Climate Change & Resource Development Scenarios for the Nechako Watershed: Workshop Report May 2015

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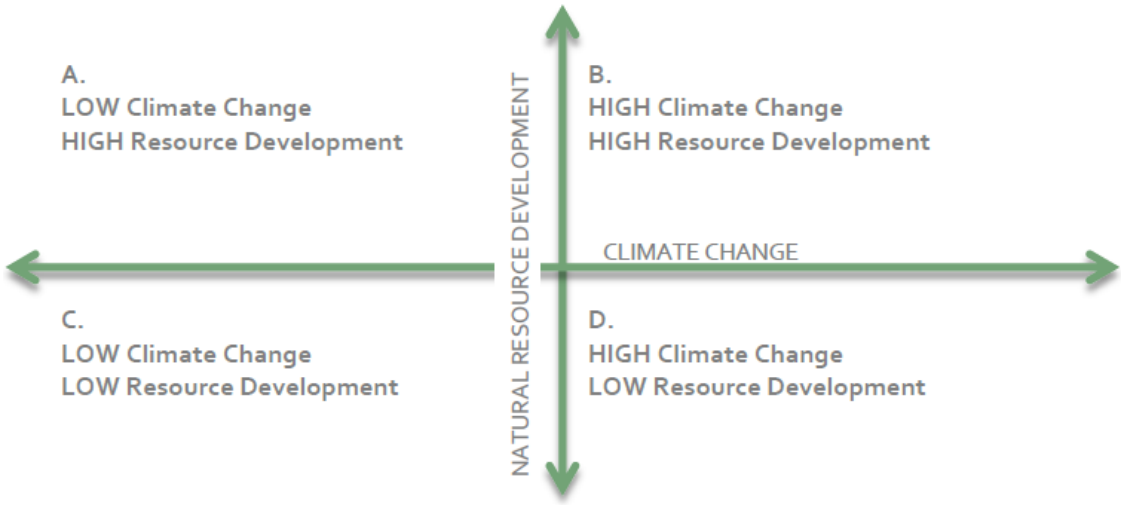
Executive Summary

This project addresses an identified need for a comprehenseive assessment of how climate change and natural resource development will affect the Nechako region in the future. To begin to fulfill this research gap, a workshop was co-hosted by researchers from the University of Northern British Columbia (UNBC) and the Fraser Basin Council (FBC) on October 27th, 2014 at UNBC's Prince George campus. This report only focuses on the UNBC scenarios workshop. Thirty-two stakeholders from eighteen groups with diverse interests in the watershed attended, including individuals representing agriculture, forestry, mining, oil and gas, non-governmental organizations, non-profit organizations, educational institutions, health authorities and all four levels of government.

One way of dealing with complexities and uncertainties is to develop a range of future senarios that could plausibly come to bear. By developing a range of scenarios, the possibility of one being similar to the future that actually unfolds is more likely. Also it can inspire people to act in a way to make a certain future a reality. The four scenarios envisioned in the workshop represented both high and low levels of both resource development and climate change. The high and low levels of resource development were determined with input from the participants, and the high and low levels of climate change were based on detailed emissions scenarios created by the Intergovernmental Panel on Climate Change. The four scenarios are illustrated in the following figure:



The main task for the workshop was for participants to create four scenarios for the Nechako watershed in the year 2050. Questions that guided the development of each scenario included how the region might change, the major impacts on natural and human systems, and how to proactively plan for and manage changes. A summary of the key themes compiled from the groups for each of the four scenarios follows:

A. Low Climate Change, High Natural Resource Development

- Although lower levels of climate change impacts are better than high, significant concerns may still exist in relation to water management, quality, and supply.
- How resources are managed is potentially more important than how much resource development occurs for the social, natural, and economic systems to remain viable.

B. High Climate Change, High Natural Resource Development

- Tensions and conflicts may accumulate amongst natural, social, and economic systems with local and global stakeholders.
- There may be large regional variations in how the landscape will change in response to climate change and resource development, with some areas in the region experiencing highly negative impacts.

C. Low Climate Change, Low Natural Resource Development

- Economic diversification in industries that are less resource-dependent, such as tourism and technology, would likely occur.
- Concerns over climate impacts may lessen but would not subside.

D. High Climate Change, Low Natural Resource Development

- Potential reasons for low resource development could be related to the climate impacts on water availability, forcing new economies to emerge that are tech- or service-based.
- If the economy is unable to diversify itself, the ability of communities to adjust to climate-related impacts and respond to events may be strained.

Although climate change is often thought of as a global issue, the impacts of climate change are felt mostly at the local and regional scale. In the workshop, scenario emphasis was placed on the linkage between climate change and natural resource development, and participants highlighted impacts and actions for natural, social, and economic systems. Envisioning plausible futures for the watershed helps to facilitate knowledge-sharing, stimulates long-term thinking, and builds capacity for climate change action and appropriate resource management. Efforts will be made to communicate the workshop findings with local stakeholders, decision-makers, and the academic community through distribution of this report, a formal research paper, and community presentations.

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UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA — www.unbc.ca

real estate foundation BRITISH COLUMBIA — www.refbc.com

NEEF Nechako Environmental Enhancement Fund — www.neef.ca

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1. Introduction

The, '***Climate change and resource development scenarios for the Nechako watershed,***' project was envisioned to address a research need identified in a previous project, '***Preparing proactively for the impacts of climate change on natural and human systems in the Nechako River Basin***' (also funded by the Real Estate Foundation of British Columbia). This previous research project, completed by Picketts, Déry, & Parkes (2014), examined cumulative impacts of resource development and climate change in the watershed in partnership with stakeholders involved in the Nechako Watershed Alliance (NWA)[1]. Although the previous research led to many discoveries related to climate and resource development impacts, it also identified a need for a more comprehenseive assessment of future interactions between climate change and natural resource development. This realization motivated a new phase of research that focused on developing detailed scenarios outlining resource development pathways and levels of climate impacts in collaboration with a diverse group of stakeholders throughout the Nechako region.

