MANITOBA CLIMATE RESILIENCE TRAINING

Natural Infrastructure Solutions to Enhance Climate Resilience

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February 2023

IISD International Institute for Sustainable Development

ENGINEERS GEOSCIENTISTS MANITOBA

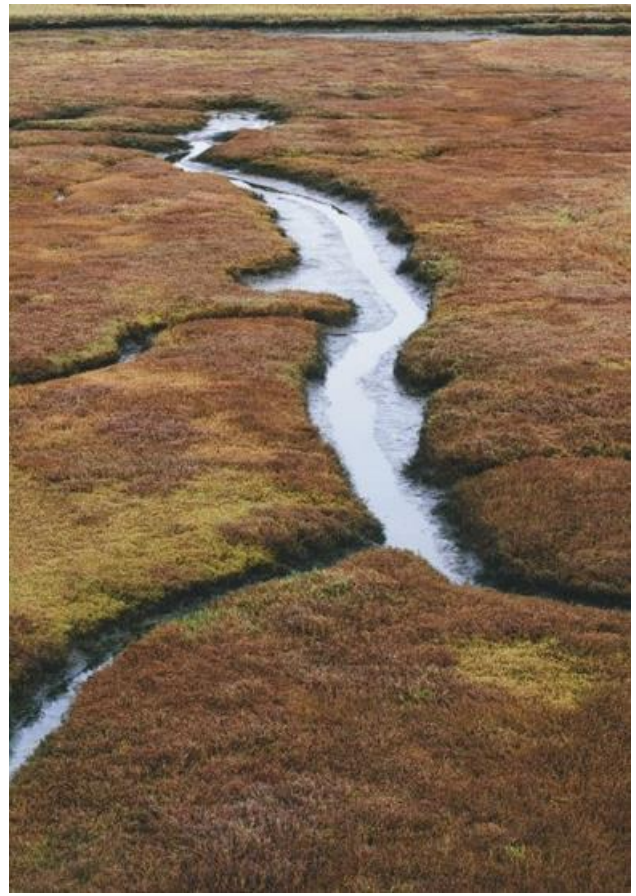
Manitoba

INTERACTION

- This course is being **recorded**
  (your participation confirms your agreement)
- Cameras and microphones are off
- **Interactive polls** (on your phone or computer)
- **Q&A**
  - Post questions and comments to the chat space
  - Please send to **everyone,** not to the presenter
  - Some questions to be addressed during webinar, with the rest during the post-webinar Q&A session
- Send **technical issues to EngGeoMB** in the chat
- A follow-up **survey** will be shared along with the webinar slides/handout

WEBINAR AGENDA

- Welcome, overview, and introductions
- **Session 1:** Introduction to Natural Infrastructure
- **Session 2:** Planning, Designing, and Monitoring of Natural Infrastructure
- **Session 3:** Making the Business Case for Natural Infrastructure
- Closing remarks
- Q&A session



THE URGENCY OF BUILDING RESILIENCE AND REDUCING CARBON EMISSIONS

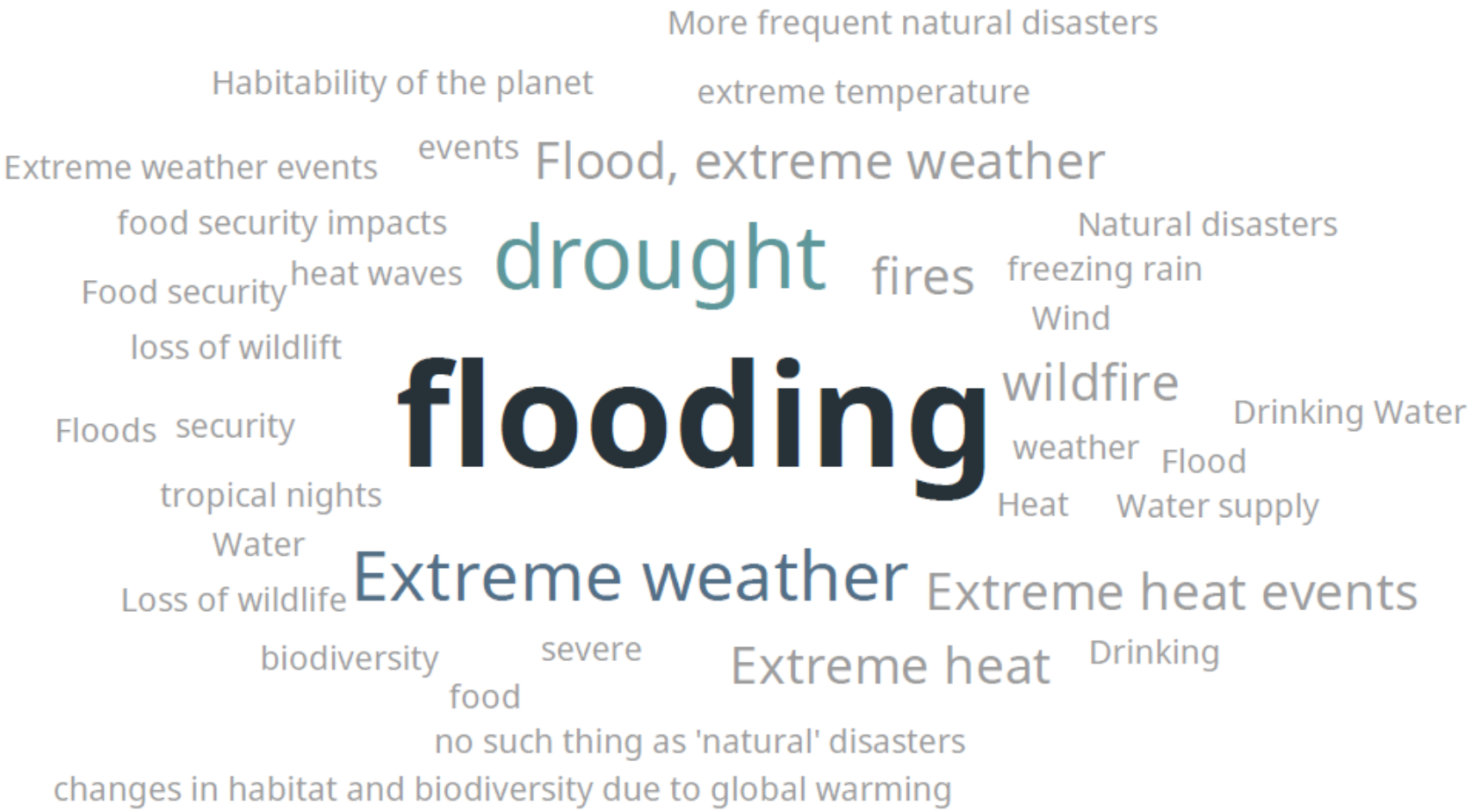
Comparing the **recent past** (1976-2005) to the **near future** (2051-2080)

Communities	Average hottest temperature of the year			Average coldest temperature of the year			Average number of days per year above 25 °C			Average number of below-zero days per year			Average length of the frost-free season		
	Recent Past	Low-Carbon Future	High-Carbon Future	Recent Past	Low-Carbon Future	High-Carbon Future	Recent Past	Low-Carbon Future	High-Carbon Future	Recent Past	Low-Carbon Future	High-Carbon Future	Recent Past	Low-Carbon Future	High-Carbon Future
Winnipeg	34.5 °C	37.8 °C	39.3 °C	-36.0 °C	-31.5 °C	-29.8 °C	55	87	98	189	161	149	127	149	161

https://climateatlas.ca/sites/default/files/Manitoba-Report_FINAL_EN.pdf

slido

What type of climate hazards are you most concerned about?



Session 1: Introduction to Natural Infrastructure

NATURAL INFRASTRUCTURE (NI)

> NI refers to the use of **preserved, restored, or enhanced** elements or combinations of vegetation and associated biology, land, water, and naturally occurring ecological processes **to meet targeted infrastructure outcomes**, such as coastal hazard management, riverine flood management, local stormwater management, and mitigation of the effects of extreme heat.

CCME
Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

NATURAL INFRASTRUCTURE FRAMEWORK: KEY CONCEPTS, DEFINITIONS AND TERMS

https://ccme.ca/en/res/niframework_en.pdf (page 6)

RURAL NATURAL INFRASTRUCTURE

https://www.iisd.org/ela/blog/video/lets-talk-about-natural-infrastructure/

NATURAL ASSETS

> Municipal natural assets refer to **the stocks of natural resources and/or ecosystems** that contribute to the provision of one or more services required for the health, well-being and long-term sustainability of a community and its residents.

MNAI.CA Making Nature Count

https://mnai.ca/media/2019/07/SP_MNAI_Report-1-_June2019-2.pdf (page 6)

MUNICIPAL NATURAL ASSETS

https://gibsons.ca/sustainability/natural-assets/

OTHER KEY TERMS:

Nature-based Solutions (NbS)

- Umbrella term for ecosystem-based approaches for addressing societal challenges.

Green Infrastructure

- Term often used in an urban context
- '**Low Impact Development**' is a term used specifically for stormwater management.

