Integrating FFEI Scientific Predictions into Community Planning and Governance

Final Report

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2012

a. ***Research process*: Describe the objectives, approach and methods employed in the research.**

b. ***Collaboration*: Describe how your team collaborated with clients, partners, and other research teams.**

c. ***Communication*: Describe how your team communicated progress and outcomes with others (e.g., other researchers, clients, partners, stakeholders, and public).**

d. ***Deviations from project plan*: Describe any significant deviations your project took from the project plan (e.g., changes in project objectives/deliverables, changes in team membership, delays in meeting milestones) and provide reasons for the deviations and/or the actions taken to address them.**

e. ***Research outcomes*: Describe the research outcomes, including how your team met the objectives and deliverables specified in your project plan.**

Please note that we are including a-e as description of the evolution of the project:

The research question that we advanced at the outset of our project was, "what is the most effective way to incorporate science into an integrated community sustainability plan?" We will argue that one way to incorporate science into a sustainability plan is to create visualizations of the outcomes of the community plan integrating the science into the landscape therefore eliminating the need to articulate complex scientific concepts to a public that does not have the tools to conceptualized and analyze scientific data.

In order to explain and demonstrate the research outcomes, it is necessary to provide a background to the genesis of this project and to explain the evolution of the approach and methods we employed. This report will unfold by explaining the trajectory of the research process: the connection to our client, the City of Prince George and their effort to develop a sustainability plan; the development of an internal "community of practice"; the engagement with our key client, the City of Prince George, in the development of the community sustainability plan (called MyPG); the decision to abandon an external "community of practice" in favour of a more direct approach to integrating science into the sustainability plan outcomes; the invitation to the Collaborative for Advanced Landscape Planning (CALP) on the creation of visualizations, the development of the visualizations; the public consultation process; and, the engagement with FFESC science as a basis for developing similar visualizations for both public and government actors as a method to simplify the presentation of complex scientific data.

Our report is structured in a way that demonstrates how the visualization tool was used in the community planning exercise conducted in collaboration with our partner, the City of Prince George, and, later in the report, we discuss the long range possibility of applying our research to forest policy.

The Background to the Sustainability Plan

All of northern British Columbia has undergone a change in the economic structure that once underpinned the province. Since the 1980s there has been a considerable change in the way the province views the old economy of British Columbia; the traditional resource extraction economy has had to shift to the new rules that govern global economics – the end of appurtenancy, the reduction of government subsidization and connectivity to global markets, like Asia-Pacific. Moreover, governments have moved in the direction of downloading and downsizing which has put more stress on local government to respond to community needs but also to find their place in the new economy. To make matters more complicated, forest dependent communities have had to respond to the pine beetle epidemic without the concomitant knowledge of how the forest ecosystems may change the "business as usual" forestry industry over the next many years.

In response to these challenges the federal government provided support for communities by funding the development of long-term community sustainability planning processes. The Integrated Community Sustainability Planning (ICSP) Initiative in British Columbia is a BC Government supported initiative that started from the 2005 Federal-Provincial-Union of BC Municipalities (UBCM) Federal Gas Tax Agreement (GTA). "Under the GTA, all local governments that receive Gas Tax funding have committed to undertake ICS Planning, either individually or as part of a regional strategy. To fulfill the requirement, a local government needed to demonstrate that plan updates or new plans considered the following key sustainability elements:

- **Long term thinking** (e.g., local governments consider extending the planning horizon beyond the normal 3-5 year planning timeframe).
- **Broad in scope** (local governments consider the communities' environmental, economic, social and/or cultural sustainability).
- **Integration** (local governments better co-ordinate their approach to community sustainability through linkages between different types of plans)
- **Collaboration** (local governments engage the public and other partners in planning processes to support community sustainability)."

These four tenets were the guiding principles of Prince George's plan for long-term sustainability. The process began in 2008 and ended with the presentation of the MyPG integrated sustainability plan in 2010.

In the first phase of the process, the City engaged stakeholders concerned with Smart Growth[1], human health and ecosystem health and engaged other agencies in developing common business plans. In the second phase the City facilitated a broad based community consultation process. Traditionally consultation has meant that proponents of a particular idea take pre-determined plans and policies out to communities; in other words, consultation has been euphemism for information sessions. The ICSP was different. The plan engaged the whole community, local citizens and stakeholders, in the development of the long-term vision for sustainability. The third phase of the plan included the creation of a committee to oversee the process of implementation of the plan which is still on-going.

Our Role

[1] "Smart Growth BC is a non-governmental organization devoted to fiscally, socially and environmentally responsible land use and development. We work throughout the province with community groups, businesses, developers, planners, municipalities and the public to create more livable communities in British Columbia." http://smartgrowth.bc.ca/AboutUs/tabid/56/Default.aspx

At the time that the FFESC grant became available, our research group composed of natural scientists and social scientists came together to discuss the issues of climate change adaptation. Even among ourselves we saw immediately the extraordinary disconnects between these two scientific communities:

- timelines (local government working in three year political cycles versus climate change models of fifty or more years)
- the communication of not only highly complex scientific data but a highly abstract idea like climate change
- the role of the scientist as objective observer versus the role of the scientist as participant researcher

Moreover, we were aware that the science of climate and ecosystem change has created considerable controversy and confusion among citizens. Much of the information is not only complex but conflated with politics and by media who confuse objectivity with a skewed conception of the "balance" of information.

