## CLIMATE CHANGE ADAPTATION PLAN FOR THE CHALEUR REGION



Commission de services régionaux Chaleur Regional Service Commission

Pointe-Verte: November 7, 2018 Bathurst: November 8, 2018

### Plan for the evening

- Introduction (5 min.)
  - Presentation of participants
  - Project setting
  - Objectives and Methods for this evening
- Regional context (15 min.)
  - Aspects of vulnerability social, economy, environment
  - Regional climate trends
  - Hazards by sub-regional units
- Multi-risk assessment to establish the local priorities (30 min.)
  - Evening 1 : Western zone (6 zones)
- ► TOWARDS ADAPTATION (45 min.):
  - Best practices for key hazards
    - Structural
    - Non-structural
  - Discussion the adaptation measures for each zone?

### Presentation of the participants

- Marc Bouffard & Mariette Boudreau, CSR Chaleur
- Ursule Boyer-Villemaire, WSP Canada
- Denis Leblanc, WSP Canada
- Ena Ristic, WSP Canada
- **Robert Capozi, G. NB.**

### Project context

## Commission de services régionaux **Chaleur**

Regional Service Commission

## Fighting against climate change takes place at different level

- New Brunswick Climate Change Action Plan
  - 7 components and 118 statements
- <u>Mitigation Plans /Green Plans</u>
  - ✓ GHG reduction plans, Electrification of transportation and Energy efficiency(biomass)
  - Many municipalities of the region participate in projects led by the AFMNB
  - ✓ It is also the responsibility of everyone to do his share at the individual and household levels
- <u>Climate Change Adaptation Plans</u>
  - ✓ City of Bathurst (completed)
  - $\checkmark~$  Regional adaptation plan of the Chaleur Region
  - $\checkmark~$  Many plans are currently underway across the province
- Emergency Measures Plans at the local and regional levels
  - Joint project of the Chaleur RSC, municipalities and Department of Justice and Public Safety



### Foundation of our approach

- ▶ Historically in NB, CCAP have been made at the local municipal level
- Chaleur RSC propose a regional approach
- This adaptation plan will provide municipalities and LSD
  - Basic information,
  - Consistent methodology, and
  - Coherent tools
  - to help them plan at the local level
- This plan may be used as a model for the other RSC of the province
- Municipalities situated in the areas most at risk must have an adaptation plan in place before 2020

### Process followed by the Chaleur RSC



- These tasks are done in consultation with the community, hence this citizen consultation process.
- Coastal Erosion Analysis GéoLittoral (on hold)
  - Measure coastal erosion rate between Petit-Rocher South and Pointe-Verte (inclusively)
  - Determine the coastline from old and recent air photos
  - Calculate the mean erosion rate
  - Project the coastline in the future

- Vulnerability Atlas CRSC (under development)
  - Dissemination Areas (about 500 people)
- <u>2019/2020</u>
- Phase 3
- Coastal Erosion Analysis
- 2020 et ....
  - Continuous process: monitoring, assessments and review





### Main Actors and their Tools



### Chaleur Regional Advisory Committee on Climate Change Adaptation (CCRACCA)

- 6 Municipalities (including City of Bathurst)
  - 1 representative per municipality: elected or appointed official, citizen
- LSD: 2 representatives
  - One citizen from Petit-Rocher South
  - There is one position to be filled (ideally a person living in the area eastward of Bathurst)
- One representative of the Climate Change Secretariat
- 2 persons at large
  - Professional engineer
  - Employee of a municipal organization
- The committee is chaired by a member of the board of directors of the Chaleur RSC

- Support Committee
  - Department of Environment and Local Government
  - Department of Energy and Resource Development
    - Geomorphologist
  - Chaleur Bay Watersheds Group
  - Municipal Administrators
  - Manager local service for the LSD (DELG)

### Some Highlights

- Recurrence concept is misunderstood
  - A recurrence period of 100 years means a 1% chance that a major event could occur every year (flooding, storm). Recurrence of 1:20 years = 5% probability.
  - 1% chance to win the lottery is huge. The same rational should also apply to incurred losses arising from climate change (social and financial costs)
  - It is a misconception to believe that risks are diminished because an event occurred recently
- Dependence on infrastructure systems increasingly saturated
  - Infrastructure capacity cannot be expanded indefinitely
- We neglect to take into consideration the positive contribution of <u>natural infrastructure</u> on the fight against climate change.
  - Healthy natural areas (wetlands, lagoons, watercourses) provide many (free) services to communities. When natural areas are degraded, it is expensive to reproduce those lost services.
  - Natural areas provide countless benefits: decreased flood risk, clean and inexpensive drinking water, recreation/tourism opportunities.
  - > Natural areas help to manage the effects of climate changes: extreme storms, erosion, flooding

### Some Highlights

- Risks factors are up
  - Extreme events are becoming more extreme in frequencies and intensities.
- Risk areas are not taken seriously
  - We continue to subdivide and to develop in flood or erosion prone areas.
- Every dollar invested in mitigation has a positive return
  - Every dollar invested by the US federal government in pre-disaster mitigation saves society \$6 in post-disaster recovery costs (US National Institute of Building Sciences)
  - In every dollar spent on improving building codes to better withstand natural disasters, society saved \$4.

# Thank you for your participation and have a good meeting



### Objectives & Methods for this evening

### **Objectives**

- ► GENERAL OBJECTIVE :
  - With the population, design a plan that meets the most urgent needs and proposes de measures that will best protect the population, the economy and the environment best in the long term against the impacts of climate change

#### Validation of risk profiles

- Interactive mapping workshop
- Prioritization of adaptation sectors
- Evaluation of preferences about adaptation measures
- Next step : Design plan (March 31, 2019)



### Western Chaleur Map



- Belledune
- Pointe-Verte
- Petit-Rocher
  - Petit-Rocher Nord
  - Petit-Rocher Sud
- Nigadoo
- Beresford
- Paroisse Beresford
  - LaPlante
  - Dunlop
  - Madran
  - Robertville
  - Tremblay

### Western Chaleur Regional Context











### West Chaleur Labour Force

#### Management

- Business, finance, and administration
- Natural and applied sciences
- Health
- Education, law and social, community and government services
   Art, culture, recreation and sport
- Sales and service
- Trades, transport and equipment operators and related
- Natural resources, agriculture and related



## Climate Change Impacts



### **Climate Data**

- Derived from Phase 1
- RCP8.5
  - The greenhouse gas trajectory used for climate modeling to represent the 'worst case' emissions scenario
- Data compares historical conditions to projections for the year 2080
- Data is categorized into:
  - Winter Mean Temperature
  - Annual Number of Days with Maximum Temperature <-10  $^{\circ}$  C
  - Winter Freeze-Thaw Days
  - Annual Number of Days with Maximum Temperature > 30  $\,^\circ$  C
  - Growing Season Length
  - Annual Total Precipitation

