Sharing the Waters of the Red River Basin: A Review of Options for Transboundary Water Governance

Prepared for

International Red River Board
International Joint Commission

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Preface

This report was prepared under contract to the International Red River Board (IRRB), International Joint Commission, by Rob de Loë Consulting Services. Members of the project team included Rob de Loë, Ph.D. (Lead Author) and Liana Moraru (Researcher). Maps were prepared by Marie Puddister, University of Guelph, Department of Geography.

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Executive Summary

The Red River basin is an important transboundary watershed shared by the United States and Canada. Reflecting the fact that demand for water resources in the basin has not been a source of dispute to date, the flows of the Red River are not currently apportioned between the two countries. However, complacency is not warranted. The Red River's flows are highly variable on an annual and seasonal basis, and demand for water in the basin could increase in future for a host of reasons, including changes in economic development, population growth and climate change.

This study was commissioned by the International Red River Board (IRRB) of the International Joint Commission (IJC). The goals of the study were to review apportionment procedures relevant to the Red River basin, and to recommend an appropriate model. The study is based on an extensive review of two main sources of information: (1) documents and reports relating to water management in the Red River Basin, and (2) the literature of transboundary water management. Field work in the Red River Basin was not conducted.

Section 2 provides an overview of the Red River Basin's physiography, climate and water resources; population, economy and water use; and actors and institutions. This overview demonstrates that Canada and the United States face water-related problems in the Red River basin that warrant development of an apportionment agreement. Importantly, this overview also demonstrates that the two countries are well positioned to create a forward looking, innovative transboundary water governance arrangement for the Red River basin under *Boundary Waters Treaty of 1909* before a water shortage crisis occurs.

International experiences offer a rich source of insights into approaches to apportionment of transboundary water resources. An exhaustive review of the contemporary transboundary water governance literature was conducted. A key finding from this work is that transboundary water resources have, for the most part, been a basis for cooperation rather than conflict. Currently there are approximately 263 international watercourses in 145 countries. These cover almost half of the earth's land surface, and are home to approximately 40% of the world's population. A substantial body of international legal principles has been developed regarding the sharing of these resources, and a number of practical models exist. It is noteworthy that equal division of the flow of transboundary rivers is only one among six distinct apportionment models for surface water resources.

International benchmarks relating to five major concerns were identified through analysis of principles and practices relating to transboundary water governance. The five benchmarks include integration, ecosystem protection, public involvement, shared governance, and adaptability and flexibility. These were selected from among a larger set of benchmarks based on their pertinence to the question of apportionment of the water resources of the Red River basin.

Two overseas and two Canada/US case studies were analyzed in detail, with the goal of revealing insights into real-world problems and solutions of transboundary water governance. Overseas case studies included the Orange-Senqu River Basin in southern Africa, a vital resource shared by South Africa, Lesotho, Botswana and Namibia, and the Murray-Darling Basin, a critical resource shared by the Australian states of Queensland, New South Wales, South Australia, Victoria, and the Australian Capital Territory. Canada/US case studies analyzed in the report include the St. Mary-Milk Rivers and the Souris River basin. The cases demonstrated that many different ways to meet the five benchmarks exist. Furthermore, all four cases reinforced the fact that cooperative management of transboundary basins has enormous benefits for the jurisdictions that share water resources.

The report concludes with a synthesis of alternative models and strategies for apportioning transboundary waters. Considerations that define the appropriateness of the various apportionment models relative to circumstances in the Red River Basin are examined. These considerations determine the ability to create and implement the various models. Based on this evaluation, a recommended model is outlined.

Major elements of the recommended apportionment model and approach to transboundary water governance in the Red River Basin include the following:

1. A prior appropriation to meet critical human and environmental needs.
2. Rules to apportion remaining natural flows between Canada and the United States based on the principle of equitable sharing.
3. Rules regarding waters that originate in the respective countries' portion of the basin but do not cross the boundary.

This model represents a balanced approach that takes account of local circumstances (e.g., the role of the *Boundary Waters Treaty of 1909*, existing management relationships, climatic conditions and the nature of water uses). At the same time, its design reflects the five benchmarks. Thus, rather than a narrow focus on apportionment, the recommended model indicates that apportionment should occur in the context of a larger commitment to transboundary water governance. In that context, identification of overall basin-wide goals and objectives for governance, economic development, environmental conditions, and other pertinent concerns is considered the starting point for negotiation of an apportionment arrangement.

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Glossary of Abbreviations

COAG	Council of Australian Governments
dam^3	Cubic decameters
ft^3/s	Cubic feet per second
EIS	Environmental Impact Statement
IJC	International Joint Commission
IRRB	International Red River Board
ISRB	International Souris River Board
IWRM	Integrated Water Resources Management
LHWP	Lesotho Highlands Water Project
m^3/s	Cubic metres per second
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
MDBC	Murray-Darling Basin Commission
MDBMC	Murray-Darling Basin Ministerial Council
NPWS	National Plan for Water Security
NSW	New South Wales
NWI	National Water Initiative
ORASECOM	Orange-Senqu River Commission
SADC	Southern African Development Community
VNJIS	Vioolsdrift and Noordoewer Joint Irrigation Scheme

1. Introduction

The Red River basin (Figure 1) is an important transboundary watershed shared by the United States and Canada. The flows of the Red River are not apportioned between the two countries. This reflects the fact that, to date, demand for the water resources of the basin has not been a source of dispute between the two countries. However, complacency is not warranted. The Red River's flows are highly variable on an annual and seasonal basis, and demand for water in the basin could increase in future for a host of reasons, including changes in economic development, population growth and climate change. As a result, a period of extremely low flows, such as was experienced in the 1930s, could be a source of considerable stress.

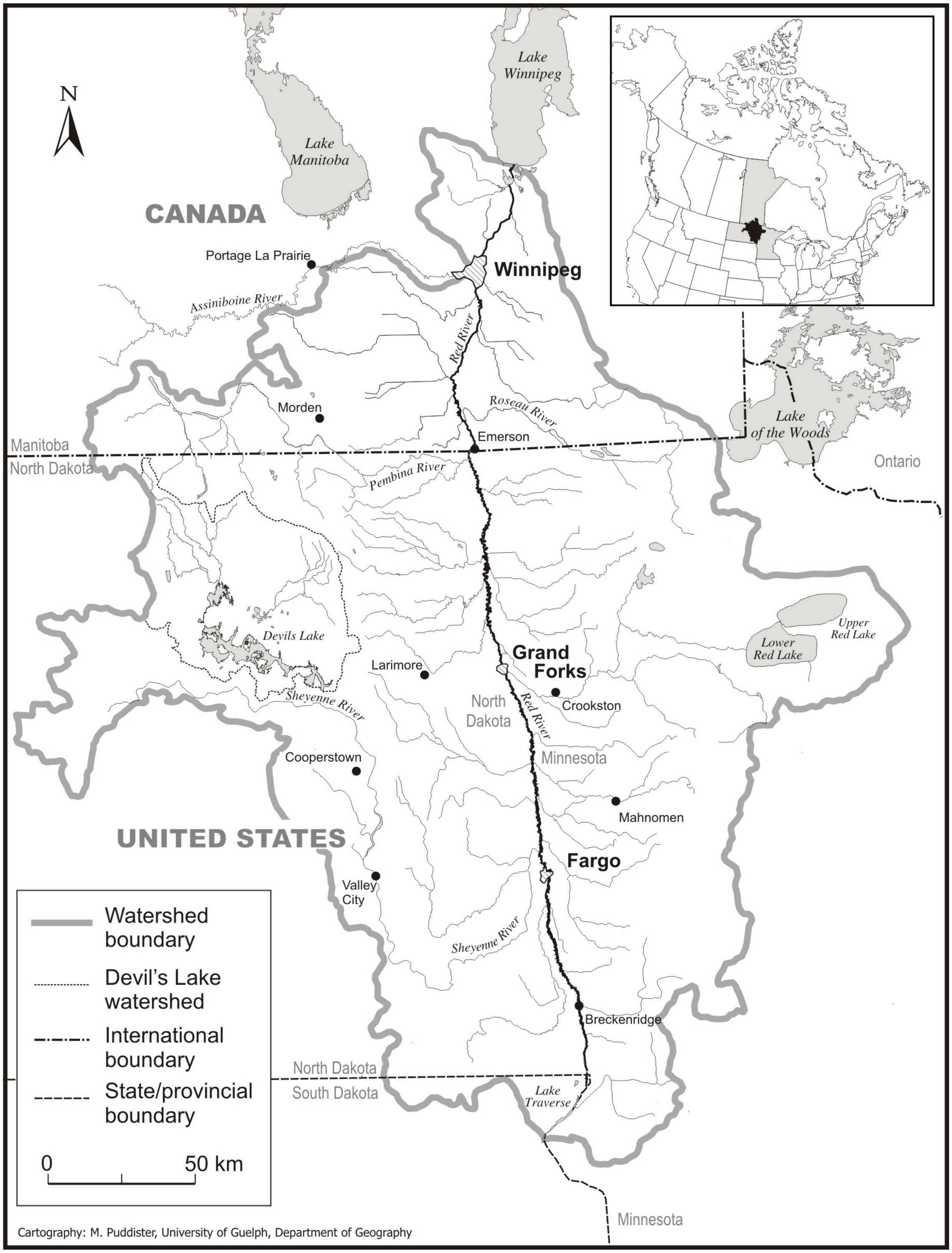
Transboundary apportionment arrangements often are created during times when competition over water is intense, and when the potential for conflict looms. This is not the ideal environment for developing lasting water sharing arrangements that increase water security and enhance cooperation between countries[92]. Canada and the US share one of the world's longest borders, and have a long and successful record of jointly managing their transboundary water resources under the auspices of the 1909 Boundary Waters Treaty and the International Joint Commission created by the treaty. Therefore, the two countries are well positioned to create a forward-looking, innovative apportionment arrangement for the Red River basin. Doing so prior to a period of low flows that leads to a dispute over water use and allocation is highly desirable.

This report presents findings from a review of apportionment procedures relevant to the Red River basin. It was commissioned by the International Red River Board (IRRB) in support of the Board's strategic water quantity objective, which states that disputes with respect to water quantity are to be avoided and, in the event that they occur, resolved in an agreement that specifies procedures for apportioning the basin's transboundary rivers at the International Boundary.

Apportioning the flow of transboundary rivers involves both *technical* and *governance* challenges.

- Technical challenges include designing flow monitoring networks; establishing appropriate standards and protocols relating to water quality, reservoir operation, and ecosystem flows; modelling basin hydrology; and developing methods that will be used to calculate flows in light of all of these considerations.
- "Governance" refers to the processes and institutions through which societies make decisions that affect water. It relates to how we decide what to do, and concerns who is involved in deciding how we decide what to do. Apportionment of transboundary water resources involves many governance challenges, including building political support; agreeing on goals and principles; deciding which levels of government, and which groups outside of governments, will be involved in decision making; and balancing scientific knowledge, public values and political needs.

Figure 1: Red River Basin



The United States and Canada, through their respective federal and state/provincial governments and other organizations, have considerable expertise and experience relating to the technical aspects of apportionment. Hence, the perspective in this study is that while the technical challenges relating to apportionment of rivers in the Red River basin are important, they are much more tractable than the governance challenges that will arise. Therefore, challenges relating to transboundary water governance are given special consideration in this report.

The report is organized as follows:

- Section 2 provides an overview of the Red River basin's climate, water resources, economy, and population. Key actors and institutions also are discussed. Major issues pertinent to apportionment are identified.
- Section 3 establishes benchmarks for transboundary water management based on international practices and experiences.
- Section 4 reviews two important international cases (Murray-Darling basin in Australia and Orange-Senqu basin in southern Africa) according to the benchmarks established in Section 3. The aim is to identify lessons and insights pertinent to apportionment in the Red River basin.
- Section 5 examines two existing Canada-United States apportionment agreements that relate to the St. Mary-Milk River basins and the Souris River basin. These existing apportionment arrangements provide valuable insights for transboundary water governance in the Red River basin.
- Section 6 presents conclusions and recommendations for apportionment of transboundary waters in the Red River basin.

2. The International Red River Basin

Problems, issues, challenges and opportunities in the Red River basin are well documented in many previous studies[70][96][130][132][161]. In this section, the focus is on concerns that specifically relate to apportionment of transboundary water resources. Background information that illuminates specific challenges is emphasized. This is not to suggest that linkages among issues do not exist. For example, wetland conservation efforts focused on habitat and wildlife conservation have implications for local and regional hydrology. Similarly, decisions about how land is used can have significant implications for water quality and quantity. These kinds of relationships are addressed throughout the report, where appropriate.

2.1. Physiography, Climate and Water Resources

The Red River basin, excluding the Assiniboine and Souris River basins, covers approximately 116,550 km^2 (45,000 mi^2) of central North America, and includes portions of the States of Minnesota, North Dakota and South Dakota, and the Province of Manitoba. Most of the basin (89%) is located in the United States. The basin itself is approximately 97 km (60 mi) at its widest point and 507 km (315 mi) in length, as measured from its southern extent at Lake Traverse, South Dakota, to its northern extent in Lake Winnipeg, Manitoba[172].

The principal river in the basin is the Red River (known as the Red River of the North in the United States). Originating in the north eastern portion of South Dakota and flowing northward, the Red River forms the border between Minnesota and North and South Dakota. Major transboundary tributaries include the Pembina River and the Roseau River in Manitoba and the Red Lake and Sheyenne Rivers in North Dakota. The Devils Lake Basin, with an area of 9,868 km^2 (3,810 mi^2), is located within the North Dakota portion of the Red River basin. It does not contribute water to the Red River system except when its level exceeds approximately 445 m (1,459 ft) above mean sea level[164], or when a controversial outlet into the Sheyenne River, which joins the Red River above Fargo, North Dakota, is operated. Due to the extremely flat topography of the basin, and the numerous mature meanders through which it flows, the actual length of flow of the Red River is almost double the straight-line distance of the basin[130].

The Red River basin has a climate that can be characterized as semi-arid, with cold winters and dry summers. Patterns in seasonal and annual streamflow in the basin reflect variability in precipitation. In broad terms, the eastern portions of the basin receive more than the western, and thus these areas produce more streamflow. Typically, 22% of annual precipitation falls as snow. In summer, precipitation often comes in the form of high intensity thundershowers, which often produce between 2.5 cm/hour and/or 7.5 cm/day (1 in/hour and/or 3 in/day) of rainfall[130].

In a typical year, the majority of streamflow occurs in spring and early summer due to melting snow, rain falling on melting snow, or heavy rains occurring on already saturated soils (Figure 2). Thus, during years of extremely low flow in the 1930s, water shortages were most severe late in the year[17]. Flows from year-to-year also vary enormously. For instance, where the Red River crosses the international boundary (near Emerson, Manitoba), annual flows have ranged from lows of 296,754 cubic decametres (dam^3) or 240,582 acre feet in 1934 to highs of approximately 11.7 million dam^3 (9.485 million acre feet) in 1997 (Figure 3). Median annual flow between 1913 and 2008 was approximately 2.92 million dam^3 (2.37 million acre feet). However, as Figure 3 demonstrates, there is tremendous variation around this amount. Across the basin, stream flows also exhibit considerable spatial variability. Volumes of flow in rivers and streams typically increase from the southwest to the northeast[130].

Groundwater is an important resource within the United States portion of the Red River Basin. The entire basin is covered with a layer of glacial drift (sand, gravel and rocks deposited by glaciers). According to the Red River Basin Board's summary of basin hydrology, aquifers are found near the land surface across the basin, while in the western portion of the basin, some groundwater also is found in bedrock aquifers beneath the layer of glacial drift[130]. The Board's study suggests that both bedrock and glacial drift aquifers are hydraulically connected to streams, in other words, groundwater provides a portion of the flow in some rivers and streams during parts of the year[130]. On balance, however, the Board's study suggests that the majority of the flow of the Red River and its tributaries is derived from runoff.

The Red River Basin Board estimated that approximately 350 water control structures exist in the basin[130]. On the US side of the International Boundary these include small reservoirs with normal capacities of less than 2.47 dam^3 (2 acre feet) operated by the Soil Conservation Service to large reservoirs operated by the US Army Corps of Engineers such as Upper and Lower Red Lakes (with a capacity of 2.22 million dam^3 or 1.80 million acre feet). Most US dams are on tributaries of the Red River. Larger structures in the US portion of the basin are used for flood control, while smaller dams are often used for soil conservation and public water supply purposes. In the Manitoba portion of the basin, the Red River Basin Board identified six reservoirs with capacities greater than 1,234 dam^3 (1,000 acre feet) and 18 smaller reservoirs with capacities of less than 1,234 dam^3 (1,000 acre feet). In addition to these reservoirs, major flood control structures exist in the Manitoba portion of the basin, including the Winnipeg Floodway, the Portage Diversion and the Shellmouth Dam[130]. The role of reservoir storage in the upstream portion of the basin should be considered in determining apportionment.

The basin's generally flat topography, combined with the climatic conditions described above, often results in serious flooding in the Red River and its tributaries. Flooding normally occurs in spring and early summer, and is exacerbated during wet periods, such as during 1966-75 and 1995-99[130]. The flood of 1997 stands out in recent memory for damage caused to communities in the basin. Following the 1997 flood, the International Joint Commission examined methods that could be used to reduce the magnitude and timing of flood flows. Several large reservoirs in North Dakota were assessed in terms of

Figure 2: Recorded Average Monthly Distribution of Annual Flows, Red River at Emerson (05OC001)

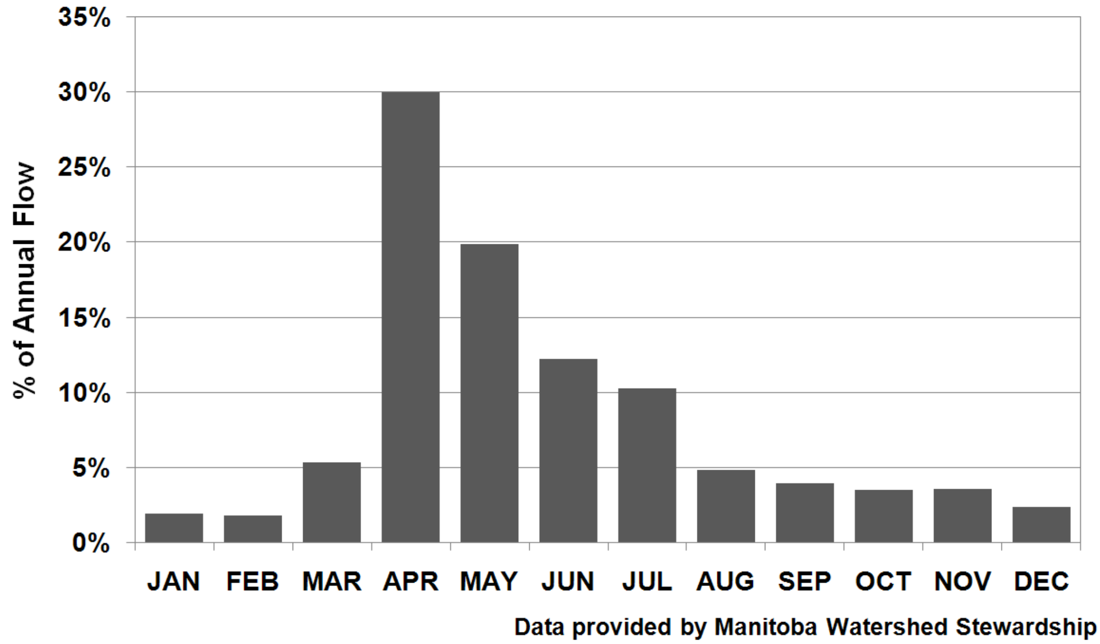
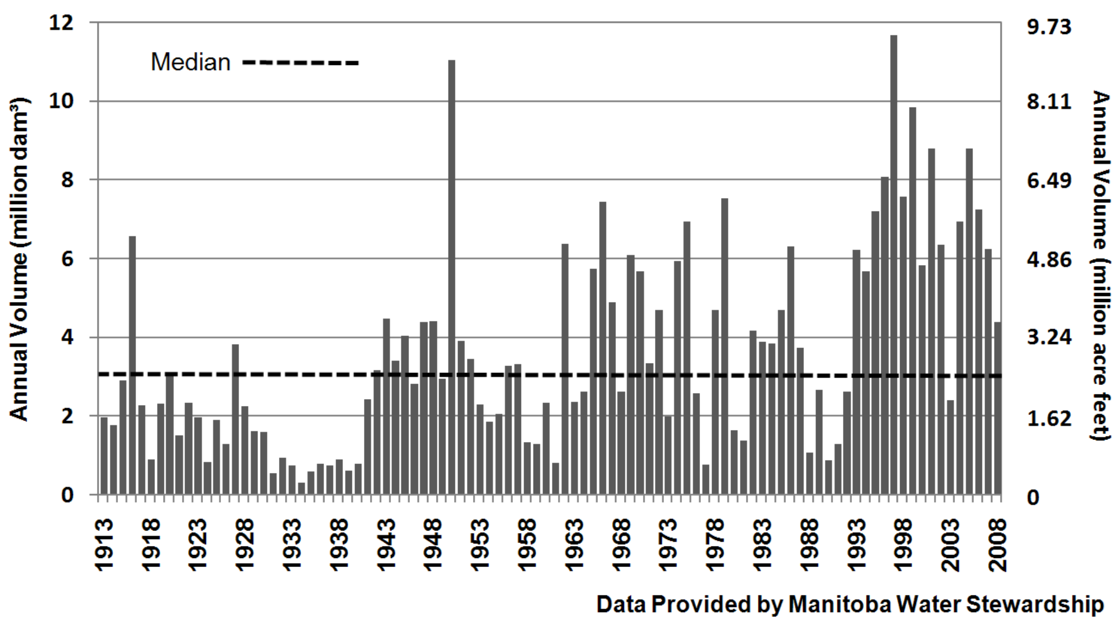


Figure 3: Recorded Annual Runoff Volumes, Red River at Emerson (05OC001)



their ability to reduce flood peaks. However, the Commission's Task Force concluded that it was not socially, economically or environmentally feasible to construct new large storage reservoirs to reduce flood peaks for major floods, and that large-scale micro-storage of flood waters on "cells" created from fields also was impractical and costly[75]. With its focus on flooding, the Task Force did not comment on the role of reservoirs in ameliorating low flows.

While flooding is a regular concern, multi-year dry periods and droughts are not uncommon in the basin. The drought that produced the famous dust bowl on the prairies during the period 1930-40 stands out, but other dry periods have occurred, including 1958-63 and 1988-1992. While devastating, the dry years of 1930-40 and 1988-92 pale in comparison to decade and century long "megadroughts" that studies of lake salinity and tree ring data show occurred regularly prior to 1200 AD[130]. This suggests that periods of extreme low streamflow linked to droughts could occur in future even under observed climatic conditions – let alone under the conditions expected due to climate change.

The potential impacts of climate change on basin hydrology are an important consideration. The Red River has exhibited a pattern of increasing flows between 1970 and 2000[17]. Based on projections of future temperature and precipitation using climate models, there are indications that the upward trend in flows observed in the basin between 1970 and 2000 could be reversed. Hence, low minimum flows such as those experienced in the 1930s could be expected late in the fall and winter due to increased evaporation. These would be compensated by increased winter and spring precipitation, which could maintain the high levels of March-July flow that occurred throughout the 1990s[17].

Water quality in the Red River basin is mixed[70][133][144]. Assessments conducted in the US portion of the basin indicate that, in general, concentrations of nitrate and pesticides are low, that wastewater discharges from municipal wastewater treatment plants do not significantly affect water quality, and that groundwater is generally potable. Nonetheless, concerns exist in some water bodies relating to pesticides, low oxygen, eutrophication, sediments, and bacteria[133]. Algae blooms in Lake Winnipeg are a significant concern, and these have been linked to phosphate and nitrogen levels in the Red River[70]. Climate change may lead to reduced water quality due to increased concentrations of pollutants during fall and winter if forecasts of reduced flows during this time of year prove accurate[17].