The primary objectives of the scenarios workshop and associated activities (such as writing this report) are as follows:

i. To bring together regional experts to showcase the knowledge and awareness of stakeholders in the Nechako watershed, and to foster a sense of teamwork and community amongst decision-makers living and working in the region.
ii. To work with stakeholders to envision four future scenarios for the Nechako watershed based on climate-change and resource development variables. These scenarios are intended to envision plausible futures for the watershed and to help inform decision-making in the region.
iii. To communicate the research outputs to a broad audience of people who live and work within the watershed (including First Nations, Regional Districts, Municipalities, Provincial Government Organizations, Federal Organizations, Non-Governmental Organizations, Community Groups, Industries and Academic Institutions). This report is the first step towards fulfilling this objective.

2. Background & Context

The following information is summarized from Picketts, Déry and Parkes (2014)[2]. The Nechako River begins in the Coast Mountains of western British Columbia (BC) and flows eastward until it meets the Fraser River at the City of Prince George (Hartman, 1996). The original undammed river was 440 km long. The Nechako River Basin (NRB) spans an area of 52,000 km^2 (see Figure 1 on following page) (Benke & Cushing, 2005). The Stuart River, which flows southeast from the Coast Mountains, is the biggest tributary of the Nechako River. The Nechako is in turn the second biggest tributary of the Fraser River. The Fraser River is the third largest river by flow volume and is the largest intact (i.e., undammed) river in North America (Benke & Cushing, 2005).

[1] The Nechako Watershed Alliance (NWA) is a volunteer multi-stakeholder group created to advise and share information about water stewardship activities in the Nechako watershed. At the time of writing, the NWA was in the process of developing a formal governance structure for ongoing activities in the watershed, and plans are underway for this new structure (for example, a Nechako Watershed Roundtable) to be consolidated in the second half of 2015.

[2] This report can be accessed at: http://nhg.unbc.ca/datafiles/ChangingLandscapes.pdf

Figure 1 Settlements in the Nechako watershed (Picketts, Déry, & Parkes, 2014).

Most of the land within the Nechako Basin is dominated by coniferous forests. The large tracks of mature forests have made it well-suited for logging (BC MoF, 1998). Many birds and mammals live in the NRB including moose, bears, wolves and great horned owls (BC MoF, 1998). The Nechako River is home to many fish species including rainbow trout and a genetically unique population of white sturgeon. It supports a large chinook salmon run, and two major runs of sockeye salmon in the Stuart river system (Benke & Cushing, 2005). The Nechako sturgeon population is classified as 'critically imperiled' (Benke & Cushing, 2005), which means that the species is facing a very high risk of extinction.

BC is home to a large and diverse population of aboriginal peoples. The Indigenous group that has lived throughout the entire Nechako Basin for thousands of years is known as the Carrier (or Dakelh) people (Attili & Sandercock, 2010; CSTC, 2011). The Carrier people were traditionally semi-nomadic, relying principally on trout, salmon, moose and deer for food.

3. Methods/Approach

One way of dealing with the complexity and uncertainty of climate change is to develop a range of future scenarios that could result from the present (Amer, Daim, & Jetter, 2013; Varum & Melo, 2010). By developing a range of scenarios the possibility of one unfolding is more likely, and we can encourage actions to reach a particular future. The structure and methods for the workshop were informed and adapted based on previous climate change scenarios workshops (Amer, Daim, & Jetter, 2013; Shaw et al., 2009).

To develop realistic scenarios we (the workshop organizers) strived to attract stakeholders with a variety of experiences, viewpoints and technical expertise related to the Nechako watershed. We made extensive efforts to invite participants that represented diverse knowledge. Workshop participants included thirty-two stakeholders from eighteen organizations with an interest in the watershed. Invitations were well-received: experts in agriculture, forestry, mining, oil and gas, non-governmental organizations, non-profits, community champions, municipal, provincial and federal government, First Nations, Northern Health Authority, First Nations Health Authority, the University of Northern British Columbia, and school districts were in attendance. Several stakeholders were unable to attend but requested to view the workshop report.

Prior to the workshop, participants were provided with a one page pre-workshop brief with definitions of important terms such as climate change, projections, and scenarios (see Appendix II), as well as the summary report by Picketts, Déry, & Parkes (2014).

The workshop began with acknowledgement of UNBC's location on the unceded, traditional territories of Lheidli T'enneh First Nation with a welcome from Elder Edie Frederick, followed by an overview of workshop protocol (see Appendix III). The research was approved by the UNBC Research Ethics Boards approval number E2014.0829.069.00. Copies of the research ethics information sheet were distributed to participants and discussed in the opening presentation. The workshop was split into three phases, which were as follows (see Appendix IV for full agenda):

1. Phase one background presentations discussed the Nechako watershed and historical and future climate projections (see Appendix I for projections).
2. In phase two, participants were split into five predefined groups to provide feedback on 'high' and 'low' levels of resource development. These high and low levels were combined with the 'high' and 'low' levels of climate change to create the four scenarios (see Figure 2).
3. For phase three participants were split into four predefined groups to develop the climate change and resource development scenarios. Groups in phases two and three were predetermined to ensure equitable distribution of stakeholders.

The methods and main outcomes of each of these phases are described in sections 4 and 5. As a follow-up to the workshop, participants were also provided the opportunity to review the draft report.

4. Envisioning Four Scenarios

Informed by previous research (Picketts, Déry, & Parkes, 2014) the main task for the workshop was for participants to envision four scenarios for the future anchored by intersecting variations of resource development and climate change (see Figure 2).