Scientists have not been very effective in connecting to community and we thought that the ICSP process would provide an opportunity to *address a priority climate-change adaptation issue (long-term community sustainability) by filling a knowledge gap (how to communicate scientific findings).* Our intention was not to simply interject scientists and science into the process or to simply have the scientists present information in a traditional way; the approach we took was to integrate ourselves into the process so that ideas about science could be communicated directly into the process.

In 2010, we committed a substantial amount of time to participating in the development of the MyPG project (the long-term sustainability project for Prince George). We worked with the City during workshops and through the Steering Committee to see the sustainability plan come to fruition. Different members of the team have participated in the City's "kitchen table" processes as well as the workshops for each part of the sustainability plan. Each workshop brought together individuals with particular expertise in the areas of economics, the environment or social development. The workshops were: food security; scenarios (two days); land use and transportation strategy and developer meeting (two days); environment strategy (one day); economic development strategy (one day); social development strategy (one day); youth priorities strategy (one day); technical review (one day) and the community review (March 27th-April 19th). There were also bi-weekly Steering Committee Workshops attended by Dr. Rolfe (our post-doctoral fellow) and / or Dr. Summerville.

Also during 2010, we met bi-weekly as a research team during the academic semesters. Part one of our research plan included the creation of a "community of practice" (CoP1) to draw together both social scientists and natural scientist to discuss and to learn from one another the various ways in which we communicate ideas to the public. The objective of the group was to discuss the key obstacles to the translation of science and to discuss practices for overcoming these obstacles. We examined how the current science / research could help us answer our research question. We also wanted to draw on the multidisciplinary approaches to the discussion and communication of climate change. Our conversations and our participation in the MyPG process led to a number of important observations that would impact our long-term methodological choices. Our original proposal had included a plan for a larger "community of practice" (CoP2) to bring together scientists and non-scientists, citizens and policy makers, in a discussion that would, we hoped, lead to a better integration of science into sustainability planning but we realized that this was unlikely to lead to us to our final goal within the timeframe of this proposal.

First, we observed that the ideas of "sustainability" and "climate change" were so multidimensional that "integrating science" became too complex a notion. The ICSP was an holistic plan for a vision of Prince George in 50 years. The various elements of sustainability included the spectrum of economic viability, social stability, and environmental health along with the maintenance of community identity. Conceptualizing sustainability was a much a part of the ICSP as was determining practical outcomes for achieving it.

Second, in light of the first observation, we wondered how we would create a "community of practice." A CoP requires a significant commitment to a long-term process of learning about a particular issue that is of shared concern. As we began to contemplate how we would invite participation in this process we realized that there were just too many aspects to sustainability to create a coherent CoP.

Third, we were to discover that Prince George did have a CoP of sorts in the group called PGAIR. PGAIR is "a multi-stakeholder, community-based organization dedicated to researching, monitoring, recommending, and implementing air quality improvements in the Prince George airshed, and to promoting education and awareness." PGAIR seeks to not only understand but also recommend and implement. In our discussions about how PGAIR works we were to discover that this CoP had worked together for over a year before finding its "feet" as a coherent group. It took a long time to develop trust. This group invites scientists to discuss latest air quality data and it took a long time before members were using the same vocabulary (across disciplines, across traditional knowledge and across interests) to ask questions and to understand the answers. We felt we could learn from the PGAIR experience without creating our own CoP for this project.

Fourth, our project had taken the view from the outset that science could be "learned." We thought that if scientific information could be brought to the table that it could be integrated though education, debate and conversation. We were surprised to discover the considerable literature that conservation psychology offers to us about the relationship among education, values and actions. We also had discussions with two psychologists who study the link between attitudes, education and behaviour in regard to environmental practice. Research indicates that values and behaviours are often not connected (see Gardner and Stern 1996).[2] When the MyPG plan was completed, we observed an interesting pattern in the outcomes. Despite the presence of the scientists in the process, the climate change adaptation goal, did not make the top 10 in the list determined by the community although "Green City and Green Practices" as well as "air quality" did make the top 10. Societal goals which touch on issues of social justice, safety and community identity were identified as six of the top ten goals.

[2] Gardner, G.T. and P.C. Stern. (1996). *Environmental Problems and Human Behavior*. Chapter 4: Educational Interventions: Changing Attitudes and Providing Information. Allyn and Bacon, Boston MA.

These observations led the CoP1 core group to reconsider where the best place for the actual integration of science might take place. We decided not to create CoP2 but to change our methodology to link more closely with the literature and practices connected to environmental behaviour change.

*The top ten goals identified by the community[3]

	Goal	**Description**
Society	Affordable, Accessible	Housing Offer accessible, affordable and safe housing for all, and eliminate homelessness.
	*Clear Identity and Pride	Have a clear identity that the community can be proud of, with a strong downtown and connection to its rivers and natural surroundings.
	*Culturally Rich	Have a rich cultural life, with more events, facilities, education, and community involvement in the arts to support economic and social growth.
	*Equitable Community	People of all backgrounds, ethnicities and income levels can access services that help to meet their needs and improve their quality of life.
	*Healthy and Active	Be a community that encourages and supports health and wellness.
	*Safe Community	Create an environment where all citizens feel safe.
	*Supportive and Engaged	Be a friendly and engaged community with strong social connections.
Environment	*Clean Air	Enjoy clean air.
	Clean Water	Protect the water supply and waterways, and reduce consumption.
	*Green City, Green Practices	Be a green city with healthy habitat and forests, and a strong environmental consciousness, led by government and local organizations that demonstrate sustainable practices.
	Green Energy	Be a leader in green energy.
	Reduce Carbon Emissions and Adapt to Climate Change	Reduce carbon emissions and dependence on fossil fuels, and be prepared for climate change
	Reduced Waste	Reduce solid waste production and landfilling.
Economy	*Diverse Economy	Have a diverse economy to augment our forestry base, responding well to changing global trends, and offering a good local return on investment through a focus on local food, service, green energy, and a knowledge based resource economy connected to the world.
	Fiscal Responsibility	Carefully budget to ensure effective and responsible use of financial resources.
	International Connections	Have well established international connections and international partners.
	Job Diversity and Accessibility	Have many good jobs to suit the diversity and aspirations of people in Prince George, with programs that support developing the skills and knowledge needed to fill them.
	Sustainable Business	Be a model for northern cities in green and local business, and bioenergy.
	*Vibrant Economy	Be a centre for vibrant economic growth in Northern