2.2. Population, Economy and Water Use

An estimated 1.3 million people live in the Red River basin[70], with 633,451 living in the largest city, Winnipeg, Manitoba[143]. The remainder of the urban population is located in much smaller centres. The next largest cities are in North Dakota: Fargo and Grand Forks, with populations in 2007 of 92,660 and 51,740, respectively. In the Minnesota portion of the basin, the largest cities are Moorehead, with a 2007 population of 35,329 people, and Fergus Falls, with a population in 2007 of 13,697[158]. In the Manitoba portion of the basin, the next largest populated place area after Winnipeg is Selkirk, population 9,515 in 2006[143].

Indigenous people have a millennia-long history of occupying the region[129]. First Nations with lands or traditional territories in the Canadian portion of the basin include Roseau River, Swan Lake, Peguis, Dakota Plains, Long Plain, Buffalo Point, Dakota Tipi and Brokenhead. In Minnesota, the Red Lake and White Earth reservations are located within the basin. In North Dakota, the Spirit Lake Dakotah Nation's reservation is located south of Devils Lake.

Projections of future population growth within the basin are not readily available. Projections for the three US states and for Manitoba are the most reliable starting point. The Manitoba Bureau of Statistics[101] suggests that the province's population of 1,208,000 in 2008 will increase to 1,518,100 by 2028. Previous trends suggest that most of this growth will take place in Winnipeg. In contrast, the United States Census Bureau's[159] state-level population projections show a decline due to net outmigration in North Dakota's population between 2000 and 2030 (from 642,200 to 606,566), a slight increase in South Dakota's population during that period (from 374,558 to 400,475) and a considerable increase in Minnesota's 2000-2030 population (from 4,919,479 to 6,306,130). In the case of Minnesota, most of the expected population growth may be expected to occur in large urban centres located outside of the basin, notably the Minneapolis/Saint Paul region.

How much the population of the basin will actually grow in future is an important concern that has implications for transboundary water allocation. For example, the proposed *Red River Valley Water Supply Project* is designed to provide water to a "service area" comprising 13 eastern counties of North Dakota and several small communities in Minnesota. These are located in the heart of the basin. According to the Environmental Impact Statement (EIS) for this project, the 2000 census population of the service area was 315,522, and the expected 2050 population will be 479,252[161]. Different projections are provided by the North Dakota State Data Center[120], which indicates that the 2005 population of the 13 counties in the service area (277,902 people) is expected to grow only slightly by 2020 (to 296,140 people); all of the growth is projected to occur in the two counties containing Fargo and Grand Forks, with the other counties either declining in population or barely holding steady. Given that population growth is a key part of the rationale for the project, this discrepancy is significant. Indeed, it was one of the concerns debated by the Government of Canada and the project proponent in response to the EIS[160].

The basin's economy is based on a mix of urban and rural activities. Winnipeg, Manitoba's capital city, has an economy based on a mix of service industry, manufacturing and public sector activities. Outside of the City of Winnipeg, agriculture is an extremely important economic activity in the basin. Approximately 84% of the basin's land area is dedicated to agricultural production, including rangeland; major crops grown in the basin include wheat, corn and sugar beets[70]. Sugar and corn processing firms connected to the agriculture industry are part of the basin's economy[163]. Livestock production occurs throughout the basin. Testifying to the economic importance of agriculture in the region, it is estimated that 24.9% of North Dakota's economy is based on the agriculture sector[132].

Major categories of water use within the Red River basin are municipal, industrial, rural domestic, livestock watering, outdoor recreation and fish and wildlife[93][132]. Industries in the basin draw water primarily from surface water sources, but groundwater sources also are used in the US portion of the basin[163]. Most people living in rural areas in the US portion of the basin are dependent on self-supplied groundwater. The City of Winnipeg does not use water from the basin. Instead, it receives its water supply from Shoal Lake, via a 135 km (84 miles) long aqueduct[25]. The Red River and its tributaries provide the water supply for communities such as Fargo and Grand Forks, in North Dakota; and Moorehead and Fergus Falls in Minnesota. The Pembina Valley Water Cooperative, which serves 45,000 customers in a 9,065 km^2 (3,500 mi^2) region in southwestern Manitoba, takes water from five sources: the Stephenfield Reservoir on the Boyne River, the Winkler Aquifer, Lake Minnewasta on Deadhorse Creek and two withdrawal points on the Red River at Letellier and Morris[122][134].

Per capita rates of water use in some basin communities are very high. For example, the Red River Basin Commission reports that in Fargo and Grand Forks, North Dakota, per capita water use is 464 l/person/day (123 gal/person/day) and 537 l/person/day (142 gal/person/day), respectively. In contrast, communities served by the Pembina Valley Water Cooperative in Manitoba used between 200 and 260 l/person/day[134] or between 53 and 69 gal/person/day. In a background study completed for the *Red River Valley Water Supply Project* EIS, the United States Department of the Interior suggests that the communities in the basin have found water savings of between 4.3% and 33.2% during the past 10-15 years, and that opportunities exist for further reductions (e.g., 7.1% in Fargo and 6.1% in Grand Forks)[162]. The study's authors suggested that further reductions were not realistic because Red River Valley residents already are conservative with their outdoor water use, and that the bulk of water use relates to "non-discretionary" indoor uses[162]. Further investigation of this claim is warranted given that communities in the Manitoba portion of the basin have achieved much lower per capita rates of water use.

According to a report of the Red River Basin Commission, the potential for groundwater development in the US portion of the basin is limited, and thus most communities in Minnesota and North Dakota will not be able to meet increased demands from groundwater supplies[132]. The proposed *Red River Valley Water Supply Project* is designed to address this need, but if the project includes interbasin transfers, then it is likely to be strongly opposed by Canada and other US states[70]. Whether or not demand for water in the basin will grow significantly alongside anticipated population growth and economic development clearly is an important focus for further study – especially in light of the anticipated impacts of climate change on water resources.

2.3. Actors and Institutions

The institutional environment within the Red River basin is complex. Numerous agencies and organizations inside and outside governments play various roles in water management in the basin, and should be viewed as potential participants and stakeholders in any processes designed to create a Canada-United States water sharing agreement. This section provides a brief overview designed to highlight the diversity of stakeholders. The Red River Basin Commission provides a more comprehensive list of agencies and organizations on its web site[135].

In addition to the two countries that share the basin (Canada and the United States), there are three states (North Dakota, South Dakota and Minnesota) and one province (Manitoba). Within each country, and within each state and province, many government agencies are involved in various aspects of water management and land use planning. For example, in Minnesota the Department of Natural Resources, the Pollution Control Agency and the Minnesota Board of Water and Soil Resources are involved in water and land management. In North Dakota, the State Water Commission and the Department of Health are important actors. In Manitoba, Manitoba Water Stewardship and Manitoba Conservation are key provincial agencies. At the federal level in the United States, key agencies include the National Weather Service, the Army Corps of Engineers, the Geological Survey, the Department of the Interior and the Environmental Protection Agency. In Canada, Environment Canada is involved in various aspects of water management in the basin, as are agencies such as the Department of Fisheries and Oceans and Agriculture Canada (among others). Federal agencies in both countries play critical roles in water management, data collection, monitoring, and government-to-government interaction. Tribes (United States) and First Nations (Canada) also are participants in water governance in the basin.

The bi-national International Joint Commission (IJC), and the International Red River Board (IRRB) formed under its authority, together are the most important international organizations involved in water governance in the basin. This report was commissioned by the IRRB, which will play a critical role in the development and implementation of any transboundary apportionment agreement.

Numerous non-government organizations (NGOs) on both sides of the border are involved in aspects of stewardship, wildlife conservation and water management in the basin[135]. They provide a voice that will be important in any discussion of transboundary water governance. The Red River Basin Commission is a particularly important NGO that represents people and organizations on both sides of the international boundary and takes a watershed-wide perspective. One of its flagship initiatives is the *Red River Basin Natural Resources Framework Plan*, a voluntary plan designed to provide goals and objectives for the integrated management of the land and water resources of the basin[132].

Municipalities are key agencies in the basin not only because of their role in water supply to their residents and businesses, but also because of the way that their land use planning decisions affect water resources. For example, the rationale for the proposed *Red River Valley Water Supply Project* is built primarily on the water supply needs of towns and cities. Thus, the extent to which they pursue water conservation and efficiency will influence actual (and perceived) future demands for water in the basin.

Various special purpose quasi-governmental organizations organized at the local level also exist. These include, for example, the Pembina River Basin Advisory Board; Watershed Districts and Soil and Water Conservation Districts in Minnesota; the Lake Agassiz Water Authority, Water Districts, and Soil Conservation Districts in North Dakota; and Conservation Districts in Manitoba.

Legal rules, policies and procedures for allocating water and responding to droughts are a particular concern in this study. In terms of these institutions, considerable complexity exists within the basin. Water allocation across the Canada-United States boundary is subject to the provisions of the *Boundary Waters Treaty* of 1909. Thus, an overall framework for transboundary water governance exists. However, as noted in the introduction to this report, no specific apportionment agreement exists. In contrast, distinct water allocation systems exist within each state and province in the basin. North Dakota, South Dakota and Manitoba assign rights to use water under modified prior appropriation (first in time, first in right) systems. In contrast, Minnesota's water allocation system is based on a permit system rooted in the riparian rights doctrine[70][125][131]. The existence of a Canada-US apportionment agreement may require complementary inter-state apportionment agreements in the US portion of the basin; this issue is revisited in Section 6.

Drought planning – whether linked to water allocation or as a separate activity – is underway in several jurisdictions in the basin. For example, Minnesota has engaged in drought response planning since 1989[125], while North Dakota released a drought mitigation plan, in draft form, in 2007. Manitoba is in the process of preparing a drought management plan that integrates drought response with long term water supply considerations. Several local governments also are preparing drought management plans and water conservation strategies[134].

2.4. Summary

Several key messages emerge from this brief profile of the Red River basin.

- Streamflow in the basin is highly variable, from month-to-month, and from year-to year. Flooding is a major concern, and the large volumes of water that move through the basin's rivers and streams in spring can leave the impression that water shortages are not a concern. However, it is important to remember that in an average year, flows during summer and fall (when demands may be highest) are a small proportion of total annual flows. Typically only 19.2% of annual streamflow occurs in July, August and September. Furthermore, droughts are normal on the Great Plains, and thus it is reasonable to expect that low water conditions such as those experienced in the 1930s may return, or may be even more severe. Climate change is likely to exacerbate low water conditions in late summer and fall.

- The Basin's population is growing, and available projections suggest that it will continue to grow during the next decades. How much it will grow, and in which parts of the basin growth will occur, is uncertain. However, larger towns and cities are expected to grow more than rural areas. During the drought of the 1930s surface water resources were not adequate to meet demands in some communities – and these same communities have grown considerably since that time.
- Demand for water resources in the basin is expected to grow. Both surface water and groundwater sources (in the US) are used to meet the needs of municipal systems and industrial users, but surface sources (the Red River and its tributaries) are most important. Groundwater is an important source of water for rural residents in the US portion of the basin. Uncertainty exists regarding the ability of the basin's water resources to meet future demands, especially during an extreme drought.
- In some basin communities levels of water use are very high, and considerable potential for further water savings remains. The United States Bureau of Reclamation, in partnership with the State of North Dakota, is promoting a water supply enhancement project, the *Red River Valley Water Supply Project*, to address anticipated water shortages. However, the proposed project is controversial because of its focus on interbasin transfers into the Red River basin.
- The range of stakeholders involved in water governance in the basin is vast, and includes agencies and organizations in Canada and the United States, inside and outside of governments. Governance is complex in light of the international boundary, the sheer number of people and organizations involved working at scales ranging from local to international, and the diverse legal systems in each jurisdiction. Nonetheless, there is evidence of a strong desire within the basin to integrate land and water management regardless of institutional barriers.
- The specter of low flows similar to those experienced in the 1930s has already prompted one major investigation of water supply alternatives that has significant transboundary implications. Recent high annual flows may give the impression that water resources in the basin are adequate to meet human demands and environmental needs. However, as demonstrated by Figure 3, naturally occurring low flows are normal and, statistically speaking, will return at some point and could be worse than previously recorded events; climate change may well guarantee future low flows. Thus, concern for apportionment of transboundary water resources in the basin is appropriate.

Taken together, these points highlight the need to develop an apportionment arrangement for the Red River basin. Transboundary apportionment arrangements often are created during times when competition over water is intense, and when the potential for conflict looms. This is not the ideal environment for developing lasting water sharing arrangements that increase water security and enhance cooperation between countries. Canada and the United States have a long and successful record of jointly managing transboundary water resources. Therefore, the two countries are well positioned to create a forward looking, innovative transboundary water management arrangement for the Red River basin *before* a crisis occurs. Recent flow conditions certainly create a better atmosphere for the negotiation of an apportionment agreement than would be the case during the potential lower minimum flow conditions that are projected for future decades.

3. Principles and Best Practices for Transboundary Water Governance

Water is a challenging natural resource. It exists as a liquid, a solid and a vapour, and it behaves differently depending on where it is located in the hydrological cycle. In rivers and streams, it flows rapidly across the landscape. It can reside in lakes and wetlands from days to centuries. In aquifers, it can move slowly, or (in terms of human time scales) not at all. Water is essential for human well being – necessary for life, and critical for countless economic activities. At the same time, it is an integral part of ecosystems. Most importantly for this study, water does not respect administrative divisions created by human beings. Because it resists being captured and cannot be tied easily to specific properties, water that flows in rivers and streams is known as a "fugitive" resource[138]. It crosses our borders and boundaries with impunity. Thus, what happens in one part of a watershed affects people and the environment in other parts of the watershed – regardless of whether or not they are in the same country. This is especially evident in cases where upstream users pollute or divert water: impacts will be felt directly by downstream users.

This section provides a brief overview of key concerns relating to international transboundary water sharing. Many of the same concerns that exist in an international context are pertinent in the context of water sharing between jurisdictions within a country, e.g., provinces in Canada and states in the United States[44][103]. Nonetheless, because the focus of this study is Canada-United States water sharing, the emphasis is primarily, but not exclusively, on contemporary and emerging goals, principles, methods and models of international transboundary water governance. The global trend is towards transboundary water governance arrangements that address a broader range of considerations than simply dividing flows, assigning navigation rights, or establishing water quality standards. Hence, this section draws attention to ways in which apportionment agreements can be a platform for joint or communal management of shared water courses that enhances mutual water security. The section concludes with a synthesis of major themes that can be used to evaluate the extent to which specific water sharing arrangements reflect current and emerging principles and practices. The framework that results from this synthesis is used in Sections 4 and 5 to explore case studies.

3.1. Sharing Water Within and Between Jurisdictions

Apportioning scarce water resources *within* sovereign jurisdictions is a major challenge, and numerous distinct legal systems have been developed to perform this task[102]. Important examples relating to surface water in North America include the riparian rights doctrine on which Minnesota's water allocation law is based, and the prior appropriation doctrine that underlies water allocation in Manitoba, North Dakota and South Dakota. The former doctrine establishes the right of riparians (people who own property adjoining rivers, streams and other flowing water bodies) to use water, along with concomitant responsibility to not compromise unduly the rights of other riparians. The latter doctrine assigns rights to use water based on the time the use began – with earlier users having precedence over later users. Separate legal doctrines sometimes exist for groundwater[148]. For example, the rule of capture can be important in jurisdictions whose water allocation systems are grounded in British common law[113][123]. In many jurisdictions, statutory water allocation systems have been layered onto these doctrines. For example, in Minnesota a statutory permit system supplements the common law doctrine of riparian rights[148]. Similarly, in Texas the common law rule of capture defines rights to groundwater, while rights to surface water are defined by a statute based on the prior appropriation doctrine[151].

Allocating water within jurisdictions in ways that reflect water's importance for ecosystems and human societies, and which integrate water allocation with related concerns such as land use planning, is very challenging. However, sharing water *between* jurisdictions having sovereignty over water, as occurs between Canada and the United States, adds another level of complexity. International law recognizes that states sharing a basin have an inherent right to a fair share of the joint resource[149]. However, determining what a "fair share" is can be challenging. Additionally, the laws of one country do not apply in neighbouring countries and, in general, no external higher authority exists to resolve disputes through enforceable rulings. This problem also exists between states or provinces having ownership over water in a federation, although to a lesser degree because overarching dispute resolution rules and procedures may exist (e.g., courts, federal agencies, constitutions).

Currently 263 international watercourses in 145 countries cover almost half of the earth's land surface; these are home to approximately 40% of the world's population, and they generate around 60% of the global flow of fresh water[100]. As more countries were created from the break up of existing ones, and as mapping technology improved, the number of shared international basins has increased[62][170].

The number of international water treaties that has been negotiated to address shared water resources is vast. In a survey published in 1984, the Food and Agriculture Organization of the United Nations identified more than 3,600 treaties that were created between 805 AD and 1894 AD, most focusing on navigation[59]. Many more have been created in subsequent years. As a result, approximately 40% of the world's international river basins are covered by cooperative treaties or agreements that address one or more transboundary concerns[62][100].

International water treaties and other arrangements address a range of concerns important to the specific parties involved, including division of flow, navigation, infrastructure, flood control, irrigation, hydro-power development, and water quality[62]. Some have created special organizations for joint implementation agreements. The *Boundary Waters Treaty of 1909,* between the United States and Great Britain (for Canada), is recognized internationally as a leading example of a treaty that includes a robust joint management organization (the International Joint Commission)[44]. However, many of the agreements that exist in international basins are "partial", in that they address only a limited number of concerns (e.g., apportionment, but not water quality), they focus on only one part of the hydrological cycle (e.g., surface water, but not groundwater), or they do not involve all countries that share the watercourse[62][100]. Agreements that promote truly integrated management of transboundary watercourses are uncommon[28].

The international community has long recognized the need for overarching principles and guidance for the management of international river basins (Box 1). Arguably the most important example in the context of this report is the 1997 *United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses* (the "UN Water Convention") – a product of decades of work by the United Nations. This "framework" convention reflects a broadly-based international consensus on how water should be shared. It establishes rules and principles that can be adopted and adapted in treaties or agreements for specific international watercourses[105]. Chief among these are commitments to the following:

- equitable and reasonable utilization and participation
- not causing significant harm to other watercourse states
- cooperating with other watercourse states to achieve optimal utilization and protection of international watercourses
- regular exchanges of data and information, and
- equality among types of uses.

Taken together, broad principles such as the ones contained in the UN Water Convention showcase a consensus that is emerging in the international community that transboundary watercourses should be managed *cooperatively* to maximize joint benefits, rather than *unilaterally* and competitively[68][124][149]. Even though the Convention has only been ratified by 16 countries (not including Canada and the US), and is thus 19 short of the number required for the Convention to enter into force[100], it is already influencing actual transboundary governance practices. For instance, the UN Water Convention

Box 1: Conventions and Declarations Relating to Transboundary Water Governance

Numerous examples exist of attempts by the international community to formulate overarching principles for the management of international river basins through conventions and declarations. Major examples include the following:

- Madrid Declaration on the International Regulation regarding the Use of International Watercourses for Purposes other than Navigation (1911)
- Helsinki Rules on the Uses of Waters of International Rivers (1966)
- Dublin Statement on Water and Sustainable Development (1992)
- United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses (1997)
- Ministerial Declaration of The Hague on Water Security in the 21st Century (2000)

influenced the form of the 2003 *Revised Protocol on Shared Watercourses of the Southern African Development Community*[104] (see Section 4.2).

3.2. The Importance of Cooperative Management

The concept of *water security* has emerged as a key rationale for cooperative management of transboundary water resources. Water security exists "when sufficient water of good quality is available for social, economic and cultural uses while, at the same time, adequate water is available to sustain and enhance important ecosystem functions"[35]. Achieving water security requires balancing human social and economic needs for water with ecosystem requirements. Water security is undermined in transboundary basins when jurisdictions are in conflict over their shared water resources.

Ismail Serageldin, a former Vice President of the World Bank, famously stated in 1995 that "if the wars of this century were fought over oil, the wars of the next century will be fought over water – unless we change our approach to managing this precious and vital resource"[140]. Armed conflict, specifically over shared international water resources, is actually quite rare. Instead, water's role in transboundary settings has overwhelmingly been to bring nations together, rather than to lead them into war[169]. Nonetheless, conflict in other forms is a concern. For instance, jurisdictions that share a water resource can engage in lengthy legal battles that consume tremendous amounts of time and energy, and thus divert attention away from integrated management of the whole basin. The "Tri-State Water Wars"[83] involving Georgia, Florida and Alabama are an example. This dispute began in 1990 when Georgia sought additional water for Atlanta from Lake Lanier, a reservoir on the Chattahoochee River in the upstream part of the basin. With the failure of negotiations over equitable apportionment of the shared watercourses, the parties turned to the courts – a decision that Draper predicted in 2006 would be perilous[44]. His prediction has been realized by the State of Georgia. On January 12, 2009, the Supreme Court ruled against Georgia, with the result that an agreement between Georgia and the US Army Corps of Engineers to take additional water out of Lake Lanier to supply Atlanta was declared illegal[38]. After almost two decades, the parties must now turn again to negotiation to resolve the dispute.

These kinds of conflicts in transboundary basins are likely to become more common. Pressure on water resources is increasing all over the world from population growth, economic development and climate change. Unilateral action to address water-related problems in transboundary basins may seem appealing, but evidence from around the world is overwhelmingly in favour of negotiated solutions and collaboration rather than conflict and competition[100][170]. Fundamentally, this results from the fact that the parties involved are sharing an incredibly complex socio-ecological system. In shared watersheds, environmental, economic and social interests exist that almost always can be maximized for all parties through cooperation[165][170]. As is illustrated in the following examples, this is true when the water resources in these basins are stressed, and when they are not.

- Equitable apportionment arrangements are the most effective way to ensure adequate amounts of water, of appropriate quality, are available for human and environmental needs in the entire basin.
- During times of shortage due to drought, apportionment agreements are a way to allocate the risk of scarcity among the parties involved. They are also a way of deciding how the risk of shortages that constrain future economic development will be shared[44].
- Well-designed apportionment agreements bring clarity and reduce uncertainty – key concerns in the context of short- and long-term economic development. The absence of well designed apportionment arrangements is felt most keenly during times of water shortage, when there are no rules that spell out the rights and responsibilities of each nation sharing a basin[170].

In addition to these direct benefits of cooperative management, experiences from around the world show clearly that joint or cooperative management of shared water resources has numerous additional benefits. In particular, cooperative management of shared basins can reduce the potential for conflict by (1) creating opportunities and forums for joint negotiation, which can ensure that interests are taken into account when key decisions are made; (2) allowing different perspectives and interests to emerge, which can reveal new options and solutions; (3) strengthening or creating trust and confidence through collaboration on tasks such as data collection and joint fact-finding; and (4) producing decisions that are more likely to be accepted, even in the absence of consensus, because stakeholders were involved[170]. In fact, cooperative management of transboundary watercourses has, in numerous instances, led to increased cooperation on other cross-border concerns[62][156]. For instance, stakeholders in the Great Lakes Basin view themselves as a community with shared interests, and this is largely attributable to the *Boundary Waters Treaty of 1909*[82][171].