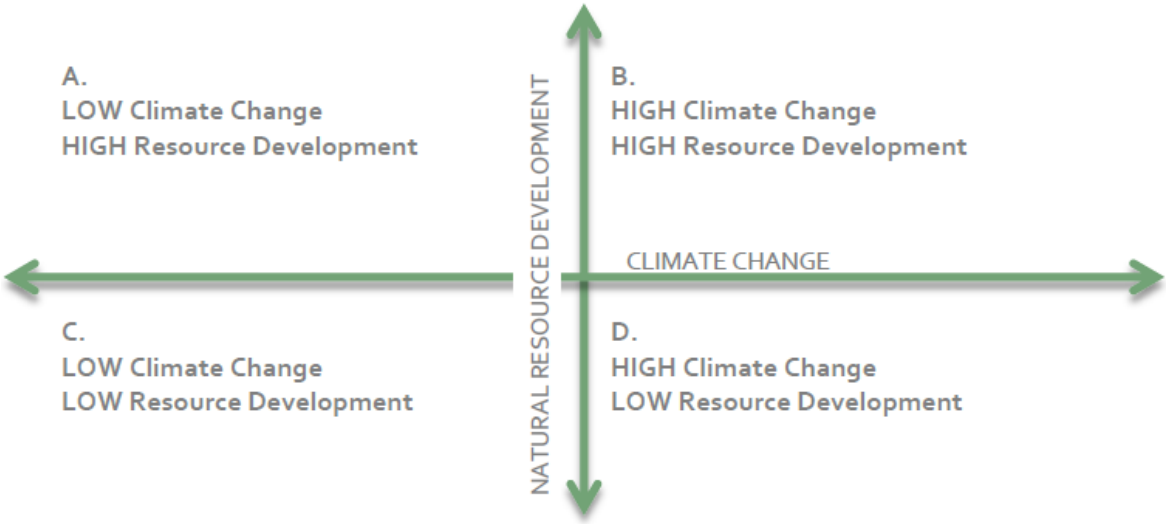

Figure 2 Four possible future scenarios used in the workshop with variable combinations of climate change and natural resource development.

a) Defining High & Low Climate Change

In advance of the workshop, the facilitators compiled historic and future climate data of temperature and precipitation in the Nechako watershed. The results of the climate analysis were presented to participants in a formal presentation, enlarged and printed on the walls, and also distributed in hard copy (see Appendix I).

For past climate analysis, historical data of temperature and precipitation developed by Natural Resources Canada (2014) were used from the period of 1950 to 2010. Information on future climate scenarios was achieved by analyzing downscaled data of temperature and precipitation compiled by the Pacific Climate Impacts Consortium (PCIC, 2014). The future scenario analysis

included linear and spatial change of temperature and precipitation for the period of 2010-2050 in the Nechako River watershed. It is difficult to project exactly how the future climate will be; therefore, scientists take several factors into consideration that will contribute to future climate change (Vuuren et al., 2011; Wayne, 2013). The 'high' and 'low' levels of climate change were based on two scenarios put forward by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2013). These two scenarios outline two future development pathways, which are as follows (IPCC, 2013; Vuuren et al., 2011):

- A low climate change scenario reflects increases in alternative forms of energy and less global fossil fuel consumption. As a result, there will be lower emissions of greenhouse gases (GHGs), and therefore lower levels of climatic change (and thus climate impacts) are projected.

- A high climate change scenario reflects continued high rates of fossil fuel use around the world, and therefore rapidly increasing GHG emissions. Under a high climate change scenario greater climatic changes (and climate impacts) are projected.

b) Defining High & Low Resource Development

The workshop facilitators did not have distinct 'high' and 'low' levels of resource development for participants to create the scenarios. Resource development scenarios depend on an array of economic, social, political, developmental and other factors. In light of this, as well as the fact that there were many experts attending the workshop, the 'high' and 'low' levels of resource development were defined by the participants at the workshop (before the scenario discussions occurred). This was accomplished as follows:

- We (the facilitators) performed background research and drafted 'high' and 'low' levels of resource development activities in the year 2050 for hydro-development, forestry, agriculture, oil and gas, and mining.
    - A 'high' level of resource activity symbolized extensive resource development and/or minimal management to reduce negative impacts.
    - A 'low' level of resource activity symbolized less resource development and/or proactive management to reduce negative impacts.
- Participants were asked to comment on and offer feedback on the resource development levels. The high and low scenarios were modified to reflect the feedback. This information was collated during a break and made available to participants.

c) Envisioning Resource Development & Climate Change Scenarios

Informed by the natural resource development exercise and the climate change projections, the main task for the workshop was for participants to create four future scenarios for the Nechako watershed in the year 2050. Stakeholders were divided into four groups to work through four possible scenarios with variable combinations of climate change and natural resource

development (see Figure 2 on previous page). Questions that guided the development of each scenario included how the region might change, the major impacts on natural and human systems, and how to proactively plan for and manage changes. Note takers captured the plenary and breakout discussions. The annotations were consolidated and analyzed in the weeks following the workshops. The following section presents key findings and themes from these annotations.

5. Findings

i. Resource Development Exercise

The results of phase two of the workshop, to explore high and low levels of resource development, are listed on Table 1 on the following page *(please note that these scenarios reflect the opinions of the workshop attendees).*

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	High Levels of Resource Development *Extensive resource development and/or minimal management to reduce impacts*	Low Levels of Resource Development *Less resource development and/or proactive management to reduce negative impacts*
Hydro-Development	Under a high scenario, the following changes were envisioned for hydro-development: • Kemano Completion Project is built: 2nd tunnel open for release, and/or additional hydro projects are proposed and constructed in the Nechako watershed. • Dredging of the Tatla narrows. • Lower reservoir levels.	Under a low scenario the following changes were envisioned for hydro development: • Kemano Completion Project is not built. • No new projects or facilities are constructed on the Nechako River. • Less water is diverted westward for power generation.
Forestry	Under a high scenario, the following changes were envisioned for forestry: • Burns Lake mill rebuilt and running. • Midterm timber supply crisis does not significantly affect production. • Asia emerges as the major export market; new, better and/or different products. • Large increase in bio-energy. • Food more as a commodity – diversity and food security may decrease.	Under a low scenario, the following changes were envisioned for forestry: • Significant regional downturn in forestry: fewer mills, fewer trees and fewer jobs. • Communities are hit hard by downturn and/or turn to different economic opportunities. • Still feeling effects of legacy of high forestry.
Agriculture	Under a high scenario, the following changes were envisioned for agriculture: • New crops and high prices make agricultural activities more profitable. • A new generation of farmers emerge and prosper, providing food security and economic development to northern markets. • Increases in ability to regionally process food – export facilitated by this. • International markets.	Under a low scenario, the following changes were envisioned for agriculture: • Some farms discontinued as farmer population ages. • Some agricultural land converted for other resource uses. • Agriculture may be seen as a challenging and unpredictable way to make a living for many farmers.
Oil and Gas	Under a high scenario, the following changes were envisioned for oil and gas: • Enbridge pipeline constructed. • LNG boom in BC leads to significant exploration and production in the Nechako watershed. • Coastal gas link approved. • Much more infrastructure, disturbance and roads.	Under a low scenario, the following changes were envisioned for oil and gas: • Enbridge pipeline not built. • LNG boom does not come to fruition. • There is still little exploration and development in the Nechako watershed. • Less use of natural gas in homes in the region.
Mining	Under a high scenario, the following changes were envisioned for mining: • High prices lead to more exploration and more investments in mines in the region. • Proposed mining projects come to fruition, and several new mines are proposed and built. • Many more workers in and out of the region. • More smelting leads to more economically viable opportunities.	Under a low scenario, the following changes were envisioned for mining: • Unstable prices and international competition challenge the mining sector. • Many proposed mines are not built, and no (or few) new mines are proposed. • Still no smelting.