[3] myPG an Integrated Community Sustainability Plan for Prince George Part One (2010): 8 http://mypg.ca/about/Documents/myPG_Part_1_web[1].pdf

The next stage for our client partner, the City of Prince George, was to move into implementation of the plan. It was at this time that we decided to draw more heavily on the work done by conservation psychologists who, as we stated earlier, were looking for different methods of connecting values and education to behaviours or actions that demonstrate a commitment to sustainable development. At this point in the project, we invited Loraine Lavallee, an Assistant Professor of Psychology at UNBC to join our team. Her expertise was integral in allowing us to make the switch to the new methodical approach that we would employ. One study conducted by researchers from the University of Plymouth and Nottingham Trent University showed thermal images people's homes that illustrated heat loss.[4] In this case, the visualizations helped the homeowner make a decision to fix the problem without having to rely solely on expert opinion that, in fact, the house was draining heat (and therefore money). The idea of removing the expert (or scientist) as the purveyor of information intrigued us. We wondered what would be the impact of a visualization built on scientific data for communicating science into the implementation of the sustainability plan. The visualizations allow people to see the outcome of scientifically designed change without having to understand the scientific data that would precede decision-making but does not preclude individuals equipped to understand the scientific data from probing behind the visualizations to examine the scientific assumptions.

We approached our City partners, who at that time, were considering the development of a greenway that would connect downtown Prince George to the river trail system. We worked directly with a number of city staff including the environmental engineer, the parks and open space planner, the long range planner and the urban forester to determine the City's needs for the space. The original plan for the area was based on a Smart Growth design that had been developed as a part of a community discussion on downtown revitalization. While the design captured the needs and vision of the community, it lacked the scientific approach that we felt would enhance a sustainable community approach to urban design and landscape. This is not a criticism of the Smart Growth process; their goals were different and their plan did reflect community input and consultation.

By this stage, the original post-doctoral fellow hired to work with us, had decided to leave the project. In the first year report to the FFESC, we said at that we would hire students to complete the work. Prior to our receiving the grant for this project, UNBC and The City of Prince George had signed a Memorandum of Understanding that opened up opportunities for faculty and students to work with the City on research applicable to the City's goals. The Memorandum provided some funding to give students the opportunity to become research assistants on these projects. Dr. Summerville acted as the liaison between UNBC and The City. We hired a number of undergraduates who worked alongside the City to provide support for the MyPG project. Among other things, they attended the workshops; ran public consultation processes; and visited local community groups to facilitate participation in the "kitchen table" process of the plan. This extraordinary group of students was lauded by the City for their work and we felt confident that we could draw on this group to help us finish our project. In the spring of 2011, we hired two students full-time: a graduate student named Alvaro Palazuelos and an

[4] See Julie Goodhew, Tim Auburn, Sabine Pahl, and Professor Steve Goodhew. (2009) "Seeing heat could prompt energy conservation" http://www.plymouth.ac.uk/pages/view.asp?page=28270

undergraduate student named Daniel Iwama. We also hired a part-time undergraduate student named Nadia Nowak.

The students began a literature review on the use of visualizations. We also turned to the Collaborative for Advanced Landscape Planning (CALP) to help us determine how to build visualizations based on science and, moreover, how to build visualizations based on the goals of the sustainability plan as outlined by the community of Prince George. Dave Flanders of CALP spent two days with our team helping us to conceptualize the approach we might take and to work with the students on the tools to create visualizations. Creating visualizations requires considerable skill, creativity and time. Our visualizations also required extensive consultation with scientists to determine the best scientific data as a basis for creating a picture that could capture the key goals set out by the community which focused heavily on community identity.

We developed a plan for the visualizations that included a number of key factors: climate change models; flood mitigation strategies, consideration of changes to plant and tree species; and the inclusion of identity constructs. In a walk around of the greenway site we identified tree and shrub species and investigated their drought tolerance and their likelihood to be sustained on the site under different climate change scenarios. The CALP visualizations were appealed to as precedents in the production of our own climate visualizations. The downscaling of climate data to be apparent at the neighbourhood or street scale was a central principle of our project. Stephen Sheppard, lead researcher at CALP, has suggested that as climate visualizations move from distant/aerial scales towards the localized/street scale, the impact they have on individuals moves from a low level awareness towards visceral responses that can stimulate behavioural change.[5] People must be able to 'see themselves' in the visualizations they are presented with, and genuinely relate to the science conveyed in them in order to perceive a sense of importance. The development of winter based scenarios in the current project addressed this need of viewers to see themselves in climate visualizations. Depicting Prince George as it appears snow covered during most months of the year allowed local residents a greater ability to insert themselves into the photo-realistic setting, increasing their depth of engagement with the project.