3.3. Approaches to Sharing Water

In this study, the focus is on the specific transboundary issue of apportionment. In that context, three main types of agreements can be identified[92]: (1) agreements that countries create to specify broad rules and principles for cooperative management of water resources, but which do not specifically apportion flows; (2) agreements that specifically apportion flows between jurisdictions sharing a water resource; and (3) agreements for joint or communal management of shared water courses, which may include actual apportionment. The focus typically is on apportioning the actual flow of water in most agreements, but some agreements also address apportionment of benefits[149]. Numerous examples of the first two types of agreements exist; the third is much less common because it demands that jurisdictional boundaries be downplayed in the search for collaborative, integrated basin management[103]. However, as noted above, this type is becoming more common.

Specific concerns that can be addressed in apportionment agreements are identified in Box 2. Reflecting the world-wide trend to comprehensiveness, contemporary agreements are including more of these elements than has been the case in previous years. For example, provision of water for the maintenance of ecological flows was not a concern in agreements negotiated early in the 20th century, but is a critical concern today. Other positive trends in more recent treaties include attention to water quality as well as water quantity; greater recognition of the need for monitoring, evaluation, data exchange, and conflict resolution; more frequent use of joint decision making bodies with enforcement powers; and greater efforts to include all basin countries[62]. To some extent, these trends speak to the success of initiatives such as the 1997 *United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses*.

Box 2: Common Elements of Apportionment Agreements

- Parties to the agreement
- Proportion or amount of flow (volume, level) that will be received by each party as measured at specific locations and during certain times, seasons or conditions
- Proportion of benefits from water development that will be received by each party
- Provisions relating to concerns such as water quality, salinity, habitat enhancement, ecosystem flows, riparian users, desired "natural" flows, conjunctive management of transboundary groundwater and surface water resources, and projects and activities that affect flows
- Methods for measuring or estimating flows
- Rules regarding operation of infrastructure
- Requirements for monitoring and reporting
- Contingency plans for situations such as droughts and floods
- Dispute resolution procedures
- Benefit sharing arrangements, including payments and future development rights
- Data sharing arrangements
- Review mechanisms, e.g., mandatory review at defined periods
- Procedures for public consultation and involvement
- Mechanisms for joint decision making

Sources:[43][44][62][92][149][170]

In terms of specific methods or strategies for apportioning surface water and groundwater resources, a relatively small number exists in practice[44]. As suggested earlier, two main strategies pertinent to surface water are commonly identified: *sharing the flow* and *sharing the benefits*[68][149]. In the former, parties divide the dependable flow of a river, while in the latter strategy, they divide the benefits that result from using the water. Both of these strategies are ways of implementing the international legal principle of *equitable utilization*.

A recent study for the American Society of Civil Engineers[44] characterized major apportionment strategies as shown in Box 3. Distinct strategies exist for surface water and for groundwater. A comprehensive strategy also exists that can be used to manage transboundary surface water and groundwater resources simultaneously. Of course, combinations of these strategies also can be used in the same agreement. Importantly, the strategies in Box 3 are not theoretical models. Rather, they reflect real-world practices that can be seen in actual agreements. For example, the *Upper Colorado River Basin Compact* is an example of apportionment based on percentage of flow, while the *Delaware River Basin Compact* is an example of the comprehensive basin management approach. The 1961 *Canada-United States Columbia River Treaty* is a well known example of the benefit sharing approach.

3.4. International Benchmarks

Building consensus on basic principles for transboundary water sharing has been the major focus of international initiatives such as the 1997 UN Water Convention. The expectation is that the parties responsible for devising treaties, compacts or other arrangements for sharing the water resources of specific basins will respect principles such as equity, cooperation, and not causing harm to other basin states. However, it is understood that they will have to create detailed implementation strategies pertinent to their own circumstances. For this reason, the UN Water Convention is silent on several specific issues that are considered critical in the contemporary literature. To illustrate, the Convention does not indicate whether or not transboundary water management should involve parties apart from the national governments of the basin countries themselves (e.g., citizens, non-government organizations, local governments, state/provincial governments). Similarly, it recognizes that climate is a consideration that should be considered when deciding whether or not water resources are being apportioned in an equitable and reasonable manner, but it does not emphasize that apportionment strategies should be flexible and adaptable in light of climate change.

This section discusses benchmarks for effective transboundary water management that add to the basic principles discussed in previous sections. It draws on contemporary literature from the fields of transboundary water management, water governance, climate change, water security, and international water law. Benchmarks discussed include the following:

- Integration
- Ecosystem protection
- Public involvement
- Shared governance, and
- Adaptability and flexibility.

Box 3: Apportionment Strategies

Surface Water

- *Guaranteed quantity at a point*: Upstream parties guarantee that a fixed volume of water will pass certain points at particular time periods. Accurate knowledge of flow history is needed, and upstream parties bear the risk during water shortages. Surpluses beyond specified amounts may be divided under agreements.
- *Percentage of flow*: Water is divided based on fixed percentages or formulas based on flow levels. Accurate data and monitoring are needed, but risk is shared among parties.
- *Priority of particular demand*: Uses are prioritized, and quantitative limits are established for each use in the basin. Economic value of water must be known, and basin must be treated as an integrated whole.
- *Storage limitations*: The amount of water that upstream parties may store in reservoirs is identified on annual, seasonal or other time periods. Withdrawals below reservoirs are not necessarily regulated, and in some years only enough water to fill reservoirs may be available.
- *Hydrological models*: River flows are modelled, and variations in precipitation amounts across the basin are accounted for. Available water is shared based on schedules derived from the models. If the models are accurate, then apportionment is based on actual conditions.

Groundwater

- *Maximum withdrawal rate*: Instead of dividing the water itself, the parties agree on extraction limits. The strategy is only effective if total withdrawals are less than recharge rates (which therefore must be known).
- *Planned depletion*: Water is withdrawn from aquifers based on economic efficiency, and without regard to recharge. Where recharge is limited or non-existent, the parties treat the aquifer as a non-renewable resource.
- *Hydrological models*: Parties share groundwater based on water budget models that characterize recharge and discharge on annual, seasonal or other time-based periods. Allocation of available water occurs based on schedules derived from the model. System is most effective when recharge is rapid, and when models accurately establish available water.

Comprehensive basin management

- An independent commission supervised by the parties provides comprehensive, basin-wide watershed management. Surface water and groundwater interactions can be addressed, as can water quality and quantity concerns, drought contingency planning, water conservation, and instream flow needs.

Source:[44]

These were selected based on their pertinence to the question of apportionment of the water resources of the Red River basin. In that sense, they should be viewed as a subset of a much larger group of concerns that can be reflected in arrangements for transboundary water sharing, e.g., peace and security, and gender equity[47][67].

Integration

Integration should be a key focus of water management at all scales. In the context of transboundary water management, integration is a particularly important concern because the parties involved are sharing *watersheds*, which are extremely complex socio-ecological systems. As noted in Section 3, watersheds naturally connect human activities over time and space because actions in one part of the watershed will be felt in others. For example, in many parts of the world, aquifers contaminated by industrial activities in one part of a watershed have contaminated drinking water supplies several decades later and many kilometers away from the original activity[81].

Numerous concerns can be, and should be, integrated when devising arrangements for transboundary water management. At a minimum, arrangements should strive to ensure that decisions regarding the following are made in an integrated fashion, rather than in isolation from each other[13][23][52][62][114][124]:

- *Surface water and groundwater interactions* (e.g., impacts of groundwater takings on baseflow, impacts of surface water takings on recharge)
- *Land use planning and water management* (e.g., extent to which land use changes transform hydrology; availability of water supplies for urban development)
- *Human and environmental water needs* (e.g., impacts of surface water withdrawals for human uses on aquatic ecosystems)
- *Water quality and water quantity* (e.g., extent to which water takings contribute to decreased water quality; degree to which water quality affects availability of supplies for agricultural uses), and
- *Economic development and water management* (e.g., relationships between water availability and the viability of regional economies).

Planning and management based on watersheds is widely recognized as the most effective way to promote integration of these concerns[33][44]. However, even proponents of watershed- or basin-based management recognize that this is a challenge. Not only do watershed boundaries rarely coincide with political and administrative boundaries, but also they often fail to capture all relevant stakeholders[147] and are not necessarily a meaningful frame of reference for all stakeholders[3][12][56]. These concerns should be recognized in transboundary water sharing arrangements that are based on watersheds.

Ecosystem Protection

Improving or maintaining environmental conditions has become a key goal of contemporary transboundary water management[149]. Concerns include improving or maintaining flows to protect fish and fish habitat (quantity, timing)[48][136][139]; sustaining or improving critical riparian habitat, such as wetlands and floodplains[16]; and achieving water quality objectives for ecosystem needs[141].

Concerns for ecosystem protection can be addressed to some extent in efforts to ensure integrated watershed management. However, special attention to these issues is warranted. For example, aquatic ecosystems have very specific needs in terms of the timing, volume, temperature and quality of flows[48]. It is possible to devise an apportionment scheme that provides water to satisfy some environmental values (e.g., fish habitat), yet still does not meet other relevant ecological water needs (e.g., the needs of riparian vegetation). Therefore, in many jurisdictions a systematic approach focused on a broad range of environmental water needs is being used. For example, in New Zealand a distinction is made between *environmental flows* and *ecological flows*. Ecological flows are the flows and water levels that are needed in water bodies to provide for the ecological integrity of fauna and flora that are present both in those water bodies and in their margins[118]. In contrast, environmental flows are the levels and flows of water in water bodies required to meet values that are established through regional planning or statutory processes.

The science of ecological flow assessment is relatively new. Nonetheless, sufficient understanding exists to permit parties devising and implementing apportionment agreements to address those needs. Importantly, while ecological flow assessment is largely a scientific activity, decisions about the desired health and status of ecosystems cannot be made only by scientists; these are in many respects political decisions that require public involvement[48][118].

Public Involvement

International transboundary water management requires negotiation between and among sovereign states. Therefore, national governments clearly are dominant players in international transboundary water management. It is for this reason that the UN Water Convention only refers to "states", and defines "participation" in terms of the involvement of all states that share a basin. However, in the wider water management field the need for, and desirability of, public involvement in transboundary water governance has emerged as a central concern[1][19][20][39][48]. This reflects both normative principles and practical realities.

In terms of principle, it is difficult to imagine implementing a goal such as equitable sharing of water resources without involving people who are affected. Therefore, modern transboundary water management arrangements commonly include some provisions for public involvement[44] simply on the basis of international norms. However, pragmatic reasons for public involvement also exist, including the following:

- Decisions about water – who has access, how much will users receive – have major economic implications. Therefore, water management is inherently a political activity[145][167]. Involving members of the public – especially people who are politically weak – is therefore critical not only for equity, but also to reduce the potential for future political conflict.
- Citizens and environmental groups are no longer prepared to leave decision making about something as fundamentally important as water to governments. Therefore, in many jurisdictions they are increasingly turning to the courts to resolve disputes, or to force governments to take specific actions regarding pollution, protection of ecosystems, and other concerns[51].
- Top-down, centralized decision making in the context of extremely complex systems such as transboundary watersheds is not conducive to effective water management[44]. Sovereign states often lack the capacity to manage such complex systems[85]. Additionally, involving a broad range of interests usually is necessary simply to ensure that decisions reflect different viewpoints, concerns, knowledge and perspectives.
- Implementation of many water management objectives occurs through the actions of private citizens. For example, meeting water quality targets in a transboundary agricultural watershed requires the cooperation of farmers. Therefore, farmer willingness to cooperate may be a key determinant of the success of a transboundary water management arrangement created by national governments[42].

Shared Governance

Concern for the role of the general public is related to a larger discussion of ways in which responsibilities for water governance can be, and should be, expanded beyond senior governments, e.g., to include local governments, non-government organizations, and citizens[157]. In this context, the term "governance" refers to the processes through which societies make decisions that affect water[35]. In an environment of shared or distributed governance, the state (e.g., federal or provincial/state governments) shares or even lets go of some of its authority[36]. This is distinct from the state *consulting* citizens and then deciding what to do (as is common in the context of public participation).

Proponents of distributed water governance argue that involving actors beyond government agencies has numerous potential benefits, including decisions that better reflect local circumstances and needs[119]. Of course, serious concerns also exist about accountability and capacity in this more complicated governance environment[167]. Nonetheless, distributed governance is an important objective if the goal is integrated basin management. Ultimately, achieving integrated management of transboundary river basins may require that the influence of political boundaries – even national boundaries – is reduced so that a basin-wide perspective can be adopted[103]. National governments alone clearly cannot create this perspective because jurisdiction over so many pertinent aspects of integrated water management lies with sub-national governments (such as provinces in Canada and states in the US), municipalities, special purpose water management agencies, and private landowners.

Adaptability and Flexibility

Water managers have always had to deal with daily, seasonal, and annual changes in precipitation, streamflow, lake levels and other characteristics of the water cycle[24][107]. A key factor contributing to their ability to successfully adapt has been the predictability of climatic variability[84]. Unfortunately, due to climate change it is no longer possible to assume that future climatic variability will be consistent with observed variability[111]. Even aggressive mitigation of CO_2 and other greenhouse gas emissions will only slow the rate of climate warming[73]. This means that a new "predictable envelope of variability" is unlikely to emerge[10][111]. As a result, water managers will have to find ways to deal with much greater complexity and uncertainty than has previously been experienced[45][86].

Climate change is, of course, only one source of uncertainty with which water managers must deal. Other important drivers include natural variability, new demands for water originating from population growth and economic development[90][109]; new societal expectations regarding governance, the goals of management, and ecosystem conditions[62]; new actors (inside and outside of shared basins)[62][147]; and new or changed scientific understanding of key processes[46][106]. Therefore, it is increasingly recognized that water management systems should be designed with *adaptability and flexibility* in mind[121].

From the viewpoint of transboundary water sharing, it is critical that apportionment methods permit flexibility, to respond to unforeseen circumstances that were not conceived of when the rules were drafted, and adaptability, to accommodate changes in flows, demands and other key considerations such as the needs of the environment[57][106][165]. Unfortunately, many of the world's existing agreements recognize seasonal variability, but do not account for year-to-year variations, extreme events and climate change, and the possibility of shifts in demands, practices and expectations[90]. Apportionment arrangements that ignore basic considerations such as inter-annual hydrological variability, drought, or the nature of environmental water needs, for example, by only specifying fixed amounts of water, do not meet this test[62]. In contrast, flexibility and adaptability can be enhanced in apportionment arrangements through periodic reviews; limited terms; special provisions for meeting environmental water needs; mechanisms for dealing with extreme circumstances such as droughts; information sharing; and the creation of organizations that are empowered by the parties to make adjustments in response to changing circumstances[2][106][139][165].

3.5. Summary

In the international transboundary water management literature specifically, and in the water management literature generally, a broad consensus is forming around key principles and best practices for transboundary water sharing. These reflect emerging international norms as well as collective experiences acquired through the development and implementation of hundreds of transboundary water management arrangements created in countries around the world.

The literature contains extensive advice regarding the design and implementation of transboundary water management agreements. In Section 3, the focus is on principles and best practices that seem most relevant to the circumstances of the Red River basin. Some concerns prominent in the literature were not pertinent, for instance, it was not necessary to discuss the merits of creating an organization for joint management of transboundary waters because one already exists – the International Joint Commission.

Principles and best practices discussed in this section should be treated as benchmarks for transboundary water governance in international river basins. In summary, these included the following:

- Extent to which core principles of contemporary international water sharing are addressed, including equitable apportionment and cooperative management.
- Recognition of key interrelationships that should be addressed in an integrated fashion (surface water and groundwater; land use planning and water management; human and environmental water needs; water quality and water quantity; economic development and water management).
- Protection of critical ecosystem functions, including instream flow needs for fish and fish habitat, and water quality objectives.
- Involvement of members of the public in decision making relating to transboundary water governance.
- Distribution of responsibility for governance beyond national governments.
- Adaptability and flexibility of water sharing arrangements.

Translating principles and best practices into real-world transboundary water management arrangements is a daunting task. Therefore, the next section examines two international case studies of transboundary water governance that involve water sharing. The goal is learning lessons from their experiences that are pertinent to the Red River basin.

4. International Case Studies

This section presents two case studies of transboundary water management in two critical international basins: the Murray-Darling Basin (MDB) in Australia, and the Orange-Senqu River basin in southern Africa. These basins were chosen based on their potential to offer useful insights into the issues raised in Section 3. In each case study, severe challenges are being addressed through major reforms to water laws and policies within countries, and to transboundary water governance arrangements in shared basins.

For each case study the following topics are addressed:

- Contextual factors (physiography, climate and water resources; population, economy and water use; water governance)
- Arrangements for transboundary water management (agreements; approaches to transboundary water governance; main features of agreements)
- Extent to which the international benchmarks discussed in Section 3.4 are addressed.

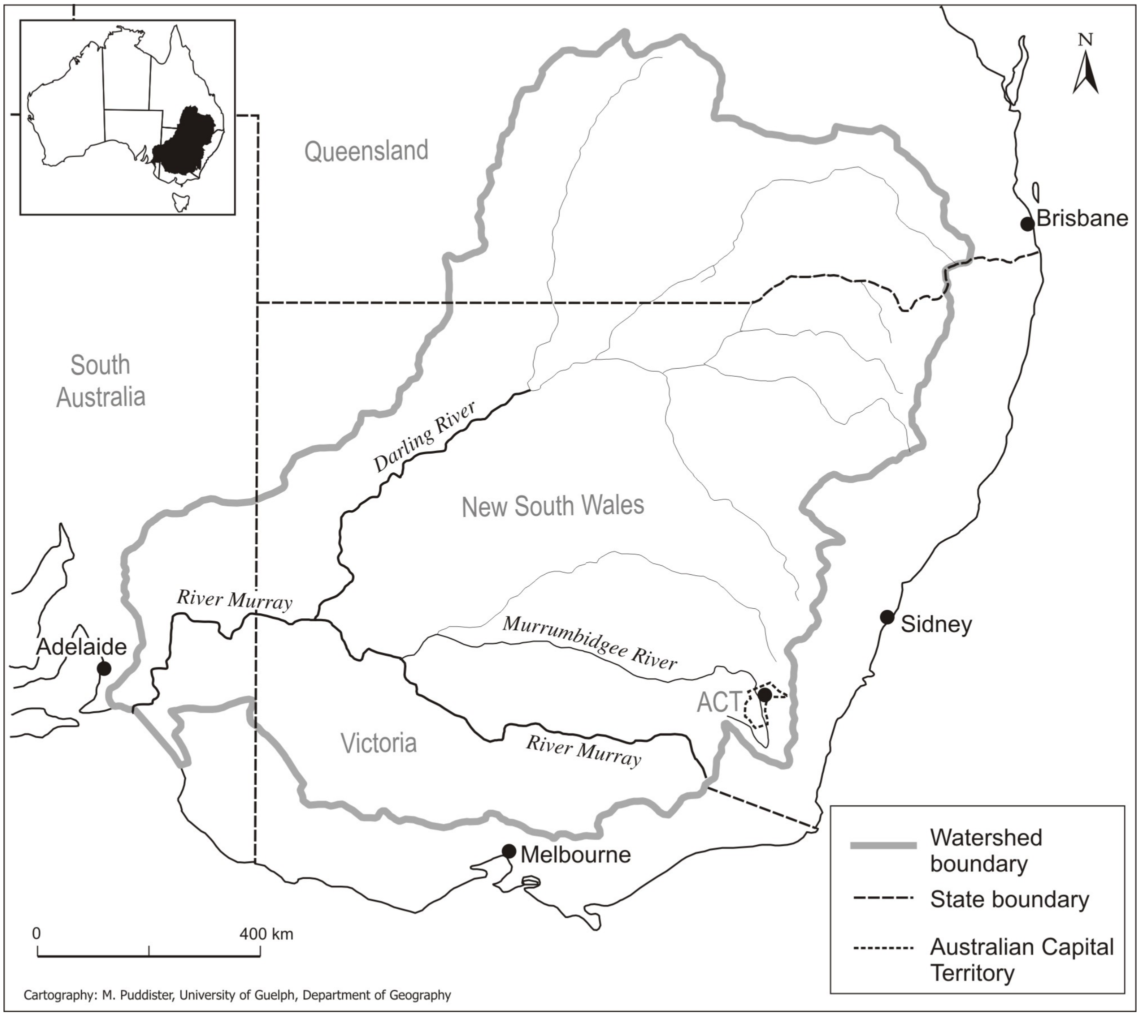
4.1. Australia: Murray-Darling Basin

The Murray-Darling Basin, located in south-eastern Australia (Figure 4), covers approximately 1 million km^2 (386,102 mi^2) or just over 14% of the country's total land area[7]. The basin is shared by four states (New South Wales, Victoria, Queensland and South Australia) and the Australian Capital Territory. States under Australia's constitution have primary responsibility for water management. However, under recent changes discussed below, the Commonwealth (federal) government now plays an extremely important role[21].

Most of the basin's area is made up of extensive floodplains and low undulating areas at an elevation below 200 meters (656.17 ft) above sea level; the plains end at the Great Dividing Range on the Basin's eastern and southern edges. The basin's overall climate is semi-arid, although the Queensland portion includes small sub-tropical areas[6]. Precipitation is highly variable across the basin, seasonally and annually, ranging from 1,200 mm/year (47.24 in/year) at the top of the Great Dividing Range to less than 200 mm/year (7.87 in/year) at its western boundaries[11]. The rate of evaporation is very high in much of the basin (96%)[7], and approximately 86% of the basin's land area contributes almost no runoff to the river systems except in times of floods or during very wet years[116].

Major rivers in the basin include the Darling, Murray and Murrumbidgee rivers and their respective tributaries (Figure 4). Flows in these rivers are highly variable from year-to-year, and seasonally – with floods and extreme low flows being common, especially in the Darling River and its tributaries. Between 1894 and 1993, annual discharge at the mouth of the Murray-Darling system has ranged from 1.626 million dam^3 to 54.168 million dam^3 with a median of 8.49 million dam^3 (1.318 million acre feet to 43.915 million acre feet with a median of 6.883 million acre feet)[116]. However, these figures are not

Figure 4: Murray-Darling River Basin, Australia



characteristic of conditions during the past decade. For example, in the two years ending in August, 2008, inflows into the Murray system were 3.54 million dam^3 (2.87 million acre feet), just over 50% of the previous two year minimum of 6.8 million dam^3 (5.51 million acre feet) in 1943-45[117]. Flows at the mouth of the Murray system are correspondingly low in light of high levels of withdrawals and severely reduced inflows.

Rivers in the basin are heavily regulated through an extensive system of water control structures[11]. Large dams in the Murray-Darling Basin can store a maximum of 24.34 million dam^3 (19.73 million acre feet), representing 29% of Australia's large dam storage capacity[6]. However, storage levels currently are extremely low. In August of 2008, active storage in the Murray system was only 20% of capacity[117].

Groundwater is an important basin resource. Surficial aquifers found in alluvial sediments in river valleys, deltas, lake sediments and in aeolian deposits are the major sources of potable groundwater[116]. Sedimentary aquifers cover large areas and contain the largest groundwater resources, but the quality of the water is marginal; nonetheless, they are relied on over much of rural inland Australia. Fractured rock aquifers are common, but extraction of large volumes of water is difficult. Importantly, recharge in many of the high-yielding aquifers is low[116]. In some regions, groundwater is a critical resource not only for domestic purposes, but also for irrigation. For example, in the Namoi region in northeastern New South Wales (NSW), the total yearly licensed groundwater entitlement is 471,823 dam^3 (382,513 acre feet) while the estimated annual sustainable yield is 212,625 dam^3 (172,378 acre feet)[97].

Approximately 2 million people live in the basin, the majority in New South Wales (39%) and Victoria (29%)[7]. Some 40% of the basin's population lives in urban areas with 25,000 or more people. The largest urban centre in the basin is Canberra, population 350,000[7]. The City of Adelaide (population 1.2 million people) receives its water supply from the Murray River, but it is not located within the basin.

