ENGINEERS GEOSCIENTISTS MANITOBA

Nature-based Infrastructure Solutions to Enhance Resilience

February 23rd, 2022

Trainer/Facilitator: Darren Swanson, P.Eng./P.E., MPA-ID

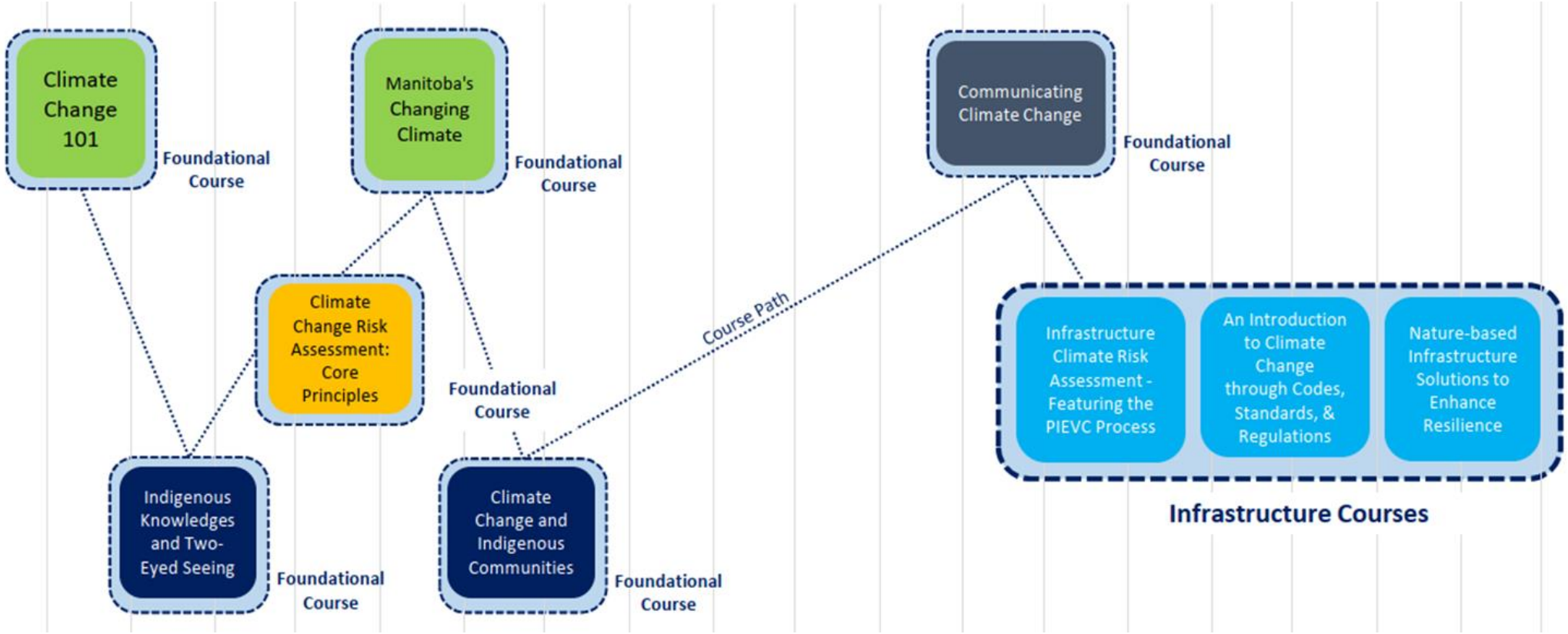
Senior Associate

IISD
International Institute for Sustainable Development

MANITOBA CLIMATE RESILIENCE TRAINING

HIGHLIGHTS FROM PREVIOUS COURSES

- MCRT Foundational and Infrastructure Courses



ENGINEERS GEOSCIENTISTS MANITOBA

INTERACTION

- This course is being **recorded**
  (your participation confirms your agreement)
- **Cameras** and **microphones** are **off**
- **Polls** to receive your feedback
- **Chat is open**
  - During presentation and Q&A
  - Comments are welcome and will be monitored
  - Please send comments to **Everyone,** not to the presenter
- Send **technical issues** to **EngGeoMB** in the chat
- Follow-up **survey,** details of the presentation

ENGINEERS GEOSCIENTISTS MANITOBA

ENGINEERS GEOSCIENTISTS MANITOBA

Nature-based Infrastructure Solutions to Enhance Resilience

Trainer/Facilitator: Darren Swanson, P.Eng./P.E., MPA-ID

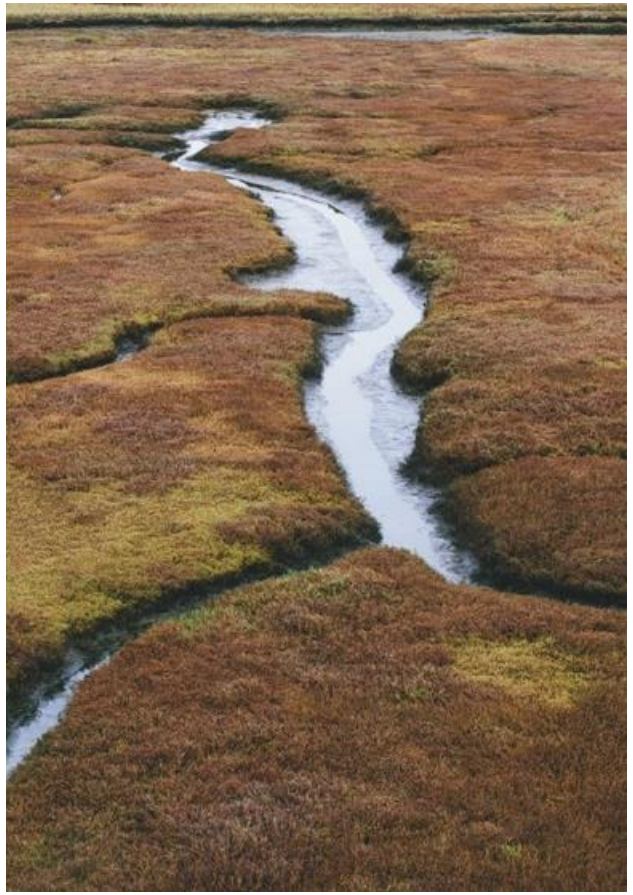
Senior Associate

IISD
International Institute for Sustainable Development

MANITOBA CLIMATE RESILIENCE TRAINING

WEBINAR AGENDA

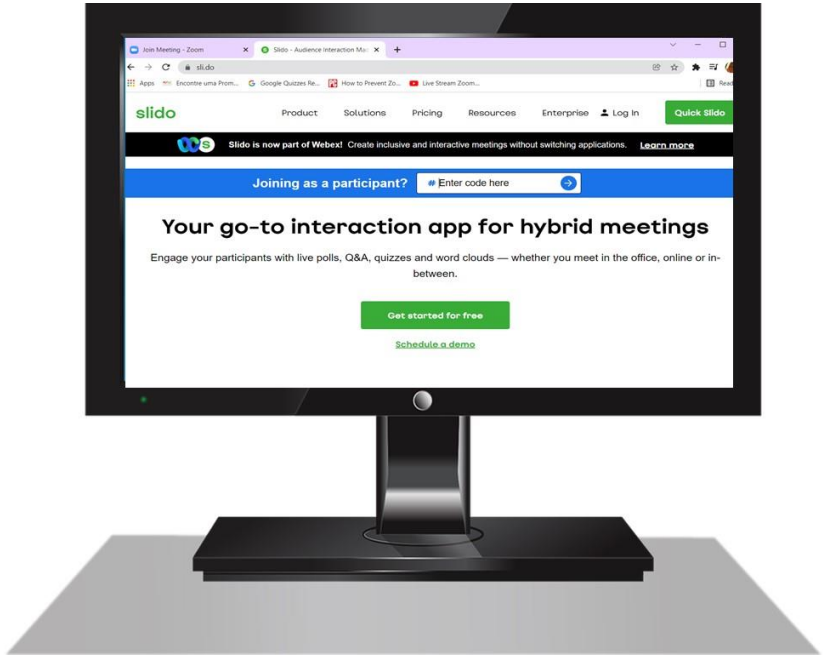
- Welcome, overview, and introductions
- **Session 1:** Introduction to Natural Infrastructure
- **Session 2:** Planning and Design Considerations for Natural Infrastructure
- **Session 3:** Financing Considerations
- Closing remarks
- Q&A session



POLLs & QUIZZES

OR

Slido.com

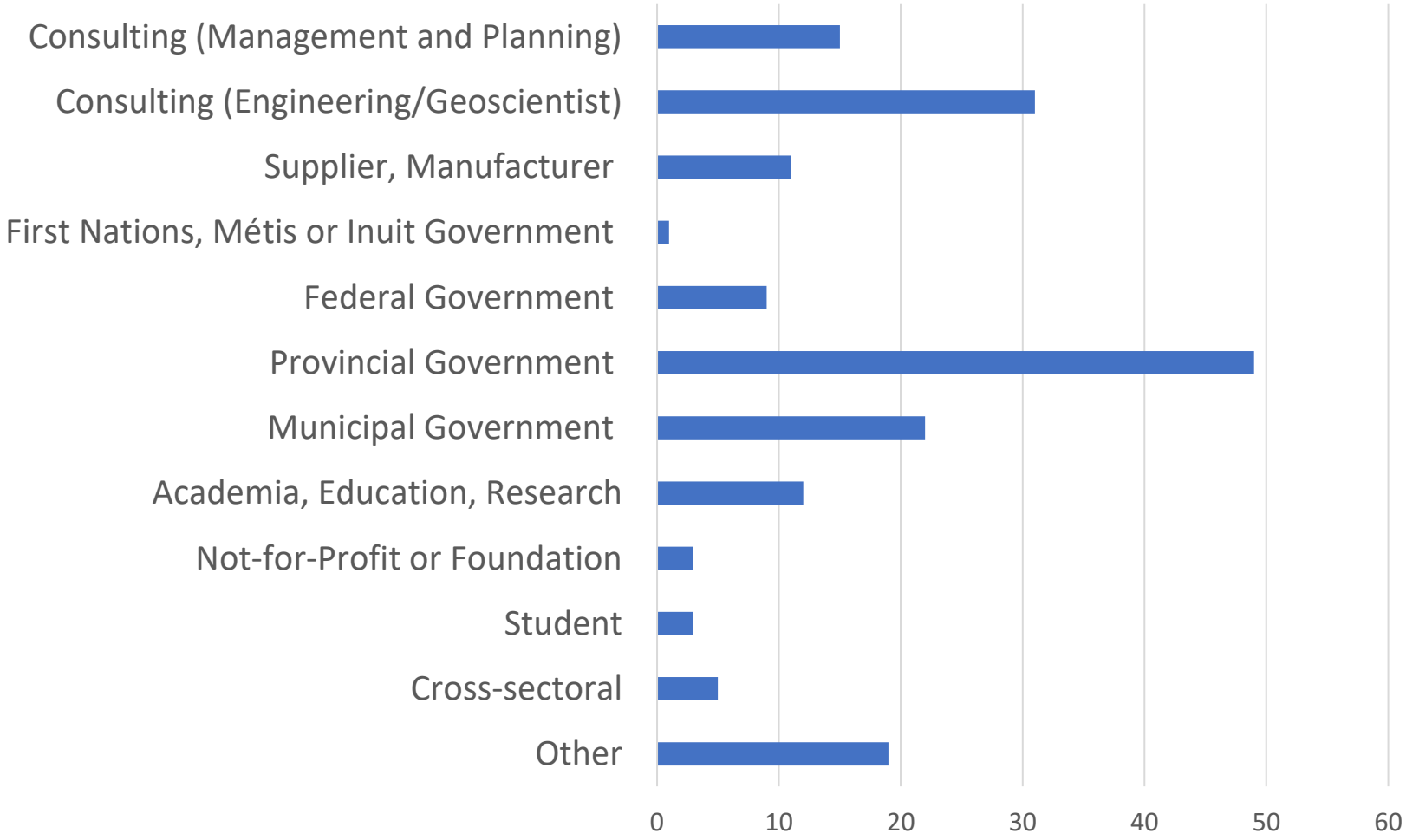


Wordcloud poll

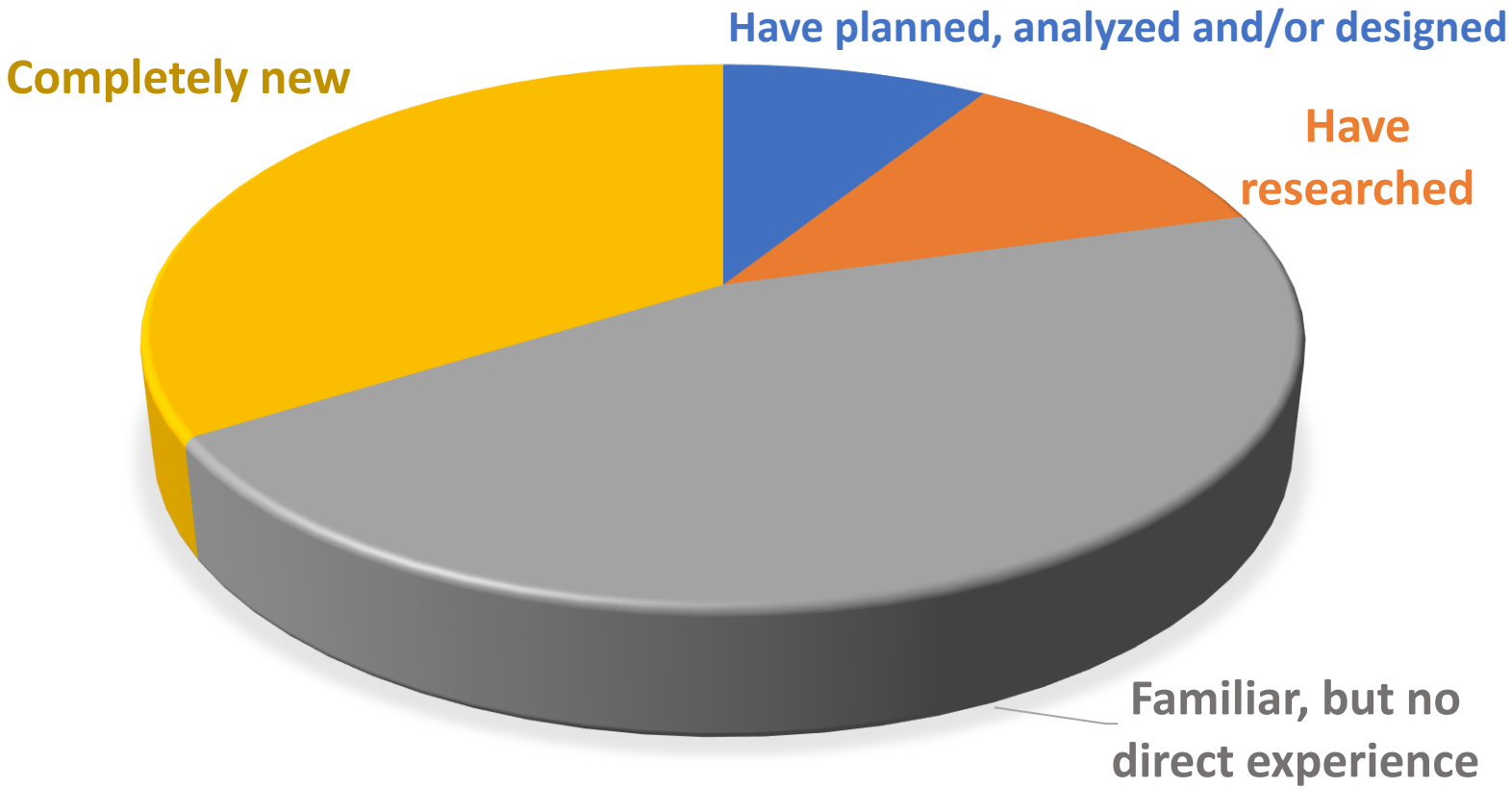
What types of climate hazards are you most concerned about?

0 6 6

YOUR SECTORS



YOUR EXPERIENCE LEVEL WITH NATURAL INFRASTRUCTURE



THE URGENCY OF BUILDING RESILIENCE

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

Session 1:
Introduction to Natural Infrastructure

MANITOBA CLIMATE RESILIENCE TRAINING

NATURAL INFRASTRUCTURE

> 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)

OTHER KEY TERMS:

Nature-based Solutions (NbS)

- As defined by the International Union for Conservation of Nature (IUCN) and the Organisation for Economic Co-operation and Development (OECD):
  - ***"Measures that protect, restore and sustainably manage natural or modified ecosystems, with the aim of maintaining or enhancing the services provided to human communities and benefits to biodiversity."*** *(in CCME, 2021)*
- Umbrella term for ecosystem-based approaches for addressing societal challenges.
  - Encompasses approaches such as Natural Climate Solutions (NCS), Ecosystem-based Adaptation (EbA), eco-disaster risk reduction, and green infrastructure.

OTHER KEY TERMS:

Green Infrastructure

- Canadian Council of Ministers of the Environment definition:
  - *"Natural vegetative systems, engineered and built features, and green technologies that collectively provide society with a multitude of economic, environmental and social outcomes."*
- Sometimes described as **enhanced natural assets**, incorporating land, water, and vegetation features alongside human-made elements to sustain ecosystem functions and services.

