THE FRASER BASIN INITIATIVE AND INTEGRATED WATER RESOURCE MANAGEMENT AS A MODEL FOR RIVER BASIN MANAGEMENT GLOBALLY

by

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Abstract

Freshwater resources above and below ground worldwide are deteriorating due to overconsumption and abuse. In the wake of this increasing deterioration, Integrated Water Resources Management (IWRM) has come to the fore as a leading process for dealing with freshwater management issues. The Fraser Basin Council (FBC), a river basin management organization in British Columbia, Canada, has been asked to present their basin management model, which operates on IWRM principles, to different countries around the globe through their International Outreach Program. Through reviewing the tenets of IWRM, the various aspects of the FBC, and select freshwater indicators in the Fraser Basin, this thesis analyzes whether the FBC is effective at managing the Fraser River Basin, and if the FBC process is applicable to other basins. Our findings indicate that although the FBC is somewhat effective at managing the Fraser Basin, the FBC model is not necessarily applicable to other basins given the FBC's lack of authority to enforce its own decisions and its reliance on government and stakeholders for action and enforcement.

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Chapter One: Introduction

The Fraser Basin Council, located in the province of British Columbia, Canada, is the current non-governmental management organization responsible for the well being of the Fraser River Basin. Based on the guiding principles of Integrated Water Resources Management, a global holistic freshwater management process that approaches water management from a basin perspective, the Fraser Basin Council has been invited to present their basin management model to a number of countries.[1,2] Further, integrated water resources management is currently one of the most popular methods of basin-level water resource management used by expert water managers around the globe.[3] The purpose of this thesis is to see if integrated water resources management principles could successfully be applied to other basins around the globe in the way that the Fraser Basin Council has applied them to the Fraser River Basin. To achieve this objective, two major questions are being asked: Has the Fraser Basin Council been successful in managing the Fraser River Basin, and would the Council's management structure, which is based on the principles of integrated water resources management, be applicable to other river basins?

The Fraser Basin Council can be looked at in two fashions, either by its internal processes or by its external actions. Internally, the Council is a non-profit, non-governmental, and non-partisan basin management organization. The Council is a 36 person body with members from across the four levels of Canadian government, the private sector, and civil society, whose function is to develop holistic and integrated solutions to social, economic and environmental issues in the Fraser River Basin. Even though the Fraser Basin Initiative began in 1997, the organization was preceded by other organizations such as the Fraser River Estuary Management Program (FREMP), Fraser Basin Management Board (FBMB) and Fraser River Management Program (FRMP), Fraser River Action Plan (FRAP), and the Fraser River Estuary Management Study.

Externally, one of the most important functions that the Fraser Basin Initiative has pursued in the Fraser Basin has been the integration of the environmental, social, and economic aspects of sustainability in the basin. To assist in accomplishing this goal the Council takes a key role in over fifty regional and basin-wide programs and has created regional committees and offices in the five regions of the basin. Although the Fraser Basin has one small tributary, the Sumas River, which flows from Washington State into British Columbia, the basin is managed as a domestic basin. Further, the Council takes the part of impartial facilitator in certain basin disputes and issues and educates the public on issues regarding the Fraser Basin. The integration of sustainability efforts within the borders of a river basin or watershed is reflected in Integrated Water Resources Management (IWRM), a set of principles meant to guide water managers towards a more holistic approach to managing water at the basin level. The Fraser Basin Council has taken this set of principles as its own, as many water managers around the globe have also done over the past two decades. Chapter two will discuss the history and principles of IWRM and the Fraser Basin Council.

The Council has been asked over the years to present the working Framework of the Fraser Basin Initiative to a number of countries in order to assist these countries in developing their own freshwater policy initiatives. Through the Council's international outreach program, members have presented the framework model to groups in Russia, the Philippines, Brazil, Iraq, Indonesia, and China, in an attempt to assist these countries in developing national or regional freshwater policy.[4] Further, in 2010 the FBC was invited to Scotland in order to be a part of a discussion on developing a set of literature meant to assist other countries in developing their own water management initiatives similar to that of the Fraser River Basin.[5] The Fraser Basin Council believes that their basin management model, which is based on the principles of IWRM, is flexible enough to be applied to nearly any freshwater basin in the world.[6]

The World Bank released a working paper on the Fraser Basin Council as part of a larger study that used a case study approach to look at and compare eight river basin management organizations around the globe. The study included a site visit to the Fraser Basin Council in Vancouver, British Columbia where the World Bank team interviewed 28 individuals, including local and provincial government officials, various stakeholders in the basin, academic researchers, and Council members. The early and middle parts of the Bank's paper detail the geography, demographics, and economic and social aspects of the basin, along with a brief history of the Council and previous organizations in the basin that led to the creation of the Fraser Basin Council, as well as the structure and functions of the Council and Initiative. The World Bank team looked at the organizations that existed before the Fraser Basin Council and their role in the formation of the Council, member participation in the Council, agencies involved, and programs and issues that the Council is involved in within the basin.

The final section of the World Bank working paper applies the analytical framework set out early on in the paper, a framework that the Bank used for each of the eight basin papers they produced. The areas that are looked at through the analytical framework include the contextual factors and initial conditions of the Council and Basin, decentralized process characteristics in the basin, central-local relationships, and the institutional arrangements within the Council. Finally, the thesis discusses the overall performance of the Council in the context of Fraser Basin management, using specific environmental indicators, such as faecal coliform counts, and examining water monitoring projects throughout the basin. It is also noted in brief that although these indicators show improvements in the basin over this time period, these improvements are not necessarily a result of the Council or predecessor action. Changes in indicator numbers throughout the Fraser Basin could be due to any number of factors such as seasonal flows or changes in industrial activities, or to natural means such as natural disasters or naturally occurring deposits of minerals.

The intent of this thesis is to identify whether the Fraser Basin Initiative, its Council, and the Framework developed under the principles of integrated water resources management (IWRM) can be applied as a standard model for sound freshwater management policy at the basin level elsewhere in the world, as claimed by the Fraser Basin Council (see website). The literature review contained in chapters two and three will discuss integrated water resources management, and the Fraser Basin Initiative, Council and its predecessors. Chapter two will look at the Fraser Basin Council and its use of IWRM in managing the Fraser River basin in order to see how the Fraser Basin Council uses IWRM in practice. Further, an historical overview of IWRM and its major parts and its strengths and weaknesses will be conducted in order to establish the strengths and weaknesses of IWRM, and how IWRM is viewed in the global freshwater management arena. Chapter three will cover the history of basin management in the Fraser River Basin since the late 1970's through to the development of the FBC to show the development, strengths, and weaknesses of water management organizations in the region leading up to the Fraser Basin Council.

Chapter four will look at select freshwater indicators that are measured throughout the Fraser River Basin as a way of analysing the managerial effectiveness of the Council's different water quality programs. Since its inception in 1997, the Fraser Basin Council has published four 'State of the Basin Reports' that include historical comparisons between environmental indicators such as aggregated water quality indicators, summed up in what is known as the Water Quality Index (WQI). The purpose behind this chapter is to take a closer look at some of these indicators that make up the WQI in order to gain a better understanding of whether the implementation of IWRM in the Fraser River Basin has had any effect on the water quality in the basin.

In chapter five, a brief comparison will be done between the Fraser Basin and its Council and three major yet quite different basins around the globe, along with another Canadian project located in the Great Lakes region. The international basins, the Murray-Darling Basin in Australia, the Danube River Basin in Central and Eastern Europe, and the Nile River Basin in Africa, were all chosen as they each have a freshwater management organization. Further, they are all large and rather important basins that share some environmental characteristics with the Fraser River Basin. It is hoped that by comparing these three basins and their respective organizations to the Fraser Basin and to the Fraser Basin Council that specific strengths and weaknesses of the FBC might emerge, shedding some light on the potential for the FBC to function as an institutional standard for global IWRM-driven basin management.

A summary is provided at the end of each of the chapters. The goal is to establish whether or not the Fraser Basin model can be applied to basins other than the Fraser Basin.

Overview

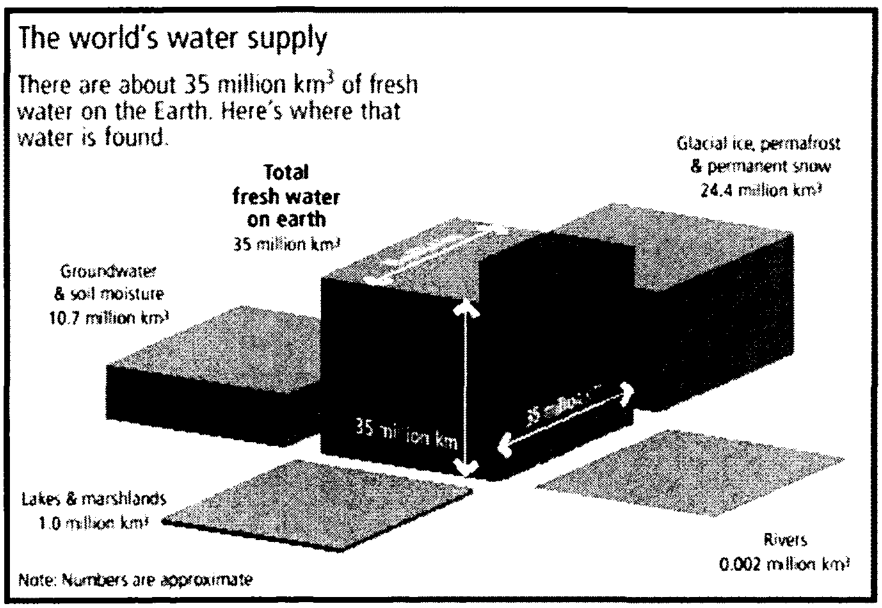
Freshwater is one of the most important yet overlooked natural resources on the globe. Water has two fundamental functions for humans: as a prerequisite for life on our planet and as a commodity and economic resource.[7] As humans we rely on fresh water in order to survive on a daily basis, from simply drinking water and growing food for basic necessity, to developing and sustaining our communities, societies, and countries through agriculture and industry. We utilize fresh water for keeping our living areas clean; for dumping our industrial, agricultural and domestic effluents in our lakes and rivers; and for maintaining heavy industrial endeavours such as mining.

Every day there seems to be more articles, websites, and commercials regarding different water issues around our community, city, region, country, or globe. For example, the City of Abbotsford in the Fraser basin has stated that the current water for the city will not prove sufficient past 2016, citing that demand has doubled in the past 20 years.[8] The Royal Bank of Canada has created the RBC Blue Water Project™, a project that gives grants to fund water stewardship programs of over 380 not-for-profit organizations.[9] In Northeast Africa, Ethiopia has decided that, with or without international support, it will build a large dam on the Blue Nile near the Ethiopia/Sudanese border despite opposition from Egypt which is heavily reliant on the Nile River for its freshwater.[10] The Amazon usually receives upwards of 78 inches of rainfall a year, yet in 2005 and 2010 the rainforest suffered massive droughts that left enough dead vegetation to release over 5 billion tons of CO_2 into the atmosphere from the 2005 drought alone. [11]

These are a few of the many types of water issues that exist today. Why do these issues exist in the first place? The answer seems both simple and complex. Due to the hydrological cycle and geography of the Earth, water is poorly distributed in both space and time.[12] No new water is ever created on the planet; it is only recycled through natural means. This means that as the human population increases there is still the same amount of water on the planet for us to share.[13] Although different geographic regions are endowed with different amounts of freshwater, it is the management of this water supply that is of more importance than the supply of water available. Over the past century the global population has tripled, yet the global use of water has increased six-fold.[14] This issue is compounded by the fact that population growth is uneven throughout the world, yet water is also unevenly distributed around the world, and the two patterns rarely match up.[15] Currently there are rivers that do not reach their oceanic destination during parts of the year due to diversion or overuse. The Earth has lost half of its wetlands in the past ten years, and one fifth of all freshwater fish are now either endangered or extinct. Further, there are aquifers that have been permanently damaged by salinization due to extraction and overuse.[16] Groundwater accounts for 90% of all freshwater that is readily available for human consumption.[17] These problems are cause for concern.

According to Sandra Postel, water's two main functions - as a prerequisite for life and as an economic resource or commodity - must be balanced.[18] That is, we need to balance the demand for water while protecting life and the ecosystem.[19] Unfortunately it is the poor who are affected the most by poor water quality. It is usually the world's poor that are forced to consume non-potable water, which can lead to poor health or even death in a number of different ways. Further, as water scarcity and competition for clean water increases, the challenge to reduce poverty also increases.[20]

Figure 1 - World's Water Supply



Source: "Freshwater: The Role and Contribution of Natural Resources Canada" *Natural Resources Canada*. Accessed June 16, 2009. http://www.nrcan-rncan.gc.ca/sd-dd/pubs/h2o/int-eng.php#int1.

The hydrological cycle encompasses more water than humans need to survive on the planet.[21] The total volume of water on the planet is 1.4 billion cubic kilometres. Freshwater makes up 35 million kilometres of that volume, where 68.9% is frozen, 30.8% is located underground in aquifers, and the remaining 0.3% is made up of lakes and rivers (See Figure 1).

The total amount of accessible water is roughly 200,000 km^3, or less than one percent of all freshwater on the planet.[22] Currently humans use 54% of all accessible water from rivers, lakes and underground sources. By 2025, water withdrawals in developed countries are expected to increase by 18%, while withdrawals in developing countries are expected to increase by 50%.[23]

People in Canada and around the world have the misperception that Canada has an abundance of freshwater. Yet there are many cities, towns, and regions around the country that have experienced water problems of some sort, some only for a short time, some for much longer period of time. The Great Lakes, known for being the largest freshwater basin in the world, has been the centre of a few water issues over the years. For example, people in communities surrounding Lake Erie, such as in Wainfleet, Ontario, regularly purchase freshwater for household use rather than utilize the lake water outside their home due to the poor quality of the water[24]. The Okanagan Valley region in British Columbia has also experienced water shortages many times, which are only getting worse[25]. The Canadian prairies have experienced drought many times over the past years, including the dustbowls of the 1930's,[26] yet this area is one of Canada's main agricultural regions.

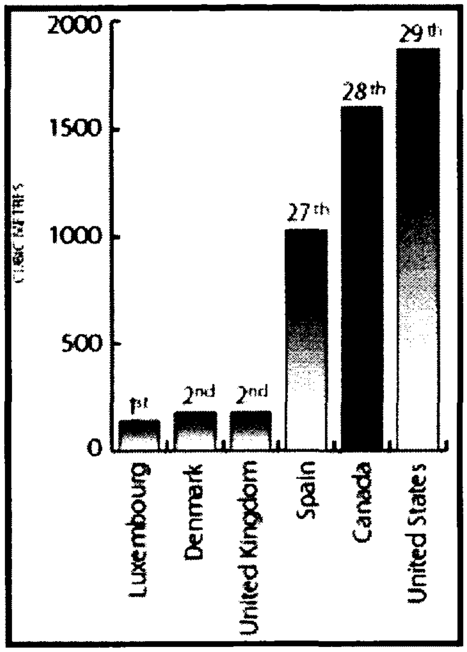
Some Canadians speak of the United States coming in and taking Canada's water as their own dries up, or suggest that Canada will become rich in the future as it will be able to sell off vast amounts of its excess freshwater to the rest of the world. Various media outlets over the years have stated that Canada holds upwards of between 20% and 40% of the world freshwater resources, making it (in their view) by far the richest freshwater country in the world.[27] The amusing thing about these ideas is that Canada does not have much more internal renewable freshwater than some other countries, including our neighbours to the south. According to the World Resources Institute there are various measurements of freshwater.[28] Earthtrends, an extension the World Resource Institute, and an online global database for environmental statistics, defines internal renewable water resources as follows:

> Internal Renewable Water Resources (IRWR) include the average annual flow of rivers and the recharge of groundwater (aquifers) generated from endogenous precipitation--precipitation occurring within a country's borders. IRWR are measured in cubic kilometers per year (km3/year).[29]

Most of the public would be unfamiliar with this method of measuring freshwater resources, and of course IRWR is not the only method of measuring freshwater within the borders of a country. It is however an accurate method of calculating the accessible volume of water within the borders of a country. There is also an indicator called Total Internal Renewable Water Resources that takes into account overlap of ground and surface water when measuring, and Actual Renewable Water Resources that calculates the maximum amount of water within a country by taking into account water generated within the borders of a country that flows out, as well as water generated outside the country that may flow in.[30]

When compared to other countries, Canada is pretty closely tied for the bronze medal when it comes to the amount of actual renewable water resources, sharing the third spot on the podium with the United States at about 2850 km^3 in Canada or 6.7% of the world's renewable freshwater supply and 2818 km^3 in the United States. In first place is Brazil, with close to 12%, and grabbing second spot is Russia, coming in at approximately nine percent.[31] John Sprague argues that most people believe that there are large amounts of water in Canada because of the large number of lakes, which account for roughly 20% of all surface water globally. Measuring freshwater merely by surface amounts and total volumes, grossly overestimates the amount of actual water available for use.

Figure 2: Freshwater Abstraction per capita in metres



Source: "Canada vs. The OECD: An Environmental Comparison." *Water: Water Consumption*. Accessed September 8, 2008. http://www.environmentalindicators.org/htdocs/indicators/6wate.htm.

Since 1980, Canada's water use has increased by over 25%, ranking it 28th out of 29 Organization for Economic Co-operation and Development (OECD) countries (See Figure 2.). Canada is beaten out only by the United States in its per capita water use.[32] As Canadians, we use roughly 1600m^3 of water per person per year, 65% higher than the OECD average.[33] As a comparison, that is twice as much as the water use in France, three times as much water as that of Germany, and eight times as much water use as that of Denmark. In contrast, nine of the OECD countries have decreased their per capita water consumption since 1980, including the United States.[34]

Almost three quarters of Canada's rivers and streams flow north to the Arctic Ocean, while only 25% of freshwater in Canada flows to either the Pacific or Atlantic Oceans, and less than half of a percent flows into the Missouri basin in the USA[35]. Considering that the majority of

Canadian citizens live in the southern part of the country, Sprague determines that only about 2.6% of Canada's internal renewable freshwater supply reaches most of the population.[36] To further this point, Statistics Canada released a new report in 2010 on the current freshwater situation in Canada. First, the "North-line", below which 98% of Canada's population reside, was defined as, "...a statistical area classification of the North based on 16 social, biotic, economic and climatic variables that delineates the North from the South in Canada." The vast bulk of economic activity takes place in this region, which has an estimated area of almost 2.6 million square kilometers.[37] During the time period of 1971 and 2004, the water yield in this area decreased by roughly 8.5%, or 3.5km^3 annually.[38] Although regions within this area lost water during separate time periods and at different rates, the underlying trend in the report showed a marked and noticeable decrease of freshwater in the large area of Canada that is home to an ever-growing population of over 30 million people.

Although Canada does have more accessible freshwater per capita than many other countries, the pervasive myth that Canada is home to large portions of freshwater needs to be overthrown if Canada is to further its development of effective water policy. Past policies historically were driven by sectoral needs,[39] where different sectors would all take from the same source without much thought to whether that source would last, either in terms of quantity or quality. We need to have a better public understanding of where Canada and the world stand in general regarding the state of freshwater. In a democratic society such as Canada there is perhaps a chance that we can change the way freshwater is understood and used.

Integrated Water Resources Management is one possible solution to the issues surrounding freshwater overuse and degradation. Chapter two will review and analyse the main discourse surrounding IWRM with a view to see just what is IWRM, what it constitutes, how it is supposed to work, and just how pervasive IWRM is in the global freshwater management arena. To begin however, the next chapter will look at the relationship between the Fraser Basin Council and Integrated Water Resources Management in order to see how strongly the Council relies on or uses the principles of IWRM.

Chapter Two: IWRM and the Fraser Basin Council

Overview

Although it is not explicitly stated in any literature, the Fraser Basin Council's basin management process is based on integrated water resources management[40]. The Council's Charter of Sustainability is largely based on the principles of IWRM, which is shown through the discussion of integration of social, economic, and environmental aspects of the basin in the Charter. Further, the collaborative nature and transparency that is discussed in the Charter is a direct reflection of IWRM principles.[41] When dealing with issues in the basin, the Council attempts to include as many stakeholders as possible that have stakes in the issue at hand.[42]

In 2005 a policy research working paper by the World Bank compared eight management organizations around the globe, including the Fraser Basin Council, that attempted to apply the principles of IWRM to manage freshwater at the basin level, and who pursued better stakeholder involvement in their management process. That is to say, these organizations use the natural boundaries of a river basin as the basis for managing a river ecosystem and include the different water users in the basin in the planning process. The other organizations used in the study were located in Costa Rica, Brazil (two), Spain, Poland, Indonesia, and Australia.[43] It should be noted here that increasing stakeholder involvement is a component of IWRM that is mentioned in most water resources management literature, making the World Bank working paper mentioned above mainly a study regarding the application of IWRM.