NATURAL INFRASTRUCTURE CO-BENEFITS

> NI elements can **improve the climate resilience** and overall lifespan of grey infrastructure, and **deliver co-benefits** including biodiversity enhancement, habitat protection, ecosystem services, support for recreation and culture, improved air and water quality, job creation, and stimulation of rural economies.

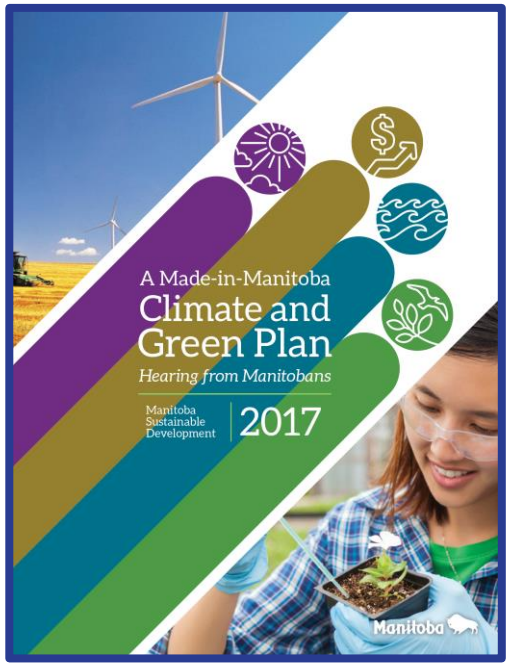
Benefits of NI, Canadian Council of Ministers of the Environment

https://ccme.ca/en/res/niframework_en.pdf (page 6, in Roy, 2018)

Pictures adapted from Unsplash

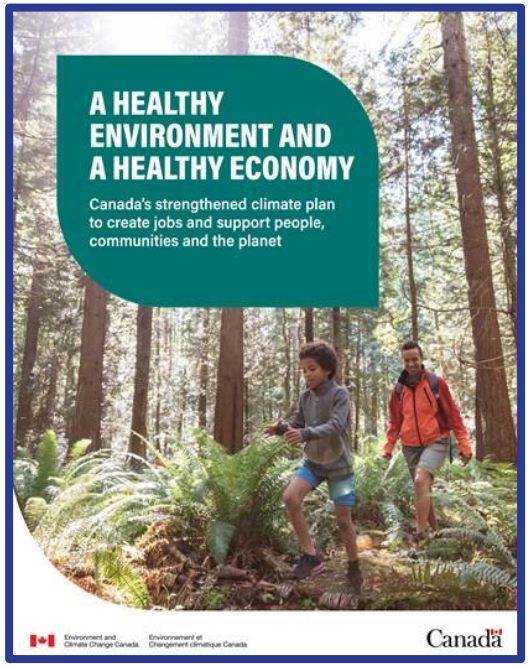
THE POLICY CONTEXT

Provincial

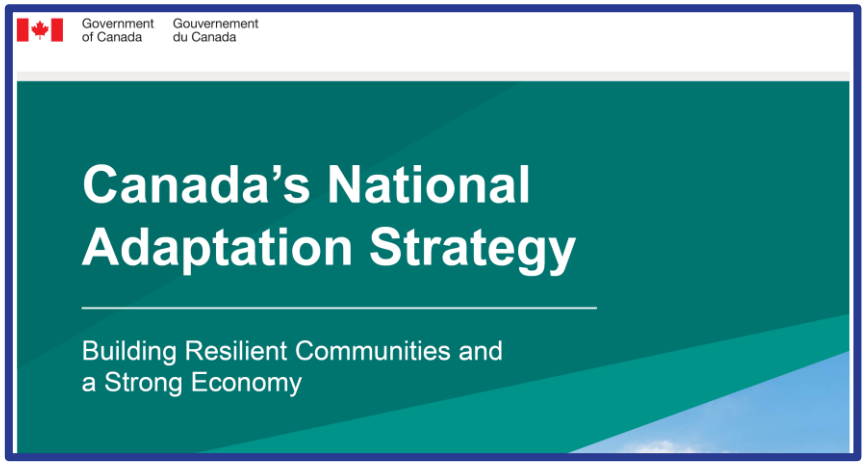


Green and natural infrastructure are introduced as cost-effective options to provide more enduring resilience to extreme events.

Federal



Emphasizes **embracing the power of nature** to support healthier families and more resilient communities.



States that "natural infrastructure solutions are increasingly seen as **win-win investments that support traditional infrastructure outcomes**, such as stormwater management, and deliver valuable co-benefits to communities, such as climate change resilience, reduced pollution, and carbon sequestration."

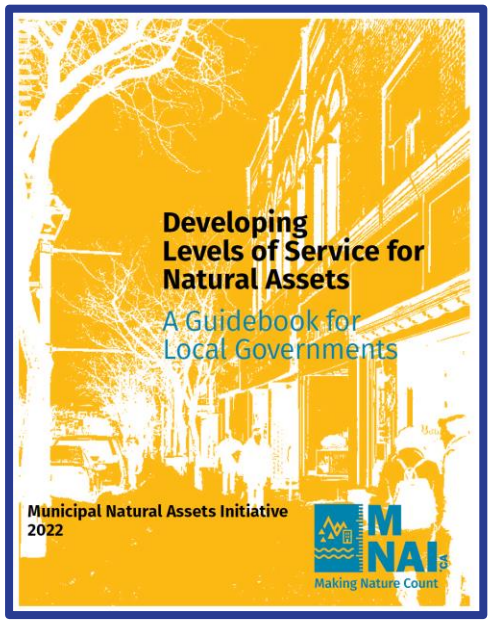
https://www.gov.mb.ca/asset_library/en/climatechange/climategreenplandiscussionpaper.pdf

https://www.canada.ca/content/dam/eccc/documents/pdf/climate-change/climate-plan/healthy_environment_healthy_economy_plan.pdf

https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html

THE POLICY CONTEXT

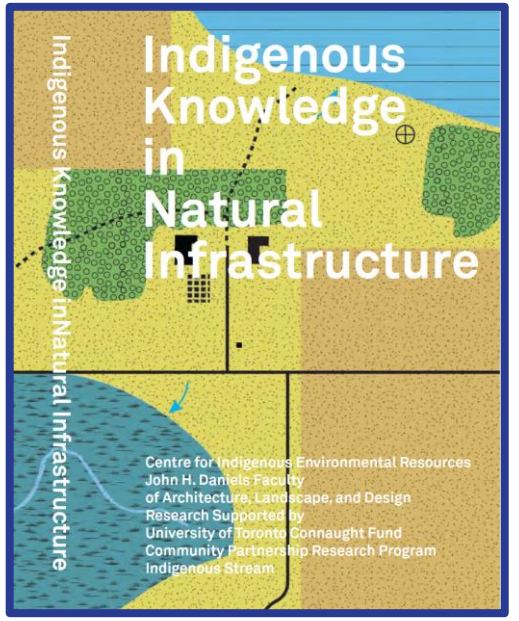
Municipal



Levels of service (LOS) define the **expected performance of assets** and represent a commitment of a local government that will **inform asset management** and **financial plans**. Provides tips for defining LOS for natural assets based on their unique characteristics compared to grey infrastructure assets.

https://mnai.ca/media/2022/01/MNAI-Levels-of-Service-Neptis.pdf

First Nations, Métis Nation



To “understand and apply traditional ways of knowing the landscape in conjunction with Western science approaches, toward a new path of environmental healing” and to “**promote the integration of Indigenous Knowledge in the design and construction of a natural infrastructure network**”

https://www.blurb.ca/b/11118460-indigenous-knowlege-in-natural-infrastructure

SCALE AND COST EFFECTIVENESS

"Studies show that natural infrastructure is cost effective and is often a more efficient use of funds compared to relying solely on built infrastructure to adapt to climate change and increase resilience (IISD 2021)."

"Ecosystem-based approaches, including natural infrastructure… **can be cheaper than relying solely upon 'grey' infrastructure, as well as yielding co-benefits.**"

"…**cost-effective way to mitigate material financial losses** that would otherwise result from flooding" and "can offer other **valuable environmental and social benefits** that are often not attainable through the implementation of traditional, grey-engineered solutions."

https://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf
http://assets.ibc.ca/Documents/Resources/IBC-Natural-Infrastructure-Report-2018.pdf

slido

Which landscape do you most often work in?

