Making Nature Count

MUNICIPAL NATURAL ASSET MANAGEMENT AS A SUSTAINABLE INFRASTRUCTURE STRATEGY: THE EMERGING EVIDENCE

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DISCUSSION PAPER

MAKING NATURE COUNT

For more information on the Municipal Natural Assets Initiative please visit https://www.facebook.com/municipalnaturalassets/?ref=bookmarks or email info.mnai@gmail.com

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1 Overview

This paper documents an emerging strategy to manage natural assets such as woodlands, wetlands, and creeks in urban areas as part of a sustainable infrastructure strategy. Specifically, the paper explores Canadian local government experience through the Municipal Natural Assets Initiative (MNAI) to identify, value, and account for natural assets' contribution to municipal government service delivery, services that would otherwise need to be delivered by engineered assets. Evidence from MNAI suggests that a structured, asset management-based approach holds great promise to tackle the twin challenges of declining urban infrastructure quality and declining ecosystem health and could have applicability well beyond Canada.

2 Limitations

This document is prepared as a submission to the *Fifth Green Grown Knowledge Platform Conference on Sustainable Infrastructure.* Activities in the five pilots are ongoing, and data cited below is therefore incomplete. There will be substantially more data from each project by the time of the Conference (November, 2017).

3 Context

Three main imperatives drive the exploration of new approaches to manage natural assets as part of a sustainable infrastructure strategy.

First, in North America and beyond, urban infrastructure is in poor shape. For example, the American Society of Civil Engineers (2017) rates the quality of the United States' infrastructure at a "D+." To the north, the Federation of Canadian Municipalities (2016) found that one-third of Canada's infrastructure is in fair, poor or very poor condition, increasing the risk of service disruption. Elsewhere, Miller (2013) notes that across Africa, for example, substandard infrastructure constricts growth by as much as 2 percent annually, with a continental annual infrastructure funding gap estimated between $30 billion to $90 billion. A wide spectrum of approaches is required to overcome these challenges.

Second, policy and scientific focus on preserving life-sustaining natural capital and ecosystem services has grown substantially since the 2005 Millennium Ecosystem Assessment[1] and has signaled the dramatic decline in many of Earth's vital natural systems.
However, only limited corresponding changes have been made in the practices and operations of governments and business to halt this decline (Ruckleshaus, 2015). Overall, natural capital is not measured, managed or valued in the same manner as human or financial capital. For example, while markets exist for food, fibre and biomass, other services from nature such as water regulation, habitat provision, pollination, disease and pest regulation, climatic regulation

[1] The Millennium Ecosystem Assessment assessed the consequences of ecosystem change for human well-being and is based on the work of over 1300 experts. See http://www.millenniumassessment.org/en/index.html

and hazard protection are not priced and are therefore ignored in most conventional decision-making processes. This often leads to a corresponding loss of natural environments and the vital ecosystem services they provide (see for example Kinzig, 2011). Here again, a spectrum of approaches is called for to halt the decline of ecosystems.

Third, there is growing – and well-documented – urgency to address infrastructure issues as a result of global population growth, urbanization trends[2], and climate change impacts including sea level rise, drought, and more frequent and intense storms (see for example Miller 2013).

4 Origins of Municipal Natural Asset Management

4.1 Foundations: modern Asset Management

Canadian local governments are seeking new strategies to improve their ability to deliver core services in an affordable, financially sustainable manner. Many have turned to modern *Asset Management* to achieve this. Asset Management involves inventorying a community's existing assets, determining the current state and value of those assets, and preparing and implementing asset management plans to maintain or replace those assets, with the goal of ensuring sustainable service delivery to a community. Asset Management requires that municipalities take a lifecycle view of assets which can, amongst other things, help predict asset failure, plan for replacement strategies and effectively time funding requirements (based on Asset Management BC, 2013). Canadian municipalities are now required to adopt modern asset management approaches as a result of measures including the 2009 Public Sector Accounting Board (PSAB) standard 3150 that includes a provision for municipal tangible capital assets to be identified, counted, valued and amortized over their useful lifetime[3].

Figure 1: *Asset Management is an integrated process that helps local governments make informed decisions that support sustainable service delivery. Source: Asset Management BC.*

[2] Currently 54 per cent of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050 (United Nations, *World Urbanization Prospects,* 2014)

[3] See PSAB 3150 http://www.municipalaffairs.gov.ab.ca/documents/ms/PSAB_3150_4_toolkit_full_document.pdf

To assist municipalities in complying with PSAB 3150, a number of guidance documents have been created, including the Asset Management BC Framework[4] and Building Together – Guide for municipal asset plans (Ontario).[5] Generally, these guidance documents are also consistent with international standards including ISO 55000, ISO 55001 and ISO 55002 and the International Infrastructure Management Manual (IIMM), itself based on ISO 55000 Asset Management Standards.

