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ASSESSING THE CAPACITY OF A NORTH AMERICAN WATERSHED MANAGEMENT REGIME TO SUPPORT ADAPTIVE MANAGEMENT

Juan Pablo Reig
Jan Adamowski

Integrated Water Resources Management Program
Department of Bioresource Engineering
Faculty of Agricultural and Environmental Sciences
McGill University
Ste-Anne-de-Bellevue, Canada

The benefits of adopting an approach based on the principles of adaptive management to overcome water resources management challenges and uncertainties are becoming clearer within the scientific community. Ongoing changes in climate and watersheds increase the already complex scenario of trans-boundary watershed management and the associated level of uncertainty. In 2005, the European NeWater project identified a number of key features required for the successful management of trans-boundary river basins. These features were then incorporated into a framework to evaluate whether watershed management regimes were capable of supporting adaptive management, and this framework was then used to assess river basins in Europe, Africa and Central Asia. This paper makes use of the framework for the first time in the United States to evaluate the Chesapeake Bay and its watershed management regime. The outcomes of this research help evaluate the framework, characterize the existing management regime in the Chesapeake Bay, identify elements still missing, and provide material for future research. In addition, the results of this research should prove very useful for other watershed management regimes in the US in incorporating the principles of adaptive management into their trans-boundary basins.

INTRODUCTION

For the past decade, water professionals (e.g., Folke et al. 2005, Huntjens et al. 2008, Tarlock 2008) around the world have been advocating for a shift towards actively incorporating adaptive management models to manage water resources. The complexity of watershed management has grown with increasing changes in climate patterns, land use and population density, among other factors. In addition, concerns regarding the outcomes and consequences of such changes have led to an awareness of the limitations in knowledge regarding the future condition and quantity of water supplies around the world. In the case of trans-boundary watersheds, this complexity has escalated driven by differences in political and legislative frameworks, culture, history and technical capabilities (Timmerman and Langaas 2005). In response to this scenario, adaptive management provides "an integrated, multidisciplinary and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices" (Holling 1978). Driven by the need to support the management of natural resources under increasing levels of uncertainty, adaptive management was first developed in the 1970's at the International Institute for Applied Systems Analysis in Vienna as well as the University of British Columbia in Vancouver (Holling 1978, Walters 1986, Walters and Holling 1990, Irwin and Wigley 1993, Parma et al. 1998, Ohlson 1999, Prato 2003). The objective of this management framework is to develop robust and flexible strategies, capable of performing well under different possible futures, and of being modified when needed. This is accomplished by treating policies as hypothesis that can be experimented with and compared (Raadgever et al. 2008). Based on the results obtained, the strategies can then be adapted to improve the overall management framework; this process is then repeated over time in order to continuously ensure improvement (Medema et al. 2008) (Figure 1). Adaptive management acknowledges that time and resources are too limited to delay actions until 'enough' information is known (Lannerstad and Molden 2009), and can therefore be considered not only as adaptive but also as anticipatory (Kay 1997).

To date, there has been limited research to assess the adaptive capacity of water resource systems (Zhou 2004, Wang and Blackmore 2009, Engle and Lemos 2010, Pandey et al. 2011), and until recently, very few to assess the features of a trans-boundary watershed management regime capable of supporting adaptive management (Raadgever et al. 2008).

Raadgever and Mostert (2005) developed a framework to assess the extent to which trans-boundary river basin regimes support adaptive management. The framework was then applied to seven trans-boundary watershed management regimes in Europe, Africa and Central Asia, evaluating their capacity for adaptive management (Huntjens et al. 2008). The research for each basin was completed by means of a literature study, followed by scoring each criterion in the assessment

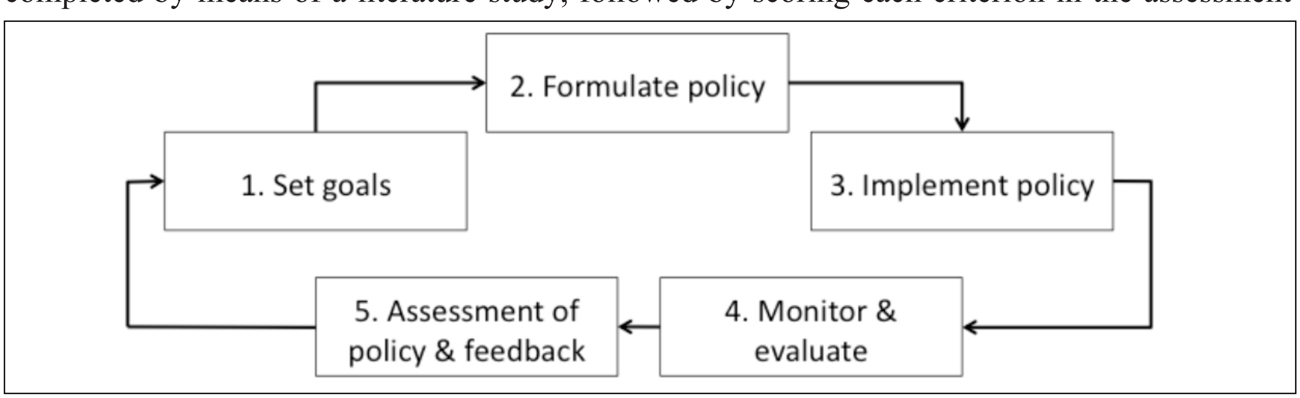

Figure 1. The adaptive management cycle (modified from Pahl-Wostl et al. 2007).

framework. Researchers compared their scoring criteria to ensure that the framework was applied in the same way (Raadgever et al. 2008). The results of the assessment of each basin were published as reports as part of the European NeWater Project – New Approaches to Adaptive Water Management under Uncertainty (Huntjens et al. 2008).

In the United States of American (US), studies have been conducted to assess the extent to which adaptive management can assist in managing natural resources (Benson 2010), as well as to explore the importance of adaptive management practices for river basin management (e.g., Prato 2003, Gober et al. 2010, Vicuna 2010). Nevertheless, there are no research studies in the literature evaluating the capacity of a watershed management regime in the US to support adaptive management. As such, the aim of this paper is to utilize, for the first time, the assessment framework developed by Raadgever and Mostert (2005) for basins in Europe, Africa and Asia, to measure the capacity of a trans-boundary watershed management regime in the US to support adaptive management.