OTHER KEY TERMS:

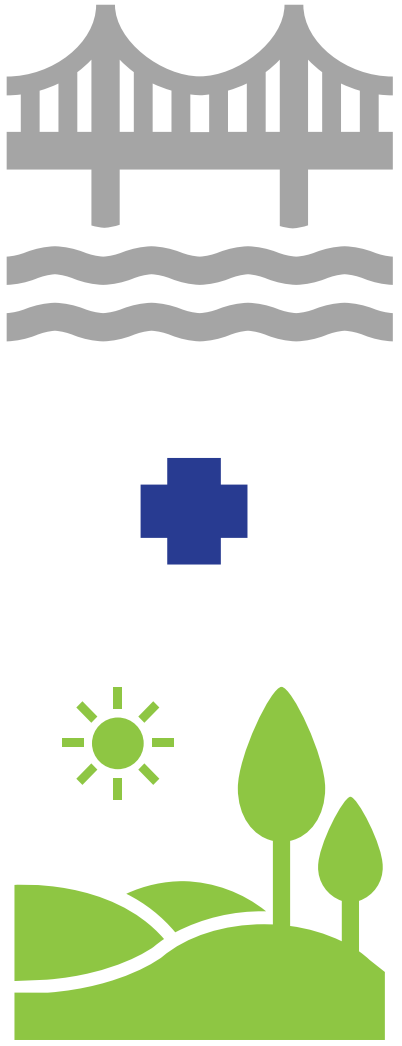
Grey Infrastructure

- Canadian Council of Ministers of the Environment definition:
  - *"…describes features of the built environment made exclusively of materials such as concrete and steel, including bridges, dams, water treatment plants, culverts, ditches and storm drains..."*

OTHER KEY TERMS:

Hybrid Infrastructure

- Canadian Council of Ministers of the Environment definition:
  - *Combine nature-based elements with grey infrastructure to enhance the resilience of both the infrastructure and ecosystem features to higher-intensity events.*
- Useful especially in coastal regions where **hard defenses with soft armouring** protect people from extreme climate-related hazards.
- Hybrid solutions often capable of achieving superior outcomes and benefits in comparison to NI or grey projects by themselves.



NATURAL INFRASTRUCTURE ON THE PRAIRIES

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

NATURAL INFRASTRUCTURE CO-BENEFITS

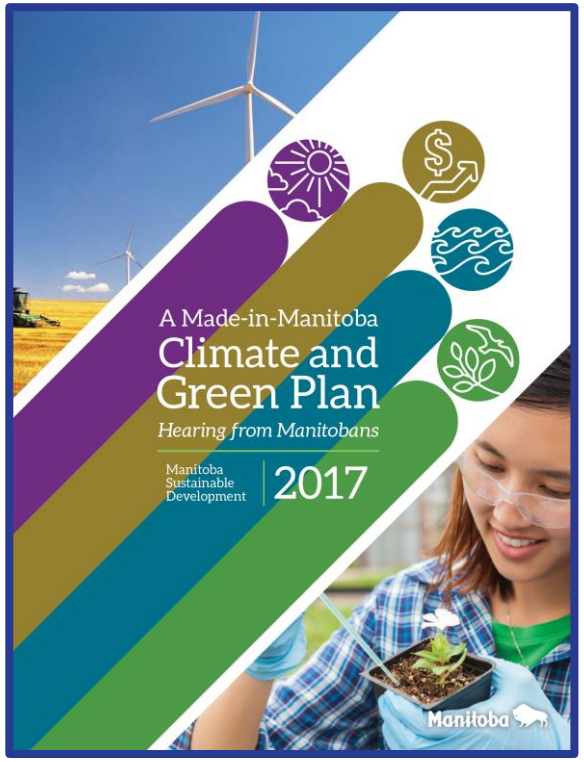
> NI elements can **improve the climate resilience** and overall lifespan of grey infrastructure, and **deliver co-benefits** including biodiversity enhancement, habitat protection, ecosystem services, support for recreation and culture, improved air and water quality, job creation, and stimulation of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

Benefits of NI, Canadian Council of Ministers of the Environment

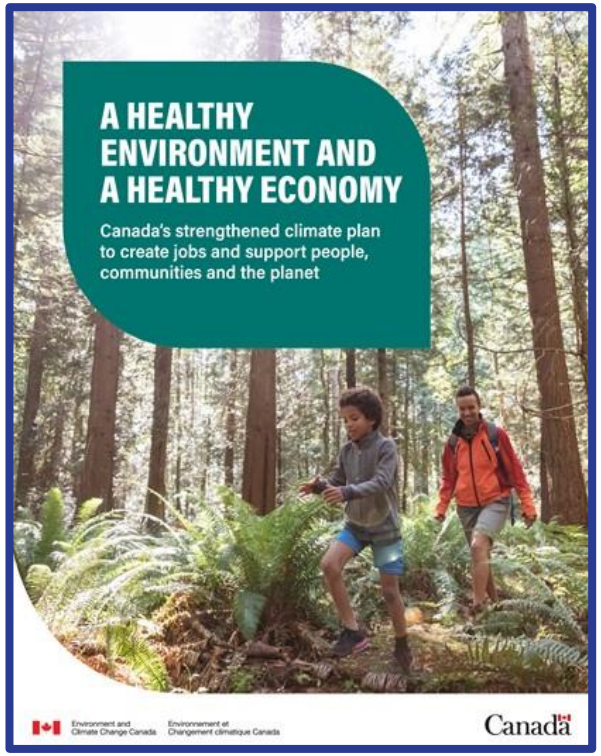
https://ccme.ca/en/res/niframework_en.pdf (page 6, in Roy, 2018)

Picture from Unsplash

THE COMPLIMENTARY ROLE OF NATURAL INFRASTRUCTURE



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



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

Calls on governments to "raise understanding of the value of nature for climate adaptation; **embed nature-based solutions into adaptation policy and planning**; and increase investment in nature-based solutions."

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://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf

SCALE AND COST EFFECTIVENESS

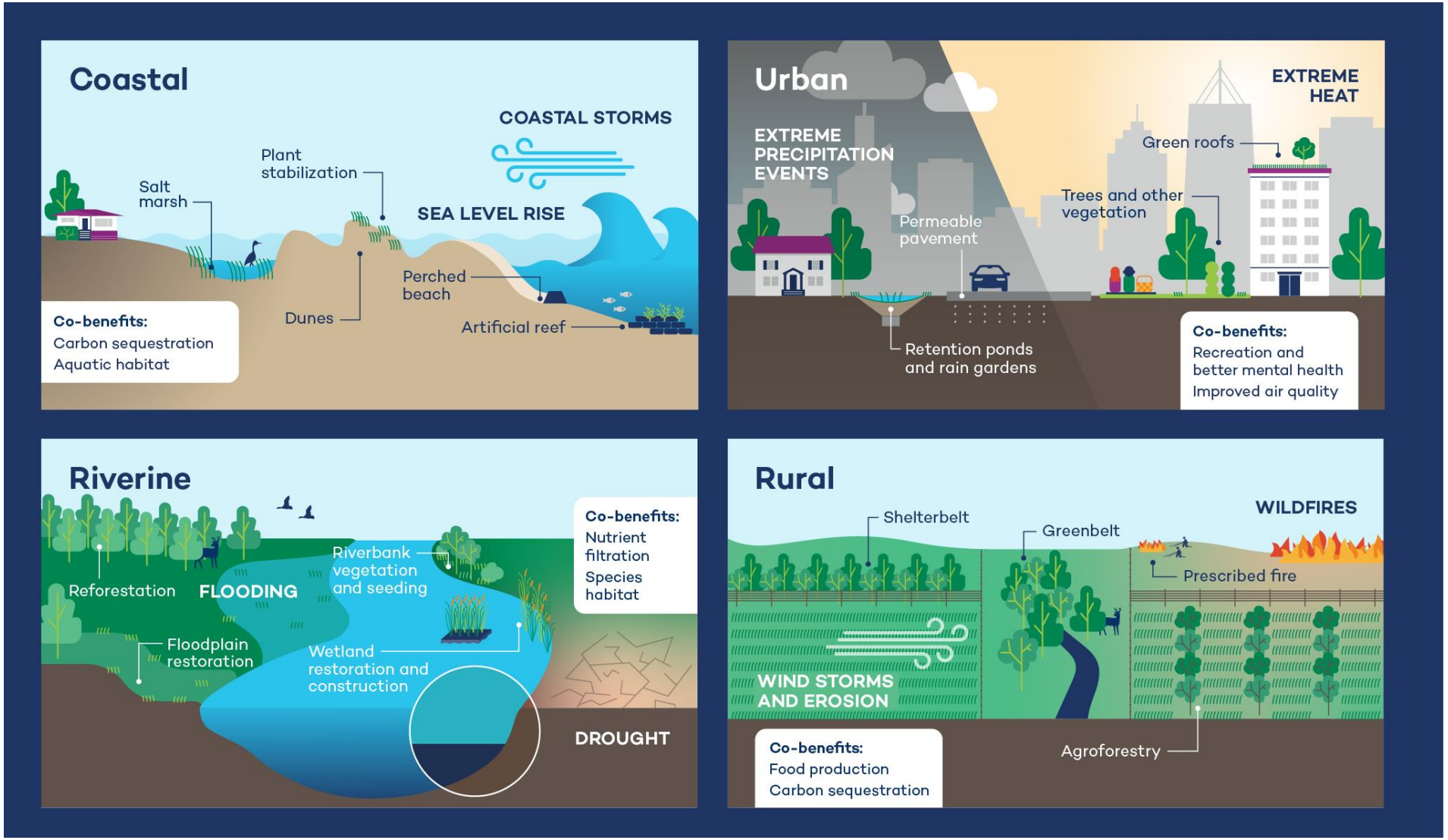
"Studies show that natural infrastructure is cost effective and is often a more efficient use of funds compared to relying solely on built infrastructure to adapt to climate change and increase resilience (IISD 2021)."

"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

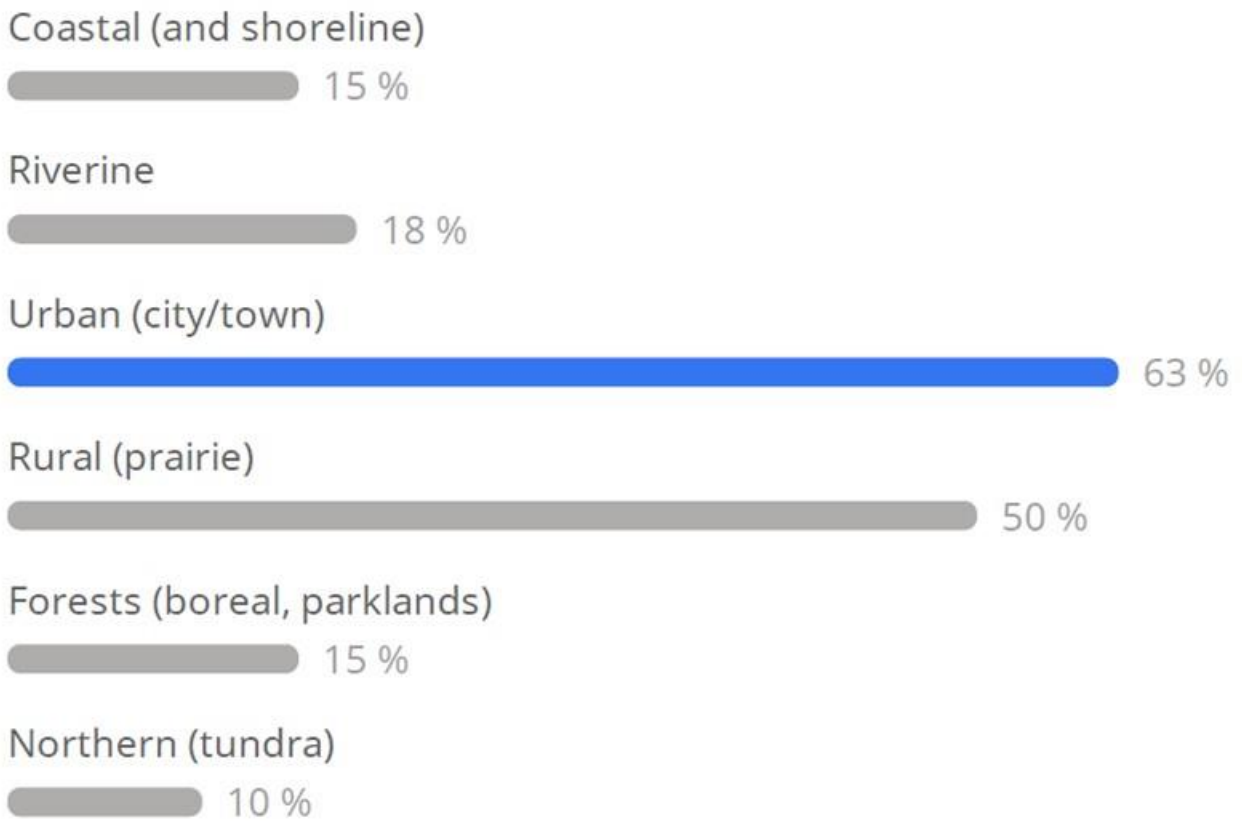
NATURAL INFRASTRUCTURE IN DIFFERENT SETTINGS

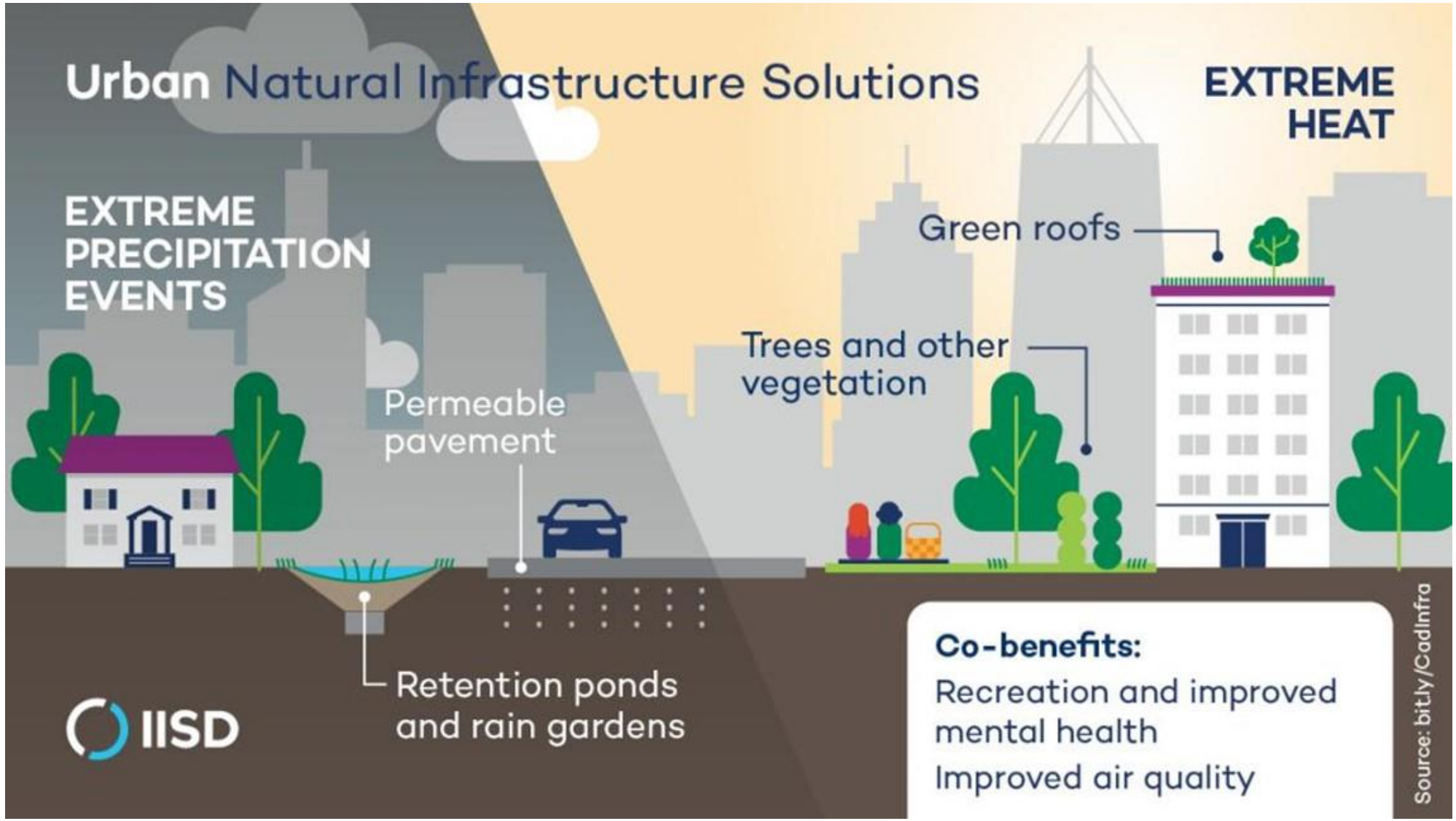


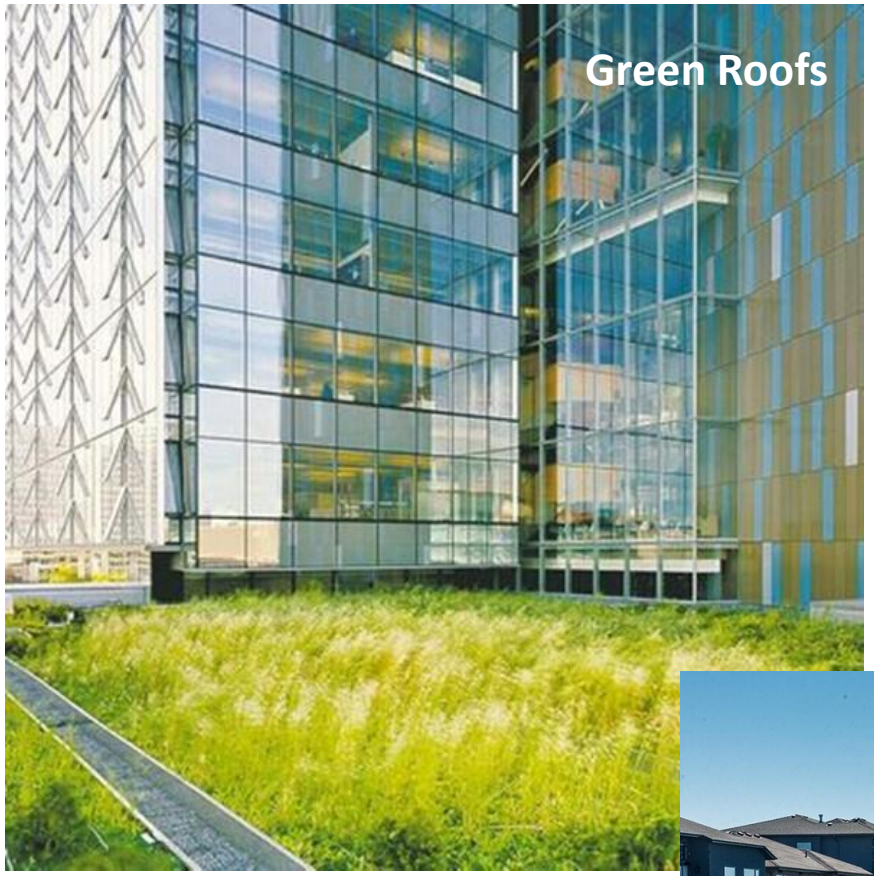
Multiple-choice poll (Multiple answers)

Which landscape do you most often work in?