### Winter Mean Temperature Baseline 1980-2010

**RCP8.5 2080** 





Winter Mean Temperature (°C)



### Annual Number of Days with Maximum Temperature under -10°C Baseline 1980-2010 RCP8.5 2080



Annual Number of Days with Maximum Temperature < -10 °C (days)



#### Winter Freeze-Thaw Days **Baseline 1980-2010**

**RCP8.5 2080** 



# Annual Number of Days with Maximum Temperature > 30 ° CBaseline 1980-2010RCP8.5 2080



Annual Number of Days with Maximum Temperature > 30 °C (days)



### **Growing Seasons Length** Baseline 1980-2010





**RCP8.5 2080** 

Growing Season Length (days)



### **Annual Total Precipitation** Baseline 1980-2010





**RCP8.5 2080** 

**Annual Total Precipitation (mm)** 



### Summary of Climate Trends

Climate Variable	Historical Average	Projected Average (2080, RCP8.5)	Change
Winter mean temperature	-8.7–4.9°C	-4.9°C1°C	爺 7.7°C
Annual days with temperatures <-10°C	14.3-21.5 days	0-7.2 days	₽14.3 days
Winter freeze-thaw days	20-35 days	35-49 days	<b>① 15 days</b>
Annual days with temperature >30°C	0-29.5 days	29.5-58.9 days	<b>1 29.5 days</b>
Growing season length (days)	148-186 days	223-261 days	<b>①75 days</b>
Annual total precipitation	926-1112mm	1112-1298mm	企 <b>186mm</b> +15%

### Hazards & Risks

https://atlantic.ctvnews.ca/hurricane-michael-on-northern-course-toward-nova-scotia-1.4128226



### Major Impacts of Climate Change

Temperature increases and changes to precipitation regimes	Sea level rise and ice cover reduction	Extreme events : oceanography & hydrometerological
<ul> <li>Droughts</li> <li>Heat waves</li> <li>Increased frequency of heavy rain events</li> <li>Forest fires</li> <li>Species migration</li> <li>Drinking water shortages</li> <li>Deterioration of road infrastructure</li> </ul>	<ul> <li>Increased coastal flooding</li> <li>Increased coastal erosion</li> <li>Salt water intrusion</li> </ul>	<ul> <li>Strong winds</li> <li>Flooding</li> <li>Fires</li> <li>Freezing rain and hail</li> <li>Snowfall events</li> <li>Heat waves</li> <li>Ice jams</li> </ul>

### **Components vulnerable to Climate Change**

People	Economy	Environment
Health and safety • Injury • Illness • Loss of life	<ul> <li>Infrastructure Damage</li> <li>Roads</li> <li>Storm water systems</li> <li>Drinking water systems</li> <li>Sanitation systems</li> <li>Energy systems</li> <li>Communication systems</li> </ul>	Ecosystems • Forests • Coastal • Saltmarshes • Dunes • Freshwater
Displacement • Temporary • Permanent	<ul><li>Damage to industries</li><li>Primary resource impacts</li><li>Damage to industry infrastructure</li></ul>	Economical important environment <ul> <li>Forests</li> <li>Mines</li> <li>Beaches</li> </ul>
Impacts to Social Health <ul> <li>Loss of community spaces</li> </ul>	Property damage • Residential • Public	<ul><li>Protected areas</li><li>National parks</li><li>Provincial parks</li></ul>
Loss of Livelihood		

### Risk rating assessment

ces	High	Major damaged including extensive <u>infrastructure</u> damage requiring major repair, major loss of infrastructure services, major or multiple injuries, <u>permanent injuries, disability, or death</u> , changes in <u>governance</u> required, major <u>economic</u> losses, <u>national</u> long-term social impacts, and significant negative impacts and losses to the local <u>ecosystem</u> requiring remedial action.	Moderate	High	High
Consequen	Moderate	Limited infrastructure damage and/or loss of service requiring <u>minor repair</u> , serious medical injury, moderate local economic impacts with some effect on the wider <u>economy</u> , local, long term impact on <u>public opinion</u> , and some <u>environmental damage</u> which may require remedial action.	Low	Moderate	High
	Low	<u>Minor, localized, and temporary</u> disruption or damage which can be absorbed through continuity actions and has minimal impact on public health, the environment, the local economy, infrastructure, and public opinion.	Low	Low	Moderate
			Low	Moderate	High
		Likely to occur between 30-50 years, or become critical/beneficial in 30-50 years	Likely to occur once between 10-30 years, or become critical/beneficial in 10-30 years	Likely to occur once a decade, or become critical/beneficial in a decade	
Probabilities					

### Overview of Region-Wide Climate Impacts

- Heavy rainfall
- Heat waves and Droughts
- Freeze-thaw events
- Species migration
- Storm events

### Heavy Rainfall

- Overland and river flooding
  - Increased soil erosion and mass wasting
  - Flooding of homes and buildings
  - Flooding of public and private infrastructure
    - Roads
    - ► Train tracks
    - Parks
    - Community spaces
  - Pollutes local freshwater sources
  - Health and Safety risk
    - Reduced access for first responders
    - Reduced access to supplies
    - Increased risk of drownings, hypothermia, bacterial infection, waterborne diseases





Annual precipitation predicted to increase + 186 mm under RCP8.5 by 2080

https://www1.gnb.ca/cnb/multimedia/searche.asp?fmonth=8&fday=14&fyear=2005&tmonth=9&tday=14&tyear=2008&keyword=&department=

### Heat Waves and Droughts

- Dehydration, fainting, dizziness, heat exhaustion, heat stroke, death
- Vulnerable groups: young & elders, isolated
- Power outages
  - Greater electricity use
  - Heat stress on energy infrastructure
- Temporary relocation
- Increased fire risk
- Decreased air quality
- 29.5 days with greater than 30°C per year



Annual number of days with temperatures over 30°C projected to increase by + 29.5 days under RCP8.5 by 2080

https://wwjnewsradio.radio.com/articles/forecast-calls-heat-wave-detroit-saturday

# Freeze-thaw events

- Damage to road infrastructure and create potholes
- Create dangerous driving conditions when water melts over road surfaces and freezes
- Costly repairs to roads and vehicles
- Acceleration of coastal erosion (cliffs)
- Ice jams





Annual increase in number of days with freeze-thaw conditions projected: + 15 days under RCP8.5 by 2080

https://www.telegraphjournal.com/telegraph-journal/story/41782505/saint-johns-asphalt-assault?source=story-related
## **Species migration**

