An Evolution in Flood Management:
An optimistic view from the left coast

ebbwater
CONSULTING INC

CWRA | March 2019 | Toronto, Ontario

Tamsin Lyle, P.Eng | Principal Engineer | Ebbwater Consulting Inc.

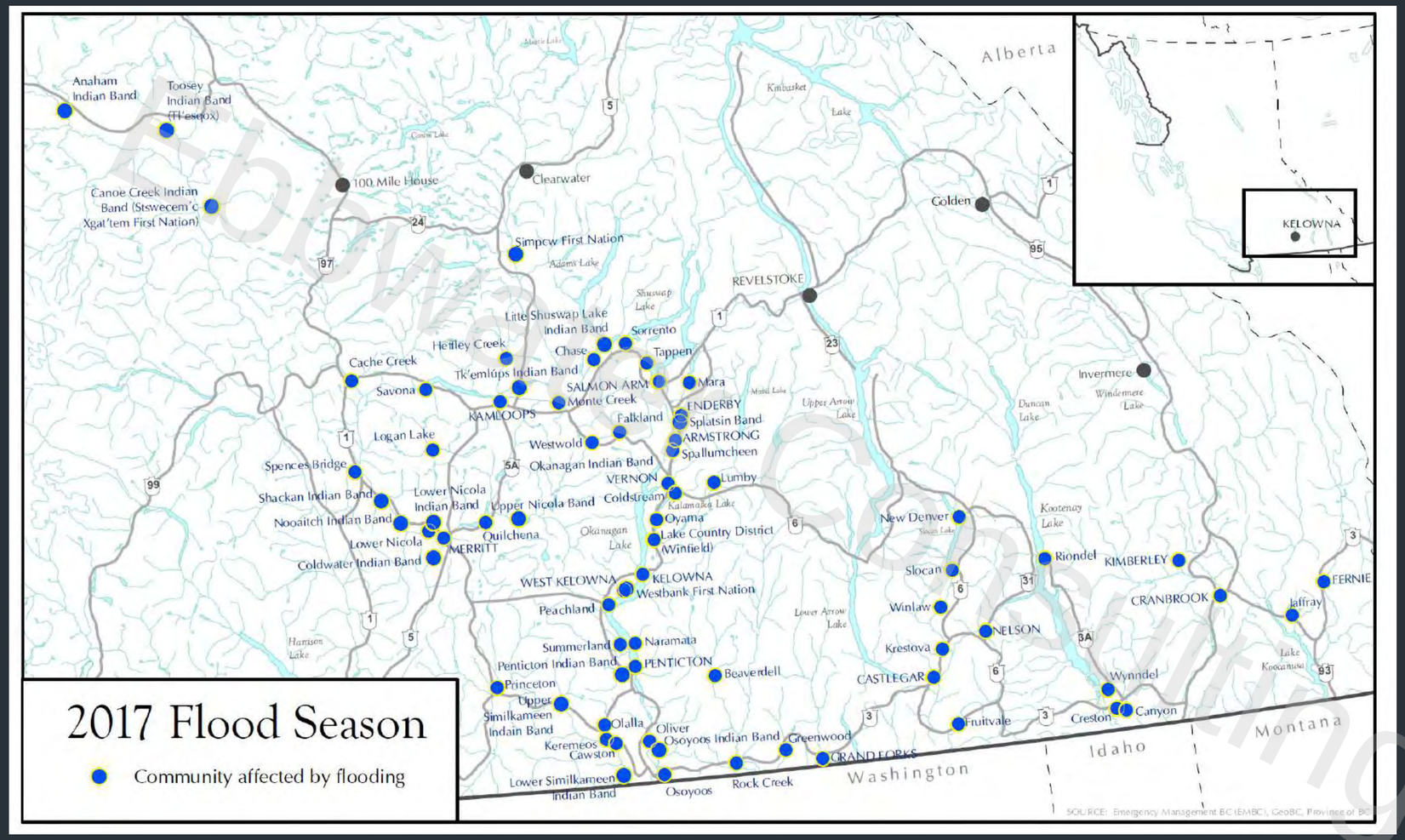


Image from BC Flood and Wildfire Review (Abbott and Chapman, 2018)