042

Coastal (and shoreline)
10 %

Riverine
14 %

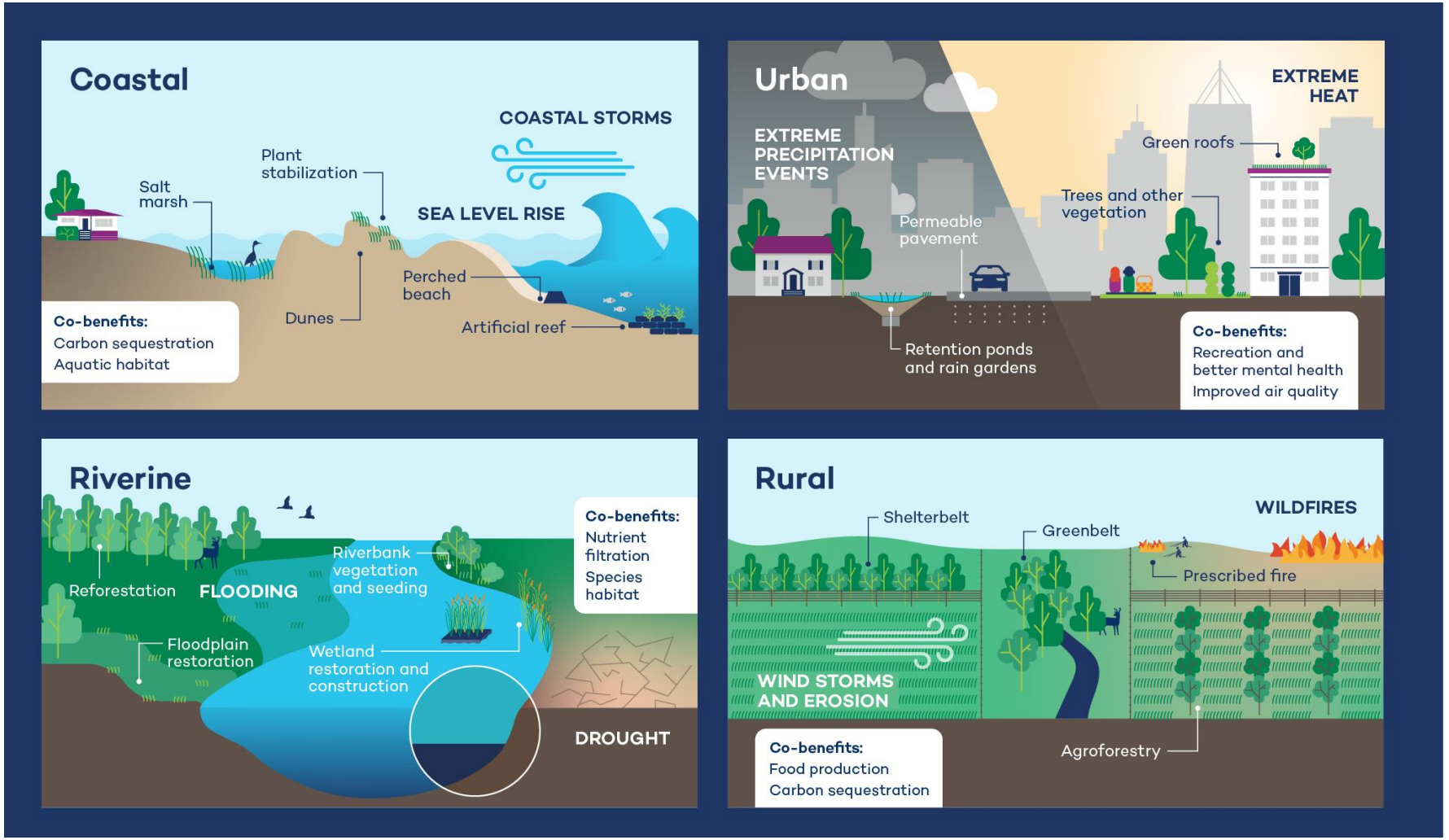
Urban (city/town)
76 %

Rural (prairie)
40 %

Forests (boreal, parklands)
12 %

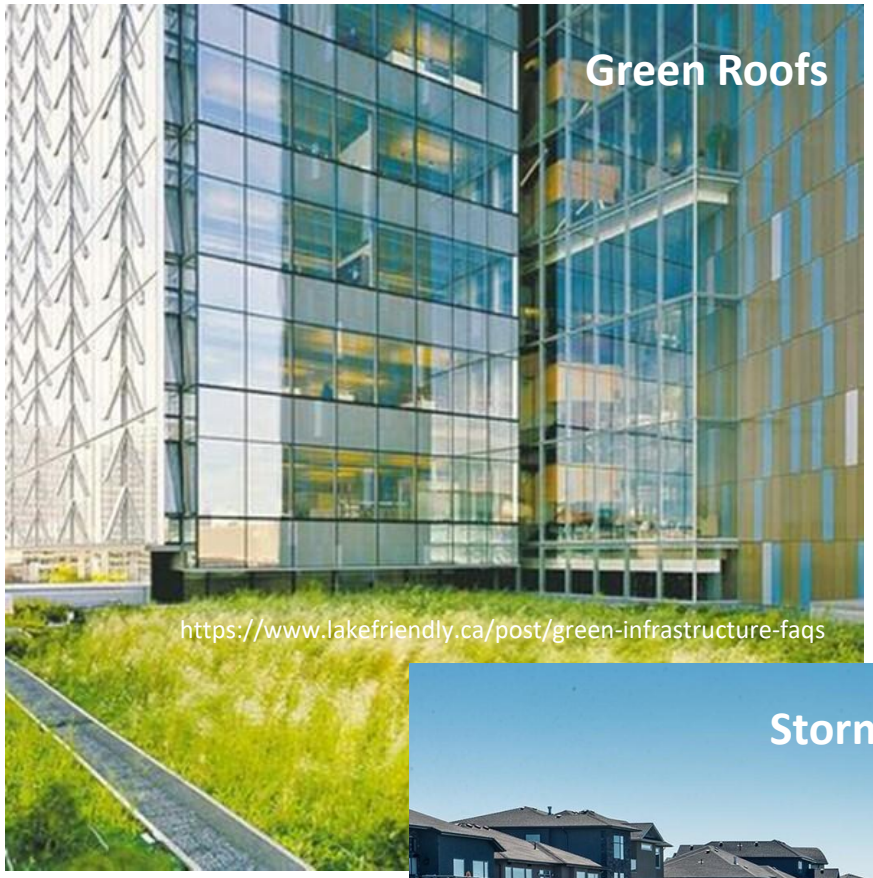
Northern (tundra)
14 %

NATURAL INFRASTRUCTURE IN DIFFERENT SETTINGS



URBAN

Green Roofs



https://www.lakefriendly.ca/post/green-infrastructure-faqs

Low-impact Development (Strata cell soil retention systems)

https://citygreen.com/case-studies/john-hirsch-place-winnipegs-first-woonerf/

Stormwater Retention Ponds

https://www.nativeplantsolutions.ca/our-work/sage-creek/

RIVERINE


Floating Treatment Wetlands
https://www.iisd.org/projects/floating-treatment-wetlands


Source: Darren Swanson


Red River Floodway
Canal de dèrivation
de la Rivière Rouge
https://www.winnipegfreepress.com/local/province-opens-red-river-floodway-569554112.html

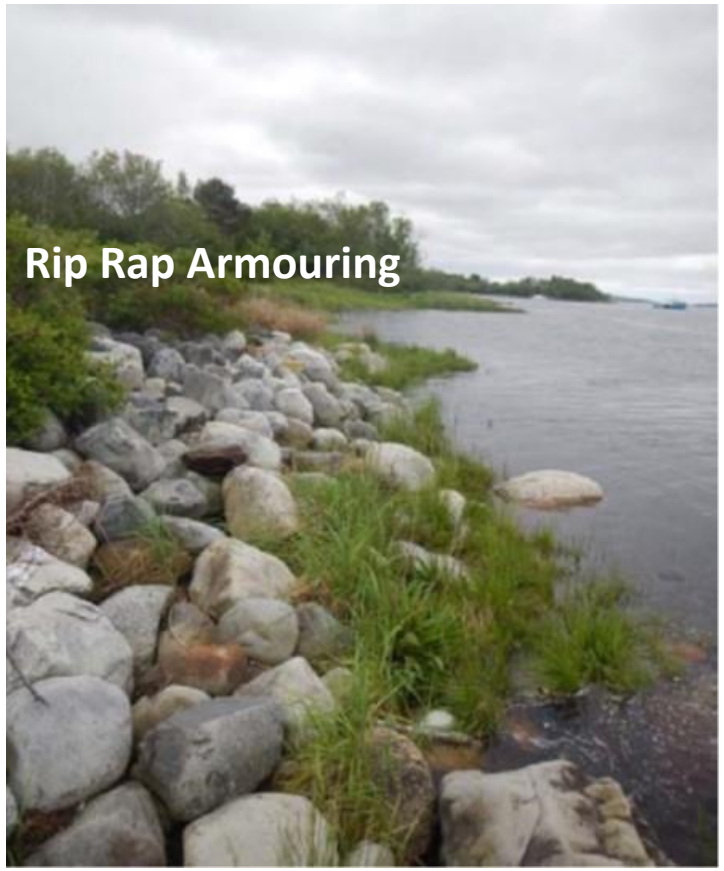
RURAL


Engineered Wetlands
Source: IISD.org


Lagoon / Wetland
Source: IISD


Shelterbelts
https://www.portageonline.com/local/trans-canada-shelterbelt-undergoes-revamp

COASTAL



Source: https://atlanticadaptation.ca/en/islandora/object/acasa%3A786

Q & A

Session 2:
Planning & Design Considerations for Natural Infrastructure

MANITOBA CLIMATE RESILIENCE TRAINING

LOW CARBON RESILIENCE(LCR):

Approach

What Is a Low Carbon Resilience Planning Approach?[6]

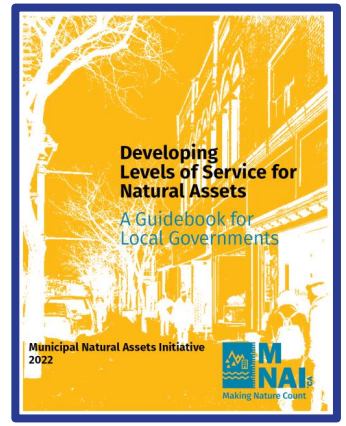
A low carbon resilience approach encourages decision-makers to pursue integrated strategies and investments that climate-proof their communities while strengthening overall sustainability. It embeds three key questions in all decision processes relating to:

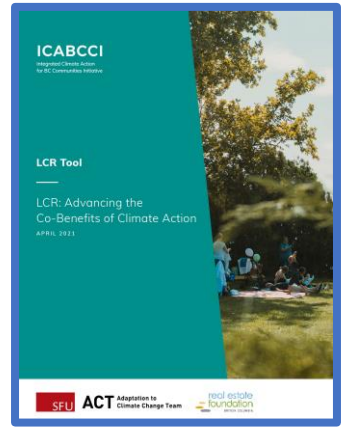
1/ **Risk:** Does the investment or action minimize community vulnerability to projected climate impacts such as flooding, wildfire, heat, and other extreme events?