Table 1 Overview of high and low levels of natural resource development in the Nechako watershed summarized from discussions at the workshop.

ii. Climate Change and Natural Resource Development Scenarios

The main task for the workshop was to envision four future scenarios for the Nechako watershed. The four scenarios are anchored by intersecting combinations of high and low levels of climate change and resource development (see Figure 2 on page 9). The findings have been summarized from notes collected in the plenary and breakout discussion. Findings for each of the four groups, for each of the four scenarios are presented below, along with two key themes for each scenario.

A. Low Climate Change, High Natural Resource Development

Group 1 – Different forest products could be developed in the future, leading to stands that are more merchantable. More resource development may change the natural system, but also may change people's needs for resources. Although low climate change impacts are better than high impacts, they are still significant with major impacts to fish, forests, as well as First Nations and other communities. Thus, resource development must occur in a responsible way that engages communities, reflects the interests of stakeholders, and sustains the health of the region.

Group 2 - Societal adaptation to climate change at the industry level and the individual level would have had to happen to reach this balance between low climate change and high resource development. The logistics of how natural resource operations could occur were brainstormed. Perhaps resource operations were more efficient, had less workers, and those workers would stay in camps and fly-in/fly-out. Alternatively, wages could decrease and manufacturing occurs locally rather than being outsourced.

Group 3 - Factors that could allow for increased resource development focused on agriculture. More overall agricultural production could occur related to cattle (i.e., beef and dairy), and more feed and inputs would be necessary. With the opportunity to expand the agri-food industry, discussion raised questions about the potential for increased water requirements to support this expansion. Concerns were raised over corporate farming in the Nechako Valley, reducing biodiversity as monocropping of cash and grain crops reduces variability. The question was raised as to whether current water supply was stable, even under current climatic conditions. The summer of 2014 saw streams dry up, raising concerns about ground water supply and drinking water springs. As surface water dries up dependence on groundwater could increase. The health of the forest was also seen as a potential concern in a low climate scenario, particularly forest pests such as birch bark beetle. More pests could mean higher pesticide use and the subsequent environmental impacts.

Group 4 - High resource development could mean oil and gas and mineral development pouring more money into the economy, infrastructure, and services. Water conflicts could increase, and water quality could decrease with impacts to communities and fisheries. Other impacts could include shifting species composition, bioaccumulation of contaminants, and decreased air quality due to more industry and less precipitation. More financial wealth from resource development could help mitigate environmental and social impacts of climate change, but also polarize extreme views of the impact on the environment. Increased

community planning would be needed to alleviate social problems associated with development, as well as the pressure on social systems with increased population.

KEY THEMES FROM THE LOW CLIMATE CHANGE, HIGH NATURAL RESOURCE DEVELOPMENT SCENARIO

- Although low climate change impacts are better than high impacts, significant concerns may exist in relation to water management, quality, and supply.

- How resources are managed is potentially more important than how much resource development occurs for the social, natural, and economic systems to remain viable.

B. High Climate Change, High Natural Resource Development

Group 1 - Changes and impacts to the forest and agricultural sectors were discussed. Agriculture and forestry could have competing interests in the land. What used to be a merchantable crop in the forest industry has reduced significantly due to the pine beetle epidemic; thus, existing forest species could be used differently in the future or new species could be introduced. For instance, the bioenergy industry utilizes wood byproducts from a variety of agricultural processes. Climate change could allow for new agricultural crops to be introduced. The question was raised that if the forest industry experiences growth whether management would be more intense, or would agricultural lands be reforested? Concerns were also raised over the pre-existing hydrological impacts of forest exploitation and the pine beetle epidemic. Agriculture, if not carefully managed, could further compound hydrological impacts through its effects on water quality and availability.

Climate change could increase the frequency of extreme events including intense forest fires, landslides, droughts, floods, and severe erosion. Severe events could have more destructive impacts than incremental climate shifts. Less water could be flowing into the Nechako River from the reservoir, and with the rise in temperature evaporation could also increase. With less water in the river, contaminant levels could increase (as there is less dilution) which impacts drinking water. Less water from the west, plus warmer water and higher evaporation could create enormous impacts on sturgeon and salmon. Less salmon would be a major loss to First Nations, could extend non-fishing periods, and close windows for commercial fishers.

Group 2 – Concerns over the health and well-being of the ecosystem, wildlife, and humans were discussed. Access was a point of contention that intersected with the health and well-being of First Nations and wildlife. Increased access roads through natural resource development could decrease or extirpate wildlife populations. Fenced off areas from natural resource operations, particularly agriculture, could decrease access to traditional First Nations

lands and impede knowledge transfer. The potential for increased fires, and the unknown impact of fire retardants on human health, was also raised. Concerns over increased population with an influx of environmental refugees could have social impacts such as violence, theft, and more strain on families.

Whether increased precipitation would fall as snow or water was explored (2.5 mm of precipitation is a large amount of snow), and whether increased temperatures would decrease water availability. A decrease in water availability would have unknown consequences for resources operations. If the amount of water increased, so would flooding incidents creating issues for infrastructure. It was also noted that that the temperature and precipitation impacts from the climate models were concentrated in the southwest corner of the watershed where the reservoir is located.

