people use a given social media platform, and the careful grooming of self-image through such venues, may also affect its use as a research tool.

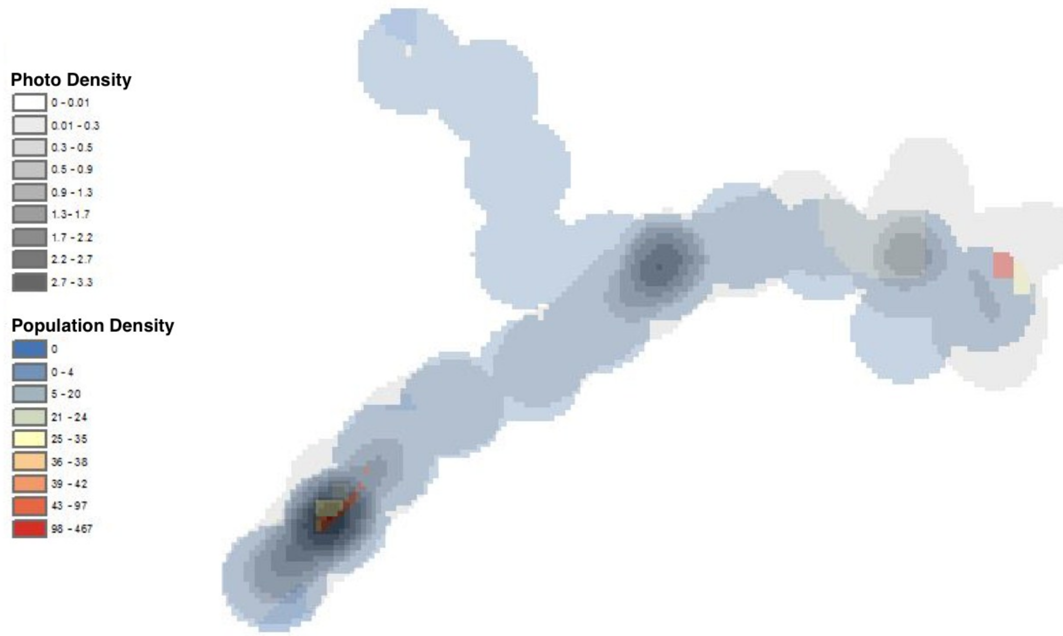
In conclusion, the methods we applied to use *Instagram* posts to understand people's landscape perceptions and the spatial patterns of landscape values in hydroelectricity study areas were effective, while presenting new opportunities for research. The results reveal stories that ring true and can inform decision makers about the current hydropower proposals in the study areas. In the future, more work is recommended in two directions: 1) how to exploit more social media sites and establish automatic analysis model, particularly for image-based data; and 2) whether and how physical landscape features or activities can facilitate formation of particular landscape values, whether based on the images themselves or drawing on base data from other sources.

APPENDIX A

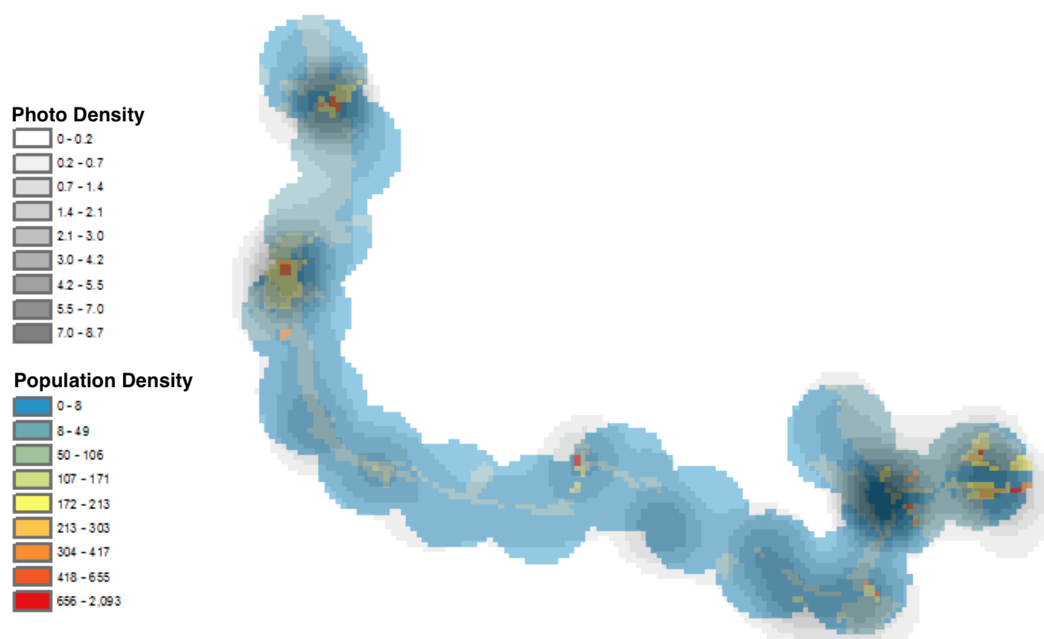
Supplemental Table 1. Correlation testing matrix of landscape values (Site C in blue, and Mactaquac in white).

	Aesthetics	Sense of Home	Community Attachment	Cultural Identity	Lifestyle	Memory
Aesthetics		0.69	0.62	0.83	0.53	0.47
Sense of Home	0.73		0.48	0.71	0.39	0.47
Community Attachment	0.62	0.57		0.86	0.81	0.70
Cultural Identity	0.73	0.42	0.45		0.70	0.61
Lifestyle	0.61	0.43	0.49	0.43		0.57
Memory	0.75	0.70	0.50	0.33	0.45	

APPENDIX B



a)



b)

Supplemental Figure 1. Density maps of *Instagram* photos and population (census block, per square kilometer), a) the Site C area, b) the Mactaquac area. View in colour.