4.2 Pioneering municipal natural asset management: The Town of Gibsons' experience

The emphasis in Asset Management on sustainable *service delivery* – as opposed to the underlying asset that delivers those services – means that natural capital can form a core element of municipal asset management strategies, since this natural capital may provide, or could be restored to provide, ecosystem services that communities rely on. From the lens of a local government, this natural capital forms a class of natural assets that deliver municipal services just like engineered assets. However, local governments lack policies and methods to measure this class of assets, which have historically not been considered on equal footing with engineered assets or included in asset management plans.

The Town of Gibsons, a coastal community of 4,400 people in British Columbia's Sunshine Coast region, was the first North American community to experiment with strategies to tackle this challenge and integrate natural assets into asset management and financial planning. In 2013, consistent with the new PSAB 3150 requirements, the Town determined the state and value of its assets. In doing so, they discovered that this list of tangible capital assets, as traditionally defined, did not include their foreshore, which protects the business area from storm surges, the Gibsons aquifer, which provides drinking water to the community, nor the forest that conveys and absorbs storm water. Town officials realized that if any of these 'natural assets' were to fail, the community would be required to develop an engineered alternative, without having allocated funds to do so. This created, effectively, an undocumented risk to the community (Machado, 2017).

This insight led the Town to develop a suite of approaches to address the newly identified risk of natural asset failure or loss. The cornerstone of the Town's approach is a natural capital management policy. In 2014, the Town of Gibsons became the first municipality in North America to explicitly deem nature to be a municipal asset, giving it the same consideration as traditional capital assets. In other words, Gibsons committed to operate and maintain its natural assets in the same manner as storm sewers, roads and other traditional engineered assets (Town of Gibsons, 2014).

Technical measures in support of this initiative included a full assessment of the Gibsons Aquifer, and a modelling of the ecosystem services, functions and corresponding values provided by the White Tower Park forest (Sahl et al. 2015). Policy measures taken in 2015-16

[4] Asset Management BC – Framework, http://www.assetmanagementbc.ca/framework/
[5] Government of Ontario, Building Together – Guide for municipal asset management plans, https://www.ontario.ca/page/building-together-guide-municipal-asset-management-plans

included adding a note in the Town's financial statements to acknowledge the value of natural assets to the community; adding a recognition in the Town's Official Community Plan of the value of natural assets and setting out policies for their identification and management; and, in the Town's Strategic Plan (2016-2018) identifying the advancement of the Town's natural asset approach as a priority (Town of Gibsons 2017).

Evidence from the Towns' efforts to date show several results:

- The Town has documented its dependence on natural assets and therefore has a more comprehensive and realistic view of the risks associated with its asset portfolio (Machado, 2017);
- The Gibsons aquifer provides sufficient water storage to supply approximately 70% of the projected population of Gibsons for the foreseeable future (Waterline 2013) with no capital costs and operating costs limited to $30,000/year for monitoring – a fraction of the cost of engineered water supply infrastructure. The assessment has led to additional preventative maintenance and the development of integrated, multi-disciplinary team to ensure its appropriate management;
- A series of ponds in the Town's White Tower Park provide stormwater management services. Approximately $15,000 is spent every 3 years for dredging sedimentation, and there was a one-time $45,000 cost for assessment and modelling the services provided by this natural asset. Providing these same stormwater management services through engineered assets would have an estimated cost of $3.5-4.0 million (Sahl et al. 2015); and
- Assessment of the replacement cost value of this natural asset led the Town to choose to place new housing developments in locations and with design requirements that protect the White Tower Park ponds.

5 Building on Gibsons' approach: The Municipal Natural Assets Initiative

5.1 General

Based on the early results from Gibsons, a group of municipal, financial, and asset management stakeholders met in November, 2015, to determine whether the approach could apply to other local governments. The group noted that while all municipalities use natural assets to varying degrees, the assets are typically over-used, and the dependence on the asset is unrecorded. Furthermore, they noted that while there were a limited number of well-cited (but not necessarily rigorously assessed) examples of municipalities deliberately substituting natural assets for engineered assets, these were very hard to replicate in absence of a common methodology or platform across municipalities.

Based on these insights, participants reached the two-fold conclusion that Asset Management was a promising mechanism for transfering the "Gibsons approach" to other municipalities; and, that a combination of enabling activities and pilot projects should be developed to expand

the approach (Brooke et al. 2015a and 2015b). This, in turn, led to program development and fundraising efforts and the development and launch of MNAI with the purpose of "*support(ing) municipalities in measuring and managing natural assets within the context of their asset management business processes, which will in turn support the sustainable delivery of municipal services and improved management and health of natural assets*".