2/ **Emissions:** Does the investment or action measurably reduce corporate and/or community emissions and help advance carbon-reduction goals?

3/ **Co-benefits:** Does the investment or action advance community sustainability goals such as health, equity, biodiversity, and economic savings and development?

From: https://mnai.ca/media/2022/01/MNAI-Levels-of-Service-Neptis.pdf; https://www.sfu.ca/act/reports/climate-change-equity-covid-1911.html

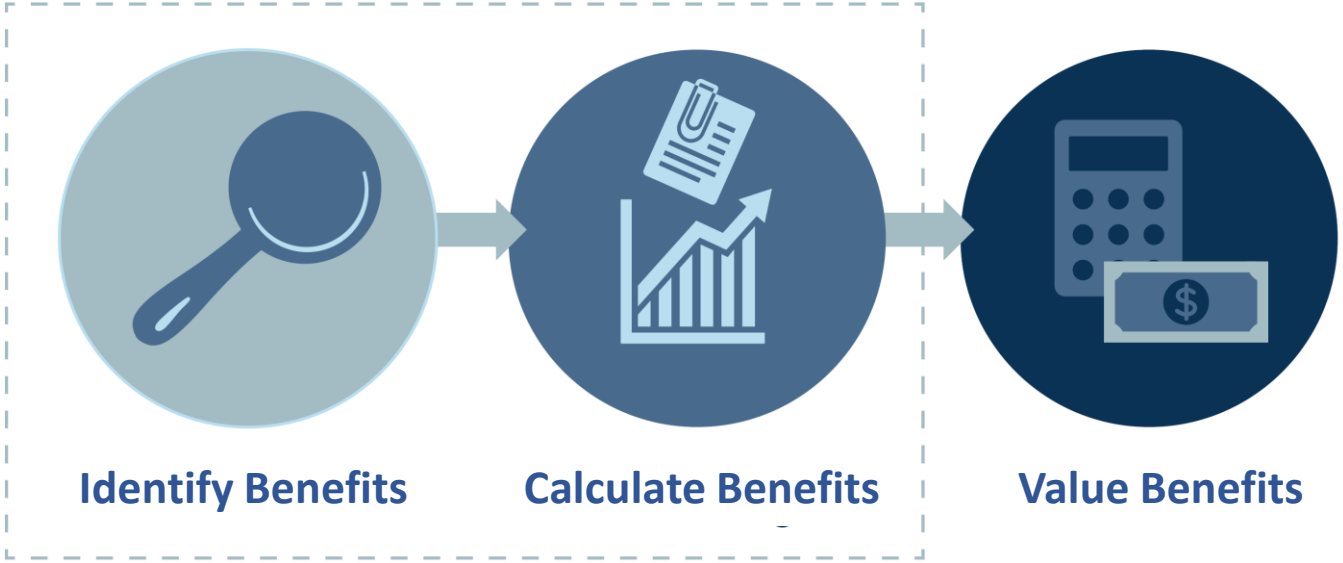


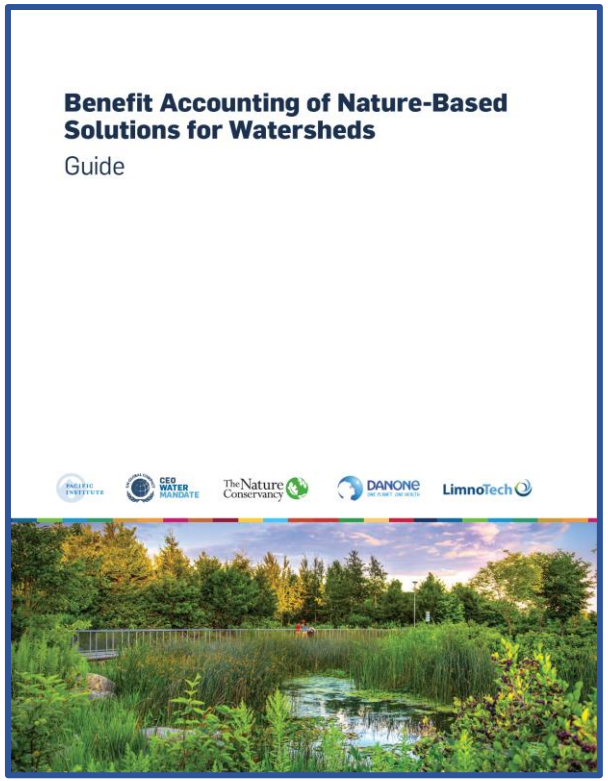


BENEFIT ACCOUNTING:

Three-step Approach

Benefit accounting has three key steps to help organizations plan and design natural infrastructure solutions:





https://ceowatermandate.org/nbs/wp-content/uploads/sites/41/2021/03/guide.pdf

BENEFIT ACCOUNTING:

Three-step Approach

Ecosystem Goods & Services

Performance Metrics

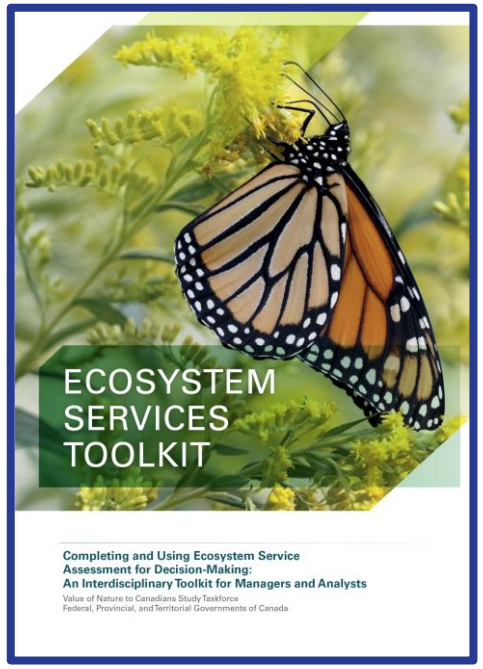
Metrics for Human Benefits & Ecosystem Function

Benefit-Cost Analysis

Total Economic Value (TEV)

https://ceowatermandate.org/nbs/wp-content/uploads/sites/41/2021/03/guide.pdf

IDENTIFYING BENEFITS:
Ecosystem goods and services



A comprehensive listing of ecosystems goods and services helps to identify the many potential **benefits and co-benefits** that natural infrastructure can deliver

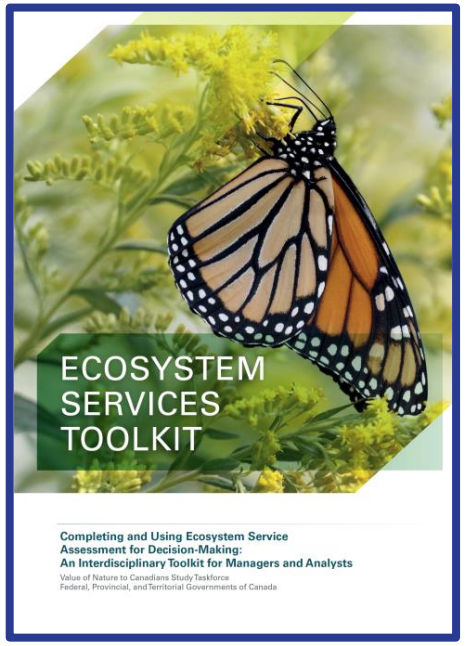
Ecosystem Service (ES)
Provisioning services – ***the result of ecosystem processes and functions that provide goods or products that humans obtain and rely upon; often with some human inputs of labour, financial, and social capital***
Food (e.g., crops, livestock, capture fisheries, aquaculture, wild foods)
Timber and other wood products / fibres, resins, animal skins, and ornamental resources
Biomass fuel
Fresh water
Genetic material
Biochemical and medicinal resources
Regulating services – ***the result of ecosystem processes and functions that regulate all aspects of the environment, providing security and habitable conditions that humans rely upon***
Air-quality regulation
Climate regulation and carbon sequestration (e.g., global climate regulation, regional and local climate regulation)
Water-flow regulation
Erosion regulation
Water purification and waste treatment
Disease regulation
Pest regulation
Pollination
Natural hazard mitigation
Cultural services – ***the result of ecosystem processes and functions that inform human physiological, psychological and spiritual well-being, knowledge and creativity***
Cultural identity and heritage
Spirituality and religion
Knowledge systems and education
Cognitive development, psychological and physical health, and well-being
Aesthetic experience
Inspiration for human creative thought and work
Recreation, ecotourism
Sense of place
Supporting or habitat services – ***the underlying ecosystem processes and functions that are necessary for the production of all other ES, creating the biological environment***
Soil formation
Primary production
Nutrient cycling
Water cycling
Habitat

https://publications.gc.ca/collections/collection_2017/eccc/En4-295-2016-eng.pdf

CALCULATING BENEFITS:

Metrics

The federal-provincial-territorial Ecosystem Services Toolkit recommends using two types of metrics for quantifying the benefits of nature-based solutions and natural infrastructure:



1. Metrics of Ecological Function

Oriented to the ecological function or type of natural capital the ecosystem service provides.