Group 3 - Increased agriculture, if not properly managed, could exacerbate climate impacts and alter the watershed ecosystem, particularly forests. Concerns were raised over foreign ownership and management of agricultural lands: particularly if new owners had different stewardship values. Increased agriculture could mean more trees being cut down and potentially (if cleared near to the water body's edge) would impact the functionality of that body of water. Agricultural regulations would have to be changed to allow for increased production at federally inspected red meat slaughter plants. The amount of water needed for irrigation of crops could also increase, but the types of crops used could also change to better suit the climate. Many of the climate variables affect the ecosystem at a very fine scale (e.g. rainfall, fertility, soil) making it difficult to imagine one solution that addresses all factors. Management factors were discussed such as a lack of presence from the Ministry of Agriculture in the region, a lack of planning at the landscape level, and lack of consideration of the cumulative impacts of multiple sectors. The impacts of resource extraction development roads on wildlife were mentioned, such as transmission lines creating linear impacts that affect habitat connectivity. The human population could potentially increase due to the appeal of a milder climate, or through environmental refugees impacted by raising sea levels and drought.

Group 4 – Transportation stressors (related to both resource activity and changing weather patterns) and the increased risk of motor vehicle accidents, train derailments, and wildlife accidents due to busy highway and rail traffic was discussed. Increased transportation could also mean increased road construction, bridges, and potential doubling of the rail lines. Social impacts could include the adverse effects of potential population increase until community services (e.g., health care and education) could catch up. Ecosystem changes could include a shift in the species compositions of forest, fish, and wildlife. Water concerns included potential water shortages and water use conflicts. Less water could be available for the environment and for human consumption in late summer and early autumn. Water demand could outweigh supply due to increased withdrawal and increased evaporation. There could be a higher risk of floods and forest fires, possibly more erosion, and flooding in urban areas if storm water systems are overwhelmed (e.g. extreme rainfall). However, perhaps the high impacts will lead to increased awareness of climate impacts and willingness to adapt behaviours.

- Tensions and conflicts could accumulate amongst natural, social, and economic systems with local and global stakeholders.

- There could be large regional variations in how the landscape will change in response to climate change and resource development.

C. Low Climate Change, Low Natural Resource Development

Group 1 – Recent events in the forest industry were noted, as the mid-term timber supply crisis will have an impact on future exploitation. With low climate change the availability of water could still decrease creating a scenario that is less bad but not good. Perhaps to some extent the impacts of climate change cannot be controlled, they can only be balanced with resource development. For such a scenario to come to fruition, Rio Tinto Alcan may have to significantly change their current practices and better manage their impact on the Nechako River.

Group 2 – Despite low climate change, the conversation was similar to the discussion on low resource development and high climate change: a new socioeconomic reality could emerge. Additional points raised were what to do with existing energy sources and infrastructure from resource development, how to re-educate people, and an increased need for healthcare workers to care for baby boomers.

Group 3 - Such a scenario could have a negative impact on social and economic systems. The population could decrease since there would be fewer jobs to support or maintain quality of life, forcing schools to close and municipal services to decrease. On the other hand, the economy could shift from resource- to technology- or tourism –based. A tourism-based economy could require healthy ecosystems (i.e., forests, fish, wildlife, and water) to flourish. UNBC was credited for diversifying the Prince George economy, and the possibility for government stimulus funding was identified. The connection between this scenario and current conditions surfaced with conversations about the current resource activity as being moderate to high, but the focus of the resource industry (particularly forestry) as diversifying.

Group 4 - It was noted that this scenario did not mean that there was no resource development, just no *new* resource development projects such as mining and oil and gas. There could be less traffic on transportation roads, thus less investment in new and aging infrastructure, and fewer incidents with humans and wildlife. Perhaps there would be a large

exodus of the population, as well as economic diversification. New approaches to economic development could be less resource-dependent such as tourism. Perhaps the local economy would become more stable with fewer boom and bust cycles symbolic of a resource economy. While this scenario specifies low climate change, discussion was still concerned about the ecosystem impacts, particularly freshwater temperature warming and less volume of water in the river. Perhaps pine forests and viewscapes would recover.

KEY THEMES FROM THE LOW CLIMATE CHANGE, LOW NATURAL RESOURCE DEVELOPMENT SCENARIO

- Economic diversification in industries that are less resource-dependent, such as tourism and technology, would likely occur.

- Concerns over climate impacts may lessen but not subside.

D. High Climate Change, Low Natural Resource Development

Group 1 - Low resource development signifies fewer harvestable trees in the forest, fewer mills, and fewer jobs. Energy costs may have increased requiring adaptations such as advances in technology. The impacts of climate change may vary by region, with some more vulnerable than others. The pine beetle impact may escalate, and preparing for extreme weather events may be a priority. However, less resource development potentially means fewer resources to respond to climate change disasters and events.

Group 2 - Socioeconomic impacts could include elevated unemployment and fewer resources (human and economic) to respond to climate change events such as fires and floods. Creativity could emerge to develop a new type of economy, such as moving from resource-based to tech- or service-based. Unanswered questions include whether there would be less overall interest from the province in the north? Would the population increase with environmental refugees, or would people be moving away from the north?

Group 3 - Potential reasons for low resource development could include uncertainty and unavailability of water. These conditions may create favourable conditions for increased tourism as accessibility for non-resource sectors could increase. On the other hand, climate change impacts could impede tourism development and affect recreation opportunities due to impacts on the health of fish and wildlife. A decreased presence of (and reliance upon) a global resource economy could turn the focus towards increasing the local economy, and provide the opportunity for local government to take leadership on conservation, energy efficiency, reduced water use, and xeriscaping. With increased climate change and the potential for an increase in population, ways to reduce energy consumption and increase self-sustainability may surface (e.g. gardening and the use of clotheslines).

Group 4 - Climate impacts could include increased air temperature and precipitation, increased flood and fire risk, and shifting species composition; however, resource pressures on the environment could decrease. There may be less habitat fragmentation due to low resource development, leaving room for native species to adapt to climate changes and for the environment to restore itself. Socially there may be less economic wealth to reinvest and adapt to a changing climate, and community planning may be needed to adapt to climate change and a shift in economic sectors.