After we determined the importance of grounding climate science at the local level, we started our search for literature focused on past trends and future projections of climate change in Prince George. At that point we started having regular meetings with Ian Picketts, a PhD candidate at University of Northern British Columbia who is researching climate change adaptation strategies for the city of Prince George. Picketts recommended two documents which showed climate change scenarios for Prince George,[6] as well as literature available from the BC Ministry of Environment's Climate Change website and literature developed by the Pacific Climate Impacts Consortium.

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[5] Sheppard, S.R.J., Shaw, A., Flanders, D., Burch, S. (2008). Can visualization save the world? Lessons for landscape architects from visualizing local climate change. *In Proceedings of "Digital Design in Landscape Architecture" 9th International Conference on IT in Landscape Architecture*, May 29-31, Anhalt University, Dessau Bernberg, Gemany

[6] Picketts, I.M., A.T. Werner and T.Q. Murdock, (2009) "Climate change in Prince George: summary of past trends and future projections." Pacific Climate Impacts

The first goal was to identify the climate change impacts that were a top adaptation priority for the city of Prince George. The document "Adapting to Climate Change in Prince George: An overview of adaptation priorities" clearly identified the top ten priority impacts that will affect this city.

Table 1. Priority impacts that will affect the city of Prince George[7]

Level of Priority	Impact
Top Priorities	Forests
	Flooding
High Priorities	Transportation infrastructure
	Severe weather / emergency response
	Water supply
Medium Priorities	Slope stability
	Stormwater
	Buildings and utilities
Other Priorities	Health
	Agriculture
	New residents and businesses

Once the top ten adaptation priorities were identified, they needed to be understood within the context of the project area. An area of Lower Patricia Boulevard had been selected as the space to develop a greenway which would provide connectivity between Downtown Prince George, the rivers and the trail system that goes through Cottonwood Park. At the moment, the rivers and trail system of Cottonwood Park remain isolated from the downtown core, especially for pedestrians. Image 1 shows the project area and its surroundings.

Consortium, University of Victoria, Victoria BC, 48 pp and Picketts, Ian, Dave Dyer and John Curry (2009) "Adapting to Climate Change in Prince George: An overview of adaptation priorities**."** UNBC and the City of Prince George.

[7] Picketts, Ian, Dave Dyer and John Curry (2009) "Adapting to Climate Change in Prince George: An overview of adaptation priorities**."** UNBC and the City of Prince George, 5.

Image 1. *Lower Patricia Boulevard project area and surroundings*

In order to determine which of the climate change impacts that will affect Prince George were relevant to the project location, we consulted with several specialists. We had the opportunity to walk through the area with Dave Dyer (City of Prince George's Chief Engineer), Dave Flanders (CALP member and Landscape Architect) and Keith Egger and Scott Green (Ecologists deeply involved in climate change research and climate science, and UNBC faculty). Through this walk and after further discussions held during personal interviews, three climate change impacts were determined which were of particular relevance to this space: flooding, transportation infrastructure, and storm water.

The visualizations tried to reflect climate change adaptation strategies appropriate to deal with increased flooding, a higher volume of storm water flows, and the increasing challenges to transportation infrastructure caused by a higher chance of augmented freeze/thaw action due to climate change. Some of the strategies identified were a containment pond in the lowest area of the region to which bio-swales would transport storm-water. Another important strategy was to increase the permeability of the surface of the area in question. At the present time, this area has a high percentage of impermeable surfaces which increase the problem of storm-water flow due to lack of ground infiltration. This contributes to the already increasing flooding events of the past years. With forecasts predicting increased wintertime precipitation, as well as rises in wintertime minimum temperatures, we can expect higher volume, and more sudden snow melts earlier in the season. Table 2 shows different scenarios of climate change effects (precipitation and temperature) in different periods of time in the Prince George area. For the purposes of this project and to reduce the number of scenarios, we chose the most likely scenario of climate change, the median scenario.

Table 2. *Climate Change Scenarios for the Prince George area*[8 9]

Temperature (°C)	Winter			Summer			Annual		
	2020s	2050s	2080s	2020s	2050s	2080s	2020s	2050s	2080s
Maximum	3.2	5.1	6.7	2.4	4.3	6.1	2.4	4.0	5.7
75th percentile	1.9	3.0	4.5	1.4	2.5	3.6	1.4	2.5	3.7
Median	1.2	2.3	3.4	1.1	2.0	3.0	1.0	2.0	2.9
25th percentile	0.7	1.6	2.6	0.8	1.6	2.4	0.7	1.6	2.2
Minimum	-0.7	0.0	0.6	0.4	0.8	0.9	0.1	0.7	1.4

Precipitation (%)	Winter			Summer			Annual		
Time Period	2020s	2050s	2080s	2020s	2050s	2080s	2020s	2050s	2080s
Maximum	17	27	34	20	26	23	11	19	27
75th percentile	8	13	19	4	5	7	6	10	15
Median	5	8	13	-1	-1	1	3	6	9
25th percentile	1	3	6	-5	-6	-8	1	3	6
Minimum	-10	-8	-7	-19	-27	-32	-7	-6	-6

In order to deal with the goal: "Have a clear identity that the community can be proud of, with a strong downtown and connection to its rivers and natural surroundings," we determined that it was essential that community members would recognize the area under consideration and that they would "see themselves" in the visualizations; that is to say, using the area or imagining it as a natural part of downtown Prince George.