There are also some examples of how the Council is applying the principles of IWRM that are clear reflections of IWRM principles. Like the name suggests, the Fraser Basin Council uses the Fraser River Basin boundaries as the natural boundaries for managing the basin. Although the majority of the basin population resides in the south, the Fraser Basin Council has a presence throughout the basin, as reflected in various different ways. First, stakeholders throughout the basin are included in the Council's management process by holding one of the 36 seats on the Council. Second, the Council has positioned one of what it terms 'Regional Managers' in each of the five major regions of the Fraser River Basin as a strategy to stay connected and disseminate information to the different areas of the basin, including other stakeholders.[44]

History of IWRM

The development of intricate and involved water management plans is quite new to most of the world. In the past there was a smaller human population, less economic activity throughout the globe and less wealthy societies, creating less demand for water.[45] Likewise, human use of freshwater did not cause as much damage to the surrounding ecosystem, compared to the present day use of most freshwater sources.[46] With far less human activity, it was common for national and sub-national governments to treat and manage water by sector, such as wastewater, hydroelectric, industry, agriculture, and domestic, a practice that is still quite common today.[47] However, with the vast increase in human population growth worldwide, greater economic activity, and more affluent societies, the demand for freshwater has grown to what it is today. This demand has surpassed the natural supply of freshwater in many areas, to a greater extent in regions prone to extended periods of drought.[48]

In order to manage freshwater properly, there is a need for a proper balance between the demand for water and the natural replenishment of freshwater in a region.[49] With demand beginning to outstrip supply around the globe, this need has only increased over the past few decades. Integrated Water Resources Management has been internationally accepted as a process towards the equitable, sustainable, and efficient use of freshwater.[50] "IWRM is the 'integrating handle' leading us from subsectoral to cross-sectoral water resource management."[51] It is no surprise then that over the past three decades IWRM has become the main arena for discussing water policy at an international level.[52]

Since the early 1990's the concept and principles of IWRM have been integrated into international and national water policy.[53] Although there has been a move towards managing water at the basin level, IWRM goes much further in conceptualizing the framework around which water should be managed. Promoted as a holistic approach to managing freshwater, IWRM integrates the natural systems determining the quantity and quality of water with the human systems such as resource use, water production and development priorities, in order to manage water fully at the basin level. This integration happens both between these two systems and within each system. Along with the inclusion of traditional water managers, such as national government bodies, IWRM also promotes the participation of all stakeholders at the discussion table, including local government and local community institutions.[54]

Description

Jonch-Clausen and Fugl argue that IWRM is not a goal but rather a process of balancing the different needs of water users and managing trade-offs among the different goals of users in order to manage water in a sustainable manner. There are three main goals of IWRM, dubbed the three "E's": economic efficiency of water use, social equity, and environmental and ecological sustainability. These can be accomplished by helping water managers view the behaviour of all water users and demands for water. Likewise, IWRM also teaches traditional water managers to deal with water from a demand-response standpoint, rather than from a traditional supply management position.[55]

The two systems that are integrated under IWRM, the natural system and the human system, are both complex in structure and a challenge to manage with each other and within themselves. The natural system includes land and water, surface and groundwater, quantity and quality of water, upstream and downstream water, and coastal and freshwater. The human system for water involves economic planning and development, political economy, and water resource and poverty alleviation.[56] Further, IWRM integrates freshwater policy into international trade policies and into national security issues. In support of this, it is noted that roughly fifty percent of all land lies within freshwater basins that cover parts of a territory spanning two or more countries - a further incentive for states to approach water management through an IWRM approach.[57]

Governments do not play a top-down managerial role within IWRM, but act as activators for the development and implementation of IWRM principles. As noted above, this is a stark change from the traditional role that governments usually play in the management of natural resources wherein they create government bodies to manage a single aspect or sector of water use. IWRM attempts to involve all stakeholders at multiple levels of basin management as opposed to a traditional top-down perspective.[58]

In order to meet the challenge of integrating these systems and ensuring the participation of stakeholders in freshwater basin management, IWRM also provides operational tools for conflict management and resolution and for the evaluation of trade-offs for the different stakeholders.[59] To this end the Global Water Partnership has created an online "toolbox" for water managers to utilize when developing water policy. This online resource has three main launch points or topic areas for water managers that expand to cover a vast area of topics regarding IWRM.

IWRM In Use

There has been definite growing international support for the concept of integrated water resources management. One example is found in the Dublin Statement on Water and Sustainable Development that came out of the International Conference on Water and the Environment (ICWE) in January of 1992 and was significant in assisting the promotion of ideals inherent in IWRM to the world leaders that were to meet in Rio de Janeiro for the United Nations Conference on the Environment and Development (UNCED) later that year. The Dublin

Statement called for the consideration of freshwater as a finite resource, the inclusion of all water users in water development, the inclusion of women as an integral aspect of water management, and the concept of water as an economic good.[60] Agenda 21 that came out of UNCED devoted an entire chapter to the issue of water management, highlighting issues brought forth by the Dublin Statements. This influence can even be seen on the chapter's subtitle, "Application of Integrated Approaches to the Development, Management and Use of Water Resources.[61]

Ken Conca notes that there is a clear movement, in both Agenda 21 and the principles of the Dublin Statement, towards the concept of IWRM.[62] However, although much of the international community involved with water policy has accepted IWRM as the process for developing freshwater policy in the past decade, some critics point to issues both within the IWRM framework and with the application of IWRM on a practical level. Most prominent is the inherently flexible nature of IWRM. While flexibility is a major characteristic of IWRM, this flexibility can reduce understanding of what it is that IWRM is supposed to provide and accomplish.[63] Further, the flexible nature of IWRM can blur the understanding on how those using an IWRM structure should move forward on different issues. Implementing IWRM on a theoretical level is one thing, but putting theory into practice is the real difficulty. The following section will look at the issues surrounding IWRM and its use as a practical solution.

IWRM has developed and grown in a global environment of fragmented international water management. Even though there are many treaties that deal on some level with freshwater, there is no international agreement regarding the framework surrounding the management of freshwater.[64] Having a treaty of this magnitude and scope would not fix the issues surrounding the fragmentation of international water policy. However, it might lend a hand in giving water managers a better understanding on how the supply and demand of water needs to be managed in the future.

Conca also points out that there are over 20 United Nations bodies that have water as part of their mandate, including the World Health Organization; the UN Education, Scientific, and Cultural Organization; the UN Development Program; the UN Environmental Programme and the World Meteorological Organization.[65] The fragmentation of water policy and management at every level is a clear indication of the severity of fragmentation globally, and may explain why the concepts and principles of IWRM are adopted in order to respond to this fragmentation. The fragmentation of water management can be clearly seen in Canada, where there are multiple federal, provincial, regional, and municipal agencies that deal with water to some degree.[66]

Another issue regarding the use of IWRM as a water management process is that not all stakeholders can be identified with ease, making it difficult to get a full understanding of how a basin is being used. There can be many stakeholders in a basin, region, or country. Yet with fewer stakeholders it may be easier to set the IWRM process into motion. Further, they can have overlapping roles when it comes to the management or use of water, and there can be conflicts among stakeholders. When stakeholders do come together to discuss policy and action, they are not likely to agree on how problems should be resolved or even on the "proper" use of freshwater in their region. It therefore becomes a major task harmonizing the goals and objectives of the stakeholders in order to develop positive solutions that take into account the needs of everyone involved.[67] Without such harmonization of goals, consensus cannot be reached, potentially leaving the process at a standstill, or the stakeholders could be forced to use up precious time and perhaps begin the process all over again.

The implementation of IWRM has been a difficult task for many countries, including those that are more industrialized.[68] Countries face two hurdles incorporating IWRM into their water management policies. First, it is difficult to develop the laws, regulations, and the institutions needed to manage water in a more environmentally sustainable, economic, and social way. Even though there are documents that give direction to developing water policy, such as the Dublin Principles or the Global Water Partnership's IWRM toolbox, policy must be designed around the environmental, social, political, cultural, and historical conditions of the country.[69] Ken Conca notes that the realm of IWRM is located mainly in (water) expert networks much more than in the political-economic arena.[70] This may lend a hand to the difficulties that governments face when attempting to develop IWRM-oriented policy, as the main IWRM players are not necessarily integrated in the forum where policy is created, but rather in more 'real world' settings.

Second, it is difficult to generate and sustain a proper water supply.[71] To manage freshwater in a sustainable fashion, a water manager must strike a balance between the demand for water and the replenishment of water in that region.[72] In the past 100 years the global population has tripled, while the use of water has increased six times, and half of all the world's wetlands have disappeared in that time. Aquifers have been permanently damaged through overuse by salinization, and it is predicted that by 2025 half of the global population will be living in severe water stress, a situation made worse by the continuing degradation of water supplies in developing countries. The sheer cost of building and maintaining water infrastructure is increasing in many countries. Further, countries differ in the status of their water infrastructure. Some areas such as Central Asia have infrastructure that is quickly decaying, while other regions such as Ethiopia lack water infrastructure.[73]

Third, some believe that the practice of IWRM is far from the theory behind IWRM.[74] Integrated Water Resources Management attempts to address two problems at once: sustainable development and cross-sectoral planning.[75] That is, some believe that IWRM is capable of balancing economic development while upholding environmental issues, while at the same time being able to integrate different water user sectors together into a single water management plan.

As such, those who try to implement IWRM are unable to address either properly, Further, some consider the concept of IWRM as an immature management tool that is not properly defined, and experts in the field have not yet addressed the implementation of the ideas. Questions arise as to what is being integrated, and how this integration is to be done.[76]

Overall, there are supporters and non-supporters of IWRM everywhere you turn in the global water management arena. Yet IWRM has still become one of the most used processes by which freshwater is managed around the world. The ability of such a process to incorporate all users into the mix, to define a boundary for management that is integral to the environment, and to provide the flexibility to adjust according to the situation at hand is perhaps what makes it appealing to water managers.

Analysis: IWRM

One of the biggest difficulties in dealing with environmental issues is turning "strategies" and policy into actions. These actions should not only look good on the surface (for political votes or for the acquisition of more funding), but should also have some positive immediate and long term results for humans and environment alike. Yet mandates, goals, values, and even action plans do not necessarily lead to policy initiatives let alone positive actions.

After all that is said and done, IWRM is quite a soft and ambiguous approach guided by good intentions and idealistic principles. If every good intention were to succeed, however, the world would not need such ideas as IWRM. It is not merely principles set out by numerous reports and international conventions that dictate whether or not we may solve issues surrounding freshwater.

Analysis: FBC and IWRM

The end of the five-year term of the FBMP saw the Fraser Basin Council continue the actions of the FRMP. Therefore, much of the work that the Fraser Basin Council executes across the Fraser Basin is a direct extension from its predecessor, set out by the Charter of Sustainability that was first introduced by the FBMB and later adopted by the Council. The goal of the FBMP was to create an integrated framework for dealing with issues in the Fraser Basin, to make sure that any plans designed to tackle a particular issue were not developed in isolation of other goals, and that these plans were developed in such a way that any actions taken are holistic. It was hoped by FBC stakeholders that taking this integrated and holistic approach would lead to innovative and effective approaches in managing the Basin.

To take a step back, IWRM is a process, not a goal to be achieved by an institution. The goal of the FBMP or the Council was not to create a holistic and integrated river basin management plan. Rather, it was to apply principles that would assist in achieving an increase in the overall health of the Fraser River Basin, while still being able to further economic productivity. The different groups working to achieve these goals have done so in a number of ways. First, most of the users in the Basin are represented in some capacity on the Council. Likewise, representation for the economic, domestic, and environmental aspects of the basin is also present in the Council, which may help balance the different uses of the basin. Effective representation was not achieved overnight. In fact, it took the better part of a year for the FBMB to develop effective lines of communication between the different stakeholder members of the Board. This effective communication has continued in the Fraser Basin Council.[77]

Second, both regional and basin-wide projects developed by the FBMB, and later by the Fraser Basin Council, have attempted to take into consideration the competing environmental, economic, and social demands inherent to each project, as opposed to addressing only the specific issues in question. This attempt to work toward overall basin health is in line with the principles of IWRM that emphasise dealing with basin issues in a holistic capacity at the basin or natural level. This process of developing means of dealing with basin issues in such a fashion was also something that took time. Every one of the organizations that preceded the FBMB had the integrity of the Fraser estuary or river in mind, rather than the entire Fraser River Basin. At the same time, each attempted to take economic development into account. IWRM stresses management at a basin level, which for the Fraser River, was not attempted until 1992 with the FBMB.

Chapter Three: The Fraser Basin Initiative and Council

Overview

The Fraser River Basin is 1,370 kilometres long, is the fifth largest basin in Canada with a mean discharge of 3540 km^3 per second[78] and has a drainage area of 233,100 km^2, a quarter of the land in British Columbia.[79] The Basin is host to over 20 million hectares of forested land, eight major production mines, and half of the agricultural land in the province.[80] The Fraser River Basin supports more than two-thirds of British Columbians,[81] a population that is expected to grow by 50% over the next 20 years. It has five species of salmon within its waters, making the Fraser River one of the most productive salmon river systems in the world.[82] It should come as no surprise then that economic activity in the Basin accounts for 10% of Canada's gross national product (GNP) and 80% of British Columbia's contribution to the gross domestic product (GDP).[83]

Currently the activities within the Fraser River Basin are monitored and managed, to some extent, by the Fraser Basin Council, a not-for-profit group that includes members from industry, the private sector, all four levels of government in Canada, the agricultural sector, and civil society.[84] However, the Fraser Basin Council is not the first governing body to guide the action surrounding the Fraser River and its tributaries. Prior to the Council, there were the Fraser River Estuary Management Program (FREMP), Fraser Basin Management Program (FBMP), and Fraser River Action Plan, the latter being part of the Mulroney government "Green Plan." The Fraser Basin Management Program (FBMP) was launched May 26, 1992, and was a result of pressure on the Fraser Basin from population growth, resource extraction, economic development and environmental pressures.[85]

History

The precursors to what is now the Fraser Basin Council can be traced as far back as the second half of the 1970's, according to The World Bank's 2005 report, "Institutional and Policy Analysis of River Basin Management: The Fraser River Basin, Canada".[86] In February of 1977 Romeo LeBlanc, Minister of Fisheries and Environment, and the British Columbia Environment Minister, James Nielsen, initiated Phase I of the Fraser River Estuary Study. The purpose of the study was to produce a management plan that would protect the ecological integrity of the Fraser River estuary as well as protect the area for human use.[87] The executive summary of the study noted that its scope needed to be quite broad in order to encompass and balance environmental and economic issues. Further, the plan needed to be flexible in order to be able to adapt to new findings presented by the study workgroups.[88]

A joint federal-provincial steering committee was set up to oversee the various activities of the study in conjunction with an independent study coordinator. Workgroups were arranged to report on land use within the estuary in four separate areas: Transportation and Development, Water Quality, Recreation, and Habitat. Further, reporting was also completed on the legislative and constitutional framework for estuary management.[89] There were different intended purposes of these workgroups and reports, such as identifying knowledge gaps, merging the existing information of the study, reviewing existing policy, and defining the scope of a management plan, and develop subsequent plans to achieve this plan.[90]

Based on these reports, a set of policy guidelines was proposed in four areas:

- Water Quality:
    - Water quality needs to be suitable for preservation of fisheries and wildlife
    - Water quality in outer estuary and Boundary Bay must allow for water-contact recreation
    - Extreme caution should be taken on levels of toxic waste dumping
- Fish and Wildlife:

  - No more wetland loss should be allowed in estuary
  - Foreshore development designed to avoid loss of important habitat
  - Undertake research on how to enhance/restore wetlands productivity

- Land Use and Transportation:
  - Port expansion in estuary region limited to currently allocated areas.
  - Future urban-industrial expansion first be directed to infill currently designated development areas where environmental productivity low & site suitability high
  - Foreshore industrial development held only for those that need water access

- Recreation:
  - Areas already used for recreation but not formally designated should be done as such and managed for public recreation
  - Where possible, recreation opportunities should be incorporated as side-use of urban, industrial and transportation uses along foreshore
  - Information on designated recreation sites should be made available to public[91]

Fraser River Estuary Management Program (FREMP)

Skipping ahead to October of 1985, five federal and provincial organizations signed a five-year agreement initiating the Fraser River Estuary Management Program (FREMP). The key objectives of FREMP were to "ensure continued opportunities" in the Fraser River estuary given the area is, and remains, a key habitat for many fish and wildlife and a vital resting point for migrating birds. Further, the estuary plays a significant role in the lives of many people in the Vancouver area, therefore the protection of the harbour area for fishing and recreation, log storage, and transportation have remained the goals of FREMP.[92]

Five organizations - Environment Canada, BC Ministry of Environment, Fisheries and Oceans Canada, North Fraser Harbour Commission, and the Fraser River Harbour Commission - decided to use the 1978 Phase I Fraser River Estuary Study Report as a benchmark for the new management program. Members of FREMP would thus be able to update information already collected, and study trends and conditions that have emerged since 1978.[93] Although it led in part to the development of the Fraser Basin Initiative, FREMP still exists today.

The FREMP publication, Fraser River Estuary: An Overview of Changing Conditions, published in 1988 noted that FREMP represented a "new, cooperative style of management." It included a management committee, six activity programs or work groups, a Coordinated Review Process, and a revised Area Designation Process. Although it took long-term and intensive cooperation between a number of municipal, provincial, and federal governments to reach an agreement, the FREMP was considered a success according to a World Bank report. Despite the praise, FREMP was criticised for not being a good platform for non-governmental organizations to be involved in the management of the Fraser River.[94]

Fraser River Action Plan

Increased environmental concerns over industrialization along the Fraser River spurred the federal government in 1990 to select the Fraser as a river in Canada that required "priority action" in order to prevent further damage to the environment, and to allow the already damaged surrounding environment to recover.[95] In 1991 the Fraser River Action Plan (FRAP) was launched as part of the federal government's Green Plan,[96] a five-year initiative the purpose of which was to change and guide federal environmental policy.[97] Backed by the Department of Environment and the Department of Fisheries and Oceans, FRAP was modelled after FREMP, the St. Lawrence Action Plan, and the Great Lakes Action Plan, as well as other initiatives.[98] Although the Green Plan was slowly abandoned after a change of government in 1993,[99] the FRAP continued until 1997.[100] The ultimate outcomes the members of FRAP wished to achieve were to improve the productivity of fish and wildlife, reduce pollution, and develop a strategy for sustainability in the Fraser Basin with the stakeholders and partners of FRAP.[101]

FRAP sought to create a member-based body to manage the Fraser River Basin, one that represented all the stakeholders in the Basin. Further, FRAP wanted this body to be responsible for the entire Basin, and have all decisions made be on a consensus basis. The thought was that if the new managerial body were government in origin, it would be seen as merely another branch of government, whether it was the Department of Environment or the Department of Fisheries and Oceans. In addition, there were and still are many branches of government that are involved in the Fraser River Basin, none with sole responsibility for issues in the basin such as pollution, and the public has little or no place to voice concerns regarding these issues. As a solution, what came about was the Fraser Basin Management Program (FBMP), discussed below.[102]

FRAP had a four part strategy to deal with the environmental degradation occurring in the Fraser River area. The first part was to deal with the issues at hand from an ecosystem perspective: moving away from viewing issues individually, and developing "ecosystem interactions through science and interpretation." The second goal was to address issues in the entire watershed as opposed to a part of it at a time. Under this philosophy a small tributary flowing to the Fraser River is still considered as part of the whole watershed. In addition, the natural boundaries that combine to create the Fraser River Basin were chosen to be the study boundaries for the Plan. The third part of the strategy was to work cooperatively between and among those involved, whom now had to rise above competing jurisdictions to create partnerships, joint actions, and develop collective stewardship within the Fraser River Basin. Last, the fourth part of the FRAP strategy called for the need to educate the public about the impact it has on the surrounding environment.[103]

Fraser Basin Management Board and Program

Launched May 26, 1992, the Fraser Basin Management Program (FBMP) began out of pressure from an increasing population, natural resource extraction, and economic development within the Basin. The lower reaches and developed areas of the Fraser River Basin were beginning to require improved environmental management[104] and, with the sponsorship of FRAP, the Fraser Basin Management Program was born.[105]

The Fraser Basin Management Board (FBMB) was the first management organization to encompass the entire Fraser River Basin rather than just the estuary. Through an agreement between the Department of Fisheries and Oceans and Environment Canada (federal agencies), and the provincial government, the FBMP was initiated as a five year program, led by the FBMB. The intent of the Board was to build consensus-based decisions regarding different basin activities through a multi-organizational and multi-interest committee comprising 19 members. Twelve of these members were from the four levels of government (three from each level), six from non-governmental organizations within the Basin, and one 'neutral' chair whose main purpose was to add an informed point of view or opinion that would not reflect those of any other member, governmental or otherwise.[106]

During its first year the FBMB created the operating principles and procedures to drive its programs. During this time the newly established Board met with stakeholders in the Fraser Basin and carried out monthly meetings,[107] where Board members developed lines of communication and learned the ideas and principles of integrated management especially thinking about the basin as a whole rather than thinking only about their area. As the 19 board members were from many different areas around the basin, had differing levels of understanding of governmental processes, and had varying educational and professional backgrounds, much time was spent learning to understand other members and be understood by fellow members of the board.[108]

In January of 1993 the FBMB released its strategic plan for the Fraser River Basin, called the Charter for Sustainability.[109] This plan focused on six areas to manage, which included water resource management, waste management, fish stock and aquatic habitat management, community economic development, information systems, and communications. For each of these focal areas an ad hoc advisory committee was assigned responsibility for the following:

- Identifying the extent and nature of existing policy,
- Identifying existing institutional arrangements,
- Determining the effectiveness and efficiency of existing programs and policy.
- Identifying the need and/or priority for improvements.[110]

The FBMB developed a number of goals in order to fulfil its mandate of ensuring sustainability in the Fraser River Basin. The first goal was "to foster the conservation, maintenance and enhancement of the ecological integrity, biodiversity, and productivity of natural processes and ecosystems of the Fraser Basin." In other words, the first goal of the FBMB was the enhancement of the Fraser Basin, both the natural systems such as hydrology and climate and human impacts on the sustainability of those natural systems, such as air and water pollution and habitat loss.[111]

Responsible use of resources was the second goal of the FBMB, especially human use of renewable and non-renewable resources. The Board also saw the encouragement of fairness and cooperation among stakeholders in the use and development of basin resources as essential for the future of the Fraser Basin. To achieve this goal, the FBMB members thought it necessary that there be a method to resolve conflicts among and within sectors of the Basin, as well as having a way to promote the rehabilitation and reclamation of ecosystems compromised by natural resource use.[112]

The third goal was "to promote healthy, prosperous, and dynamic community life where community needs and aspirations are met." Quite simply, the objective of this goal was to empower all communities, whether urban, rural, First Nations, resort, or other such communities, to meet their own needs, such as clean water, food, shelter, livelihoods, and safety, as well as to develop a living standard that is sustainable over time.[113]

The fourth goal was "to promote equitable and planned growth and distribution of regional, economic, and social activity to ensure sustainability of the basin." In other words, the FBMB sought to develop a plan to ensure sustainable economic growth and promote proper and equitable use of resources in the basin. Further, this goal emphasises that the growth and use of resources should have a positive impact on sustainability and the quality of life within the basin.[114]

The final goal aims at developing and improving the relationships and communication between government and non-governmental organizations (NGO's) in the basin. The FBMB believed that it was important to have strong public and private institutions with the outcome of this goal being to "adjust, simplify, streamline, and/or improve" the institutions involved. At the end of its five-year life, the FBMB recommended that an organization was needed to oversee the application of the Charter, an organization that should be independent of government but where government is involved, preferably in the management structure of the new organization.[115] In June of 1997 the Fraser Basin Council Society and the Fraser Basin Council was formed. The Society acts as the legal foundation for the Council, has charitable status through Revenue Canada, and is registered as a non-profit society under the *Societies Act* of British Columbia. Through this status, the Society is able to secure funding both through government means and through private sources.[116]

Fraser Basin Council

The Fraser Basin Council is a 36 member, non-partisan, non-profit organization based in Vancouver, British Columbia,[117] and is the operational arm of the Fraser Basin Council Society designated to implement the *Charter for Sustainability*.[118] The Fraser Basin Council is the current management organization for the Fraser River Basin, and has grown out of the Fraser Basin Management Board as described above.[119] The main goal of the Council is to advance the sustainability of the Basin at the regional and local levels.[120]

The Council's Charter of Sustainability also comes from its predecessor, the FBMB, and takes a watershed management approach to the issues and solutions of the Basin. The Charter is a "good faith" agreement, and therefore not legally binding, between the residents and organizations of the Fraser Basin. Outlined in the Charter are the Council's main visions, goals, directions, principles, and values to lead the Basin into a more sustainable future.[121]

The directions and goals set out in the Charter focus on the strengthening of communities, caring for ecosystems in the Basin, understanding sustainability, and improving decision-making. The Charter's twelve Principles of Sustainability set out how the Council and its partners should attempt to interact. These twelve principles are: mutual dependency; accountability for actions; equity among all communities; integration of all social, economic, and environmental costs and benefits; creation of adaptive approaches; coordinated and cooperative efforts; open and informed decision-making; exercising caution; managing uncertainty; recognition of rights, agreements, and obligations; acknowledgement of aboriginal rights/titles; and accepting that transition takes time.