2. Metrics of Human Benefit

Oriented to how people benefit from the natural capital, ecological functions, and ecosystem services.

https://publications.gc.ca/collections/collection_2017/eccc/En4-295-2016-eng.pdf

CALCULATING BENEFITS:

Metrics

Ecosystem Service	Indicators for Natural Capital, Ecological Functions and ES	Human Benefits Indicators
Fresh water for human consumption and use	• Total amount of water (m^3/ha) • Maximum sustainable water extraction (m^3/ha/year) • Presence of water reservoirs • Untreated spring and groundwater (million m^3) and percentage share of water supply	• Number of people with access to clean water or who do not have access to clean water • Cost ($) to clean water where ecosystem is degraded (e.g., all infrastructure, labour, inputs that could have been avoided, plus maintenance costs)

https://publications.gc.ca/collections/collection_2017/eccc/En4-295-2016-eng.pdf

CALCULATING BENEFITS:

Levels of Service Metrics

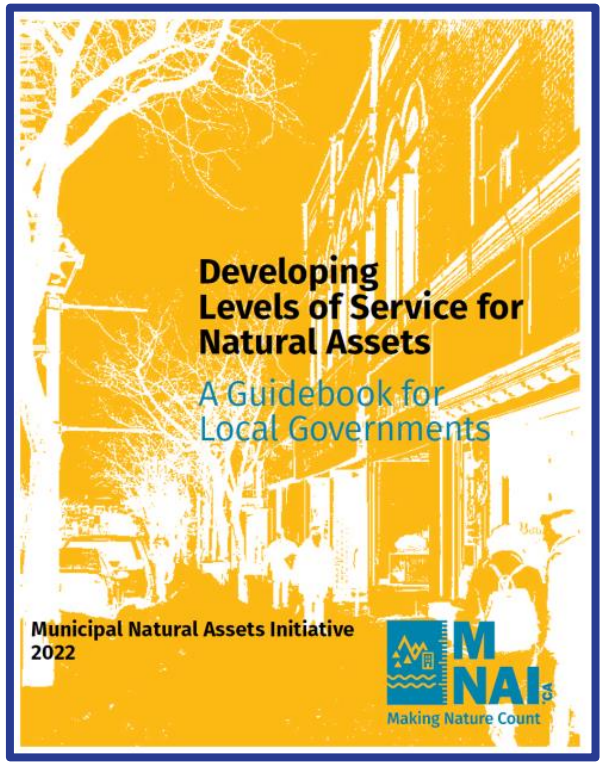
Levels of Service (LOS) is a term used by municipal governments to define the "expected performance of assets". LOS is a "commitment of a local government" that informs asset management and financial plans.

Customer LOS (i.e., human benefits)

- A performance measure that describes the service the community should expect to receive, expressed in terms that make sense to them.

Technical LOS (i.e., ecological functions)

- A performance measure …. to measure the ecological performance of natural assets

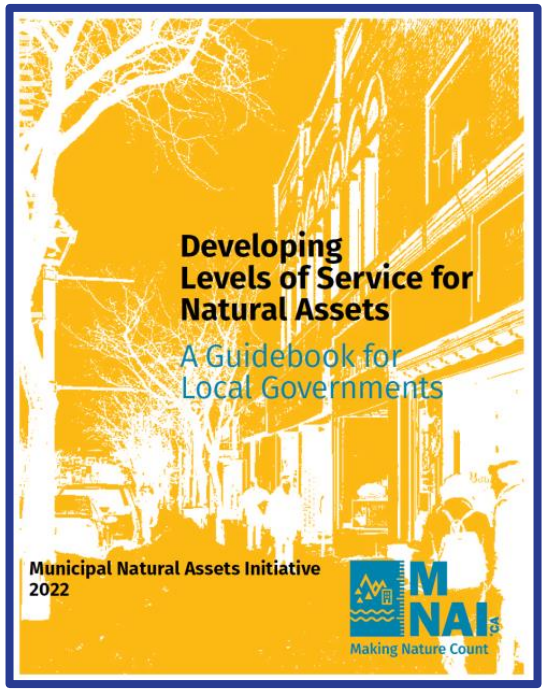


https://mnai.ca/media/2022/01/MNAI-Levels-of-Service-Neptis.pdf

CALCULATING BENEFITS:

Levels of Service Metrics

CORPORATE LOS OBJECTIVE	PERFORMANCE MEASURES Customer LOS shown on white, Technical LOS shown shaded	SERVICE VALUE (attribute)
Protect and preserve the natural assets to reduce incidences of flooding and drought	# residents affected by flooding	Safety
	# residents affected by drought	Safety
	Length of time residents affected	Customer service
	% of wetlands, stream channels, forests restored to support drainage	Sustainability
	Up-to-date flood mapping completed, with climate scenarios incorporated	Safety
	Percentage of properties in municipality resilient to a 100-year storm.	Safety
	Percentage of the municipal stormwater management system resilient to a 5-year storm.	Safety
	No repetitive losses	Reliability
	No increases in base flood elevation due to new development	Safety

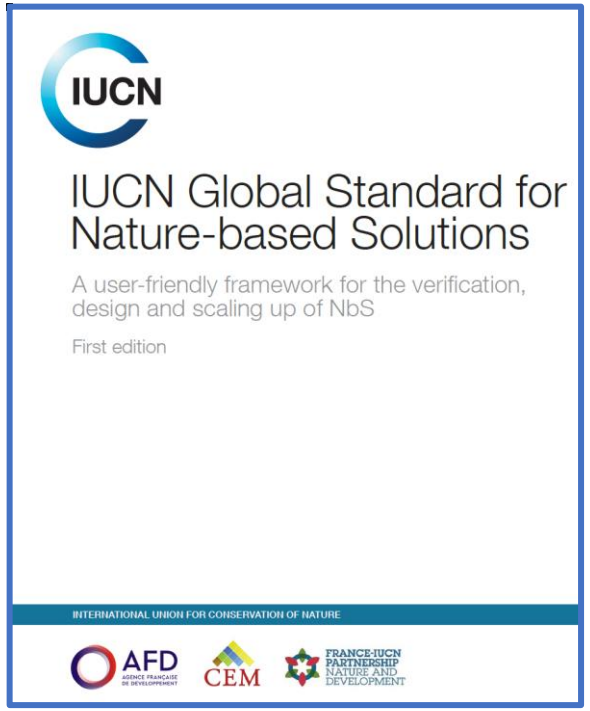


https://mnai.ca/media/2022/01/MNAI-Levels-of-Service-Neptis.pdf

PLANNING & DESIGN CONSIDERATIONS:

Participatory and rights-based approaches

Criterion 5A: NbS are based on inclusive, transparent, and empowering governance processes.