0 6 2




Urban Natural Infrastructure Solutions
EXTREME PRECIPITATION EVENTS
EXTREME HEAT
Green roofs
Trees and other vegetation
Permeable pavement
Retention ponds and rain gardens
IISD
Co-benefits:
Recreation and improved mental health
Improved air quality
Source: bit.ly/CadInfra


Green Roofs

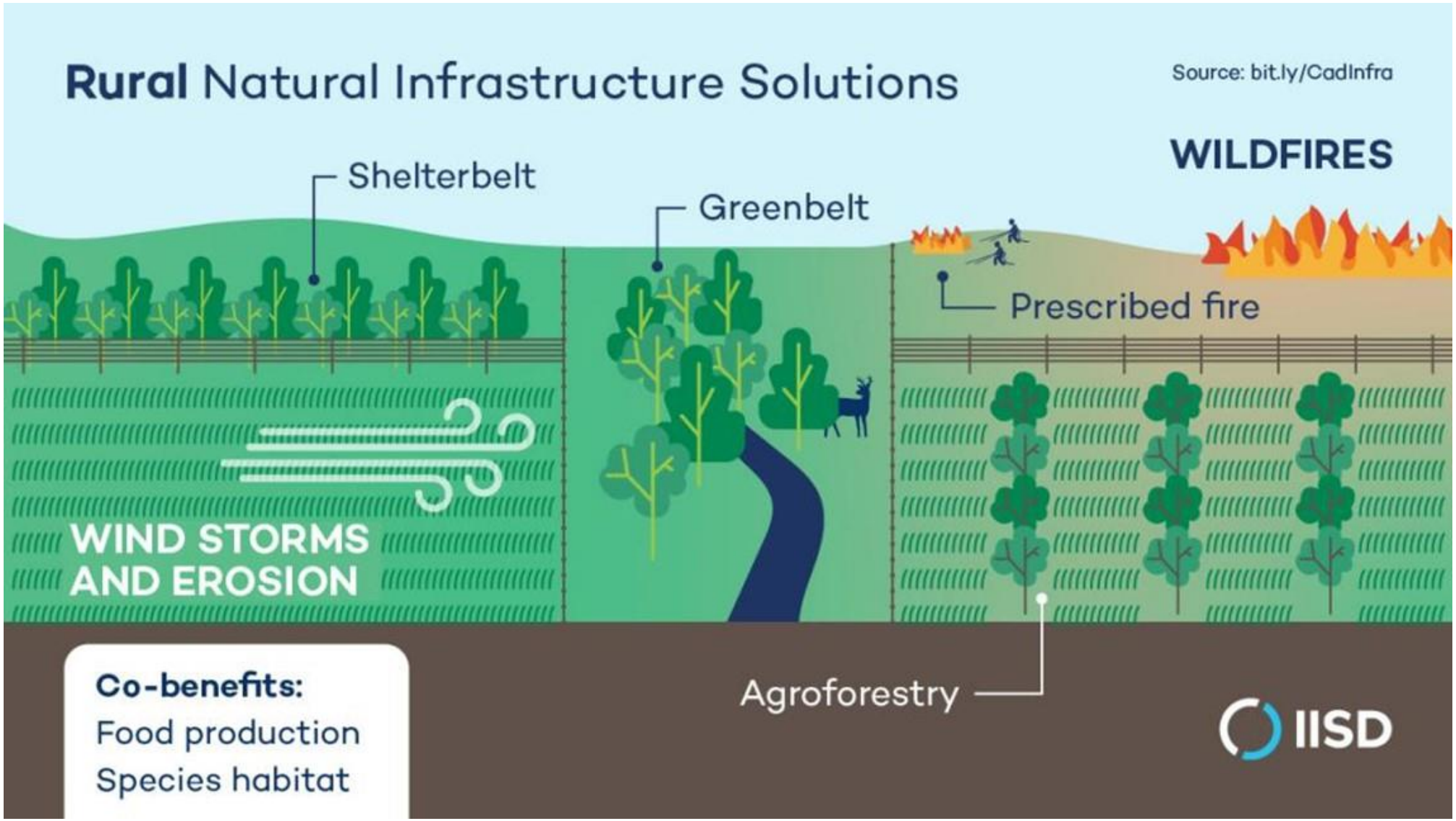

Retention Ponds


Riverine Natural Infrastructure Solutions
Co-benefits:
Nutrient filtration
Species habitat
Reforestation
FLOODING
Riverbank vegetation and seeding
Floodplain restoration
Wetland restoration and construction
DROUGHT
IISD
Source: bit.ly/CadInfra

Floating Treatment Wetlands

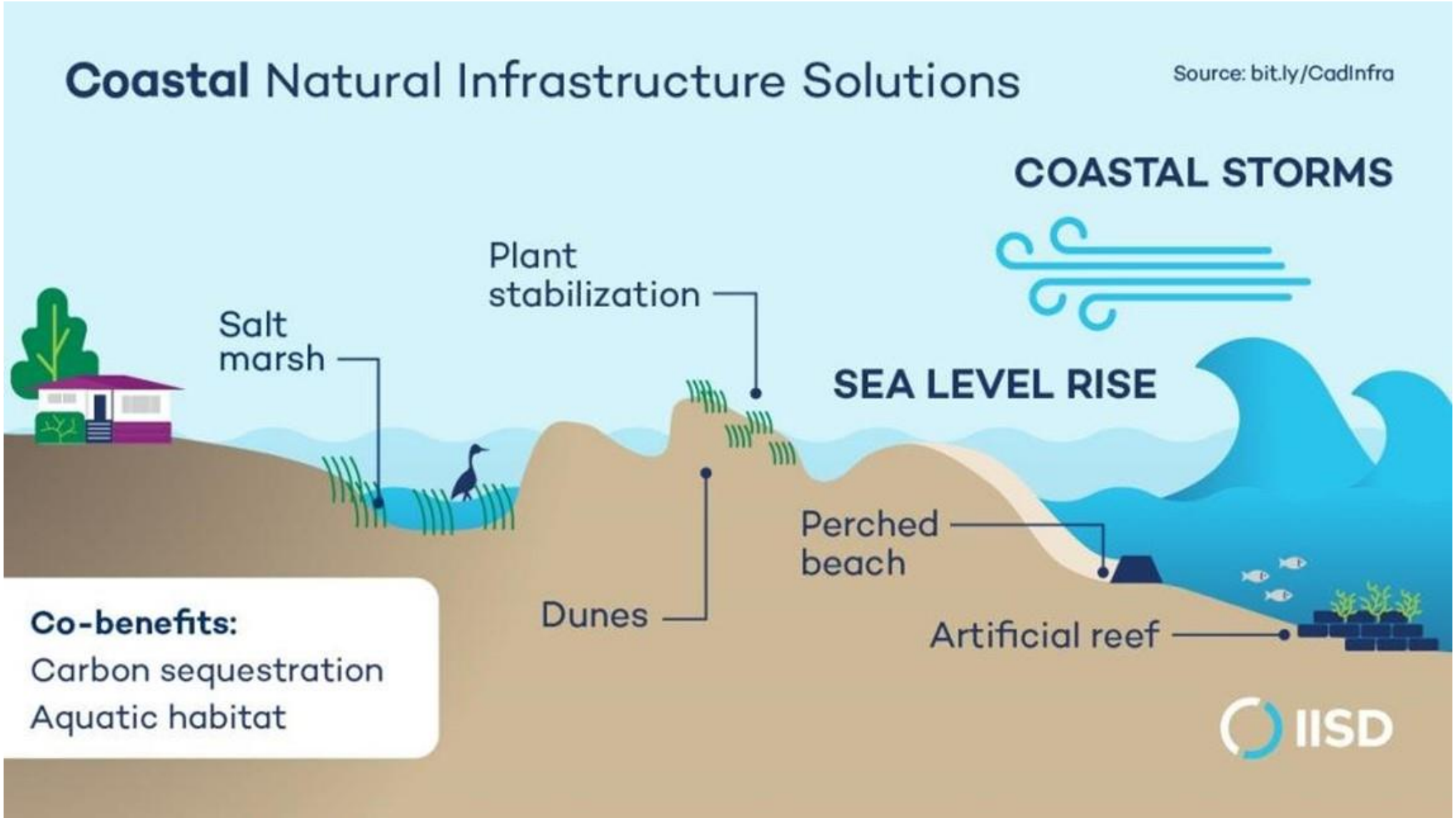
https://www.iisd.org/projects/floating-treatment-wetlands

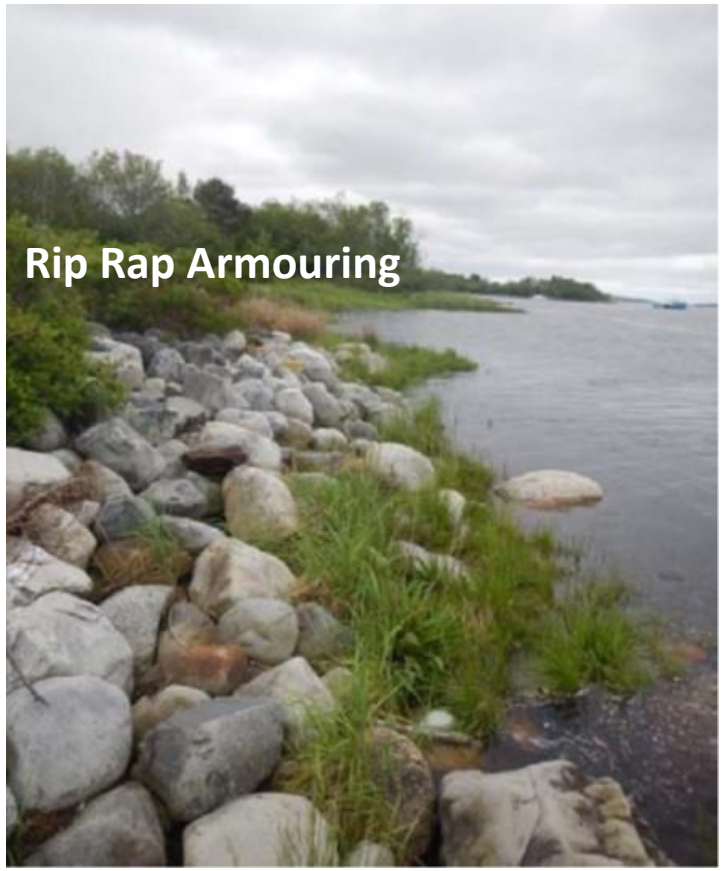
https://www.winnipegfreepress.com/local/province-opens-red-river-floodway-569554112.html


Rural Natural Infrastructure Solutions
Source: bit.ly/CadInfra
WILDFIRES
Shelterbelt
Greenbelt
Prescribed fire
WIND STORMS
AND EROSION
Co-benefits:
Food production
Species habitat
Agroforestry
IISD

Source: IISD.org

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


Coastal Natural Infrastructure Solutions
Source: bit.ly/CadInfra
COASTAL STORMS
Plant stabilization
Salt marsh
SEA LEVEL RISE
Perched beach
Dunes
Artificial reef
Co-benefits:
Carbon sequestration
Aquatic habitat
IISD

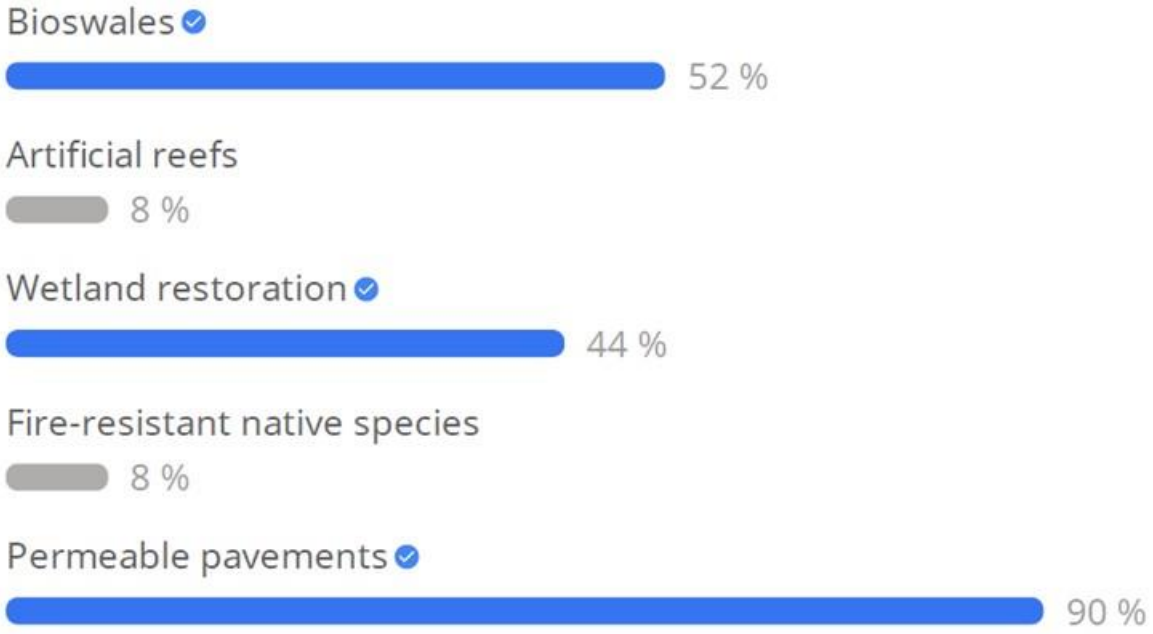


Source: https://atlanticadaptation.ca/en/islandora/object/acasa%3A786

Multiple-choice poll (Multiple answers)

Which of the following natural infrastructure solutions enhance resilience to increased stormwater in urban areas? (select all that apply)
(1/2)

0 6 1

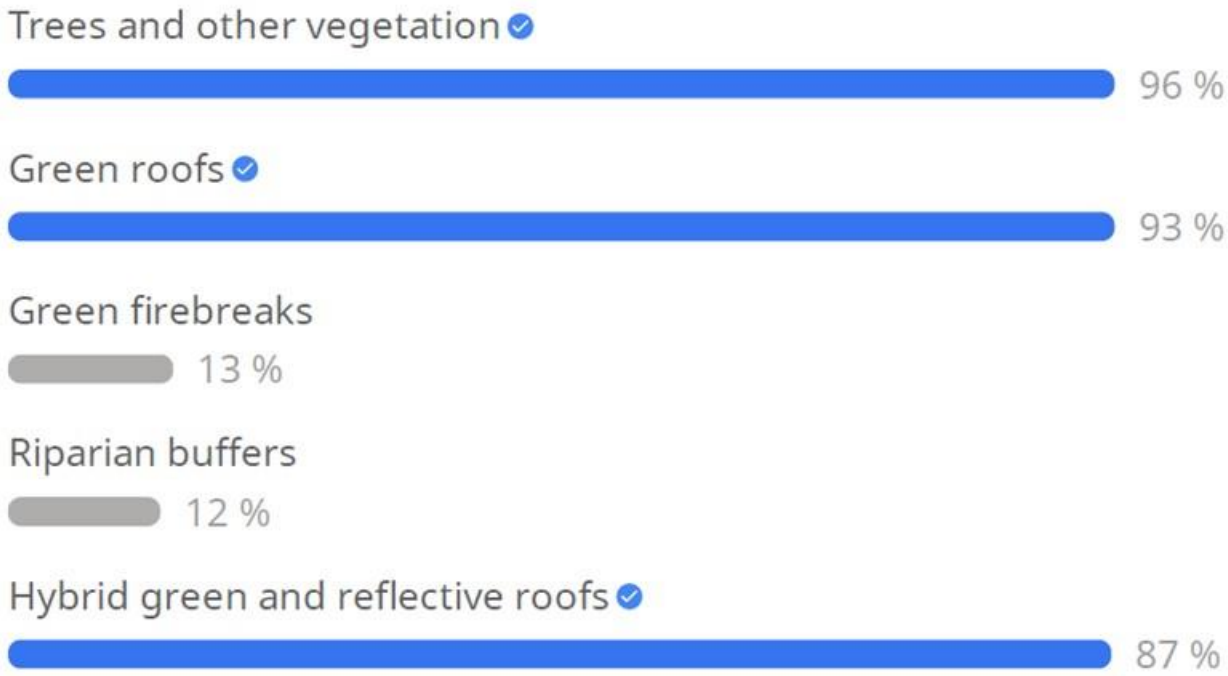


slido

Multiple-choice poll (Multiple answers)

Which of the following natural infrastructure solutions enhance resilience to extreme heat in cities and towns? (select all that apply)

0 6 7



slido

Session 2:
Planning & Design Considerations for Natural Infrastructure

MANITOBA CLIMATE RESILIENCE TRAINING

PLANNING & DESIGN CONSIDERATIONS:

Resilient planning and design

Qualities of Resilient Systems

City Resilience Framework

Integrated	Bringing together and aligning city systems to promote consistency in decision making and investments.
Robust	Assets are designed, constructed, and maintained in anticipation of high-impact climate events.
Flexible	Willingness and ability to adopt alternative strategies in response to changing circumstances or sudden crises.
Redundant	Spare capacity to account for disruptions and surges in demand, and to provide multiple ways of fulfilling a need or function.
Reflective	People and institutions learn from past experiences to inform future decision making.
Resourceful	Citizens and institutions are aware of climate risks, able to adapt to shocks and stresses, and can quickly respond.
Inclusive	The need for broad consultation and many views to [solve complex challenges and] create a sense of shared ownership or a joint vision to build city resilience.

www.bit.ly/CityResilienceFramework

The ROCKEFELLER FOUNDATION ARUP

PLANNING & DESIGN CONSIDERATIONS:

Whole-of-society approach

For example, “The Emergency Management (EM) Framework describes the **sharing of EM responsibilities among FPT governments themselves, as well as with their respective EM partners** (including but not limited to: Indigenous peoples, municipalities, communities, volunteer and non-governmental organizations, the private sector, critical infrastructure owners and operators, academia, and volunteers).