This paper first explains the features identified by Raadgever et al. (2008) as key elements for the success of a trans-boundary watershed management regime. This is followed by a description of the selected US basin and management framework that is assessed: the Chesapeake Bay and its management regime. The paper then applies the framework, presents the results of the assessment and, to conclude, comments are provided on the strengths and weaknesses of the evaluation tool, as well as on potential areas for future research stemming from this research.

KEY FEATURES OF ADAPTIVE WATERSHED MANAGEMENT REGIMES

The framework proposed by Raadgever and Mostert (2005) is based on five main features that have been deemed essential in the literature for effective trans-boundary watershed management (Raadgever et al. 2008) (Figure 2). These features were then complemented with the principles of adaptive management and incorporated into a framework to measure the capacity of a watershed management regime to support adaptive management (Table 1) (Raadgever et al. 2008). Each feature has a number of criteria, and each criterion has indicators to help the researcher 'score' the regime. Based on Raadgever et al. (2008), the five features and their role in supporting adaptive management are described below.

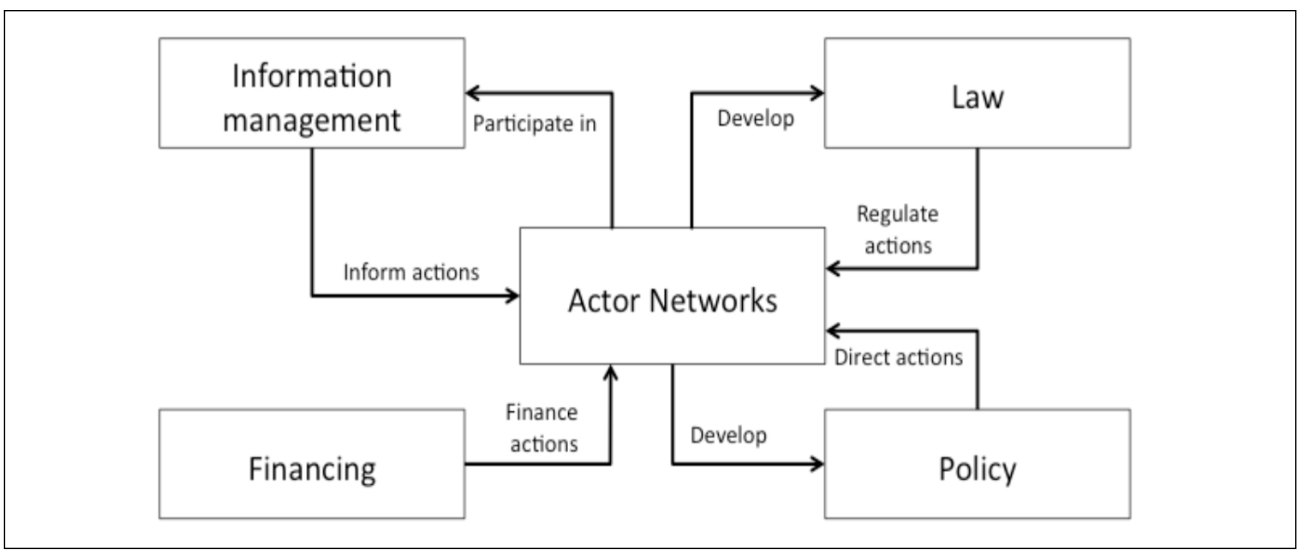

Figure 2. Features of trans-boundary watershed management regimes (modified from Raadgever et al. 2008).

Table 1. Framework for adaptive management regimes (Raadgever and Mostert 2005).

CRITERIA	INDICATORS
A. ACTOR NETWORKS	
1. Cross-sectoral cooperation	Sectoral governments actively involve other government sectors
	Cooperation structures include government bodies from different sectors; many contacts generally
	Conflicts are dealt with constructively, resulting in inclusive agreements to which the parties are committed
2. Cooperation between administrative levels	Lower-level governments are involved in decision making by higher-level governments
	Cooperation structures include government bodies from different hierarchical levels; many contacts generally
	Conflicts are dealt with constructively, resulting in inclusive agreements to which the parties are committed
3. Cooperation across administrative boundaries	Downstream governments are involved in decision making by upstream governments
	International/ trans-boundary cooperation structures exist (e.g., river basin commissions); many contacts generally
	Conflicts are dealt with constructively, resulting in inclusive agreements to which the parties are committed
4. Broad stakeholder participation	Legal provisions concerning access to information, participation in decision making (e.g., consultation requirements) and access to courts
	Cooperation structures include non-governmental stakeholders
	Non-governmental stakeholders actually contribute to agenda setting, analyzing problems, developing solutions, and taking decisions ("co-production")
	Non-governmental stakeholders undertake parts of river basin management themselves, e.g., through water users' associations
	Governments take stakeholder input seriously
B. LEGAL FRAMEWORKS	
5. Appropriate legal framework	A complete and clear legal framework for water management exists (with sufficient detail)
	Policies have to be reviewed and changed periodically
6. Adaptable legislation	Laws and regulations can easily be changed
	Water (use) rights can easily be changed / are not permanent
C. POLICY	
7. Long time horizon	Solutions for short-term problems do not cause more problems in the (far) future (20 years or more)
	Preparations are already being made for the (far) future (20 years or more)
8. Flexible measures, keeping options open	Measures taken now or proposed for the near future do not limit the range of possible measures that can be taken in the far future and are preferably reversible
9. Experimentation	Small-scale policy experiments take place / are financially supported
10. Full consideration of possible measures	Several alternatives and scenarios are discussed
	Alternatives include small- and large-scale and structural and non-structural measures
11. Actual implementation of policies	Plans and policies are actually implemented
	Policies are not dogmatically stuck to when there are good reasons not to implement them, e.g., new and unforeseen circumstances and new insights

Table 1 (continued). Framework for adaptive management regimes (Raadgever and Mostert 2005).