MNAI is based on the Asset Management "platform". It also draws upon concepts related to natural capital, ecosystem services[6], comprehensive wealth[7], and environmental and natural capital accounting. However, the purpose of MNAI is not primarily to measure the value of natural assets, "put a price on nature" or integrate environmental information into measures of economic activity. Rather, MNAI seeks to *apply* concepts related to the value of the services from natural assets in municipal decision-making. It does so by extending the application of existing municipal systems for asset management municipally-valuable services from nature, and incorporating that value into asset management. This can enable maintenance, monitoring, land acquisition, restoration, rehabilitation, environmental management or other actions to be undertaken within the context of a municipal asset management framework.

MNAI is managed by four Convening Partners: The Town of Gibsons, the David Suzuki Foundation, Smart Prosperity Institute, and Brooke and Associates. Several partners collaborate closely with MNAI including: Asset Management BC, The Natural Capital Lab, and the Partnership for Water Sustainability. Funders include: the Real Estate Foundation of BC, Green Belt Foundation of Ontario, Salamander Foundation, Province of British Columbia through the Ministry of Community, Sport and Cultural Development, Sitka Foundation, Vancity Credit Union and Tides Foundation.

Key components of MNAI include:

- Establishing a shared definition of municipal natural assets;
- The development of a methodology to allow local governments to determine the ecological function of one or more natural assets; the services provided to the local government from those functions; the condition and capacity of the natural asset(s); how the services would differ in varying climate change, environmental management, urban development or other scenarios; and the value of the asset if it had to be provided by other means;
- The implementation in 2016-2017 of the methodology in 5 Canadian municipalities, including ongoing support and guidance from MNAI;
- Research activities on the role of private landowners in protecting and managing land that provides services to municipalities; and on barriers and challenges at the level of professional disciplines relevant to local government contexts (e.g. planners, engineers);
- Communication, outreach and awareness-raising activities to maximize the value and learning from the 5 projects.

[6] See for example Sustainable Prosperity (2014)
[7] See for example IISD 2016

The remainder of this document focuses on the definition of municipal natural assets, and the methodological approach, pilots, the learning to date, and the potential implications in a global context.

5.2 Establishing a shared definition

The emerging term for the approach adopted by the Town of Gibsons and now other municipalities is *municipal natural asset management* (MNAM).

5.2.1 A definition for Municipal Natural Assets

Municipal asset management is focused on *"the infrastructure assets that are used by a municipality for the provision of a sustainable municipal service"* (Municipal Natural Assets Initiative 2017).

The MNAI definition of **municipal natural assets**, currently being peer reviewed, is "*the stock of natural resources or ecosystems that contributes to the provision of one or more services required for the health, well-being, and long-term sustainability of a community and its residents"* (Municipal Natural Assets Initiative 2017).

The premise of the MNAI project is that *"Natural assets that are owned or managed by the municipality or that provide the same municipal service as engineered infrastructure can therefore be considered as tangible capital assets*". The MNAM approach views municipal natural assets through an infrastructure asset management lens and generally considers those municipal natural assets "*that would otherwise need to be provided by a municipality, regional government, or other form of local government"* (Municipal Natural Assets Initiative 2017). Table 1 provides an example of the types of municipal services typically provided by engineered infrastructure that can also be provided by natural assets. This can conversely be viewed as natural infrastructure that, if lost, would need to be replaced by engineered infrastructure.

Table 1: *Example of water specific municipal services that can be provided by natural assets and ecosystem services*

Municipal Water Services	Ecosystem Service	Natural Asset	Engineered Replacement
Drinking Water Supply	Aquifer Recharge	Aquifer & Source Water Area	Pipes for bringing in water supply
	Lake Recharge	Lake Watershed	Water Treatment Plant
	River Headwaters	Headwater lands	
Drinking Water Treatment	Water purification	Wetlands, forests, vegetation	Water Treatment Plant
	Water Filtration	Wetlands, forests, vegetation	
Stormwater Management	Rainwater Absorption	Wetlands, forests, vegetation	Stormwater pipes, culverts, storm drains, stormwater ponds
	Rainwater Filtration	Wetlands, forests, vegetation	
Flood Mitigation	Rainwater Absorption	Wetlands, forests, vegetation	Dams, retaining walls, embankments

5.2.2 Natural Assets vs. Green Infrastructure

The terms natural asset and green infrastructure are often used interchangeably, but one is broader than the other. Whereas the term *natural assets* refers to the stock of natural resources and ecosystems that yield a flow of benefits to people, *green infrastructure* includes designed and engineered elements that have been created to mimic natural functions and processes in the service of human interests (see Figure 2).

MNAM is focused primarily on these pre-existing stocks of natural assets as opposed to newly created enhanced or engineered assets.