- Species may act as disease vectors
  - ▶ i.e. Lyme disease
- Threat to native species and ecosystems
- May negatively impact local industries
- Example Emerald Ash Borer (pictured)
  - Found in Edmundston, NB, in 2018
  - Migrated northward
  - Disastrous impacts on Ash tree species and habitats





Winter Mean Temperatures projected to increase by +7.7°C under RCP8.5 by 2080

https://www.cbc.ca/news/canada/new-brunswick/emerald-ash-borer-edmundston-nb-1.4668654

#### Extreme hydrometeorological events

- Winds gusts
- Hail and ice storms
- Heavy Rainfall
- Heavy Snowfall
- Floods
- **Fires**
- Effects:
  - Damage to infrastructure
  - Power outages
  - Flooding
  - Health and Safety impacts
  - Reduce mobility for emergency vehicles or isolation of areas
  - Reduce access to aid and supplies

Rain, wind warnings expanded as second storm slams New Brunswick

f)(**y**)(**o**)(in

(Cases)

Most of the province is under either a rain or wind warning, or both Jordan Gill · O

Some N.B. residents could be without power for three days

Windstorm knocked out power to more than 100,000 homes across Atlantic Canada

New Brunswick hardest hit with 92,000 households without electricity

Mairin Prentiss · CBC News · Posted: Nov 04, 2018 7:00 AM AT | Last Updated: 9 hours ago

https://www.cbc.ca/news/canada/new-brunswick/rain-wind-warnings-expanded-1.4890646

## Impacts in coastal Area

**Region-Specific Impacts** 

## **Overview of Coastal Region-Specific Impacts**

- Sea level rise
  - 4.2 m in 2100 for a 100 yr return period storm (Daigle, 2017)
  - Coastal Flooding
    - Increased risk of injury, illness, and loss of life
    - Increase anxiety and depression
    - Decreased access to jobs, medical care, food, other resources
    - Risk to coastal property
  - Coastal Erosion
    - Increased risk of direct injury
    - Risk to coastal property
  - Salt water intrusion
    - Negative impacts on drinking water resources
    - Harm to local freshwater ecosystems



#### **Belledune Population Profile**

BELL	LEDUNE LABOUR FORCE	
Management occupations		
Business, finance and administration occupations	13%	6% 11%
Natural and Applied Sciences and related occupations	5%	
Health occupations		4%
<ul> <li>Education, law, social, community, and governemnt services</li> <li>Occupations in art, culture, recreation, and sport</li> <li>Sales and service</li> </ul>	20%	8%
<ul> <li>Trades, transport and equipment operators</li> </ul>		14%
Natural resources, agriculture, related	17%	2%
■ Manufacturing and utilities		

Total population (2016)	1,417
Population 0-14yrs	9.5%
Population 65+	31.4%
English as first language	1,230
French as first language	185
English as only language	1,080
French as only language	20



## **Belledune Impact Summary**



of roadway



heavy industrial sites



- Coastal flooding
  - Industrial
    - Port of Belledune and terminals
    - NB Power generating station secondary structures
    - Smelter outbuildings
  - Residential, recreational, agricultural, retail area
- Moderate coastal erosion
  - 0.3m/year
  - Coastal streets such as Gagnon and Fenderson have begun to see coastal erosion as well as two coastal cemeteries
- Big Hole Brooke River has twice flooded and caused infrastructure damage
- Suggested that storm water management systems are inadequate for projected trends

### **Pointe-Verte Population Profile**

#### POINTE

#### Management occupations

- Business, finance and administration occupations Natural and Applied Sciences and related occupations
  - Health occupations
  - Occupations in education, law, and social, community, and government services Occupations in art, culture, recreation, and sport
  - Sales and service
  - Trades, transport and equipment operators
  - Natural resources, agriculture, related
  - Manufacturing and utilities

-VERTE LABOUR FOI	RCE
8% 7%	6% 14%
19%	3% 15%
18%	0%10%

Total population (2016)	886
Population 0-14yrs	<b>9</b> %
Population 65+	27.1%
English as first language	90
French as first language	795
English as only language	40
French as only language	345



Buildings within 4.2 m flood zone	Structure count
Pumping station	2
Camp/Cottage/Recreational vehicle	25
Residential 1-2 units	64
Seaport/Wharf/Marina	2
Accessory	75

#### **Pointe-Verte Impacts**







- Coastal flooding
  - Coastal infrastructure such as wharf at risk
  - des Chalets Street and du Parc Est Street have required B.N.P.P intervention at least twice due to flooding
  - 19% of buildings (107 buildings)
  - 982 m (1%) of roads 917m of Sanitary systems in flooded area
  - 410m of storm water systems
- Low historical coastal erosion rates (less than 0.3m/year)
  - A cemetery in Pointe-Verte has been losing ground to erosion
- Well systems are at risk of coastal flooding
- Suggested that storm water management systems are inadequate for projected trends

#### **Petit-Rocher Population Profile**

Petit-Rocher, Petit-Rocher Nord, Petit-Rocher Sud

#### PETIT-ROCHER LABOUR FORCE

#### Management occupations



Buildings within 4.2 m flood zone	Structure count	
ssory	95	
p/Cottage/ eational vehicle	43	
npground	6	
tel/Motel/Inn	11	
ini and Mobile Home ot in park)	3	1
ıblic ark/playground	4	1
mping station	2	
sidential 1-2 units	80	
sidential 3-5 units	2	
aport/Wharf/Marina	2	
eatment plant wage), Lagoon	2	( j
lucation	1	

### **Petit-Rocher Impacts**







342m f storm water systems



- Coastal flooding
  - 12.7% of buildings
  - 1411m of sanitary infrastructure
  - 842m of storm water infrastructure
  - 3,073m of roadway
- Coastal erosion
  - Moderate at 0.3 m/year
  - Streets between Arseneau and Maurice street have been noted to have erosion
  - The coast between Beach Park and the wharf
- Has been known to be problematic in terms of clogged ditched and drains
- Surface water flooding
  - Camp Ectus Road is flooded occasioning during storm events
  - Arsenault and Maurice Streets have been flooded
    - Maurice Street had to be rebuilt

## Nigadoo Population Profile

Total population (2016)	963
Population 0-14yrs	10.9%
Population 65+	<b>22.9</b> %
English as first language	85
French as first language	875
English as only language	40
French as only language	260

Management occupations

#### Business, finance and administration occupations

 Natural and Applied Sciences and related occupations
 Health occupations

 Education, law, social, community, and governemnt services
 Occupations in art, culture, recreation, and sport

■ Sales and service

- Trades, transport and equipment operators
- Natural resources, agriculture, related
- Manufacturing and utilities