D. INFORMATION MANAGEMENT	
12. Joint or participative information production	Different government bodies are involved in setting the terms of reference and supervising the search, or are at least consulted (interviews, surveys etc.)
	The same for non-governmental stakeholders
13. Interdisciplinarity	Different disciplines are involved in defining and executing the research: in addition to technical and engineering sciences, also, e.g., ecology and the social sciences
14. Elicitation of mental models / critical self-reflection about assumptions	Researchers allow their research to be challenged by stakeholders and present their own assumptions in as far as they are aware of them
	Research results are not presented in an authoritative way, but in a facilitative way, to stimulate reflection by stakeholders about what is possible and what it is they want
15. Explicit consideration of uncertainty	Uncertainties are not glossed over, but communicated (in final reports, orally)
16. Broad communication	Governments exchange information and data with other governments
	Governments actively disseminate information and data to the public: on the internet, and also by producing leaflets, through the media, etc.
17. Use of information	New information is used in public debates (and is not distorted)
	New information influences policy
E. FINANCING	
18. Appropriate financing system	Sufficient (public and private) resources are available
	Costs are recovered from the users by public and private financial instruments (charges, prices, insurance, etc.)
	Decision making and financing under the same control
	Authorities can take loans and depreciate their assets to facilitate efficient use of resources and replacement of assets

Actor Networks. For adaptive management to succeed in a trans-boundary watershed management scenario, all stakeholders – government, industry, experts, general public, NGO's, etc. – must cooperate horizontally and vertically during the decision-making process. This in turn enables active learning, the recognition of their interdependency to accomplish goals, and the consideration of all points of view needed for successful joint decisions to be made.

Legal framework. The literature does not contain much regarding this feature. Raadgever et al. (2008) hypothesize, based on the principles of adaptive management, that legislation should be clear, accessible to the public and applicable, but at the same time capable to experiment with, review and adapt to change.

Policy. As pointed out in the introduction, policies must be robust and flexible. Adaptive management acknowledges the uncertainty inherent in policies; therefore these must be kept open to options, as well as to change. Policies should be experimented with at a small scale, long-term goals must be set, and policies implemented.

Information management. The importance of this feature stems for the critical role played by the active learning process of all relevant stakeholders. Information management should involve all government and non-governmental stakeholders, giving them the chance to express their information needs and share their knowledge base and understating. Transparency and information flow must occur both at the local and trans-boundary levels, and in turn will maximize the chances of real learning.

Financing. Funding must maximize learning, while avoiding inappropriate pricing and ensuring sufficient funds. Multiple sources of funding increase economic stability and although critics point out the higher initial expenses of adaptive management models, in the long run adaptive management can prevent unnecessary costs due to inflexible or irreversible decisions. Cost recovery adds to robustness, as does uniting decision-making and financing. Finally, long-term investments should be facilitated to authorities.

THE CHESAPEAKE BAY AND ITS WATERSHED MANAGEMENT REGIME

The Chesapeake Bay

Located on the East coast of the US, the Chesapeake Bay is the largest estuary in the country. It covers more than 64,000 square miles, over parts of six different US states: Delaware, New York, Pennsylvania, Virginia, and West Virginia, as well as the entire nation's capital (Figure 3). Its land-to-water ratio (14:1) is the largest of any costal water body in the world. In the Chesapeake Bay watershed there are over 100,000 tributaries, and 50 of these are considered major tributaries. The Bay receives half of its total volume of water from the Atlantic Ocean, and the other half from its watershed. The main activities carried out in the Bay include maritime transportation, recreation and fisheries (Chesapeake Bay Program 2010).

There are approximately 17 million people living in the Chesapeake Bay watershed, and most people live within minutes of one of its many tributaries. As such, any action carried out on land has a significant and direct impact on the health of the estuary; the many streams and rivers act like pipelines, directly connecting basin communities with the Bay (Chesapeake Bay Program 2010).

The health of the Chesapeake Bay watershed is mostly influenced by factors such as pollutants and land use. Three major pollutants primarily affect the water quality of the system: nitrogen, phosphorus and sediments. The main sources of the pollutants include agriculture, urban and suburban runoff, wastewater, and air pollution. The health of the watershed has also declined due to an increase in population, and the associated development of the watershed. Finally, natural factors, such as snowfall and rain carrying pollutants, have also influenced the bay, as have climate change, invasive species and fisheries harvesting (Chesapeake Bay Program 2010).

The Chesapeake Bay Watershed Management Regime

A watershed management regime can be defined as the principles, norms, rules, and decision-making procedures around which the expectations of actors in watershed management converge (Raadgever et al. 2008). The challenge of trans-boundary watershed management is that the expectations of actors converge over different political and administrative management regimes, potentially hindering the implementation of watershed management strategies, policy and legislation. In order to overcome this challenge and facilitate trans-boundary watershed management, independent institutions can be created to assist in unifying the management efforts within the watershed. In the case of the Chesapeake Bay, the trans-boundary watershed management efforts are carried out through the Chesapeake Bay Program, which includes representatives of all the watershed's stakeholders.

An alarming amount of excess nutrient pollution was identified in the Chesapeake Bay in the early 1980's. In response to this finding, the Chesapeake Bay Program (CBP) was created as a means to unify the restoration efforts throughout the watershed (Wolflin 2008). In 1983 the Chesapeake Bay Council pledged to work together to restore and protect the Bay and its watershed