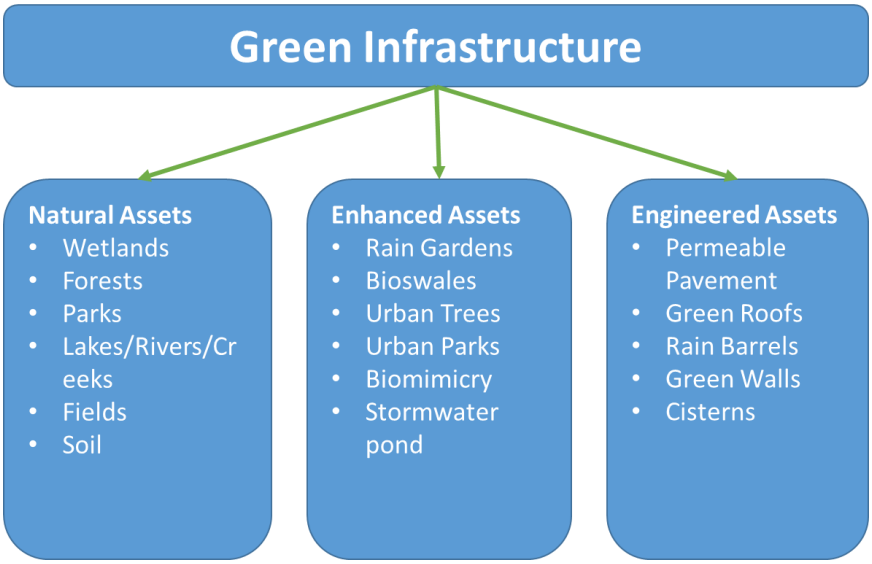

Figure 2: *Elements of green infrastructure. Natural assets are the stock of natural resources or ecosystems that provide, or could be restored to provide, services just like enhanced or engineered assets. Enhanced assets have been built to act like natural assets, whereas engineered assets have been designed to function like natural assets but are new designs not found in nature. Source: MNAI 2017.*

5.3 MNAI methodology

Beginning in early 2016, MNAI Convening Partners reviewed methodologies for determining the functions, services and values of natural capital. Early decisions were made i) to focus on stormwater management services for the purpose of the first round of five pilots, since no single methodology was available to also address other municipal services such as drought mitigation, sea-level rise or heat island effect; and ii) to develop an approach that closely resembled the steps and activities required for asset management. Within this context, a prototype methodology was developed by MNAI through a peer-review process. It provides local governments with a framework to:

- Characterize their natural asset(s);
- Develop alternative scenarios around the natural asset;
- Develop and run a hydrologic model;
- Conduct an economic valuation using the replacement cost method;
- Assess beneficiaries; and
- Develop an operations and maintenance plan for their natural assets.

The methodology was designed to complement existing asset management guides developed for local governments and thus focuses only on the unique or novel considerations required for municipal natural capital and their associated services (Molnar et al. 2016).

The methodology is supported with a Guidance Document that provides details related to general issues such as the skill sets required to address natural capital issues in a local government context (see Table 2). It also offers detailed guidance on conducting the hydrologic modelling. The US Environmental Protection Agency Storm Water Management Model[8] (SWMM) was selected to conduct the hydrologic modelling as it free, open-source and well-known to many municipalities. SWMM models rainfall-runoff processes and can be used for single event or continuous simulations of stormwater quantity and quality. During setup, users define sub-catchments that have homogeneous landscape characteristics, as well as a network of pipes and channels to which each sub-catchment drains (US EPA, 2015).

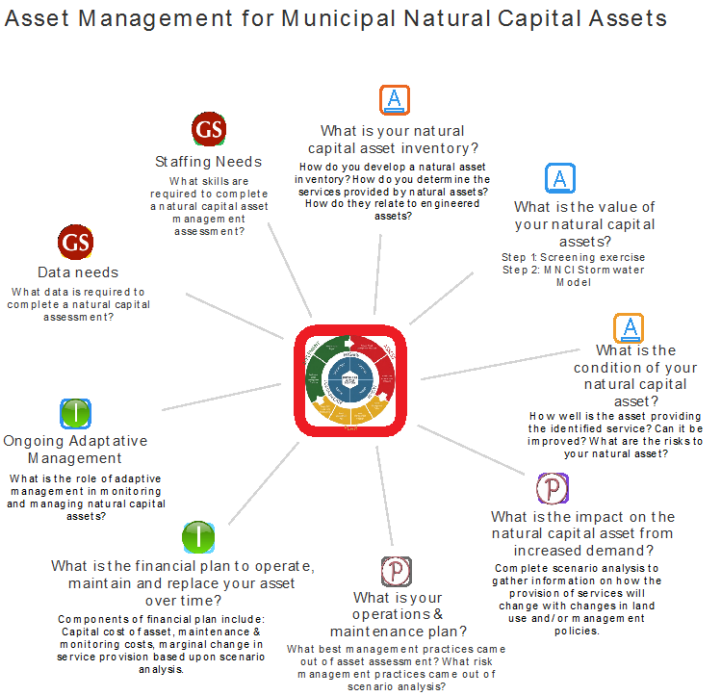

Figure 3: *The MNAM methodology focuses on the unique or novel considerations required for municipal natural capital and their associated services. Source: Molnar et al. 2016.*

The Guidance Document provides information to support hydrologic modelling related to:

- Estimating time and data requirements to effectively model the functions and services provided by natural assets;
- Scenario development to compare the functions, services and value corresponding to the hydrology of watersheds in different scenarios including land intensification, climate change, use different environmental management techniques; and use of engineered options; and,
- Running the model over different timeframes and for single events (i.e. single storm events) and/or continuous time series (i.e. over extended periods, including wet and dry periods), all with varying data requirements, and calibrating the model to test accuracy.