## Nigadoo Impacts



- Coastal flooding
  - 2 buildings
  - 25m of sanitary infrastructure
  - 33m of roadway
- Coastal erosion
  - Chaleur street has experienced erosion
  - Nb. Buildings in 0-25 m
- Nigadoo river has previously observed low water levels
  - Water boil advisory due to high turbidity following heavy rains combined with snow melt

## Beresford Population Profile

#### BERESFORD LABOUR FORCE

#### Management occupations

- Business, finance and administration occupations
- Natural and Applied Sciences and related occupations
- Health occupations
- Education, law, social, community, and governemnt services
- Occupations in art, culture, recreation, and sport
- Sales and service
- Trades, transport and equipment operators
- Natural resources, agriculture, related
- Manufacturing and utilities



Total population (2016)	4,288
Population 0-14yrs	12.3%
Population 65+	22.8%
English as first language	730
French as first language	3.515
English as only language	325
French as only language	780

Buildings within 4.2 m flood zone	Structure count	
Accessory	908	
Camp/Cottage/Recreati onal Vehicle	153	SE REAL
Education	1	
Indoor Recreation	2	
Small Retail/Service/Office (<200M²)	2	
Large Retail/Service/Office (>200M²)	5	
Mini and Mobile Home (not in park)	4	
Public Park/Playground	16	
Pumping station	4	
Residential 1-2 units	252	
Residential 3-5 units	3	

## **Beresford Impacts**



- A portion of Beresford may be affected by tide water from Baie des Chaleurs
- John Cormier and Jacques Cartier streets have previously flooded, blocking access
- Beach Park, Chalets, and Baie Streets experienced previous flooding
- Intersections of Thomas and Bel Air Street at risk
- Department of Fisheries and Oceans Canada at risk
- 4795m of sanitary infrastructure
- 1386m of storm water infrastructure
- 9747m of roadway infrastructure
- Coastal erosion
  - Beresford beach is built up every year to ensure erosion and protect from coastal flooding
  - Several coastal alleys have reported erosion
- It has been suggested that changes need to be made to Beresford to improve storm water infrastructure
  - Seawater has infiltrated storm water drainage system and caused a back up into a house





Pumping stations

# **Inland Area**

Region-Specific Impacts

### **Beresford Parish Population Profil**

#### BERESFORD PARISH LABOUR FORCE

#### Management occupations

Total population (2016)	6,248
Population 0-14yrs	12.7%
Population 65+	18.9%
Aboriginal identity population	215
English as first language	530
French as first language	5,585
English as only language	215
French as only language	1,810

/
administration
occupations
Natural and Applied
Sciences and related
occupations
Health occupations
■ Education, law, social,
community, and
governemnt services

Business, finance and

governemnt services
Occupations in art, culture, recreation, and sport
Sales and service

- Trades, transport and equipment operators
- Natural resources, agriculture, related
- Manufacturing and utilities



## **Beresford Overview**

- Forest fires
  - Events 1980-2017 in NB
    - Over 80 % are small fires <10 ha
  - Property damage and destruction
  - Risk of illness, injury, or loss of life
  - Destruction of wildlife and ecosystems
  - Impacts on air quality
  - Economic loss of resources
  - Direct and indirect damage to industry



http://cwfis.cfs.nrcan.gc.ca/ha/nfdb?type=poly&year=9999

# Towards Adaptation



#### Towards adaptation

Workshop: Interactive mapping (15 min.)

1) Is this profile a good representation of your territory's most preoccupying risks? Are we missing anything?

#### 2) How do you rank these hazards in your area?

#### Coastal areas

- Heavy rainfall and inland flooding
- Heat waves and Droughts
- Freeze-thaw events
- Species migration
- Storm events
- Coastal flooding
- Coastal erosion

Inland areas

- Heavy rainfall and inland flooding
- Heat waves and Droughts
- Freeze-thaw events
- Species migration
- Storm events
- Forest fires

	Onshore, hard & linear	(Partly) Submerged	Coastal ecosystem oriented	Other sediment management interventions	Asset-oriented	Precipitation- oriented			
	Maintenance, Repair or Repla cement of Existing Structure	Shore Perpendicular Breakwater	Perched Beach (Sill)	Buried Revetment	Floodwalls/Dry Flood Proofing	Stormwater Management - Reduce Runoff			
	Scour Protection	Nearshore Breakwaters	Beach Nourishment	Passive Bluff Drain	Raised Infrastructure	Stormwater Management - Increase Conveyance (Drainage Ditch)			
	Engineered Revetment	Near Shore Artificial Reefs	Plant or Bio-Engineered Stabilization	Dredging	Wet Flood Proofing Buildings	Stormwater Management - Increase Storage (Detainment Pond)			
	Seawall, Retaining Wall & Rip-rap Armouring	Groynes	Living Shorelines (Coastal Wetlands and Salt Marsh Restoration)		Floating Building/Amphibio us Foundation	Stormwater Management - Rain Garden/Construct ed Wetland			
	Dykes & Tide Barriers/Aboiteaux		Dune Building		Relocate or Abandon Infrastructure (Retreat Strategy)				
Ada	dapted from Leys and Bryce, 2016. ACASA. https://atlanticadaptation.ca/en/islandora/object/acasa%3A789								

Policy and planning framework tools	Landuse planning tools	Regulatoray and landuse change tools	Site design tool	Emergency management tools
Provincial policy statement	Statuatory community plan	Wetland regulation	Urban design standards	Emergency preparedness program
Partnerships	Secondary plan or area plan	Land use by-laws, zoning	Conservation subdivision design	Emergency management plan
Educative programs	Regional plan or land use plan	Setbacks, managed retreat, managed abandonment, abandonment	Coastal development rating system	Critical infrastructure/asset planning (ex. diversion routes)
Local committees	Guidance, action and management plans	Subdivision by-law or regulation, foreshore lease	Site monitoring	Business continuity plan
Community engagement	Incentives	Development standards		EM capacity of intervention program
Community asset management	Wetland policy, plan, guidelines	Development agreement		Public preparedness
Vizualisation		Transfer of dvpt credit		Recovery planning
Scenario planning		Land swap		EM Volunteer work agreement
Data gathering and mapping and vulnerability assessment		Land use conversion and redevelopment		
		Variances, waivers,		
		Land Trust, rolling & conservation easment		

Improved from Manuel, Reeves and Hooper, 2016, ACASA, https://atlanticadaptation.ca/en/islandora/object/acasa%3A788



## **Towards adaptation**

3) Which measures do you prefer/refuse for limiting the consequences for...? (10 min)