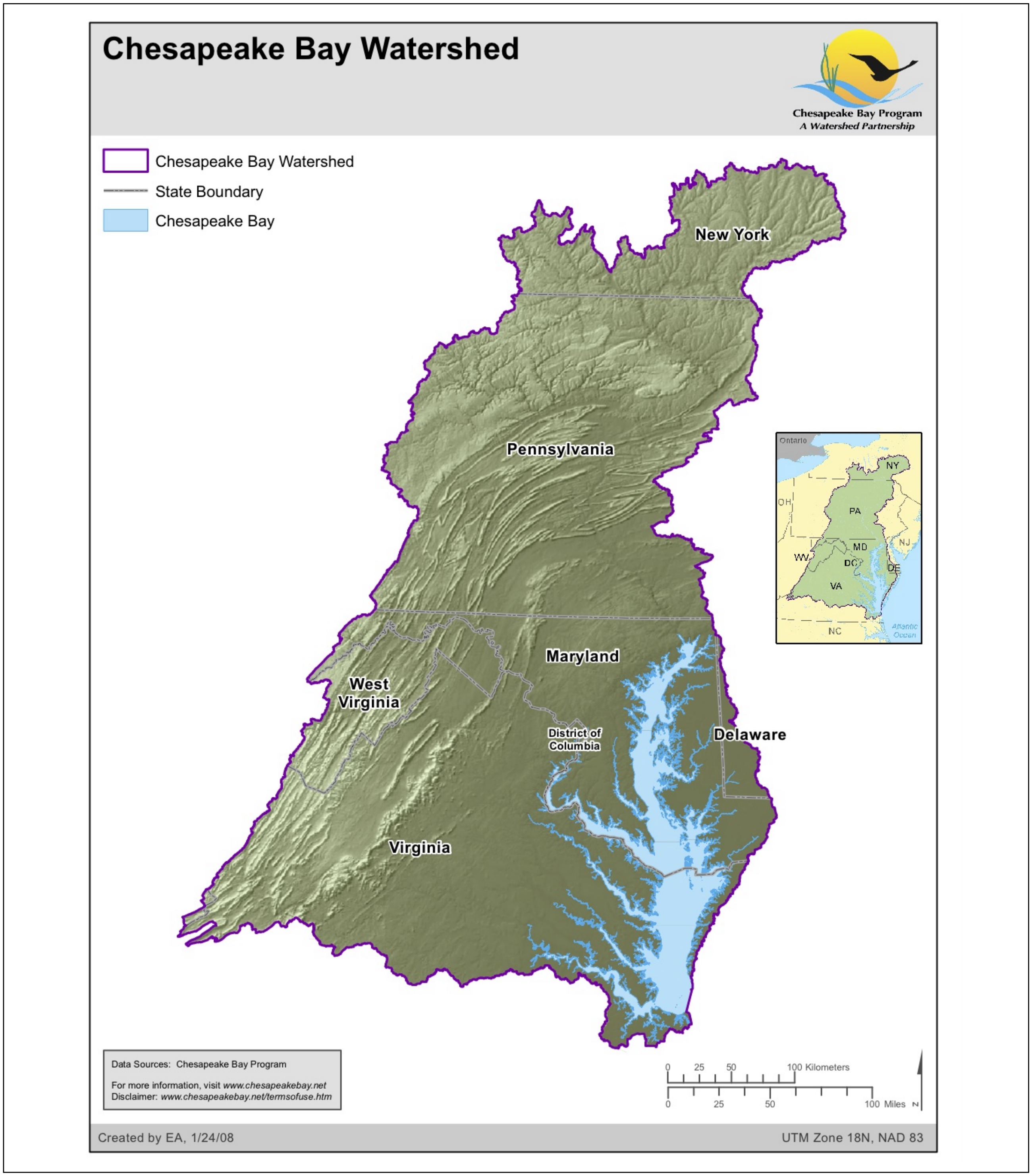

Figure 3. Chesapeake Bay Watershed (Chesapeake Bay Program 2010).

by signing the Chesapeake Bay Agreement. The Council was formed by the governors of the three Bay States, Virginia, Maryland, and Pennsylvania, the mayor of Washington DC, the US Environmental Protection Agency (EPA) and the Chairman of the Chesapeake Bay Commission (Chesapeake Bay Program 2010).

In 1987, the CBP Executive Council signed the 1987 Chesapeake Bay Agreement, with the goal to reduce nitrogen and phosphorous entering the Bay by 40 percent by the year 2000. This specific numeric goal and timeline was unprecedented at the time. Five years later, the CBP partners agreed to attack nutrients at the source by signing the 1992 amendments documents. Two years after that, officials from 25 agencies of the US Federal Government signed the Chesapeake Bay Agreement of 1994, committing to ecosystem management and new collaborative efforts between different Federal agencies. In June of 2000, the CBP partners signed the Chesapeake 2000 Agreement, setting the course for the Bay restoration and protection for the next decade. In addition to that, the three headwater states, New York, Delaware and West Virginia, also committed to water quality goals. Today, the Program continues to work towards preserving and restoring the Chesapeake Bay and its watershed. The CBP does so by means of a partnership model, engaging the full range of stakeholders in the decision-making process, developing agreements with multiple jurisdictions working across state lines. Over time, the CBP has demonstrated the effectiveness of a cooperative trans-boundary approach to watershed management (Chesapeake Bay Program 2010).

The CBP partners include the Chesapeake Bay Executive Council (the original signatories of the Chesapeake Bay Agreement), three headwater state partners, over twenty different US Federal Agencies, fifteen different academic partners, and nineteen other partners, including but not limited to sub-watershed organizations, foundations, citizen groups, and conservation groups.

Within the CBP, each of the partners agrees to use their resources to implement watershed restoration and conservation projects and activities. The actions are defined collectively through formal, voluntary executive council documents, which provide general policy direction through directives, agreements and amendments. These documents are signed by the Executive Council, and voluntarily by the CBP partners. When members sign an executive council document, they commit to using all their available resources to carry out the document's goals. In the case of the Executive Council, governors commit all state agencies. The EPA represents the entire US Federal Government, and the Chesapeake Bay Commission provides the support of legislators from all three Bay states (Chesapeake Bay Program 2010).

The CBP is organized in a way that enables collaboration and cooperation at a horizontal and vertical level, between local and federal governments, as well as with stakeholders, academia and other organizations. There are seven different groups within the CBP, all of which work together during the decision-making process, and implementation of actions (Figure 4).