Options are provided for conducting beneficiary analyses (see Table 3) and planning to manage the selected natural asset based on the result of the analysis. There are a variety of methods for natural capital and environmental valuations; the Guidance Document proposes economic valuations based on replacement costs (i.e. the capital and operating costs of delivering of providing the natural asset's services, if they had to be delivered through engineered means).

[8] https://www.epa.gov/water-research/storm-water-management-model-swmm

Table 2: *The MNAI Guidance Document contains information on issues such as the skill sets required to conduct municipal natural asset management. Source: Molnar et al 2016.*

Specialist	Integrated Stormwater Management Planning	Hydrology	Hydraulics	Stormwater Modelling	Water Quality	Design	Spatial Mapping/ Data Acquisition	Natural Asset Valuation	Accounting/ GAAP	Biology/ Aquatics	Construction/ Estimating
Environmental Economist								■			
Civil/ Hydrotechnical Engineer	■	■	■	■	■	■					■
Hydrologist	■	■		■	■						
Aquatics Scientist	■				■	■				■	
GIS Specialist							■				
Accountant									■		

Table 3: *MNAI Guidance Document information on conducting beneficiary analysis. Source: Molnar et al. 2016*

Service	***E.g. beneficiaries***	***Driver of demand***	***Possible assessment method (and data needs)***
Flood mitigation	Urban dwellers in flood prone areas and downstream population centers	Presence and vulnerability of urban dwellers in flood-prone areas or in downstream population centers	Use flood maps (historic or modeled data) to identify urban dwellers at risk and overlay this information with supply of service
Water quality improvement	Water treatment facilities or reservoir managers (avoided sedimentation)	Sensitivity of water treatment facilities to increases in sediment loads or water quality impairment	Use the relationship between water quality and facilities' treatment costs to assess the importance of the water purification service
Improvement of stream health	Taxpayers, recreationists, stakeholders valuing clean waters	Stormwater regulations, current biological state of stream waters	Use stormwater regulations as the valuation framework (see Section on Economic valuation)
Increase in groundwater recharge	Within city or downstream groundwater users	Whether the area is prone to water scarcity issues	Use a regional hydrogeological assessment to assess how increase in infiltration may impact groundwater recharge and baseflow

Overall, the methodology leads local governments to a point where they can make informed decisions about how to manage a particular natural asset(s) such that they can provide identified services on an ongoing basis. Planning and management tools include Operations and Maintenance (O&M) plans, which ideally would provide local governments with a practical, operational basis for managing their natural assets over the long-term.

5.4 Implementing the methodology

MNAI is implemented on a partnership basis in which MNAI Convening Partners and participating local governments have distinct responsibilities. To implement the five MNAI pilots, the Convening Partners are responsible for:

- Support for a detailed project scoping to ensure a clear common understanding of the initiative and its objectives;
- Providing detailed guidance and support documents;
- Leading an on-site workshop to launch;
- Providing an ongoing "help desk" technical function which provides support to municipalities as they work through the pilot. This is tailored to each municipality at approximately 10-15 hours per month per municipality for 16 months, and typically involves extensive support at each stage of the Asset Management cycle depicted in Figure 1 ranging from: support for scoping data needs; support in finding data sources to enable modelling; trouble-shooting; training on modelling (e.g. EPA SWMM model); support for developing an Operations and Maintenance plan (or equivalent where private land is involved);
- Regular webinar check-ins at each project milestone to (a) extract lessons on how work is progressing and (b) provide support for the next project step;
- Conducting all principal aspects of the economic analysis to determine the value of the natural assets' services;
- Group / cohort learning webinars to share experience across project; and,
- Project evaluation at the end of the pilot (monitoring will be conducted throughout).

Throughout, MNAI Convening partners also conduct extensive outreach, awareness raising and a range of enabling activities.

Participating pilot municipalities are responsible for:

- Demonstrating from the outset the explicit support from Council and/or the Chief Administrative Office for the project, including for identifying and allocating additional capacity in staff workplans for the project;
- Demonstrating a clear commitment to a structured asset management approach across the organization;
- Committing to explore changes to decision-making as a result of the project, including, for example, costed O&M Plans;

- Committing the engagement of a multi-disciplinary staff team representing relevant departments such as Finance, Public Works, Engineering, and Parks and well as a single point-person for the MNAI team;
- Committing to gathering all data required to run and calibrate the SWMM model effectively; and,
- Making a financial commitment to the project.