Australia is one of the world's major agricultural producers of grain, beef and dairy, and the Murray-Darling Basin is Australia's most important food-producing region. Crop production (cereals, cotton, legumes, fruits and nuts, grapes, vegetables, canola and livestock fodder) and livestock production are the dominant economic activities in the basin, generating AUD$15 billion in 2005-06 or 39% of the total value of Australia's agricultural production[7]. Approximately 65% of Australia's irrigated land is located in the basin[7]. Thus, agriculture is by far the largest consumer of water in the basin[7].

The relatively limited water resources of the Murray-Darling basin have been under pressure throughout the past century, but during the past two decades they have been in crisis. Severe water quality problems received national attention throughout the 1990's. Extreme dryness has been experienced in recent years[7], along with the worst drought in Australia's recorded history[29]. Salinity, land degradation and loss of bio-diversity also are significant long-term problems[128]. Adding to these concerns, the combination of drought-induced low flows and heavy water use has placed considerable stress on aquatic ecosystems, including the basin's thousands of wetlands. Climate change is considered to be an extremely serious threat in Australia[126]. A recent review commissioned by the Commonwealth government suggests that a 1ºC increase in temperature is expected to produce a 15% decrease in streamflow in the basin[61]. In the absence of a successful global greenhouse gas mitigation effort, implications for irrigated agriculture in the Murray-Darling basin are extremely serious due to reductions in river flows, increases in drought frequency, and increased evaporation from water storage reservoirs[61].

Reflecting the above concerns, water governance in Australia has been in a state of continuous change during the past two decades. A national approach to water emerged in Australia in 1994 through the Council of Australian Governments (COAG) water reforms, which instituted market-based approaches at the state and territorial level and established a greater role for communities. The pace of reform increased under the 2004 National Water Initiative (NWI), which expanded water trading and focused attention on the environmental and economic needs of the Murray-Darling Basin[108].

Because the NWI was agreed to by all states and the Commonwealth, it provides Australia's overarching policy framework for water[72]. Under the NWI, states are obliged to return all catchments to sustainable levels of extractions[30]. This will be accomplished through water sharing plans, which are regulatory documents. In each catchment, catchment management organizations are required to define environmental needs, and then define the amount of water available for consumption (the consumption pool), and how the pool will be shared among existing entitlement holders. Substantial and uncompensated cuts to existing entitlements have occurred, especially in New South Wales. Water sharing plans will be revised every five years, and the consumptive pool redefined according to considerations such as shifts in demand, new knowledge, and climate change. Future changes to entitlements, due to redefinition of the consumptive pool, will only be compensated up to a certain level. Importantly, due to the severity of the drought catchment plans have been suspended in New South Wales, putting into question the robustness of this system[142].

The Murray-Darling Basin has long been recognized as a critical transboundary resource in Australia. With the exception of trade and commerce, constitutional authority over water is vested in the states and territories, each with its own system of water allocation. Thus, integrated management of the Murray-Darling Basin historically has been extremely difficult. Nonetheless, special provisions have existed for joint management of the basin since 1915 when the *River Murray Waters Act* was created and the River Murray Commission was formed to oversee construction of works on the river. That legal framework was replaced in 1983 by the Murray-Darling Basin Act, and the Murray-Darling Basin Commission (MDBC) was formed in 1985. The *Murray Darling Basin Agreement* (1987) was amended in 1992 to permit Queensland to join. Several key actions have been taken through the Agreement:

- In 1997 the MDBC instituted a cap or upper limit on the surface water diversions in New South Wales, Victoria and South Australia, with the goal of maintaining and, where possible, improving existing flow regimes and achieving sustainable water consumption[128].
- In 2002 the Commission established the Living Murray initiative, which had the goal of providing water for environmental enhancement at six critical sites in the basin through acquiring water from willing sellers and allocating it to the environment[11].
- In 2004, the Murray-Darling Basin Ministerial Council committed AUD$500 million (AUD$200 million from the Australian Government) over five years to provide an average of up to 500,000 dam^3 (405,357 acre feet) of water per year in support of the Living Murray initiative[8].

On January 25, 2007, the Commonwealth Government of John Howard announced a National Plan for Water Security (NPWS). An investment of $10 billion over a period of ten years was aimed at making rural water use sustainable by modernizing on- and off-farm irrigation infrastructure, addressing over-water allocations and, given that diversions under the existing Cap are not sustainable, setting a new sustainable Cap on diversions[108]. Under the NPWS, the Commonwealth government proposed to take control of water management in the MDB. Commonwealth funds would be available for a host of water-related purposes, including modernizing water management infrastructure in the various states. A new basin-level organization with enhanced responsibilities and powers – the Murray Darling Basin Authority – would be created. In parallel, the Commonwealth put in place a new legal framework, the *Water Act 2007*.

Prime Minister Howard's government was defeated in 2008 before the NPWS could be implemented. However, his successor, Kevin Rudd, developed a new national water plan, *Water for the Future*, incorporating elements of the earlier plan[7]. Additionally, the basin states and the Commonwealth entered into an agreement to revise and implement the *Water Act 2007*[27] and states' own legislation.

A revised Murray-Darling Basin Agreement, agreed to by all the states and the ACT, is incorporated in the amended *Water Act 2007*. The *Water Act 2007* and the Agreement instituted a framework for environmental protection, monitoring, enforcement, water sharing and trading, and created the independent Murray-Darling Basin Authority (MDBA) to replace the MDBC. Specific provisions regarding water sharing and trading are being finalized, and will be introduced as regulations. The Commonwealth's Minister for Climate Change and Water is responsible for the Act, and the MDBA reports to the Minister[115]. The Authority's members are appointed by the federal government[128]. States retain all of their constitutional rights and duties relating to water. However, by entering into the new agreement they have given primacy to the Commonwealth in key areas relating to basin management. For example, the MDBA is responsible for developing a single, consistent and integrated basin plan; recommending limits on surface and groundwater diversions to the Commonwealth Minister for Climate Change and Water; and advising the Minister on the accreditation of water resource plans in each state. Commonwealth and state ministers sit on the Murray-Darling Basin Ministerial Council (MDBMC), which existed under the previous Agreement. The Council provides oversight to the MDBA, and has responsibilities relating to River Murray operations. The Act also created the position of Commonwealth Environmental Water Holder, whose duties include acquiring and managing the Commonwealth's environmental water assets inside and outside of the basin[128].

Detailed and specific rules and procedures for transboundary water sharing in the basin are established under the Agreement. For example, South Australia's entitlement during normal periods is expressed in monthly volumes. Entitlements for New South Wales and Victoria are defined in terms of proportions of flow of the River Murray, and specific volumes of water from particular reservoirs and lakes. New South Wales and Victoria share the flow of the River Murray on an equal basis, but have a specific obligation to pass defined volumes of water to South Australia. Because of their role as upstream states, New South Wales and Victoria also have a specific duty to provide South Australia's entitlement, and South Australia is given access to storage in reservoirs located in these states.

The Act also establishes provisions for maintenance and enhancement of environmental flows; meeting critical human needs (defined as minimum amounts of water that can only reasonably be provided from Basin water resources to meet core human consumption requirements and water needed to avoid incurring prohibitively high social, economic or national security costs); resolving disputes; water accounting; water charges (full cost pricing); water trading between states; revising entitlements during periods of low flow, e.g., through mechanisms such as special requests to the MDBA; risk sharing during extreme circumstances (droughts and low flows); operation of reservoirs; and a host of other considerations. Thus, it provides a broad, overarching framework for transboundary water governance and management.

Benchmarks

This section summarizes the extent to which the core principles and international benchmarks, discussed in Section 3, are addressed in the Murray-Darling Basin.

- *Core principles*: Core principles for water sharing that have emerged at the international level are strongly reflected in the Murray-Darling Basin. The Murray-Darling Basin Agreement, under the amended *Water Act 2007,* is based on a strong commitment to cooperative transboundary water management. Equitable and reasonable utilization of water resources, sharing of risks and benefits, participation by all basin states, information sharing and exchange, and protection of the environment are defining features of the Agreement. Importantly, the fact that the basin is shared by states within a federation, rather than by sovereign countries, greatly facilitated development of this comprehensive approach. However, it also should be noted that implementation of the principles of the Agreement has not been trouble free. For instance, South Australia recently launched a suit against Victoria and New South Wales aiming to force them to release more water down the river[65].
- *Integration:* The framework for water sharing that has been created for the basin establishes a highly integrated approach. Apportionment of surface water is the primary concern of the Murray-Darling Basin Agreement, but groundwater-surface water interactions and water quality-quantity relationships (including salinity concerns) are recognized. In an important change relative to the 1992 Murray-Darling Basin Agreement, groundwater management will be brought under the MDBA's control in the new Agreement through the basin plan the Authority now has to create[128]. Meeting human water needs, primarily for agricultural irrigation, is a key objective of the Agreement. However, environmental water needs are a major concern against which traditional human social and economic needs are balanced. Finally, in terms of integration, basin-level arrangements and state-level catchment land and water management systems are supposed to be closely integrated because the MDBA's forthcoming basin plan will have primacy. Whether or not this actually will occur in the face of severe over-allocation of rivers and aquifers is not clear.

- *Ecosystem protection:* Detailed and specific requirements and procedures for ecosystem protection have been established in the new framework. For example, the MDBA is required to develop an Environmental Watering Plan, and the Commonwealth Environmental Water Holder will manage the Australian government's environmental water holdings in the basin according to this plan. These measures build on existing measures such as the 1997 Cap on surface water diversions, the Living Murray initiative, and requirements for maintenance of environmental flows in state-level legislation. Whether or not these will be successful remains to be seen. For example, due to the severity of the drought, restoration of degraded environments through programs such as the Living Murray project has been slow[29]. Stresses on the water resources of the basin are so severe that the extent to which ecosystem functions can be restored (let alone protected from further degradation) is in serious doubt. For example, the first biennial assessment of the National Water Initiative determined that water markets have not address over-allocation, and that river quality continues to decline[31]. Additionally, at the state level, water sharing plans that are meant to provide environmental flows have been suspended in recent years[142].
- *Public involvement:* The process of water reform in Australia, including the development of the 1994 COAG reforms, the 2004 National Water Initiative, the 2007 National Plan for Water Security and its successor, and the new Murray-Darling Basin Agreement, were all developed at the government-to-government level. In other words, citizen involvement in the creation of the overarching policy framework for Australia, and for the basin, has been limited. However, public involvement and consultation on the development and amendment of the MDBA's basin plan are required under the *Water Act 2007*[27]. Community participation in Murray-Darling Basin water management is facilitated through a Basin Community Committee, which advises the MDBA and the MDBMC. Additionally, at the state level, reforms introduced starting in the 1990s have created key roles for citizens in catchment management planning[142]. Citizen involvement has been integral to the development of the plan, but the process has revealed tension between water users (especially irrigators) and others[97].
- *Shared governance:* The overall approach to governance in the basin reflects the primacy of government agencies in Australian water management, and the manner in which Australia's water reform process has unfolded. Decision making responsibility is concentrated in bodies such as the MDBA, the MDBMC, and state governments. It is only at the state level, through activities such as planning by catchment-based bodies that have statutory responsibilities under state laws to develop catchment management plans, that governance is being shared more widely beyond governments[137][142]. However, it is important to remember that part of the water reform process has been the creation of water markets. Thus, one can argue that in the context of water that is available for trading, decision making responsibility has been handed to companies and individuals engaging in the water market.
- *Adaptability and flexibility:* Australians have demonstrated an uncommon willingness and capacity to adapt to changed circumstances, and to experiment with innovative

approaches to water allocation. As noted earlier, the amended *Water Act 2007* and the Murray-Darling Basin Agreement are only the latest stage of a long series of fundamental reforms during past decades. The Agreement incorporate a host of measures designed specifically to permit adaptation to changed climatic and economic circumstances. These include provisions for flexible apportionment among states based on water resource conditions; special provisions for dealing with droughts and low flows; basin-wide planning that shapes water sharing objectives and provides a larger framework for catchment-level planning through state processes; procedures for regular plan revision and amendment; and a framework for water trading that, depending on its final form, may create considerable flexibility. However, it is important to note that the robustness of the system that has been created is already in question (as demonstrated by the fact that NSW has suspended water sharing plans in the face of the drought).

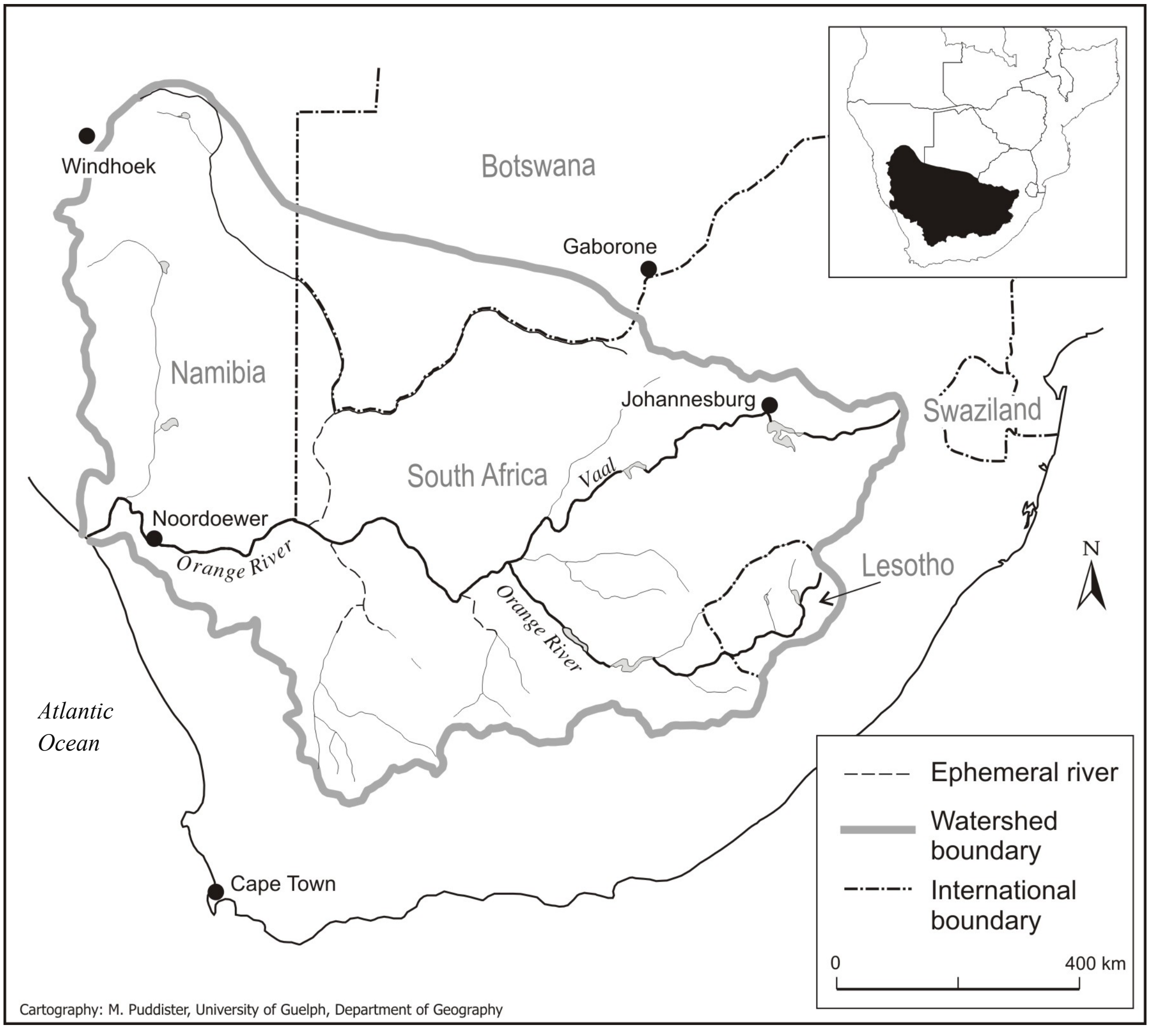
With the most recent reforms at the national level, and in the Murray-Darling Basin, Australia has developed a sophisticated (and complicated) system for transboundary water management. Australia's states have demonstrated a capacity to be as parochial about water as any sovereign country, yet they also have shown an ability to see beyond their individual interests and to act cooperatively. Thus, the Australian experience provides an oft-cited international benchmark for transboundary water governance[11]. However, two key facts must be kept in mind in considering the Australian experience. First, water reform has occurred in direct response to an exceptionally serious, long-term environmental, economic and social crisis. This crisis has been a key driver of water reform, and has narrowed the range of options that can be pursued. Second, and most importantly, the most recent reforms were undertaken partly in response to previous reforms that were unsuccessful. In other words, it is premature to suggest that the current reforms will be able to address the severe challenges faced in the basin better than has been the case under previous reforms[173].

4.2. Southern Africa: Orange-Senqu River Basin

The Orange-Senqu (also known as the Orange) River Basin in southern Africa (Figure 5) covers approximately 896,368 km^2 (346,090 mi^2) and is shared by four countries: the Republic of South Africa, the Kingdom of Lesotho, the Republic of Namibia and the Republic of Botswana. Most of the basin (64.2%) is located in South Africa. Botswana has 12.2% of the basin, and Namibia has 24.5%[53]. Only 3.4% of the basin is located in Lesotho. Nonetheless, as will be seen below, Lesotho's position as a headwater state in the basin is critical.

With the exception of Lesotho, which is a mountainous region made up mostly of temperate highlands, the basin is dominated by savannah grassland in the central plateau and desert conditions in the west. The Lower Orange basin is arid to extremely arid[150]. Precipitation is highly variable across the basin, seasonally and annually. In Lesotho, average annual precipitation exceeds 1,800 mm (70.87 in) while average annual evaporation rate is 1,100 mm (43.31 in). At the mouth of the river, where it drains into the Atlantic

Figure 5: Orange–Senqu River Basin, Southern Africa



Ocean (Figure 5), average precipitation is less than 50 mm (1.97 in) per year while annual evaporation rates can exceed 3,000 mm (118.11 in)[40]. Portions of the basin contribute little or no runoff.

The Orange is the largest river in the basin. It originates in north-east Lesotho (where it is known as the Senqu), and flows generally westward through South Africa. The Vaal River in South Africa is a critical tributary[49]. Other tributaries include the Fish, Caledon, Molopo and Nossob rivers[95]. These contribute a relatively small portion of the flow. For instance, surface water from the Molopo and Nossob rivers in Botswana (Figure 5) has not flowed into the Orange River in living memory[90][98]. As a result, more than 95% of the water in the Orange River Basin originates in Lesotho and South Africa[98]. Mean annual runoff of the Orange River as measured at Noordoewer, in Namibia (Figure 5), is 11.1 million dam^3 (9 million acre feet) [54]. Dams and reservoirs are used throughout the basin to capture streamflow, and numerous intra- and interbasin water transfer schemes supply water to municipalities, industry and irrigation farms inside and outside the basin[49][155]. The Mohale and Katse dams in Lesotho, part of the Lesotho Highlands Water Project (LHWP), are particularly important for Lesotho and South Africa.

Groundwater is an important resource in the basin, but basin-wide data on the quality and availability of groundwater resources are limited[150]. Groundwater is especially important for basin countries that have limited streamflow. For instance, in Botswana, streamflow is intermittent, with some internal rivers flowing for only 10-75 days per year. To meet its water needs in its portion of the basin, Botswana relies primarily on groundwater resources that recharge slowly due to limited precipitation[90][98]. Thus Botswana's groundwater resources in the basin are under considerable pressure because abstraction is effectively mining a limited resource[54].

The Orange-Senqu basin's population in 2004 was estimated to be 19 million people, most of whom are considered poor to very poor[150]. The vast majority of the population (approximately 11 million) lives in South Africa[49]. Lesotho, which is located entirely within the basin, had an estimated population of 1.881 million in 2006[89]. Namibia's portion of the basin is sparsely populated and expected to decline due to urbanization[90]. Botswana's sparsely populated portion of the basin is entirely covered by the Kalahari desert[49]. Johannesburg, South Africa (population around 7 million people including surrounding suburbs), is the largest population centre in the basin, and is located in Gauteng, the smallest but most densely populated and fastest growing province of South Africa. Despite significant urbanization, population growth rates in all basin countries have slowed due to decreasing fertility rates and high mortality resulting from HIV/Aids[150].

The basin's economy is dominated by South Africa, which is the primary trading partner for Lesotho, Namibia and Botswana. South Africa accounts for 93% of the total gross domestic product (GDP) in the basin and has the highest GDP per capita while Lesotho has the lowest[150]. Lesotho derives 40% of total non-tax revenue from the LHWP, which provides water to South Africa[88]. Wages earned by people from Lesotho who work in South Africa's mines are also important to the country's economy. Soils in Lesotho are considered very poor, and thus irrigation potential is low[53]. In the Namibia portion of the basin, livestock production is a dominant activity, although mining and commercial agriculture dependent on the Orange River takes place[150]. Irrigation potential in Botswana in the Orange River Basin is considered negligible because of a lack of renewable water resources, and low in Namibia due to the scarcity of irrigable lands and limitations on water availability[53]. However, Namibia does grow table grapes near the mouth of the Orange River[4]. In the drier western parts of the basin South Africa, Namibia and Botswana derive income from safari-based tourism[150]. Mining, manufacturing and agriculture are key economic activities in the central and eastern portion of the basin in South Africa, and are concentrated in Gauteng, in the Vaal Catchment[150]. Irrigation and dry-land cash crop production occurs predominant in the central basin, and stock farming is found in the remaining parts of the central basin[150]. In 2005, 95% of all water demand in the basin was from South Africa, and an estimated 60% of that was for irrigation[150]. The Vaal River is especially important to South Africa's economy because it provides water for

Gauteng province, which accounts for 60% of the country's wealth[152]. Given the importance of water for South Africa's economy, it should not be surprising that increasing the security of supplies in the Orange River Basin through transboundary water management has been a central political, economic and sometimes military goal of various South African governments[155].

Water resources in the Orange River Basin are under pressure from a variety of sources, including highly variable flows; high water demands, especially in the Vaal and Lower Orange catchments; and contamination from urban areas, land use activities and industries[49][95][150]. The Vaal catchment in particular is considered highly polluted due to industrial and agricultural activities[150]. Annual flow of the Orange River is now estimated to be 25% of natural mean annual runoff, due in large part to high demands on the Vaal River to support economic activities in Gauteng[150], but also due to a prolonged drought in the western portion of the basin[37]. Ecosystems throughout the Orange River basin are severely degraded due to water quality concerns, soil erosion and wetland degradation, and because natural flow regimes have been disrupted[49][150].

Total demand for water in the basin between 2005 and 2025 is expected to grow by 8.5% (from 5.687 to 6.168 million dam^3, or 4.611 to 5 million acre feet). Most of the expected increase in demand will occur in South Africa, but expansion of irrigation in Namibia by 2025 also is expected[150]. In light of existing demands and pressures, chronic water scarcity is expected in most parts of the basin by 2025. Climate change will significantly increase existing climatic variability. Decreases in precipitation are anticipated in the western portion of the basin, while precipitation in the eastern highlands may increase[90]. Importantly, climate change is expected to lead to the loss of perennial flows in already water-stressed portions of the basin. This has serious implications for the rural poor who depend on these resources[37]. Additional intra- and interbasin transfers also will strongly determine future water availability within the basin[90]. Thus, both water scarcity and ecosystem degradation are expected to become more severe in already stressed portions of the basin.

The countries that share the basin have recognized the importance of strengthening their own water management systems. All four have reformed, or are in the process of reforming, legislation and policies[150]. For instance, South Africa has instituted extensive water reforms that include national water legislation (the Water Act) and catchment-based planning programs[9]. Botswana established a National Water Master Plan[146]. Of course, how effective these initiatives are depends on the extent to which profound political, economic and social challenges, that undermine capacity to implement plans and programs in all four basin countries, can be addressed[145][150].