2017 Flood Season

Extensive - Long Duration - Impactful

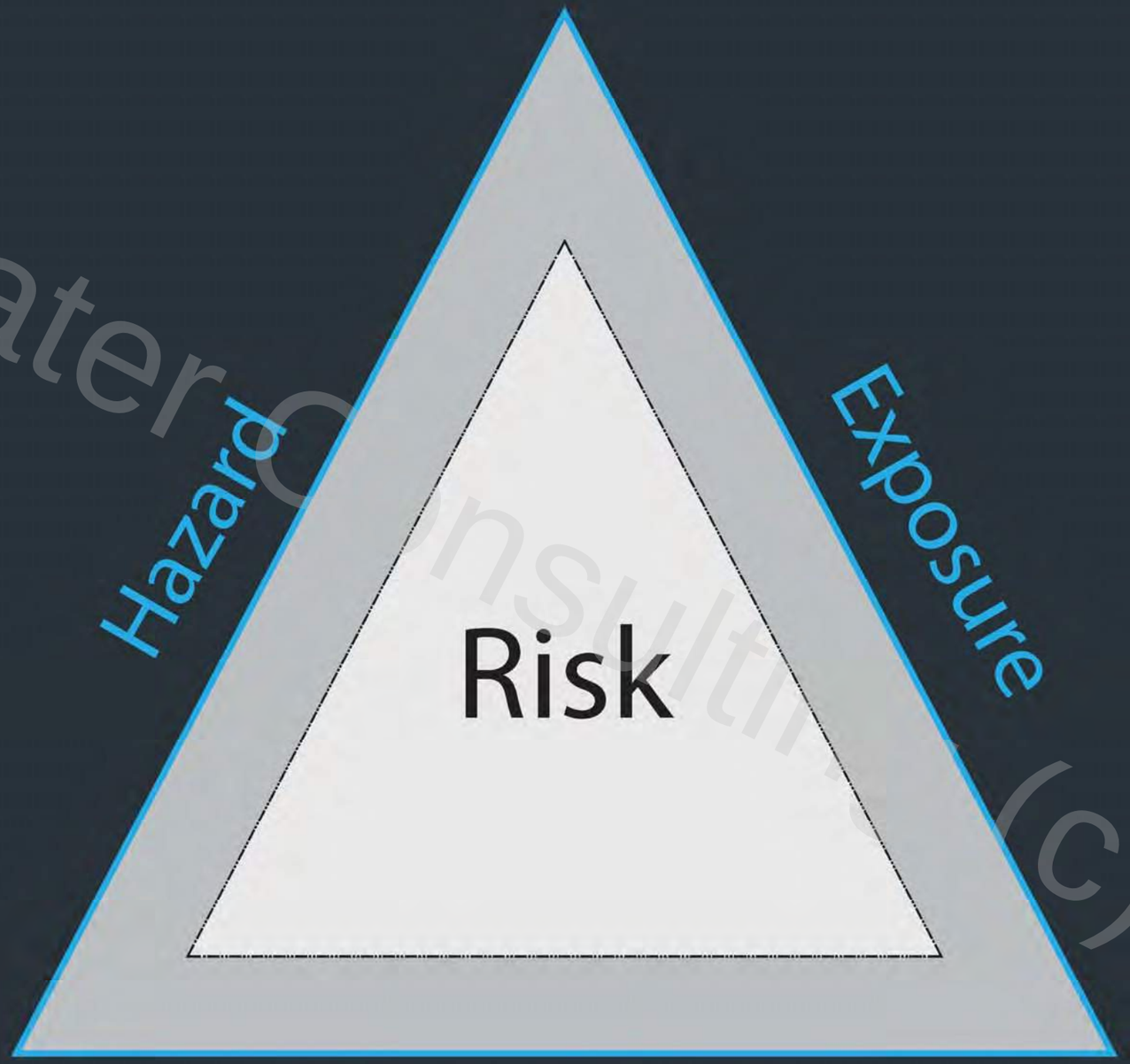
Response Costs > $73 Million

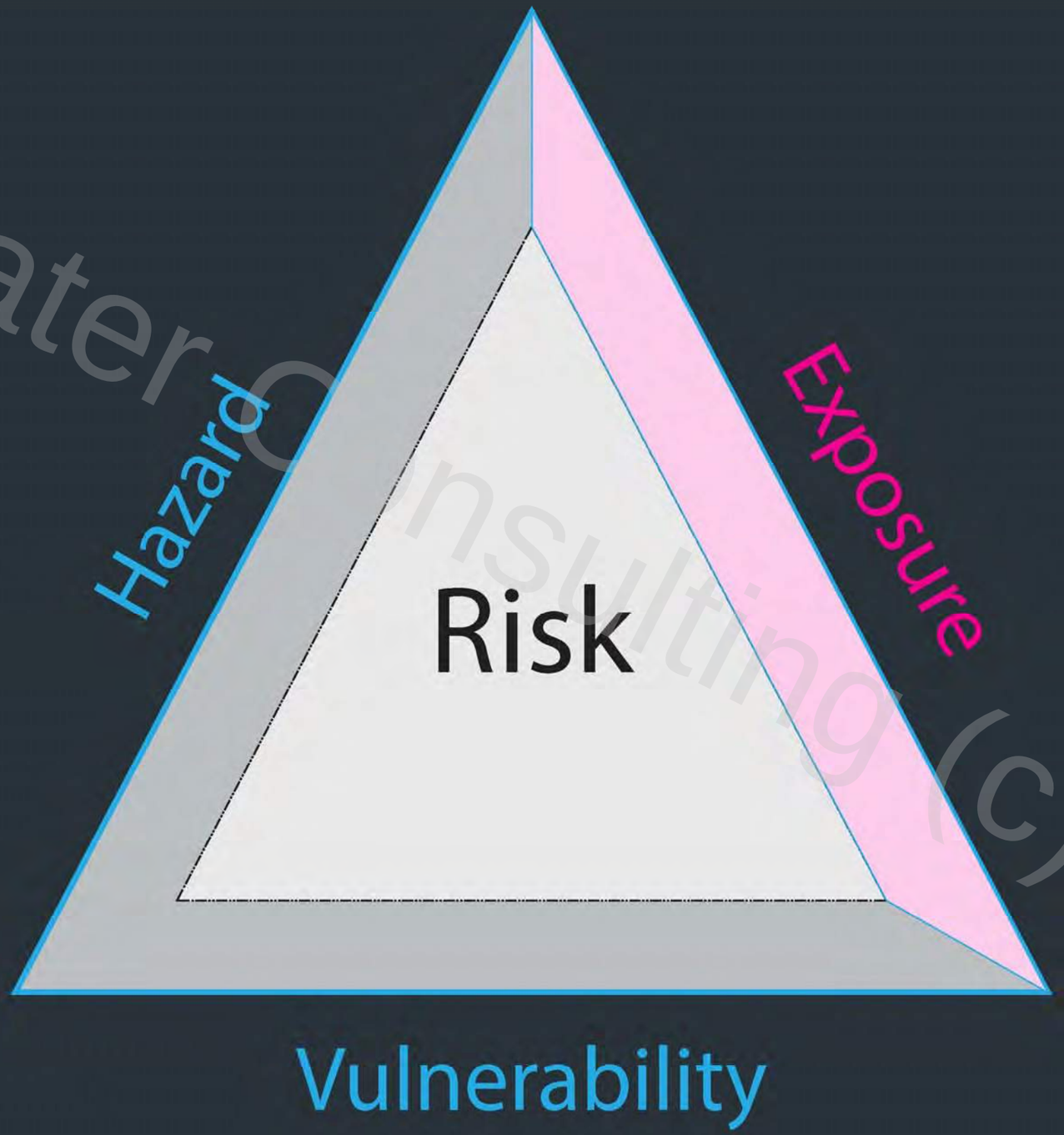