Finally, there are two sets of values present that encompass the entire Charter. These values are different from the principles as they guide the direction that the principles take. The first set promotes the fundamental principles of integrated elements of sustainability. The second set promotes the Council's culture of working together to achieve sustainability in the Fraser River Basin.[122]

The Council was founded on the belief that a single jurisdiction is unable to solve the management issues of the Fraser Basin.[123] Throughout Canada, water is managed by many entities,[124] and utilized by many more. Every user has different water needs that should be addressed, however sometimes those needs are in conflict with one another, such as an industry utilizing the river as a destination for waste. These conflicts can and often lead users to compete over the same water source within or between sectors or regionally,[125] further degrading or depleting an already overused source of freshwater for everyone in the community. To follow through on this belief, the Council argues the "need to integrate social, economic, environmental dimensions of sustainability."[126] This is done in a number of ways, including acting as a facilitator on select basin issues, and having directors who represent many types of organizations including local, provincial, federal, and First Nations governments; the private sector; and civil society.[127] The Council has brought together these different groups in over fifty "action-oriented" projects throughout the Fraser River Basin. While some of these projects are basin-wide in scope, many are regional projects.[128] Some of these projects will be reviewed in closer detail below as a way to analyze the effectiveness of the Council and the projects managed by it.

Public awareness is also a key goal of the Council. It seeks to motivate people to take action, promote sustainability issues within the basin, and to show that the needs of the basin should always be viewed over any region or jurisdiction within it. As of 2005, the Council's Strategic Priorities have been labelled as: strengthening communities; Fraser fish and fisheries together; protecting people and property from the next great flood; measuring progress towards a sustainable Fraser Basin; and enhancing aboriginal–non-aboriginal collaboration.[129]

The Council's programs include water governance, flood hazard management, climate and clean air, energy, invasive plants, industry issues such as mining and forestry, community development and strengthening, plus much more.[130] As each region has unique needs and issues, there are both similar and different region-wide programs to deal with specific set of issues. These issues can be brought to the Council in a number of different ways, such as by a Board member or other staff member, a regional committee, or even by the public. The Board decides which issues to tackle by first making sure that the issue is within the mandate and strategic plan of the Council, and finally deciding by consensus.[131] At times however, choosing which issues to deal with are guided by the type of funding options available to the Council, while at other times it is a lack of expertise among board members that limits decision making.[132]

On the other hand, the FBC boasts of many successes both on their website and in publications by the FBC and the World Bank. The management model of the FBC has been successfully implemented nationally in the Philippines by way of a new national water policy. Likewise, Indonesia has also adopted a form of the FBC's management model, however as it is in the early stages of implementation, it is too early to tell whether it will be successful or not. Members of the Council have travelled to Iraq to assist water managers there in their efforts to develop a new management plan for wetlands damaged by the on-going conflict in the region.[133]

Success of an IWRM process is measured by the ability to integrate the different systems and stakeholders together in order to manage freshwater at the basin level cohesively and holistically. According to the working papers by the World Bank, the Fraser Basin Council has, to some extent, achieved this. The FBC has been able to integrate First Nations and the private sector into Council consensus building in ways that government agencies find difficult to do. Likewise, regional and basin-wide projects developed by the FBC attempt to include most, if not all, social, economic, and environmental factors when dealing with basin issues, thereby creating more comprehensive plans. Approaching basin issues as an NGO has also allowed the FBC to span political jurisdictional demarcations in a federal system. Further, the Council has provided a decent forum for producing and sharing information among stakeholders, has succeeded in developing a diverse financial base outside of government funding, and has been able to promote the idea of interdependency between stakeholders.[134]

Analysis

The development of organizations originally centred on the Fraser River Estuary and the Fraser River, but eventually focused on the Fraser River Basin might possibly be one of the

Council's greater strengths. The way the history unfolded, it appears that each organization was born out of the last, beginning with FREMP, as a result of growing understanding for the need of a more comprehensive management organization for the estuary and, eventually, the basin. When the Fraser Basin Council began in 1997, there was already a vast amount of data and completed research on different aspects of the Fraser River available to the Council that had been conducted and compiled by the previous organizations such as the FRAP and the FBMP, as well as FREMP which began in the 1980s and still exists today. The collective knowledge rested not only on actual data but also on the realization how little was known about such things as water indicators and the health of the freshwater ecosystems in the basin.

The Fraser Basin Council has come to deal with issues in the basin with a flexible approach that has developed over time, and not one that remained static. This flexibility may be the result of the recommendations given by the FBMB at the end of its five-year term and its Charter of Sustainability on which the FBC is based, the work of many individuals who have worked in this or other similar organizations, or the guiding principles of IWRM. Whatever the case, the Council takes on a number of different issues in the basin, both regional and basin-wide in scope and covering a wide variety of environmental concerns and, through cooperation with stakeholders in the basin, develops regional and basin-wide programs and projects to mitigate or combat negative aspects of these issues through learned experience by both their own involvement and the involvement of their predecessors.

Unfortunately the FBC cannot implement or enforce programs, and depends solely on the board members and stakeholders involved to implement consensus decisions made by the Council. This means that if a stakeholder decides to withdraw from the Council program, the FBC has no power to enforce their decisions.

Although this thesis focuses on the applicability of the FBC's approach to basin management worldwide, the history surrounding the sheer number of environmental, social, and economic issues that have been undertaken in the Fraser Basin by organizations such as the Fraser Basin Council and its predecessors shows that the ecological integrity of the Basin is being taken into consideration by the stakeholders of the FBC. This inclusion of stakeholders and the management of the freshwater and the basin level indicate that the FBC has somewhat faithfully applied the principles of IWRM, but the principles are in some respects so general that they do not lend themselves to precise applications.

Effective management of the Fraser Basin is only half of the issue however. To pose the second of the topic questions: Is the FBC model applicable to other river basins? The geography of the Fraser Basin varies by region, from mountain to the east in the Rockies and west in the Coastal Mountains, to relative dry and desert-like areas in the south central region, to temperate foothills and boreal forests farther north. The different types of geography could be considered obstacles in developing environmental policy as the changing environment may mean a much more involved process in the development and deployment of the policy basin-wide.

The variety of geography in the Fraser Basin could also be considered an asset in disguise when detailing how the Fraser Basin Council and its framework for river basin management could be applied to other basins around the globe. As far as environmental regions go, the Fraser Basin has as much variety as many of the basins worldwide, such as the Nile River Basin. The Council and its predecessors have developed entirely new ways by which to manage the basin as a whole, while still honouring the integrity of each of the separate geographic regions in the basin. This process began with the FBMB planting regional coordinators in strategic places around the Basin.

As noted by the authors of the World Bank working paper, "Institutional and Policy Analysis of River Basin Management: The Fraser River Basin, Canada", the FBMB action was both practical and symbolic. It was symbolic in that it showed the Basin population north of Vancouver that the Council was not merely an entity managing from the far south. It was practical in that the regional coordinators were placed so that people and other organizations in those areas had someone close with whom to discuss basin issues. The Fraser Basin Council, in carrying on the work of the FBMB, has kept the regional coordinators around the Basin.[135] The establishment of regional coordinators around the basin seems to have had the intended effect of giving the public a channel to voice their concerns in each region. Listed on the Fraser Basin Council website are programs specific to each region, an indication that voices in each region are being heard.

Due to the nature of government and politics in Canada, the responsibility for keeping Canada's freshwater clean and safe falls into many bureaucratic hands. Due to Canada's political structure, the higher levels of government do not necessarily have authority over the lower levels. Rather the differing levels have different, sometimes overlapping, roles when dealing with freshwater.[136] The development of the FBMB and later the Fraser Basin Council was an organizational stepping stone of sorts, where federal, provincial, First Nations, municipal governments and agencies could meet alongside other stakeholders within the Fraser Basin to discuss and plan strategies to overcome environmental issues in the Basin.

The Fraser Basin Council is considered a success, at least in the view of the Council itself and the World Bank. One of the main factors behind its success is the economic wealth of Canada and British Columbia[137] and the importance of the Fraser Basin to the province. The majority of economic activity within British Columbia occurs within the Fraser Basin, roughly 80 percent, and it encompasses about 65 percent of all household income in the province.[138]

As a non-governmental organization, however, the Fraser Basin Council depends on outside funds in order to operate. Moreover, funding options seem to affect what issues end up being adopted by the Council. Government agencies are only one source of funding for the Council, albeit an important one. Other sources of funding include regional and basin-wide projects, international projects, as well as funds generated from conferences and workshops.[139] Without this variety of funding, the Council would likely not have been as effective in securing and developing programs in the basin.

In order to achieve a more comprehensive view of the management of Fraser River Basin water quality, the next chapter will look at specific indicators used to determine the health of an aquatic ecosystem, such as pH and nitrate levels, along with more human-specific indicators such as coliforms. Looking at literature pertaining to the indicators set out below and at the data should provide an ecological view of the Fraser River Basin, a view that cannot be seen by merely looking at the history and organizational structure of the Fraser Basin Council and its members.

Chapter Four: Quantitative & Qualitative Data

Introduction

The quality of the water in a river basin is an accurate way to tell the health of the entire basin ecosystem as every living organism in the basin relies on freshwater to survive. The following chapter deals with historical water quality data at seven locations throughout the Fraser Basin. The purpose behind this chapter is to determine if there have been any positive or negative changes in the water quality of the Fraser Basin since the inception of the Fraser Basin Council. On paper it looks as if the FBC has made some progress in developing a process that is able to integrate the stakeholders of the basin to manage the Fraser River basin holistically. If this is the case then there may be evidence to support this conclusion in the data collected below.

Water Quality Index

One way that the Fraser Basin Council measures the health of the Fraser River Basin over the years is to look at aggregated freshwater indicator data through a Water Quality Index (WQI). The WQI is a set of variables utilized by water quality experts to define the health of a river, lake, or other freshwater source. The Canadian WQI is measured out of 100, and uses between five and fifteen variables for a freshwater source where guidelines are measured in terms of aquatic health, not human health. Variables are measured by amplitude, frequency, and scope; in other words; how much, how often, and how many times are the guidelines exceeded. The Canadian WQI was set up as a means to disseminate water quality information to the Canadian public in a simple, efficient, and consistent manner that is easy to understand.[140]

However, the WQI also has some shortcomings. Amalgamating any number of indicators into a single measurement can mask any single indicator that may be above or below a certain required health standard. Therefore it is important to keep in mind that this measurement may give an idea of the overall health of the water, but will not pinpoint specific issues that may be present. Further, some indicators may be more important than others in terms of overall aquatic health. For this reason the impacts of certain chemicals are weighed prior to the development of water quality objectives, mitigating the need to make some indicators more important than others when developing the WQI for a given water body.[141]

According to the Fraser Basin Council, the WQI of monitoring stations has improved, been sustained, and deteriorated in quality over the 2004-2006 measurement period compared to the previous measurement period of 2001-2003. In the latest Snapshot Report by the Fraser Basin Council, it was reported that four of the monitoring sites achieved a "Good" or "Excellent" ranking, meaning that the WQI for those sites indicated little or no disparity compared to natural levels. Two sites were ranked as "Fair", and two were ranked as "Marginal".[142] The CESI website that hosts historical and real-time data confirms this statement for the seven monitoring sites found in the Fraser Basin.[143] An eighth station northeast of Prince George in Hansard that was deactivated in 2006 also shows WQI measurements for the 2001-2003 and 2002-2004 of 82.6 and 82.7, respectively.[144]

Three of the sites' WQI scores improved from the 2001-2003 period: Red Pass, Hansard, and Salmon River at Salmon Arm. While Red Pass and Hansard both have scores that qualify as good or excellent, the shift of the Salmon River at Salmon Arm site from poor to marginal is a marked improvement. The Thompson River and Fraser River at Hope maintained the same WQI score, while the WQI scores of Marguerite, Nechako, and Sumas River locations dropped. The Sumas location dropped by over 20 points and Marguerite and Nechako sites by roughly five points or less.[145]

This pattern indicates a slight improvement in the overall aquatic health of the Fraser River, while the Thompson has stayed the same and the Nechako and Sumas Rivers have dropped. The ratings for Salmon River at Salmon Arm show a significant improvement over its previous score, although the WQI for the Salmon River is still significantly lower than the rest of the other measurements throughout the basin. As any sort of change takes time, especially when it comes to the environment, this general trend of an increasing WQI measurement in the Salmon River in such a short time span is a good sign.

In order to assess any direct and indirect effects that the Fraser Basin Council has had on the quality of the water in the Fraser River and its tributaries, data from Environment Canada's Canadian Environmental Sustainability Indicators (CESI) webpage has been used to assess the quality of the freshwater in the Fraser Basin. Data have been collected over the past two to three decades from monitoring stations located across Canada in 392 rivers and 19 lakes. Of those sites, 32 are located in British Columbia. These sites measure many different indicators for a number of categories; such as metals, organic contaminants, pathogens, oxygen, acids and bases, carbon, major ions nutrients, non-metals, and physical indicators.[146] Of the 32 sites in British Columbia, seven are in the Fraser River Basin and these are used for this report. These monitoring sites, in relative geographic order, are: Red Pass on the Fraser River, the Nechako River in Prince George (where the Nechako River meets up with the Fraser River), Fraser River at Marguerite, Salmon River at Salmon Arm (feeding into the Thompson River), Thompson River at Spences Bridge, Fraser River at Hope and Sumas River at the International Boundary (feeding into the Fraser River). Further, all but the Nechako River monitoring station are coupled with hydrometric stations that collect data regarding river levels. Indicator data collected for these six locations therefore include river discharge information.

The indicators chosen for the purpose of analysing water quality in the Fraser Basin are as follows: pH level, dissolved chloride and nitrogen nitrate, total lead and arsenic, faecal coliforms, and turbidity. These were chosen from well over 100 possible indicators and all of the indicators chosen are important for a number of reasons, explained in brief below. The time period for this analysis was between January 1, 1990 and January 1, 2009. This date range was chosen because data for the different indicators were collected at different times from each other in the 1970s and 1980s. Using the 1990-2009 date range ensures that there will be data for each of the selected indicators for this study. The levels of each of the indicators over this period (that is, the descriptive data for each) are presented and discussed.

It should be noted that the data available and employed do not include those for numerous other pollutants, including toxic contaminants. The purpose of reviewing the selected indicators is to get an idea of the aquatic health of the water in the Fraser Basin. The indicators selected are those that are more likely to be monitored due to their relation to industry (chloride, arsenic, pH), agriculture (coliforms, nitrogen) and the general water infrastructure of a community (lead).

It was noted above that turbidity levels were accessed along with the other indicators. Turbidity occurs mainly in springtime as spring runoff causes the churning of sediment in the riverbeds. Therefore increases in turbidity can be connected to increases in river flows, which naturally occur in late spring or early summer as spring runoff from higher areas enter the main river stems, as well as by precipitation that may increase river levels.[147] The rise and fall of river levels can affect indicator levels beyond other natural or human causes. The indicator data will thus be correlated against turbidity for each site to determine whether increases in river flows are a reason for increases or decreases in indicator levels over time. Correlations have been conducted with SPSS statistical software, using the Pearson Correlation Coefficient.

Table 1: Summary of Correlation between Selected Indicators and Turbidity

Monitoring Site	Arsenic	Lead	Nitrogen	Faecal Coliforms	Dissolved Chloride
Red Pass	**0.542**	0.041	**-0.470**	-0.009	0.059
Nechako River	**0.439**	**0.682**	-0.001	0.102	0.006
Marguerite	**0.625**	**0.837**	**0.216**	-0.029	-0.028
Salmon River	**0.388**	**0.743**	-0.107	0.061	**-0.385**
Thompson River	**0.237**	0.002	0.069	**0.731**	-0.042
Fraser R. at Hope	**0.502**	**0.715**	0.039	**0.244**	**-0.251**
Sumas River	**0.563**	**0.244**	0.059	0.084	**-0.493**
Legend					
Significance	**0.01 level**	**0.05 level**	Not Sig.		

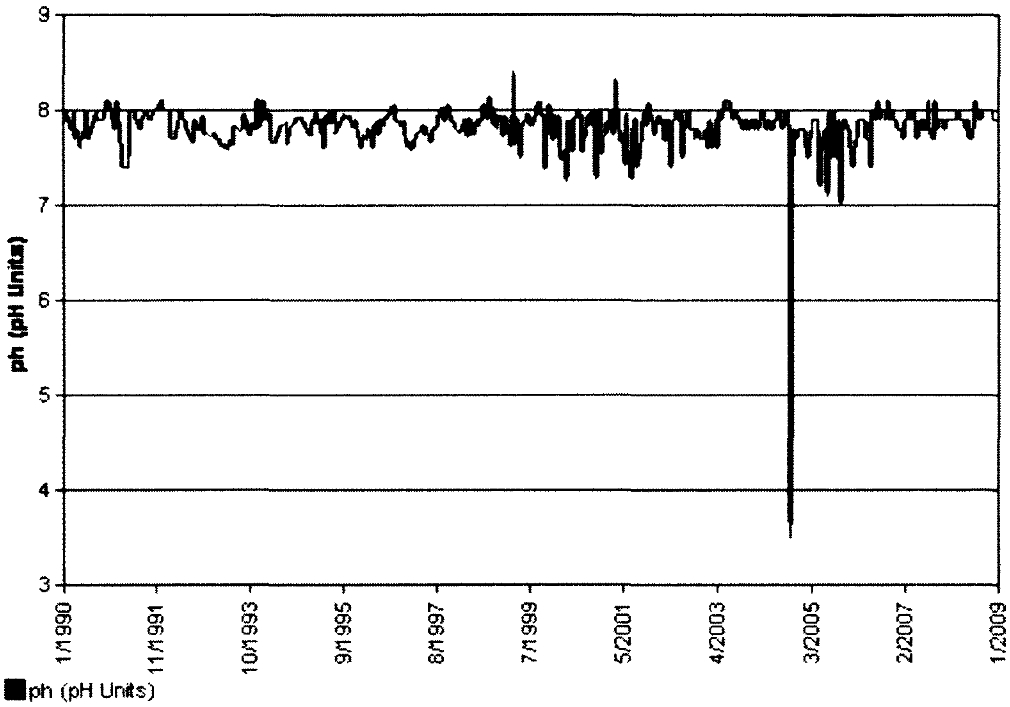
The table above shows correlation between the listed indicators and turbidity levels at the seven different monitoring stations around the Fraser Basin. Positive correlations infers that the amount of an indicator in the river rises and falls with the rise and fall of river flows, suggesting that the force of the increased water flow and subsequent turbidity is the cause of the increase in the indicator. A negative correlation would denote that as a river rises the amount of an indicator decreases, or more specifically, as the water rises the indicator becomes more diluted in the river.