At the same time as they have recognized the need to improve their own water management systems, the countries sharing the basin have recognized their international commitments, and the need for basin level coordination, planning and water resources development[91][90]. This is reflected in the number of bi-lateral and basin-wide arrangements that exist[4][90][155]:

- The four countries are signatories to the Southern African Development Community's (SADC) *Revised Protocol on Shared Water Course Systems*. The Revised Protocol, signed in August 2000 and ratified in September 2003, is designed in part to make transboundary water governance in southern Africa consistent with the principles reflected in the UN Water Convention[104].
- In 2000, South Africa, Lesotho, Namibia and Botswana signed the Agreement on the establishment of the Orange-Senqu River Commission (ORASECOM), which led to a regional coordination body designed to help balance the interests of the four states that share the basin. This is the first agreement created under the *Revised SADC Protocol on Shared Watercourse Systems* as well as being the first basin-wide multilateral agreement signed by all riparian states of the Orange-Senqu River[49]. Importantly, Botswana is recognized as a riparian under this agreement even though it contributes no streamflow, and does not make use of surface water from the Orange River. As a formally-recognized basin state, Botswana now has guaranteed access to groundwater resources in the basin.
- Seven bi-lateral agreements also exist in the basin. Two of these – the 1986 *Treaty of the Lesotho Highlands Water Project* (LHWP) and the 1992 Agreement that established the Vioolsdrift and Noordoewer Joint Irrigation Scheme (VNJIS) between Namibia and South Africa – include specific water allocations to the parties involved[90].

The objectives of these arrangements vary widely. For example, the Treaty of the Lesotho Highlands Water Project focuses specifically on water development, and does not adopt a basin-wide perspective[5]. The LHWP Treaty is an example of an apportionment arrangement focused on sharing benefits of water development, rather than simply division of water. The project involves the transfer of water from the Senqu basin in Lesotho by gravity into the Vaal River[94]. South Africa would have received the water anyway through natural flows (Figure 5), but via the project receives high altitude storage, and has been able to avoid the cost of pumping water from the Orange River in its territory to the Gauteng area where it is needed[94][155]. In return for delivery of water, Lesotho receives monthly royalties from South Africa, and uses the water to generate hydroelectric power before delivering it to South Africa[154]. In contrast, the Orange-Senqu River Basin Agreement is focused on broader regional development goals including regional integration, socio-economic development, poverty alleviation, and protection of ecosystems[71]. While these agreements are based on mutually-recognized self-interest, it should be remembered that they also reflect South Africa's desire to increase regional stability and its own water security[155].

Benchmarks

This section summarizes the extent to which the core principles and international benchmarks, discussed in Section 3, are addressed in the Orange-Senqu River Basin.

- *Core principles:* Early arrangements for transboundary water management in the basins were bi-lateral in nature, and focused on specific concerns. For example, as noted earlier, the 1986 Treaty of the LHWP excludes two of the basin states, and thus their interests are not recognized. Nonetheless, it is generally acknowledged that the Treaty does reflect an effort to apportion benefits of water resource development equitably between South Africa and Lesotho[5][49]. Subsequent arrangements are much more strongly reflective of international norms. For example, the revised *1997* SADC *Protocol on Shared Water Course Systems* explicitly recognizes the UN Water Convention, and the Agreement on the establishment of the Orange-Senqu River Commission (ORASECOM) builds on the Protocol.
- *Integration:* ORASECOM is based on the concept of Integrated Water Resource Management (IWRM), as are water policies within the four basin countries. However, the extent to which principles of integration are reflected in actual practices in the basin is highly variable. This reflects not only the magnitude of the social, economic and environmental challenges faced, but also the significant capacity challenges that exist[94], and the complexity of the various internal and transboundary water management systems. Hence, while the 2000 ORASECOM agreement promotes an integrated perspective, major developments continue to be developed through bi-lateral approaches (which undermines an integrated, basin-wide perspective)[90].
- *Ecosystem protection:* Degradation of ecosystems is severe throughout the basin, a fact that is recognized in more recent transboundary water management arrangements and, increasingly, in water management practices. For instance, South Africa operates the Gariep and Vanderkoof dams on the Orange River downstream of Lesotho to provide environmental flows[150]. However, water allocation and flow regimes have not been determined for the basin as a whole[90], and no provisions for environmental flows exist on the heavily stressed Vaal River[150]. Instream flow requirements downstream of the LHWP dams were not considered at the time the 1986 Treaty was created; severe deterioration of rivers affected by the LHWP is expected if its next phases are built as originally conceived[127]. Hence, subsequent negotiations relating to the next phases of this project are giving more attention to ecosystem considerations.
- *Public involvement:* A long tradition of public involvement in decision making relating to water management does not exist in southern Africa[18][87]. This reflects a number of considerations, including the facts that experience with public involvement is relatively new in the region, high levels of poverty and underdevelopment exist, and forums for involvement simply have not been available in previous decades. For example, an environmental impact assessment was not completed for Phase 1A of the LHWP, and thus opportunities for public involvement did not exist in that project, and

environmental and social impacts were not adequately addressed[127]. However, because funding was provided in part by the World Bank, public participation and environmental impact assessment were at least mandated in subsequent phases[168]. All four basin states are signatories to the SADC *Revised Protocol on Shared Watercourse Systems*, which explicitly promotes public awareness and public participation[18]. And, efforts are underway to establish basin-wide programs for stakeholder involvement[94]. Thus, efforts are being made to increase public involvement in transboundary water governance in the basin, but ensuring that public involvement is not limited to powerful economic interests, and that public involvement processes create meaningful roles for citizens[26], will be a major challenge.

- *Shared governance:* Transboundary water governance is occurring through a number of joint bodies created under the agreements mentioned earlier. For example, through a protocol created under the 1986 Treaty on the LHWP, the Lesotho Highlands Water Commission (comprising three delegates each from South Africa and Lesotho) has overall responsibility for the project. However, there have been few opportunities for non-government actors to be involved in transboundary water governance[94]. This reflects the dominance of government agencies in internal water management, e.g., South Africa's Department of Water Affairs and Forestry, and the absence of opportunities for non-government actors (apart from elites) to be involved in transboundary issues. It should be noted, however, that new laws and policies within the basin countries are creating opportunities for governance that involves more players than just governments. For instance, South Africa's National Water Strategy involves tiers of decision making, with Water Users' Associations and Catchment Forums having specific responsibilities[9]. The extent to which these will influence transboundary water governance is not clear.

- *Adaptability and flexibility:* In light of the uncertainty regarding future water demands and supplies[90], flexible and adaptable transboundary water management arrangements are essential in the basin. The various agreements identified above that actually apportion water address this concern in different ways. For instance, the VNJIS agreement dedicates 20,000 dam^3 (16,214 acre feet) of water to this irrigation project – 11,000 dam^3 (8,918 acre feet) to farmers in South Africa and 9,000 dam^3 (7,296 acre feet) to those in Namibia. The treaty does not include guidelines for adjusting these fixed volumes over time, but two bi-lateral organizations are empowered to investigate and make recommendations to the governments[90]. Taking a different approach, the Treaty of the LHWP requires Lesotho to deliver specific amounts of water to South Africa between 1995 and 2020. Delivery requirements are tied to four specific project phases in the Treaty, with the minimum set at 57,000 dam^3 (46,211 acre feet) in 1995 and 2.208 million dam^3 (1.790 million acre feet) after 2020. The two components of the first phase were completed in 1998 and 2004, respectively[49]. Provisions exist for continuous monitoring and adjustment of project implementation to reflect South Africa's actual water needs[99]. Hence, the original delivery schedule already has been altered to reflect the fact that demands for water in South Africa have not increased as quickly as expected[90].

Collectively there is an ongoing shift to transboundary water governance in the Orange River Basin. This is demonstrated by the various agreements that have been developed, and in practices such as joint planning and decision making and joint project development. However, it is important to remember that politically, economically and militarily South Africa dominates the other basin states, and historically has used its power to increase the security of transboundary flows and to create a more stable basin-wide regime[60][155]. Nonetheless, even under these circumstances, South Africa has found it beneficial to pursue benefit sharing in line with the principles established in its Constitution and Water Act, and consistent with regional agreements such as the SADC's *Revised Protocol on Shared Water Course Systems*. This testifies to the importance of water in the region, and the fact that a cooperative approach to transboundary water governance is seen as the only viable option.

4.3. Summary

In Section 3 it was argued that cooperative management of transboundary basins has numerous benefits for the states that share these water resources. The two cases here not only confirm this argument, but also demonstrate that cooperative transboundary water management can be the *only* viable choice. In both the Murray-Darling basin and the Orange-Senqu basin, unilateral action has not been an option.

The two cases also highlight the importance of the "benchmark" concerns that were discussed in Section 3. In neither case were all the benchmarks addressed with complete success. In fact, in both cases many benchmarks were addressed only at the level of *intentions*. Whether or not they are addressed in *practice* remains to be seen. Nonetheless, it is clear from these two cases that the themes addressed in Section 3 are considered crucial in two cases where pressure on transboundary water resources is exceptionally severe.

Finally, the two cases draw attention to two broad issues with implications for the Red River basin:

- Water crises motivate action, but they also narrow the range of choice. For instance, in the Murray-Darling Basin innovative and wide-ranging water reforms have been put in place at the state and national levels. However, these were established in an atmosphere of crisis in response to problems that had been identified many decades earlier. This has created two serious problems. First, the reforms may or may not be the most appropriate ones. Had the process started earlier, when the crisis was less severe, other options might have been available. Second, even if the reforms are appropriate, it may not be possible to implement them given the severity of the problems now being experienced. For instance, as noted earlier, water sharing plans have been suspended in

New South Wales in response to *existing* conditions. Their ability to deal with future conditions is highly uncertain.

- Apportionment can, and should be, addressed in the larger context of transboundary water governance. Both cases demonstrated that apportionment arrangements can be nested within agreements that have larger goals for water and regional economic development. At the same time, they demonstrate different ways of linking arrangements. In the case of the Murray-Darling basin, a systematic process of water reform was pursued. Thus, state-level laws and policies were adjusted to fit intergovernmental agreements and policies. In contrast, in the Orange-Senqu case, bi-national arrangements were created first, and then a basin-wide arrangement was established. This has worked against the establishment of basin-wide allocation in the near term. Nonetheless, over the long term, new bi-national arrangements, or re-negotiated existing arrangements, can be made consistent with overarching basin-wide arrangements.

5. United States–Canada Apportionment Agreements

Canada and the United States share an 8,000 km (4,971 mi) boundary that divides approximately 300 lakes, rivers and streams[14]. Issues relating to these boundary waters have been resolved effectively during the past century through the *Boundary Waters Treaty of 1909*. The Treaty establishes principles and procedures for transboundary water sharing, and a critical governance body, the International Joint Commission (IJC). In recent years considerable attention has focused on transboundary water issues in the Great Lakes Basin. Nonetheless, the *Boundary Waters Treaty of 1909* also provides the foundation for apportionment of prairie rivers shared by Canada and the United States. This section provides an overview of features of the *Boundary Waters Treaty of 1909* that are pertinent to this study, and then examines apportionment in two basins where formal arrangements under the Treaty exist: the St. Mary-Milk River basins, and the Souris River basin. Other examples of apportionment of flow between Canada and the United States exist, including the Niagara River Treaty and the Poplar River Bilateral Monitoring Committee, but these are not addressed here.

5.1. Boundary Waters Treaty of 1909

During the last century, the *Boundary Waters Treaty of 1909* has provided the foundation for successful transboundary water management along the Canada-United States boundary. The full title of this treaty, signed on January 11, 1909, is *Treaty Between the United States and Great Britain Relating to Boundary Waters, and Questions Arising Between the United States and Canada*. It has legislative authority in Canada under the *International Boundary Waters Treaty Act* (Revised Statutes of Canada, 1985, c. I-17).

The *Boundary Waters Treaty of 1909* was the product of a protracted period of negotiation between Canada and the United States. During the late 1800s and early 1900s, problems were occurring along the international boundary relating to navigation rights, power generation from the Niagara River, and irrigation water rights in the St. Mary and Milk Rivers[55]. Both countries realized that a mechanism was needed to resolve transboundary water concerns, but they differed regarding the scope of such an arrangement. Canada wanted an arrangement that would include all the transboundary basins and their tributaries, while the US sought a body whose mandate would be limited to the Great Lakes, excluding tributaries. The treaty that was signed in 1909 reflects a compromise position[58]:

- Only boundary waters (rather than all the waters of boundary *basins*) were included under the Treaty. The exception is the St. Mary and Milk Rivers, where tributaries were included under Article VI (see below). Boundary waters included lakes, rivers and streams, but no mention was made of groundwater.
- The Treaty created the IJC, with equal representation from Canada and the United States. Three commissioners are appointed by Canada and three by the United States, and the Commission itself has joint chairs, one from each country.

- A litigation provision was included in the Treaty, and a mechanism for references by the governments to the IJC was created. These references result in advice to the two countries, but historically they have had considerable influence[14].

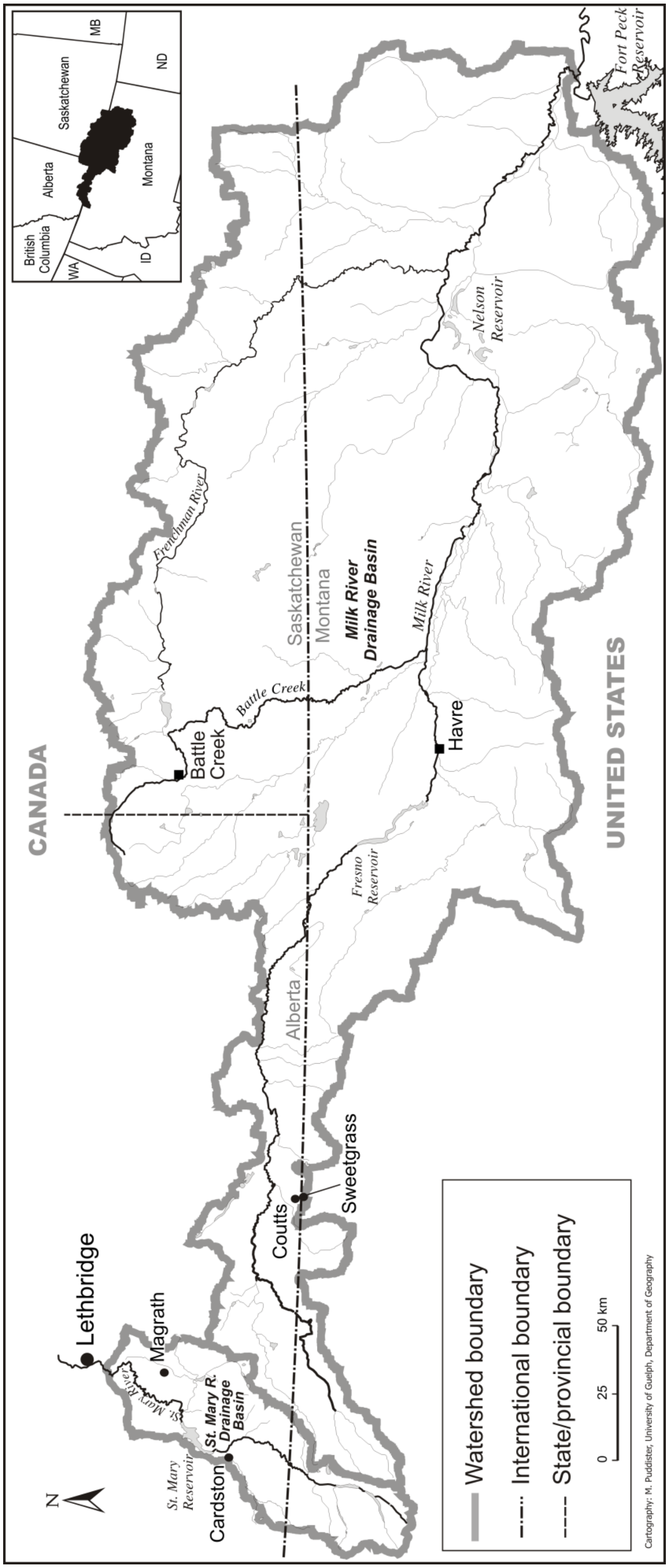
The Treaty provides the foundation for transboundary water governance along the Canada-US border because it mutually obliges the two countries to protect the natural levels or flows of surface water bodies they share. The IJC plays a key role under the Treaty. It issues Orders of Approval concerning works that affect the levels of transboundary waters, and it makes recommendations that relate to references it has received from the two governments[55]. Importantly, while commissioners are appointed by their respective governments, they are required to serve in their personal capacities, and not as representatives of their governments[66].

Since it was created a century ago, there have been several attempts to re-open the *Boundary Waters Treaty of 1909*, but none have been successful. Instead, as concerns such as water quality and bulk water export have gained prominence, they have been addressed through References, Orders of Approval, amendments to implementing legislation and regulations, and through the creation of a variety of numerous complementary institutions. For example, water quality concerns in the Great Lakes basin were addressed through the *Great Lakes Water Quality Agreement*, originally signed in 1972 and amended in 1978 and 1986[58]. Concerns relating to bulk water diversions from the Great Lakes basin prompted the two governments to establish specific legal prohibitions – in Canada, under the *International Boundary Waters Regulations (SOR/2002-445)*, and in the United States, through *Public Law 106-53, Section 508*. One important concern that the Treaty does not mention is groundwater. Groundwater quality in the Great Lakes basin is addressed through the *Great Lakes Water Quality Agreement*, but transboundary groundwater quantity issues are not addressed[113].

5.2. St. Mary–Milk River Basins

The St. Mary and Milk River basins contain important transboundary water resources shared by Montana, Alberta and Saskatchewan (Figure 6). The Milk River watershed covers approximately 61,642 km^2 (23,800 mi^2), 35% of which is in Canada, while the much smaller St. Mary watershed covers approximately 3,600 km^2 (1,390 mi^2), 33% of which is in the United States[80][153]. Both rivers have their origins in Montana. However, the Milk River rises in the foothills, while the St. Mary River has its source in Montana's Rocky Mountain glaciers. The Milk River discharges into the Missouri River near Fort Peck Reservoir and ultimately joins the Mississippi River which, in turn, discharges into the Gulf of Mexico. In contrast, the St. Mary River is a tributary of the Oldman River, which discharges into the South Saskatchewan River and eventually into Hudson Bay[80]. Large areas of both countries within the basin are suitable for irrigation[69] and have been used for that purpose since the late 1800s. Water from the St. Mary and Milk rivers irrigates approximately 161,874 ha (400,000 acres) in southern Alberta and about 40,468 ha (100,000 acres) in northern Montana[66].

Figure 6: St. Mary and Milk River Basins



Currently, the St. Mary River has a larger and more reliable flow than the Milk River, which accounts for its importance to the development of irrigation projects in both Alberta and Montana[55][69]. However, given the contribution of glaciers to the St. Mary River's flow, climate change has particularly serious implications in these basins as these glaciers are expected to disappear by 2030[17].

Allocation of the waters of the St. Mary and Milk Rivers was a long-standing problem between Canada and the United States in the late 1800s and early 1900s because both countries used the rivers to support irrigation developments. In 1894, US interests proposed a diversion canal that would take water from the St. Mary River on the US side and transfer it into the Milk River. In response, Canadian interests demonstrated in 1904 that they had the ability to simply divert the water back from the Milk River on their side of the boundary[55]. This dispute was resolved under Article VI of the *Boundary Waters Treaty of 1909* (discussed below). Since 1917, water from the St. Mary River has been diverted into the North Milk River, for use in the lower Milk River valley, via the 47 km (29.2 mi) St. Mary diversion canal and related storage works in northern Montana. The canal is operated primarily from April to October, during the irrigation season[110]. Without this diverted water, the Milk River would not flow for 6 out of 10 years[153].

Under Article VI of the *Boundary Waters Treaty of 1909*, the St. Mary and Milk Rivers and their tributaries in Montana and Alberta are treated as one stream, to be apportioned equally. To maximize the beneficial use of the waters of the rivers for each country, Article VI allowed more than half of the water to be taken from one river and less than half from the other, and establishes prior appropriations for each country on each river during the irrigation season (April 1 to October 31). During the irrigation season, the US is entitled to a prior appropriation of 500 f^3/s (14.16 m^3/s) of the Milk River, or 75% of its natural flow, and Canada is entitled to a prior appropriation of 500 f^3/s (14.16 m^3/s) of the St. Mary River, or 75% of its natural flow[79]. Article VI also established provisions relating to conveyance of diverted St. Mary River water through the Canadian portion of the Milk River, and to administrative procedures regarding measurement of flows.

Despite the explicit nature of the apportionment agreement in Article VI, questions remained about exactly how measurement would be undertaken, and when division would occur[15]. In 1914, IJC commissioners toured the region and discovered that Canadian and US officials were interpreting Article VI differently. They concluded that this could lead to conflicts over water sharing[69]. Therefore, the Commission held hearings in 1915, 1917, and 1920, and issued temporary orders in 1918, 1919, 1920, and 1921. The final order was issued on October 4, 1921[22]. The main provisions of the 1921 Order are described in Box 4. In addition to these provisions, the Order also established where gauging stations would be maintained, and how records would be collected and kept[55].