Domains	Coastal hazards	Pluvial & fluvial issue	Forest fires and diseases	Heat waves & drougth
Onsite	<ol> <li>Onshore, hard &amp; linear</li> <li>(Partly) Submerged</li> <li>Coastal ecosystem oriented</li> <li>Other sediment management interventions</li> <li>Asset-oriented</li> <li>Precipitation- oriented</li> </ol>	<ol> <li>Retrofit of drainage systems</li> <li>Overflow basins</li> <li>Dykes</li> <li>Shoreline green infrastructure</li> <li>Sediment management</li> <li>Asset-oriented</li> <li>Precipitation-oriented</li> </ol>	<ol> <li>Preventive cutting</li> <li>Preventive spreads</li> <li>Trenching</li> <li>Additionnal engineering structures</li> <li>Asset-oriented adaptation</li> </ol>	<ol> <li>Building design code</li> <li>Adding conditionning systems for residential</li> <li>Adding conditionning systems for public buildings</li> </ol>
Management	<ol> <li>Landuse planning to</li> <li>Policy and planning</li> <li>Regulatory and lands</li> <li>Site design tool</li> <li>Emergency managem</li> </ol>	ols 6. Public framework tools 7. Public use change tools services nent tools 8. Collec	health collective tion (ex. boiling notice) health individual additional (ex. door-to-door survey of le households) tive cold islands	

# A sincere thank you for your participation!

http://www.csrchaleurrsc.ca/fr

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# CLIMATE CHANGE ADAPTATION PLAN FOR THE CHALEUR REGION



Commission de services régionaux Chaleur Regional Service Commission

#### Plan for the evening

- Introduction (5 min.)
  - Presentation of participants
  - Project setting
  - Methods
- Regional context (15 min.)
  - > Aspects of vulnerability social, economy, environment
  - Regional climate trends
  - ► Hazards by sub-regional units
- Multi-risk assessment to establish the local priorities (30 min.)
  - Eastern zone (5 zones)
- ► TOWARDS ADAPTATION (45 min.):
  - Best practices for key hazards
    - Structural
    - Non-structural
  - Discussion the adaptation measures for each zone?



#### Presentation of the participants

- Marc Bouffard & Mariette Boudreau, CSR Chaleur
- Ursule Boyer-Villemaire, WSP Canada
- > Denis Leblanc, WSP Canada
- Ena Ristic, WSP Canada
- **Robert Capozi, G. NB.**



#### Project context

Commission de services régionaux Chaleur Regional Service Commission

# Fighting against climate change takes place at different level

- New Brunswick Climate Change Action Plan
  - 7 components and 118 statements
- Mitigation Plans /Green Plans
  - ✓ GHG reduction plans, Electrification of transportation and Energy efficiency(biomass)
  - ✓ Many municipalities of the region participate in projects led by the AFMNB
  - ✓ It is also the responsibility of everyone to do his share at the individual and household levels
- <u>Climate Change Adaptation Plans</u>
  - ✓ City of Bathurst (completed)
  - $\checkmark$  Regional adaptation plan of the Chaleur Region
  - $\checkmark$  Many plans are currently underway across the province
- Emergency Measures Plans at the local and regional levels
  - Joint project of the Chaleur RSC, municipalities and Department of Justice and Public Safety



#### Foundation of our approach

- Historically in NB, CCAP have been made at the local municipal level
- Chaleur RSC propose a regional approach
- This adaptation plan will provide municipalities and LSD
  - Basic information,
  - Consistent methodology, and
  - Coherent tools
  - ▶ to help them plan at the local level
- This plan may be used as a model for the other RSC of the province
- Municipalities situated in the areas most at risk must have an adaptation plan in place before 2020


# Process followed by the Chaleur RSC

- 2017/2018
  - Phase 1 IRZC (completed March 2018)
    - Portrait and diagnostic of the climatic hazards (current situation)
    - Meetings with focus groups (Municipal Infrastructures and Public Utilities)
    - Report available on the website of CRSC
- <u>2018/2019</u>
  - Phase 2 WSP (under development)
    - Identify, classify and prioritize risks based on their probabilities, frequencies and severity of their consequence
    - Issues and Options to integrate in the plan,
    - Proposed Strategies and Actions: ex: development standards and implementation measures
    - These tasks are done in consultation with the community, hence this citizen consultation process.
  - Coastal Erosion Analysis GéoLittoral (on hold)
    - Measure coastal erosion rate between Petit-Rocher South and Pointe-Verte (inclusively)
    - Determine the coastline from old and recent air photos
    - Calculate the mean erosion rate
    - Project the coastline in the future

- Vulnerability Atlas CRSC (under development)
   Dissemination Areas (about 500 people)
- <u>2019/2020</u>
  - Phase 3
  - Coastal Erosion Analysis
- 2020 et ....
  - Continuous process: monitoring, assessments and review







# Chaleur Regional Advisory Committee on Climate Change Adaptation (CCRACCA)

- 6 Municipalities (including City of Bathurst)
  - 1 representative per municipality: elected or appointed official, citizen
- LSD: 2 representatives
  - One citizen from Petit-Rocher South
  - There is one position to be filled (ideally a person living in the area eastward of Bathurst)
- One representative of the Climate Change Secretariat
- 2 persons at large
  - Professional engineer
  - Employee of a municipal organization
- The committee is chaired by a member of the board of directors of the Chaleur RSC

- Support Committee
  - Department of Environment and Local Government
  - Department of Energy and Resource Development
    - Geomorphologist
  - Chaleur Bay Watersheds Group
  - Municipal Administrators
  - Manager local service for the LSD (DELG)

# Some Highlights

- Recurrence concept is misunderstood
  - A recurrence period of 100 years means a 1% chance that a major event could occur every year (flooding, storm). Recurrence of 1:20 years = 5% probability.
  - 1% chance to win the lottery is huge. The same rational should also apply to incurred losses arising from climate change (social and financial costs)
  - It is a misconception to believe that risks are diminished because an event occurred recently
- Dependence on infrastructure systems increasingly saturated
  - Infrastructure capacity cannot be expanded indefinitely
- We neglect to take into consideration the positive contribution of <u>natural infrastructure</u> on the fight against climate change.
  - Healthy natural areas (wetlands, lagoons, watercourses) provide many (free) services to communities. When natural areas are degraded, it is expensive to reproduce those lost services.
  - Natural areas provide countless benefits: decreased flood risk, clean and inexpensive drinking water, recreation/tourism opportunities.
  - Natural areas help to manage the effects of climate changes: extreme storms, erosion, flooding

# Some Highlights

- Risks factors are up
  - Extreme events are becoming more extreme in frequencies and intensities.
- Risk areas are not taken seriously
  - > We continue to subdivide and to develop in flood or erosion prone areas.
- Every dollar invested in mitigation has a positive return
  - Every dollar invested by the US federal government in pre-disaster mitigation saves society \$6 in post-disaster recovery costs (US National Institute of Building Sciences)
  - In every dollar spent on improving building codes to better withstand natural disasters, society saved \$4.