5.5 Current status of the pilots

At the time of writing, each pilot had completed:

- Defining data requirements to enable accurate modelling;
- Substantial parts of the data gathering process, which, depending on the context, included accessing reports and studies, analyzing data sets from weather monitoring stations; and installing data loggers to determine water flow rates within the pilot areas and/or calibrate the models;
- Condition assessments of the natural assets;
- Defining ways to conduct beneficiary assessments; and,
- Finalizing scenarios to test.

The actual modelling of the different scenarios using the EPA SWMM model is scheduled to take place during June-August 2017, with the economic modelling to take place in August-September 2017. Thus, at the time of the *Fifth Green Grown Knowledge Platform Conference on Sustainable Infrastructure* it will be possible to speak to the value of the services from the natural assets in each pilot. Development of management options for each natural asset will be underway but may not be fully complete by November 2017.

Section 5.6, below, will be updated for the GGKP conference with the information available by November 2017.

5.6 Experience from MNAI pilots

Participating municipalities were selected by the MNAI convening partners following a national call for proposals, review of applications and interviews. The MNAI convening partners sought, in particular, participants with a demonstrated commitment to asset management since this is the platform on which activities are based. The five MNAI pilots were launched over the course of the summer of 2016, with a project completion date of December 2017. Each started with an initial *in situ* workshop to refine the scope of the project and determine the scenarios that each pilot wanted to explore through the process and start developing workplans. Since the launch, the pilots have proceeded on a cohort basis with: regular group webinars to share lessons and findings; ongoing support from the MNAI team to guide activities and maintain progress towards each milestone; and webinars at each milestone to review progress to plan activities towards the next milestone.

5.6.1 Pilot 1: City of Nanaimo

The City of Nanaimo (population: approximately 90,000) is located on Vancouver Island, in the Province of British Columbia, Canada.

A key objective for the City of Nanaimo relates to understanding, and maximizing municipal services from the Buttertubs Marsh Conservation Area, a 55 HA/133 acre reclaimed wetland/floodplain in the center of the City. Prior to the MNAI pilot, City efforts related to the Marsh focused primarily on maintaining open water habitat, inventorying and restoring natural biodiversity, and removing invasive species. No costing estimates for the value of stormwater management or other services had been conducted.

The City of Nanaimo wanted to answer a number of management questions through the project, including:

- How resilient is the Marsh to future storm events; how well can it manage in different storm scenarios?
- What is the value of the services provided from the Marsh; if these services were degraded, what costs would need to be incurred elsewhere by the City? Conversely, if they were enhanced, would there be savings to the City?
- What is the value of the wetland's water retention properties? Does it offset future capital expenditures and / or justify any land acquisition?
- What is the value of the Marsh in terms of assuring downstream water quality?

To the extent possible with the model and data availability, these questions are addressed in the context of other natural and engineered components of the sub-watershed.

Potential outcomes of the pilot include (to be revised November 2017):

- Management options to minimize localized and downstream flooding;
- Possible justification for future capital expenditures (e.g. capital projects, land acquisition);
- Operations and maintenance plan that could describe issues such as: the best way to manage flooding, how to consider climate change inputs; options to preserve and enhance biodiversity of the Marsh; and, strategies to enhance water quality and quantity; and
- Risk assessments and cost estimates of potential projects.

5.6.2 Pilot 2: District of West Vancouver

The District of West Vancouver (population: approximately 42,000) is a district municipality located on the coast of the Province of British Columbia, Canada.

The District contains 13 watersheds, each with numerous tributaries. Some tributaries are in a natural state, and others are channeled through underground pipes and culverts. The ecological benefits of returning streams to above ground channels or "daylighting" and returning them to a more natural state are well-documented. They can include improvements to water quality, flood mitigation and habitat creation. The financial case for local governments to daylight streams, by contrast, is not well-documented.

The District's objectives relate to a covered 90-metre tributary to a creek near an elementary school. The District hopes to understand the financial and risk management case in terms of avoided future asset replacement costs for daylighting the tributary as well as the potential benefits in terms of increased habitat for cutthroat trout and coho salmon species.

Management questions the District wants to answer through the process include:

- Determining the value of the services provided by the stream in its natural (daylighted) state versus the value of the services in its current covered form; and versus the size and type of pipe that would be required to meet current standards / requirements.
- Developing a simple model that can be used elsewhere in the District and in other areas, to estimate the financial value of daylighted versus covered streams.

Potential outcomes of the pilot include (to be revised November 2017):

- A holistic understanding of the potential value of daylighting the covered portion of the stream compared to asset replacement with the use of a pipe;
- A multi-criteria decision analysis tool to incorporate economic and non-economic criteria into the decision-making process regarding stream daylighting;
- Management options for the District to apply to Westcot Creek and other steams that are daylighted to maximize benefits;
- Furthering local government's understanding of how to place a value on reclaimed natural assets and to account for this within current processes;
- A model that can be applied elsewhere in the District and by other local governments to estimate the financial value of daylighting streams;
- An operations and maintenance plan for the stream should the District proceed with daylighting; and
- Local public/student engagement in the process of daylighting and awareness of the value of natural assets.