Integrated

Resourceful

Inclusive

https://www.iisd.org/publications/climate-resilience-canadian-infrastructure

PLANNING & DESIGN CONSIDERATIONS:

Sustainable development

2030 Agenda for Sustainable Development, adopted by 193 UN member countries

"…the sustainable development goals…are ***integrated and indivisible***…" (para 18)

"…we pledge that ***no one will be left behind***. Recognizing that the dignity of the human person is fundamental, we wish to see the Goals and targets met for all nations and peoples and for all segments of society…" (Para 4)

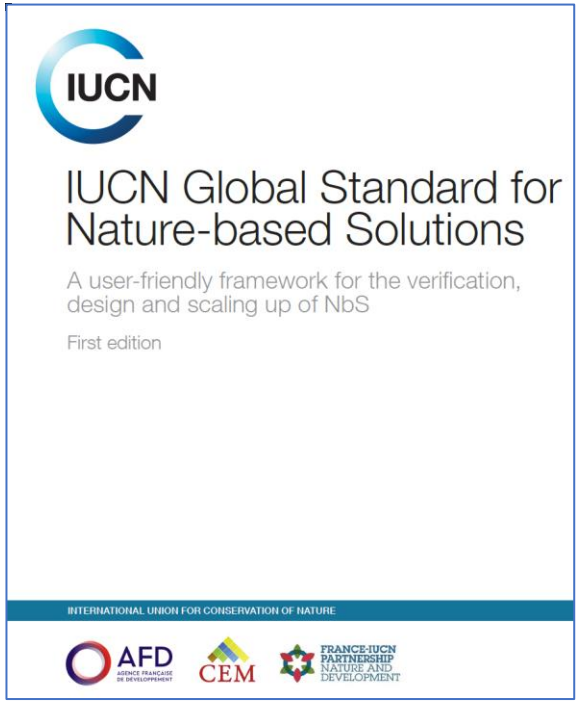
Integrated

Inclusive

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:

Indigenous perspectives and reconciliation

Four recommended areas for improved NbS financial and technical decision making:

1. The importance of culture and secure land and resource rights.
2. The need to avoid offsetting emissions and biodiversity loss.
3. The need for human rights-based conservation approaches and sustainable use.
4. The critical importance of avoiding human rights violations.

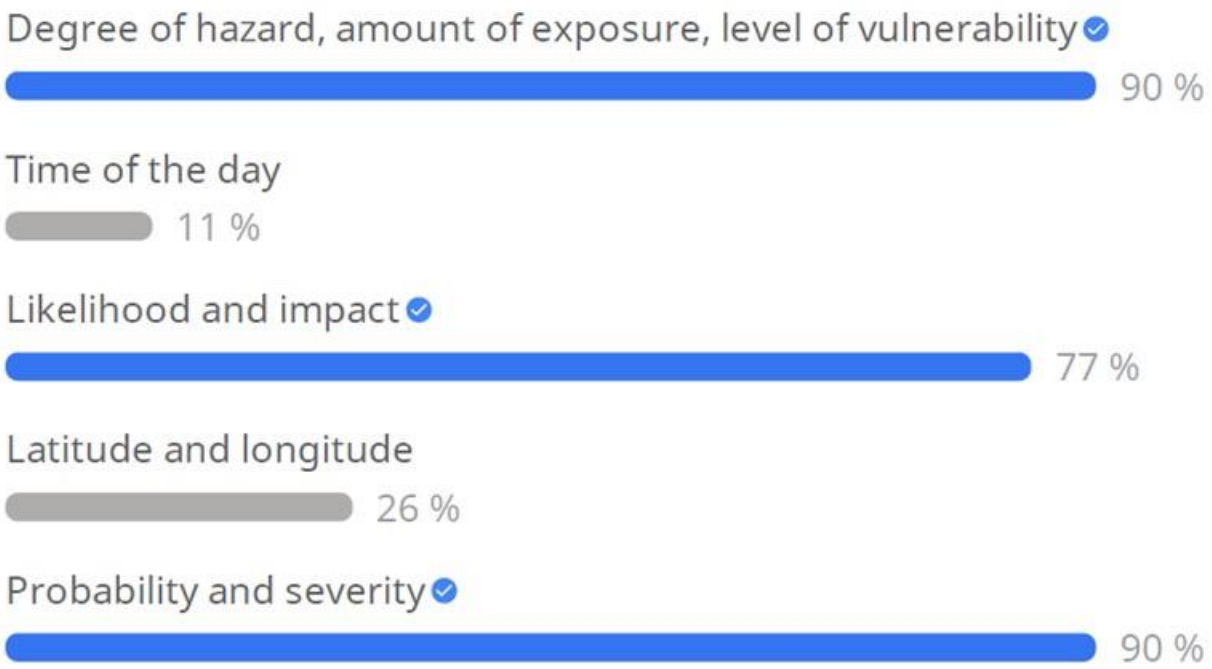
Forest Peoples Programme

https://www.forestpeoples.org/sites/default/files/documents/Re-thinking%20nature-based%20solutions_Seeking%20transformative%20change%20through%20culture%20and%20rights_0.pdf

Multiple-choice poll (Multiple answers)

What factors determine level of risk? (select all that apply)

0 6 2



slido

PLANNING & DESIGN EXAMPLE:

Water retention facilities for flood and drought resilience

Hank Venema, PhD, P.Eng.

CEO and Senior Engineer

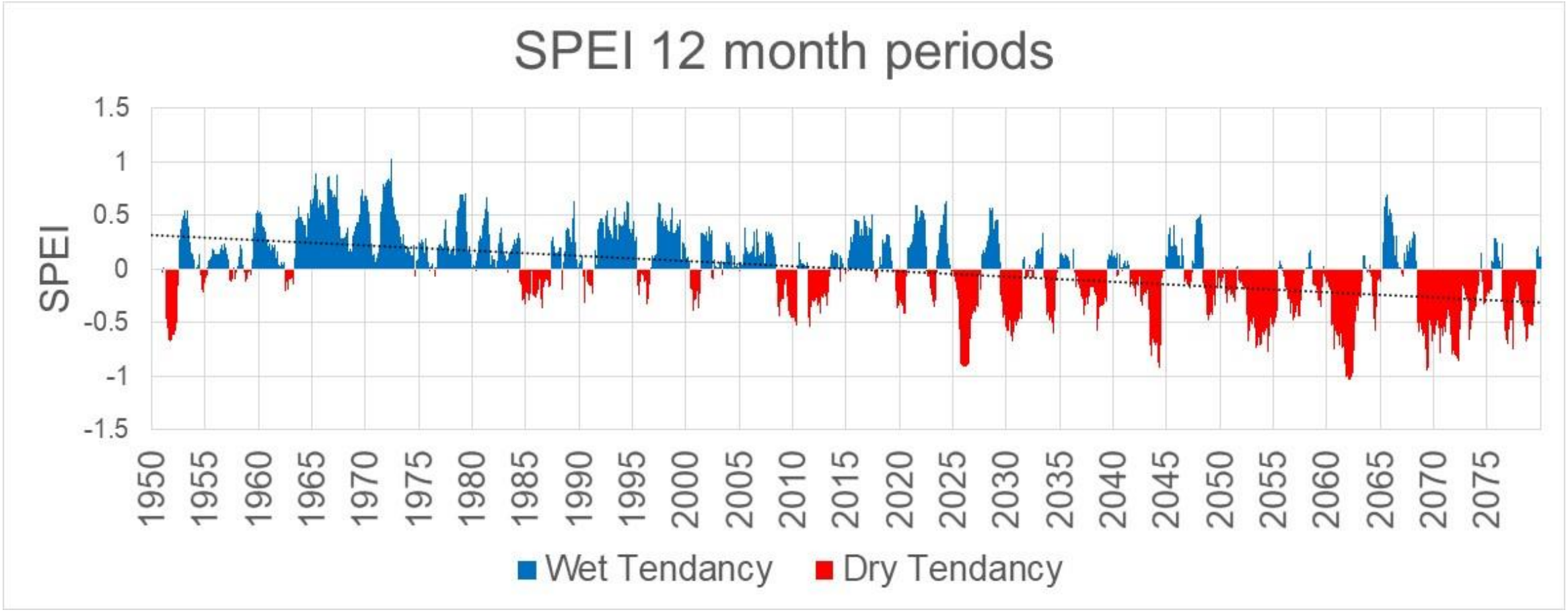
hank@strategicse.ca

204.899.0104

www.strategicsystemsengineering.ca.

Winnipeg Drought Risk: historic + climate projected

Standardized Precipitation and Evaporation Index (SPEI)



STRATEGIC SYSTEMS ENGINEERING INC.

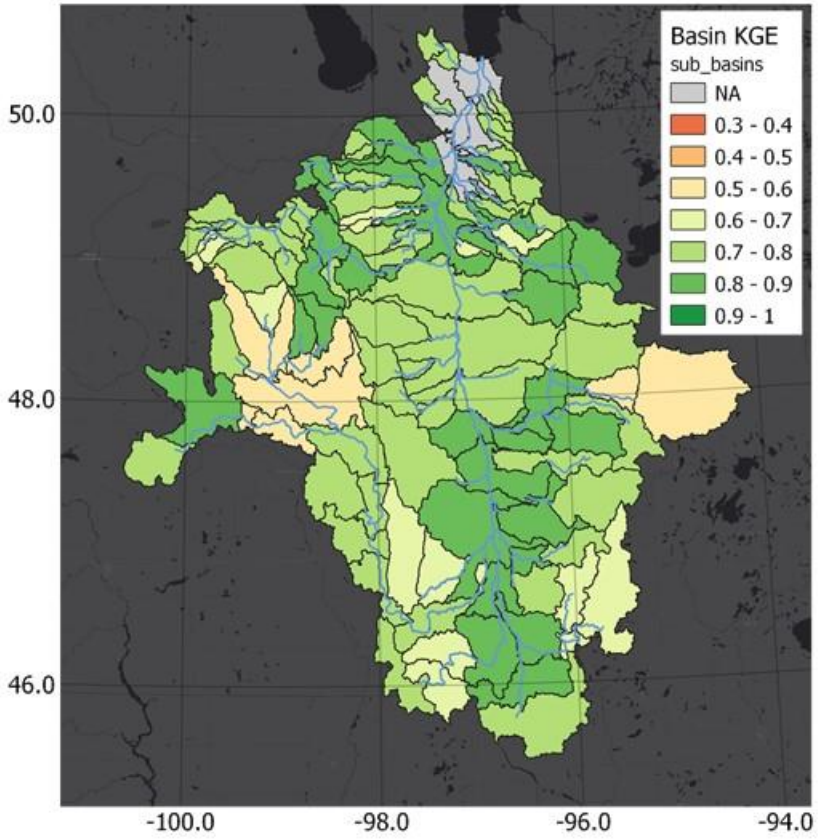
Red River Hydrologic Model

First Seamless International Model

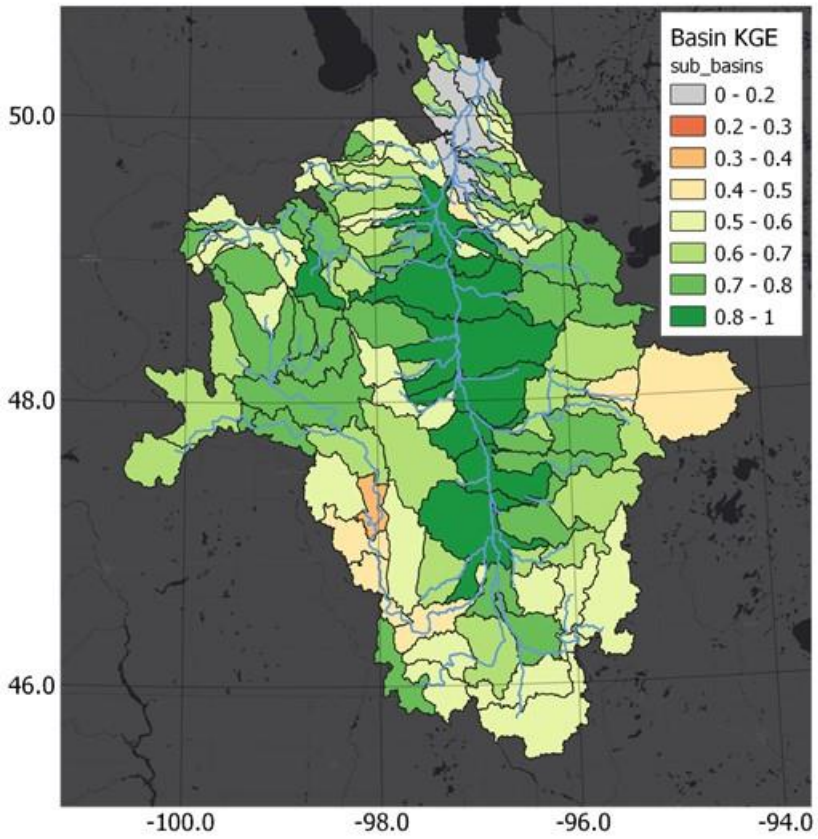
Calibration goal > 0.7
Validation goal > 0.6