# Thank you for your participation and have a good meeting





# Objectives & Methods for this evening



# **Objectives**

#### ► GENERAL OBJECTIVE :

With the population, design a plan that meets the most urgent needs and proposes de measures that will best protect the population, the economy and the environment best in the long term against the impacts of climate change

#### Validation of risk profiles

- Interactive mapping workshop
- Prioritization of adaptation sectors
- Evaluation of preferences about adaptation measures
- Next step : Design plan (March 31, 2019)





## Eastern Chaleur Map



- Bathurst Parish, North
   Tetagouche & Big River
- Allardville & St.Sauveur
- New Bandon-Salmon Beach & New Bandon



# East Chaleur Labour Force

#### Management

- Business, finance and administrative
- Natural and applied sciences and related
- Health
- Education, law and social, community and government services
- Art, culture, recreation and sport
- Sales and service
- Trades, transport and equipment operators and related
- Natural resources, agriculture and related production
- Manufacturing and utilities





# **Climate Data**

- Derived from Phase 1
- RCP8.5
  - The greenhouse has trajectory used for climate modeling to represent the 'worst case' emissions scenario
- Data compared historical conditions to projections for year 2080
- Selected climate indices:
  - Winter Mean Temperature
  - Annual Number of Days with Maximum Temperature <-10  $^{\circ}$  C
  - Winter Freeze-Thaw Days
  - Annual Number of Days with Maximum Temperature > 30  $^\circ$  C
  - Growing Season Length
  - Annual Total Precipitation



### Winter Mean Temperature Baseline 1980-2010



**RCP8.5 2080** 



Winter Mean Temperature (°C)



# **Annual Number of Days with Maximum Temperature <-10° C Baseline 1980-2010 RCP8.5 2080**

Annual Number of Days with Maximum Temperature < -10 °C (days)



### Winter Freeze-Thaw Days Baseline 1980-2010

RCP8.5 2080



Winter Freeze-Thaw Days (days)





# Annual Number of Days with Maximum Temperature > 30 ° C

### **Baseline 1980-2010**

RCP8.5 2080





Annual Number of Days with Maximum Temperature > 30 °C (days)



### **Growing Seasons Length Baseline 1980-2010**



148

186

223



# **Annual Total Precipitation** Baseline 1980-2010





Annual Total Precipitation (mm)



# Summary of Climate Trends

Climate Variable	Historical Average	Projected Average (2080)	Change
Winter mean temperature	-8.7–4.9°C	-4.9°C1°C	৫ <b>7.7°C</b>
Annual days with temperatures <-10°C	14.3-21.5 days	0-7.2 days	<b>↓14.3 days</b>
Winter freeze-thaw days	20-35 days	35-49 days	企 15 days
Annual days with temperature >30°C	0-29.5 days	29.5-58.9 days	<b>û29.5 days</b>
Growing season length (days)	148-186 days	223-261 days	<b><sup>1</sup>75 days</b>
Annual total precipitation	926-1112mm	1112-1298mm	企 <b>186mm</b>





# Major Impacts of Climate Change

Temperature increases and changes to precipitation regimes	Sea level rise and ice cover reduction	"Extreme" events associated with a rising sea level, temperature increases and changes to precipitation regimes
<ul> <li>Droughts</li> <li>Heat waves</li> <li>Increased frequency of heavy rain events</li> <li>Forest fires</li> <li>Species migration</li> <li>Drinking water shortages</li> <li>Deterioration of road infrastructure</li> </ul>	<ul> <li>Increased coastal flooding</li> <li>Increased coastal erosion</li> <li>Salt water intrusion</li> </ul>	<ul> <li>Strong winds</li> <li>Flooding</li> <li>Fires</li> <li>Freezing rain</li> <li>Snowfall events</li> <li>Heat waves</li> </ul>

# **Risks Factors of Climate Change**

People	Economy	Environment
<ul><li>Health and safety</li><li>Injury</li><li>Illness</li><li>Loss of life</li></ul>	<ul> <li>Infrastructure Damage</li> <li>Roads</li> <li>Stormwater systems</li> <li>Drinking water systems</li> <li>Sanitation systems</li> <li>Energy systems</li> <li>Communication systems</li> </ul>	Ecosystems • Forests • Coastal • Saltmarshes • Dunes • Freshwater
Displacement • Temporary • Permanent	<ul><li>Damage to industries</li><li>Primary resource impacts</li><li>Damage to industry infrastructure</li></ul>	Economical important environment <ul> <li>Forests</li> <li>Mines</li> <li>Beaches</li> </ul>
Impacts to Social Health <ul> <li>Loss of community spaces</li> </ul>	Property damage • Residential • Public	<ul><li>Protected areas</li><li>National parks</li><li>Provincial parks</li></ul>
Loss of Livelihood		

# Risk rating assessment

ces	High	Major damaged including extensive infrastructure damage requiring major repair, major loss of infrastructure services, major or multiple injuries, permanent injuries, disability, or death, changes in governance required, major economic losses, national long-term social impacts, and significant negative impacts and losses to the local ecosystem requiring remedial action.	Moderate	High	High
Consequen	Moderate	Limited infrastructure damage and/or loss of service requiring minor repair, serious medical injury, moderate local economic impacts with some effect on the wider economy, local, long term impact on public opinion, and some environmental damage which may require remedial action.	Low	Moderate	High
	Low	Minor, localized, and temporary disruption or damage which can be absorbed through continuity actions and has minimal impact on public health, the environment, the local economy, infrastructure, and public opinion.	Low	Low	Moderate
			Low	Moderate	High
		Likely to occur between 30-50 years, or become critical/beneficial in 30-50 years	Likely to occur once between 10-30 years, or become critical/beneficial in 10-30 years	Likely to occur once a decade, or become critical/beneficial in a decade	
		Probabilities			

# Overview of Region-Wide Climate Impacts

- Heavy rainfall
- Heat waves and Droughts
- Freeze-thaw events
- Species migration
- Storm events

# Heavy Rainfall

- Overland and river flooding
  - Increased soil erosion and mass wasting
  - Flooding of homes and buildings
  - Flooding of public and private infrastructure
    - Roads
    - Train tracks
    - Parks
    - Community spaces
  - Pollutes local freshwater sources
  - Health and Safety risk
    - Reduced access for first responders
    - Reduced access to supplies
    - Increased risk of drownings, hypothermia, bacterial infection, waterborne diseases



