Recreational value of irrigation infrastructure: a case study of Chestermere Lake, Alberta, Canada

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Abstract

Irrigation infrastructure is a central component of agriculture in southern Alberta. It is often associated with ecosystem services (ES) that may enhance people's well-being. However, population growth, increasing economic activity and climate change may threaten aquatic ecosystem health in Alberta's waterways and consequently the provision of ES. In order to meet ecosystem needs and maintain the provision of ES, new policies and regulations are initiated to formulate a sustainable water allocation and reallocation system in Alberta. It is, therefore, critical to understand what types of ES benefits and economic values are provided by water bodies faced with competing demands from various sectors.

This paper describes the recreational activities associated with an irrigation reservoir, Chestermere Lake and estimates its recreational value in monetary terms. A mixed method is used by combining a qualitative description based on observations and interviews with stakeholders with a quantitative analysis using geographic information system (GIS) analysis and the travel cost method. The findings reveal a substantial economic value of the reservoir in addition to the variety of recreational ES benefits offered by the reservoir. The findings of this research provide valuable information for decisions makers who aim to design water management policies and make water management decisions to balance the needs of water for ecosystem health, extractive use and recreation.
Keywords: travel cost method, GIS, ecosystem services, recreation, irrigation infrastructure, water management.

WIT Transactions on Ecology and The Environment, Vol 168, © 2012 WIT Press
www.witpress.com, ISSN 1743-3541 (on-line)
doi:10.2495/SI120361

1 Introduction

Ecosystem functions and processes contributing to human well-being are generally termed “ecosystem services” (ES) [6, 14, 28]. The health of ecosystems has a direct connection to the provision of ES [28]. Past water management decisions globally and in Alberta have paid little attention to ensure that adequate water is allocated to sustain ecosystem functions and processes and its health [6, 28]. As such, the reduced provision of ES has affected the well-being of people worldwide [28]. The deterioration of ecosystem health has occurred in Alberta’s aquatic ecosystems and already reduced the ES provision in the region [6, 7]. Change to water management practices is needed to avoid continuing decline in ecosystem health and prevent further loss of ES benefits.

Water resources in Alberta are not distributed evenly. Most of the available surface water is located in the northern half of the province while the majority of extractive water demands are centred in the southern half [2]. The South Saskatchewan River Basin (SSRB) is located in the southern half of Alberta, and many of the sub-basins in the SSRB are near or beyond the natural flow [3]. Irrigation is the largest water use sector in the SSRB with the majority and most senior of the licensed water allocations held by a handful of irrigation districts [2, 11]. Irrigation infrastructure in southern Alberta was originally developed to store and convey water for agriculture [25]. Over time, this infrastructure began to be demanded by sectors beyond agriculture including recreation [1, 9].

The purpose of this study was to understand the value of recreational ES benefits provided by the Chestermere Lake reservoir (the Reservoir) near Calgary, Alberta, Canada. The research objectives were twofold. The first was to estimate the value of recreational ES benefits provided by the Reservoir to day users in monetary terms. The second was to gain information on the recreational activities, spatial extent of recreational ES benefits (service area), and the demographic characteristics of visitors. This study only considered recreationalists that travel to the Reservoir from nearby communities (non-residents). Other non-recreational ES benefits and the value of recreation ES benefits to residents of the Town of Chestermere (the Town) were not included in this study. The remainder of the chapter is organized as follows. Section two presents the overall policy context of the study. Section three provides the background and literature review. Section 4 describes the methods used to achieve the research objectives. Section 5 details the findings and discussion. Section six offers conclusions.

2 Policy context

2.1 Water legislation in Alberta

The passing of the *Northwest Irrigation Act* (NWIA) in 1894 brought about significant changes to Canadian water allocation and management [31, 32]. Under this act, the riparian rights doctrine became obsolete, the ownership of all water belonged to the Crown, a license was required to divert water, and the

First-in-Time-First-in-Right (FITFIR) principle was employed to govern water access during shortages [19, 32]. The province of Alberta was created in 1905 and gained control over water allocation and management in 1930 [32]. Since that time, two water laws have governed water allocation and management: the *Water Resources Act* in 1931 and the *Water Act* in 2000 [31]. Both of these acts maintained characteristics of the federal NWIA including crown ownership of water, licensing requirements, and the FITFIR principle [31]. The current *Water Act* was created to address the problems of ecosystem decline alongside ensuring continued regional economic growth [31]. The *Water Act* allows transfers of all or a portion of a license entitlement between users under a high level of scrutiny to ensure protection of aquatic ecosystem health [31]. In Alberta, water resources for agricultural irrigation are also governed by *Irrigation District Act*. The act was first established in 1914 and is most recently revised in 2000. The act establishes the structure, governance, powers and duties for the formation and operations of Irrigation Districts.