Selected Indicators

pH Levels

According to Health Canada, there are no specific guidelines for the pH levels of freshwater in relation to public health. Although there are limits for pH levels in Canada, these levels are in reference to the corrosion or encrustation that can occur above or below the pH levels of 6.5 (acidic) or 8.5 (basic), where 7 is neutral. A pH level of below 6.5 can lead to corroded metal, such as piping infrastructure, whereas a pH level above 8.5 can cause encrustation or scaling build up in water infrastructure.[148]

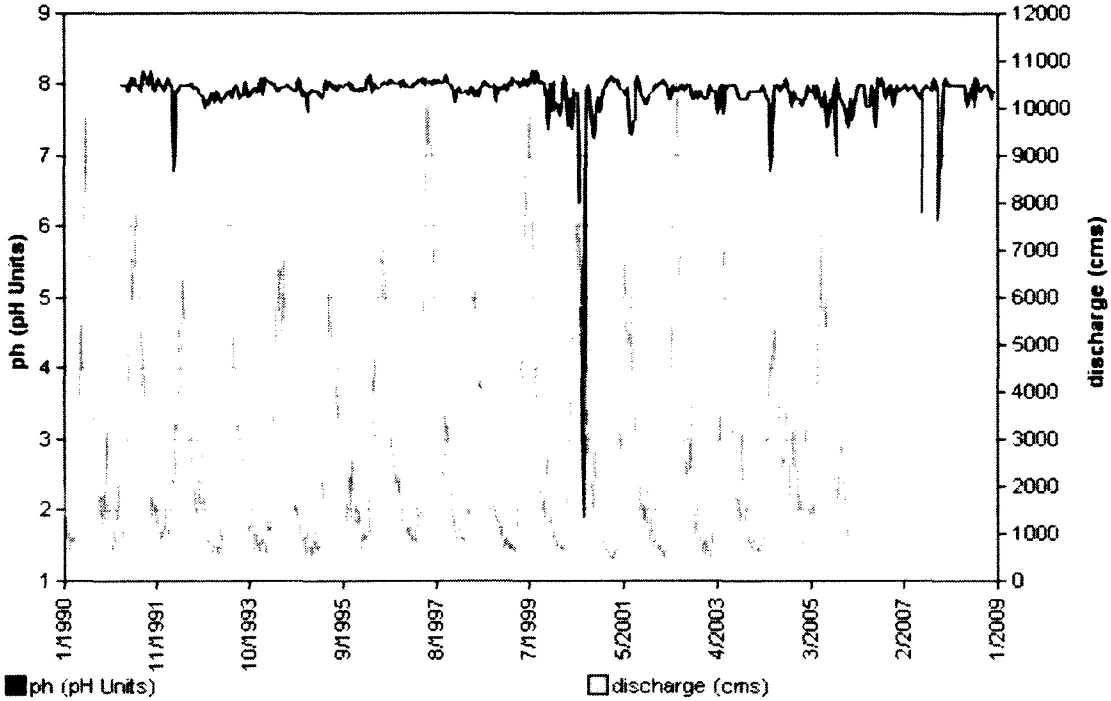
Figure 3: pH Level - Nechako River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

The pH levels at most of the stations in the Fraser Basin indicate an average pH level of roughly 8.0, slightly basic but within the guidelines that Health Canada has set out. There are notable exceptions where the pH levels dip below the acceptable acidic levels and where the cause is not known. For example, in the middle of 1993, in the Nechako River in Prince George where it meets up with the main stem of the Fraser River, the pH level dipped down to around 3.5 (Figure 3: pH Level – Nechako River), while during the rest of the years the river stays an almost constant pH level of 7.5 - 8.0. (This dramatic and unusual change could be a result of a measurement error.)

Figure 4: pH Level – Fraser River at Hope



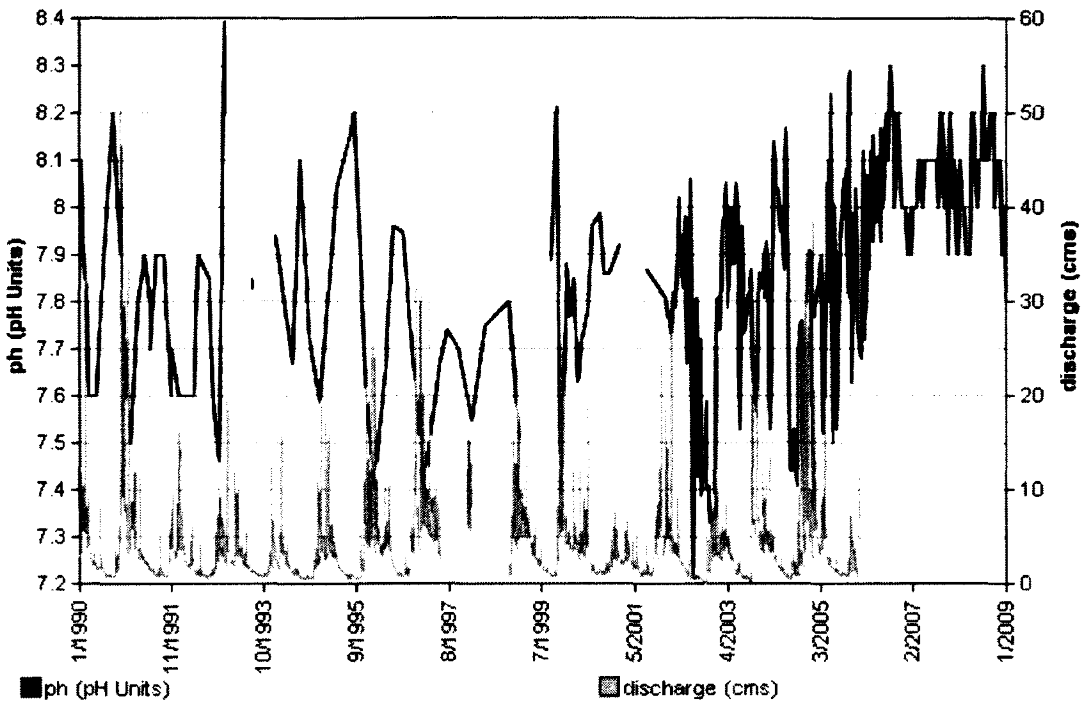
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Second, the pH levels dip down twice near the town of Hope during the 1990-2009 period. The first occurs early in 1991, where the pH levels drop to roughly 6.8 but still within the standards. However the second time this occurs the pH levels of the Fraser River at Hope drop below standard healthy levels twice in 2007 to 6.2 and 6.1 respectively.

At the third monitoring station along the Fraser River near Williams Lake, the pH levels are usually around 8.0. However the levels fluctuate in both directions between 1990 and 2009, beginning in late 1990 where the pH level drops to 5.9, lower than anywhere else during the two decades. Then, in early 2001, the pH level spikes to 8.6, slightly above Canadian standards.

The Salmon River near Salmon Arm has a varied pH level for the two decades measured, peaking at 8.5 and just below 7.3.

Figure 5: pH Level – Sumas River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

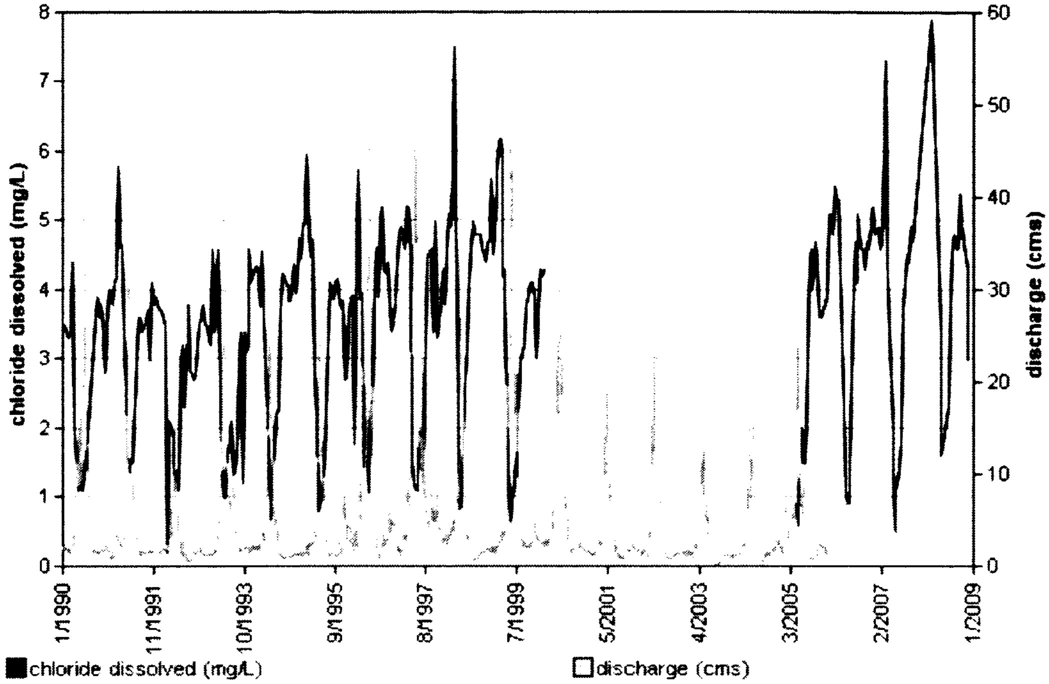
Although spots of data are missing for Sumas River Figure 5: pH Level – Sumas River at the international boundary, the pH levels for this river are slightly higher than averages for the rest of the Fraser River, almost reaching unacceptable levels in early 1992 (pH 8.4) as well as numerous times between 2005 and 2009 (pH 8.3).

Overall the pH levels in the Fraser River Basin and its tributaries are within the guidelines set out above, with one notable exception. At Thompson River in early 1993 the pH level seemed to spike to almost 800. Considering that pH levels are measured from 0 - 14, this number is most definitely a mistake in the data entry.

Chloride

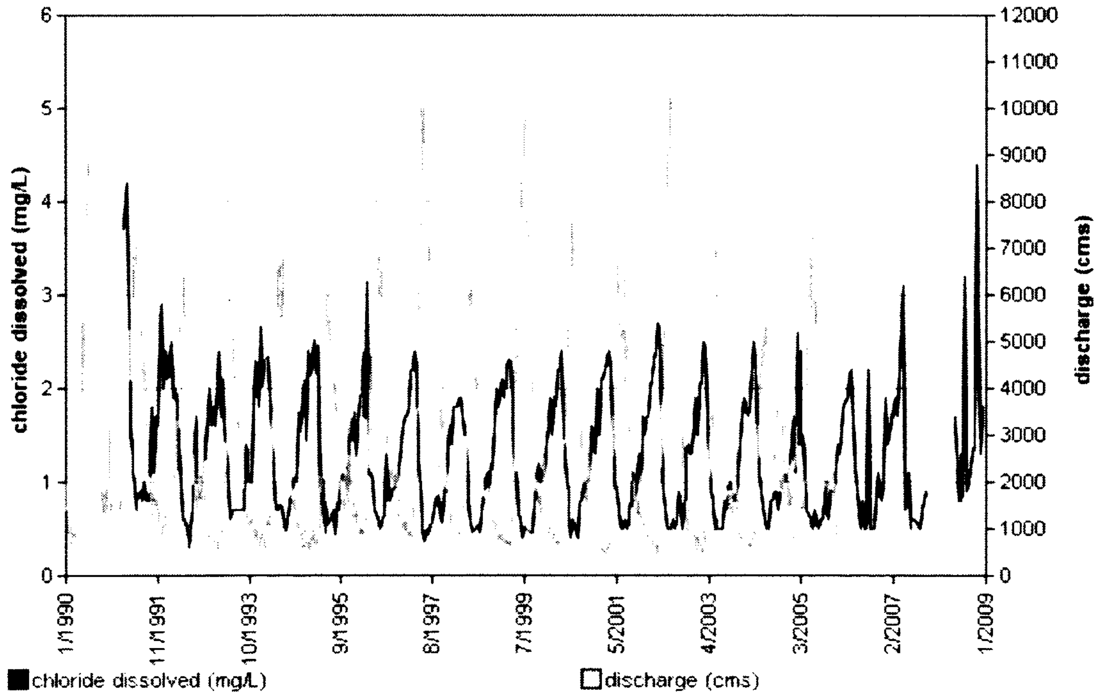
Although naturally found in small concentrations in surface water in Canada, as well as found throughout nature in sodium (NaCl) and potassium (KCl) salts, dissolved chlorides can be an indicator of many types of activity along or near waterways. Some activities that can lead to abnormally high levels of chloride ions in freshwater sources include: highway salting, chemical/industrial effluents, irrigation drainage and seawater intrusion, among other activities. Due to the nature of chloride salts and their ability to be absorbed by water, conventional water treatment plants are unable to filter out excess chlorides prior to discharge. For this reason industrial sites must use alternative methods at the source of use, such as reverse osmosis. Although there is not a maximum acceptable level of chloride in freshwater set by Health Canada due to the nature of the human body and its ability to absorb and use chlorides as salts for proper bodily functions, there is an aesthetic objective set of less than 250mg/L for taste threshold objectives.[149]

Figure 6: Dissolved Chloride – Salmon River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

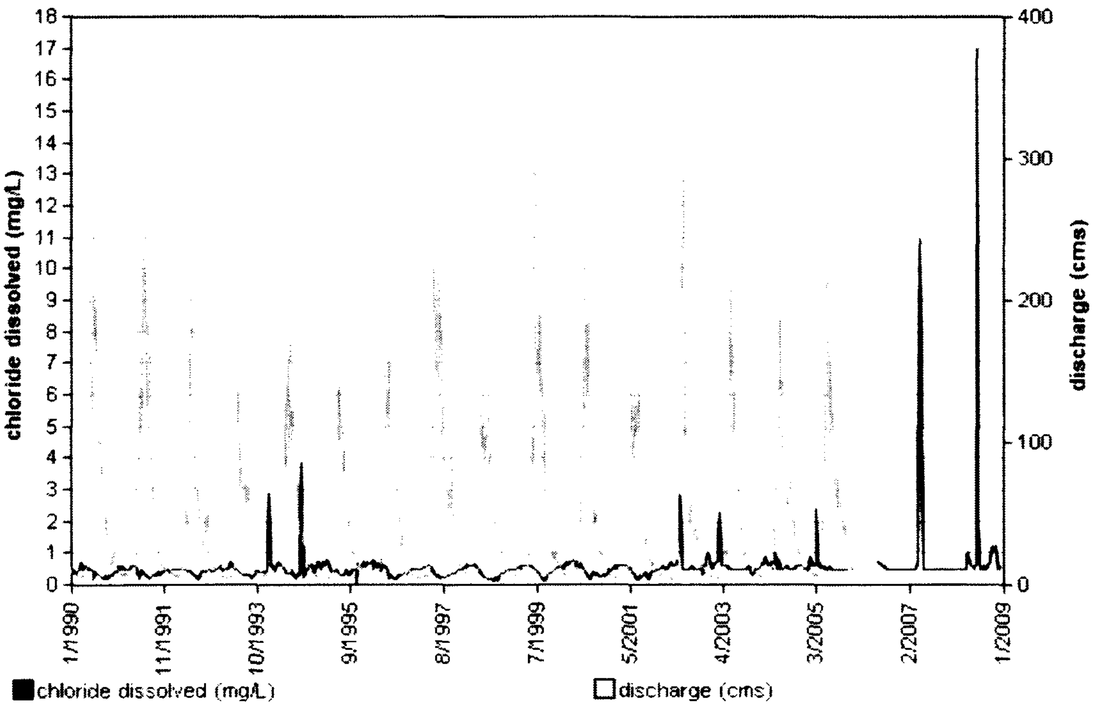
Figure 7: Dissolved Chloride – Fraser River at Hope



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

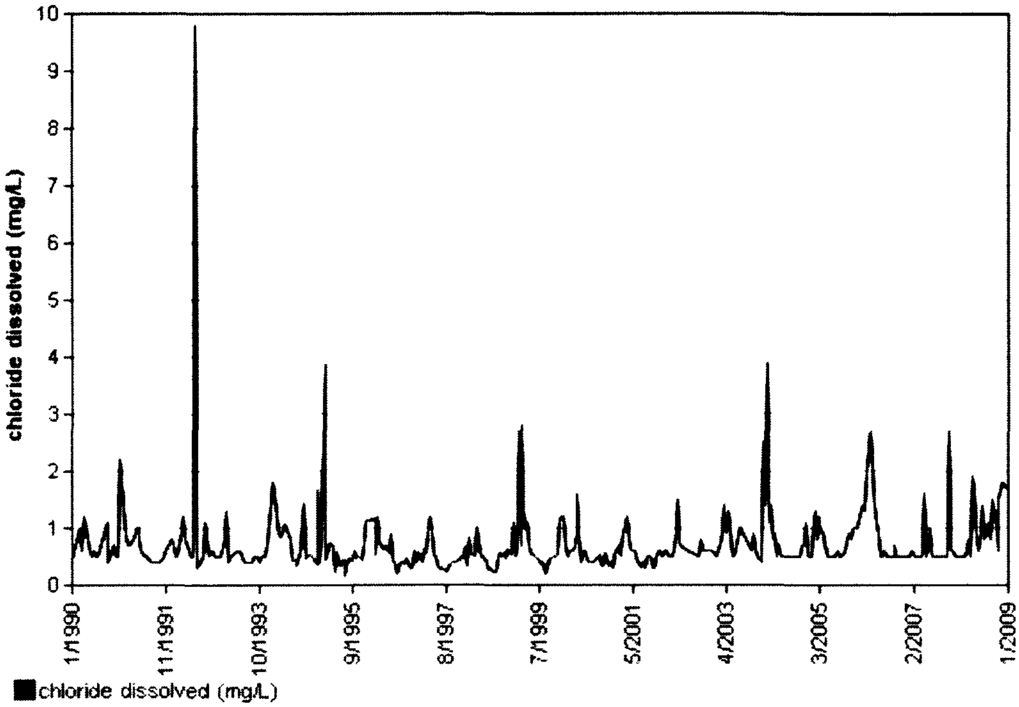
Chloride levels measured by the Fraser Basin monitoring stations vary between locations from lows of almost zero mg/L to a high of roughly 21.5mg/L. As noted above, these measurements are well within the aesthetic guidelines of 250mg/L of drinking water. Looking at the figures, chloride levels along the Fraser River or its tributaries peak and dip opposite to river discharge levels, suggesting that the chloride levels being measured at these monitoring stations are steady overall, and become diluted as spring river flows rise. That pattern can be seen at the Salmon River, Fraser River at Hope, and Sumas River monitoring stations. At these sites there were statistically significant negative correlations for chloride levels versus turbidity of the respective water body ($r = -.385, -.251, -.493$, sig = 0.01). Beyond this, there are some abnormal peaks within the data that are worth mentioning.

Figure 8: Dissolved Chloride – Fraser River at Red Pass



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

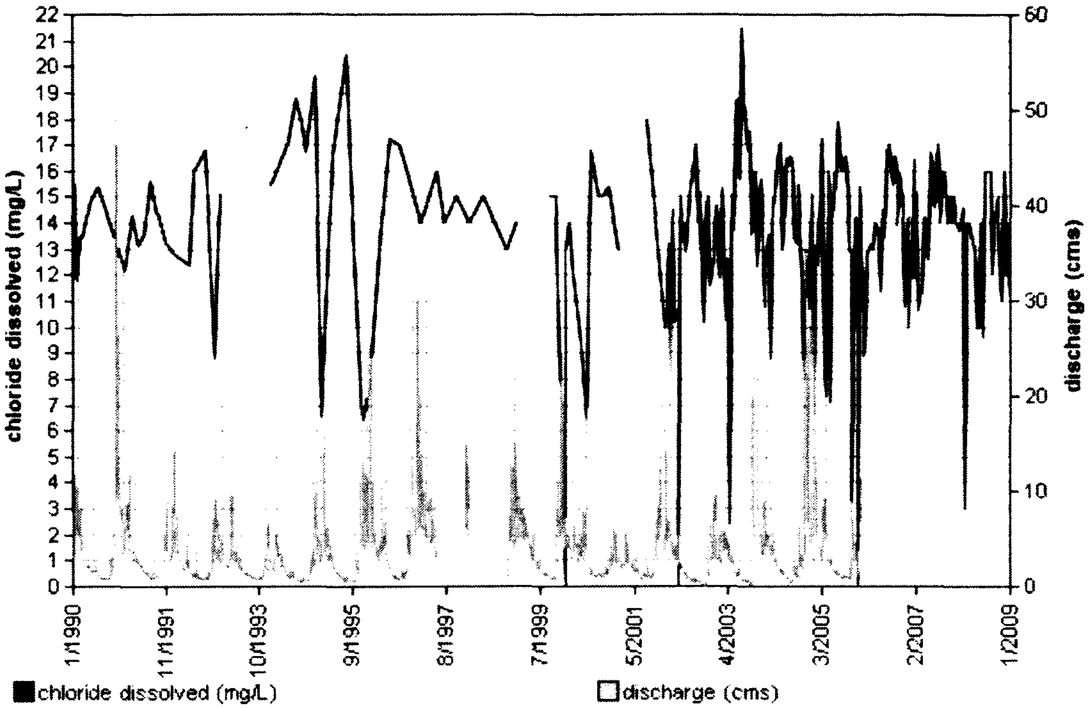
Figure 9: Dissolved Chloride – Nechako River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

At Red Pass along the Fraser River there were two spikes in chloride levels in 2007 and 2009 well above the average for that location. While the average for that station is around .5mg/L, during early 2007 and 2009 the levels spiked to 11 and 17 mg/L, respectively. A similar spike occurs at the Nechako station in 1991, where the usual chloride levels of .5mg/L jump to almost 10 mg/L. At the Salmon River monitoring station, chloride measurements are missing from years' 2000 to 2005. Yet from what data is shown in Figure 9, average levels seem to increase over time, as well as the difference between peaks and valleys for each year leading to 2009. The same trend cannot be determined for any of the other six stations.