Box 4: Main Provisions of the IJC's 1921 Order

The International Joint Commission's Order of October 4, 1921, In the Matter of the Measurement and Apportionment of the Waters of the St. Mary and Milk Rivers and their Tributaries in the United States and Canada, had the following apportionment provisions:

St. Mary River:

During irrigation season (April 1 to October 31):

When natural flow at international boundary is equal to or less than 666 ft^3/s (18.86 m^3/s):

- Canada receives 3/4 of flow
- U.S. receives 1/4 of flow

When natural flow at international boundary is greater than 666 ft^3/s (18.86 m^3/s):

- Canada receives 500 ft^3/s (14.16 m^3/s)
- U.S. receives 166 ft^3/s (4.7 m^3/s)
- Excess flow over 666 ft^3/s (18.86 m^3/s) is divided equally

During non-irrigation season (November 1 to March 31):

- Natural flow at international boundary is divided equally

Milk River:

During irrigation season (April 1 to October 31):

When natural flow at eastern crossing of international boundary is equal to or less than 666 ft^3/s (18.86 m^3/s):

- Canada receives 1/4 of flow
- U.S. receives 3/4 of flow

When natural flow at eastern crossing of international boundary is greater than 666 ft3/s (18.86 m^3/s):

- U.S. receives 500 ft^3/s (14.16 m^3/s)
- Canada receives 166 ft^3/s (4.7 m^3/s)
- Excess flow over 666 ft^3/s (18.86 m^3/s) is divided equally

During the non-irrigation season (November 1 to March 31):

- Natural flow at eastern crossing at international boundary is divided equally

Eastern Tributaries of the Milk River (Battle Creek, Lodge Creek and Frenchman River):

- Natural flow to be divided equally where they cross the international boundary during both the irrigation and non-irrigation seasons

Waters Not Naturally Crossing the International Boundary:

- Tributaries that rise in each country but do not flow across the international boundary are apportioned to the country in which they originate

Source: [74][77]

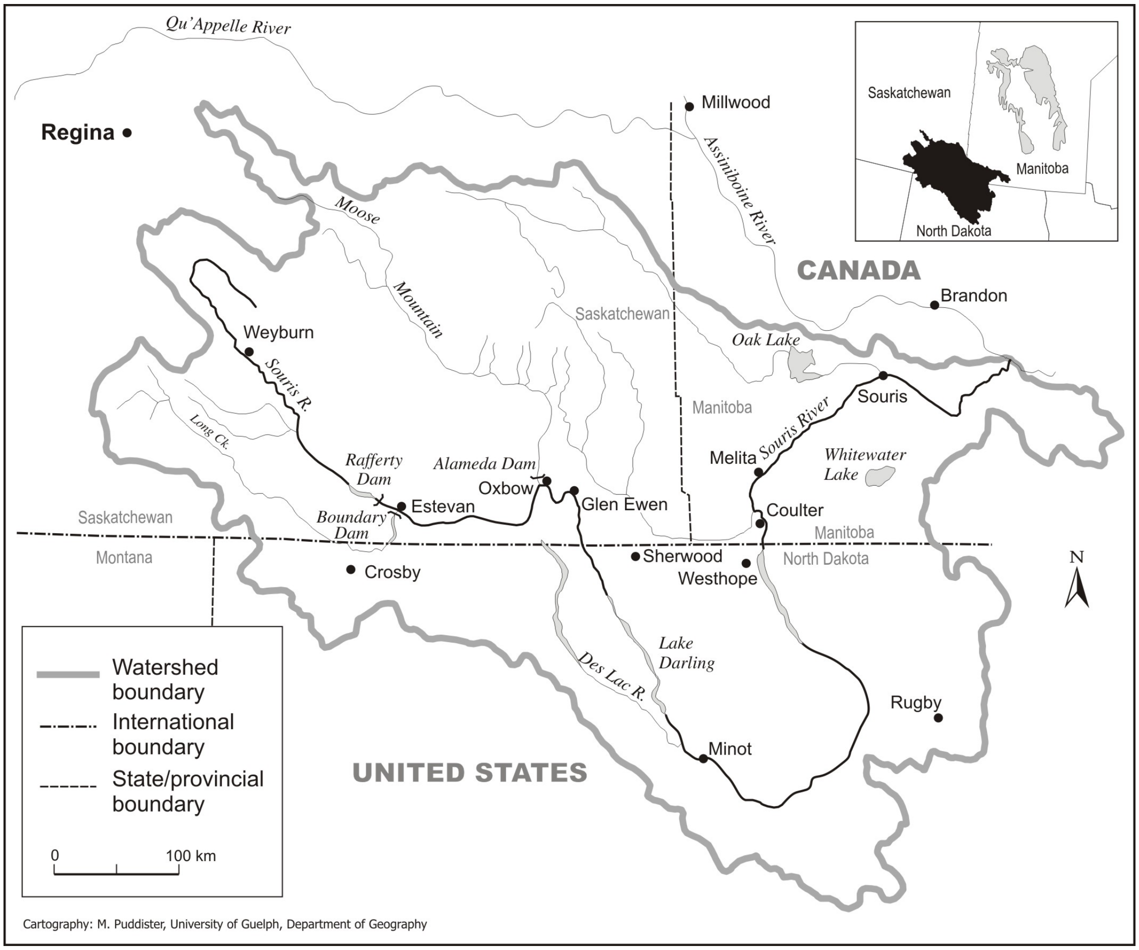
The 1921 Order still stands, although there have been several attempts to introduce changes[55]. In large part these reflect the fact that people in Montana have never entirely accepted that the 1921 Order follows the terms of the Treaty[66]. Most recently, the Governor of Montana wrote the IJC in April, 2003, requesting an evaluation of the 1921 Order pursuant to Article VI of the Treaty. Montana's concerns, elaborated in a subsequent letter from the Governor in 2004, were that the Order does not equally divide the waters of the two basins, that circumstances have changed, and that the Order was not being implemented satisfactorily[69]. Public meetings were organized by the IJC in Alberta, Saskatchewan and Montana, and in 2004 an Administrative Measures Task Force was appointed[15]. Following extensive investigation of actual diversions, the Task Force submitted its draft report in 2006[80]. It determined that of the combined natural flows of the St. Mary River, the Milk River and the eastern tributaries at the international boundary, the US's entitlement is 45%, but historically it has diverted or received 41%. The Canadian entitlement of the combined natural flows of the two rivers and tributaries is 55%, but historically it has diverted or received 59%. The shortfall in water diverted by the US from the St. Mary River, the report indicates, is partially offset by Canada being unable to fully divert its entitlement of the Milk River and Eastern Tributaries[80]. The IJC is continuing its deliberations regarding Montana's concerns. In the meantime, however, Commission staff are seeking ways for Alberta and Montana to strengthen cooperation on the joint management of water resources in the two basins through the Montana-Alberta St. Mary and Milk Rivers Water Management Initiative[78][112].

5.3. Souris River Basin

The Souris River Basin is located along the international boundary in southeast Saskatchewan, north-central North Dakota, and southwest Manitoba (Figure 7). It covers an area of approximately 63,714 km^2 (24,600 mi^2)[166]. Originating in Saskatchewan, the Souris River flows across the international boundary near Sherwood, North Dakota and loops back through North Dakota to re-cross the boundary near Westhope. It then flows through southwestern Manitoba, where it joints the Assiniboine River southeast of Brandon. The Assiniboine then flows into the Red River at Winnipeg, Manitoba.

Throughout its approximately 700 km (270 mi), the Souris River's valley bottom is flat, shallow and extensively cultivated[76]. Several communities in Manitoba, Saskatchewan and North Dakota rely on the Souris River for all or part of their water supply. For example, Minot, North Dakota (population 35,000) takes its water supply from groundwater pumped from aquifers that are recharged by the Souris River. Also in North Dakota, the Upper Souris and J. Clark Salyer National Wildlife Refuges rely on the Souris River to maintain the habitat for fish and migratory birds[166]. The basin's semi-arid prairie climate creates a region of extremes. Periodic droughts result in extremely low flows, and spring snowmelt regularly triggers severe flooding[41]. Consequently, flood control and the provision of adequate water supplies have been long-standing objective of water management in the basin[41]. Major reservoirs constructed in the basin for these purposes include the Boundary, Rafferty and Alameda Reservoirs in Saskatchewan and Lake Darling in

Figure 7: Souris River Basin



North Dakota. Wildlife refuges and small impoundments are found along the US portion of the river[76][166].

Apportionment in the Souris River basin has been recognized as a concern by the United States and Canada since 1940. In January 1940, Canada and the United States asked the IJC to investigate water use, regulation and flow on the Souris River and its tributaries, and to make recommendations regarding apportionment[76]. The Interim Measures recommended by the Commission in 1940 were approved in 1941. These were modified in 1959, primarily because of the construction of the Boundary Dam and the associated Boundary Generating Station. The International Souris River Board of Control was created in 1959 to monitor compliance with the Interim Measures[76]. Further changes to apportionment arrangements were made after the 1989 *Canada-United States Agreement for Water Supply and Flood Control in the Souris River Basin* (Box 5) was concluded due to construction of the Rafferty and Alameda dams. The most recent adjustment to the basin's apportionment arrangements are contained in the 2007 *Directive to the International Souris River Board, Interim Measures as Modified for Apportionment of the Souris River*[77]. Thus, today apportionment in the Souris River basin occurs through arrangement specified in Box 6, under the supervision of the International Souris River Board (ISRB).

Box 5: Canada–United States Agreement for Water Supply and Flood Control in the Souris River Basin

The *Canada-United States Agreement for Water Supply and Flood Control in the Souris River Basin* was concluded in 1989. This agreement was developed primarily to address flooding in the United States and water supply concerns in Canada. It centred on two dams that would be constructed in Canada to provide flood storage capacity: the Rafferty Dam on the Souris River above Estevan, Saskatchewan, and the Alameda Dam on Moose Mountain Creek above Oxbow, Saskatchewan (Figure 7). The 1989 agreement had the following key features:

- The two dams would be built by Canada subject to mutually agreed design standards.
- The United States agreed to pay Canada $26.7 million (1985 US currency) for flood control storage at Rafferty Dam and $14.4 million (1985 US currency) for flood control storage at the Alameda Dam.
- Canada agreed to provide 466,000 dam^3 (377,792 acre feet) of flood storage in the two reservoirs.
- Saskatchewan would be responsible for operating the dams.
- An Operating Plan for the reservoirs would be developed to ensure flood protection and water supply objectives are met. The plan would be reviewed at five year intervals (or as mutually agreed).
- The Souris River Bilateral Water Quality Monitoring Group was created to address water quality concerns in the basin.

The agreement was formally revised through exchange of letters in 2005 to include a reference under Article IX of the *Boundary Waters Treaty of 1909,* which assigns water quality responsibilities contained in the 1989 Agreement to the IJC.

Source: [63][77]

The ISRB is responsible for assisting the IJC to prevent and resolve transboundary water quantity and quality issues in the Souris River basin. The ISRB was created in 2002 by combining the International Souris River Board of Control and the Souris River aspects of the International Souris-Red Rivers Engineering Board (which had been created in 1948 to report on water use and development activities in the Souris, Red, Poplar and Big Muddy river basins[76]). The functions of the Souris River Bilateral Water Quality Monitoring Group, created in the 1989 Agreement, were added to the ISRB in 2007[50].

Box 6: Apportionment of the Souris River

The 2007 *Directive to the International Souris River Board, Interim Measures as Modified for Apportionment of the Souris River* establishes the apportionment regime:

- Saskatchewan has the right to divert, store and use water that originates in its portion of the basin so long as the calculated annual natural flow of the river at Sherwood Crossing, as determined by the ISRB, is not diminished by more than 50%. At the same time, for benefit of riparian water users between Sherwood Crossing and the upstream end of Lake Darling, Saskatchewan will, as far as is practicable, ensure that the flow of the Souris River at the Sherwood Crossing is not less than 0.133 m^3/s (reported as 4 ft^3/s in the Directive) when that flow would have occurred prior to construction of the Boundary, Rafferty and Alameda dams.
- In recognition of evaporative losses from the Rafferty and Alameda reservoirs, and under specific circumstances noted, Saskatchewan is entitled to pass only 40% of the annual natural flow at Sherwood Crossing to North Dakota.
- Notwithstanding the above, Saskatchewan will, as far as is practicable, deliver to North Dakota before June 1st 50% of the first 50,000 dam^3 (40,500 acre feet) of natural flow occurring between January 1 and May 31. This is so that North Dakota can try to meet existing senior water rights.
- Lake Darling and the Canadian reservoirs will be operated (insofar as is compatible with the Projects' purposes and consistent with past practices) to ensure that the pool elevations, which determine conditions for sharing evaporative losses, are not artificially altered.
- As much as possible, flow releases to the United States are to occur as they would have under natural conditions. Balanced against this provision, Saskatchewan is expected to release water in a way that reflects periods of beneficial use in North Dakota.
- Circumstances under which flow releases by Saskatchewan to the United States can be delayed are identified.
- The ISRB will determine the annual apportionment balance each year on or about October 1st. Shortfalls that exist as of that date are to be delivered to Saskatchewan prior to December 31.
- The right of North Dakota to store and use waters of the Souris River that originate in its portion of the basin, or which are delivered to it at Sherwood Crossing, is affirmed.
- Manitoba is entitled to the waters of the Souris River basin that originate in its territory and, except during severe drought, is entitled to receive from North Dakota specific amounts of water during the months of June through October. The Interim Measures as Modified for Apportionment of the Souris River directive carries forward the arrangement created in 1959, which is 6,069 acre-feet at the rate of 20 ft^3/s (or 7,486 dam^3 at a rate of 0.566 m^3/s).
- During periods of severe drought, North Dakota's responsibility is limited to providing water for human and livestock consumption and for household uses in Manitoba as may be practicable, in the opinion of the ISRB.

Source: [63][77]

5.4. Summary

Drawing on the material presented above, this section briefly summarizes the extent to which the international benchmarks, discussed in Section 3, are addressed in the cases examined:

- *Core principles:* The *Boundary Waters Treaty of 1909* and the International Joint Commission that it created are an internationally recognized example of successful cooperative transboundary water management[44]. The principles of equitable and reasonable use of shared water courses, not causing harm to other basin states, cooperating to achieve optimal utilization and protection of international water resources, and regular exchanges of data and information are strongly reflected in actual practices. Disputes have arisen during the past century, but these have been resolved cooperatively at the professional level, or in some cases, through votes among the six commissioners of the IJC. Demonstrating the IJC's ability to act in an impartial manner, voting by commissioners along national lines is extremely rare[69].
- *Integration:* The focus of transboundary water management in the two cases examined in this section has been relatively narrow. In the St. Mary-Milk basins, the primary concern is apportionment of surface waters. Concerns such as surface water-groundwater interactions and water quality are not addressed in the 1921 order. In the Souris River basin, a broader focus has been adopted since the 1989 Agreement. Flooding, water supply, water quality and wildlife water needs are addressed in arrangements created since 1989, and the ISRB itself was created, in part, to help promote a broader, ecosystem-focused approach[76]. It is important to emphasize that the *Boundary Waters Treaty of 1909* itself focuses on transboundary surface waters, excluding groundwater and tributaries that do not cross the boundary. Thus, where a more integrated approach has been adopted, such as in the Great Lakes basin, this has occurred through complementary arrangements. A key example is the *Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement* and the *Great Lakes-St. Lawrence River Basin Water Resources Compact* under the *Great Lakes Charter and Annex 2001*[32].
- *Ecosystem protection:* Ecosystem protection was not a concern in 1909, when the *Boundary Waters Treaty* was created[69], and was not addressed in the 1921 Order relating to the St. Mary and Milk rivers. Similarly, the original apportionment arrangements in the Souris River basin did not address the needs of aquatic ecosystems. Under the 1989 Agreement, Operating Plans for basin reservoirs should reflect ecosystem needs (although the focus is primarily on flood control and water supply). Hence, as much as possible, flow releases to the United States are supposed to occur as they would have under natural conditions.
- *Public involvement:* The IJC plays a critical role in facilitating public involvement in transboundary water management along the Canada-United States boundary. For example, in the recent debate regarding the 1921 Order, the Commission held hearings in

communities across the basin, and received submissions from government agencies, non-government organizations, Aboriginal communities, and private citizens that addressed a range of issues, including drought, water shortages, instream flow needs, recreational issues and a series of administrative concerns relating to apportionment[69]. Other forums for public involvement also exist apart from the IJC. For instance, the Rafferty and Alameda dams were subject to an environmental assessment under Canada's process[64]. This process included a public involvement phase.

- *Shared governance: The Boundary Waters Treaty of 1909* is an agreement between two sovereign countries, and thus they play the dominant role in transboundary apportionment issues. The fact that states and provinces had major interests in decision making regarding boundary waters was recognized during the negotiations that created the Treaty, but they are not formal parties. Nonetheless, opportunities for involving state and provincial agencies have, in practice, been created through membership of boards such as the ISRB, which currently has 11 members including representatives from Manitoba, Saskatchewan, and North Dakota government agencies as well as federal officials. This approach allows for professionals to build long lasting relationships that facilitate a non-political approach to dealing with transboundary water concerns[14]. Overall, however, transboundary water governance in the cases examined here is not distributed much beyond governments.
- *Adaptability and flexibility:* A measure of flexibility and adaptability have been hallmarks of transboundary water management in the cases examined in this section. It is true that apportionment of the St. Mary-Milk rivers is "locked in" by virtue of the provisions established in Article VI of the Treaty and in the 1921 Order[69]. As suggested in Section 3, this approach does not facilitate flexibility and adaptation to changed circumstances. Nonetheless, in the St. Mary-Milk river basins the two countries have used tools such as Letters of Intent signed by the Accredited Officers to create flexibility in the administration of the Treaty's provisions[69]. In the case of the Souris River basin, apportionment arrangements establish specific requirements that are increasingly difficult to meet[17]. However, flexibility is promoted through measures that recognize the variability of flows. More fundamentally, in both cases examined here the United States and Canada have demonstrated considerable willingness to seek mutually-beneficial solutions to changed conditions. For example, even though the 1921 Order was not changed as Montana wished, the process of considering the issues has led to an initiative to strengthen cooperation between Alberta and Montana.

6. Conclusions and Recommendations

Stress on water resources in many shared basins around the world is growing in the face of population growth, contamination, demands for ecosystem protection and climate change. As a result, effective transboundary water management has become an international priority. Two international cases were examined in this study: the Murray-Darling basin in Australia and the Orange-Senqu basin in southern Africa. In both basins, pressures on water resources are severe and growing, and the parties involved have recognized that the issues they face cannot be solved unilaterally.

Canada and the United States face water management problems in the Red River basin that warrant development of an apportionment agreement. Flooding is a major concern in the basin, but numerous other issues exist that call for cooperative management of the basin's water resources. Problems in the Red River basin are not nearly as severe as those currently being experienced in the Murray-Darling and Orange-Senqu basins. However, this must be seen as a reason for *action* rather than *inaction*. An opportunity currently exists to establish robust transboundary water governance arrangements in the basin that can accommodate expected (and unexpected) future circumstances.

This section has two main components:

- In Section 6.1, models and strategies for apportioning transboundary waters are synthesized from the review of literature in Section 3 and the detailed case studies presented in Sections 4 and 5. A summary of considerations that define the appropriateness of the various apportionment models is presented. These address factors that influence the ability to create and implement the various models.
- In Section 6.2, considerations that define the appropriateness of the various apportionment models are explored in the context of the Red River basin. Based on this discussion, approaches to apportionment and transboundary water governance are suggested for the basin. Key considerations that should be addressed in these arrangements are identified, and potential impacts on water management practices in the basin are explored.

6.1. Models and Strategies for Apportionment

Numerous models for apportioning transboundary water resources exist. Within each of these models, specific strategies can be used to accomplish apportionment goals. This is illustrated in the following examples:

- The most straightforward apportionment model involves single-purpose arrangements designed to equitably divide flows of surface waters crossing a boundary between two or more jurisdictions. The 1921 Order regarding the St. Mary and Milk Rivers is an example of such an arrangement. It apportions flows of transboundary surface water between Canada and the United States, and specifies procedures for measuring, monitoring and reporting. In terms of surface water apportionment strategies (Box 3), the

1921 Order uses a combination of prior appropriations of flows at certain time periods for each country, along with percentage shares of flow. The 1921 Order does not create new bodies for joint management, and it does not address concerns other than flow apportionment, e.g., groundwater-surface water interactions, water quality, or ecosystem flow needs.

- Single-purpose arrangements may, in addition to apportioning flows of water, establish agreements regarding development of infrastructure that will be needed to provide specific amounts of water to the various parties. The *Treaty of the Lesotho Highlands Water Project* is an example of this type of arrangement. It created a number of bodies for joint management, identified plans for infrastructure, and established cost sharing and benefit sharing arrangements. In terms of surface water apportionment strategies, the Treaty specifies guaranteed volumes of surface water that will be delivered by Lesotho to South Africa each year at various stages of the project.
- Apportionment also can be set within a larger framework for basin-scale water management and governance. The current *Murray-Darling Basin Agreement* is an example of this comprehensive approach. The Agreement not only addresses apportionment of surface water among the basin states, but also deals with issues such as water quality, salinity, land degradation, groundwater quality and quantity, and ecosystem needs. Numerous surface water apportionment strategies are used in the Agreement, including guarantees of volumes and flows, percentages of flows, and storage limitations (Box 3). Inter-state water trading also is established as a surface and groundwater strategy under the Agreement.
- Finally, the case of transboundary water governance in the Orange-Senqu basin demonstrates a hybrid model. Specific arrangements such as the *Treaty of the Lesotho Highlands Water Project* and the Agreement that established the Vioolsdrift and Noordoewer Joint Irrigation Scheme are nested within a larger structure, the Agreement on the establishment of the Orange-Senqu River Commission.

These examples demonstrate that jurisdictions sharing transboundary basins can draw from an enormous menu of broad *models* (from narrow, single-purpose arrangements to broad, comprehensive frameworks), and can use many different *strategies* for apportioning surface water and groundwater resources. It is important to emphasize, however, that no one model or strategy is universally appropriate. For instance, arrangements that apportion flows of transboundary surface water bodies are not necessarily better than those that divide benefits. Single purpose arrangements that simply divide surface water equitably between countries are not necessarily inferior to complex, basin-scale arrangements that address surface water, groundwater and a host of other considerations. Instead, arrangements should be evaluated based on the extent to which they both reflect international norms and best practices (as outlined in Section 3) and their appropriateness relative to local circumstances such as the following:

- Nature of the climate and water resources in the shared basin (e.g., annual and inter-annual flow patterns in shared rivers and streams, groundwater-surface water interactions, water quality, drought frequency and magnitude, flood risk).
- Consistency with existing arrangements for transboundary water management and with water allocation systems in each basin jurisdiction.
- Past history of cooperation between basin jurisdictions, and current ability and willingness of these jurisdictions to act jointly to achieve their mutual interests.
- Existing and future potential in the basin to regulate surface water flows using reservoirs and diversions.
- Technical, social and financial capacity of the jurisdictions involved (e.g., availability of staff with skills needed to facilitate shared governance and model complex hydrological systems; and level of organization, interaction and interest among citizens and non-government organizations).
- Quality and availability of data and information relating to water resources and water uses needed to support joint decision making through hydrological modelling (e.g., for purposes of calculating the natural flow); and to forecast future climatological, hydrological and socio-economic conditions.
- Current and future pressures on water resources from human uses, e.g., current and future urban and rural populations; agricultural production (irrigated and non-irrigated); industry; natural variability; and climate change.
- Existing environmental quality, and water needed to attain desired future environmental quality.

6.2. Recommended Model for the Red River Basin

Options and opportunities for apportionment of the water resources of the Red River basin are discussed in this section. Circumstances in the basin are discussed relative to the considerations outlined in Section 6.1. Building on these considerations, several key assumptions are outlined and a recommended model for apportionment and transboundary water governance in the basin is presented.

Specific Considerations

Section 2 characterized the basin in terms of its physiography, climatology and hydrology, population and economy. Drawing on that information, the following "local circumstances" influence the apportionment models and strategies that will be appropriate for the basin:

- Under the *Boundary Waters Treaty of 1909*, the United States and Canada have set an internationally-recognized example of successful transboundary water management and governance. Previous apportionment arrangements, such as the ones in effect in the St. Mary-Milk River basins, the Souris River basin, and the Great Lakes basin, demonstrate the willingness of the two countries to act jointly to achieve their mutual interests.

- In the Red River basin, water management relationships between the two countries extend beyond those formed through the International Joint Commission and the work of the International Red River Board. For example, the Red River Basin Commission – a non-government organization – is actively advancing a basin-wide, integrated watershed management agenda. Through its Board, the Commission has representation from the two federal governments; South Dakota, North Dakota, Minnesota and Manitoba; local governments; Aboriginal people; and environmental organizations.
- In spring and early summer the concern in the basin normally is high flows rather than low flows. Therefore, pressure for apportionment of scarce water resources normally will be strongest during late summer and fall. Climate change is expected to reinforce this concern, with low minimum flows such as those experienced in the 1930s becoming more common in the fall and winter. The seasonality of flows will be an important consideration in any apportionment arrangement.
- Since records have been kept in the basin, there have been occasions when demands for water for human uses could not be met due to drought and limited streamflow (e.g., during the 1930s). In future, the combination of increased periods of low flow combined with enlarged demands from municipal, industrial and agricultural water users may lead to more frequent water shortages. Addressing ecological flow needs and human demands during these periods is a growing concern.
- Concerns exist regarding water quality due to runoff from land use practices and discharges from sewage treatment plants. Habitat degradation also is a concern in portions of the basin, and serious water quality problems exist in Lake Winnipeg. Overall, however, the natural environment of the basin is not considered severely degraded.
- The potential for additional large-scale storage to alleviate high flood peaks (beyond existing facilities in the upstream portion of the basin) was explored by the IJC following the 1997 flood, and found to be neither economically nor environmentally feasible. However, the need for, and viability of, storage on the Red River or its tributaries to augment low flows to meet basic human and environmental needs in the basin is a subject for further study.