2.2 Irrigation in Alberta

Irrigation in Alberta began as farm level projects that diverted water from nearby rivers and streams to flood fields using gravity [25]. Large scale irrigation works developed following the passing of the *Northwest Irrigation Act* in 1894 [25]. The Canadian Pacific Railway (CPR) was granted one of the first licenses and constructed irrigation infrastructure to ensure water was available for irrigation of land located away from watercourses [25, 30]. The construction of irrigation infrastructure was viewed by the CPR as a means of encouraging settlement and securing long term revenues from land sales and contracts to supply water [25, 30]. However, the expected profits failed to realize and the CPR gradually transferred their stake in irrigation infrastructure to irrigation districts and the provincial government [25, 30]. Irrigation districts are producer cooperatives that manage irrigation infrastructure to ensure water is available for members [25]. Today, the ownership and management of irrigation infrastructure is vested in a mixture of irrigation districts and the provincial government [25]. Irrigation districts own and manage the infrastructure and distribute the water from river off-takes to farm fields, while the government owns and controls the head works and infrastructure that store and deliver the water to the point where the irrigation districts and private license holders extract the water.

2.3 Water policy in Alberta

The Alberta government recognized the need to change water and land management policies due to the declining health of ecosystems [11, 26]. The *Water for Life* and *Land Use Framework* are two recently adopted regulatory policy documents that detail the policy direction and goals of the Alberta government with respect to water and land management [26]. The *Water for Life Strategy* incepted in 2003 was the original policy document detailing the objectives and goals of the Alberta government with respect to ensuring water supply stability, water quality, ecosystem protection, and continued economic growth [8]. The *Water for Life Renewal* document in 2008 confirmed the *Water for Life* goals and key directions based on the experience gained and called for the Government of Alberta to effectively implement the *Water for Life Strategy* [5]. The *Water for Life Action Plan* in 2009 supplemented the *Water for Life Renewal* document with greater detail on the timeframe and specific actions needed to achieve policy goals and objectives [4]. The *Land Use Framework* compliments the *Water for Life* documents by using a set of guiding principles to ensure that sustainability is the foundation for resource management decisions [21]. The creation of the *Alberta Land Stewardship Act* in 2009 provided legislative backing for the *Land Use Framework*, and the act was given precedence over other natural resource management legislations to ensure the *Land Use Framework* is followed in decision making [21, 26].

The use of market based instruments (MBIs) is promoted in the *Water for Life Strategy* and the *Land Use Framework* [26]. Market based instruments have increasingly been promoted internationally as a more efficient way of achieving policy objective due to the failure of command-and-control measures often resulted from a lack of political will and monitoring and enforcement. The successful experience using MBIs to protect ecosystem health at the least cost, increase water use efficiency, and achieve sustainable economic growth in other jurisdictions was one of the rationales for the adoption of MBIs in Alberta [24, 26]. A second key action of current policy is the acquisition of scientifically based information to guide the development of future legislation and update policy goals [4, 21, 26]. A lack of information has been identified as a barrier to achieving policy goals, and has hindered the expansion of market based water transfers in Alberta to date [4, 6, 29].

3 Establishing recreational values

Ecosystem services are the benefits provided to humans through the transformations of resources into a flow of essential goods and services [14]. Recreational uses are important benefits associated with water bodies. Demand for these services has increased substantially with the growth of wealth and leisure time. Different approaches exist to estimate the economic values of such ES benefits. Two methods are commonly employed in the literature to estimate the value of recreational ES benefits based on the willingness to pay (WTP) for participating in recreational activities [35]. The first one establishes the WTP based on revealed preferences. This method uses actual expenditure data as a shadow value for the value of ES benefits [35]. The second method is based on the stated preference method. It uses hypothetical ES provision outcomes and costs, and the stated WTP for the selected outcome is taken as the shadow value of ES benefits [35]. Estimation methods commonly used to value recreational ES benefits include the travel cost model, hedonic price method, and the continent valuation method [35], with the first two using revealed preferences and the third stated preferences.