The Executive Council leads the partnership, and it meets annually, signs executive documents, and is accountable for the progress made by the CBP actions. The Principal Staff Committee (PSC)

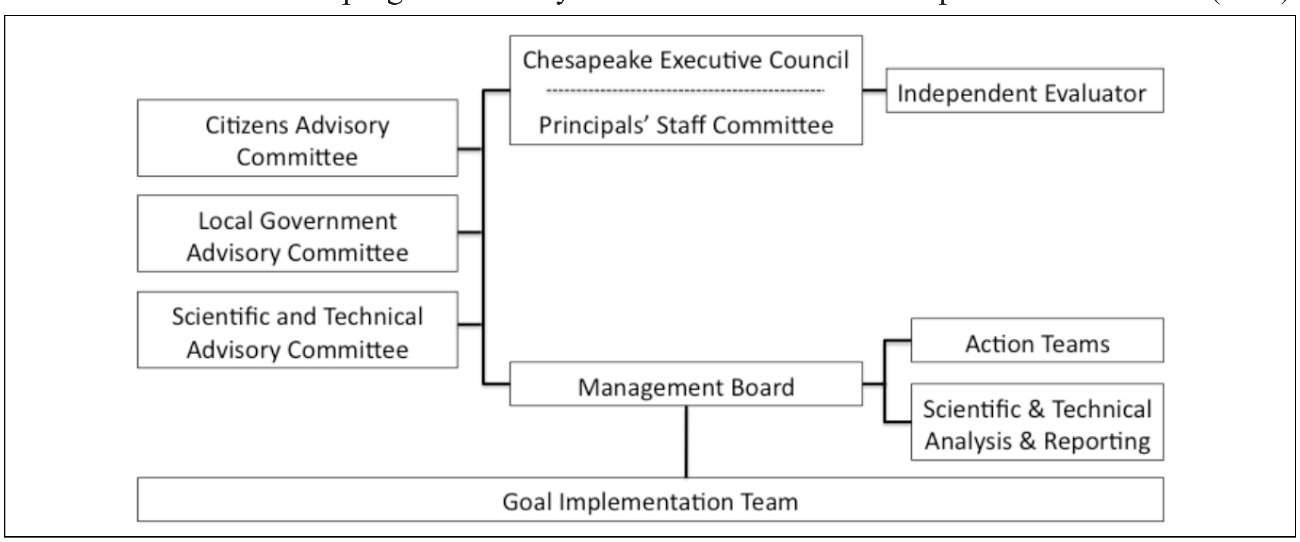

Figure 4. Chesapeake Bay Organizational Structure (modified from Chesapeake Bay Program 2010).

advises the Executive Council in matters of policy, and accepts items for Committee consideration, provides briefings, and sets the agenda for the Council meetings. It also assists the implementation teams with policy and program direction. Local stakeholders, by means of the Citizens Advisory Committee (CAC), assist as needed in implementing the program actions. The CAC is the branch of the partnership that communicates with their constituents increasing awareness and understanding of the Bay programs and activates. The CAC is broad-based, including representatives from agriculture, businesses, industry, conservation associations, and civic groups. The CAC provides the perspective of the watershed stakeholders, and they have close to thirty members and their own website (Chesapeake Bay Program 2010).

The Local Government Advisory Committee (LGAC) is a body of officials appointed by the governors of the Bay states and the mayor of Washington DC. The goal of the LGAC is to improve the role of local governments in CBP efforts, by developing strategies to increase local government participation in the program. LGAC strives to do so by improving communications, providing technical assistance to local governments, and bringing to the table local government perspective to policy development. The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Program. Separate to the STAC, the Scientific and Technical Analysis and Reporting (STAR) group sets out to provide scientific information to managers, and expand communication between workgroups. It engages both agencies and academia. With their monthly meetings, STAR enables continual dialogue between implementation teams and, and ensures an effective and responsive use of scientific resources while addressing management questions (Chesapeake Bay Program 2010).

The CBP Management Board is formed of 22 members; it strategically plans, prioritizes and provides operational guidance for the implementation strategy of the CBP, using the Conservation Action Planning (CAP) system, and an adaptive management framework for planning, implementing and measuring success for conservation projects (The Nature Conservancy 2007). There are six different goal implementation teams under the management board, which correspond to the six goals outlined in the CBP Strategic Framework.

In order to unify the multiple planning documents within the CPB, the partners developed the CBP Strategic Framework. The framework is composed of six goal strategies; each one includes a goal, its importance, the desired outcome, and the strategies for its implementation. The six goals include: protect and restore fisheries, protect and restore vital aquatic habitats, protect and restore water quality, maintain healthy watersheds, foster Chesapeake stewardship, and enhance partnering, leadership and management.

Recently, the Bay partners recognized that many elements of an adaptive management system exist in the Chesapeake Bay Program. They also noted that there was no one set of strategies for achieving goals, nor a comprehensive activity plan and framework to organize these parts into a whole. In order to overcome this challenge, the CBP adapted the Kaplan and Norton (2008) five-stage model of adaptive management to the Program's specific needs and operations (Figure 5).

The Bay Program has succeeded in many fields, from environmental restoration, science, modeling, monitoring, to partnering and trans-boundary cooperation. Specifically, and as previously mentioned, the CBP has demonstrated the effectiveness of a cooperative approach to trans-boundary watershed management. Their partnership model has been mimicked in other programs and efforts, both domestically and internationally. On a different note, the CBP has provided state of the art scientific research, and established numeric goals and deadlines for natural resource management outcomes.