KEY THEMES FROM THE HIGH CLIMATE CHANGE, LOW NATURAL RESOURCE DEVELOPMENT SCENARIO

- Potential reasons for low resource development could be related to the climate impacts on water availability, allowing new economies to emerge that are tech- or service-based.
- If the economy is unable to diversify itself, the resiliency of communities in responding to climate change disasters and events could be strained.

6. Conclusion

Although climate change is often thought of as a global issue, the impacts of climate change are felt mostly at the local and regional scale (Shaw et al., 2009). The same adage holds true for natural resource management and development. The scenarios aimed to discuss awareness and action of climate and resource-related impacts in the Nechako watershed with a variety of stakeholder groups. Scenarios emphasized the linkage between climate change and natural resource development, and participants highlighted impacts and actions for natural, social, and economic systems. Envisioning plausible futures for the watershed helps build understanding of climate change impacts, stimulates long-term thinking, and builds capacity for climate change action (Shaw et al., 2009). Efforts will be made to communicate the workshop findings with local stakeholders, decision-makers, and the academic community through distribution of this report, a formal research paper, and community presentations.

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8. Appendix

I. Past and Future Climate Projections

A. Past Climate Projections

Temperature

Recent years in the Nechako Watershed have been warmer with an average temperature increase of 2.28 degrees Celsius from 1950-2010. Spatially, the increase in temperature was highest in the northern and central-eastern areas of the watershed with a maximum change of 3.37 degrees Celsius, mostly in the Stuart River Basin and Fort St. James region (see Figure 3). The lowest temperature increase was 1.4 degrees Celsius in the south-western region.

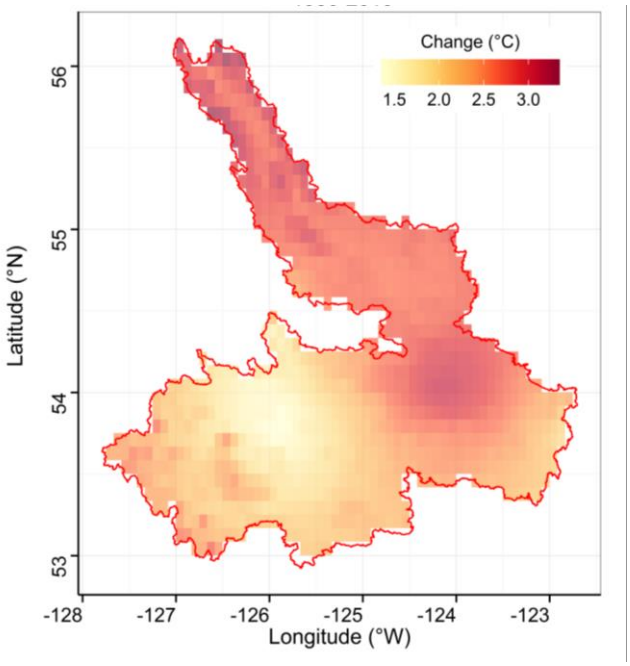

Figure 3 Historical annual mean temperature change in the Nechako watershed from 1950-2010.

Precipitation

Overall, mean annual precipitation (which could be snow, rain, or both) has decreased by 33 millimetres in the last six decades, but has followed no specific pattern as some years are drier while others are wetter. The majority of the watershed shows no significant change in precipitation, except for the Stuart River Basin in the northern tip which shows increased precipitation of up to 90 millimetres, and the eastern portion which shows a decrease of up to 380 millimeter from 1950 – 2010 (see Figure 4).

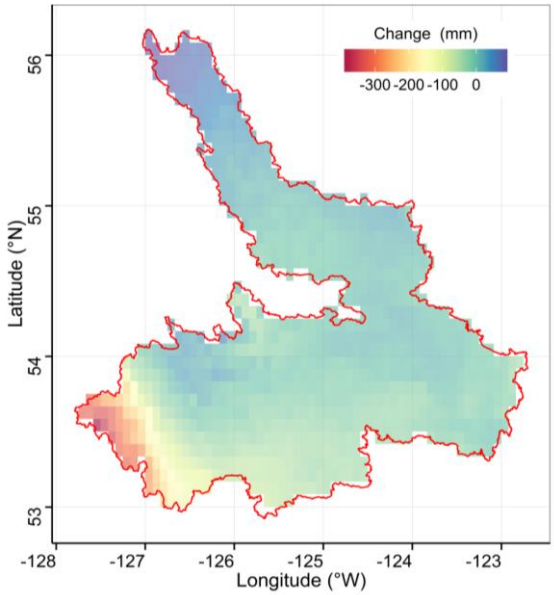

Figure 4 Historical annual precipitation change in the Nechako watershed from 1950-2010.

B. Future Climate Projections

It is difficult to project exactly how the future climate will be; therefore, scientists use a range of scenarios considering many factors that will contribute to future climate change. A low climate change scenario is one in which there will be less emissions of greenhouse gases (GHGs) and pollutants, while in a high climate change scenario there would be more GHG emissions. Under a low climate change scenario, lower change in future climate is expected while under a high climate change scenario there will be greater change in climate than present.

Low Climate Change Scenario

Temperature

Even in a low climate scenario, the Nechako watershed will be warmer and drier. The mean annual temperature would increase by 1.64 degrees Celsius compared to the years 1950-2010. The spatial distribution of these increases is similar to past climate changes (see Figure 5). The Stuart River Basin in the north will see a temperature increase of up to 1.65 degrees Celsius, whereas the south-western region of the watershed will see increases as low as 1.21 degrees Celsius. The mean temperature increases in all seasons, highest during the summer (up to 2.57 °C) and lowest in the winter (only 0.59°C).