1. A defined and fully agreed upon **feedback and grievance resolution mechanism** is available to all stakeholders before an NbS intervention is initiated.
2. Participation is based on mutual respect and equality, regardless of gender, age, or social status, and **upholds the right of Indigenous Peoples to free, prior, and informed consent.**
3. Stakeholders who are directly and indirectly affected by NbS have been **identified and involved in all processes** of the NbS intervention.
4. Decision-making processes **document and respond to the rights and interests** of all participating and affected stakeholders.
5. Where the scale of NbS extends beyond jurisdictional boundaries, mechanisms are established to enable **joint decision-making** of the stakeholders in the affected jurisdictions.

https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

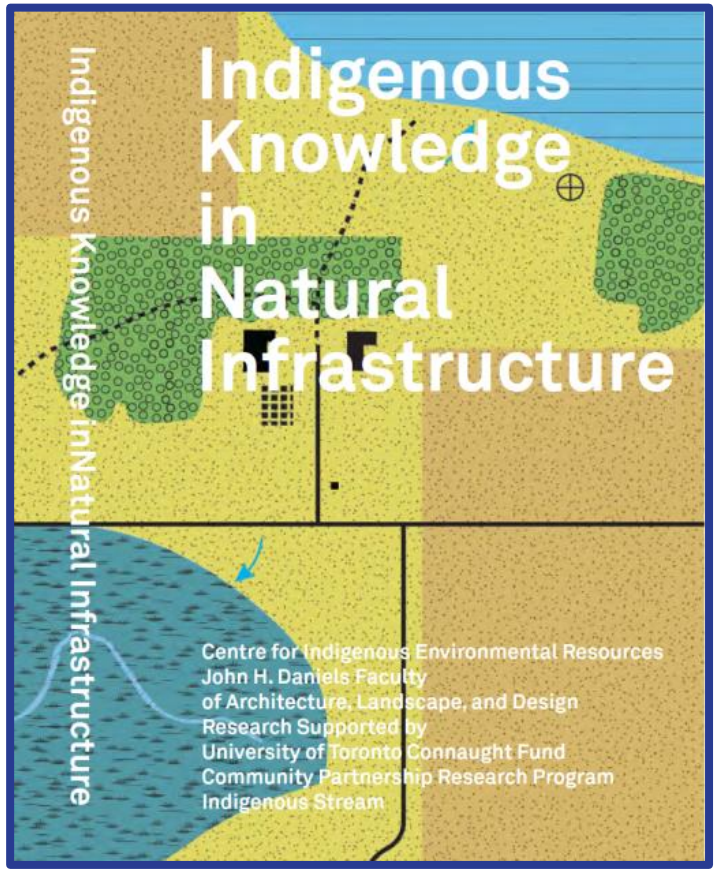
PLANNING & DESIGN CONSIDERATIONS:

First Nations perspectives

"Promote the **integration of Indigenous Knowledge** in the design and construction of a natural infrastructure".

"Involve people of all ages, especially elders and youth, as well as administrative staff and hunters or harvesters with knowledge of the land".

Effective collaborations "involve **in-person visits from** technical specialists and discussions that account for communities' key issues, recognizing that different communities have different needs. This can sometimes mean **making time for several visits** and to evaluate different options collaboratively, engaging.



https://www.blurb.ca/b/11118460-indigenous-knowlege-in-natural-infrastructure

PLANNING, DESIGN & MONITORING:

Panel Discussion

Natural Infrastructure for Water Solutions (NIWS) on the Prairies

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IISD
International Institute for Sustainable Development

Design and Investment Aspects for Natural Infrastructure

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STRATEGIC SYSTEMS ENGINEERING

PLANNING, DESIGN & MONITORING:

Panel Discussion

1. What are one or two notable **examples** of natural infrastructure across the prairies and how are these **performing** to meet climate change adaptation and mitigation needs?
2. What are some key **planning, design and monitoring** considerations for natural infrastructure?

Q & A

Session 3:
Making the Business Case for Natural Infrastructure

MANITOBA CLIMATE RESILIENCE TRAINING

BENEFIT ACCOUNTING:

Three-step Approach

Ecosystem Goods & Services

Performance Metrics

Metrics for Human Benefits & Ecosystem Function

Benefit-Cost Analysis

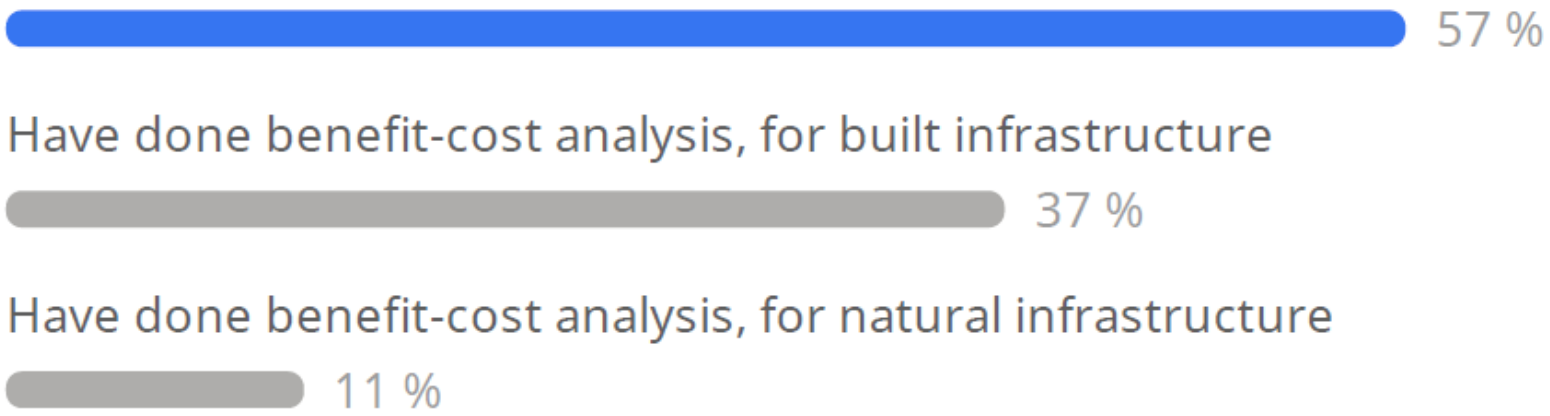
Total Economic Value (TEV)

https://ceowatermandate.org/nbs/wp-content/uploads/sites/41/2021/03/guide.pdf

slido

What is your experience level with estimating the benefits and costs of natural infrastructure solutions? (select all that apply)

0 3 5



BENEFIT-COST ANALYSIS FOR NATURAL INFRASTRUCTURE

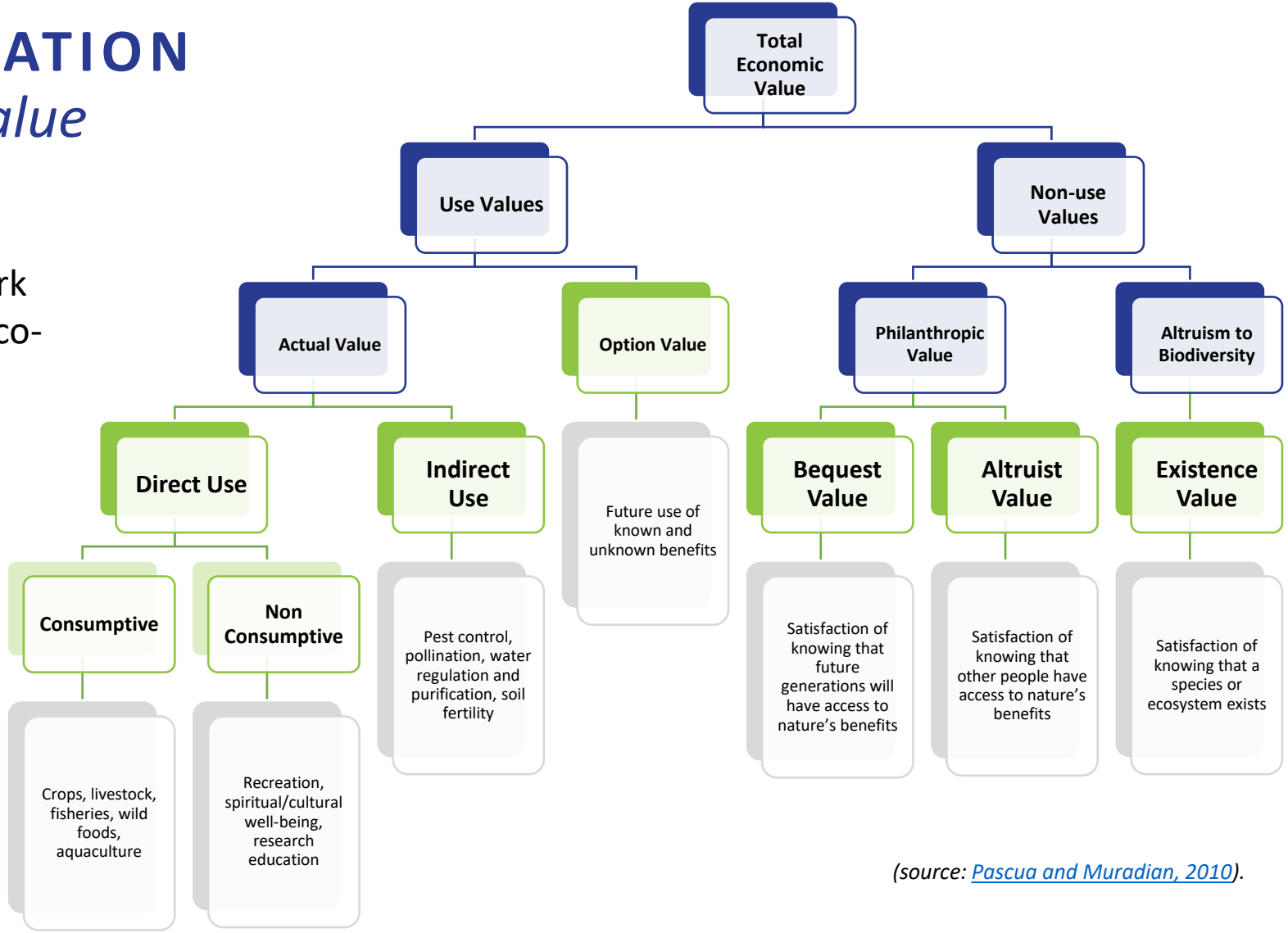
Total economic value

- Goes **further** than traditional benefit-cost analyses.
- Uses a **total economic value** approach to capture direct and indirect costs and benefits.
- Values the **ecosystem goods and services** delivered by infrastructure.