Consideration and measurement of the spatial aspects of ES benefits has appeared in the literature [23]. The recreational ES benefits provided by a given location are generally limited to a certain area due to the fact that the cost of obtaining the recreational benefit (travelling, equipment, etc.) may increase to the point where benefits cannot cover the costs [22]. Spatial value decay can be used to describe the rate of decline in the value of recreational ES benefits as distance increases [22]. The gravity model can be used to predict the number of visitors to a site based on the principle of spatial value decay [18]. The development of geographical information system (GIS) and its software has improved ES benefit studies by providing a means to incorporate multiple spatial aspects in one dataset and process distance measurements quickly [9, 12].

Numerous studies are published in the field of valuing recreational ES benefits associated with reservoirs and other types of recreational sites. For example, Boxall *et al.* employed a combination of a GIS and the travel cost model to estimate the value of camping site in Alberta's Rocky Clearwater Forest and they found its annual monetary value to be around $750,000 [12]. Chizinski *et al.* [13] used a travel cost model to value day use fishing at the Lake Kemp reservoir in Texas. They found the site was worth a value ranging from $114 to $230 per trip. McNaughton [27] combined a quantitative continent valuation method based on survey data with qualitative informal conversation to estimate the recreation value at some reservoirs in southern Alberta, and found that the value of these reservoirs were between $19,000 and $1.1 million annually depending on the characteristics and location of the reservoirs.

4 Methods

The selection of the Reservoir as the study site was due to its unique characteristics in comparison with other reservoirs in southern Alberta. The close proximity of the Reservoir to the city of Calgary and a lack of other reservoirs within a 50 km radius result in a high number of non-resident visits. The Reservoir has also been the subject of past conflict over access and use of the water for non-irrigation purpose [34]. Two case study organizations located in the Town were included in the study: Camp Chestermere and the Calgary Yacht Club. They are included because their operations require the presence of the Reservoir and the recreational benefits to their members are expected to be substantial.

This study employed a combined qualitative and quantitative approach. Following McNaughton's [27] approach, the qualitative data were derived from interviews with stakeholders, informal conversation with survey respondents, and onsite observations. The quantitative approach is adopted for the estimation of the monetary value of the reservoir. Following the approach of Boxall *et al.* [12] and Chizinski *et al.* [13], a framework based on a GIS and the travel cost method was employed to calculate the travel costs of non-resident visitors. A total of 308 visitors were surveyed onsite over the period of October 2010 to October 2011. The questionnaire was designed to collect information about postal code, total onsite expenses, recreation activities, number of trips each month of the year, number of adults and children in the household, annual income, educational attainment, and employment status. The service area of the reservoir and average trip cost can then be estimated. Vehicle counting equipment was deployed over a 12-month period to estimate the number of visitors to the reservoir. The counting equipment was placed at the entrance to parking lots near recreation sites at the Reservoir. The recreation value estimate is calculated by multiplying average trip cost and the number of non-resident recreation visitors. Based on the field observation and interviews, three scenarios were used to determine the ratio of non-resident to total visitors recorded by the counting device. The scenarios were designed to reflect the two main factors that influence the ratio of residents to non-resident. The first is the management agreement between the Western Irrigation District (WID) and the Town of Chestermere. According to this agreement, WID undertakes to maintain low water levels during winter (mid-October to mid-April) to protect jetties and other recreational structures build by homeowners along the Reservoir against ice damage. Similarly WID undertakes to maintain the water level high during the summer period (mid-April to mid-October) to maximize recreational benefits from boating, swimming, fishing etc. The second factor is the difference between week-days and week-ends, with residents constituting a larger proportion of total vehicle counts than during week-ends. The first scenario is that non-resident visitors account for 15% for weekdays and 30% for weekends for both water level periods. The second scenario is that non-resident visitors account for 15% for weekdays and 30% for weekends when the water was down, and 20% for weekdays and 40% for weekends when the water was up. The third scenario is that non-resident visitors account for 20% for weekdays and 40% for weekends for both water levels. Another factor that influence the value estimates is the driving cost assumptions and the cost of time factor. Based on onsite personal interviews and the literature, it is assumed that the trip is to the Reservoir only but not a multi-destination trip, and the travel to and from Chestermere is by the fastest and shortest possible route using a private vehicle. Following the convention in the literature on the travel cost analysis, this study only considers the variable vehicle costs including fuel, maintenance (wear and tear), and tire costs. To assess the sensitivity of value estimates, we computed travel costs based on three different vehicle cost rates. The rate of $0.20 km is the standard rate for large vehicle class according to the Canadian Automobile Association, and the rate of $0.09 km is its light vehicle rate. Based on onsite observation and the need to tow heavy boats and other equipment most vehicles seem to be in the heavy category. Hence, the rate of $0.20 km was used as the base for our final cost estimates. Finally we also included the rate of $0.40 km which is University of Lethbridge mileage rate for a full vehicle cost. According to the literature one third of the wage rate was adopted to represent the opportunity cost of travel time.