Recommended Model

This section illustrates in broad strokes an approach to transboundary water governance and apportionment for the Red River basin. Concerns that should be addressed are identified, key assumptions are noted, and options are outlined. Any apportionment arrangement that is developed for the Red River basin by the United States and Canada will be the product of extensive consultation, negotiation and detailed study. Thus, the recommended model presented in this section should be viewed as an illustration of an option that fits the specific considerations outlined above. It is not based on the kind of detailed legal and technical analysis that will be necessary as part of negotiations to produce an agreement.

The model discussed in this section has two main elements: (1) a framework of overall goals and objectives for the basin, which could be developed outside of the scope of the *Boundary Waters Treaty of 1909*; and (2) an apportionment agreement developed within the scope of the Treaty, but in a manner that reflects overall basin goals and objectives. Box 7 outlines key underlying assumptions that shape the recommended model described here. Box 8 describes how the recommended model achieves the benchmarks for transboundary water governance that were used throughout this report.

This model has many practical benefits, discussed below. Fundamentally, though, it is appropriate for circumstances in the basin because while Canada and the United States have the *authority* to apportion the transboundary waters of the Red River basin, the *consequences* of apportionment decisions will be borne by state/provincial governments, Tribes and First Nations, local communities and individual water users.

Overall Goals and Objectives

International experiences support the importance of approaching apportionment of transboundary waters in the context of overall basin-wide goals and objectives for governance, economic development, environmental conditions, and other pertinent concerns. Two approaches, among the many ways in which such a basin-wide perspective can be formed, were discussed in Section 4.

A basin-wide perspective already is being promoted by the Red River Basin Commission. The Commission's *Natural Resources Framework Plan*[132] outlines a vision and specific goals for water management, land use, habitat and other related concerns. *An apportionment agreement made between the United States and Canada under the* Boundary Waters Treaty of 1909 *clearly cannot be subordinate to a basin plan developed by a non-government organization*. Nevertheless, such an agreement should reflect, and be cognizant of, the needs, aspirations, and concerns of state/provincial governments, local governments, industrial and agricultural water users, Tribal and First Nations interests, environmental organizations and the general public in the Red River basin. If the Commission's *Framework Plan* is not considered an appropriate source of overall goals and objectives, then a collaborative process should be used to create a basin-wide perspective.

Basin-wide goals and objectives will be addressed through the actions of a wide range of stakeholders. These actions include watershed and sub-watershed planning efforts; municipal water supply and conservation planning programs; state/provincial water allocation decision making; drought contingency planning; and actions by individual water users. Ideally, land use planning and economic development also will reflect overall goals and objectives for the basin's water resources. Apportionment of transboundary waters in the context of an agreement made under the *Boundary Waters Treaty of 1909* determines how much water is available for purposes such as environmental protection and economic development. Therefore, an apportionment agreement also is a key means of accomplishing basin-wide goals and objectives for water.

Elements of an Apportionment Agreement

Presuming that overall goals and objectives for water management in the basin have been formulated and accepted by the various stakeholders, a complementary apportionment agreement should be developed. Reflecting the assumptions presented in Box 7, this agreement should have the following basic elements:

1. A prior appropriation to meet critical human and environmental needs.
2. Rules to apportion remaining natural flows between Canada and the United States based on the principle of equitable sharing.
3. Rules regarding waters that originate in the respective countries' portion of the basin but do not cross the boundary.

The second and third elements are common features of many apportionment arrangements. The environmental focus of the first element is a departure from conventional practice, but it is an important opportunity to achieving the IJC's concern for ecosystem protection.

Critical human needs should be protected through a prior appropriation. Human needs considered critical can be defined in a number of ways. In the Souris River basin, critical human needs for Manitoba were defined as basic domestic water supply and water

Box 7: Assumptions Underlying the Recommended Model

- As reflected in the terms of reference for this project, the IJC, through the International Red River Board (IRRB), supports an integrated, participatory approach to dealing with transboundary apportionment issues. Given that the mandate of the IRRB encourages protection of the aquatic ecosystem of the basin, it is assumed that protection and enhancement of environmental features is a priority.
- The Boundary Waters Treaty of 1909 will provide the framework within which transboundary waters are apportioned. Concerns identified as important during negotiations, but which are not within the scope of the Treaty, will necessarily be addressed separately (e.g., apportionment of groundwater, tributaries that do not cross the boundary).
- Manitoba, North Dakota and Minnesota (the boundary states/province) have jurisdiction over water allocation within their boundaries. While these systems may need be adjusted in future, they will not be completely replaced (e.g., with market-based water trading systems). Water trading between the states/province (let alone between Canada and the United States) is not expected to be a consideration.
- Large-scale infrastructure development in the Red River Basin, whether for flood control or for low flow amelioration, will not be a significant consideration in negotiations relating to development of an apportionment agreement. However, small-scale infrastructure (e.g., for community water supplies or for individual farm operations) may be part of an overall strategy for drought mitigation in the basin, and should be considered in an apportionment agreement.

Box 8: Achieving the Benchmarks in the Recommended Model

Benchmarks for effective transboundary water governance were used throughout this report. The extent to which the model outlined in Section 6.2 could meet those benchmarks is discussed here.

- *Integration*: An agreed set of goals and objectives for water management, land use and habitat in the basin could provide a framework for the various stakeholders to integrate their activities. For example, groundwater withdrawals regulated by state/provincial governments could be coordinated with shares of natural flows determined under an apportionment agreement. Similarly, the apportionment agreement will clarify volumes of flow at certain times of the year, but water quality must be protected and enhanced through the actions of land owners, municipalities, stewardship groups, and state/provincial governments.
- *Ecosystem protection*: Critical ecosystem features in transboundary sub-watersheds should be identified through collaborative basin-planning exercises. Water to meet these needs in transboundary sub-watersheds will be provided through prior appropriations under an apportionment agreement. However, state/provincial governments will have to take steps to ensure that these needs are met, and that related concerns such as groundwater-surface water interactions are addressed.
- *Public involvement*: Citizen involvement is required to determine overall goals and objectives for the basin. Public support of the priorities established for the basin, especially regarding water conservation and environmental water needs, is a prerequisite.
- *Shared governance*: The IJC and the IRRB will be responsible for apportionment, but basin-wide goals and objectives cannot be met by these agencies alone. Full participation by state/provincial governments, non-government organizations such as the Red River Basin Commission, municipalities, watershed management districts, industries, and others is needed. Thus, governance is inherently shared under the option proposed here. Given that parties on both sides of the border have interests that do not necessarily align, governance mechanisms must incorporate clear rules and procedures to resolve disagreements and conflicts.
- *Adaptability and flexibility*: Regular review and updating of overall basin goals and objectives will be needed to permit adaptation to changed climatic and socio-economic conditions. To facilitate adaptation and to permit flexibility in apportionment of transboundary waters, the model described here assigns responsibility for dealing with emergency situations, adjusting environmental flows, and accommodating changes in demand on both sides of the basin to the IRRB.

needed to maintain livestock health. Under Australia's *Water Act 2007*, "critical human needs" also are defined in a way that facilitates decision making (see Section 4.1). Importantly, any definition of critical human needs should assume that best practices relating to water conservation are in place prior to a human need being defined as "critical".

Needs will change over time. Therefore, provisions will be required to deal with situations such as population growth or the expansion of livestock production in areas dependent on transboundary waters. As part of a process designed to provide a basin-wide perspective, it will be necessary to consider how much growth in the human uses that have been defined as "critical" can be supported by the basin's water resources. High quality data on withdrawals and consumption will be needed for this purpose.

Experiences from the two international basins, examined in this report, demonstrate unequivocally that protecting environmental conditions and restoring degraded environmental features is extremely difficult once water shortages become severe. In fact, in both basins many people believe it is already too late, and that critical aquatic ecosystems cannot be restored. To avoid this situation in the Red River basin, an apportionment agreement should provide a *prior appropriation for water needed to meet environmental needs* relating to wetlands, riparian habitat, instream flow needs, and other environmental features considered significant. Among the many strategies described in Box 3, two could be used to apportion water for critical environmental needs of the transboundary watersheds of the Red River basin:

- First, a volume of flow needed to meet critical environmental needs in each transboundary watershed could be determined on a seasonal basis. Specific rules would be needed to deal with situations of extreme low flows below the seasonally-appropriate amount, and to accommodate changes in environmental conditions and new knowledge. Rather than fully specifying these rules in an agreement (making them difficult to change), international best practices suggest that room for flexibility should be created by empowering a body such as the IRRB to determine the most effective way to deal with extremes and changed circumstances.
- Second, the "hydrological models" strategy described in Box 3 could be used. Rather than a fixed prior appropriation for the environment that is adjusted on an emergency basis, apportionment for the environment could occur flexibly in each transboundary watershed based on modelled conditions. This approach is more complicated, but readily accommodates changes in climatic conditions, new knowledge, and other considerations.

Determination of environmental water needs is extremely complicated and requires balancing scientific information and public values. However, experiences with catchment management planning in Australia, and in many other countries, demonstrates that it can be done using the strategies described above. Regardless of which strategy is adopted, it will be necessary for the state/provincial governments, which are responsible for allocating waters within their territories, to ensure that transboundary waters apportioned for critical environmental needs are used for those purposes. This most likely will require adjustments to state/provincial water allocation systems. For instance, clear policies and procedures will be needed for times of extreme low flows when human needs not falling under the "critical" definition cannot be met. At the same time, broad public support for this approach must be built because during times of low flow, some water users will see water being provided to the environment while their own critical human needs go unmet.

Once water has been provided for critical human and environmental needs in transboundary watersheds, the *remaining natural flow must be divided equitably to meet existing and future human needs that have not been defined as "critical"*. In Minnesota, North Dakota, South Dakota and Manitoba, towns and cities, industries, farmers, and other water users are allocated water from transboundary watercourses through state/provincial water allocation systems. As much as possible, the apportionment agreement created by the United States and Canada should account for these pre-existing allocations (i.e., volumes of water and timing of uses). Therefore, accurate measurement of actual water use in each jurisdiction is a priority. Likely future water demands in various sectors also should be taken into account (e.g., expected increases in demand due to urban population growth). Two of the strategies described in Box 3 are feasible in this context.

- Apportionment could be based on actual needs (current and future). Once these needs are determined in each country, natural flows of transboundary rivers and streams can be apportioned with the goal of meeting those needs during the times when they actually occur (e.g., irrigators require water primarily in summer and fall). As actual needs change, the apportionment of natural flows would be adjusted.
- Alternatively, in each transboundary watershed, natural flows above the amount needed to meet critical human and environmental needs could be divided between the two countries based on an agreed proportion. An equitable division is not necessarily an equal division, but this should be the starting point.

As is noted in Box 3, the first alternative (division based on actual needs) requires treating the basin as an integrated whole. This approach permits flexible adaptation to changed circumstances. However, of the two strategies it is the most difficult to implement because of jurisdictional concerns (two countries, and four distinct state/provincial water allocation systems) and data needs (high quality data on withdrawals and consumption will be required). Furthermore, under this approach, rules will be required to ensure that "needs" are reasonable, e.g., increased demand for water in a town that has made no effort to conserve water may not be viewed as a legitimate need. Agreements made under the Great Lakes Charter and Annex 2001 address these kinds of concerns[32]. For example, the *Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement* identifies "Environmentally Sound and Economically Feasible Water Conservation Measures" as a guide for decision making regarding withdrawals and consumptive uses from the Great Lakes.

The second strategy is much more straightforward, and is therefore recommended. Under this approach, risk of water shortage is shared equitably between the two countries. The IJC would have two critical roles: (1) for each transboundary watershed, determining the natural flow and the amount of water that is available for division between the two countries after prior appropriations for critical human and environmental needs have been met;

and (2) conducting the monitoring needed to ensure that the two countries receive their agreed share. Importantly, in order for the IJC to determine the natural flow, accurate water use data on both sides of the boundary will be needed. Once the proportion of the natural flow to each country is determined for each transboundary watershed, it may be necessary to apportion the United States share among the three basin states through separate agreements among those states.

Additional implications for water management in the two countries that follow from using the recommended strategy include the following:

- State/provincial governments in the basin will have to plan for various scenarios of water availability based on observed and predicted patterns of streamflow. For instance, they will need to ensure that total available allocations are not exceeded, and that appropriate risk management measures are put in place (e.g., enhancement of community water supplies, water conservation programs, drought contingency plans).
- Individual water rights holders will need to manage risks associated with insufficient water availability through investments in water conservation technologies, creation of small-scale storage facilities, and shifts in practices.

These kinds of activities already are occurring in the basin. However, they will have to be undertaken in a more systematic fashion that reflects risks of water shortage in each transboundary watershed that have been defined more clearly through the agreement.

The final element of the recommended apportionment model relates to *waters that originate in the respective countries' portion of the basin but do not cross the boundary*. Apportionment arrangements in the Souris Basin provide a straightforward solution: water that originates within each country's portion of the basin can be used and stored by the state/province within which the water originates, with two conditions: (1) use and storage does not compromise the agreed prior appropriations for critical human and environmental needs, and (2) use and storage does not compromise agreed shares of the remaining natural flow above those prior appropriations.

Summary

Within the broad model recommended here, several strategies with varying degrees of complexity are available. As experience with the 1921 Order for the St. Mary-Milk River basins demonstrates, it can be extremely difficult to change an apportionment agreement when water is scarce. Therefore, there is merit in selecting straightforward strategies that permit flexibility and adaptation to changed circumstances. Examples of such strategies were provided above.

The 1921 Order offers a second important example for the Red River basin. In the early years of the 20th century, the population and economy of the St. Mary-Milk basins was quite small, and federal governments had important day-to-day responsibilities. For instance, the Province of Alberta existed in 1921, but the Government of Canada was directly responsible for water allocation within its territory[34]. Today, in the Red River basin, Canada and the United States have specific responsibilities under the *Boundary Waters Treaty of 1909*. However, state/provincial governments, municipalities, Tribes and First Nations, and water users are critical stakeholders because they – not the governments of Canada and the United States – will most directly experience the consequences of a poorly designed – or non-existent – apportionment arrangement. Thus, it is vital that they be involved in decisions regarding the apportionment model that is developed.

7. Reference List

1 Affeltranger, B. and Otte, A. 2003. Shared freshwater resources: management or governance? In *Transboundary Rivers, Sovereignty and Development: Hydropolitical Drivers in the Okavango River Basin,* eds. A. Turton, P. Ashton, and E. Cloete, 251-274. Pretoria, South Africa: African Water Issues Research Unit, Centre for International Political Studies, University of Pretoria.

2 Alaerts, G. J. and Dickinson, N. L. 2009. *Water for a Changing World – Developing Local Knowledge and Capacity* Leiden: CRC Press.

3 Allan, T. 2003. *IWRM/IWRAM: A New Sanctioned Discourse?*, Occasional Paper 50 London: SOAS Water Issues Study Group, University of London.

4 Amakali, M. 2009. *Historical Background Information on the Bilateral Negotiation Between Namibia and South Africa on the Sharing of Water of the Orange River* Namibia: Ministry of Agriculture, Water and Forestry.

5 Ashton, P. J., Earle, A., Malzbender, D., Moloi, M. B. H., Patrick, M. J., and Turton, A. R. 2006. *A Complilation of All the International Freshwater Agreements Entered into by South Africa With Other States: Report to the Water Research Commission*, WRC Report No. 1515/1/06: Water Research Commission.

6 Australian Bureau of Statistics. 2008. *2008 Year Book Australia*, ABS Catalogue No. 1301.0. Number 90 Canberra: Australian Bureau of Statistics.

7 Australian Bureau of Statistics. 2008. *Water and the Murray-Darling Basin. A Statistical Profile 2000-01 to 2005-06*, ABS Catalogue No. 4610.0.55.007 Canberra: Australian Bureau of Statistics.

8 Australian Government. 2009. The Living Murray Initiative. Available at http://www.environment.gov.au/water/mdb/lmi.html. Accessed March 21, 2009.

9 Backeberg, G. R. 2005. Water institutional reforms in South Africa. *Water Policy,* 7, 107-123.

10 Bergkamp, G., Orlando, B., and Burton, I. 2003. *Change: Adaptation of Water Resources Management to Climate Change* Gland, Switzerland and Cambridge, UK: IUCN.

11 Bhat, A. 2009. The politics of model maintenance: the Murray Darling and Brantas River Basins compared. *Water Alternatives,* 1 (2), 201-218.

12 Biswas, A. K. 2004. Integrated water resources management: a reassessment. *International Water Resources Association,* 29 (2), 248-256.

13 Bjornlund, H. 2003. Efficient water market mechanisms to cope with water scarcity. *Water Resources Development,* 19 (4), 553-567.

14 Bourget, L. and Clamen, M. 1998. Managing extremes: the IJC experience. *Canadian Water Resources Journal,* 23 (2), 135-142.

15 Bourget, L. and Clamen, M. 2005. Agreements and questions on water apportionment in the St. Mary and Milk rivers. In World Water Congress 2005: Impacts of Global Climate Change - Proceedings of the 2005 World Water and Environmental Resources Congress, 15-5-2005. Anchorage, AK: American Society of Civil Engineers.

16 Brouwer, R., Georgiou, S., and Turner, R. K. 2003. Integrated assessment and sustainable water and wetland management: a review of concepts and methods. *Integrated Assessment,* 4 (3), 172-184.

17 Bruce, J. P., Martin, H., Colucci, P., McBean, G., McDougall, J., Shrubsole, D., Whalley, J., Halliday, R., Alden, M., Mortsch, L., and Mills, B. 2003. *Climate Change Impacts on Boundary and Transboundary Water Management* Canada: CCAF.

18 Bruch, C. 2003. Role of public participation and access to information in the management of transboundary watercourses. In *International waters in southern Africa,* ed. M. Nakayama, 38-70. Tokyo and New York: United Nations University Press.

19 Bruch, C., Jansky, L., Nakayama, M., and Salewicz, K. A. 2005. *Public Participation in the Governance of International Freshwater Resources* Tokyo, New York and Paris: United Nations University Press.

20 Bruch, C. E. 2004. New tools for governing international watercourses. *Global Environmental Change Part A,* 14 (Supplement 1), 15-23.

21 Bruton, A. and De Wilde, F. 2007. *Water Security in the Murray Darling Basin*. TressCox Lawyers.

22 Canada, Department of the Interior. 1923. *Annual Report of the Department of the Interior for the Fiscal Year Ended March 31, 1922* Ottawa: F.A. Acland, Printer to the King's Most Excellent Majesty.

23 Carter, N., Kreutzwiser, R. D., and de Loë, R. C. 2005. Closing the circle: linking land use planning and water management at the local level. *Land Use Policy,* 22 (2), 115-127.

24 Cech, T. V. 2003. *Principles of Water Resources: History, Development, Management and Policy*, 2nd edition USA: John Wiley & Sons, Inc.

25 City of Winnipeg, Water and Waste Department. 2007. *Annual Report 2007. City of Winnipeg Water Supply System* Winnipeg, MB: City of Winnipeg, Water and Waste Department.

26 Cleaver, F. 1999. Paradoxes of participation: questioning participatory approaches to development. *Journal of International Development,* 11 (4), 597-612.

27 Commonwealth of Australia, State of New South Wales, State of Victoria, State of Queensland, State of South Australia, and Australian Capital Territory. 2008. Agreement on Murray-Darling Basin Reform. Made in Sydney on 3 July 2008.

28 Conca, K. 2006. *Governing Water: Contentious Transnational Politics and Global Institution Building*. Global Environmental Accord: Strategies for Sustainability and Institutional Innovation series, Series editor Choucri, N. Cambridge, Massachusetts: The MIT Press.

29 Connell, D. 2007. Responses to climate change in the Murray-Darling basin. In *International Conference on Adaptive and Integrated Water Management: Coping with Complexity and Uncertainty.* 2007.

30 Council of Australian Governments. 2004. *Intergovernmental Agreement on a National Water Initiative* Canberra, Australia: Commonwealth of Australia.

31 Council of Australian Governments, Working Group on Climate Change and Water. 2008. *Report to Council of Australian Governments - March 2008* Canberra: Council of Australian Governments.

32 Council of Great Lakes Governors. 2009. Great Lakes Water Management. The The Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement and the The Great Lakes-St. Lawrence River Basin Water Resources Compact . Available at http://www.cglg.org/projects/water/Agreement-Compact.asp.

33 Davis, M. D. 2007. Integrated water resource management and water sharing. *Journal of Water Resources Planning and Management,* 133 (5), 427-445.

34 de Loë, R. 1997. Return of the feds, part I: the St. Mary dam. *Canadian Water Resources Journal,* 22 (1), 35-44.

35 de Loë, R., Varghese, J., Ferreyra, C., and Kreutzwiser, R. 2007. *Water Allocation and Water Security in Canada: Initiating a Policy Dialogue for the 21st Century* Guelph: Guelph Water Management Group, University of Guelph.

36 de Loë, R. C. and Kreutzwiser, R. D. 2006. Challenging the status quo: the evolution of water governance in Canada. In *Eau Canada: The Future of Canadian Water Governance,* ed. K. Bakker, 85-103. Vancouver: University of British Columbia Press.

37 De Wit, M. and Stankiewicz, J. 2006. Changes in surface water supply across Africa with predicted climate change. *Science,* 311 (5769), 1917-1921.

38 DeButts, J. 2009. Supreme Court denies Georgia petition in water war with Alabama. Available at http://www.bizjournals.com/birmingham/stories/2009/01/12/daily4.html.

39 Dellapenna, J. W. 2007. Transboundary water sharing and the need for public management. *Journal of Water Resources Planning and Management,* 5 (1), 397-404.

40 Department of Water Affairs and Forestry, South Africa. 2009. Introduction To The Orange River Basin.

41 Dirschl, H., Novakowski, K., and Sadar, M. H. 1993. Evolution of environmental impact assessment as applied to watershed modification projects in Canada. *Environmental Management,* 17 (4), 545-555.

42 Dombrowsky, I. 2008. Institutional design and regime effectiveness in transboundary river management - the Elbe water quality regime. *Hydrology and Earth System Sciences,* 12, 223-238.

43 Draper, S. E. 1997. International duties and obligations for transboundary water sharing. *Journal of Water Resources Planning and Management,* 123 (6), 344-349.

44 Draper, S. E. 2006. *Sharing Water in Times of Scarcity: Guidelines and Procedures in the Development of Effective Agreements to Share Water Across Political Boundaries* Reston, VA: American Society of Civil Engineers.

45 Draper, S. E. and Kundell, J. E. 2008. Impact of climate change on transboundary water sharing. *Journal of Water Resources Planning and Management,* 133 (5), 405-415.

46 Drieschova, A., Giordano, M., and Fischhendler, I. 2008. Governance mechanisms to address flow variability in water treaties. *Global Environmental Change: Human and Policy Dimensions,* 18 (2), 285-295.

47 Dube, D. and Swatuk, L. A. 2002. Stakeholder participation in the new water management approach: a case study of the Save catchment, Zimbabwe. *Physics and Chemistry of the Earth,* 27, 867-874.

48 Dyson, M., Bergkamp, G., and Scanlon, J. 2003. *Flow: The Essentials of Environmental Flows* Gland, Switzerland: IUCN - The World Conservation Union.

49 Earle, A., Malzbender, D., Turton, A, and Manzungu, E. 2005. *A Preliminary Basin Profile of the Orange/Senqu River* Cape Town: AWIRU.

50 Environment Canada. 2009. Souris River Bilateral Water Quality Monitoring Group. Available at http://www.mb.ec.gc.ca/water/fa00s05.en.html. Accessed March 21, 2009.

51 Estrin, D. and Swaigen, J. 1993. *Environment on Trial: A Guide to Ontario Environmental Law and Policy* Toronto, Ontario: Emond Montgomery Publications Limited.