Figure 10: Dissolved Chloride – Sumas River



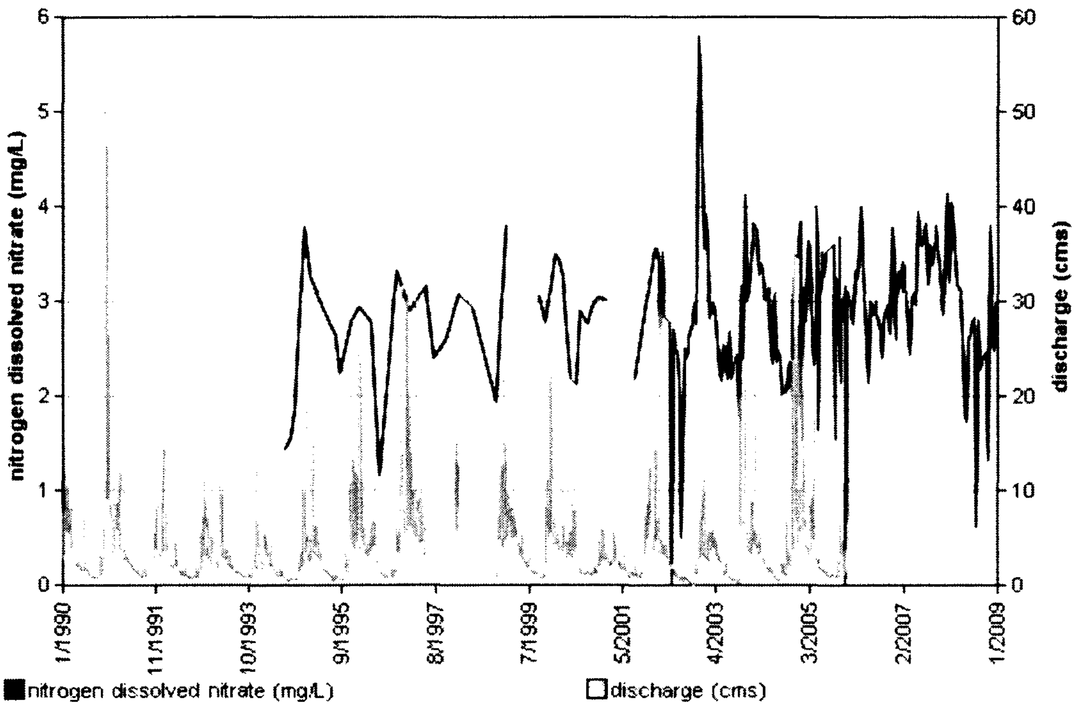
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Sumas River has a much higher average than the rest of the locations in the Fraser Basin (Figure 10: Dissolved Chloride – Sumas River), as well as having somewhat sporadic high levels of chloride over the past two decades. Thompson River and Hope stations measurements are relatively uniform and almost identical in measurements, although the Thompson River station shows a lower overall average than Hope does.

Nitrogen

There are many ways that nitrates and nitrites can occur in nature, such as naturally through the oxidization of nitrogen in water, plants, or soils. However, nitrates are also widely used in inorganic fertilizers, as oxidizing agents in some industries, and as a food preservative. High levels of nitrates have been associated with such ailments as methaemoglobinaemia, cancerous tumours, and malformed childbirths. Infants under three months are more likely to develop methaemoglobinaemia than older infants, children and most adults, through the ingestion of high levels of nitrates, finally resulting in their haemoglobin being unable to provide oxygen to the muscles of the body. The maximum acceptable concentration of nitrates in drinking water is 45mg/L.[150]

Figure 11: Dissolved Nitrogen – Sumas River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

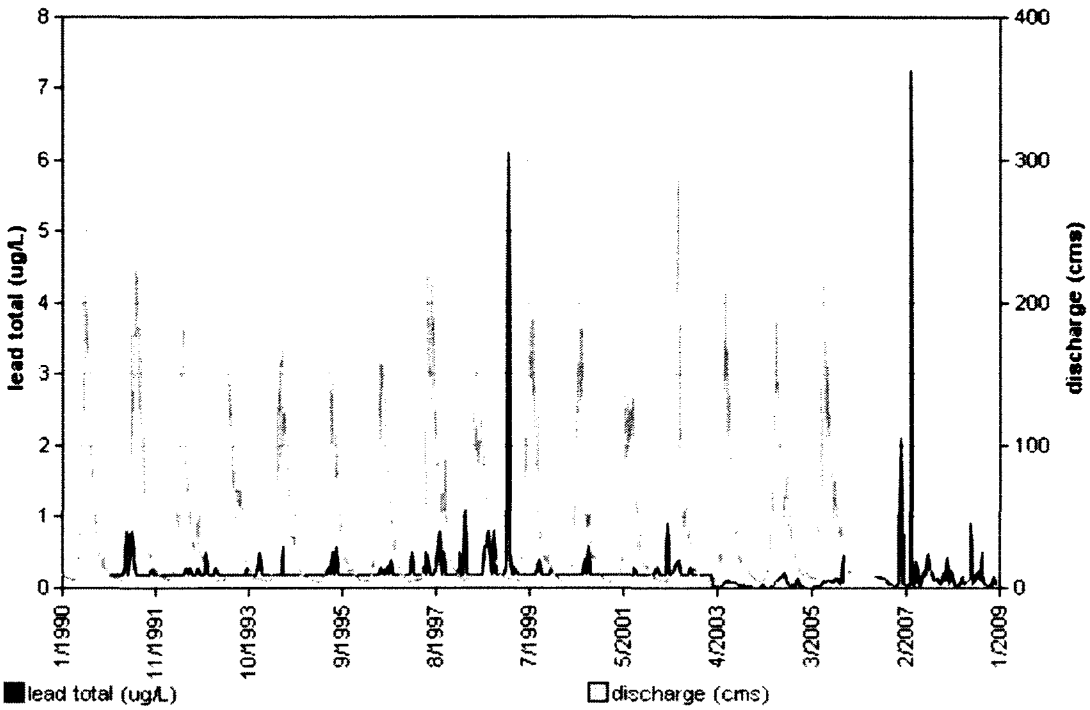
Nitrate levels in the Fraser River Basin seem relatively unmonitored. The Canadian Environmental Sustainability Indicators website only shows nitrate data from 1994 to 1999 for all but the Sumas River, where data starts in 1994 but continues on until the present. Generally however, nitrate levels in the Fraser Basin and its tributaries are well within safe drinking levels. The Sumas River levels are by far the highest, where the highest levels recorded were around 6 mg/L, and the average is between three and four (Figure 11: Dissolved Nitrogen – Sumas River). For the rest of the monitoring sites, the average amount of nitrate in the water is somewhere around 0.1 mg/L, well under the safe drinking water limit of 45 mg/L noted above.

There was very little or no correlation between turbidity and nitrogen levels at five of the seven sites. However, at Red Pass in the Upper Fraser River area, there was a significant negative correlation ($r = -.470$, sig. $= 0.01$), suggesting that as the river levels rise from spring flows from Mount Robson, nitrogen levels are diluted. Yet at the Marguerite monitoring station, the opposite occurred. Data for Marguerite indicate that there is a smaller but significant positive correlation between turbidity and nitrogen levels ($r = .216$, sig. $= 0.05$). This result could indicate a large level of nitrogen in the sediment for that portion of the Fraser River. This occurrence does not continue downstream however, suggesting that whatever amounts of nitrogen enter the water at or above the Marguerite monitoring station they are greatly diluted further downstream before the Hope station.

Lead

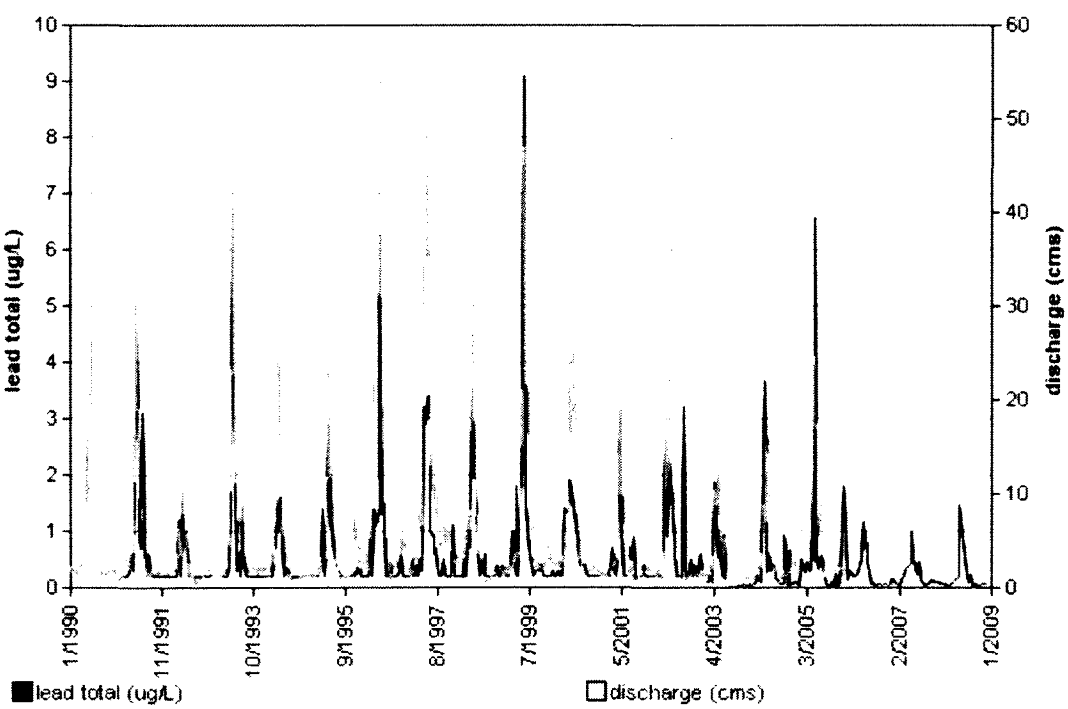
Due to its low melting point, resistance to corrosion, and the fact that it is a soft metal, lead has been utilized in many ways since Roman times. Absorbed by inhalation, absorbed topically, or ingested, lead is a material that builds up in the body over time as the human body is unable to process or expel it from its system. The accumulation of high amounts of lead in the human body can result in headaches, poor attention, loss of memory, muscle spasms, hallucinations, restlessness, and irritability. Long term exposure of two years or more can lead to gastrointestinal issues, muscle weakness, and mood changes. Conventional water treatment plant techniques to remove lead are generally effective. However, most lead found in drinking water enters after the water has left the municipal treatment plant, according to Health Canada, by way of leaching from materials used for household plumbing or the water distribution system. Corrosion control, through adding corrosion inhibitors and slightly increasing the waters' alkalinity, are effective additional methods of mitigating lead from entering the drinking water system. In Canada, the maximum acceptable concentration of lead in our drinking water is 10μg/L.[151]

Figure 12: Total Lead – Fraser River at Red Pass



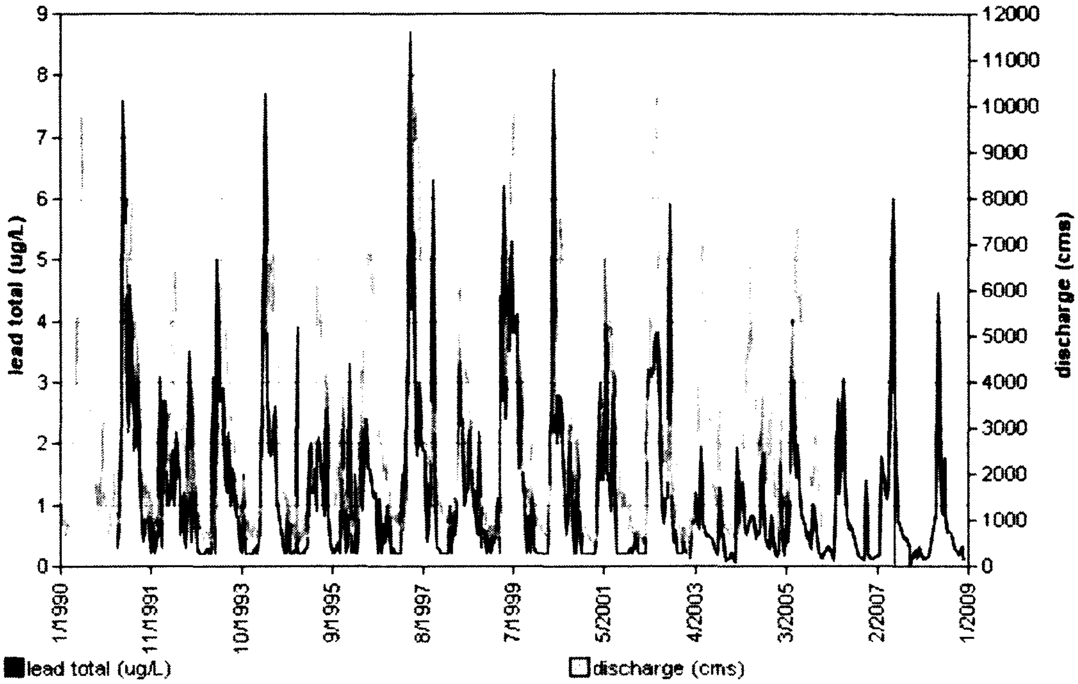
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 13: Total Lead – Salmon River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

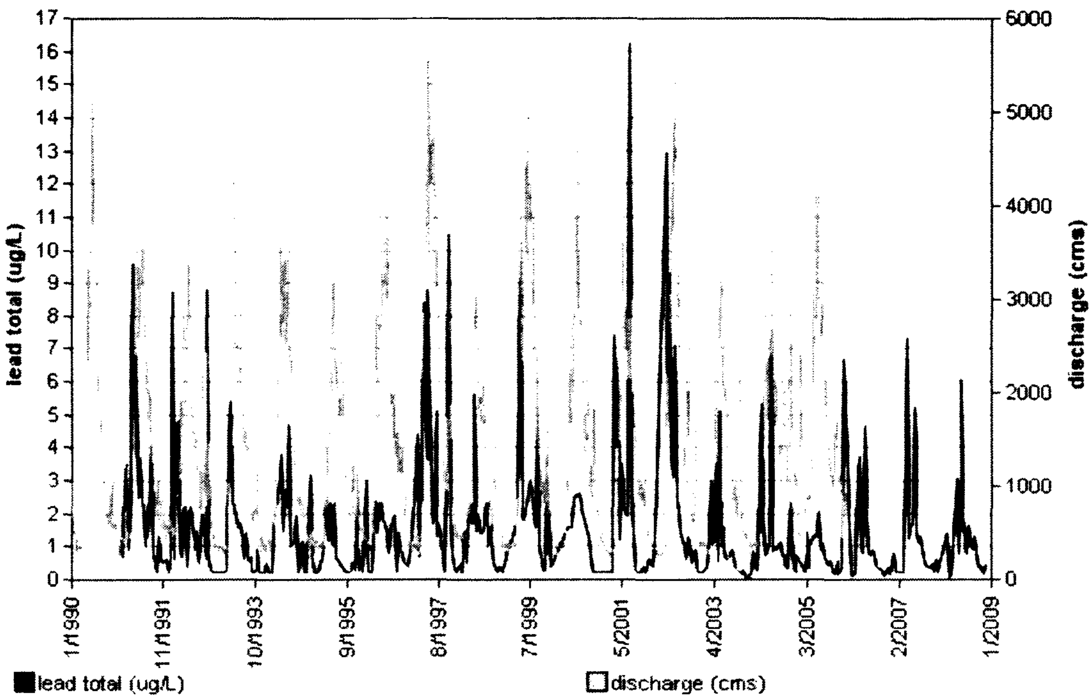
Figure 14: Total Lead – Fraser River at Hope



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Lead levels in the Fraser River Basin generally comply with the safe drinking water standards. Yet over the past two decades some monitoring stations have picked up higher than acceptable levels of lead at two stations, and three stations have come close to surpassing the standards. The Red Pass, Salmon River, and Hope monitoring stations have all recorded levels of lead at various times that have come close to the 10 μg/L limit set by Health Canada. The rest of the data shows averages levels less than 1 μg/L of water. The other two stations have much higher averages with many peaks that seem to correlate to seasonal river flows. Some of these peaks have come close to breaking through the 10 μg/L ceiling.

Figure 15: Total Lead – Fraser River at Marguerite



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

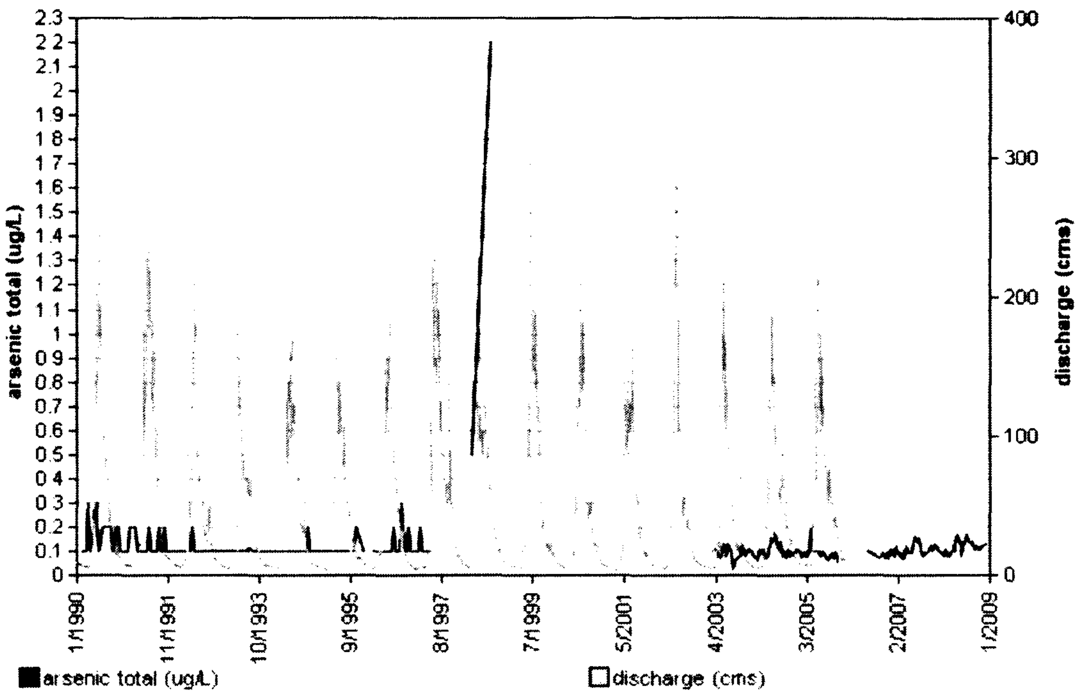
The Marguerite monitoring station detected breaches in the river water lead level on four occasions over five years, with two slightly higher than 10ug/L. At two other times, in 2001 and 2002, the amount of lead in the river rose to 13 and 17 μg/L for short periods of time. In the last twenty years the Sumas River has had lead levels over the Canadian drinking water standard on three separate occasions, the first two being around 1991, where the levels reached 12 and 13 μg/L. The other occasion was in 2000 when the levels again rose slightly higher than the standard. Increases in levels of lead seem to be almost directly correlated with yearly river discharge. Overall however, lead levels in the Fraser River Basin are well within safe drinking water limits.

Five of the seven monitoring sites indicate high positive correlations between lead and turbidity. The only two sites where correlations were not positive and significant were Red Pass and the Thompson River. For the other five sites the correlation coefficient ranged from a low of r = 0.244 at the Sumas station, to a high of 0.837 (sig. = 0.01) at Marguerite near Williams Lake. This strong correlation at the majority of these monitoring stations indicates that there could be an excess of lead in the soil or sediment in much of the basin from around the Prince George area and downstream.