Annual precipitation predicted to increase 186 mm under RCP8.5 by 2080

1000

https://www1.gnb.ca/cnb/multimedia/searche.asp?fmonth=8&fday=14&fyear=2005&tmonth=9&tday=14&tyear=2008&keyword=&department=

# Heat Waves and Droughts

- Dehydration, fainting, dizziness, heat exhaustion, heat stroke, death
- Vulnerable groups: young & elders, isolated
- Power outages
  - Greater electricity use
  - ▶ Heat stress on energy infrastructure
- Temporary relocation
- Increased fire risk
- Decreased air quality
- 29.5 days with greater than 30 degrees C per year



Annual number of days with temperatures over 30°C projected to increase by 29.5 under RCP8.5 by 2080

https://wwjnewsradio.radio.com/articles/forecast-calls-heat-wave-detroit-saturday

# Freeze-thaw events

- Damage to road infrastructure and create potholes
- Create dangerous driving conditions when water melts over road surfaces and freezes
- Costly repairs to roads and vehicles
- Acceleration of coastal erosion (cliffs)



https://www.telegraphjournal.com/telegraph-journal/story/41782505/saint-johns-asphalt-assault?source=story-related

Annual increase in number of days with freeze-thaw conditions projected: 15 under RCP8.5 by 2080

# **Species** migration

- Species may act as disease vectors
  - ▶ i.e. Lyme disease
- Threat to native species and ecosystems
- May negatively impact local industries
- Example Emerald Ash Borer (pictured)
  - Found in Edmundston, NB, in 2018
  - Migrated northward
  - Disastrous impacts on Ash tree species and habitats





Winter Mean Temperatures projected to increase by 7.7°C under RCP8.5 by 2080

ttps://www.cbc.ca/news/canada/new-brunswick/emerald-ash-borer-edmundston-nb-1.4668654

# "Extreme" climate events

- Winds gusts
- Hail
- Heavy Rainfall
- Heavy Snowfall
- Floods
- ► Fires
- ► Effects:
  - Damage to infrastructure
  - Power outages
  - Flooding
  - Health and Safety impacts
  - Reduce mobility for emergency vehicles or isolation of areas
  - Reduce access to aid and supplies

Rain, wind warnings expanded as second storm slams New Brunswick

f 🕑 🍯 in

Most of the province is under either a rain or wind warning, or both Jordan Gill - CE Some N.B. residents could be

🍯 ) ( 🥳 ) ( in

[

Some N.B. residents could be without power for three days

Windstorm knocked out power to more than 100,000 homes across Atlantic Canada

f 🕑 🎯 in

New Brunswick hardest hit with 92,000 households without electricity

Mairin Prentiss  $\cdot$  CBC News  $\cdot$  Posted: Nov 04, 2018 7:00 AM AT | Last Updated: 9 hours ago

https://www.cbc.ca/news/canada/new-brunswick/rain-wind-warnings-expanded-1.4890646

# **Coastal Area**

Region-Specific Impacts



# **Overview of Coastal Region-Specific Impacts**

- Sea level rise
  - Coastal Flooding
    - Increased risk of injury, illness, and loss of life
    - Increase anxiety and depression
    - Decreased access to jobs, medical care, food, other resources
    - Risk to coastal property
  - Coastal Erosion
    - Increased risk of direct injury
    - Risk to coastal property
  - Salt water intrusion
    - Negative impacts on drinking water resources
    - Harm to local freshwater ecosystems



## Salmon Beach & New Bandon Population Profile

Total population (2016)	2,027
Population 0-14yrs	<b>9</b> %
Population 65+	<b>29</b> %
English as first language	1270
French as first language	760
English as only language	1,025
French as only language	335



#### SALMON BEACH & NEW BANDON LABOUR FORCE Management ■ Business, finance, 3% 7% administration 14% Natural and applied sciences and related Health 6% 27% ■ Education, law and social, community and government services Art, culture, recreation and 6% sport Sales and services 7% ■ Trades, transport and 1% equipment operators and related ■ Natural resources, 14% 15% agriculture and related production Manufacturing and utilities

# New Bandon-Salmon Beach

Bathurst	-
	(
1:25,000 0,30.6 1.2 1.8 2.4 3	L

New Pandan Salman Pasah	
Buildings within a 4.2 flood zone	Structure count
Accessory	45
Camp/Cottage/Recreational vehicle	55
Children camp	1
Residential: 1-2 units	20
Retail area with large outdoor storage areas	2
Seaport/Wharf/Marina	2




#### Salmon Beach & New Bandon Impacts



- Coastal erosion
  - Highest coastal erosion rates in Chaleur Region at 0.6m/year
  - West side of miller brook wharf in salmon beach experiencing erosion
  - More frequent freeze-thaw episodes are accelerating cliff erosion from Salmon beach to Grande-Anse
- Coastal flooding
  - 7.2% of buildings will be affected by a 4.2m flood
- Salt water intrusion
  - Multiple wells at risk of coastal flooding

#### **Inland Regions Overview**

- Forest fires
  - Property damage and destruction
  - Risk of illness, injury, or loss of life
  - Destruction of wildlife and ecosystems
  - Impacts on air quality
  - Economic lose of resources
  - Direct and indirect damage to industry
- Fluvial flooding
  - Increased risk of injury, illness, and loss of life
  - Increase anxiety and depression
  - Decreased access to jobs, medical care, food, other resources
  - Risk to property

http://cwfis.cfs.nrcan.gc.ca/ha/nfdb?type=poly&year=9999

Chaleur

#### Bathurst Parish, North Tetagouche, & Big River Population Profile

Total population (2016)	6,463
Population 0-14yrs	12.4%
Population 65+	20.4%
English as first language	3,255
French as first language	3,145
English as only language	2,065
French as only language	415





## Bathurst, North Tetagouche & Big River Parish Impacts

- River flooding
  - Nepisiguit and Middle Rivers are the ones most likely to cause flooding

Bâtiments dans la zone inondable	Tetagouche River	Middle River	Nepisiguit River
Accessory	8	6	Na
Camp/Cottage/Recreational vehicle	15	9	Na
Residential: 1-2 units	5	28	Na
Mini homes and mobile homes (not in parcs)		4	Na

- Forest fires
  - Isolated nature of certain communities leaves them vulnerable
  - 70 residents in Nepisiguit Falls are isolated in the event of a fire, the nearest fire department is 45 minutes



75 Structures in river flood plains Of 3 rivers



70 Isolated residents in Nepisiguit Falls

#### Allardville & St.Sauveur Population Profile

Management

related Health

Total population (2016)	2,705
Population 0-14yrs	11.6%
Population 65+	23.2%
English as first language	90
French as first language	2595
English as only language	40
French as only language	1390



#### ALLARDVILLE & ST. SAUVEUR LABOUR FORCE

#### 4% 7% Business, finance and administrative Natural and applied sciences and 21% Education, law and social, community and government services Art, culture, recreation and sport ■ Sales and service ■ Trades, transport and equipment operators and related ■Natural resources, agriculture and **9**% related production 23% Manufacturing and utilities

#### Allardville & St.Sauveur Impacts



- River flooding
  - Historically Little Bass River has washed away a bridge
  - A second bridge is often close to being submerged on Bass River
- Forest fires
  - Residents surrounded by forests are at a higher risk
- Drought conditions
  - Recent cases of dry wells have been reported

## Towards Adaptation



#### Towards adaptation

Workshop: Interactive mapping (15 min.)