52 Falkenmark, M. 2003. Freshwater as shared between society and ecosystems: from divided approaches to integrated challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences,* 358, 2037-2049.

53 FAO Land and Water Division. 1997. *Irrigation Potential in Africa: A Basin Approach*. FAO Land and Water Bulletins - 4 series Rome: Food and Agriculture Organization of the United Nations.

54 FAO Land and Water Division. 2005. *AQUASTAT - FAO's Information System on Water and Agriculture* Rome: Food and Agriculture Organization of the United Nations.

55 Faveri, G., MacCulloch, G., Boals, R., and Halliday, R. 2005. Apportionment of the waters of the St. Mary and Milk rivers. In Reflections On Our Future: A New Century of Water Stewardship, 14-6-2005. Cambridge, ON: Canadian Water Resources Association.

56 Ferreyra, C., de Loë, R. C., and Kreutzwiser, R. D. 2008. Imagined communities, contested watersheds: challenges to integrated water resources management in agricultural areas. *Journal of Rural Studies,* 24 (3), 304-321.

57 Fischhendler, I. 2004. Legal and institutional adaptation to climate uncertainty: a study of international rivers. *Water Policy,* 6 (4), 281-302.

58 Fischhendler, I. and Feitelson, E. 2005. The formation and viability of a non-basin water management: the US–Canada case. *Geoforum,* 36, 792-804.

59 Food and Agriculture Organization of the United Nations. 1984. *Systematic Index of International Water Resources Treaties, Declarations, Acts and Cases, by Basin. Volume II. Legislative Study 34* Rome: Food and Agriculture Organization of the United Nations.

60 Furlong, K. 2006. Hidden theories, troubled waters: International relations, the 'territorial trap', and the Southern African Development Community's transboundary waters. *Political Geography,* 25 (4), 438-458.

61 Garnaut, R. 2008. *The Garnaut Climate Change Review: Final Report* Port Melbourne, Cambridge, New York and Melbourne: Cambridge University Press.

62 Giordano, M. A. and Wolf, A. T. 2003. Sharing waters: post-Rio international water management. *Natural Resources Forum,* 27 (2), 163-171.

63 Government of Canada and Government of the United States of America. 1989. Agreement Between The Government of Canada And The Government Of The United States of America For Water Supply And Flood Control In The Souris River Basin.

64 Government of Canada, Federal Environmental Assessment Review Agency. 1991. *Report of the Environmental Assessment Panel, Rafferty-Alameda Project* Ottawa, ON: Federal Environmental Assessment Review Agency.

65 Government of South Australia. 2009. Ministerial Statement – Premier Mike Rann – Constitutional Challenge on Water Trading. March 5, 2009. Accessed at http://www.premier.sa.gov.au/news.php?id=4445.

66 Gray, H. 2008. Canada / US Transboundary Water Issues looking through western Canada. Notes for a Lecture Given By The Rt. Hon. Herb Gray, P.C., C.C., Q.C., Canadian Chair of the International Joint Commission of Canada and the United

States, to the Institute for United States Policy Studies of the University of Alberta. Presented at the Law School of the University of Alberta, Edmonton, on Monday, March 17, 2008.

67 Green Cross. 2000. *National Sovereignty and International Watercourses* Geneva, Switzerland: Green Cross International.

68 Grey, D. and Sadoff, C. 2003. Beyond the river: the benefits of cooperation on international rivers. *Water Science and Technology,* 47 (6), 91-96.

69 Halliday, R. and Faveri, G. 2007. The St. Mary and Milk rivers: the 1921 order revisited. *Canadian Water Resources Journal,* 32 (1), 75-92.

70 Hearne, R. 2007. Evolving water management institutions in the Red River Basin. *Environmental Management,* 40, 842-852.

71 Heyns, P. S. V. H., Patrick, M. J., and Turton, A. R. 2008. Transboundary water resource management in southern Africa: meeting the challenge of joint planning and management in the Orange River basin. *Water Resources Development,* 24 (3), 371-383.

72 Hussey, K. and Dovers, S. 2006. Trajectories in Australian water policy. *Journal of Contemporary Water Research and Education,* 135, 36-50.

73 Intergovernmental Panel on Climate Change. 2007. Summary for policymakers. In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* eds. M. L. Parry et al., 7-22. Cambridge, UK: Intergovernmental Panel on Climate Change.

74 International Joint Commission. 1923. *In the Matter of the Measurement and Apportionment of the Waters of the St. Mary and Milk Rivers and Their Tributaries in the United States and Canada. Order, October 4, 1921. Recommendations, October 6, 1921* Washington: Government Printing Office.

75 International Joint Commission. 2000. *Living With the Red: A Report to the Governments of Canada and the United States on Reducing Flood Impacts in the Red River Basin* Washington and Ottawa: International Joint Commission.

76 International Joint Commission. 2007. International Souris River Board. http://www.ijc.org/conseil_board/souris_river/en/souris_home_accueil.htm. Accessed March 12, 2009.

77 International Joint Commission. 2007. January 27, 2007 Letter from Murray Clamen to Russ Boals, with Directive to the International Souris River Board.

78 International Joint Commission. 2007. Letter to the Montana's Governor Brian A. Schweitzer and Alberta's Premier Ed Stelmach from the International Joint Commission, Canada and United States.

79 International Joint Commission. 2009. Treaty Between the United States and Great Britain Relating to Boundary Waters, and Questions Arising Between the United States and Canada. Available at http://www.ijc.org/rel/agree/water.html.

80 International St. Mary - Milk Rivers Administrative Measures Task Force. 2006. *Report to the International Joint Commission* Ottawa and Washington: International St. Mary - Milk Rivers Administrative Measures Task Force.

81 Ivey, J. L., de Loë, R. C., and Kreutzwiser, R. D. 2006. Planning for source water protection in Ontario. *Applied Geography,* 26, 192-209.

82 Jackson, J. 2005. Citizens working across national borders: the experience in the North American Great Lakes. In *Public Participation in the Governance of International Freshwater Resources,* eds. C. Bruch et al., 118-138. Tokyo, New York and Paris: United Nations University Press.

83 Jordan, J. L. and Wolf, A. T. 2006. *Interstate Water Allocation in Alabama, Florida and Georgia: New Issues, New Methods, New Models* USA: University Press of Florida.

84 Kabat, P. and van Schaik, H. 2003. *Climate Changes the Water Rules: How Water Managers Can Cope With Today's Climate Variability and Tomorrow's Climate Change* Netherlands: Dialogue on Water and Climate.

85 Karkkainen, B. 2005. Transboundary ecosystem governance: beyond sovereignty? In *Public Participation in the Governance of International Freshwater Resources,* eds. C. Bruch et al., 73-87. Tokyo, New York and Paris: United Nations University Press.

86 Kashyap, A. 2004. Water governance: learning by developing adaptive capacity to incorporate climate variability and change. *Water Science and Technology,* 49 (7), 141-146.

87 Kidd, M. and Quinn, N. W. 2005. Public participation in southern African watercourses. In *Public Participation in the Governance of International Freshwater Resources,* eds. C. Bruch et al., 156-168. Tokyo, New York and Paris: United Nations University Press.

88 Kingdom of Lesotho. 2004. *Poverty Reduction Strategy 2004/5 -2006/7* Maseru, Lesotho: Government Printer.

89 Kingdom of Lesotho, Ministry of Finance and Development Planning, Bureau of Statistics. 2007. *2006 Lesotho Census of Population and Housing: Preliminary Results Report* Maseru, Lesotho: Bureau of Statistics.

90 Kistin, E. J. and Ashton, P. J. 2008. Adapting to change in transboundary rivers: An analysis of treaty flexibility on the Orange-Senqu River Basin. *International Journal of Water Resources Development,* 24 (3), 385-400.

91 Kistin, E. J., Ashton, P. J., Earle, A., Malzbender, D., Patrick, M. J., and Turton, A. R. 2008. An overview of the content and historical context of the international freshwater agreements that South Africa has entered into with neighbouring countries. *International Environmental Agreements: Politics, Law and Economics*.

92 Kliot, N., Shmueli, D., and Shamir, U. 2001. Institutions for management of transboundary water resources: their nature, characteristics and shortcomings. *Water Policy,* 3 (3), 229-255.

93 Koshida, G., Alden, M., Cohen, S. J., Halliday, R. A., Mortsch, L. D., Wittrock, V., and Maarouf, A. R. 2005. Drought risk management ion Canada-U.S. transboundary watersheds: now and in the future. In *Drought and Water Crises: Science, Technology, and Management Issues,* ed. D. Wilhite, 287-318. Boca Raton: Taylor & Francis.

94 Kranz, N., Interwies, E., and Vidaurre, R. 2005. *Transboundary Regimes in the Orange Senqu Basin. Contribution to NeWater Deliverable 1.3.1. Report of the NeWater Project - New Approaches to Adaptive Water Management Under Uncertainty* Berlin, Germany: Ecologic – Institute for International and European Environmental Policy.

95 Kranz, N. and Vorwerk, A. 2007. Public participation in transboundary water management. In *Amsterdam Conference on the Human Dimensions of Global Environmental Change, March 30, 2007.* Amsterdam: Institute for Environmental Studies, Vrije Universiteit.

96 Krenz, G. and Leitch, J. 1998. *A River Runs North: Managing an International River* Winnipge, MB: Red River Water Resources Council.

97 Kuehne, G. and Bjornlund, H. 2006. Frustration, confusion and uncertainty - qualitative responses from Namoi Valley irrigators. *Water,* 32, 51-55.

98 Lange, G. M., Mungatana, E., and Hassan, R. 2007. Water accounting for the Orange River Basin: An economic perspective on managing a transboundary resource. *Ecological Economics,* 61 (4), 660-670.

99 Lindemann, S. 2005. Explaining success and failure in international river basin management – lessons from southern Africa. In *The 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community.Global Environmental Change, Globalization and International Security: New Challenges for the 21st Century.* 9-10-2005. Bonn, Germany: University of Bonn.

100 Loures, F., Rieu-Clarke, A., and Vercambre, M. 2008. *Everything You Need to Know About the UN Watercourses Convention* Gland, Switzerland: World Wildlife Fund.

101 Manitoba Bureau of Statistics. 2008. *Manitoba's Future Population Growth 2009 to 2028: A Conservative View* Winnipeg, MB: Manitoba Bureau of Statistics.

102 Matthews, O. P. 1984. *Water Resources, Geography and Law* Washington, D.C.: Association of American Geographers.

103 Matthews, O. P. and St.Germain, D. 2007. Boundaries and transboundary water conflicts. *Journal of Water Resources Planning and Management,* 5 (1), 386-396.

104 Mbaiwa, J. E. 2004. Causes and possible solutions to water resource conflicts in the Okavango River Basin: The case of Angola, Namibia and Botswana. *Physics and Chemistry of the Earth,* 29 (15-18 SPEC.ISS.), 1319-1326.

105 McCaffrey, S. 2008. Convention on the Law of the Non-Navigational Uses of International Watercourses, New York, 21 May 1997. Available at http://untreaty.un.org/cod/avl/ha/clnuiw/clnuiw.html.

106 McCaffrey, S. C. 2003. The need for flexibility in freshwater treaty regimes. *Natural Resources Forum,* 27 (2), 156-162.

107 McDonald, A. T. and Kay, D. 1988. *Water Resources: Issues and Strategies* Harlow, Essex, England: Longman Scientific & Technical.

108 McNamara, P. 2007. Murray Darling Basin: Drought, Over-Allocation, Conservation. *Trust News Australia,* 14-16.

109 Milich, L. and Varady, R. G. 1998. Managing transboundary resources: lessons from river-basin accords. *Environment,* 40 (8), 10-15-35-41.

110 Milk River Watershed Council Canada. 2008. *Milk River: State of the Watershed Report 2008* Milk River, Alberta: Milk River Watershed Council Canada.

111 Milly, P. C. D., Betancourt, J., Falkenmark, M., Lettenmaier, D., and Stouffer, R. J. 2008. Stationarity is dead: whither water management. *Science,* 319 (5863), 573-574.

112 Montana - Alberta St. Mary and Milk Rivers Water Management Initiative. 2008. Montana - Alberta St. Mary and Milk Rivers Water Management Initiative, Terms of Reference.

113 Morris, T., Mohapatra, S. P., and Mitchell, A. 2008. Conflicts, costs and environmental degredation: impacts of antiquated ground water allocation policies in the Great Lakes Basin. *Water Policy,* 10 (5), 459-479.

114 Murray, B. R., Zeppel, M. J. B., Hose, G. C., and Eamus, D. 2003. Groundwater-dependent ecosystems in Australia: It's more than just water for rivers. *Ecological Management & Restoration,* 4 (2), 110-113.

115 Murray-Darling Basin Authority. 2008. About the Murray-Darling Basin Authority. http://www.mdba.gov.au/. Accessed March 10, 2009.

116 Murray-Darling Basin Commission. 2005. Murray-Darling Basin e-Resources 2005. http://www.mdbc.gov.au/subs/eResource_book/index.htm. Accessed February 25, 2009.

117 Murray-Darling Basin Commission. 2008. *MDBC Murray System Drought Update*, Issue 15, September 2008 Canberra: Murray-Darling Basin Commission.

118 New Zealand Ministry for the Environment. 2008. *Proposed National Environmental Standard on Ecological Flows and Water Levels. Discussion Document* Wellington, NZ: Ministry for the Environment.

119 Norman, E. and Bakker K. 2005. Drivers and Barriers of Cooperation in Transboundary Water Governance: A Case Study of Western Canada and the United States. Report to The Walter and Duncan Gordon Foundation.

120 North Dakota State Data Center. 2009. ND Population Projections. Available at http://www.ndsu.edu/sdc/data/ndpopulationprojections.htm. Accessed March 2, 2009.

121 Pahl-Wostl, C. 2007. Transitions towards adaptive management of water facing climate and global change. *Water Resources Management,* 21 (1), 49-62.

122 Pembina Valley Water Cooperative Inc. 2007. *Annual Report 2007*: Pembina Valley Water Cooperative Inc.

123 Percy, D. R. 1988. *The Framework of Water Rights Legislation in Canada.* Calgary, AB: Canadian Institute of Resources Law, University of Calgary.

124 Phillips, D. J. H., Allan, D. J. A., Clausen, S., Granit, J., Jägerskog, A., Kistin, E., Patrick, M., and Turton, A. 2008. *The TWO Analysis: Introducing a Methodology for the Transboundary Waters Opportunity Analysis*, Report Number 23 Stockholm: Stockholm International Water Institute.

125 Pirie, R. L., de Loë, R. C., and Kreutzwiser, R. D. 2004. Drought planning and water allocation: an assessment of local capacity in Minnesota. *Journal of Environmental Management,* 73, 25-38.

126 Pittock, B. 2003. *Climate Change: An Australian Guide to the Science and Potential Impacts* Canberra: Australian Greenhouse Office.

127 Pottinger, L. 2007. *Lowering the Bar on Big Dams, Making a Case for WCD Compliance on African Dams* Berkeley: International Rivers Network (IRN).

128 Prasad, A. 2008. Murray-Darling Basin, Australia: A Success Story in Trans-Boundary Water Management. In *IV International Symposium on Transboundary Waters Management, Thessaloniki, Greece, 15-18 October, 2008.*

129 Ray, A. J. 1996. *I Have Lived Here Since the World Began: An Illustrated History of Canada's Native People* Toronto, ON: Lester Publishing Ltd. and Key Porter Books.

130 Red River Basin Board. 2000. *Inventory Team Report: Hydrology* Moorehead, MN: Red River Basin Board.

131 Red River Basin Board. 2000. *Inventory Team Report: Water Law* Moorehead, MN: Red River Basin Board.

132 Red River Basin Commission. 2005. *Red River Basin Natural Resources Framework Plan* Winnipeg, MB: Red River Basin Commission.

133 Red River Basin Commission. 2008. *Water Quality Update* Winnipeg, MB: Red River Basin Commission. January 2008.

134 Red River Basin Commission. 2008. *Water Supply Update. January 2008* Winnipeg, MB: Red River Basin Commission.

135 Red River Basin Commission. 2009. Links. Available at http://www. redriverbasincommission.org/Links/links.html. Accessed March 3, 2009.

136 Richter, B. D., Mathews, R., and Wigington, R. 2003. Ecologically sustainable water management: managing river flows for ecological integrity. *Ecological Applications,* 13 (1), 206-224.

137 Robins, L. and Dovers, S. 2007. NRM regions in Australia: the 'haves' and the 'have nots'. *Geographical Research,* 45 (3), 273-290.

138 Rogers, P. 1996. *America's Water: Federal Roles and Responsibilities* Cambridge, MA: The MIT Press.

139 Sengo, D. J., Kachapila, A., van der Zaag, P., Mul, M., and Nkomo, S. 2005. Valuing environmental water pulses into the Incomati estuary: key to achieving equitable and sustainable utilisation of transboundary waters. *Physics and Chemistry of the Earth,* 30 (11-16 Special Issue), 648-657.

140 Serageldin, I. 2009. Water. Available at http://www.serageldin.com/water.htm. Accessed March 7, 2009.

141 Shmueli, D. F. 1999. Water quality in international river basins. *Political Geography,* 18 (4), 437-476.

142 Smiley, S., de Loë, R. C., and Kreutzwiser, R. D. In Press. Appropriate public involvement in local environmental governance: a framework and case study. *Society & Natural Resources*.

143 Statistics Canada. 2009. 2006 Community Profiles. Available at http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E. Accessed March 2, 2009.

144 Stoner, J. D., Lorenz, D. L., Goldstein, R. M., Brigham, M. E., and Cowdery, T. K. 1998. *Water Quality in the Red River of the North Basin, Minnesota, North Dakota, and South Dakota, 1992–95*, Circular 1169: United States Geological Survey.

145 Swatuk, L. A. 2005. Political challenges to implementing IWRM in Southern Africa. *Physics and Chemistry of the Earth,* 30, 872-880.

146 Swatuk, L. A. and Rahm, D. 2004. Integrating policy, disintegrating practice: Water resources management in Botswana. *Physics and Chemistry of the Earth,* 29 (15-18 SPEC.ISS.), 1357-1364.

147 Swatuk, L. A. and Wirkus, L. 2009. *Transboundary Water Governance in Southern Africa: Examining Underexplored Dimensions*. Sustainable Peace and Global Security Governance series vol. 2. Baden-Baden, Germany: Nomos Verlagsgesellschaft.

148 Tarlock, A. D. 2005. Water regulation along the Great Lakes divide. In *Straddling the Divide Conference.* Straddling the Divide: Water Supply Planning in the Lake Michigan Region, Chicago, Illinoise, February 15-16, 2005, Southern Lake Michigan Regional Water Supply Consortium.

149 Tarlock, A. D. and Wouters, P. 2007. Are shared benefits of international waters an equitable apportionment? *Colorado Journal of International Environmental Policy,* 18 (3), 523-536.

150 Tethys Environmental Consultants and Southern African Institute for Environmental Assessment. 2009. *Orange-Senqu River Basin Preliminary Transboundary Diagnostic Analysis Adopted by ORASECOM in April 2008, Main Report*: Global Environment Facility, UNDP and ORASECOM.

151 Texas A&M AgriLife. 2009. Texas Water Law. Available at http://texaswater.tamu.edu/waterlaw.texas.htm.

152 The Department of Water Affairs and Forestry. 2008. Outcomes of Cabinet Discussion on Water and Augmentation of the Vaal River System, Media release by the Department of Water Affairs and Forestry. December 4, 2008.

153 The Milk River International Alliance. 2002. *The Milk River: International Lifeline of the Hi-Line. A Guidebook*: The Milk River International Alliance.

154 Turton, A. 2003. An overview of the hydropolitical dynamics of the Orange River basin. In *International Waters in Southern Africa,* ed. M. Nakayama, 136-163. Tokyo and New York: The United Nations University Press.

155 Turton, A. and Funke, N. 2008. Hydro-hegemony in the context of the Orange River Basin. *Water Policy,* 10 (S2), 51-69.

156 Uitto, J. I. and Duda, A. M. 2002. Management of transboundary water resources: lessons from international cooperation for conflict prevention. *The Geographical Journal,* 168 (4), 365-378.

157 United Nations World Water Assessment Programme. 2003. *Water for People, Water for Life: The United Nations World Water Development Report* New York: UNESCO Publishing.

158 United States Census Bureau. 2009. Cities and Towns. Available at http://www.census.gov/popest/cities/SUB-EST2007-4.html. Accessed March 3, 2009.

159 United States Census Bureau. 2009. US Population Projects: State Interim Population Projections by Age and Sex: 2004 - 2030. Available at http://www.census.gov/population/www/projections/projectionsagesex.html. Accessed March 2, 2009.

160 United States Department of the Interior, Bureau of Reclamation. 2009. Responses to Environment Canada Comments on the Draft Red River Valley Water Supply Project Needs and Options Report. September 29, 2005 letter from Environment Canada with annotations by Bureau of Reclamation.

161 United States Department of the Interior, Bureau of Reclamation and State of North Dakota, Garrison Diversion Conservancy District. 2007. *Final Environmental Impact Statement: Red River Valley Water Supply Project*, Filing Number: FES 07-52 Bismarck, ND: United States Department of the Interior, Bureau of Reclamation and State of North Dakota, Garrison Diversion Conservancy District.

162 United States Department of the Interior, Bureau of Reclamation, Dakotas Area Office. 2004. *Report on Red River Valley Water Supply Project Needs and Options. Water Conservation Potential Assessment Final Report* Bismarck, ND: United States Department of the Interior, Bureau of Reclamation, Dakotas Area Office.

163 United States Department of the Interior, Bureau of Reclamation, Dakotas Area Office. 2004. *Report on Red River Valley Water Supply Project Needs and Options. Water System Assessment Executive Summary Final Report* Bismarck, ND: United States Department of the Interior, Bureau of Reclamation, Dakotas Area Office.

164 United States Geological Survey. 2009. Devils Lake Basin in North Dakota. Available at http://nd.water.usgs.gov/devilslake/. Accessed March 3, 2009.

165 van der Zaag, P. and Vaz, A. C. 2003. Sharing the Incomati waters: cooperation and competition in the balance. *Water Policy,* 5, 349-368.

166 Vecchia, A. V. 2000. *Water-Quality Trend Analysis and Sampling Design for the Souris River, Saskatchewan, North Dakota, and Manitoba*, Water-Resources Investigations Report 00-4019 Bismarck, North Dakota: U.S. Department of the Interior and U.S. Geological Survey in Cooperation with the North Dakota Department of Health.

167 Warner, J., Philippus, W., and Bolding, A. 2008. Going with the flow: river basins as the natural units for water management? *Water Policy,* 10 (2), 121-138.

168 Willemse, N. E. 2007. Actual versus predicted transboundary impact: A case of phase 1B of the Lesotho Highlands Water Project. *International Journal of Water Resources Development,* 23 (3), 457-472.

169 Wolf, A. T. 1998. Conflict and cooperation along international waterways. *Water Policy,* 1 (2), 251-265.

170 Wolf, A. T., Kramer, A., Carius, A., and Dabelko, G. D. 2005. Managing water conflict and cooperation. In *State of the World 2005: Redefining Global Security,* eds. E Assadourian et al., 80-95: World Watch Institute.

171 Wolf, A. T. and Newton, J. 2008. Case Studies of Transboundary Dispute Resolution: Canada and the United States of America. In *Managing and Transforming Water Conflicts,* eds. J. Delli Priscoli and A. T. Wolf. Cambridge, MA: Cambridge University Press.

172 Yohe, L. 2003. International watershed planning, policy and vision. In *International Waters Conference 2003.* Fargo, ND: International Waters Institute.

173 Young, M. and McColl, J. 2008. *A Future-Proofed Basin: a New Water Management Regime for the Murray-Darling Basin* Adelaide, South Australia: University of Adelaide.