We tested three different conceptual frameworks by designing questions that related to the participants from the perspective of: a minimal approach (information presented with little context), an historical memory approach (relating the information to the participant's memory of changes that have taken place in PG over the years), and a scientific approach (expressing the questions in the scientific terminology of climate change). Our expectation was that participants would be most familiar with the historical memory-oriented approach and least familiar with the science-oriented approach and least retentive of the minimal approach. The historical memory approach removes any discussion of scientific language from a discussion of the visualizations. It asks participants to remember weather events, like flooding, in order to explain the potential adaptation and mitigation tools used in the visualization.

Each group was surveyed with and without visualizations to test if visualizations helped participants to conceptualize and remember the information presented from the different conceptual perspectives. A survey was conducted with 111 participants randomly assigned to six groups: 1. Minimal with visualizations (n=17), 2. Historical Memory with visualizations (n=22); 3. Scientific with visualizations

[8] 140 Global Climate Model projections were added to produce temperature and precipitation forecasts for the Prince George area over a 70-year time scale.
[9] Picketts, I.M., A.T. Werner and T.Q. Murdock, (2009) "Climate change in Prince George: summary of past trends and future projections." Pacific Climate Impacts Consortium, University of Victoria, Victoria BC, 25 and 27.

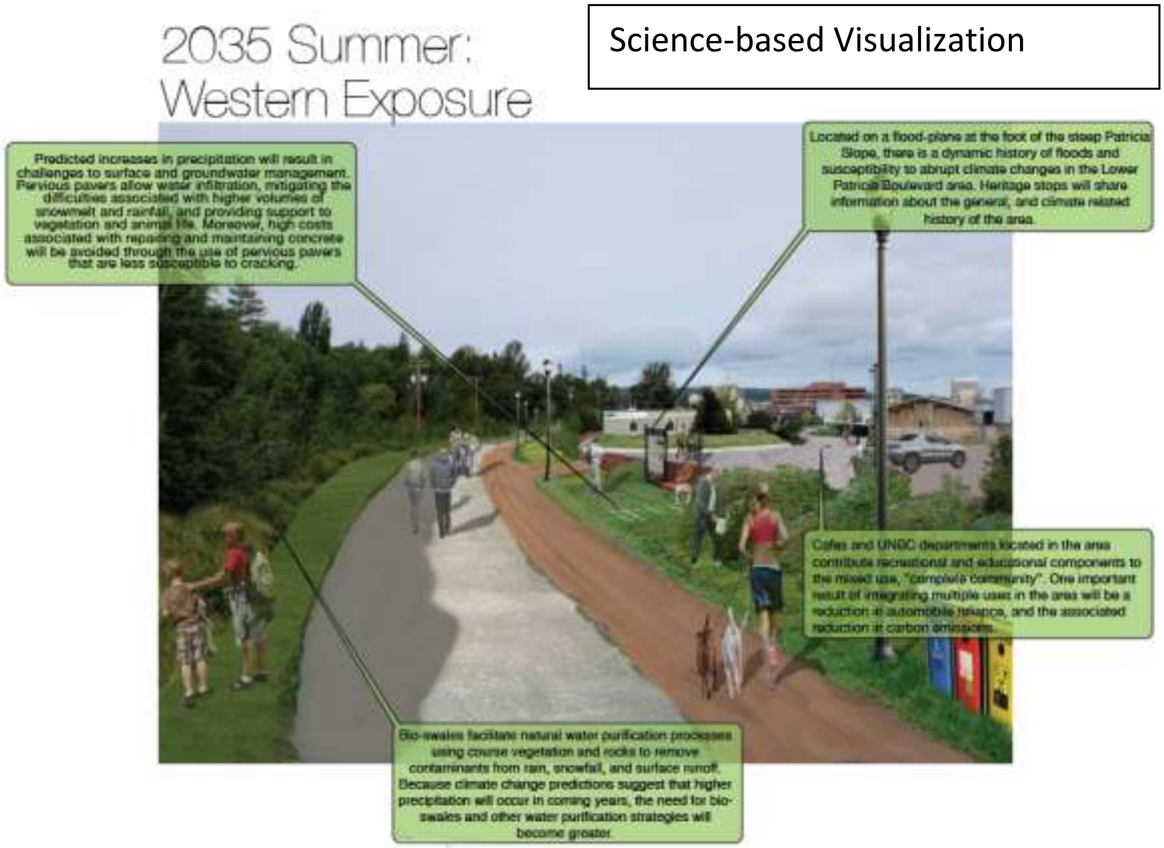
(n=20); 4. Minimal without visualizations (n=18); 5. Historical memory without visualizations (n=17); and 6. Scientific without visualizations (n=17).

The Site In 2011

Following are samples of visualizations used in our survey.

Historical Memory Visualization

Science-based Visualization



RESULTS

Were the visualizations liked more or less by different treatment groups?

A one-way between subjects ANOVA was conducted to compare the effects of the presence or absence of visualizations and three different levels of conceptual language (normal, scientific, historical memory) on:

1) How much participants considered that the project represented a desirable design for proposed greenway.

2) How much the participants thought that the changes proposed in the project represented appropriate changes to the area in question.

With regards to the first question, there was a significant difference in participant perceptions of the desirability of the design by group; members of the Historical Memory/No Visualization group found the design significantly less desirable than the other groups.

Regarding whether the participants thought that the proposed changes were appropriate, there were no significant differences among the groups. Our interpretation is that all groups endorsed changes to the area (probably because the current state of the area is such that any development is seen as an improvement), but that responses were influenced by the conceptual framework of the questions and/or the visualizations, with the Historical Memory/No Visualization group finding the changes significantly less desirable (it would require further surveying to determine if this latter observation was a statistical aberration).