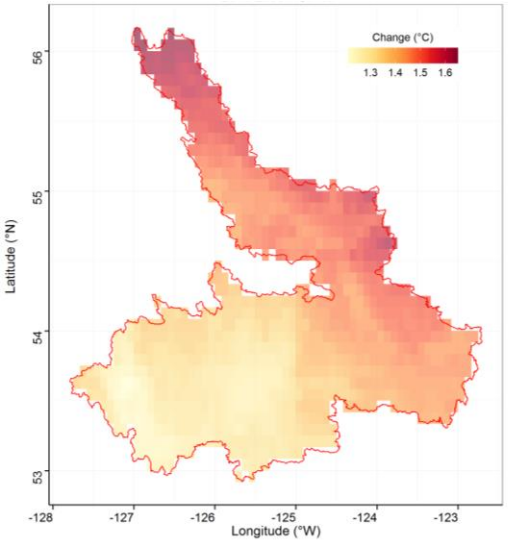

Figure 5 Future annual mean temperature change from 2010-2050 in the Nechako watershed in a low climate change scenario.

Precipitation

The region will be drier with total annual precipitation decreasing by an average of 53 millimetres in the next 40 years. The maximum precipitation decrease would be by 152 millimetres and concentrated in the south-western region (see Figure 6). The minimum decrease would be by 22 millimetres concentrated in the south-eastern and northern regions. Annual precipitation will decrease in all seasons except spring, with the largest decrease in the summer (33.24mm) and the lowest decrease in the winter (0.01mm).

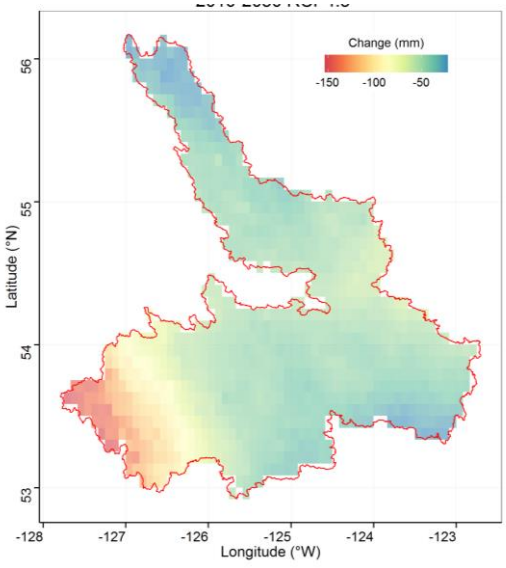

Figure 6 Future annual total precipitation change from 2010-2050 in the Nechako watershed in a low climate change scenario.

High Climate Change Scenario

Temperature

In a high climate scenario the Nechako watershed will be warmer and wetter. The mean annual temperature in the period 2010-2050 would increase by 3.02 degrees Celsius compared to the years 1950-2010. The spatial distribution of these increases is similar to the past climate changes (see Figure 7). The Stuart River Basin will see a temperature increase of up to 3.17 degrees Celsius in the north, whereas the southwestern region of the watershed will see increases as low as 2.84 degrees Celsius. The mean temperature increases in all seasons, and in contrast to the low scenario the increase is highest during the winter (up to 3.73 °C), followed by summer (3.54°C), and lowest during the fall (1.85°C).

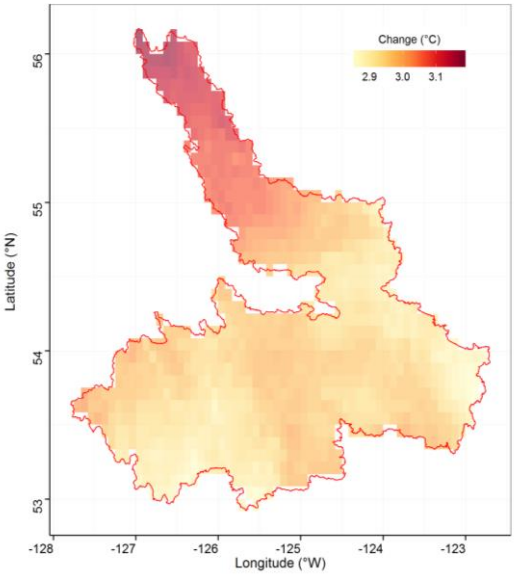

Figure 7 Future annual mean temperature change from 2010-2050 in the Nechako watershed in a high climate change scenario.

Precipitation

In contrast to the low climate scenario, the total annual precipitation will increase in a high climate scenario by an average of 109.55 millimetres. The minimum precipitation increase would be by 67 millimetres in the south-central region of the watershed, and the highest increases would be by up to 137 millimetres in the eastern and southwestern regions (see Figure 8). Precipitation will increase in all seasons, with the highest increase during the winter (32.16mm) and lowest increase in the spring (4.22mm).

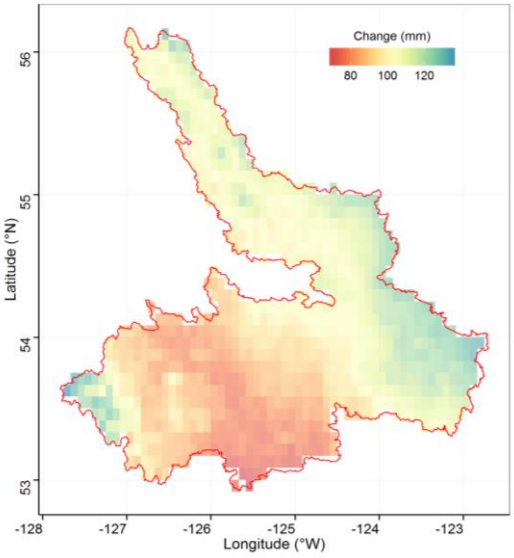

Figure 8 Future total precipitation change from 2010-2050 in the Nechako watershed in a high climate change scenario.

II. Pre-Workshop Briefer

Nechako Watershed Scenarios Workshop Briefer

Key Terms

Climate Change: Long term changes (generally over at least 30 years) in temperature and precipitation patterns, and/or the number of and severity of events.

Projection: A description of the future that allows for certain conditions to develop (such as increases in greenhouse gas emissions). Therefore, projections are expectations that are conditional on certain things happening.

Scenario: A plausible description of a possible future. Scenarios are often based on a range of projections.

• A climate significantly different than the present is more plausible than one with little or no change.

• Although climate change is often thought of as a global issue, the impacts of climate change are felt mostly at the local and regional scale.

• Efforts toward awareness and action of climate impacts at the local scale are increasing.

• One way of dealing with the complexity of climate change is to develop a range of future 'scenarios' that could result from the present. By developing a range of scenarios, the possibility of one of these scenarios unfolding is more likely.