Strong model performance

Calibration KGE Scores



Validation KGE Scores



GLOBAL WATER FUTURES
SOLUTIONS TO WATER THREATS IN AN ERA OF GLOBAL CHANGE

Integrated Modelling Program for Canada
Global Water Futures

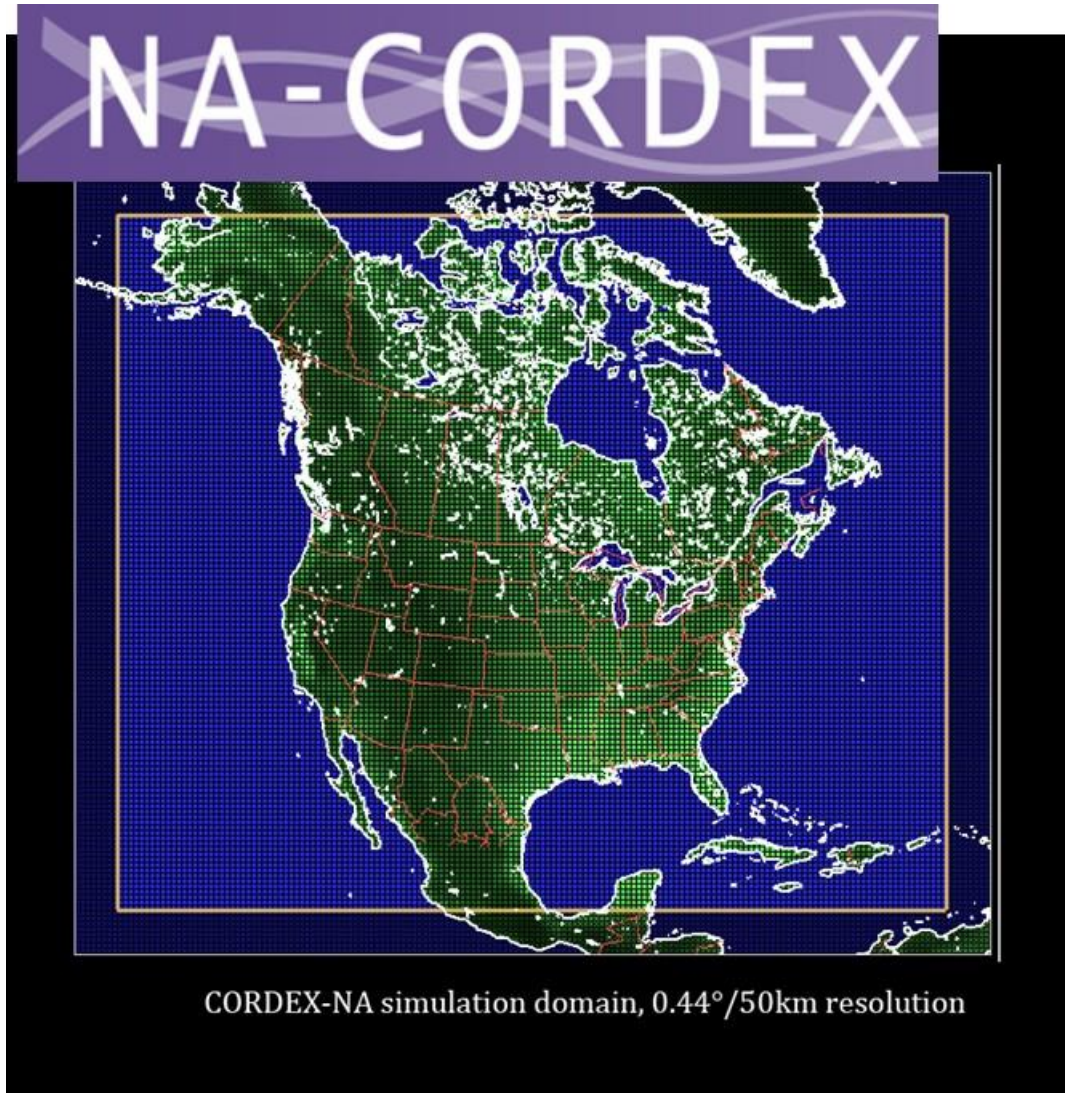
HEC-HMS

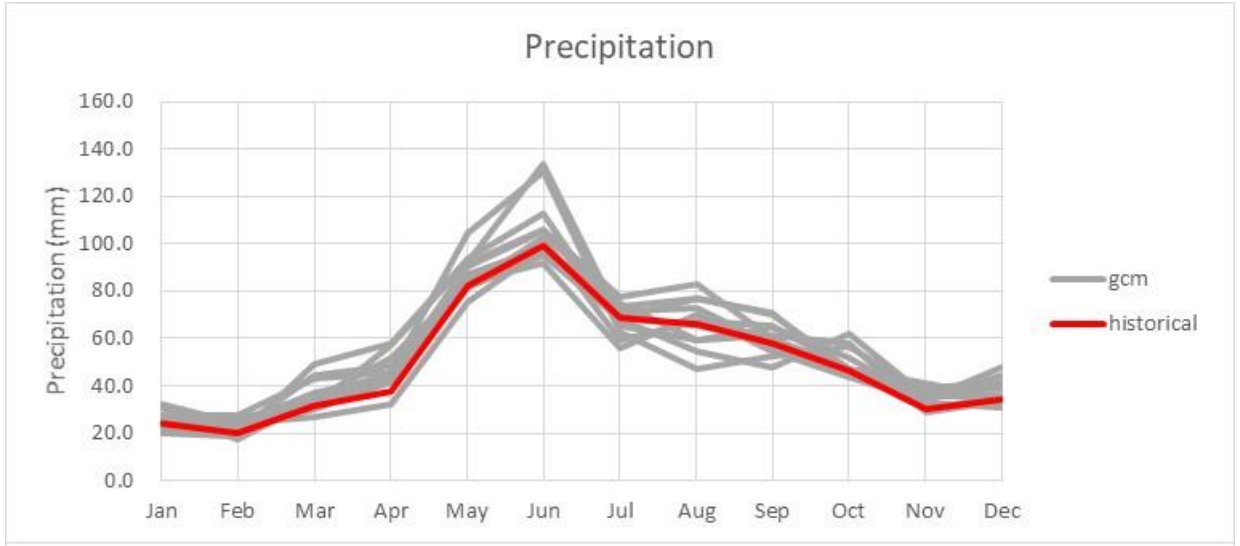
US Army Corps of Engineers

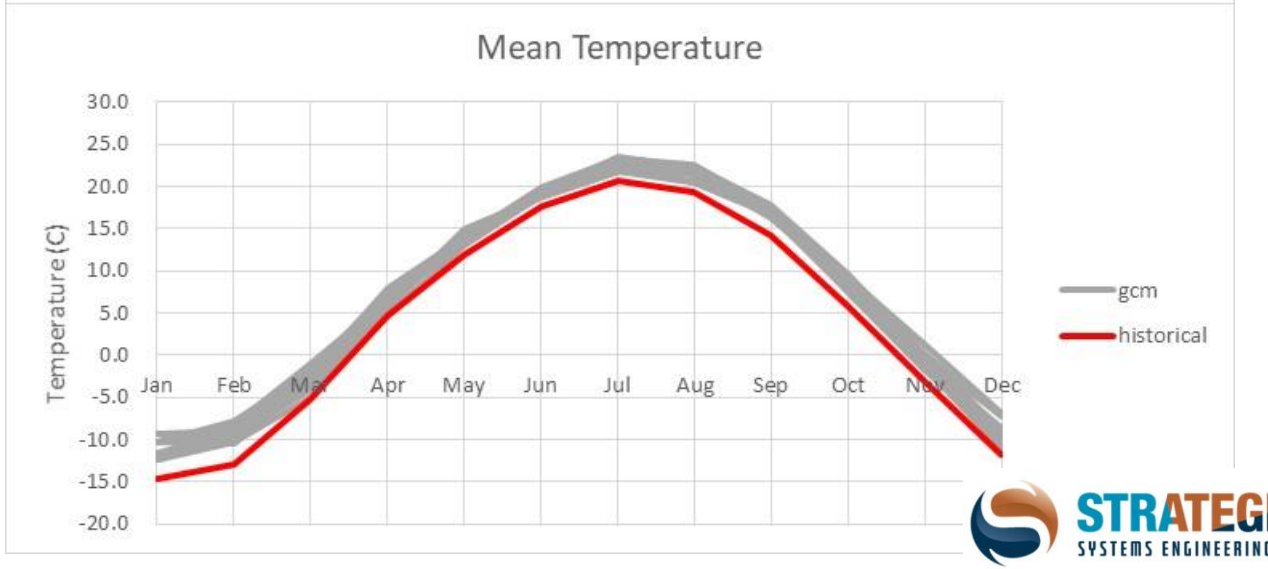
STRATEGIC SYSTEMS ENGINEERING INC.

Global Climate Model Projections

For Red River Basin







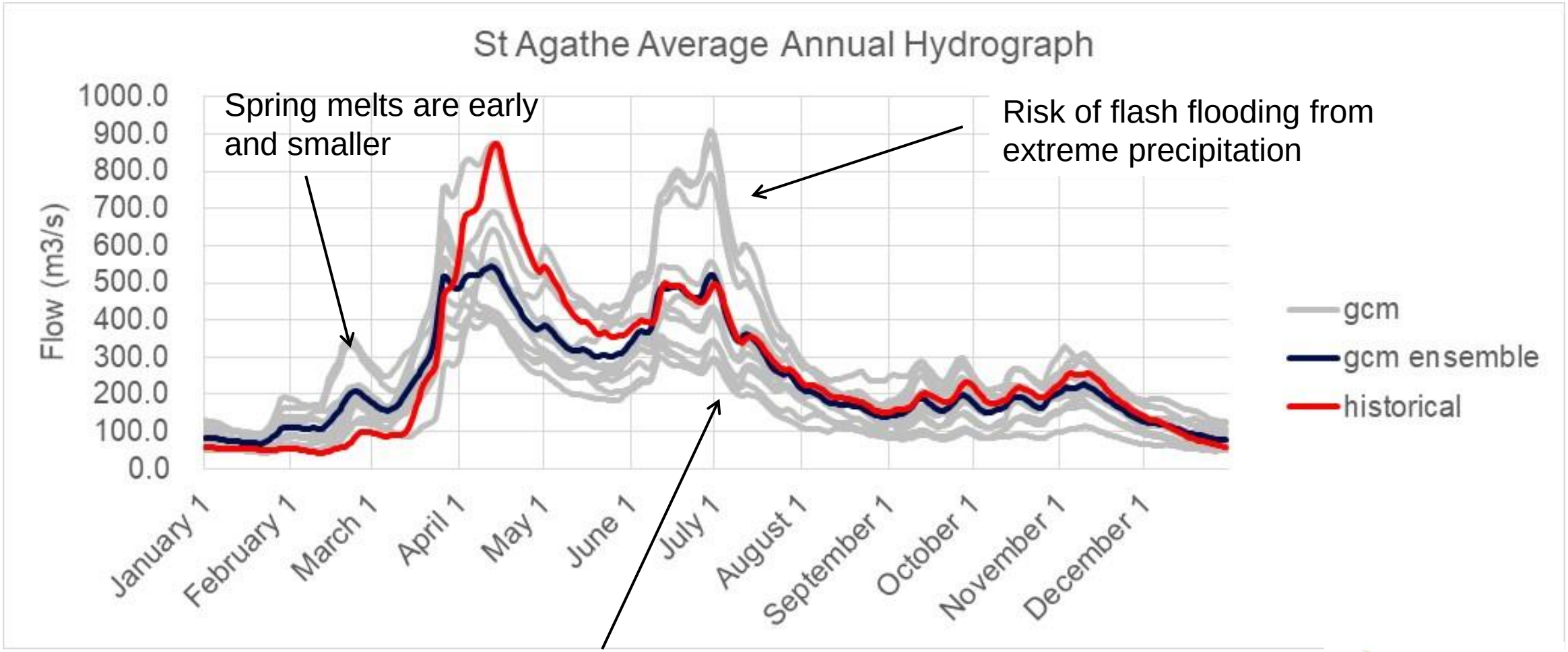
STRATEGIC SYSTEMS ENGINEERING INC.

Climate Impacts on Red River

Hydrology (@ St. Agathe)

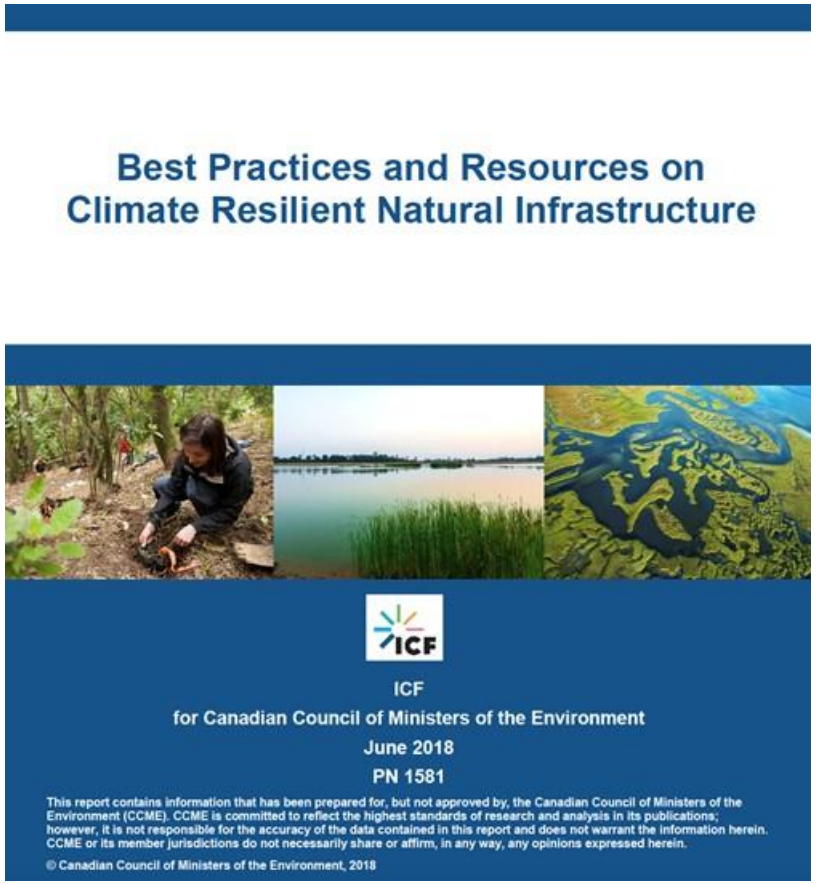
Key Messages

- Elevated Flood and Drought Risk
- Ensemble model average projects 7% less water per year – seasonality changes significantly



Natural Infrastructure for flood + drought + environmental protection

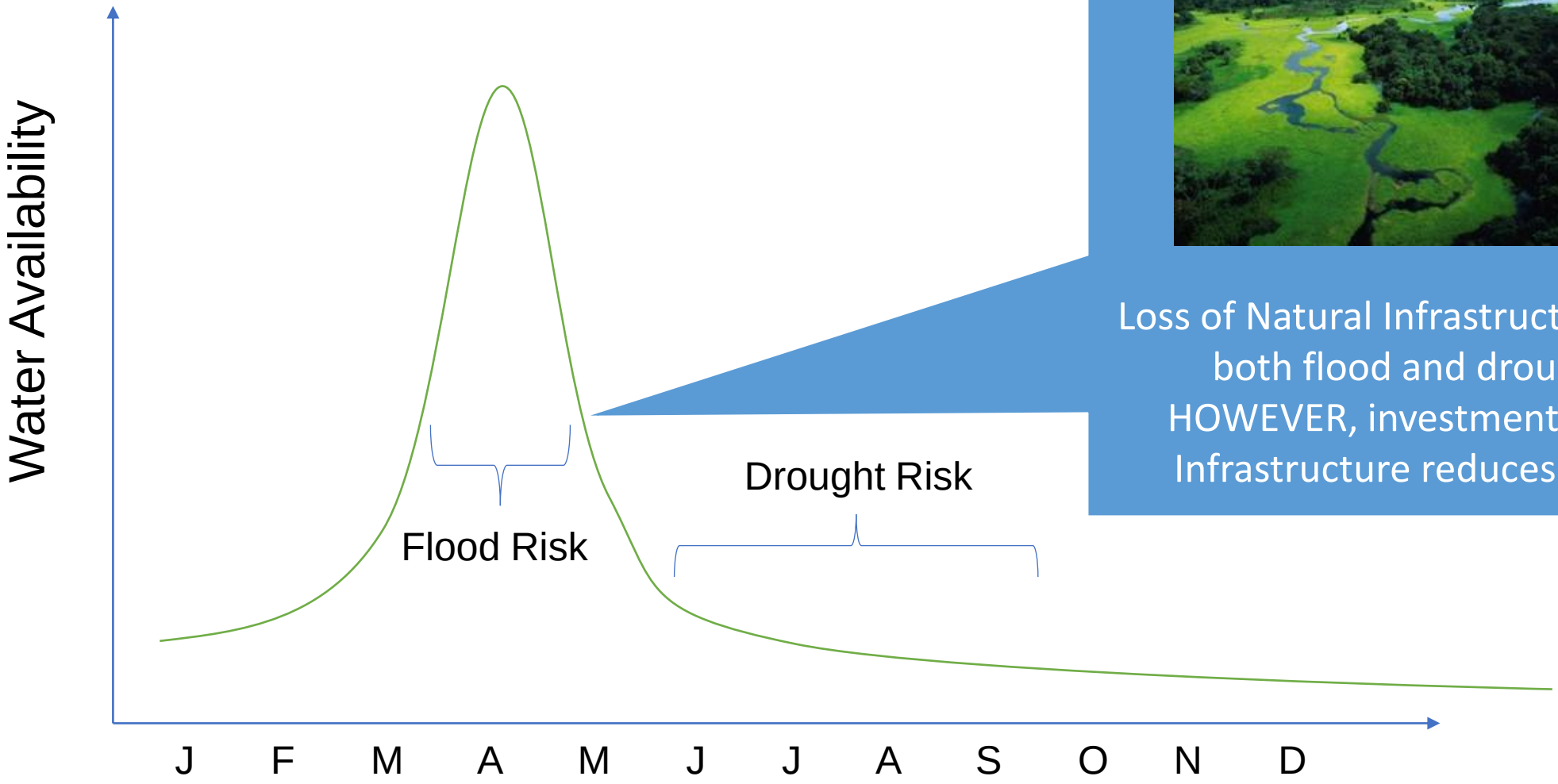
- *"existing, restored, or enhanced combinations of vegetation and associated biology, land and water, and naturally occurring ecological processes that generate infrastructure outcomes such as preventing and mitigating floods, erosion, and landslides; mitigating effects of extreme heat; and purifying groundwater…* can be existing natural features or **human-made and constructed**." (ICF, 2018)."
- Key point: Natural Infrastructure stacks multiple benefits, typically has high ROI
- **If you have it, keep it. If you need it, build it**



STRATEGIC SYSTEMS ENGINEERING INC.

Seasonal Water Availability

typical temperate Northern Hemisphere

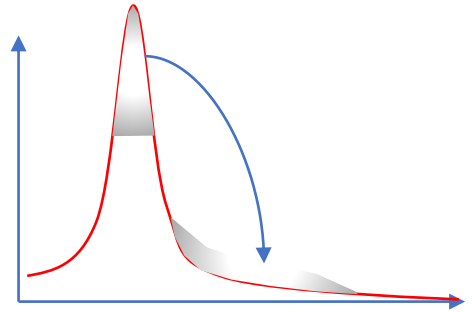


Loss of Natural Infrastructure increases both flood and drought risk; HOWEVER, investment in Natural Infrastructure reduces both risks

STRATEGIC SYSTEMS ENGINEERING INC.