Did any treatment help reinforce the cognitive process in order to remember the changes proposed better?

We were most interested in whether visualizations helped participants to conceptualize and remember the information better. Our expectation was that visualization would help participants to assimilate the more unfamiliar scientific concepts surrounding climate change but would likely have minimal effects on the historical memory and minimal presentation of the survey questions.

Question number six asked participants to mention how many changes proposed in the project they could remember, and question number seven asked interviewees to mention at least one built feature incorporated into the proposal that took changing climate into consideration.

On question #6, we found a strong interaction between visualizations and participant responses to these questions. There was no significant difference between the minimal, historical memory and scientific approaches in the groups that did not receive visualizations. However, in the groups that did receive the visualization materials, the group that received the science-oriented questions had a significantly higher rate of recollection of proposed changes compared to the group receiving minimal information.

In order to test the results of question number seven, participants were asked to mention at least one built feature incorporated into the proposal that took changing climate into consideration. Again, there was a significant difference between the groups in the capacity of participants to remember climate change information. Figure 1 shows the percentages within groups who undertook different treatments who could or could not remember built features incorporated into the proposal that took a changing climate into consideration (responses rated as zero) and the percentages of those who could remember at least one proposed built feature that took a changing climate into consideration (rated as one).

As can be seen from Fig. 1, the group with the worst retention of built features related to climate change were those who had a minimal explanation of the data. Although adding visualizations in this group helped, retention improved only moderately. The two groups that showed the highest levels of retention of built features relate to climate change were the historical memory group without visualizations and the science-oriented group with visualizations.

Our interpretation of these results is consistent with our expectation that participants would be most comfortable with a historical memory approach as this is a familiar way of conceptualizing landscape change for non-scientists. Interestingly, visualizations appeared to have little or no effect on retention of the information for this group. These results are also consistent with our expectation that the visualizations would provide the greatest benefit to the group receiving the science-oriented questions by allowing them to assimilate the scientific information visually. As expected, the group that received the science-oriented questions without the benefit of the visualizations struggled to conceptualize and retain the information.

Our overall conclusion is that visualizations are an effective tool for communicating science to non-scientists because it provides a visual context for the predicted changes rather than requiring non-scientists to form abstract conceptions based upon unfamiliar scientific terms and concepts.

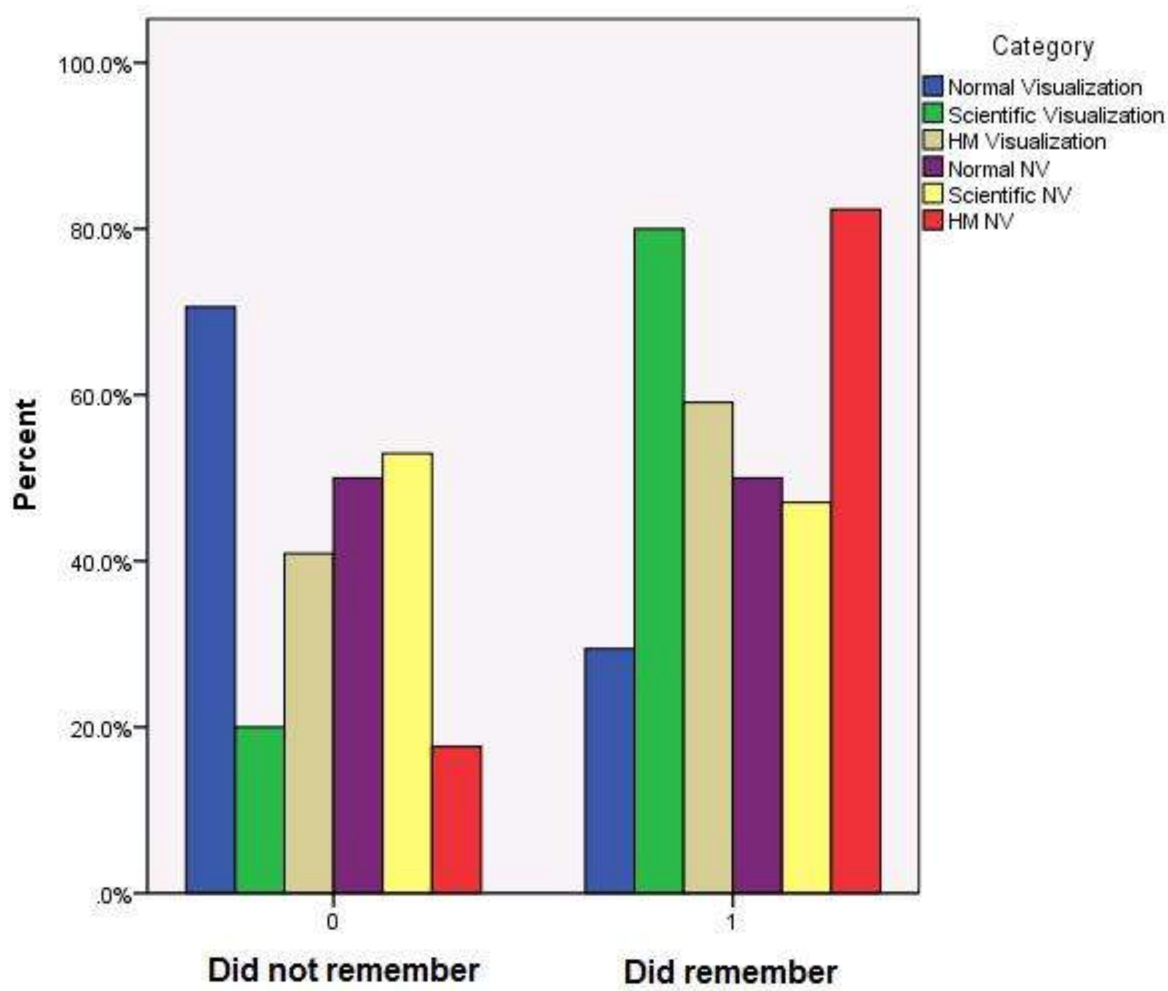


Figure 1. Percentages of each treatment group which remembered proposed changes meant to deal with the effects of a changing climate

f. ***Recommendations*****: Identify knowledge users (clients) of your research outcomes, and describe how your research outcomes have contributed or could contribute to their decision-making, especially evaluation and adaptation of existing forest and range management legislation and policies.**