1) Is this profile a good representation of your territory's most preoccupying risks? Are we missing anything?

2) How do you rank these	e hazards in your area?
Coastal areas	Inland areas
<ul> <li>Heavy rainfall and inland flooding</li> <li>Heat waves and Droughts</li> <li>Freeze-thaw events</li> <li>Species migration</li> <li>Storm events</li> <li>Coastal flooding</li> <li>Coastal erosion</li> </ul>	<ul> <li>Heavy rainfall and inland flooding</li> <li>Heat waves and Droughts</li> <li>Freeze-thaw events</li> <li>Species migration</li> <li>Storm events</li> <li>Forest fires</li> </ul>

	Onshore, hard & linear	(Partly) Submerged	Coastal ecosystem oriented	Other sediment management interventions	Asset-oriented	Precipitation- oriented
	Maintenance, Repair or Repla cement of Existing Structure	Shore Perpendicular Breakwater	Perched Beach (Sill)	Buried Revetment	Floodwalls/Dry Flood Proofing	Stormwater Management - Reduce Runoff
	Scour Protection	Nearshore Breakwaters	Beach Nourishment	Passive Bluff Drain	Raised Infrastructure	Stormwater Management - Increase Conveyance (Drainage Ditch)
	Engineered Revetment	Near Shore Artificial Reefs	Plant or Bio-Engineered Stabilization	Dredging	Wet Flood Proofing Buildings	Stormwater Management - Increase Storage (Detainment Pond)
	Seawall, Retaining Wall & Rip-rap Armouring	Groynes	Living Shorelines (Coastal Wetlands and Salt Marsh Restoration)		Floating Building/Amphibio us Foundation	Stormwater Management - Rain Garden/Construct ed Wetland
	Dykes & Tide Barriers/Aboiteaux		Dune Building	, ,,, , , , , , , , , , , , , , , , , ,	Relocate or Abandon Infrastructure (Retreat Strategy)	
Ada	Adapted from Leys and Bryce, 2016. ACASA. https://atlanticadaptation.ca/en/islandora/object/acasa%3A/89					

Policy and planning framework tools	Landuse planning tools	Regulatoray and landuse change tools	Site design tool	Emergency management tools
Provincial policy statement	Statuatory community plan	Wetland regulation	Urban design standards	Emergency preparedness program
Partnerships	Secondary plan or area plan	Land use by-laws, zoning	Conservation subdivision design	Emergency management plan
Educative programs	Regional plan or land use plan	Setbacks, managed retreat, managed abandonment, abandonment	Coastal development rating system	Critical infrastructure/asset planning (ex. diversion routes)
Local committees	Guidance, action and management plans	Subdivision by-law or regulation, foreshore lease	Site monitoring	Business continuity plan
Community engagement	Incentives	Development standards		EM capacity of intervention program
Community asset management	Wetland policy, plan, guidelines	Development agreement		Public preparedness
Vizualisation		Transfer of dvpt credit		Recovery planning
Scenario planning		Land swap		EM Volunteer work agreement
Data gathering and mapping and vulnerability assessment		Land use conversion and redevelopment		
		Variances, waivers,		
		Land Trust, rolling & conservation easment		

Improved from Manuel. Reeves and Hooper. 2016. ACASA. https://atlanticadaptation.ca/en/islandora/object/acasa%3A788

## Adaptation measures

Adaptive measure	Pros	Cons	
Structural (i.e. Dykes, seawalls, reinforced buildings)	<ul> <li>High impact</li> <li>Easily measurable results</li> <li>Faster timeline</li> </ul>	<ul> <li>Expensive</li> <li>Often site- specific</li> </ul>	Reduction
Non-structural (i.e. Zoning, community awareness, development permits)	<ul> <li>Cost efficient</li> <li>Community -scale</li> <li>Increases individual resiliency</li> </ul>	<ul> <li>Often lower impact</li> <li>Difficult to measure results</li> <li>May require a slow timeline</li> <li>Subject to public opinion</li> </ul>	Low Risk I

High Cost				
	<ul> <li>Dyke</li> <li>Environmental buffers</li> <li>Upstream water retention measures</li> </ul>		High I reduc	
• Comi awar	<ul> <li>Land-use planning</li> <li>Zoning</li> <li>Developmental permits</li> <li>munity</li> <li>Emergency detour plan</li> </ul>		risk ction	
Low	Cost			

#### **Towards adaptation**

# 3) Which measures do you prefer/refuse for limiting the consequences for...? (10 min)

Domains	Coastal hazards	Pluvial & fluvial issue	Forest fires and diseases	Heat waves & drougth
Onsite	<ol> <li>Onshore, hard &amp; linear</li> <li>(Partly) Submerged</li> <li>Coastal ecosystem oriented</li> <li>Other sediment management interventions</li> <li>Asset-oriented</li> <li>Precipitation- oriented</li> </ol>	<ol> <li>Retrofit of drainage systems</li> <li>Overflow basins</li> <li>Dykes</li> <li>Shoreline green infrastructure</li> <li>Sediment management</li> <li>Asset-oriented</li> <li>Precipitation-oriented</li> </ol>	<ol> <li>Preventive cutting</li> <li>Preventive spreads</li> <li>Trenching</li> <li>Additionnal engineering structures</li> <li>Asset-oriented adaptation</li> </ol>	<ol> <li>Building design code</li> <li>Adding conditionning systems for residential</li> <li>Adding conditionning systems for public buildings</li> </ol>
Management	<ol> <li>Landuse planning to</li> <li>Policy and planning</li> <li>Regulatory and land</li> <li>Site design tool</li> <li>Emergency manager</li> </ol>	ols 6. Publi framework tools 7. Publi use change tools service vulnera nent tools 8. Colle	c health collective ntion (ex. boiling notice) c health individual additional s (ex. door-to-door survey of ble households) ctive cold islands	

# A sincere thank you for your participation!

http://www.csrchaleurrsc.ca/fr

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