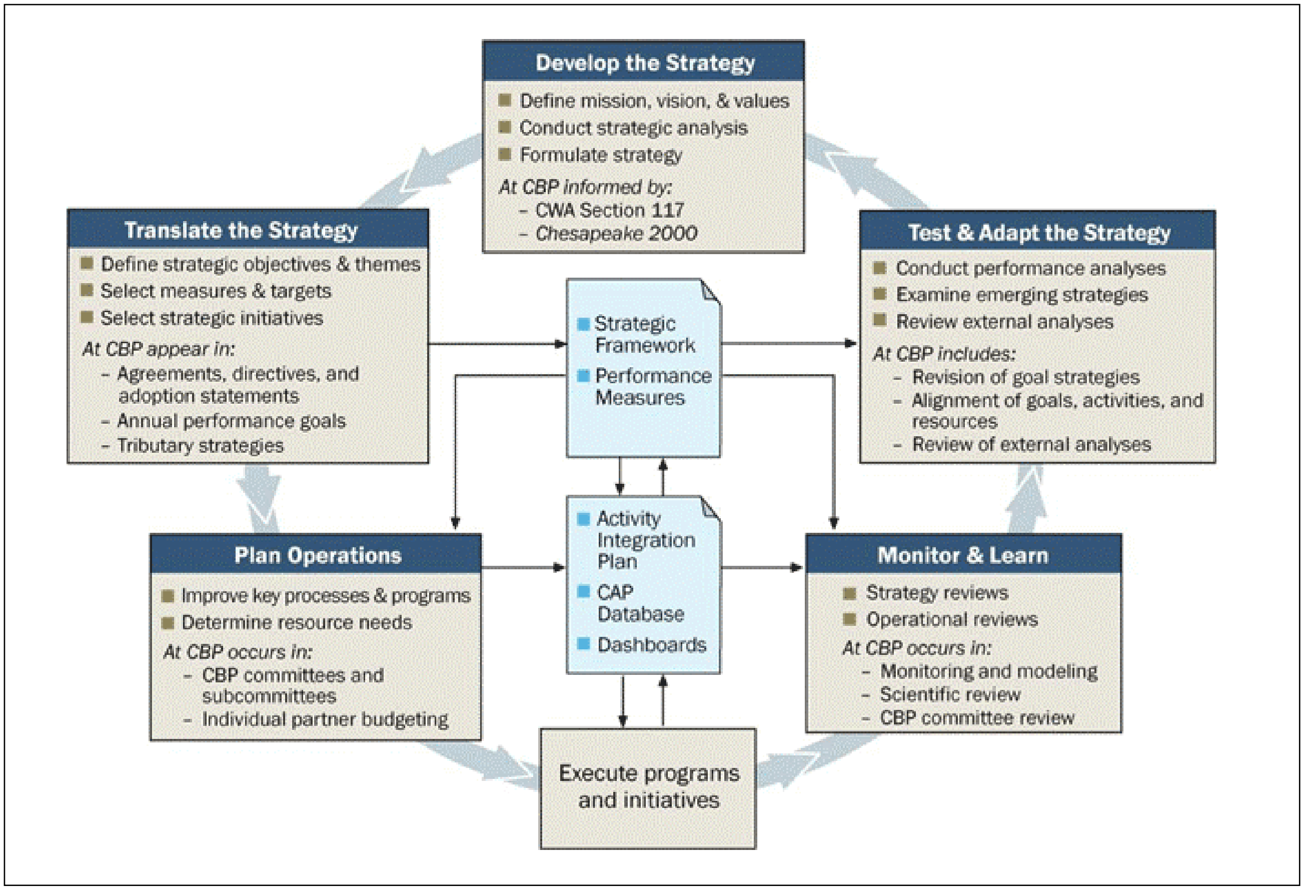

Figure 5. Chesapeake Bay Adaptive Management Model (Chesapeake Bay Program 2010).

ASSESSMENT OF THE CHESAPEAKE BAY WATERSHED MANAGEMENT REGIME

Table 1 includes the framework to qualitatively measure the capacity of a watershed management regime to support adaptive management. The framework has been applied to the Chesapeake Bay watershed management regime in order to assess and provide additional information regarding the regime's adaptive management characteristics. As previously mentioned, the framework was tested on seven international trans-boundary river basin regimes in Europe, Asia and Africa (Raadgever and Mostert 2005). In this case, the assessment framework has been applied to a non-international estuary watershed, in a tri-state multi-legislative management regime along the East coast of the United States of America.

There is little academic literature (apart from Hennessey 1994, Wolflin 2008) published outside the Chesapeake Bay Program partnership describing the Chesapeake Bay watershed management regime. However, the Chesapeake Bay Program provides extensive and detailed information regarding the watershed partnership and its history; as well as how it carries out its operations and activities, the decision-making process, and the outcomes of its efforts. In order to assess the regime, information was obtained from the CBP web site (Chesapeake Bay Program 2010), CBP and STAC publications (Curreiro 2008, Pyke et al. 2008, Chesapeake Research Consortium 2010, Weller 2010), and written interviews. Each criterion within the framework was then scored using a three-point scale: low (0), average (1) or high (2). The values for each feature were graded using the average scores of the criteria. This section presents the results of the qualitative assessment of the Chesapeake Bay watershed management regime (Table 2). Overall, the average score for the Chesapeake Bay is high (1.72 over 2), with an outstanding stakeholder network and basin level management approach. The results of each criterion are described below.

Actor Networks

Actor networks scored high. The trans-boundary cooperation between basin states has been in place for close to three decades, and has proven to succeed in formulating scientifically backed restoration and preservation efforts throughout the watershed. An example of this is the underlying awareness of the close ties between basin activities and the water quality of the Bay. This led to the formation of the Chesapeake Bay Program watershed partnership, and drove it to incorporate all levels of stakeholders in the decision-making process, as well as during conflict resolutions. As clearly reflected in the CBP organizational structure, and proven by the content of the Citizens Advisory Committee Annual Reports (Citizens Advisory Committee to the Chesapeake Executive Council 2010), watershed stakeholders have the opportunity to assist in providing guidance and direction for policy, as well as to bridge the gap between the top-down and bottom-up approach. The CBP brings together all levels of government, including the US Federal Government and all Bay and headwater states, as well the local governments within each state through the Local Government Advisory Committee. In addition to that, the CBP also actively incorporates and utilizes the resources provided by academia through the Scientific and Technical Analysis and Reporting system currently in place.

Legislation

The legal framework of the estuary basin regime scored average. The Chesapeake Bay Commission serves as the legislative arm of the CBP, and is fully involved in policy and

Table 2. Qualitative scores of the Chesapeake Bay watershed on criteria for adaptive management (Scores: Low = 0, Average = 1, High = 2) (Modified from Raadgever and Mostert 2005).