Natural Infrastructure Examples (medium scale)

Pelly's Lake, Oakburn Bioretention, Grant's Lake

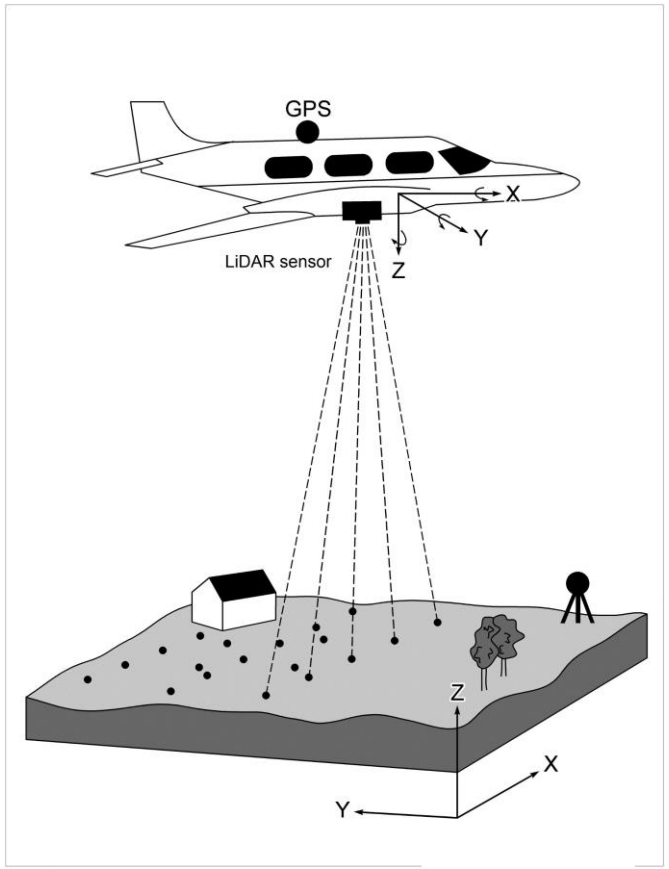


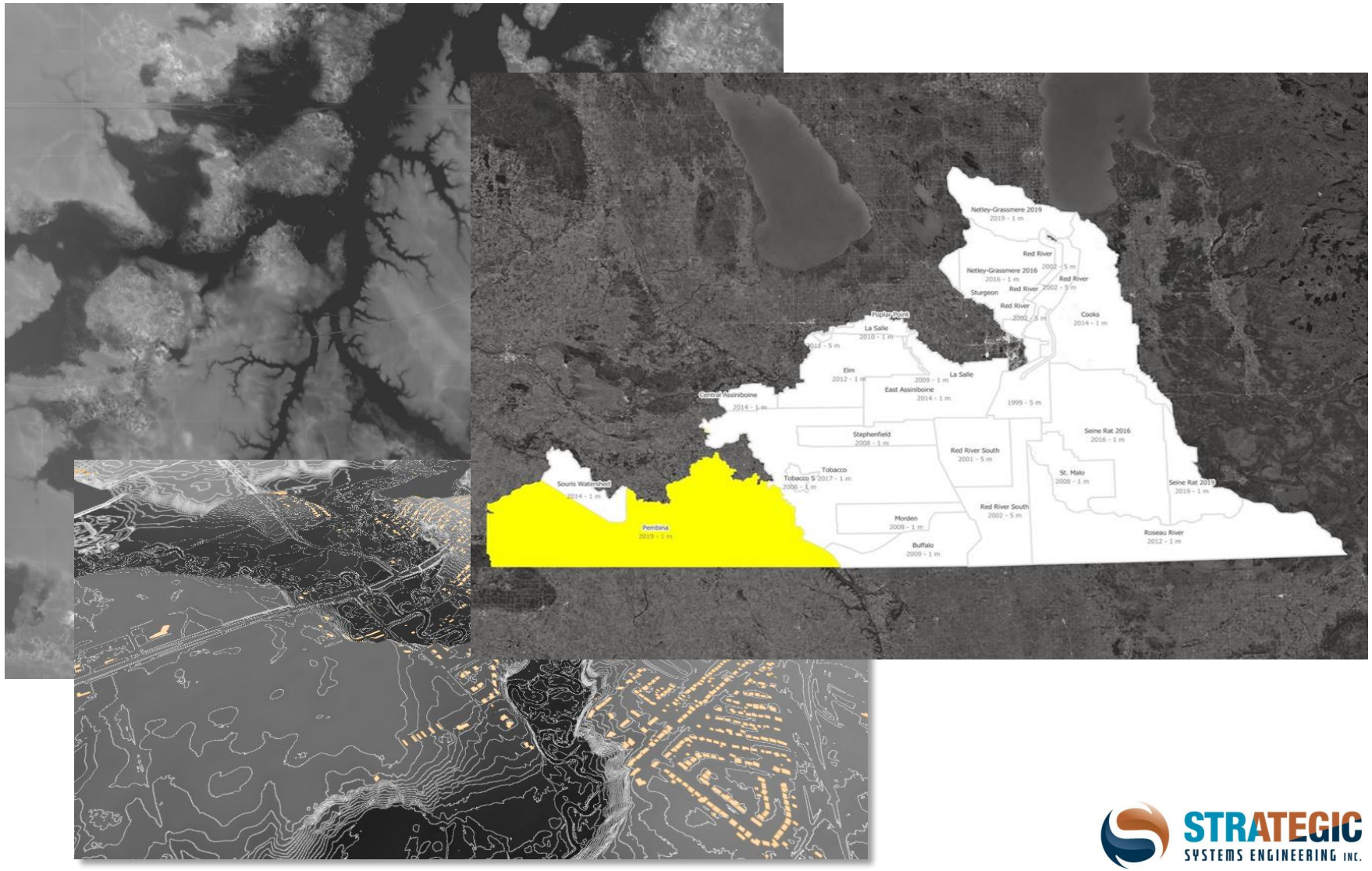
Question: Why is LiDAR important?

Answer: LiDAR accelerates Natural Infrastructure system design from field to basin-scale

STRATEGIC SYSTEMS ENGINEERING INC.

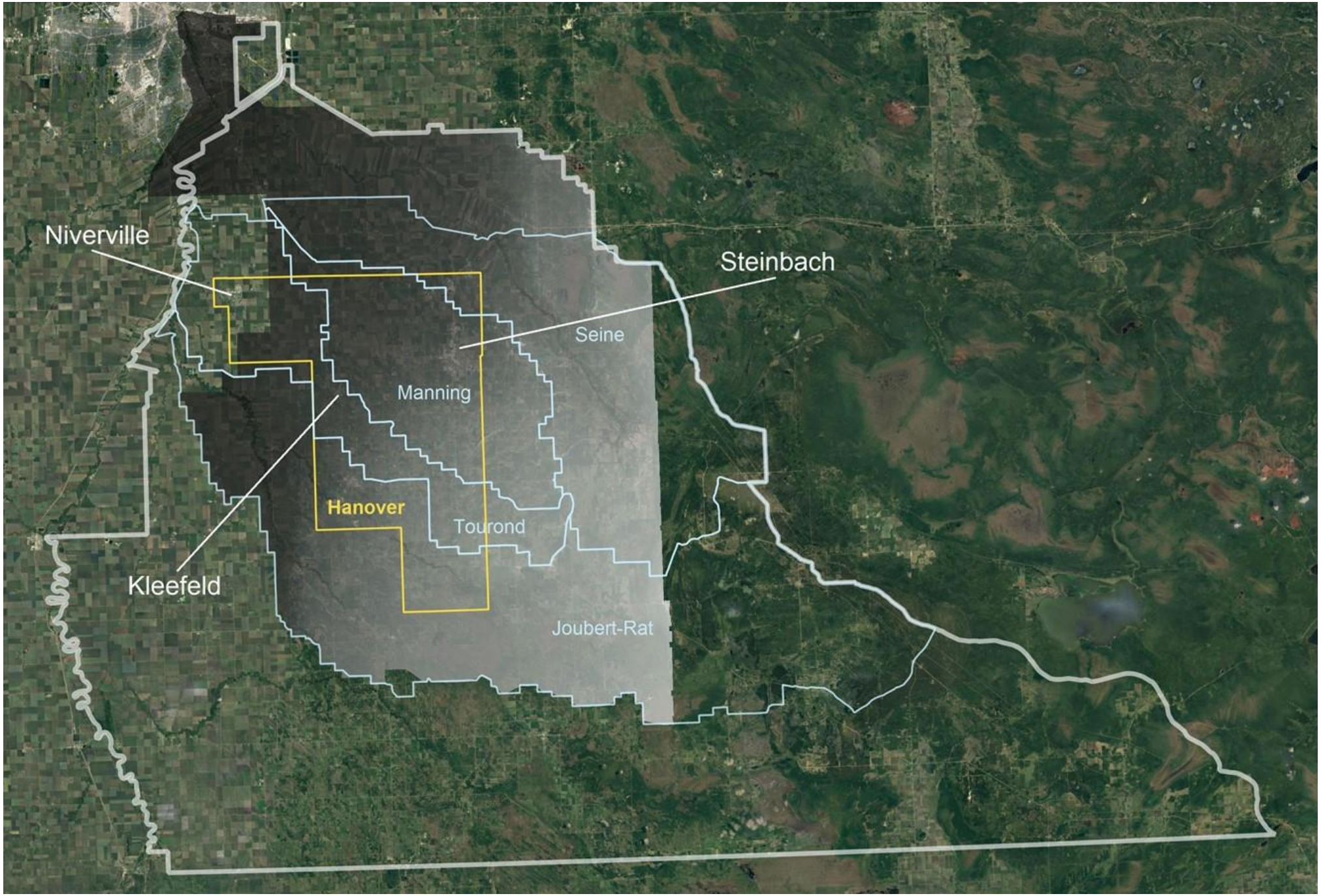
Celebrating Complete LiDAR coverage in the RRB





Case Study:
RM Hanover / Seine Rat
Roseau Watershed District

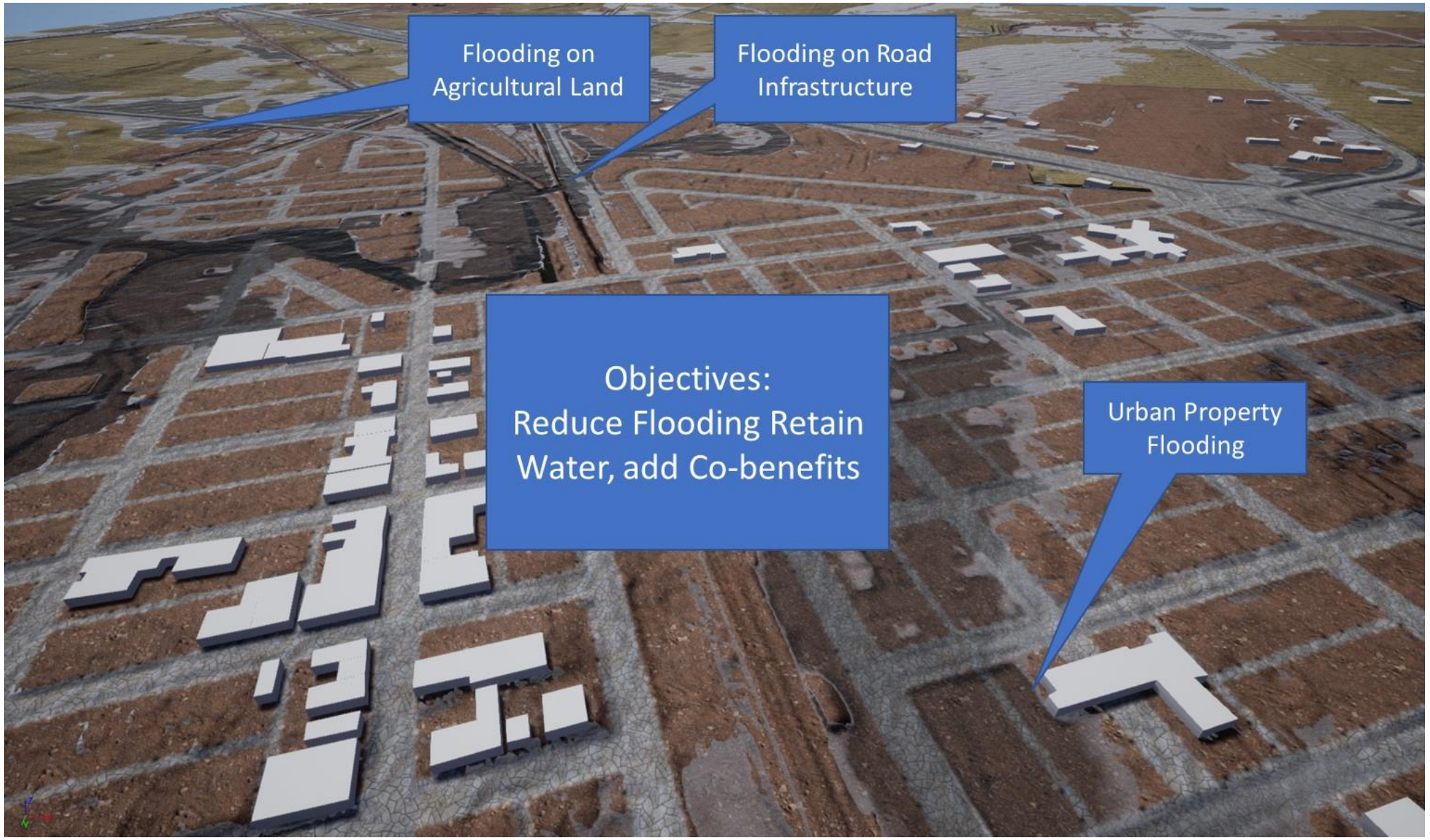
STRATEGIC
SYSTEMS ENGINEERING INC.


Niverville
Steinbach
Seine
Manning
Hanover
Tourond
Kleefeld
Joubert-Rat

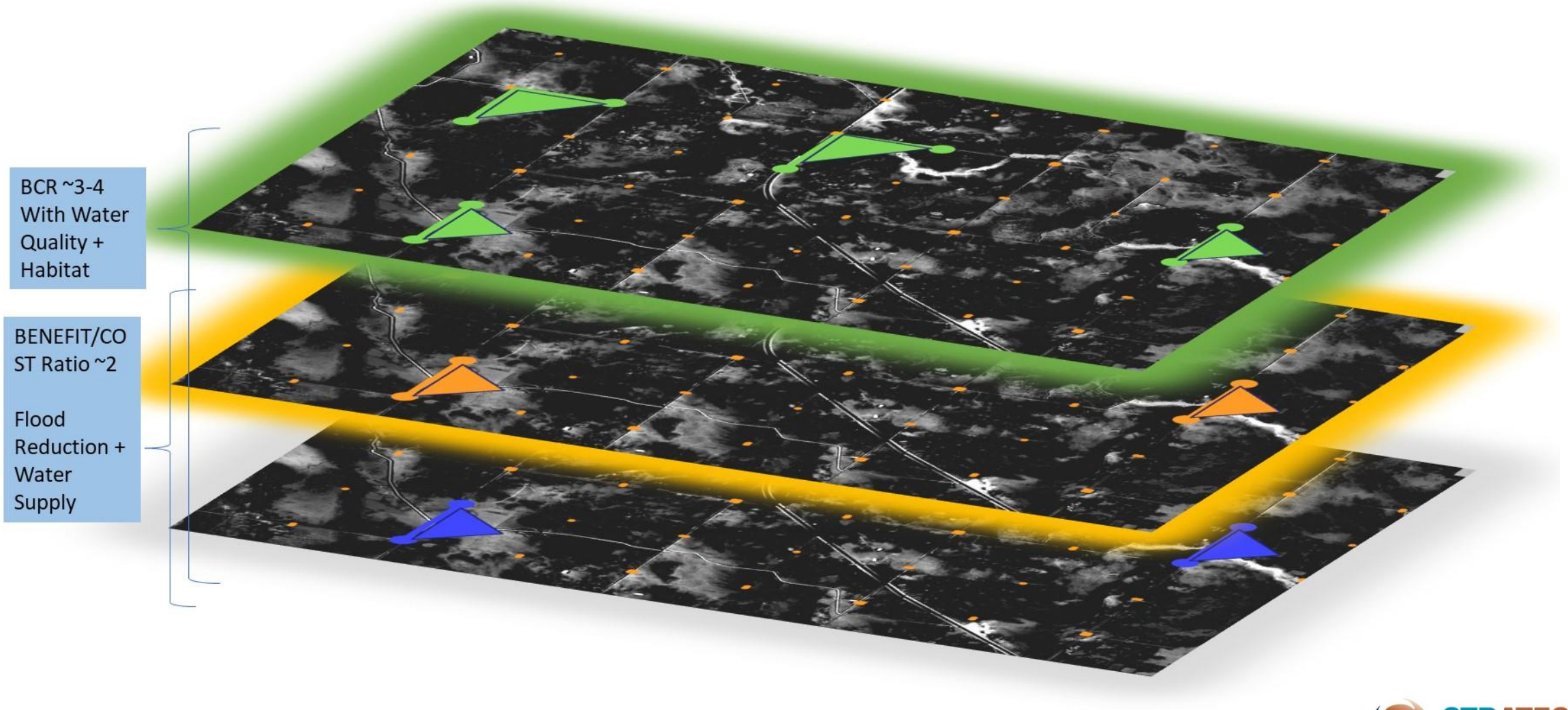
Adaptation via Appropriate Technology

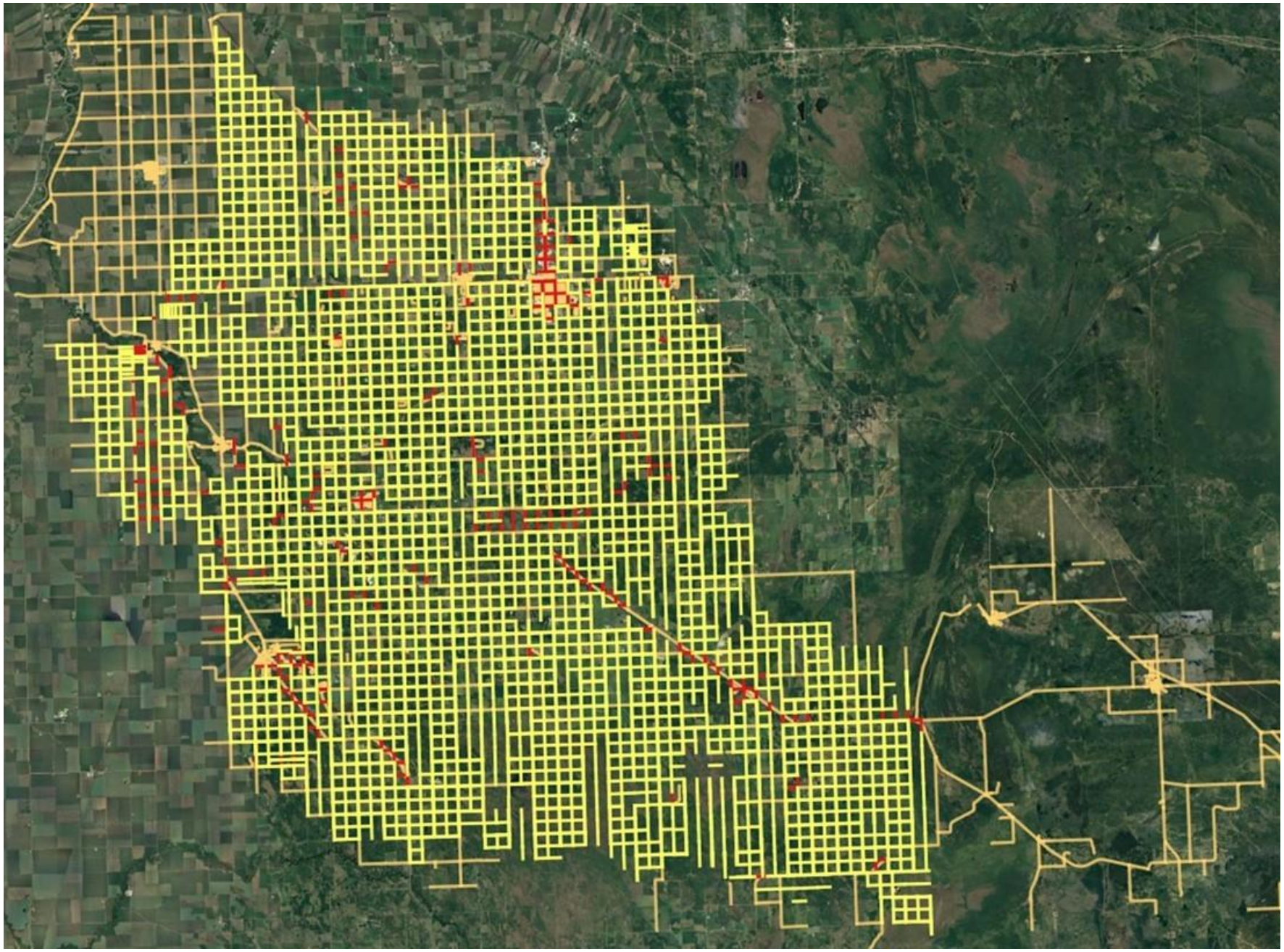
Flood and Drought protection using Retention Earthworks

STRATEGIC SYSTEMS ENGINEERING INC.