Arsenic

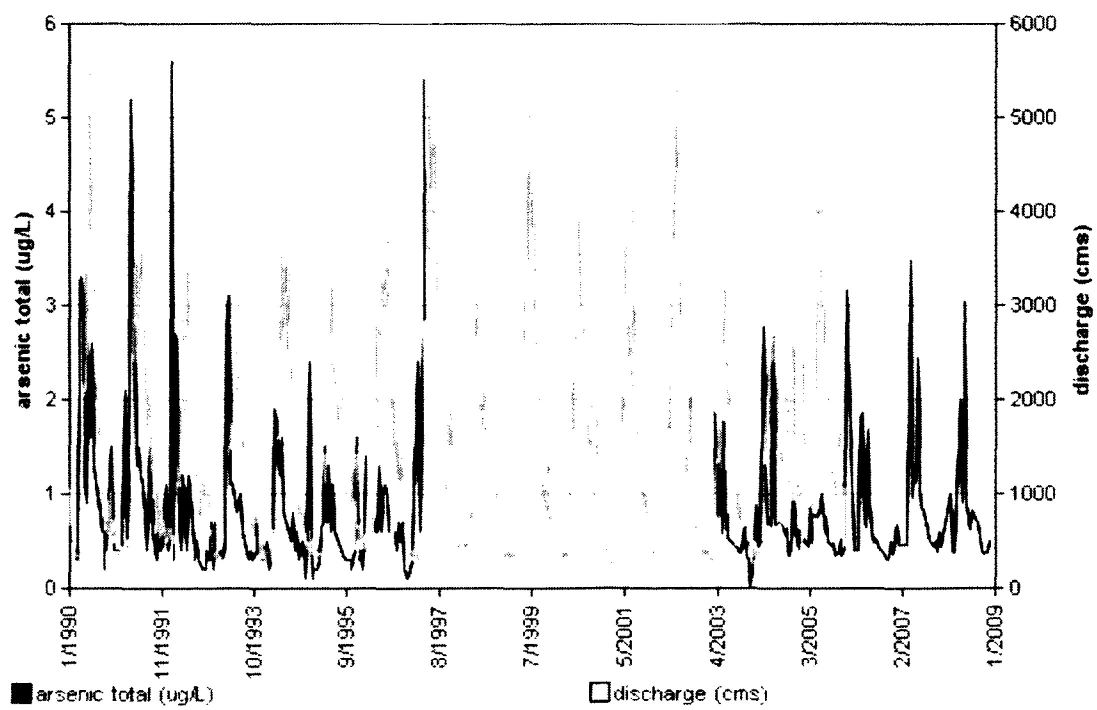
Monitoring arsenic levels in drinking water is essential to creating clean, safe drinking water for a community. Arsenic is a poisonous and carcinogenic material for humans and found throughout nature, entering both ground and surface water sources through erosion of soil content and treatment of ores (such as gold). Arsenic may enter water sources directly through industrial effluent disposal or indirectly through atmospheric discharge and absorption. Arsenic mainly enters humans through ingestion via water or food, whereas inhalation or topical contact is not thought to be a major risk. Further, the harmfulness of the arsenic depends on what form it is in upon ingestion. There are many treatments a small or large municipal water treatment plant is able to perform in order to lower the amount of arsenic in the drinking water supply. Likewise, household devices are also capable of lowering the amount of arsenic to acceptable levels. Similar to lead, the maximum acceptable concentration of arsenic in drinking water in Canada is 10μg/L of water.[152]

Figure 16: Total Arsenic – Fraser River at Red Pass



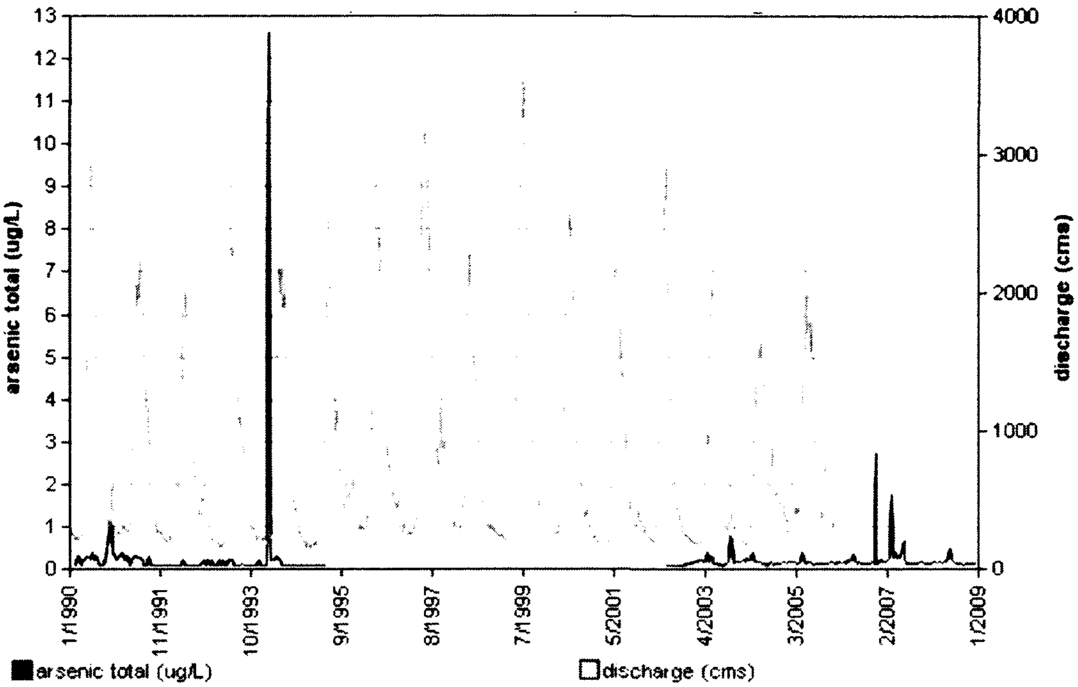
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 17: Total Arsenic – Fraser River at Marguerite



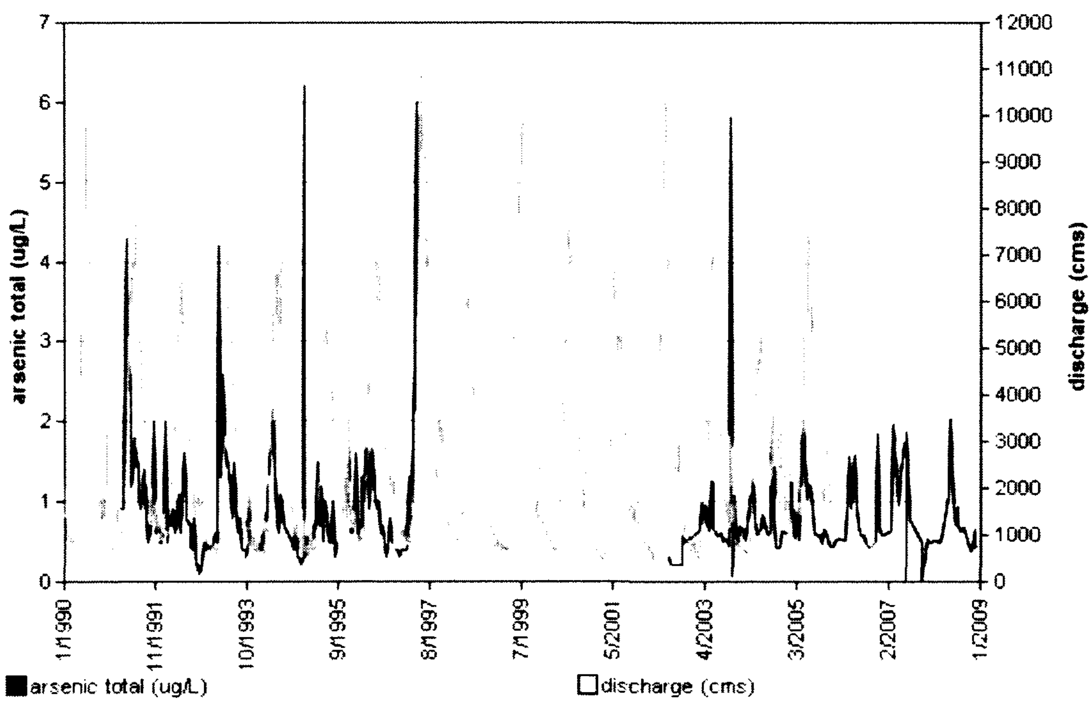
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 18: Total Arsenic - Thompson River at Spences Bridge



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 19: Total Arsenic – Fraser River at Hope



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Generally, the arsenic levels in the Fraser River Basin are well within the limits set by Health Canada. The only notable exception is in the Thompson River in 1993, when levels briefly shot up to 13 μg/L. Both the Hope and Marguerite monitoring stations indicate higher average levels of arsenic than the other five stations, where the average is between one and two μg/L with recurring spikes around the five to six micrograms per litre range. Trends for these two sites indicate a slight lowering of levels over time, yet as the r value for these trend lines are quite low, the reliability of the data is questionable. The other stations average somewhere in the vicinity of 0.1-0.3 μg/L, with some small spikes averaging 2-3 μg/L.

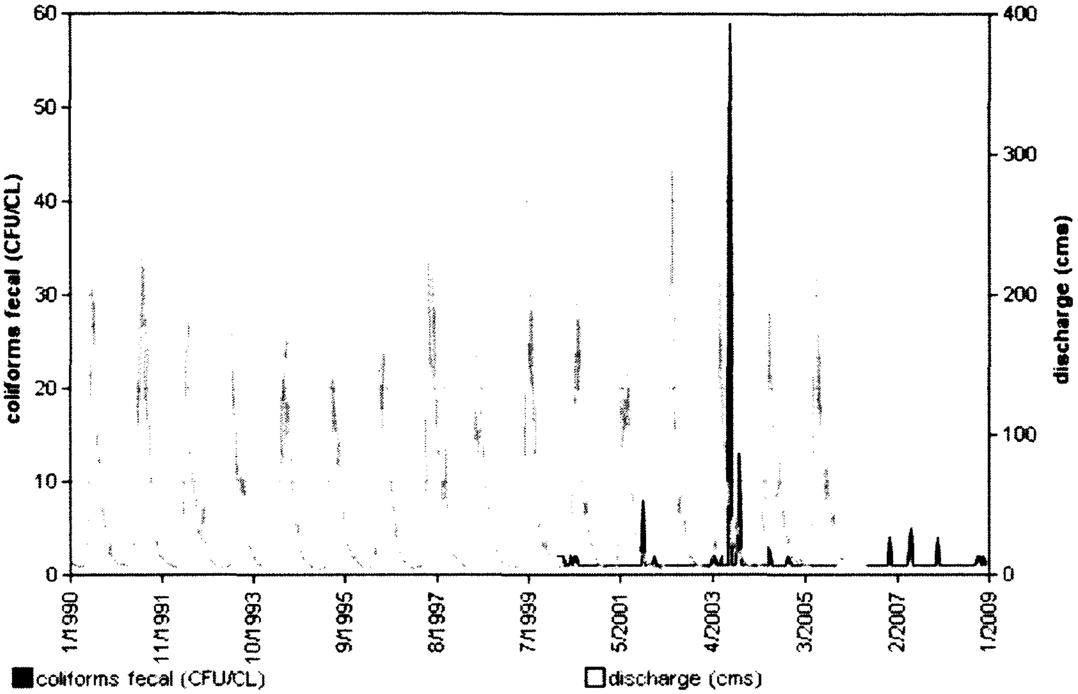
Every monitoring site indicates positive correlations between turbidity and arsenic levels in the Fraser Basin. Correlation coefficients range from a low of 0.237 at the Thompson River to 0.625 at Marguerite (sig = .001). Although arsenic levels in the Fraser Basin are well within healthy limits overall, the direct correlation of arsenic and turbidity throughout the basin is interesting. Arsenic is the only indicator in this study that showed significant correlation with turbidity at all seven stations. This pattern may indicate natural or non-point sources of arsenic through the basin, or maybe similar industrial practices along the Fraser and its main tributaries.

Coliforms

Coliforms are traditionally and perhaps arguably one of the most important indicators of drinking water health, as high levels of different coliforms can lead to various illnesses and ailments. Coliforms are microorganisms found in water, and take the form of bacteria, viruses, or protozoa. Of these, *escherichia coli* (*E. coli*) is probably the most recognized by the public. Coliforms are mainly found in surface water and can occur naturally, but also enter water sources through human and animal waste, such as faeces. As coliforms are capable of causing illness in humans, a main goal of municipal water treatment plants is to kill these microorganisms with chlorine. However, since currently used detection techniques are not capable of detecting all coliforms that could be present in our drinking supply, treatment plants test for E. coli that is found in the faeces of all humans and animals. High *E. coli* levels are assumed to indicate faecal contamination of the water supply in question. In Canada, the maximum acceptable concentration of E. coli in drinking water in Canada is none per 100mL.[153]

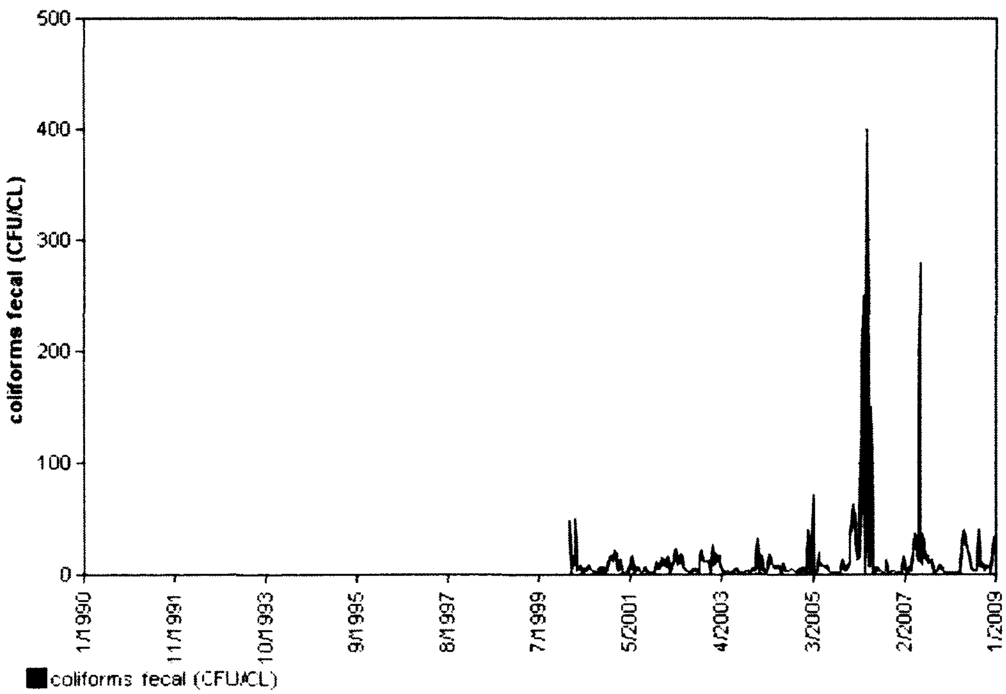
Coliform is the only indicator measured and used in this study for which available data do not extend back beyond the late 1990's in the Fraser River Basin. Yet within the available data set there are possibly alarming trends. Since Health Canada indicates that any coliforms in drinking water are potentially harmful, unlike the other five indicators listed above, it would be expected that the data would show little or no coliforms in the water. In the upper and middle reaches of the Fraser River Basin this is somewhat the case, with a few exceptions along the way. However the data collected farther downstream shows a rather different picture.

Figure 20: Faecal Coliforms – Fraser River at Red Pass



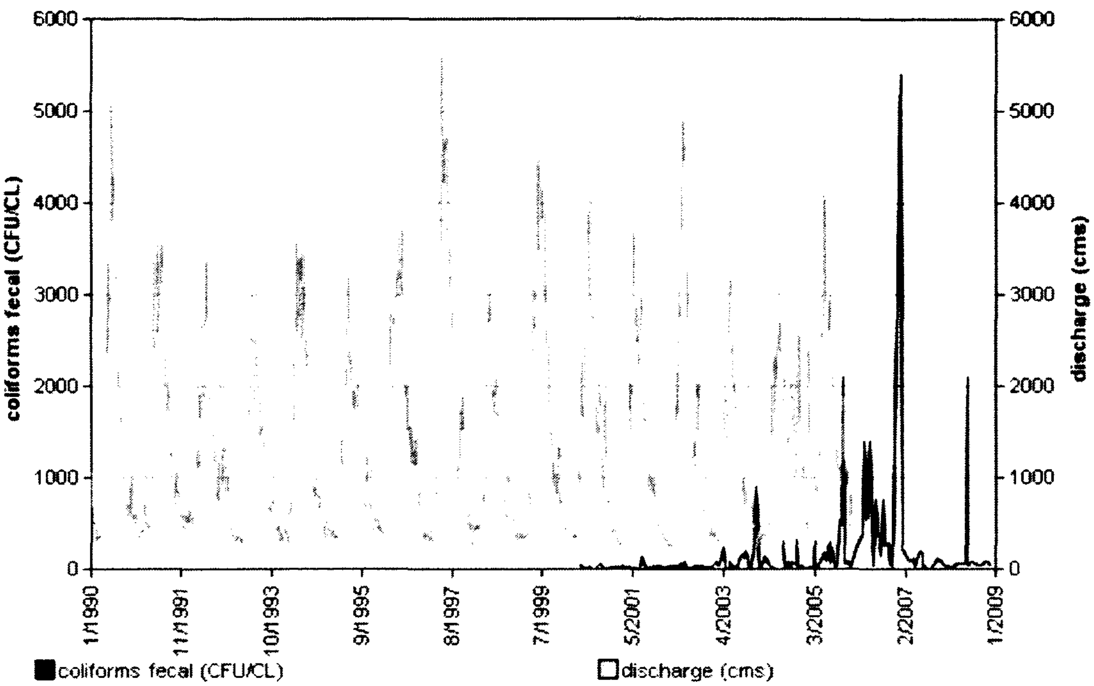
Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 21: Faecal Coliforms – Nechako River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

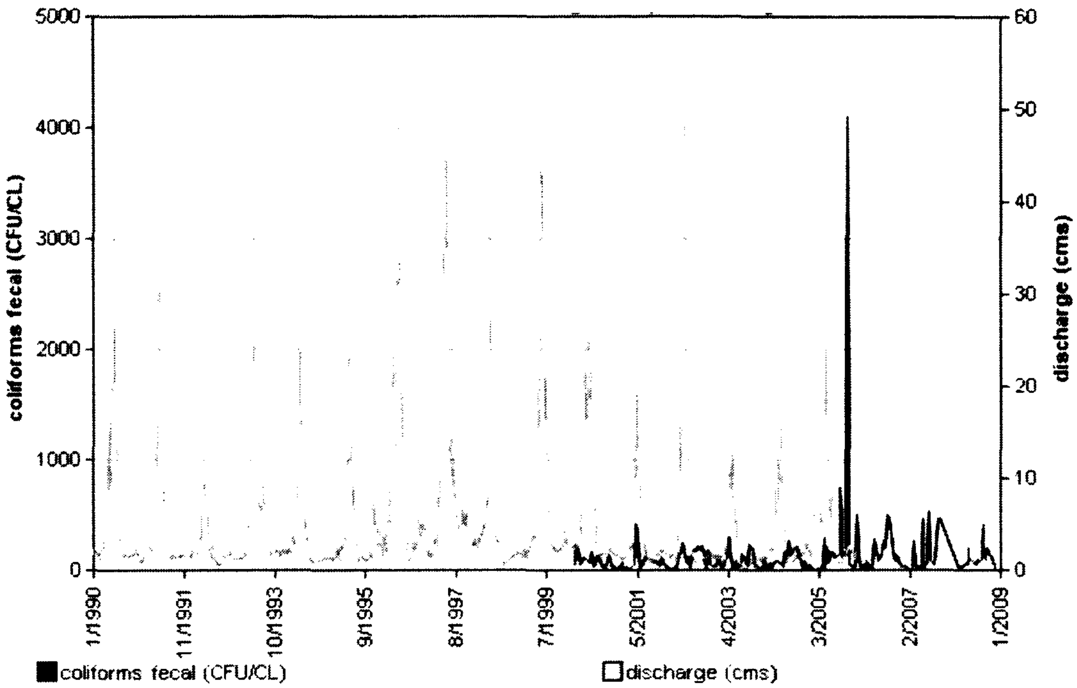
Figure 22: Faecal Coliforms – Fraser River at Marguerite



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

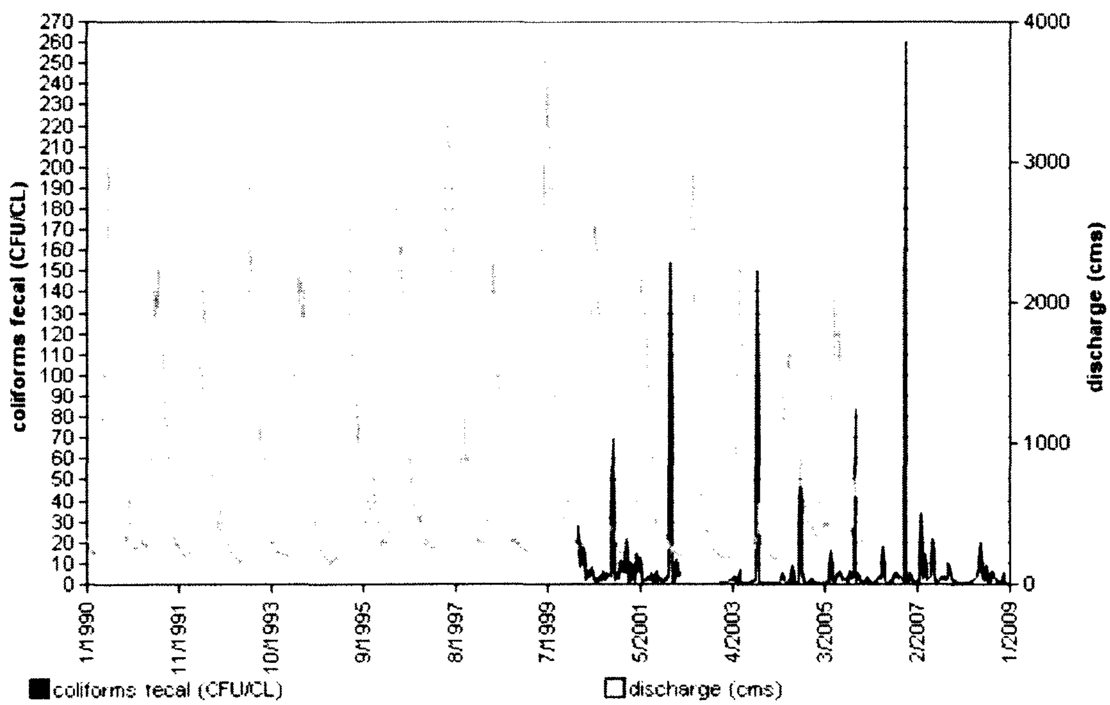
Figure 19 indicates very low levels of coliforms at Red Pass in the Upper Fraser since the late 1990's, with the exception of a small spike 2003 when the faecal coliform count rose to 60 coliform faecal units (CFU) per 100mL's. The Nechako River (Figure 20: Faecal Coliforms – Nechako River) shows similarly low faecal coliform levels, except in 2006 when levels rose to 400 CFU/100mL, then again to almost 300CFU/100mL in 2007. Those levels seem low compared to the coliform spikes experienced by the monitoring station at Marguerite where, in 2007, the levels rose to over 5000 (Figure 21: Faecal Coliforms – Fraser River at Marguerite). To a lesser extent there were two other increases in coliform levels at Marguerite in 2005 and 2008, when levels rose to a little over 2000 CFU.