5.6.3 Pilot 3: City of Grand Forks

The City of Grand Forks (population: approximately 4,000) is a municipality located very close to the Canada-US border in the West Kootenay Region of British Columbia, Canada.

The City's principle interest is to start the process of integrating natural assets into its overall asset management plan. Water-related issues were already topical in Grand Forks as the City aquifer had been damaged due to gas contamination. Accordingly, the City chose to focus on an oxbow wetland in the center of the urban area. The wetland represents a substantial series of assets in the center of Grand Forks, one that links to the interconnected issues of stormwater, aquifer health, localised flooding and the quality of fish-bearing streams.

Management questions that the City wanted to address through the pilot project included:

- What is the value of the services (quantity, flood control, drought control) provided from the wetland; if these services were degraded, what costs would need to be incurred elsewhere by the City?
- What is the value of the wetland's water retention properties? Does it offset future capital expenditures and / or justify any land acquisition?
- What is the value of the oxbow wetland in terms of assuring downstream water quality for both fish-bearing rivers and wetland / touristic areas bordering the Kettle River?

Potential outcomes of the pilot include (to be revised November 2017):

- Determination of management options to minimise local flooding and drought issues, and the value of these options relative to engineered alternatives;
- Understanding the value of the wetland in terms of avoiding a built (engineered) stormwater system;
- Developing of a business case for Council to weigh options for land acquisition to maintain or enhance services;
- Understanding of how data from Pilot could support stormwater management plans.
- Determining communications and outreach options to engage local population in understanding the value of the wetland and acting accordingly; and
- Developing O&M plans to include within an asset management plan.

5.6.4 Pilot 4: Region of Peel

The Regional Municipality of Peel (population approximately 1,000,000) is a regional municipality in Southern Ontario, Canada. The pilot area is the Credit River Watershed located for the most part within the Region of Peel. The CRW is approximately 1000 km^2 in size with 22 sub-watersheds. Given the large watershed size and correspondingly high data requirements, the pilot focussed on an urban and rural *sub*-watershed. The Region of Peel – together with partner organization Credit Valley Conservation Authority (CVCA) – had as its principle interest the integration of natural assets into asset management frameworks. As with the City of Grand Forks, water issues were already topical as costs associated with storm events and infrastructure increased due to the impacts of climate change, growth and development.

Management questions that the Region and CVCA are exploring include:

- What is the value of the services in financial terms provided by the natural assets in the sub-watersheds with respect to avoidance of flooding/erosion, maintenance of clean water (quality) and maintenance of base-flow (quantity)?
- What are the management options with a view to maximization of these services?
- How will observed climate change trends impact the natural assets and the services they provide?
- What are the operations and maintenance costs associated with the management options associated with the natural assets for each scenario?

Potential outcomes of the pilot include (to be revised November 2017):

- Determination of management options to minimise local flooding and drought issues, and the value of these options relative to engineered alternatives;
- Understanding the value of the wetland in terms of avoiding a built (engineered) stormwater system;
- Developing of a business case for Council to weigh options for land acquisition to maintain or enhance services;
- Understanding of how data from Pilot could support stormwater management plans.
- Determining communications and outreach options to engage local population in understanding the value of the wetland and acting accordingly; and
- Developing O&M plans to include within an asset management plan.

5.6.5 Pilot 5: Town of Oakville

The Town of Oakville (population approximately 192,000) is a town in southern Ontario, located on Lake Ontario, and is part of the Greater Toronto Area, one of the most densely-populated areas of Canada.

Intensification of land use in Oakville, primarily in the form of larger homes than traditional norms, is putting increased pressure on the existing storm water system. As new, larger homes are built, there may be a corresponding and tangible loss of storm water service to the municipality through reductions in permeable surface to absorb and manage the water.

The pilot area is fully urbanized, and so the natural assets that form the basis of the pilot include: publicly-owned ditches, green spaces, tree canopy and the remnants of once-intact streams; and, privately held natural assets such as streams and ditches on the property of individual landowners.

Management questions that Town of Oakville is exploring through the MNAI initiative include:

- What is the value to the Town of the loss of municipal services created by the

conversion of existing natural assets, and is there any corresponding financial risk and/or liability to Oakville?
- What can be learned from the remnant stream in the pilot area that would help Oakville better prioritize and manage other streams in the community?
- Can the monetization of municipal services create a basis for new municipal strategies to manage natural assets?

Potential outcomes of the pilot include (to be revised November 2017):

- Determine monetary value of services provided by natural assets in improving water quality, decreasing water quantity and reducing flooding, and the potential risk / liability to the Town of Oakville if these assets ceased to perform their functions;
- Understanding management options to maximize the value of remnant streams and other natural assets based on experience in pilot area; possible development of operations and maintenance plans and integration into asset management planning;
- Understanding the relationship between the value of services from natural assets and new municipal strategies to manage storm water in Oakville; and
- Development of options and tools to support collaborative decision-making to protect or enhance natural assets.