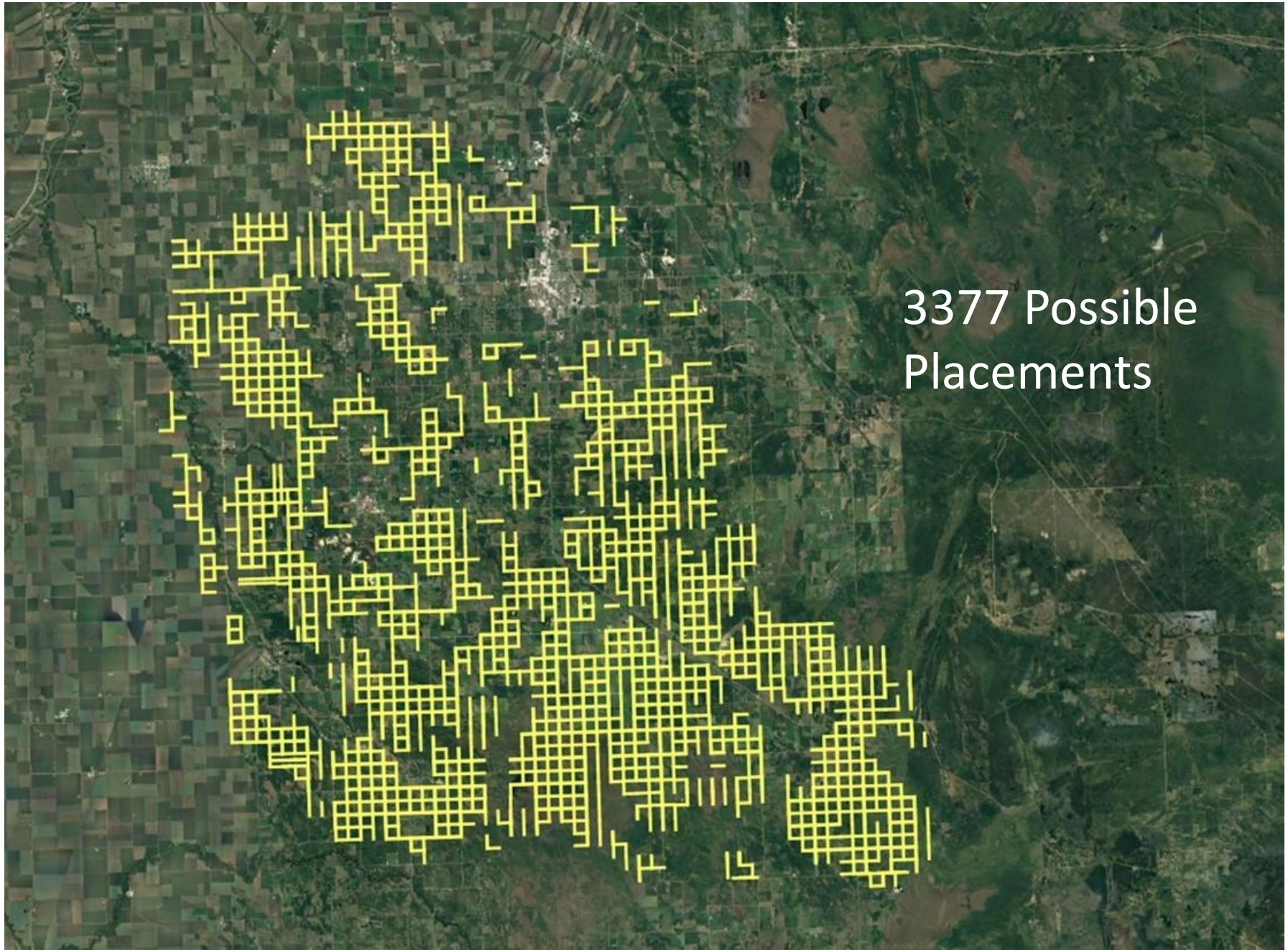

Flooding on Agricultural Land
Flooding on Road Infrastructure
Objectives:
Reduce Flooding Retain Water, add Co-benefits
Urban Property Flooding

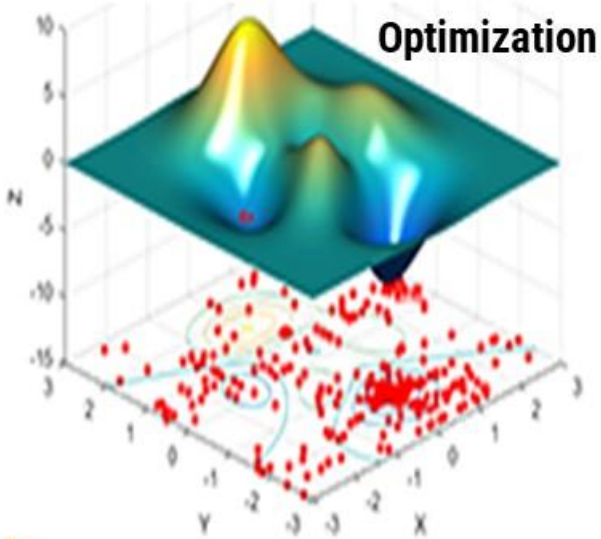
Building the Investment Case





STRATEGIC
SYSTEMS ENGINEERING INC.

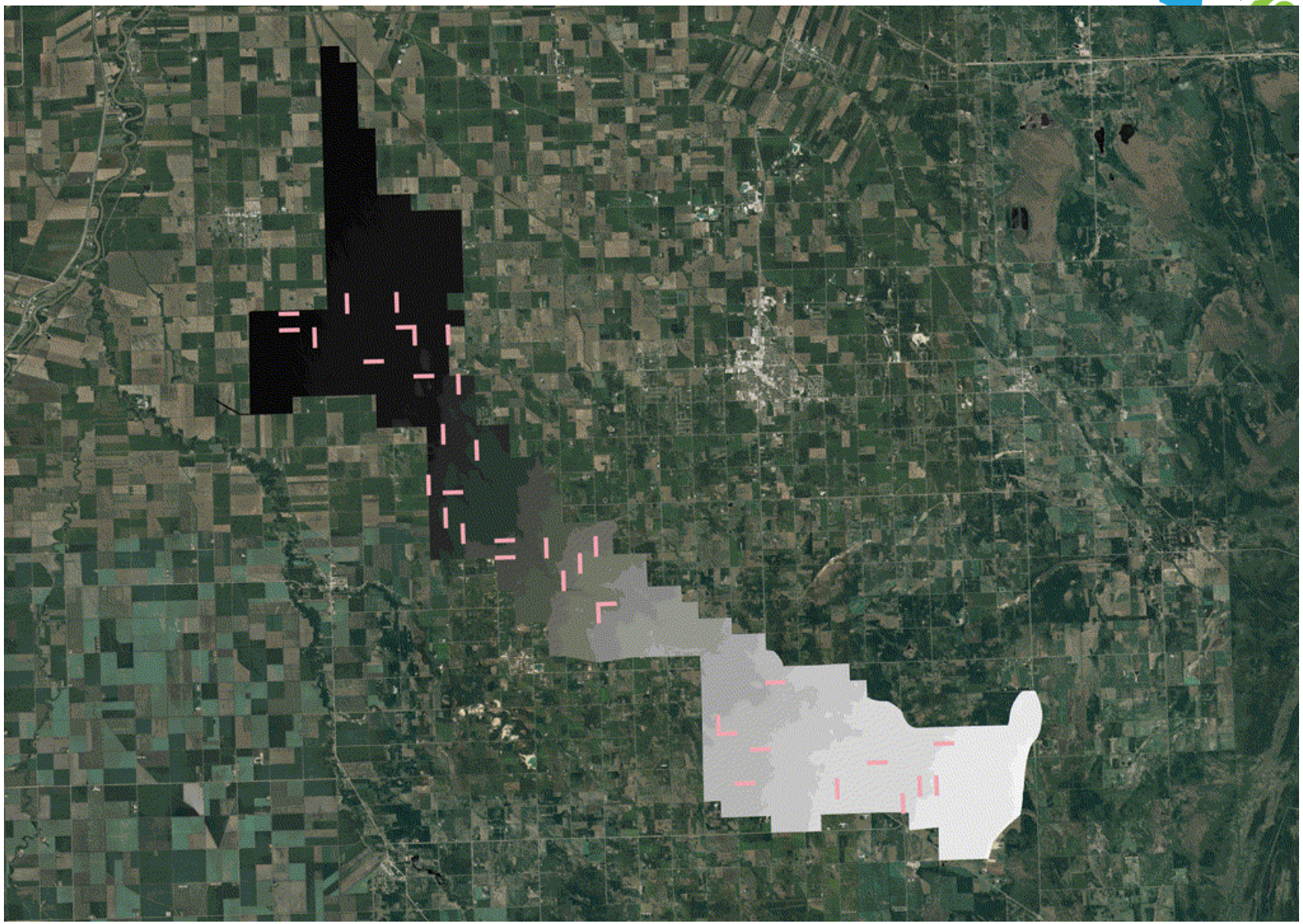

3377 Possible
Placements



DISTRIBUTED
EVOLUTIONARY
ALGORITHMS IN
PYTHON

amazon
web services™

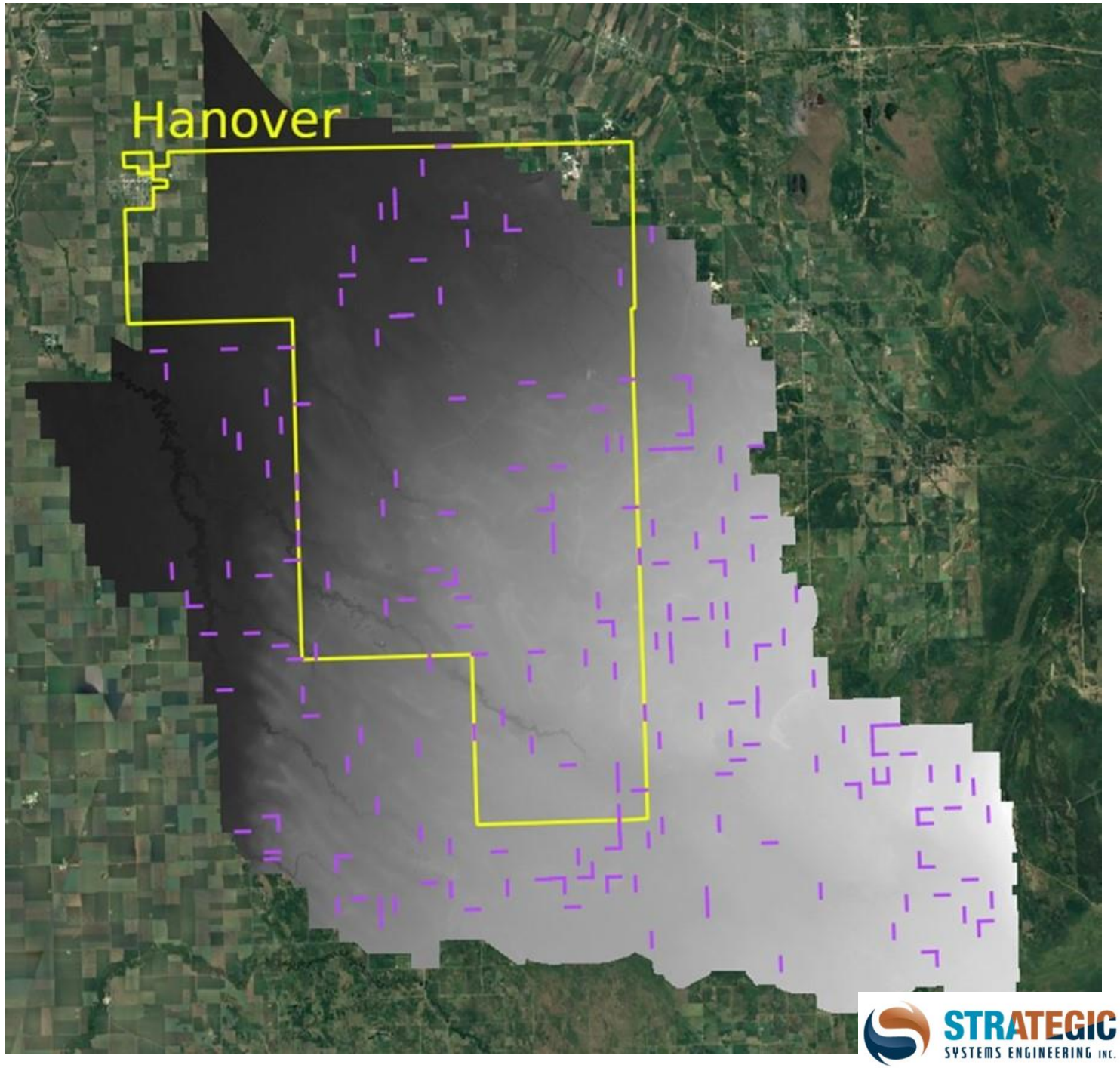
NVIDIA
CUDA



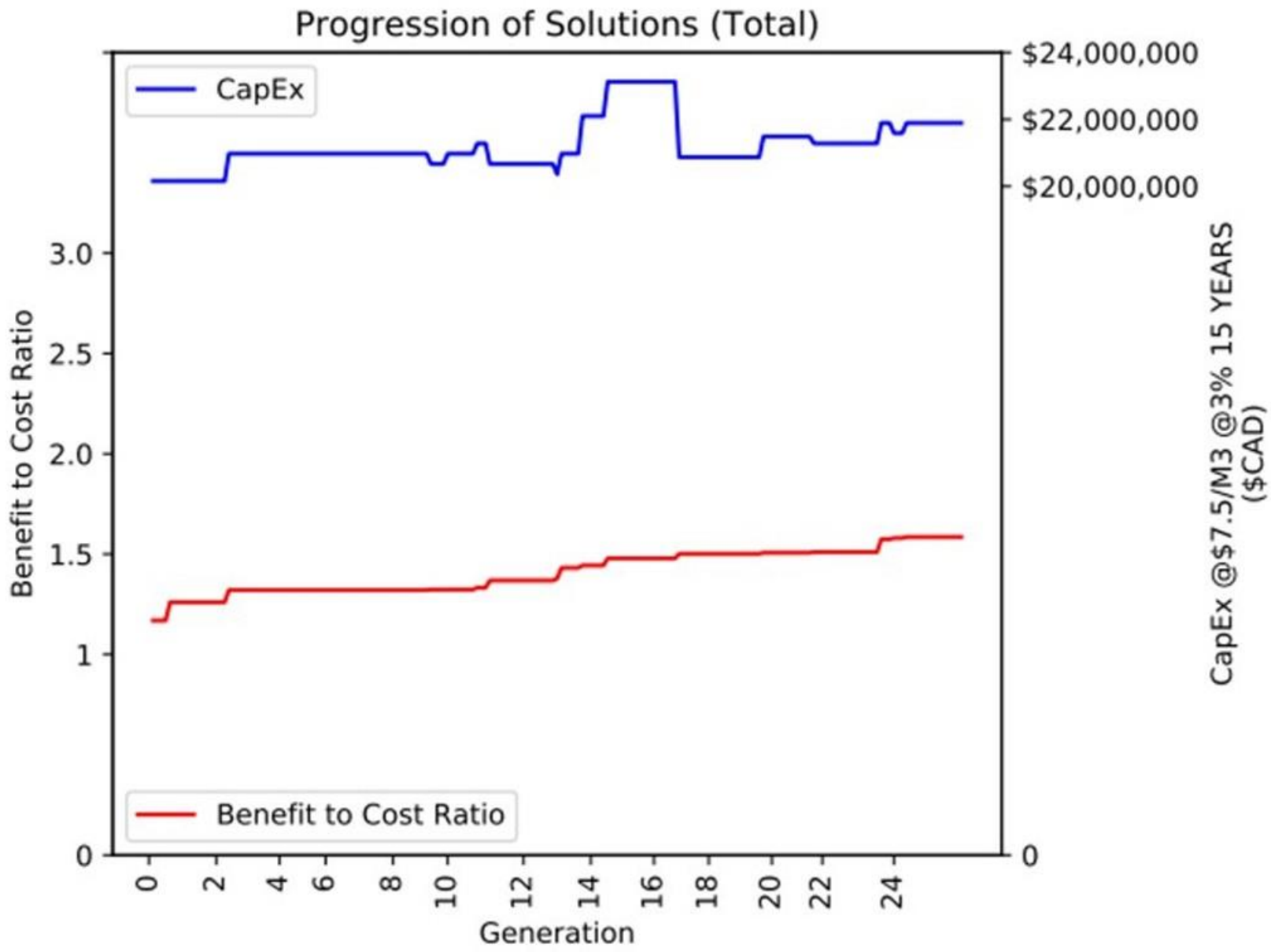
STRATEGIC
SYSTEMS ENGINEERING INC.