• By encouraging thinking about what the future might look like, we can encourage actions to reach a particular future.

• The best way to develop scenarios is through the inclusion of a variety of viewpoints and technical expertise. This workshop is working toward that goal, but inviting input from over 30 individuals representing diverse stakeholder groups, including: academic, First Nations, government (municipal, provincial, and federal), health, NGOs, non-profits, concerned citizens, and resource industries.

III. Research Ethics Information Sheet

Researchers: **Dr. Stephen Déry (W) 250-960-5193 (email) sdery@unbc.ca**
Dr. Ian Picketts (C) 250-613-3129 (email) picketts@unbc.ca
Dr. Margot Parkes (W) 250-6813 (email) margot.parkes@unbc.ca

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What is this research?

During this workshop, we will be focusing on creating multiple future scenarios for the Nechako watershed based on different: projected levels of change in temperature, precipitation, stream-flow and other climate-related variables, and their associated impacts; and projected levels of natural resource development. These scenarios will form the basis for in-depth descriptions of the potential future states of natural ecosystems, water budgets, socio-cultural health, food security and economic well- being in the watershed.

The workshop format is specifically designed to allow for conversation to take place between all participants on the research topic, and is facilitated where necessary by the moderator or researcher. The information gleaned from this workshop will then be used to help advance sustainability, climate action and natural resources planning and management in the NRB. No individual participants will be identified within the assessment, although a general description of some of the comments obtained from the workshop may be used. By participating you are representing your own opinions only, and not those that you work for. Due to the small group nature of this project, anonymity and confidentiality in the research cannot be completely guaranteed.

Notes from the workshop conversations will be transcribed by researchers. Once the research has concluded, all of the transcriptions will be securely stored, any digital copies will be stored on a password protected computer, and all data will be deleted and hard copies shredded by a commercial shredding service no later than the end of December 2015.

Voluntary Participation Your participation in the workshop is entirely voluntary and, as such, you may choose not to participate. If you participate, you may choose to not answer any questions that make you uncomfortable, and you have the right to end your participation in the workshop at any time and have all the information you provided withdrawn from the study. Please keep in mind that by participating you are only representing your own opinions.

Potential Risks And Benefits We do not consider there to be any risks to participation. Benefits include an improved knowledge of climate impacts, resource development impacts and what the acceptable limits of related change are is particularly important for the people living in the NRB. An enhanced understanding of what the future impacts of development may

mean will help people to vision what a healthy and prosperous region means, and what types and levels of development are possible.

Financial Sponsor This project is funded by the BC Real Estate Foundation Partnering Grant.

Purpose & Goals The project has direct linkages to resource development, land use and proactive environmental decision-making. The outputs are designed to help communities make responsible long-term decisions and to plan for social and ecological resilience in an uncertain future. By developing scenarios, thresholds and limits, the completed research will be accessible and applicable by a range of decision- makers.

How You Were Chosen & What You Are Asked To Do You were chosen as a result of your extensive knowledge and experience regarding the Nechako Watershed. Information regarding climate change in the region will be presented, the group will split into smaller groups to develop the four scenarios into detailed stories, and present those scenarios back to the larger group for discussion. We will be seeking your engagement in both the large and small group discussions, and sharing of your knowledge and experience. This will all occur in a neutral and non-political space, and confidentiality will be maintained.

Confidentiality:

- Your participation in the workshop is voluntary
- The workshop will not be recorded; however, there will be note takers. All notes will be recorded without any identifiable information. The notes will be available for review by participants.
- Although there will be no identification of anyone in the final results, the group nature of this project means that anonymity and confidentiality in the workshop cannot be guaranteed.
- All notes and data will be under the control of the research team only to maximize the confidentiality of all participants and the information that is provided to the greatest extent possible. The data will be stored on the hard drives of the researchers for an indefinite amount of time, and will only be available to them or their research assistant, Carling Matthews.
- Please feel free to ask any questions that you may have regarding the workshop, the research, or the confidentiality of this information at any time.
- The results of this research and the workshop will be made available in report form to each participant prior to the end of March 2015.
- Any complaints about this workshop can be directed to the Office of Research at the University of Northern British Columbia, 250-960-6735 or reb@unbc.ca

Workshop Protocol

The workshop will have the following stages:

1. Introduction and background information on the topic
2. Focus groups discussing different scenarios

In each focus group, the following steps will occur:

a) Introduction of researchers, research topic and the researchers' roles as facilitators
b) Round table introduction of all focus group participants
c) Review of research information
d) Focus group discussion
e) Questions
f) Concluding Remarks

Within each stage of the process each participant and the researchers must adhere to the following protocols:

- All individuals who wish to speak must be given the opportunity to speak.
- Only one person may speak at a time.
- The conversation must remain respectful of other people's opinions although discussion on different points of view will be encouraged.
- One person may not dominate the conversation at the expense of excluding others.
- Foul language, culturally insensitive discussion or insults will not be tolerated.
- Participants will need to adhere to the time limits on discussion points.
- Any individual who wishes to withdraw from the workshop may do so at any time.

Thank you for your time and your participation

IV. Agenda

	Task	Time
8:45 – 9:00	Participants arrive, get nametags (coffee and tea available)	15 min
9:00 – 9:20	Welcome and introductions	20 min
9:20 – 9:40	Presentation - Overview of scenarios	20 min
9:40 – 10:00	Presentation - Climate change information	20 min
10:00 – 10:30	Groups - Set natural resource development scenarios	30 min
10:30 – 10:45	BREAK	15 min
10:45 – 12:00	Groups - Rotate through four scenarios	75 min
12:00 – 12:30	LUNCH	30 min
12:30 – 12:50	Present back scenario stories to large group	20 min
12:50 – 1:15	Plenary discussion and debrief	25 min
1:15 – 1:30	Final (Segway to indicators)	15 min
1:30 – 3:30	Indicators Workshop*	120 min
	Total	**7 hours**

**Note: the indicators workshop is a distinct 2-hour session facilitated by the Fraser Basin Council to discuss indicators of watershed health and to explore potential overlap and synergies with the scenarios project.*