Criterion	Score
A. ACTOR NETWORKS (average criterion score 1 to 4)	2.00
1. Cross-sectoral co-operation	2
2. Cooperation between administrative levels	2
3. Cooperation across administrative boundaries	2
4. Broad stakeholder participation	2
B. LEGAL FRAMEWORKS (average criterion score 5 to 6)	0.50
5. Appropriate legal framework	1
6. Adaptable legislation	0
C. POLICY (average criterion score 7 to 11)	1.60
7. Long time horizon	1
8. Flexible measures, keeping options open	2
9. Experimentation	2
10. Full consideration of possible measures	2
11. Actual implementation of policies	1
D. INFORMATION MANAGEMENT (average criterion score 12 to 17)	2.00
12. Joint or participative information production	2
13. Interdisciplinarity	2
14. Elicitation of mental models / critical self-reflection about assumptions	2
15. Explicit consideration of uncertainty	2
16. Broad communication	2
17. Use of information	2
E. FINANCING (criterion 18)	2
18. Appropriate financing system	2
OVERALL SCORE (average criterion score 1 to 18)	1.72

implementation decisions. Nevertheless, its mission remains to advise the General Assemblies of the Bay states (Virginia, Maryland, Pennsylvania, and the headwater states) on cooperatively managing the Bay. Each Bay State remains separately responsible for developing possible legislative solutions under their different jurisdictions. The Bay Program and Commission assist in unifying this effort, but the legislative framework remains fragmented between state boundaries. Therefore, the legal framework of the estuary basin regime scored average. On a different note, and stemming from the existing framework, laws and regulations cannot be easily changed or modified. Legislation must be approved by the General Assembly of each state. The General Assembly of a state represents the citizens in the formulation of public policy, enacts laws, approves the budget, levies taxes, elects judges and confirms appointments by the Governor. A representative of the Chesapeake Bay Commission pointed out that in the Bay watershed there is no exception; legislation can take over a decade to be approved.

Policy Development

Policy development in the watershed regime scored high. Since it was founded, the CBP has been characterized as one of the first watershed organizations to establish tangible and numeric goals and timelines to increase water quality. On a different note, policy implementation scored average. The Chesapeake 2000 agreement has only met 47 percent of the goals set out to accomplish by 2010 (Table 3) (Chesapeake Bay Program 2010), and more recently, in 2009, the partnership achieved only 64 percent of its goals regarding restoration and protection efforts (Chesapeake Bay Barometer 2009). Evidence of this lack of policy implementation is the still degraded health of the bay (Wolflin 2008), which achieved only 45 percent of its goals in 2009, representing only a 6 percent increase from 2008 (Chesapeake Bay Barometer 2009).

Regarding long time horizons, the regime also scored average. Goal setting time frames range from short-term to long-term. For example, in May 2009, the CBP Executive Council set short-term 2-year goals to accelerate cleanup and increase accountability (Chesapeake Bay Barometer 2009). The Chesapeake 2000 agreement set 10-year objectives – many of which are still ongoing (Chesapeake Bay Program 2010); and the Maryland Watershed Implementation Plan for the Chesapeake Bay Watershed set a number of goals to be achieved within 20 years (Maryland Department of the Environment 2010). Policy options appear to be kept open, and therefore that criterion scored high. The CPB now calls for strategic and operational reviews, and the STAC has raised awareness regarding the need to monitor and adapt to change, specifically in response to the effects of climate change (Pyke et al. 2008). As pointed out by a Chesapeake Bay Commission representative, small-scale policy experiments do take place all the time; research is always going on to test future options that may be ripe for policy. The awareness of possible futures also scored high. For example, in January of 2003, and in order to assist policy direction, the STAC published *Chesapeake Futures: Choices for the 21st Century*. This publication outlines the likely consequences of choices made now, their implications for the future of the Bay, and potential technical and non-technical solutions to address them (Chesapeake Bay Scientific and Technical Advisory Committee 2010).

Table 3. Chesapeake 2000 Agreement Status (Chesapeake Bay Program 2010).

Status	Agreement Commitments
Completed	47%
Partly completed	9%
Not completed	9%
Ongoing	36%

Information Management

Information management scored high. Different government bodies and non-governmental stakeholders are involved in setting the terms of reference and supervising the search of information. As pointed out by a coordinator from STAC, "the Bay Program relies on STAC to ensure that its programs and policies are scientifically sound and robust". To do so, STAC hosts a variety of workshops and peer reviews as mechanisms to review and vet the science; in many cases, these also involve outside experts, from within and outside of the watershed. In addition to that, the CBP also relies on community and local government input, which is channeled through the other two advisory committees: the Citizens Advisory Committee and The Local Government Advisory Committee. Different disciplines are involved in defining and executing the research, as STAC is composed of a wide range of scientific expertise, which encompass both the natural and social sciences; including experts in agriculture, fresh and saltwater fisheries, ground water, monitoring, modeling, wastewater engineering, climate change, urban planning, storm water, anthropology, and economics, among others. A STAC representative indicated that they define workgroups to identify and address scientific needs for the Bay Program, focusing on four priority topics: monitoring and modeling, ecosystem and climate change, land-based effects on the watershed, and social sciences.

In an effort to increase the presence of social sciences during the decision making process, the group of social science experts at STAC is currently putting together a workshop to help define social science research priorities for the Chesapeake Bay Program, which are currently significantly lacking. As a committee of scientific stakeholders, STAC challenges the Bay Program's research, as well as its own. An interview with a SATC member reveled that they host quarterly meetings, which are all open to the public, and strive to involve outside scientific stakeholders, allowing them to bring in their own perspectives and input; there have been many instances where STAC recommendations have been challenged both in and outside of the Committee. A good example of this is STAC's review of the Chesapeake Bay Program's monitoring network and subsequent recommendations to realign monitoring funds to support more monitoring in the headwaters of the watershed – a priority need indicated by the senior level managers within the CBP. On a different note, research results are not presented in an authoritative way, but in a facilitative way, to stimulate reflection by stakeholders about what is possible and what it is they want. As an example of this, STAC only has advice and consent capability; they have a seat and voice on the Bay Program's Management Board and Principle Staff Committee, but no vote. Also, and as noted in the multiple STAC publications, uncertainties regarding possible futures are raised and communicated in final reports (Weller 2010, Curreiro 2008, Chesapeake Research Consortium 2010). Finally, it is important to note that the CBP strives to use the information to influence policy, specifically through the Chesapeake Bay Commission and its tri-state legislative assembly.

Table 4. CBP Budget Allocation (Chesapeake Bay Program 2010).