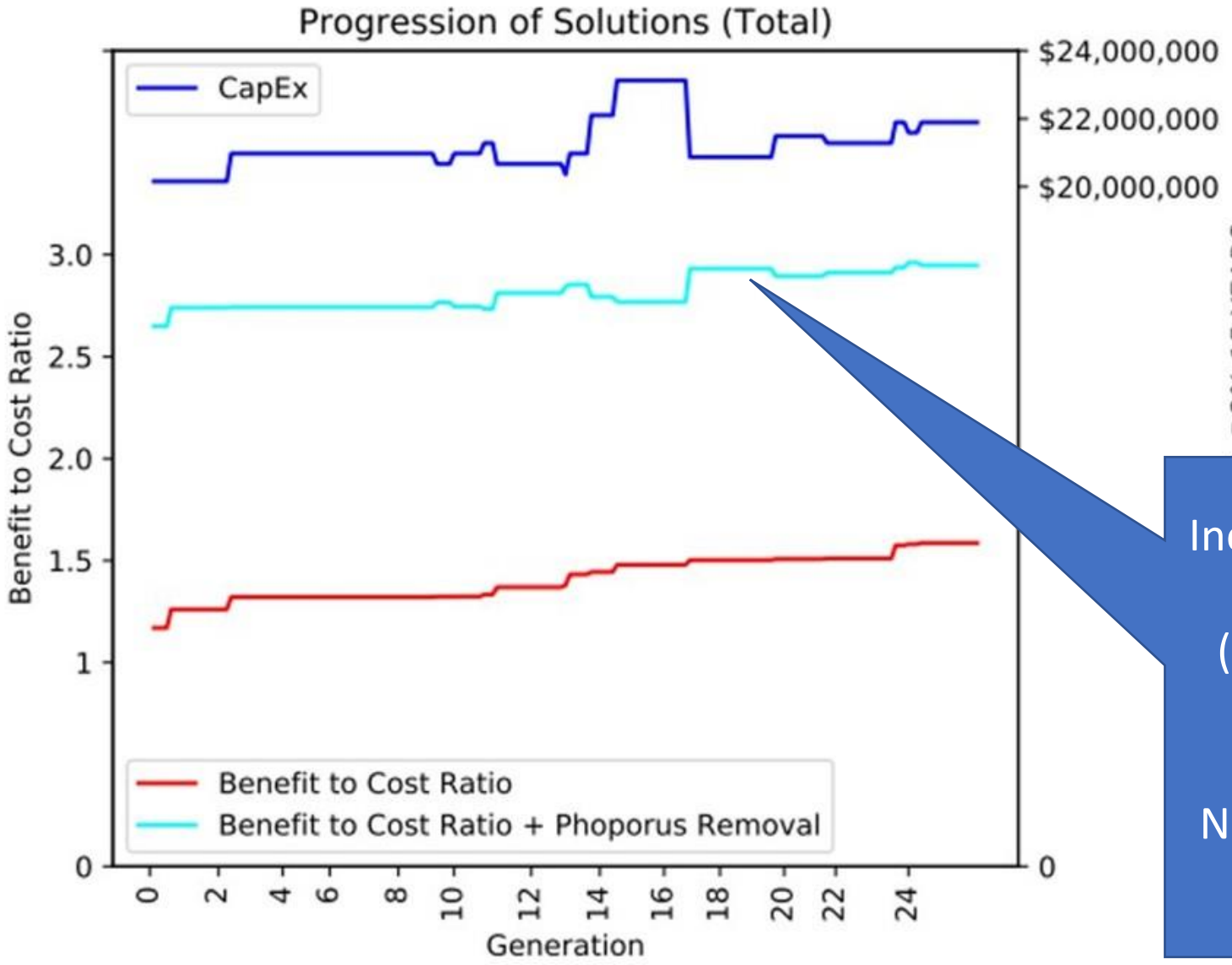
Tourond + Manning BCR:
1.71642

Joubert-Rat BCR:
1.50636



STRATEGIC
SYSTEMS ENGINEERING INC.


Progression of Solutions (Total)
CapEx
Benefit to Cost Ratio
$24,000,000
$22,000,000
$20,000,000
0
3.0
2.5
2.0
1.5
1
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Generation
Benefit to Cost Ratio
CapEx @$7.5/M3 @3% 15 YEARS ($CAD)



Including Water Quality Benefit
(Phosphorus removal as biomass)
@$60/kg
Not including energy + habitat benefit

Collaboration is key to unlocking Adaptation Funding

Q & A

Session 3:
Financing Considerations for Natural Infrastructure

MANITOBA CLIMATE RESILIENCE TRAINING

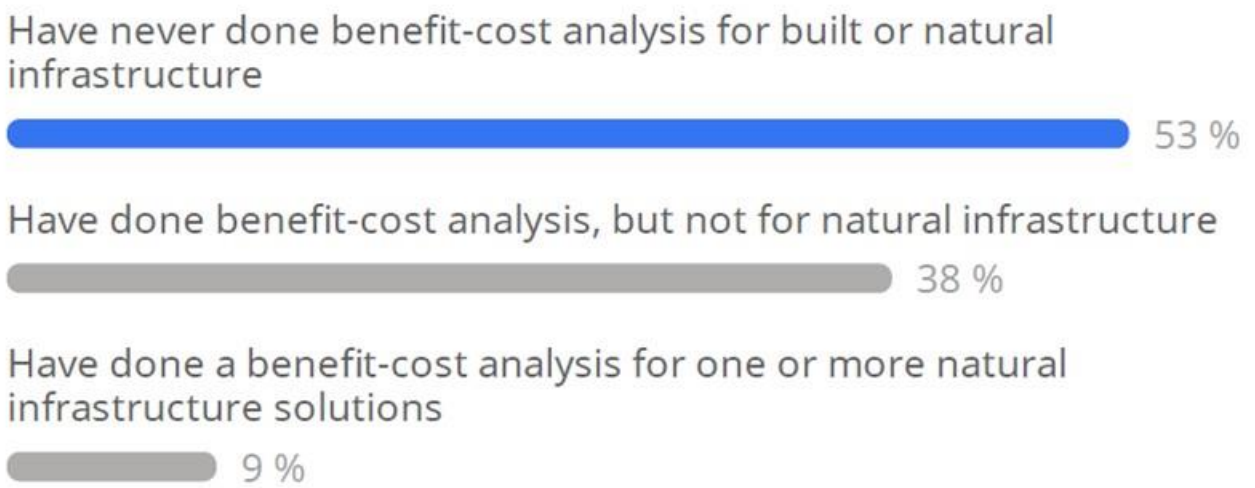
BENEFIT-COST ANALYSIS FOR NATURAL INFRASTRUCTURE

- 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.

Multiple-choice poll

What is your experience level with estimating the benefits and costs of natural infrastructure solutions?

0 4 5



BENEFIT-COST ANALYSIS CONCEPTS:

Methods

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

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

(source: Pascual et al., 2010, Chapter 5)

BENEFIT-COST ANALYSIS CONCEPTS:

Ecosystem goods and services

Main service types
PROVISIONING SERVICES
Food (e.g., fish, game, fruit)
Water (e.g., for drinking, irrigation, cooling)
Raw materials (e.g. fiber, timber, fuel wood, fodder, fertilizer)
Genetic resources (e.g. for crop-improvement and medicinal purposes)
Medicinal resources (e.g. biochemical products, models & test-organisms)
Ornamental resources (e.g. artisan work, decorative plants, pet animals, fashion)

HABITAT SERVICES
Maintenance of life cycles of migratory species (incl. nursery services)
Maintenance of genetic diversity (especially in gene pool protection)

CULTURAL & AMENITY SERVICES
Aesthetic information
Opportunities for recreation & tourism
Inspiration for culture, art and design
Spiritual experience
Information for cognitive development

Standard and peer-reviewed list provides a practical inventory of potential co-benefits delivered by natural infrastructure.

REGULATING SERVICES
Air quality regulations (e.g. capturing (fine) dust, chemicals, etc.)
Climate regulation (incl. C-sequestration, influence of vegetation on rainfall, etc.)
Moderation of extreme events (e.g. storm protection and flood prevention)
Regulation of water flows (e.g. natural drainage, irrigation and drought prevention)
Waste treatment (especially water purification)
Erosion prevention
Maintenance of soil fertility (incl. soil formation)
Pollination
Biological control (e.g. seed dispersal, pest and disease control)

(source: de Groot et al., 2010, Chapter 1)

BENEFIT-COST ANALYSIS:
Urban Green Infrastructure

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

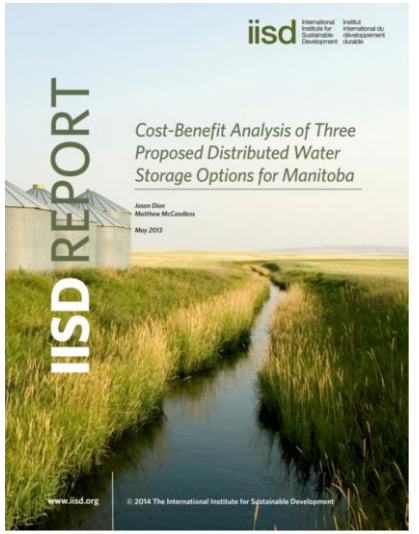
Image source: https://ccme.ca/en/res/niframework_en.pdf

BENEFIT-COST ANALYSIS EXAMPLE:

Distributed water storage options

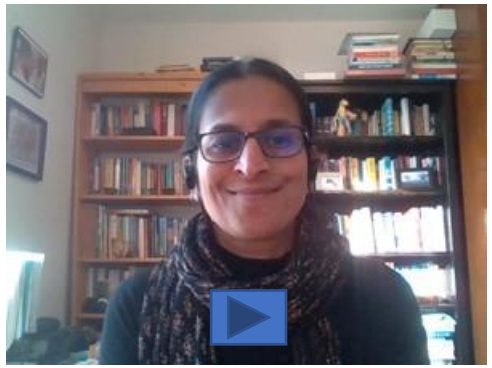
COSTS AND BENEFITS OF OPTION 3: BACK-FLOODED DAMS

VARIABLE	UNITS	MONETARY VALUE	IMPACT (IN UNITS)	MONETIZED IMPACT
Benefits				
Avoided drought	Megalitres of water	$150.00	0.00	$ -
New wetland habitat	Acres of wetland	$82.13	80.00	$6,570
Cattails produced	Tonnes of cattails (total biomass)	$16.59	388.50	$6,445
Carbon credits	Tonnes of carbon	$15.00	407.93	$6,119
Avoided flooding costs	Megalitres of flood mitigation	$1,297.14	12.77	$16,561
Reduced eutrophication	Kilograms of phosphorus	$10.00	854.70	$8,547
Total				**$44,242**
Costs				
Capital costs (annualized)	Capital costs	$7,000.00	20 year amor.	$7,000
Annual operating costs	Operating costs	$140.00	2% of cap. cost	$140
Opportunity costs	Hectares of lost farmland	$60.00	80	$4,800
TOTAL				**$11,940**
ANNUAL NET BENEFIT	Dollars			$32,302
BENEFIT: COST	Ratio			371%

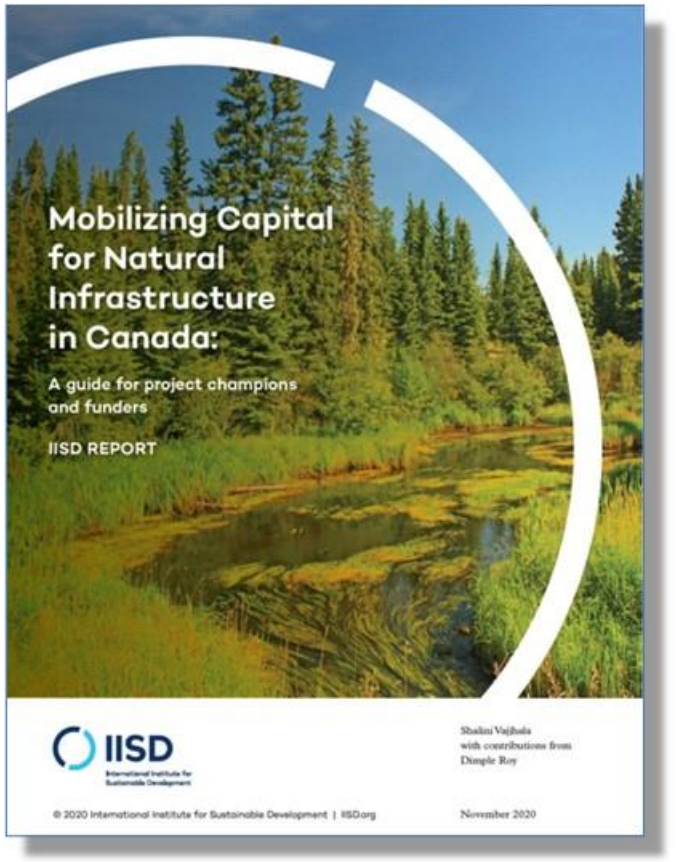


https://www.iisd.org/publications/cost-benefit-analysis-three-proposed-distributed-water-storage-options-manitoba

MOBILIZING CAPITAL FOR NATURAL INFRASTRUCTURE



- Mobilizing capital for natural infrastructure projects requires a strong focus on:
  - Who benefits?
  - How much?
  - And what level of effort are they willing to commit up front to lead?



https://www.iisd.org/publications/mobilizing-capital-natural-infrastructure-canada

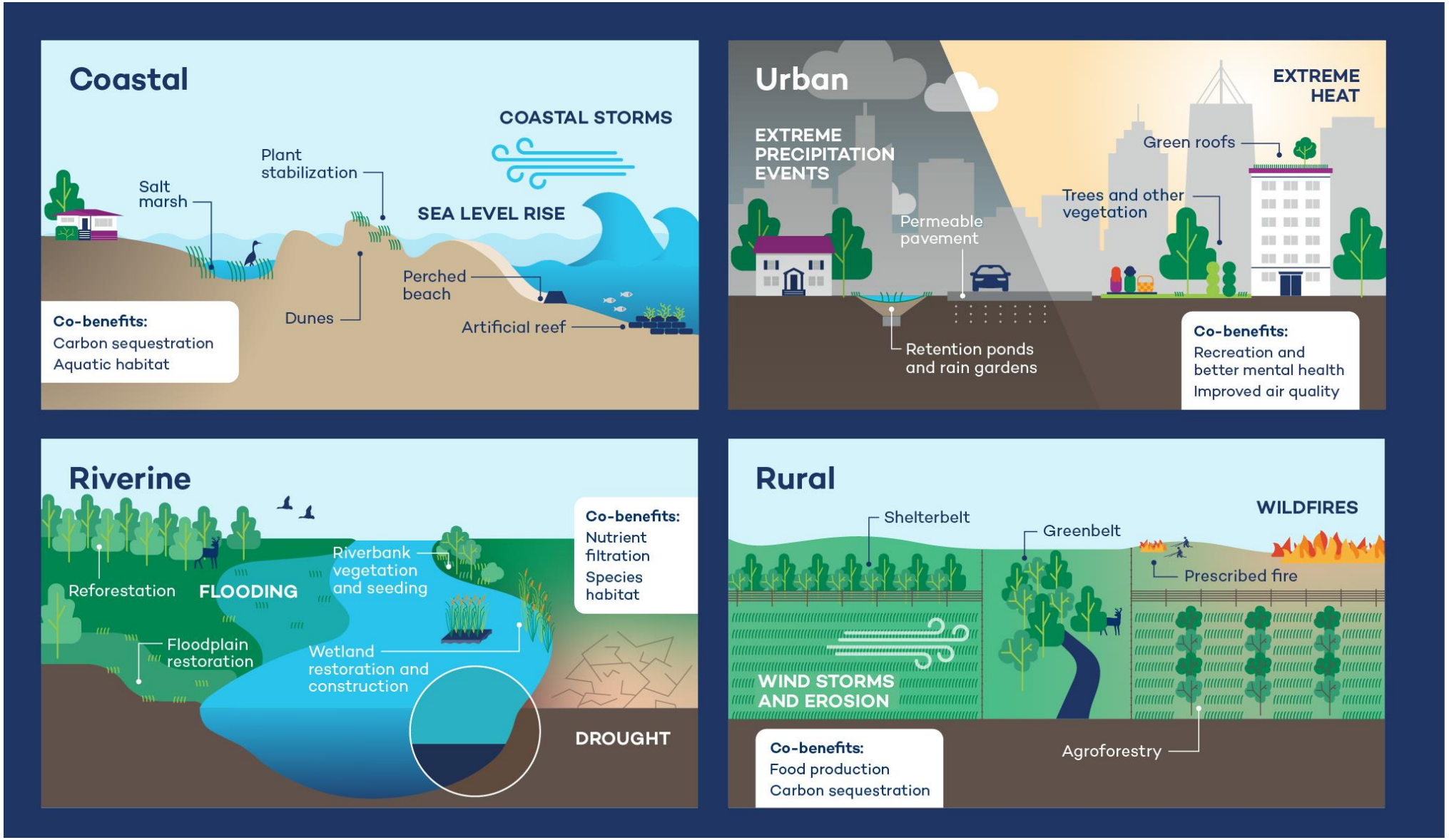
GUIDANCE ON MOBILIZING CAPITAL:

For project champions

Five basic steps:

1. **Start with a driver**: Identify clear, time-sensitive environmental mandates, resource needs, disaster risks and losses, or policy goals.
2. **Identify a lead beneficiary or project implementer**: Focus on quantifiable benefits attached to clear and specific beneficiaries (the fewer, the better).
3. **Develop a pitch**: Do the preliminary analysis to motivate further action.
4. **Establish a partnership**: Set up collaborative agreements, as needed, to pursue the next stage of planning and project predevelopment support.
5. **Secure catalyst/predevelopment funding**: Create a path to implementation.

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
Reforestation
FLOODING
Riverbank vegetation and seeding
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

MANITOBA CLIMATE
RESILIENCE TRAINING

ICLEI Local Governments for Sustainability CANADA

ENGINEERS GEOSCIENTISTS MANITOBA

Natural Resources Canada | Ressources naturelles Canada
Canada

DILLON CONSULTING

Prairie Climate Centre

Manitoba