MNAI pilots and climate change. Climate change and variability is an important consideration in the Town of Gibsons and all 5 pilots. For example, climate change is putting increased pressure on existing infrastructure systems and underscoring the need for complementary strategies to deliver service while containing costs. Furthermore, natural asset solutions may be inherently more adaptable and resilient to climate change given that many of them can be managed to provide a range of services under a variety of circumstances. By contrast, many engineered solutions – for example, a culvert or stormwater bypass pipe – are inherently limited by their engineering specifications. This multi-functional aspect of natural assets can aid communities to adapt to climate change. Finally, natural assets may provide support for climate change mitigation. For example, eel grass beds may reduce the impact of storm surges and also act as a carbon sink.

5.7 Next steps for MNAI development

In 2017, MNAI will complete the current five pilots. At the time of writing, a funding application is being developed for a second cohort of 5 pilots given the strong interest and promising initial results. MNAI has also received support to explore changes to the business model and corporate structure to support a broader scale-up of the approach in 2018 and beyond. The results of the current 5 pilots will be shared widely in early 2018, and a full project evaluation will be conducted by that point also.

6 Observations and initial conclusions

Additional data will be available from the 5 pilots by the end of the project period in November-December 2017. At that time, it will be possible to draw additional conclusions. In the interim, the following observations and initial conclusions can be made:

1. **Natural assets and risk.** Based on the evidence from the Town of Gibsons and the MNAI pilots, municipal natural asset management can, at a minimum, help municipalities to better understand dependencies on natural assets that are not accounted for in decision-making, and thereby reduce risk.
2. **MNAM as a process not a single tool.** As with asset management more generally, MNAM, even for relatively minor natural assets, requires systems approaches and work across numerous municipal line departments to achieve changes in decision-making. Therefore, it cannot be conceived of as, or delivered using, a single tool or simply applying an accounting protocol. Rather, MNAM can be thought of as a process of change management that uses several tools and protocols. Over time, the application of this process will become more rigorous and the results more comparable.
3. **Natural assets and lower costs.** Natural assets have the potential to provide the same services as engineered alternatives but with no capital cost and lower operating costs, although not always at the full level of service a municipality must deliver. They can achieve this through the protection, monitoring, better management and/or rehabilitation of ecosystems. These approaches can also provide communities with numerous benefits apart from a specific municipal service.
4. **Additional services and adaptability of natural assets.** Some natural assets provide many functions beyond those of immediate interest to the municipality, and can be adaptable over time; for example, the Gibsons case demonstrates that forests may mitigate flood risk *and* provide cultural and recreational space. This contrasts with many engineered assets, which can perform only a single task. As a counterpoint, there may be a lack of control over the performance of some natural assets relative to engineered alternatives.
5. **MNAM and as a path to ecosystem restoration**. MNAM may provide a strong evidence base or rationale for the acquisition, restoration or rehabilitation of natural assets that provide municipal services.
6. **Research needs.** There are likely many fruitful areas for research to enable MNAM in Canada and beyond, including, for example**:**
    - (a) a review of international standards including ISO 55000, ISO 55001 and ISO 55002 and the International Infrastructure Management Manual (IIMM) to determine the extent to which they enable municipal natural asset management;
    - (b) the development of an understanding of the skills required for natural asset management versus physical infrastructure, and the potential for associated community economic development; and
    - (c) the application of MNAM across an entire watershed that encompasses numerous jurisdictions /governance regimes.

7. **MNAM contributions to international initiatives.** The results from future MNAM-based projects could contribute to international efforts to develop statements of natural accounts (e.g. WAVES[9]) by (a) demonstrating the practical value and application of environmental-economic accounting and (b) over time, contributing data that can be integrated into national statements of accounts.
8. **Applicability in a developing country context.** All municipalities have natural assets that provide, or could be restored or rehabilitated to a point where they could provide, vital services on a cost-effective basis. It could be fitting and appropriate to explore the potential for municipal natural asset management in developing country contexts given that human well-being can be more closely linked to natural resources, agriculture and environmental factors than in developed countries.
9. **Applicability in a post-conflict peacebuilding context.** Related to the above point, natural resources can be both a liability or asset in post-conflict contexts. For example, post-conflict natural resource management can help re-establish social and political relationships. As MNAM evolves, it could potentially be considered as a possible confidence-building and peacebuilding tool in certain peacebuilding / post-conflict contexts (see Bruch et al. (2016) for extensive discussion on natural resources and post-conflict peacebuilding).

[9] Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a project of the World Bank to assist five pilot countries (Botswana, Costa Rica, Colombia, Madagascar and the Philippines) to implement natural capital accounting.

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