Budget Allocation	Percentage
Implementation grants for Bay States	45%
Monitoring programs	15%
Conservation, upgrade and pilot projects	20%
Computer modeling	5%
Overhead (office, personnel, etc…)	15%

Financial Systems

The Chesapeake Bay management regime scored high for financial systems. The high score is due to the regime's steady source of funding over time, and specifically to its constant effort to ensure that the funding is allocated in a cost-efficient way. For the past 15 years, the CBP has received steady annual funding from the US Environmental Protection Agency, amounting to approximately $20 million a year. Funds are allocated to a variety of different sources (Chesapeake Bay Program 2010) (Table 4). In 2003, the Chesapeake Bay Commission published the *Cost of a Clean Bay* report, tagging the price of the Bay restoration at $19 billion. A year later, the Commission published the *Cost-Effective Strategies for the Bay: 6 Smart Investments for Nutrient and Sediment Reduction.* This document outlined what control measures and management practices are both cost-effective and widely applicable; specifically, what practices will deliver the largest nutrient and sediment load reductions for the least cost. In response to the 2010 deadline for the 2000 Agreement commitments and low dollar availability, the report aimed to provide guidance and assistance to the Bay states in prioritizing the allocation of funds. In addition to the EPA funding, the CBP receives special grants from other federal agencies, such as the Small Watershed Grants, Targeted Watershed Grants, B-WET grants or Getaway and Water Trails Grant. Finally, the CBP Budget Steering Committee assists the EPA by providing insights on how appropriated dollars should be spent every year (Chesapeake Bay Program 2010).

DISCUSSION

This research set out to use an existing framework to assess the capacity of the Chesapeake Bay watershed management regime to support adaptive management. It is important to keep in mind that the framework was based on the assumption that actor networks, policies, legislation, information management and financial systems are supposed to look a certain way in order to support adaptive management (Raadgever et al. 2008).

It is also important to point out that adaptive management is not always necessary (van Eeten and Roe 2002), and can sometimes come hand in hand with high cooperation and integration costs (Dombrowsky 2007), as well as with an increase in time and resources associated with the additional information gathering requirements (Lee 1999). In this case, however, the Chesapeake Bay Partnership had already acknowledged certain trends in the regime associated with those essential for an adaptive management approach. These include a functional actor network and participatory management approach, as well as constant monitoring and availability of information. As discussed, an adaptive management model was incorporated into the Program's operations. The model bridges and unites strategies and operations, with the objective of driving towards continual improvement of implementation activities and organizational performance.

The framework used in this research assesses the independent variables or regime characteristics, but not the dependent variables or operational water management (Raadgever et al. 2008). In the case of the Chesapeake Bay regime, the CBP had already incorporated these independent variables into an adaptive management operational model; therefore future research could evaluate this model and explore whether it supports adaptive operational management. The results would provide information regarding both the existence and operation of elements that support adaptive management.

Overall, the Chesapeake Bay watershed management regime scored between average and high capacity to support adaptive management. All of the features evaluated scored above average except for the legislative framework. The low score assigned to the legislative framework stems from the regime's inability to provide adaptive and flexible legislation. Water resources related legislation still follows the standard approval process established by the General Assembly in each US State. Future research in this area is needed to comprehensively assess the capacity of the regime to overcome this barrier.

Certain situations suggest that not all elements of an adaptive management regime can be implemented if the institutional and political framework cannot support them (Raadgever et al. 2008). The results of this research indicate that this is not the case in the Chesapeake Bay watershed. Based on the existing framework, and on the results of the assessment, the Bay basin management regime presents all the required characteristics to support adaptive water resource management, except for flexible legislation. This is due to the Chesapeake Bay Program and its actor network, participatory model and access to information, knowledge, monitoring systems and financing.

The framework proposed by Raadgever and Mostert (2005) that was used to assess the adaptive capacity of the Chesapeake Bay management regime can be considered subjective. The subjectivity of the assessment framework stems from the lack of a standard scoring methodology for the researcher to score the criteria. The absence of the scoring methodology makes the success of the framework rely heavily on the researcher's knowledge and understanding of the regime. As previously described, indicators for each criterion were identified and their presence/absence scored, nevertheless, the score is based on the researcher's opinion, and not on a comparison to a reference value, percentage of completion, or statistical methodology. For each indicator, understanding the number of actions successfully implemented and the associated timeframe is essential for scoring the success/failure of each criterion, and therefore that of each feature of the management regime. Two potential solutions to overcome the subjectivity of the framework proposed by Raadgever and Mostert (2005) include the use of percentages, and the incorporation of numeric indicators.

A percentage of accomplished actions over the total number of proposed actions during a specific time frame could assist the researcher in scoring the presence/absence of such an indicator in a regime, with 0 being completely absent and 100 completely present. In addition to that, the use of numeric indicators, such as those utilized by Pandey et al. (2011) to quantitatively calculate the Adaptive Capacity Index (ACI) and asses the adaptive capacity of a water resources system, could be incorporated into the framework developed by Raadgever and Mostert (2005). In both cases, the resulting framework would enable a more objective and widely applicable tool that could be used by researchers not familiar with the basin to conduct the assessment. An interesting topic for future research is the application of the framework proposed by Pandey et al (2011) to the Chesapeake Bay watershed, as well as the incorporation of numeric or percentage based indicators to the framework used in this paper.

CONCLUSION

To conclude, the assessment of the Chesapeake Bay watershed management regime was facilitated by the large amount of information available to the public regarding the Bay Program, its operations and framework. The outcomes of the assessment reveal that the key features and criterion identified by Raadgever et al. (2008) as essential to trans-boundary watershed management regimes are in line with those identified by the CBP as essential to an adaptive management system.

In both cases, the management regime was identified as one capable of supporting adaptive management. These results should encourage other trans-boundary watershed management regimes to incorporate the identified features in their regime, in an effort to evolve towards a management system designed to continually improve and adapt to change.

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ADDRESS FOR CORRESPONDENCE
Juan Pablo Reig
Integrated Water Resources Management Program
Department of Bioresource Engineering
Faculty of Agricultural and Environmental Sciences
McGill University
21,111 Lakeshore Road
Ste-Anne-de-Bellevue, QC H9X 3V9
Canada

Email: juan.reig@mail.mcgill.ca