Potential knowledge users: This project outlines a tool for the communication for the integration of science into planning and policy processes. There are a number of potential knowledge users but the key to this tool is its capacity to act as a bridge between knowledge users. For example, a city planner might use the tool to explain potential choices that a City Council might make in terms of adaptation to climate change. In turn, City councilors might use the same visualizations to explain to the media and to local constituents the future plans arising out of ICSP processes. The use of this tool allows for a technical and scientific discussion with the scientific data as a backdrop. The tool also allows for a clear a representation of potential mitigation and adaptation strategies without the scientific data at the forefront of the discussion.

g. ***Extension of research outcomes*****: Describe how your research implementation plan was executed, including how research outcomes have been used by clients to inform decision-making, especially evaluation and adaptation of existing forest and range legislation and policies.**

We connected with a team from the City who were asked to develop a potential greenway. The City planner was working from a Smart Growth plan. We decided to create the alternative scientific plans demonstrated through the visualizations. Once they were complete we met with two City planners and we gave them the visualizations in order that they might use them to further develop the greenway in line with the ICSP.

We are planning to have at least two articles from the research written by the team in summer 2012 to be sent to academic journals. We are also planning to attend the FFESC conference in June 2012 to discuss our results and to do a seminar on the visualization study to the government's forest and range research and policy specialists.

h. ***Utility of the FFESC research program:*** **Comment on successful aspects as well as opportunities for improvement in the execution of your research project, especially in relation to the composition of your team (a mix of natural and social sciences) and your engagement with clients and communities. The FFESC will use this feedback to assess the utility and value of the FFESC research program, and to provide input into future Government-funded climate change adaptation research programs.**

The FFESC project that we conducted was a success on a number of accounts:

Highly Qualified Personnel (HQP) – The students we had working on this project have gained a highly marketable skill. Here we included the testimonials of our two full-time research assistants.

Testimonials of Research Assistants

Alvaro Palanzuelos (graduate student completed during his research assistantship on the project): The experience as a research assistant to Professor Tracy Summerville in the FFESC grant project has been one of constant growth and learning. At first the task seemed easier than it proved to be. When we first started looking at the research question "how to incorporate science into a sustainable community plan?" we would have never guessed the broad range of skills that we were going to develop in the following eight months.

I came into this project as a social scientist with a good grasp on how to perform a community intervention, develop a survey and do statistical analysis. During the first four months of this project I was trained into the development of visualizations that would accurately express how climate change would affect a particular location. To do this we spent almost three months learning how to use, to a high level of expertise, the software Photoshop and Google SketchUp. Also, throughout this time we learned how to incorporate data from different disciplines (planning, environmental science, soil science, climate science, forestry) to develop scenarios on how a particular area could look like in the future. This interdisciplinary understanding of variables, along with newly acquired digital design skills, allowed us to generate realistic visualizations which took into consideration different climate change scenarios along with different adaptation and mitigation strategies which could be adopted by a city. All this was done while respecting the identity in the short, medium and long term of a sustainable community plan developed by the city in question. I was not expecting to develop the amount and level of skills that I developed throughout this research.

Daniel Iwama (undergraduate student) My involvement with the Summerville project has spanned from software training and the production of digital visualizations, to developing a formal research program and the execution / data analysis associated with such an undertaking. The group of supervising faculty that worked with us to develop the research program was diverse and provided crucial support in moments of uncertainty. Being able to consult a behavioural psychologist, soil scientist, terrestrial ecologist, political scientist, professional planner, professional engineer, and two landscape architects allowed the project to be deeply interdisciplinary. I am now highly skilled with software programs such as Google Sketchup and Adobe Photoshop, and understand how those programs can be used to advance research projects in numerous fields of study. In its focus on bridging academic /non-academic gaps, the Summerville project has also contributed to my moral constitution by training my future research goals on participatory processes and the democratization of community planning. After 1.5 years as a research assistant for the Summerville project, I have gained new, highly employable skill sets, developed an advanced understanding of social research methods, and now have a deep appreciation for progressive models of public engagement.

Working with our client partner, The City of Prince George – We were able to work directly with our partner throughout this process. Once the ICSP was completed, we worked with city planners to develop the visualizations that would become the core of our study. In the last few months of the project there was an election and with a change in mayor and a number of councilors. Some of the staff with whom we had been working was made redundant in the budget process. We had, initially, planned to have a joint public consultation process for the greenway development but this did not come to fruition as the plan for the greenway was put on hold. This fact of political life is an important lesson in the study of policy processes. It marks an important part of the discussion between the scientific community and the policy community. The vagaries of politics can make the long-term planning, mitigation and adaptation strategies, and the development of human relationships of trust tenuous. We were able to conduct our public consultation but we removed any reference to the potential development of the greenway as a City initiative.