The method to estimate the value of the Reservoir to Camp Chestermere and the yacht club is similar. The travel cost to the camp and the yacht club include round trip vehicle cost, fees paid to access Camp or the yacht club, and opportunity cost of travel time. The postal codes of the camp users during 2010 were extracted from the data file provided by the camp. Non-resident member data in the yacht club was not available for this study. However, the club staff indicated that about half of their membership was non-residents who were mainly from Calgary. The income data of the postal code area was derived from the 2006 Canadian census. The value of recreational ES benefits provided by the Reservoir for both the camp and the yacht club was then estimated.

5 Findings and discussion

5.1 Findings

The average annual income of survey respondents was $60,000–$70,000. The average round trip travel distance was 60 km with an average round trip travel time of 46 minutes. The majority of survey respondents had a post secondary education (65%) and worked full time (59%). Most survey respondents originated from Calgary (85.4%), and a majority of respondents (57.2%) made five or fewer recreation day trips to the Reservoir in a year. A small portion made a high number of trips. These frequent visitors were primarily workers from industrial businesses in southeast Calgary coming to the Reservoir frequently to enjoy scenic viewing while eating lunch. Figure 1 shows the recreational service area of the Reservoir from which 90% of day trip recreation users originate (Figure 1).

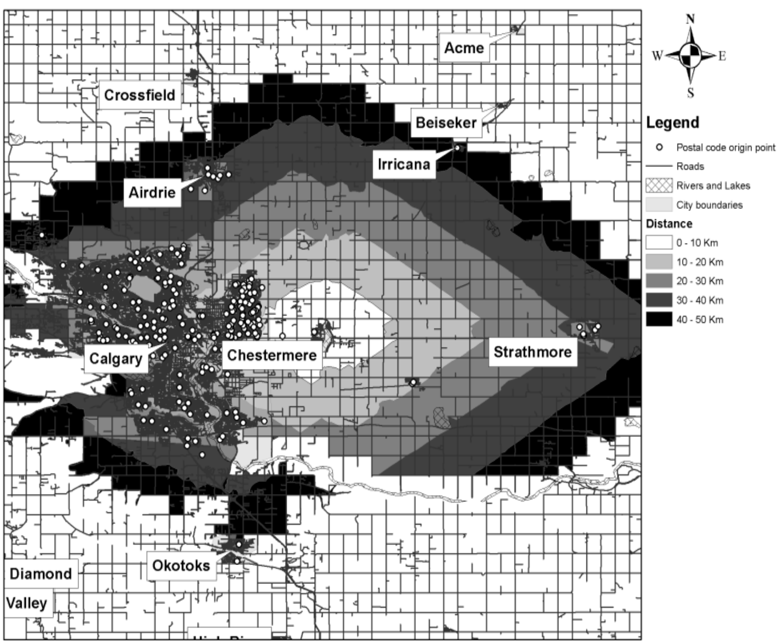

Figure 1: Service area of recreational ES benefits provided by the Chestermere Reservoir in southern Alberta.

To understand the effects of socio-economic and demographic characteristics on the nature of recreational activities of individuals, a set of χ^2 tests were conducted. First, the number of trips per year is significantly associated with income (p = 0.066) and educational attainment (p = 0.092), but is independent of employment status. Those with higher incomes and possessing a post-secondary education tend to take more trips annually. Second, walking and snowmobiling are associated with educational attainment (p = 0.003, and 0.085). Those with less than a post-secondary education tend to participate in walking and snowmobiling more frequently. It was also found that personal income is not associated with the types of recreational activities that individuals are involved in.

Based on the postal code of camp users, the average income was $45,766 according to the 2006 Canadian census. Camp users travelled on average 70 km for a round trip, equivalent to an average time of 58 minutes. Most camp users were from Calgary (71.7%) followed by Strathmore (11.8%), Langdon (6.7%), and less than 2% coming from 28 other communities. The travel cost calculation for the camp was divided into two groups based on whether a user's postal code was east or west of the camp. Based on the interviews with camp management personnel, the users from eastern locations were assumed to use the day program option, and those from western locations were assumed to use the overnight program option. The findings for average cost of using Camp programs ranged from $261–$336 for the day program, and $362–$387 for the overnight program, depending on the driving cost used in calculations. The estimated value of recreational benefits provided by the Reservoir to the camp users ranged from $185,000–$206,000 annually.