APPENDIX C

Discussion about The Potential Heterogeneity of Social Media Use

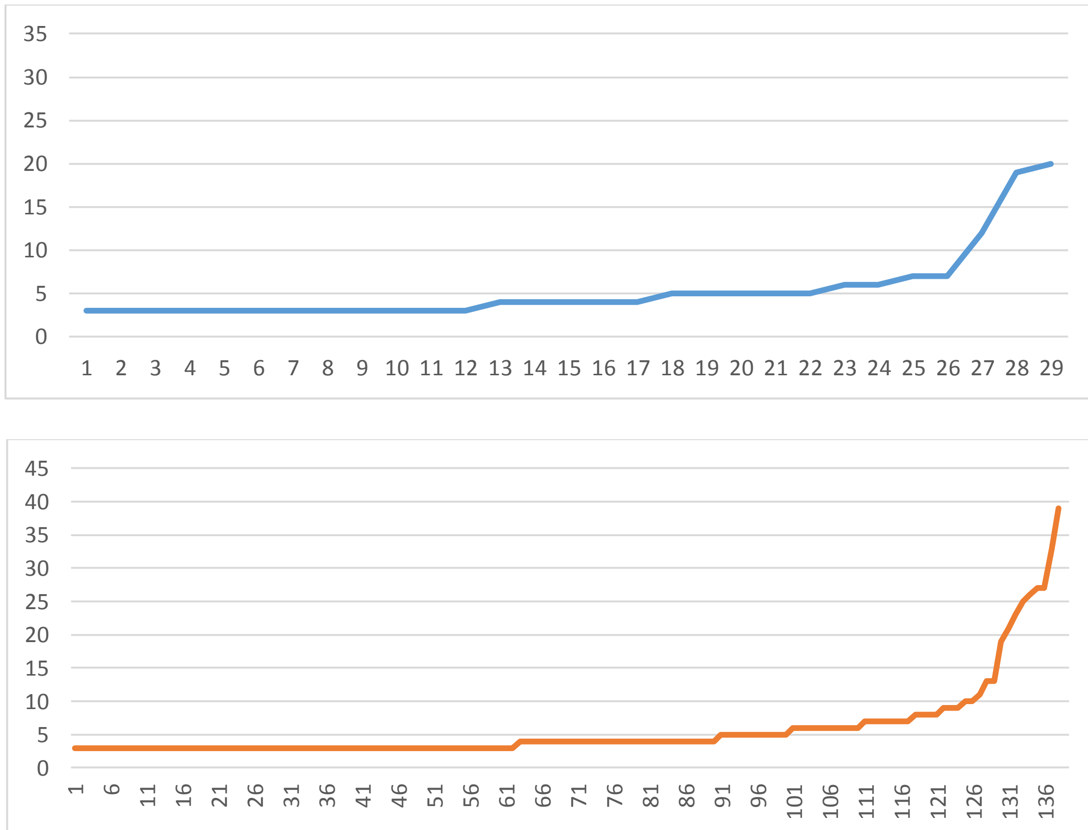
Due to large size of the datasets, we examined the potential data noises from some big users in both study cases. The main concern lies in whether such heterogeneity of social media use can cause palpable biases for this research. We identified 29 (17.7%) and 138 (7.7%) big users, respectively in Site C and Mactaquac (Supplemental Table 2). However, among them, only 12 users posted more than or equal to 5 photos for a year period in Site C, and 14 users posted more than or equal to 10 photos in Mactaquac (Supplemental Figure 2). Also, the maximum number of posts posted by single user is 20 for Site C and 39 for Mactaquac, both of which account a small part of the whole datasets. Thus, considering the size of the entire datasets and the one-year collection window, we believe the influence from these big users are acceptable. There is an example from the case of Mactaquac. We had identified a big user who posted many photos showing that she is doing yoga outside. We worried that if this would influence coding results for activities, making yoga as a popular activity in the area. However, the analysis results do not show such bias, which indicates the impact from big users is not prominent.

Supplemental Table 2. Numbers of total posts, total users, average posts, big users who posted more than average posts, and maximum posts posted by single user (use the datasets from Chapter 3 for discussion).

	Total Posts	Total Users	Average Posts	Big Users	Max Posts
Site C	316	164	2	29	20
Mac.	1786	980	2	138	39

a)

b)



Supplemental Figure 2. Counts of posts posted by big posters (sort smallest to largest), a) the Site C case, and b) the Mactaquac case (horizontal axes show big users in serial number instead of user names).

It is admitted that these big users may bring some biases, though acceptable as discussed above, there are difficulties to eliminate such data noises. First, the criteria for ‘big user’ are ambiguous. We identified users who posted more than the average as big users. However, it is unreasonable to say there is a big difference between users who posted 2 photos (the average) and those who posted a few more than 2. Second, even if we can decide who are the big users, another problem follows that what we should do to deal with the photos they posted? If we filter out all the posts from them, this may cause other biases.

Therefore, we decided to keep all the posts from big users in the valid datasets at first and would like to see whether the results could be largely influenced. Eventually, the analysis results show no obvious bias caused by these posts. But, this dose not indicate that this approach works for every case. On the contrary, we suggest that potential heterogeneity of social media use should be carefully examined case by case.

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