Figure 23: Faecal Coliforms – Salmon River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

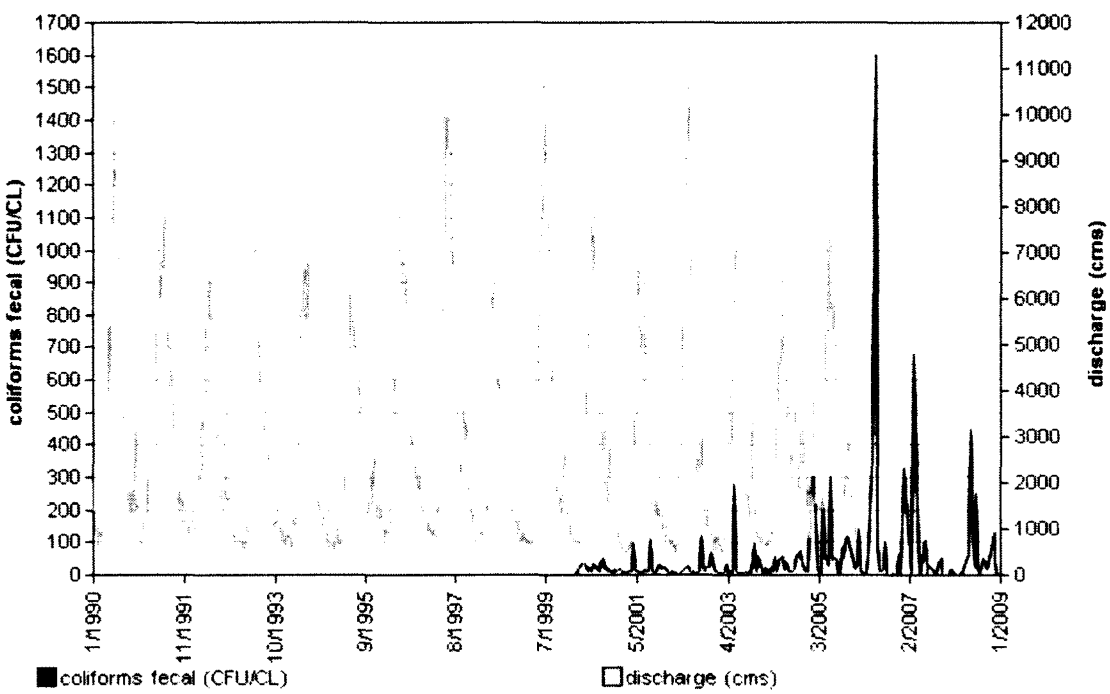
Figure 24: Faecal Coliforms – Thompson River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada.* Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

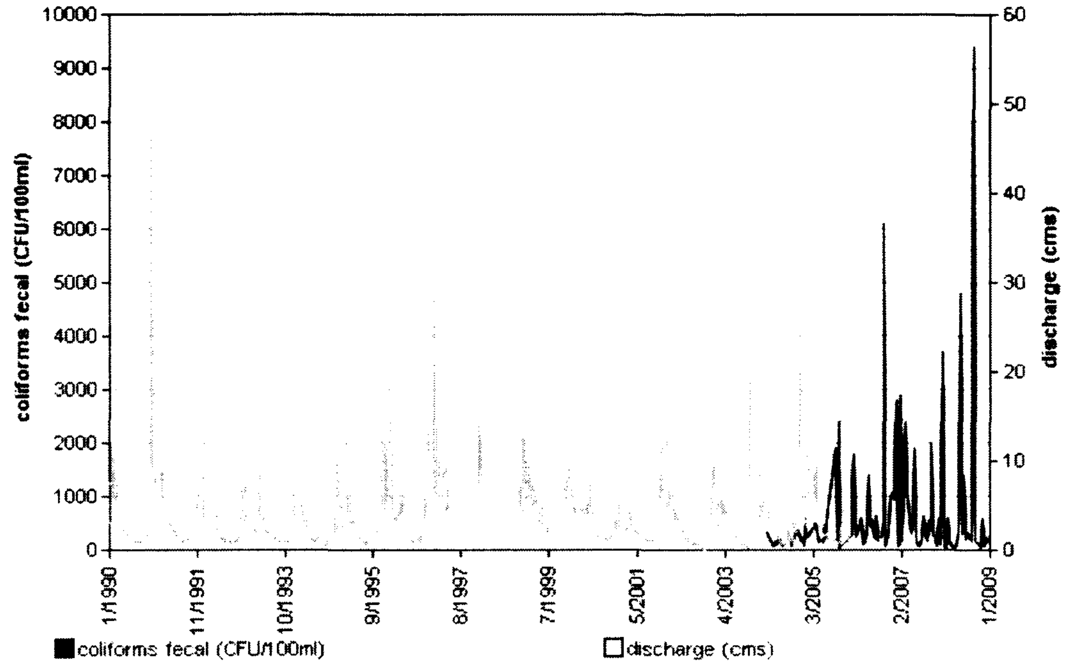
The Salmon River also shows similar trends as for the other sites; relatively low coliform counts until a drastic momentary increase in 2005, after which the coliform levels appear to become slightly higher on average than before the spike occurred. Similar to the other sites so far, the Thompson River monitoring station indicates relatively low faecal coliform counts overall. However sharp rises in counts occur in near uniform time frames from 2003 to 2007, with the last being the highest level measured over the decade, at 260 CFU/100mL. The spike in 2003 measured 150, and the two mid rises measured between 60 and 90. There was also a previous rise in coliform levels in 2001 of 70 CFU/100mL.

Figure 25: Faecal Coliforms – Fraser River at Hope



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

Figure 26: Faecal Coliforms – Sumas River



Source: Environment Canada. "CESI Interactive Mapping Application." *Environment Canada*. Accesses February 4, 2010. http://maps-cartes.ec.gc.ca/indicators-indicateurs/.

The Fraser River at Hope monitoring station shows slightly elevated coliform levels since the late 1990s, with one major increase during 2006 when the levels jumped to 1600 CFU/100mL. There were two subsequent increases in 2007 and 2008 when levels increased to almost 700 and 450. The Sumas River shows the highest levels of faecal coliforms in the entire basin, although data recording only begins in 2004. While the average spikes in coliform levels are around 2000 to 3000, there are some serious jumps to almost 5000 in 2008, 6000 in 2007, and over 9000 later in 2008.

Only two sites indicate statistically significant positive correlations between turbidity and faecal coliform counts, those being the Thompson River (r = .731, sig. = 0.01) and Fraser River-Hope (r = .244, sig. = 0.01) monitoring sites. Both sites are near or in the vicinity of agricultural areas, possibly indicating that spring runoff or irrigation collects faecal matter as it makes its way towards the major river bodies of Thompson River or Fraser River north of Hope. The faecal coliform levels at Hope could also be due in large part to its location downstream from where the Thompson River joins the Fraser, thereby also picking up similar coliform levels as the Thompson River monitoring site. Faecal coliform levels increase further downstream in the Fraser River Basin, and this pattern may indicate a potentially serious health problem. These levels may need to be watched more closely as the bulk of the population of the Fraser Basin live downstream of these two sites. The Sumas River has the highest faecal coliform levels of any of the seven sites. Those levels do not seem to be related to river turbidity or discharge levels.

Reviewing the indicator data set out above, a couple of patterns emerge. First, over the past decade, there has been no real improvement in the indicator levels throughout the Fraser Basin. Second, faecal coliform counts at different stations in the Fraser Basin show spikes in coliform levels over the past few years, with larger spikes further downstream. With the Thompson River station as the major exception, these spikes have all occurred since 2006. As noted above, under Health Canada regulations there are no acceptable level of coliform count in Canada's freshwater sources. The lack of improvement for these indicator counts and deterioration of faecal coliform counts in the Fraser Basin is not the fault of the Fraser Basin Council as it is not a regulatory body. If any faults were to lie with the FBC regarding indicator counts in the Basin, it would be in the lack of projects set up by the Council to tackle such issues.

Yet it might not be for a lack of trying. Starting from the 1977 Fraser River Estuary Study to FREMP, FRAP, FBMB, and finally the Fraser Basin Council, there is clear indication of a desire to understand and alter how the Fraser River, estuary, and eventually basin, are being used and managed. As these organizations developed in the 1980s and 1990s, IWRM was also quickly becoming the most popular way in which countries or regions were dealing with escalating freshwater issues, the Fraser River included.

Analysis

Aquatic health is measured in part through looking at the different chemicals found in the water, such as the indicators listed in the previous chapter. Some chemicals are less harmful than others, while some can even be beneficial in certain amounts to those who consume the water. Data on five of the six indicators chosen for this study suggest that Fraser River Basin water quality generally conform to the overall safe levels set out by Health Canada, and have done so for the most part since 1990. Faecal coliforms were the one exception. The acceptable coliform limit (for E Coli) under Canadian water quality standards is zero, but every site indicated spikes in coliform levels at various points over the past decade. Indicators such as nitrogen, chloride, and to some extent pH in the Sumas River, tend to increase as water levels drop, and decrease as water levels rise. Other indicators, such as lead and arsenic, increase and decrease with water levels of the respective waterway. However, as river discharge information is not readably available to test correlation against these indicator numbers, this is a visual observation of the graphs downloaded from the CESI website.

Although discharge information was not always available, turbidity data was available for all seven sites, and was collected along with the other indicator information. Using the Pearson coefficient the correlation between turbidity and five of the Fraser Basin indicators was tested. What the resulting data showed was that there was a direct positive correlation between arsenic and turbidity at the seven different water measurement stations, and a positive correlation between lead and turbidity at five of the seven stations. Faecal coliforms also showed positive correlation to turbidity at two of the stations further down river. In contrast, chloride showed a negative correlation to turbidity at three of the stations.

What the positive relations with turbidity suggest is that the chemicals that rise with turbidity are more than likely being churned up by increases in river flows as spring melts enter the rivers system, causing annual spikes in the normal levels of these indicators. If this is the case, these indicator chemicals are more than likely lying dormant in riverbed sediment. The other option is that these chemicals are being brought downstream from up high in the mountains (perhaps from accumulated winter snow packs) by the spring melt. This option is much less likely as there seem to be multiple and somewhat unrelated chemicals that all have positive correlation to turbidity.

The Canadian WQI measurements for the Fraser Basin show slight improvements at three of the sites over a four-year period, while two sites remained about the same and three sites decreased in overall water quality. With the exception of the Salmon River site that has a status improvement from poor to marginal from the previous measurement, the overall aquatic health of the basin has remained the same, with only slight increases and decreases in WQI scores trading places over the four-year period.

Between the WQI measurements for the past decade and the indicator measurements for the past two decades, a couple of details about the water in the Fraser Basin become apparent. First, there has been little overall change in the select indicators over the twenty-year period. All of the indicators conform, most of the time in most of the locations, to the overall aquatic health standards set out by Health Canada. Faecal coliform levels are the major exception, where almost all of the stations show serious spikes in coliform levels over the past five years. This demonstrates that the environmental health of the basin is decent but could use improvement, especially since any levels of coliforms can lead to serious illness and death.

Second, the WQI at the different measurement stations in the basin illustrate how the different regions of the basin are affected differently from each other, and how each area is changing over time. For the most part records from each of the stations illustrate the stable aquatic health of the basin, as the indicators signify. Besides coliforms which were just discussed, another exception is the Salmon River at Salmon Arm, which has quite a low WQI compared to the other stations in the basin.

In general, however, there is no clear evidence that the aquatic health of the Fraser Basin is related or unrelated to efforts by the Council to improve the overall health of the basin. The most that the Council seems to be able to do is to monitor and assess. While its work may have led to changes in the real world, the impact remains unproven. The direct actions that are required to increase the quality of freshwater in the Fraser Basin, however, cannot be performed or enforced by the Council, since it is not a regulatory body. Rather these actions must be taken by stakeholders and/or by governments. This dependency on others means the Council is rather powerless in the sense of taking action. The FBC is able to develop many ideas, plans, and projects to address issues such as low water quality in a region, but when action needs to be taken it is powerless to move forward. This inability to enforce decisions made by the Council will be compared to similar organizations in the following chapter.

The next chapter will look at a slightly different type of water management plan in Ontario where multiple environmental issues are dealt with in the Great Lakes Basin. Next, the chapter will compare three water management organizations that share some similarities and differences with the Fraser Basin Council.

Chapter Five: Case Studies

Discussed below are examples of three select basins from around globe, two international in scope, and one regional in scope much like the Fraser Basin, all of which have basin management initiatives in place. First however, there is an example of another type of freshwater management initiative in Canada similar in scope and ideology that should be discussed.

Great Lakes Basin Remedial Action Plans

There have been quite a few efforts over the years in Canada to manage freshwater regionally, the Fraser Basin Council being only one of many. Another such effort that residents of both Canada and the United States may be familiar with, at least in the Great Lakes Basin, are the Remedial Action Plans (RAPs) that were introduced in November of 1987 by the International Joint Commission (IJC) and the governments of Canada and the United States.[154] The RAPs and FBC share similarities in how they approach solving freshwater issues in the Great Lakes and Fraser River Basin. However, unlike the FBC, the RAPs are a response to an environmental problem that already exists in a specific area, whereas the FBC attempts to mitigate environmental issues in the Fraser Basin before they occur as well as to develop plans to deal with existing environmental issues in the Basin.

A remedial action plan is a mechanism that communities and governments may develop and use to address specific degraded areas, which in the Great Lakes basin context are called Areas of Concern (AOC).[155] The AOCs were pinpointed and designated as such beginning in 1987 by scientific and technical teams created by Environment Canada and the Ontario Ministry of the Environment, based on environmental degradation that has spoiled the use of the areas in question.[156] Due to the range of topics dealt with by the different RAPs surrounding the Great Lakes, responsibility for the remedial actions can fall to one or more of the three traditional levels of government, to industry, and sometimes to individuals in the separate communities where the RAPs are located.[157] Communities in the AOCs form committees or advisory councils to work alongside the different scientific and technical groups working on the RAP.[158]

In total there have been 43 AOCs designated by the IJC in the Great Lakes Basin, either solely in the United States or Canada, or shared jointly where the AOC in question spans the border between the two countries. These AOCs can have one of three classifications describing their current status: Areas of Concern, Areas in Recovery, or Restored.[159] In order for AOCs to become listed as restored, all remedial actions must first be completed by those involved, after which the AOC becomes classified as an "Area in Recovery" as the environment reacts to the rehabilitation of the habitat, and efforts to clean up the AOC and/or to control the source or sources of the pollution. During this recovery period the site is monitored by those involved. If there is sufficient evidence that the restoration targets have been met by the remedial actions and those involved in the remediation agree, then the AOC in question can be declassified as an AOC.[160] To date, three AOCs have been classified as restored: Collingwood Harbour, in 1994, Severn Sound, in 2003,[161] and Wheatley Harbour, in 2010.[162] Likewise, the Spanish Harbour AOC was classified as "in recovery" in 1999 and has continued to be monitored for the past decade.[163]

The majority of the sites designated by the IJC as AOCs in the late 1980's still exist as such today, rather than being re-listed as Areas in Recovery or as delisted AOC's. After over twenty years of being active, and very little progress in most areas, some may view the AOCs as being a largely unsuccessful attempt at cleaning up the environment.

The RAP process and the FBC share similarities in that they both include multiple stakeholders from the community, such as civil society and industry, as well as three levels of government. The FBC also parallels the RAPs in how they develop plans towards cleaning up problem areas in the Fraser Basin through taking an ecosystem approach and consensus building.

It is another question whether either process has been in some sense "successful". How should the FBC be evaluated? Can it be considered successful and, if so, why is this so? We shall return to these questions hereafter.

The next section examines three well-known rivers with institutions developed around managing their basins: the Murray-Darling Basin in Australia, the Danube River Basin in Central and Eastern Europe, and the Nile River Basin in north-eastern Africa. Some of these river basins share certain commonalities with the Fraser River Basin, such as being only regional (rather than international) in scope (the Murray-Darling River Basin), or winding through multiple ecosystems (such as the Nile River Basin), or hosting diverse economic activity (like the Danube River Basin). Of course, other similarities are evident between and among the four basins; one of the most prominent is that they all have institutions based on the principles of IWRM and developed around the concept of managing water at the basin level.

Australia's Murray-Darling Basin

The Murray-Darling Basin in southeastern Australia is made up of two major rivers and their tributaries, the Murray and Darling Rivers, and has 23 river valleys in total throughout the basin.[164] With a total coverage of one million square kilometres and spreading across six states, the Murray-Darling Basin accounts for 70% of irrigation that occurs in Australia and 40% of its agricultural product. According to the Murray-Darling Basin Authority, 94% of all precipitation in the Basin transpires through plants or evaporates, while four percent drains to the ocean. The last two percent soaks into the soil.[165] The total volume of runoff from the Basin to the Indian Ocean has varied. Over the past century, the river runoff to the ocean has been as low as 1.4 million m^3 and as high as 50 million m^3, with a mean of 13 million m^3 and a median of 11 million m^3.[166] In the first decade of the 21^{st} century, the Murray-Darling Basin has suffered from major environmental issues, including land degradation, salinity, bio-diversity loss, and major drought.[167]

The recent drought in the Murray-Darling Basin has spurred the Australian federal government to take measures to ensure the sustainable use of water in the basin. Although the Basin has been managed by a Ministerial Council and Commission since 1992 under the Murray-Darling Basin Agreement, in late 2008 the federal government took over management of the basin through the Murray-Darling Basin Authority (MDBA).[168] The original basin agreement, signed in 1915, was only between three of the five states that shared the main stem of the Murray River. By the 1980s, as further understanding of the interconnection between the Murray and Darling rivers developed, the two others states that share the Basin signed in to the agreement.[169]

The MDBA is a single federal government body with 300 support staff. The six-member Authority team consists of the chair, chief executive, and four part-time members whose main responsibility is to develop a basin plan that places sustainable long-term limits to water use in the basin. Employing their collective knowledge and experience in areas such as water, the environment, and natural resource management, the MDBA was to introduce an integrated water management plan in 2010 for public review and develop a final integrated water management plan for 2011.[170] The draft IWRM plan can be accessed through the main MDBA website, and there is a section for the public to access online forums, check frequently asked questions and answers, and most importantly provide feedback on the draft plan.[171]

Along with the MDBA mentioned above, there are two other groups that were formed to assist with water management in the Murray-Darling Basin. The Ministerial Council and the Basin Officials Committee were formed through the Murray-Darling Basin Agreement in 2007, and each has its own roles to play in assisting the MDBA. The Ministerial Council, made up of the federal water minister and ministers from each of the basin states, takes on an advisory role to the Authority in the development of the MDBA's plan. Likewise, the Council also plays a role in the development of policy and decision-making with issues related to critical human needs, state water shares, and the funding and delivery of natural resource management programs in the basin. Beyond these functions, the Council also has the responsibility of giving direction to the Basin Officials Committee in regards to the function and powers of the Committee.[172]

The Basin Officials Committee, chaired by a federal committee member, called a Commonwealth committee member by the MDBA, is made up of officials from the six states in the Murray-Darling Basin. Along with providing advice to the Ministerial Council, the Committee's main purpose is to implement policy and decisions made by the Council, as well as set objectives for the MDBA to achieve. Likewise, the Committee plays an advisory role to the MDBA in the development of the Basin Plan.[173]

The 2007 federal takeover of the Murray-Darling Basin, initiated through a $10B National Plan for Water Security (NPWS), was a direct response to the declining quantity and quality of water resources in the basin as a result of overuse.[174] Through the MDBA and the NPWS, the federal government is attempting to return millions of litres of water rights to the environment through the "Restoring the Balance in the Murray-Darling Basin Program" through water buybacks in the basin,[175] essentially decreasing the amount of water extracted or degraded by users. This Program, with a budget of $3.1 billion, is aimed at irrigators who are willing to sell their water entitlements.[176]

Another change that is meant to increase the quantity of water in the basin is new caps on surface water diversion. In 1997 the Murray-Darling Basin Council created caps, or upper-limits, on surface water diversion in the different river valleys in the basin. The caps were measured by 1993-94 development levels and infrastructure rules that existed during the 1993/94 period rather than merely the amount of surface water used during that time period.[177] Over the past century water use in the Murray-Darling basin has increased fivefold. This over-use combined with multiple years of severe drought in the region has led to insufficient quantities of water for a healthy environment in the basin.[178] Increasing understanding of internal and external factors that affect water resource supplies in the basin has led the federal government to create more sustainable groundwater and surface water caps, as well as to provide investment for farm irrigation infrastructure.[179]

Danube River Basin

The Danube River in central and eastern Europe, 2870 kilometres in length, connects 19 countries, some that are almost entirely within the Danube River Basin while other countries have less than 5% of their land mass within the basin. Beginning in Germany at the convergence of the Brigach and Breg Rivers, the Danube River Basin has a total of 26 rivers, each with its own sub-basin.[180] The Danube River Basin is used for navigation, irrigation, hydroelectricity, tourism and recreation, and various industrial activities.[181]

The Danube River is the main destination for a large amount of pollution from the various countries, causing water quality problems in the basin.[182] The river is the chief source of nutrients for the Black Sea where the river ends.[183] The foremost source of pollution comes from agricultural fertilizer runoff that causes increased amounts of phosphorous and nitrogen in the river. Other pollution issues in the basin include soil and groundwater contamination from ionic metals and organic pollutants in the river.[184] Due to increased discharge in the Danube River over the past few decades, the Black Sea has been experiencing increased eutrophication, or excess nutrients in the water. Further, over the past century and a half, over 80% of floodplains and wetlands in the Danube River Basin have been lost.[185]