BENEFIT VALUATION

Total economic value

Practical overall framework for considering potential co-benefits of natural infrastructure



(source: Pascua and Muradian, 2010).

BENEFIT-COST ANALYSIS:
Valuation methods

A range of practical methods are available to estimate the potential benefits and costs of natural infrastructure solutions.

More tangible values ← → Less tangible values

Market Valuation Methods
- Market Price
- Avoided Cost
- Replacement Cost
- Mitigation / Restoration Cost
- Production Function

Revealed Preference Methods
- Travel Cost Method
- Hedonic Pricing Method

Simulated Preference Methods
- Contingent Valuation
- Choice Modelling

BENEFIT-COST ANALYSIS EXAMPLES:

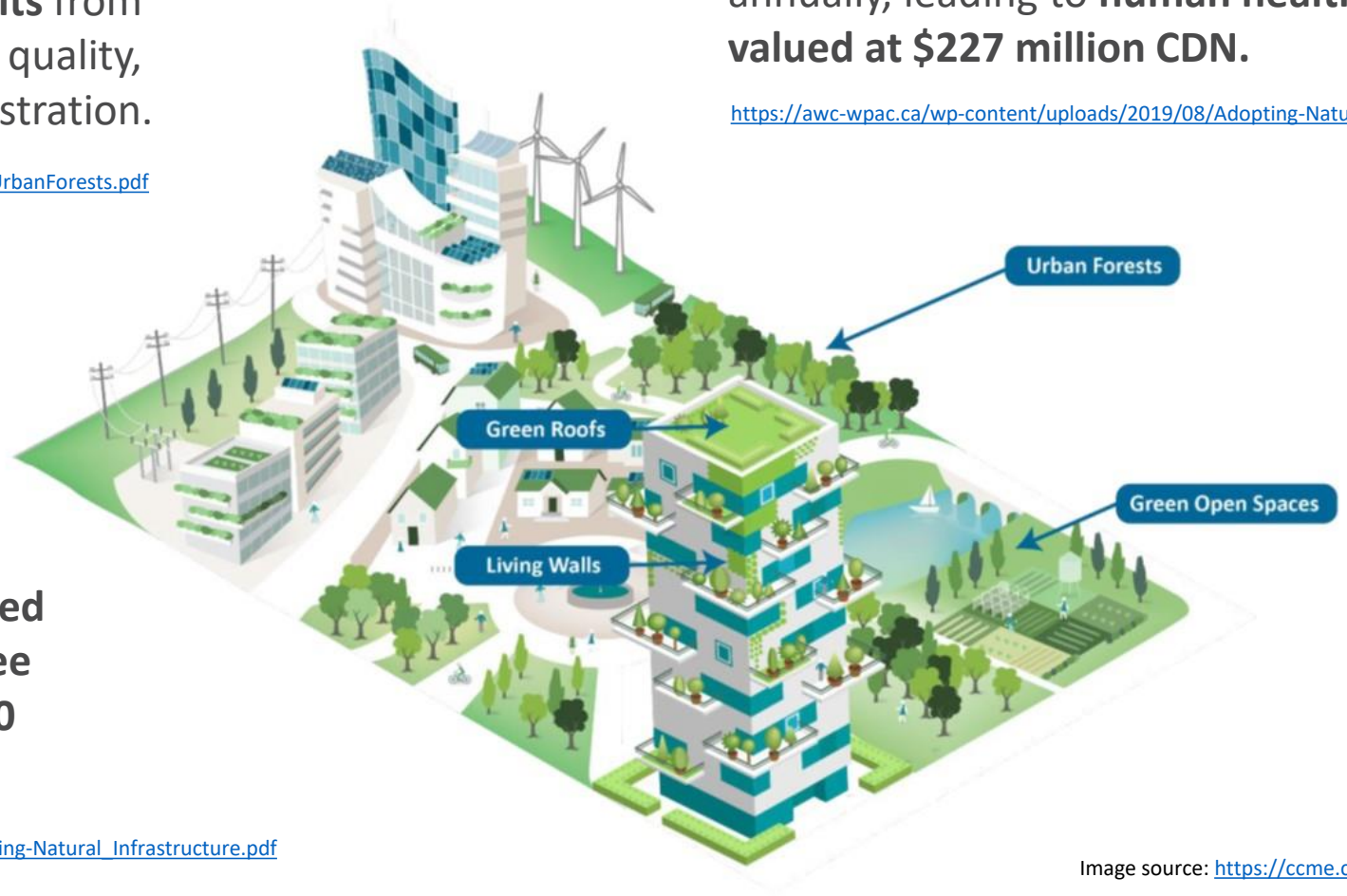
Urban Green Infrastructure & Natural Assets

In Toronto, **urban forests provide over $80 million per year in benefits** from stormwater management, air quality, energy savings, carbon sequestration.

https://www.td.com/document/PDF/economics/special/UrbanForests.pdf

A study of 86 Canadian municipalities found that trees remove over 16 Mt of air pollution annually, leading to **human health benefits valued at $227 million CDN.**

https://awc-wpac.ca/wp-content/uploads/2019/08/Adopting-Natural_Infrastructure.pdf



In Toronto, **each dollar invested in the maintenance of the tree coverage returns nearly $3.20 in benefits to city residents.**

https://awc-wpac.ca/wp-content/uploads/2019/08/Adopting-Natural_Infrastructure.pdf

Image source: https://ccme.ca/en/res/niframework_en.pdf

BENEFIT-COST ANALYSIS EXAMPLES:

Rural Natural Infrastructure

Pelly's Lake Wetland in Manitoba:

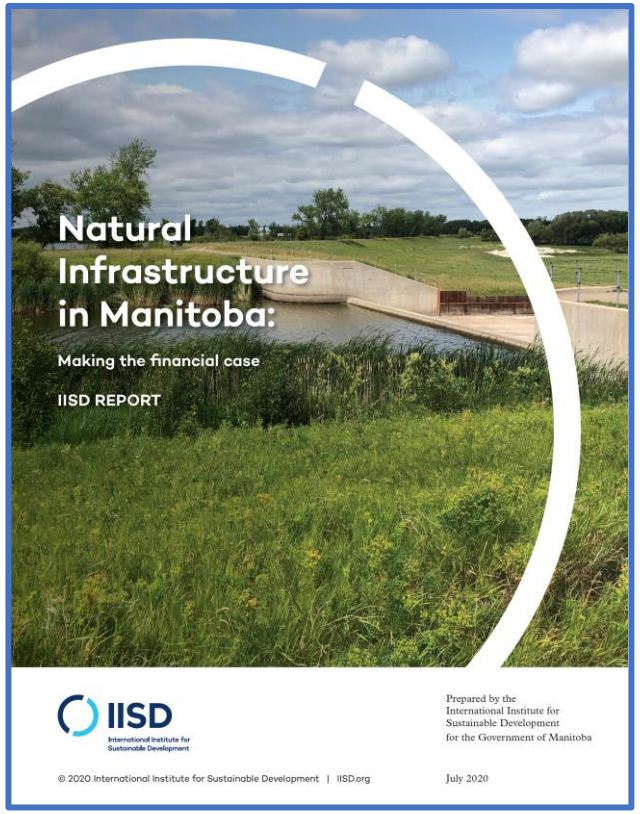
- The total direct financial benefits and total environmental co-benefits for flood attenuation, biomass harvesting, carbon sequestration, and nutrient removal were estimated at **CAD $449,540 per year** (in 2017 dollars).
- The net present value for the project was estimated at CAD 3.7 million, with a **benefit/cost ratio of 3.64**.

Red River Basin Waffles:

- "Waffles" use the existing raised road infrastructure network of the prairie landscape to temporarily store water. Construction of prairie "Waffles" have potential net benefits of **USD $500 million**.

Floating Treatment Wetland (FTW) in Louisiana:

- The capital and operating cost of a FTW at a Louisiana Correctional Facility was USD 40,000, including installation, plants, and monitoring for one year, and resulted in **a cost avoidance for existing built infrastructure maintenance in the amount of USD 1,000,000.**



BENEFIT-COST ANALYSIS EXAMPLES:

Municipal Natural Assets Across Canada

$18.9 MILLION

7 km riverbank in the Oshawa Creek watershed in Ontario provides $18.9-million worth of **stormwater conveyance & drainage** annually to nearby communities based on replacement cost.