The average annual income of the non-resident members of the yacht club was $41,303 based on data from the 2006 Canadian census. This finding is likely an underestimation of the average income for the yacht club members. Membership in a boating club requires costly equipment (boat, gear, etc.), high fees, and travel. In the survey, those respondents reporting boating as an activity have an average annual income of $60,000–$70,000 annually. It is found that the average round trip travel distance and time for the non-resident members was 46 km and 38 minutes, respectively. The finding for average annual cost for the recreational activities at the yacht club was estimated to ranges from $476–$546 depending on driving cost used in calculations. The estimated value of recreational ES benefits provided by the Reservoir to the yacht club ranged from $32,000–$36,000 annually.

Based on the survey and visitor counting data, the total monetary value of recreational ES benefits provided by the Reservoir to non-resident day users was estimated to range from $794,000–$980,000 annually. The estimate is sensitive to the scenarios specifying driving costs and non-resident visitor portion of counting used in calculations. The period where the water was up was found to have a higher value than when the water was down. This finding is reasonable given the number of activities requiring the water to be raised, and that the water is up during summer months. Weekends (Saturdays and Sundays) were found to have a higher value than weekdays (Monday to Friday). This finding is reasonable with the majority of day use recreationalists working full time leaving weekends as the time for recreation.

5.2 Discussion

The value of recreational ES benefits provided by the Reservoir was found to be substantial, and was largely in line with results from previous studies. As expected, most of day users of the Reservoir were from nearby communities. The travel distance and round trip time are found to be shorter than that revealed in the previous studies. One reason for this discrepancy may be the fact that multiple recreational sites are often reported in previous studies [27] and whether the study is based on individual survey data or on aggregate data. Findings on the association of the number of trips per year and participation in recreation activities with individual characteristics are not quite consistent with those in the literature. The discrepancy between previous studies and the findings of this study likely is a result of differences in study sites. Previous studies often examined locations with multiple recreation site options within close proximity. This provides an opportunity for individual characteristics to influence one's site choice. For example, those with higher income, certain educational attainment, or employment status may choose one boat launch facility or campground over another. In this study, there are no other day use recreation sites within the service area of the Reservoir. As a result, all recreational day users must use the same facilities, and the influence of individual demographic characteristics may not be fully discernible.

As noted above, the finding for the estimated value of recreational ES benefits provided by the Reservoir is sensitive to choice of driving cost and counter data manipulation. The value of the Reservoir presented above was calculated using more than one driving cost options. The estimated total value of recreational ES benefits provided by the Reservoir may change if other possible driving costs are used in calculations. The range of total monetary value of the Reservoir for recreation activities is however in line with what previous studies had reported.

6 Conclusion

Globally, the demand for ES from water courses and irrigation infrastructure is on the rise due to increasing variability in climate, growing population, and increase in affluence, recreational time, and economic activities. The ability to meet this growing demand is deteriorating due to declining environmental conditions. In Alberta, new institutional frameworks such as the Water for Life Strategy and the Land Use Framework were proposed to alter conventional water management practices and promote sustainable water resource governance. Market-based instruments are advocated as important tools to increase water use efficiency and facilitate the reallocation of water to higher value sectors. The implementation and success of such policy changes in water governance will depend largely upon an understanding of ES benefits provided by water bodies.

Little is known about the nature of recreational activities and monetary values associated with irrigation reservoirs in Alberta. This study estimates the monetary value of recreational ES benefits provided by the Reservoir and gains information on the types of recreation activities, demographic characteristics of visitors, and the service area of the Reservoir. It provides valuable information for policy makers when making water allocation decisions and when designing market-like tools for water transfer purposes. The understanding generated from this is also important to irrigation infrastructure managers in administering and scheduling water management for irrigation purpose. The council members of the Town may also be interested in the information from this study as the nature of recreational activities and monetary value brought about by non-resident visitors to the Reservoir contribute significant to the local economy.

The research method in this study also demonstrates the utility of combining qualitative description and quantitative estimation in valuing recreational ES benefits. A combined GIS and travel cost model approach proves to be effective in estimating recreational ES benefits from reservoirs.

Caution must be taken when considering the transferability of the findings from this study to other reservoirs. Differences in the available amenities, locations of nearby population centres, ES benefits studies, and the passage of time between future work and this study may affect value estimates.

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