Prior to the political changes in the late 1980s in Europe brought on by the end of the Cold War there was not much environmental cooperation in the Danube River Basin. Desires to join the European Union have been an incentive in developing cooperation on environmental issues in the Basin.[186] In 1994 the European Commission and other European countries signed the Danube River Protection Convention (DRPC), which was a culmination of efforts since 1991 to manage the Danube River Basin.[187] The main body of the Danube Convention is the International Commission for the Protection of the Danube River (ICPDR), which was formed in 1998 and encompasses one of the largest and most active bodies of IWRM experts in the world. Due to the high eutrophication in the Black Sea, one of the main goals of the ICPDR is the reduction of nutrients in the Basin.[188]

In 2000 the European Union Water Framework Directive (WFD) was created, encouraging the inclusion of NGOs and civil society in the development of national level water management plans.[189] The WFD requires every European Union member and those acceding to the European Union to utilize a basin approach to managing water, and requires every basin in the European Union to develop a basin analysis and management plan to achieve sustainable goals by 2015. Further, the WFD calls for cooperation between countries in the management of fresh water.[190]

Nile River Basin

The Nile River is one of the most famous rivers in the world. Ten countries and 300 million people share its basin[191] in North-eastern Africa. The main stem begins as two rivers, the White Nile and Blue Nile, each with a different origin. The Blue Nile begins in Ethiopia and supplies 60%-80% of the water flowing into the Nile, with only 15%-20% of the land area of the basin.[192] The White Nile begins in the Equatorial Lake Plateau that includes Tanzania, Rwanda, Burundi, Kenya, Democratic Republic of the Congo (DRC), and Uganda, and makes up the remainder of the river's overall volume.[193]

During the late 1800s the Nile River provided an estimated annual flow of 110 billion cubic meters (BCM). At the beginning of the 21st century, the annual flow has been estimated at roughly 80BCM. The majority of the issues surrounding the sharing and use of the Nile waters affect mainly Egypt, as the country is almost 100% dependent on the Nile River for its freshwater. River flows of the Blue Nile can change drastically throughout the year, with the flood season providing up to 95% of the total water in the main Nile. In contrast, the swamp areas around the sources of the Blue Nile and in large parts of Sudan cause much of the river water to evaporate before it even reaches the borders of Egypt. Due to these large fluctuations in annual and seasonal flow, there is a lot of tension between these northern African countries, and Egyptian authorities keep close watch on all upstream development along both stems of the Nile River.[194] This Egyptian concern is only furthered by the fact that Egypt's demand for water has increased over the past century as it has developed most of the hydroelectricity and irrigation potential of the Nile River.[195]

Sudan and Egypt share the first agreement over the allocation of the Nile waters, originally negotiated back in 1929, giving Egypt 48BCM's and Sudan 4BCM's annually. As Sudan developed its agriculture over the next decade, its need for more water grew. In the early 1950s Sudan demanded that the treaty between the two countries be renegotiated to provide more water rights for Sudan. After bilateral tensions subsided, the treaty was successfully renegotiated in 1959, re-estimating the annual runoff of the Nile River at 82BCMs and allocating 55.5BCMs to Egypt, 18.5BCMs to Sudan, and the rest to evaporation.[196]

Due to past and current political issues in Sudan, combined with the treaty between Egypt and Sudan, Egypt has a vested interest in Sudan staying as one country. If Sudan does split as it is about to, the current treaty that allocates the Nile waters between the two countries could be in jeopardy, and a new treaty might have to be constructed with the new Southern Sudan and Egypt if Egypt wanted access to water trapped in the interior lakes of the new Southern Sudan.[197] Egypt has pursued other options to secure the future of its water. The Egyptian government funds projects to drill boreholes in Kenya's Rift Valley as a way of assisting Kenya to use less of the water in Lake Victoria, the headwaters of the White Nile. Further, Egypt could take other actions, both covert and overt, to ensure its share of downstream water in the Nile River.[198]

With so much political tension between the countries that share the Nile River, six ministries of water came together in 1993 to create an initiative to develop ways to promote cooperation and development in the Nile. It was not until February of 1999 that the Nile Basin Initiative (NBI) was officially founded. The first five years after the initial meeting of the ministers of water were used to develop a common basis among the countries, along with creating a shared vision and action plan for the future initiative. The next two years were used to finalize the documentation. During the February 1999 meeting of the ministers where the NBI was established, the focus was on common interests and confidence building among the ministers.[199]

There are many issues in a basin such as the Nile, due in large part to the high number of riparian countries and the large number of river basin users, the different ways that the river is used, the high evaporation rate in large parts of the basin due to the arid and semi-arid climate of the different sub-basin regions, and the different political character and stages of the countries. Some of the issues that the NBI focus on are river regulation, water quality, malaria and other disease control, trade development, and protection of wildlife. Further, in order to develop further programs and research for the basin, the NBI established a database to collect all relevant information regarding the Nile Basin, such as satellite images, water and meteorological data, agricultural information, and sociological data.[200]

The structure of the NBI is much like what exists for the Danube and Murray-Darling River basins in that the NBI is mainly a government-designed and run organization. The operational structure of the NBI consists of three bodies: the Council of Ministers (Nile-COM), the Technical Advisory Committee (Nile-TAC), and the Secretariat (Nile-SEC). Nile-Com involves the ministers of water affairs for all of the Nile Basin countries. The purposes of Nile-COM are to approve programs, projects, work plans, and budgets, and provide policy guidance to riparian country governments. Nile-TAC is the Technical Advisory Committee, which as the name implies, offers technical advice and other assistance to Nile-COM. The administrative duties for both Nile-COM and Nile-TAC are performed by Nile-SEC.[201]

If followed properly, the basic principles of IWRM lead organizations to manage freshwater sources at the river basin level, include all stakeholders, and integrate both human and natural systems together in a management structure that is meant to manage freshwater holistically. Following such a process should create better cooperation among water users, lead to better management of water sources, and lead to less water use in each sector and overall better quality and larger quantities of potable water.

Analysis

The Fraser Basin and the Fraser Basin Council share some characteristics with the other basins discussed above, and their respective basin organizations, although it may not seem so at first glance. First, they all have taken a somewhat holistic approach and developed management plans in accordance with the principles of IWRM. These management plans develop tailored approaches to separate issue areas, such as agricultural pollution or the restoration of wetland habitat, yet these programs are developed as part of a larger development plan that takes into consideration the entire basin and not merely a small section or tributary of the basin. Second, each of these basins and the major rivers within them have the multiple usage, such as navigation, irrigation, recreation, industry, fishing, agriculture, and domestic uses.

The Fraser Basin also shares specific characteristics with several of the basins. Beginning with the Murray-Darling Basin in Australia, the first and most obvious characteristic that these two basins share is the fact that both are domestic, not international, in scope. As well, both basins are major economic players for the region and country. Where the Murray-Darling Basin accounts for 70% of irrigation and 40% of the Australian GDP, the Fraser Basin accounts for 80% of the provincial economic output and half of all agriculture in the province.

The Danube Basin is also similar to the Fraser Basin in that they are both singular rivers with a number of sub-basins within them. Both basins have a large amount of diverse industrial activity within basin borders. Most notably however is that both the European Union Water Framework Directive (WFD) for the Danube River Basin and the Fraser Basin Council include multiple NGOs and civil society members in the development of basin-wide management programs and initiatives.

As one of the longest and most historic rivers in the world, the Nile also offers some compelling similarities to the Fraser River. For one thing, there are many different groups of people within the Nile Basin. Similarly, the Fraser Basin is home to a vast array of different people, especially in the lower mainland and in the city of Vancouver. Much of the agricultural activity in the Fraser Basin occurs mainly downstream in the Fraser Valley, similar to the Nile where a large amount of agricultural occurs in northern Egypt to the point where Egypt has almost run out of irrigation resources. Another interesting commonality is the variety of geographic features of the two basins. They both have multiple mountain regions, desert or dry areas, forested areas, high plateaus, and deep canyons.

Differences notwithstanding, given all of these parallel features of these basins, the Fraser Basin Council may well have developed a basin management design that could fit other basins. The Council is capable of bringing together many different groups of people from a wide range of sectors both governmental and non-governmental, from a large geographic area in order to tackle many different and even opposing issues that many regional and international basins seem to also deal with. Further, geographic diversity does not seem to be an issue as the Fraser Basin encompasses forest arid and barren or desert landscapes, and a vast mountainous area. The Fraser Basin is a major economic source in Canada through both industry and agricultural activities, much like all three other basins.

However there are starkly opposing attributes of the basins that should be discussed that may shed light on whether or not the Council model would be successful in other basins. First, and by far most important, is that all three basins compared here to the Fraser have organizations that are governmental or intergovernmental in scope, whereas the Fraser Basin Council is a non-governmental organization that includes government members. As such the Council is unable itself to put its programs, projects, and policy ideas into action, but rather relies on the separate sectors and government bodies to do so.

In contrast, the Nile Basin Initiative, Murray-Darling Basin Authority, and the EU Water Framework Directive all have the ability to develop and initiate projects and implement policy, unlike the FBC that depends on committee members and stakeholder to implement decisions made by the board members. Under the EU Water Framework Directive, the countries signatory to the Danube River Protection Convention are bound by law to "cooperate on fundamental water management issues" through technical, legal, and administrative means to maintain and where possible improve the current conditions in the Danube Basin.[202] The Murray-Darling Basin Authority has direct authority to implement and enforce the Basin Plan for the Murray-Darling River Basin.[203] The Nile-Com of the Nile Basin Initiative, made up of water ministers from its ten riparian countries, approves all programs and projects and provides policy guidance for water management in the Nile Basin.[204]

Another difference between the Fraser River and the Nile, Danube, and Murray-Darling Rivers is that the Canadian Government designated the Fraser River as a "heritage river," essentially protecting the river from damming or diversion. In contrast, all three of the rivers listed above have been dammed or diverted in multiple areas for all of the usual reasons, such as water storage, flood defence, and hydroelectric power. Its heritage status however does not protect the Fraser River from industrial development along its shores, or being used for industrial or mining effluent dumping or as a destination for agricultural runoff. All of these are major issues in the Fraser Basin in various areas from the upper reaches of the basin all the way to the very developed estuary.

The Fraser River situation also differs from the other three rivers in another respect. The Nile River is the main source of water for much of the population in the Nile Basin and the only real source in places such as Egypt. The Fraser Basin, which includes all ground and surface water within the basin boundary, is also the only source of fresh water for the population of the basin. Yet the Fraser River is only one of many sources of water for the majority of the population in the basin as there are many large and small tributaries to the Fraser River, groundwater, and other surface water sources in the basin. Another difference is the Nile Basin flows by the Sahara Desert in its northern area and has seen many civil and international wars among its member states, some of which have caused major movements of refuges.

Another major difference is the international nature of both the Nile and Danube basins, as opposed to the Fraser Basin, which is a domestic river basin. This lack of a cross-border element, and perhaps potential conflicts, may very well be one of the main factors that inhibit the Fraser Basin Council's management framework from being applicable to many other basins around the globe, roughly two thirds of which are international in nature. Although the Council has been relatively successful at bringing together different government department members from the four levels of Canadian government, there has never been a need for the Council to work with foreign government bodies on the Fraser Basin.

One difference specifically between the Danube and the Fraser is the lack of intergovernmental cooperation in the Danube Basin prior to the end of the Cold War. Within the Fraser Basin there has been cooperation towards managing the river more sustainably since the 1970s, cooperation manifest in the two main managerial organizations that exist today in the basin - the Fraser Basin Council and the Fraser River Estuary Management Program. That cooperation spans nearly twice as long as what has been seen in the Danube Basin, and it might be assumed this cooperation among users and stakeholders has pushed the development of river basin management forward in the Fraser Basin. It is not to say that the Danube Basin has not seen cooperation as well, but merely that an international or even regional basin without stakeholder cooperation of some sort will find it vastly more difficult to develop any type of basin management plan.

There are also a few differences between the Murray-Darling Basin and the Fraser Basin as well. One of the most notable organizational differences is that, not only the Australian federal government control the current Murray-Darling Basin Authority (MDBA) but also that body was put in place to take over the former Murray-Darling Basin Ministerial Council and Commission. This federal organization and its takeover are in stark contrast to how things are run in the Fraser Basin. Although all levels of government are present in the 36 member FBC council, the government reps have no more say than any other stakeholder at the table.

A second major difference lies in the main programs of the two organizations. While the Fraser Basin Council seems to develop and support programs to curb the demand for water, such as the Nicola Water Use Management Program or the BC Hydro Water Smart Program, the MDBA has developed a comparatively aggressive water rights buy-back program to re-obtain freshwater from private owners such as farmers. While this program may instil a better sense of water management in the farmers, in essence the buy-back of water rights seems to be a supplyoriented project. Further, the MDBA has instituted 'caps' on water use, something that the Fraser Basin Council has not officially suggested on a scale larger than domestic use.

Although the Council does share some characteristics with similar organizations on other major river systems, and does deal with similar river management issues, the Council is lacking in certain areas. In the end the Fraser Basin Council represents more of a think tank, data collection centre, and project developer than a complete basin management organization, as it has no direct authority to implement or enforce policy changes out of the projects it develops with its stakeholders. However, as noted above, the Council does adhere to the principles of IWRM, and to a large degree this seems to have helped make the FBC successful through bringing users to the table in order to develop regional and basin wide projects.

That being stated, it is unlikely the Council's basin management structure would be successful operating on other basins around the globe. Due to its non-governmental status, regional or federal governments would not likely want to give up management power to such an organization, especially with freshwater issues becoming ever more apparent worldwide. The three international basins discussed above are clear examples of this.

Finally, although there has been a history of river and basin management in the Fraser Basin, this history does not necessarily equate to strength in the current Fraser Basin Council. Rather, the development of different and ever-expanding water management organizations, such as the FREMP, FRAP, and FBMB, seem to have led to more comprehensive projects through a greater understanding of the Fraser Basin and through the involvement of more basin stakeholders as time progressed. However, more involved stakeholders can also lead to slower management processes, and ultimately less chance of action.

In summary, the effectiveness of the Fraser Basin Council needs to be viewed in two ways. First, the FBC has faithfully applied the principles of IWRM, creating a process that is both holistic and inclusive. The FBC is holistic in that the management boundaries of the FBC are the natural boundaries of the Fraser River Basin, and inclusive by way of involving many basin stakeholders in regional and basin-wide programs and projects. This unfortunately has not led to better water quality in the basin, as suggested by the indicators used above, demonstrating that the FBC is limited in its effectiveness at managing the Fraser Basin. While this chapter analyzed the evidence regarding the questions of FBC effectiveness and FBC applicability, the next chapter will summarize these findings.

Chapter Six: Conclusions and Recommendations

The Fraser Basin Initiative and its Council have many strengths and weaknesses in terms of its effectiveness and on the question of whether or not the framework model is applicable to any other basin around the world. Likewise, integrated water resources management also has strengths and weaknesses when applied to a river basin.

Assessing Effectiveness

The Fraser Basin Council is not the first managerial organization for the Fraser River or even in the Fraser River Basin. There have been a variety of task forces, studies, development programs and initiatives that emerged over the years preceding the Fraser Basin Initiative. Studies on the state of the Fraser River have been conducted as early as the late 1970s, in time leading to the first institution for the Fraser River created to protect the river ecosystem while attempting to further economic development.[205]

Integrated water resources management as a set of principles seems attractive in theory. Yet, as a practice, it does not always succeed and it is difficult to assess whether or not it is fully functional. Whether or not an organization is adhering to the principles of IWRM, as a process and not a goal, is difficult to determine. In reviewing the literature on IWRM, as well as the history and makeup of the Fraser Basin Initiative, it is argued that IWRM can work as a planning process with the right mix of individuals and knowledge. The Fraser Basin Council does seem to apply the principles of IWRM to its everyday workings; such as including all users, taking a basin approach and taking into consideration economic and social development when dealing with issues of the environment.

To summarize, the water quality findings as measured through the six indicators pH, faecal coliforms, nitrogen, chloride, arsenic, and lead, were largely stable over time with a few exceptions. That is, there has been no long-term trend in the Basin neither toward improvement nor toward deteriorating water quality. Turbidity caused by spring flows could have accounted for many of the sudden changes in measurements, as there were strong positive correlations between some of the indicators and turbidity. Serious spikes in coliform levels were measured at most of the sites around the basin. Though short in duration, these spikes could indicate a trend towards much poorer water quality levels. For now, however, the spikes are short in duration and sporadic at best.

Likewise, the Canadian Water Quality Index for six of the seven sites in the basin was more or less stable and relatively unchanged over the measurement time periods, with the exception of one site that has seen an increase in the WQI recently. Overall, the water quality in the Fraser River Basin has not declined, or improved, since the inception of the Council. Aside from the sporadically high coliform counts in recent years, it seems that the provincial management of the basin has been relatively successful. The project and planning work done by the FBC could have contributed indirectly to this record.

The history of estuary, river and basin management that has led to the Fraser Basin Initiative and Council seems paramount in the strength of the Council and its endeavours. As one study or organization has led to the next, the knowledge and experience gained by the individuals involved have acquired a much greater understanding of how the human and natural systems in the river basin interact. The level of understanding seems to have led to more comprehensive projects.

This history is not unique, however, as two of the four basins compared in this study share the same characteristic of longevity. While the Nile has seen international cooperation of sorts between Sudan and Egypt as far back as the 1930s, the Murray-Darling Basin also had an agreement regarding the shared use of the Murray River between three of the five basin states decades before the Murray-Darling Basin Authority existed. Although not extremely important for the integration process, historical cooperation in the Nile and the Murray-Darling river systems indicates an early understanding at the governmental level of the issues in these two rivers, and may have led to attempts at solutions to those issues earlier on than other basins with similar issues.

Another factor that emerged with three of the four basins was the weakness of a non-governmental basin management organization such as the FBC. While the Nile Basin Initiative, Murray-Darling Basin Authority, and the Danube's EU Water Framework Directive are governmental in nature and government enforces the decisions they make, the Fraser Basin Council is only able to develop ideas and projects, and to make recommendations, not to put these ideas or policy initiatives into action or enforce them. It is thus limited in how effective it can be with respect to protecting the river basin.

Finally, the comparison to the RAPs in the Great Lakes Basin highlighted how some of the basic principles of IWRM can be applied to problem areas without taking into consideration the entire basin. The AOCs in the Great Lakes Basin are small areas where some sort of environmental degradation was and is taking place. This approach, while seeming to take an IWRM process, does not incorporate the basin as whole. The end goal was not to create a process by which the area and ultimately the basin were managed in a holistic and encompassing manner, but rather to fix the issues and move on. Due to a host of factors, including the inability of stakeholders to cooperate, only three of the 43 AOCs in the basin have been declassified so far. If there is any lesson to be taken from the Great Lakes RAPs it is that, even when diverse groups of stakeholders collectively attempt to solve even small-scale environmental issues, success is not guaranteed. While the FBC process has worked to some degree in the Fraser River Basin, mainly with respect to planning rather than eliminating pollution, that process is not necessarily going to work elsewhere in the world where the goal is actually to ameliorate environmental problems.

Assessing Applicability

Is the Fraser Basin Initiative's framework model for managing a river at the basin level readily applicable to other basins around the world? After reviewing all of the data set forth in this project, the simple answer is no. At best, the Fraser Basin Initiative could develop management initiatives in regional basins around the world (as they already have), and may experience limited success since one third of all major river basins are regional in scope and do not cross an international border. So far the FBC has only assisted countries in developing regional and national policy. Operating on a domestic river and on a regional scale in Canada allows the Council little experience dealing with international rivers, and other countries, however friendly or hostile. As this thesis mainly looked at the applicability of the FBC's model to international basins, further study into the applicability of the FBC basin management model on domestic basins is highly recommended.

Canada is a wealthy country, and the Council has probably experienced better financing than similar bodies that might be set up in many other less-wealthy countries. Simply put, many countries are much poorer than Canada and if the Fraser Basin Council were to attempt to assist the setup or reform of a similar approach in such countries it may not succeed due in part to limited funding, but maybe in larger part to the fact that most governments do not want to lose control over the management process. Overall the Fraser Basin is well managed as a basin in North America. As a regional basin management organization, the Council could potentially be successful as a model for certain other regional basin management initiatives around the globe. By adhering to the basic IWRM principles, such as management at a basin level, managing the basin in a holistic manner, and including all basin users in the development of a basin management plan, the Council and its predecessors have been able to create a cohesive basin management plan that could be applicable to other *non-international* basins.

Another major factor to keep in mind is that the Fraser Basin Initiative does not deal with international issues while two of the three comparison cases do involve international rivers. Two thirds of all major river basins in the world cross an international boundary, and countries that are not friendly towards one another share many of these basins. Nothing in the literature, history, projects, or actions of the Fraser Basin Initiative indicates any practical experience in dealing with countries that share the same river basin. The only international project of the Council is the Outreach Project, discussed in Chapter 1.

In sum, the Fraser Basin Council does not have the international experience needed to develop a successful, working basin management plan for a basin that crosses political boundaries. The state of the Fraser River as a heritage river has made the management of the aquatic health of the river less difficult than it might be, and there is relatively little development upstream. The economic wealth of both the region and the country have made the acquisition of funds for Council operations relatively easy. Further, the regional nature of the basin has led to a lack of international experience of the Council, and as such it is not foreseeable that the Council could develop a working management plan that could operate in an international and possibly hostile climate, such as the Nile or Jordan River Basins.

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Appendix 1 Contractual Agreement Between Parties

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