Creating a multidisciplinary structure – While we had a transition of team members over the course of the two years, we successfully integrated the ideas and knowledge of social science and natural science into our project. The creation of CoP1 was a great tool to open up discussions about approaches, timelines, and paradigms of our respective work.

The FFESC project that we conducted was *less successful* in connecting to the data from other FFESC projects primarily because our timelines were concurrent and because our project was linked directly to an on-going ICSP process (a process that got underway before our funding became available). Also there was concern about releasing data before the quality had been verified and it had been checked for accuracy. However, there is considerable potential for future collaboration as we can now integrate the FFESC science into our visualization work.

For example, we were able to do some simulation examples in collaboration with Craig Delong and their FFESC project entitled "Risk Management and Decision Support Tool". The intent of the Risk Analysis and Decision Support Tool team was to develop a tool to assess risk over the intermediate term (20-40 years) of forest change at the site to landscape level. This risk assessment was largely based upon drought-induced mortality in susceptible tree species. We worked with Craig to develop visualizations for scenarios based upon drought-risk to forest surrounding and within the City of Prince George, the partner in our FFESC project.

Purpose:
• To apply the visualization skills learned through the Summerville project to a natural science project that incorporates FFESC data, and
• to display the potential of science based visualizations for extension to a broad range of academic research.

Sample Visualizations:
The following visualizations were produced, some with the assistance of Craig DeLong and some without, in order to extend this project's visualization skill sets to a forest risk model.

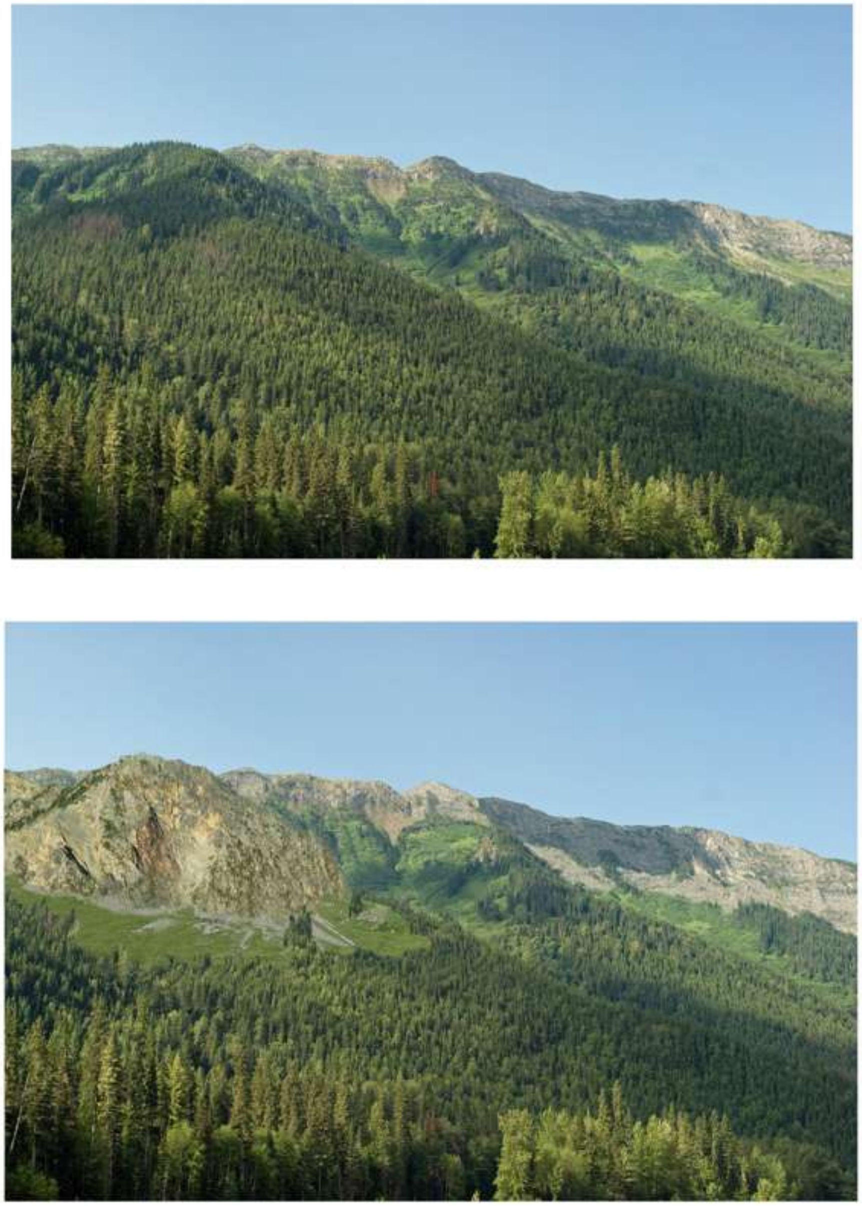


Fig. 2. The upper panel shows a current forest scene near Purden Mountain east of Prince George. The lower panel illustrates a modification of this scene to show increased high-altitude mortality due to climate change or insect infestation for example. These panels could be used in a simulation to illustrate climate change increasing high altitude mortality on a south-facing slope along with increased erosion.

Fig. 3. Panel of simulations showing progressive loss of vegetation along a ridge beside the Nechako River in Prince George and increased erosion.

These simulations are provided as examples to illustrate how simulations can be applied to communicate climate change impacts. Given our primary finding that visualizations significantly increased the ability of non-scientists to conceptualize and remember scientific information, we feel that our approach has great potential for making science-based information accessible to non-scientists.