$3.5-4 MILLION

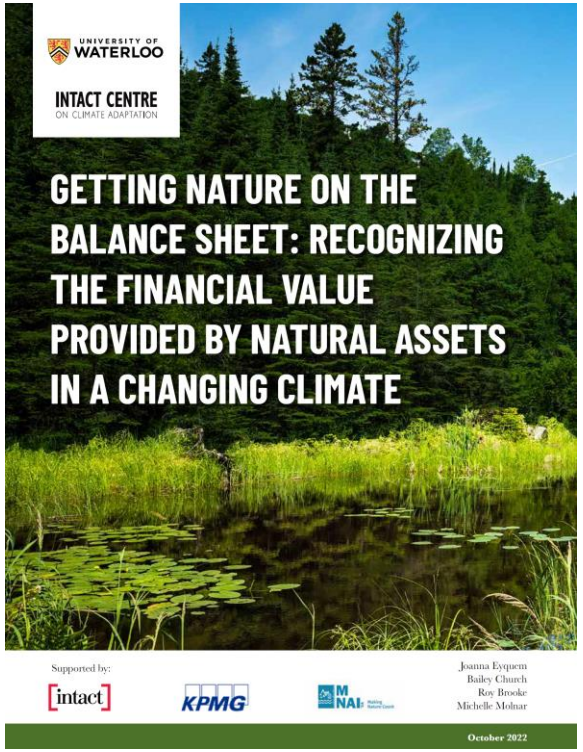
Naturally occurring ponds in White Tower Park in Gibsons, B.C. provide between $3.5-$4-million in **stormwater storage** to the local government based on replacement cost.

$2.4 MILLION

Widening and naturalizing 1,292 m of the Courtenay River riverbank in Courtenay, B.C. provides $2.4-million in **flood-damage reduction** to downstream properties during a 1-in-200-year flood event.

$1.4 MILLION

Protecting four wetlands that comprise 13 791 m^2 in the Mill Creek Watershed in New Brunswick delivers $1.4-million in **benefits during a 1-in-100 year flood event**.



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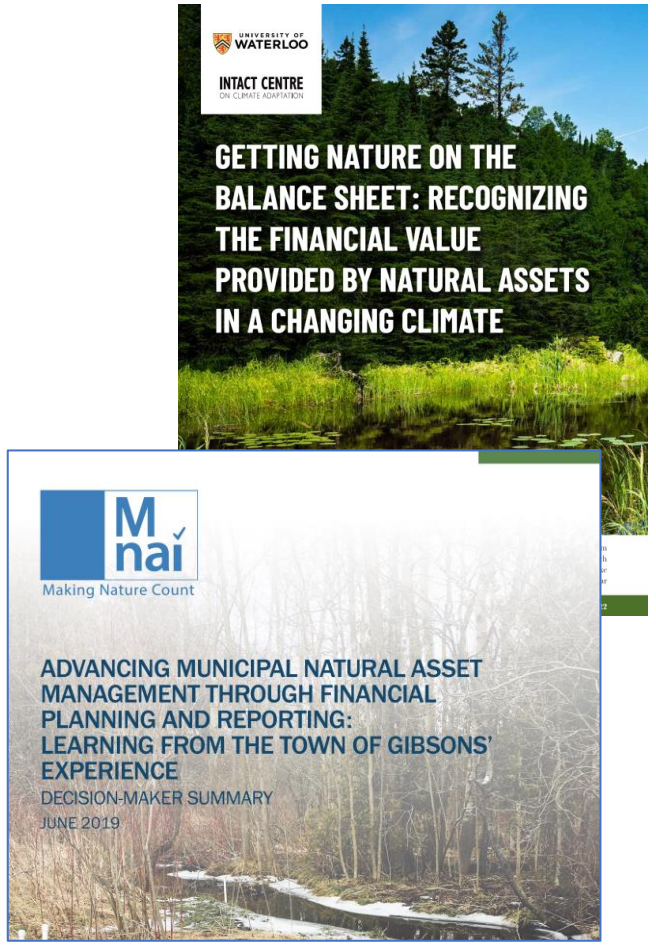
GETTING NATURE ON THE BALANCE SHEET:

The Case of Gibsons, B.C.

- **Issue:** Despite the direct value this natural asset has to the town, Gibson's finance administrators **can't reflect the asset on its balance sheet**.

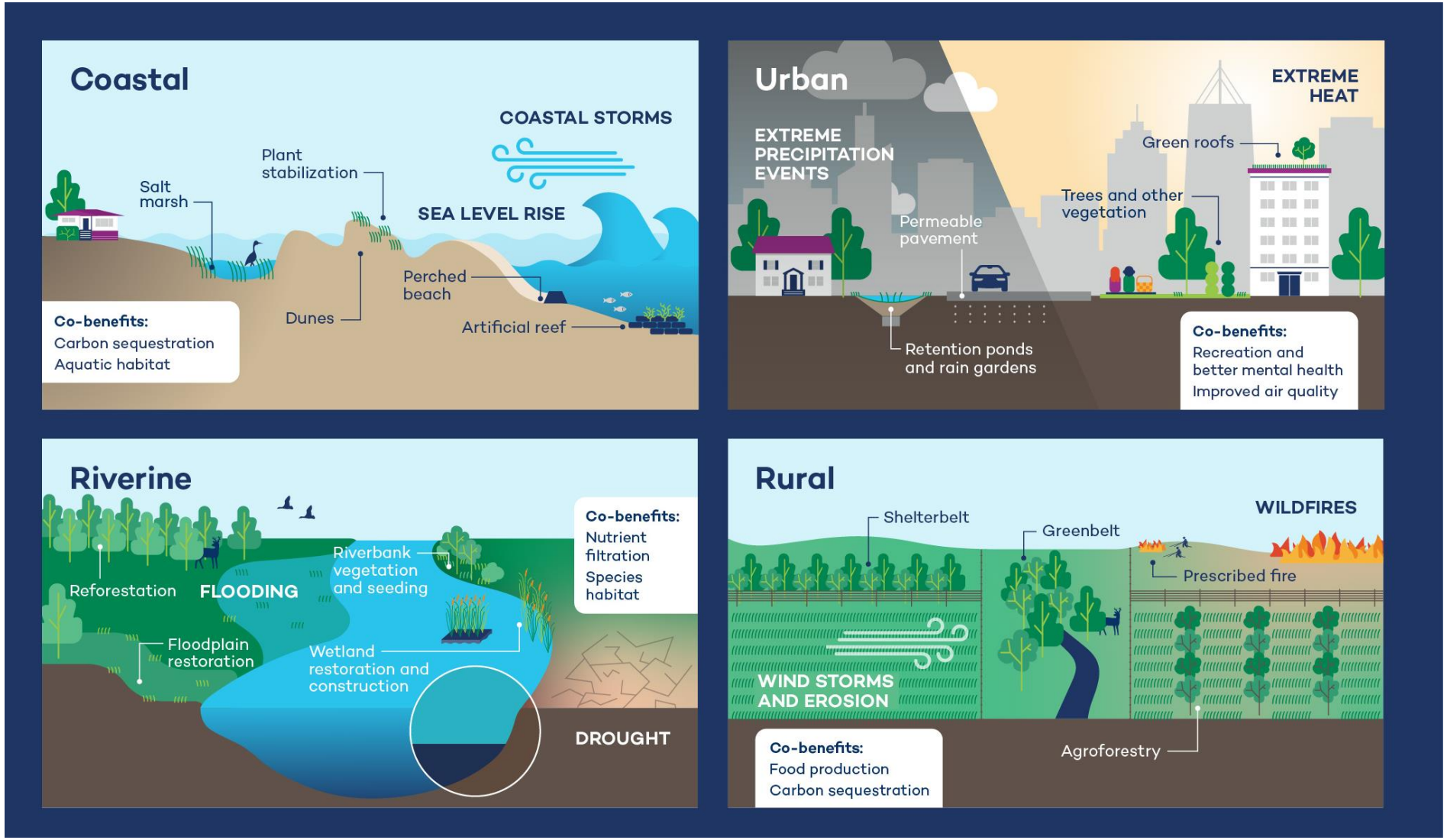
- **Consequences**:
  - Degradation of assets over time could become an **undocumented liability**.
  - Financial reporting can **misrepresent the contribution of the assets to the municipal budget** and potentially affect a municipality's ability to borrow over time to maintain natural assets

- **Solutions:**
  - Add **notes to its financial statements** "to acknowledge the importance of natural assets and the need to manage them in conjunction with engineered assets".
  - The town has been able to **integrate its natural assets into municipal planning** (e.g., general capital budget, annual operating budget)



https://mnai.ca/media/2019/07/SP_MNAI_Report2_June2019.pdf

SUMMARY


Coastal
COASTAL STORMS
Plant stabilization
Salt marsh
SEA LEVEL RISE
Perched beach
Dunes
Artificial reef
Co-benefits:
Carbon sequestration
Aquatic habitat
Urban
EXTREME HEAT
EXTREME PRECIPITATION EVENTS
Green roofs
Trees and other vegetation
Permeable pavement
Retention ponds and rain gardens
Co-benefits:
Recreation and better mental health
Improved air quality
Riverine
Co-benefits:
Nutrient filtration
Species habitat
Riverbank vegetation and seeding
Reforestation
FLOODING
Floodplain restoration
Wetland restoration and construction
DROUGHT
Rural
WILDFIRES
Shelterbelt
Greenbelt
Prescribed fire
WIND STORMS AND EROSION
Agroforestry
Co-benefits:
Food production
Carbon sequestration

Closing Remarks

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Post-webinar Q&A