2018 Flood Season

Extensive - Long Duration - Impactful

City of Dawson Creek Images

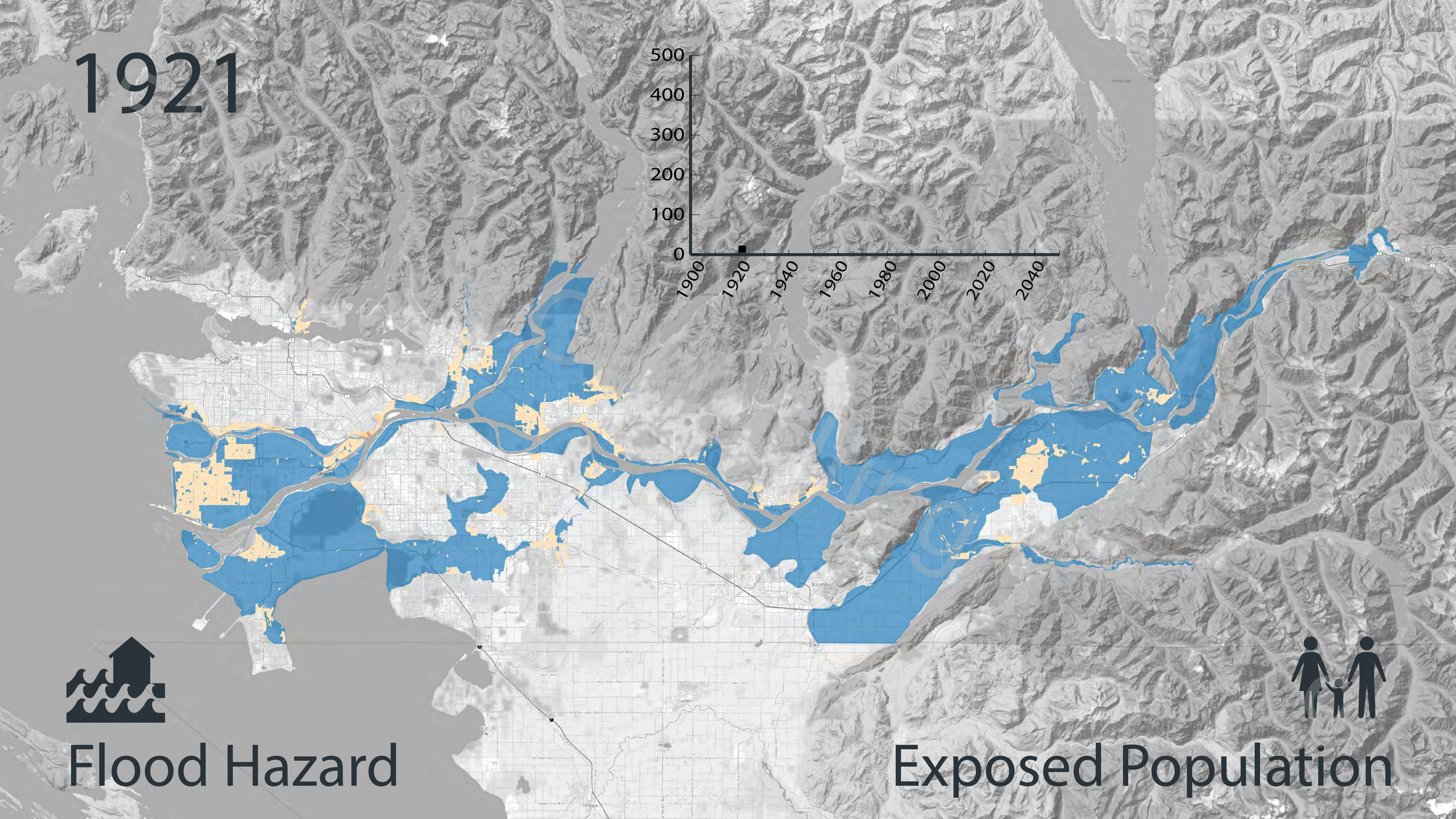
Geological Survey of Canada Images





1894

Flood Hazard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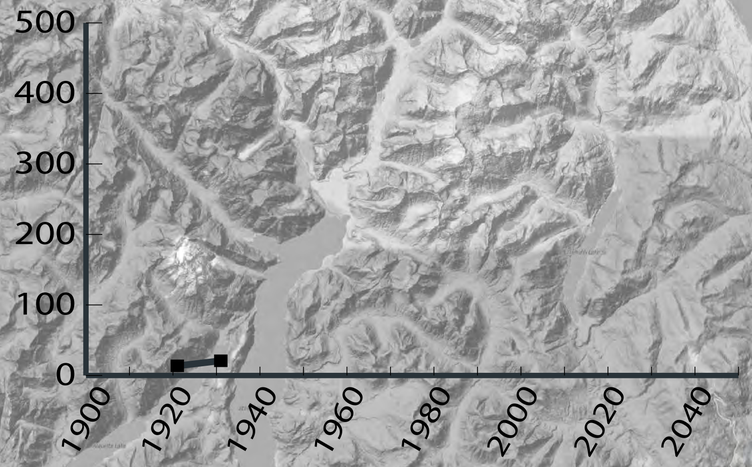
Abbotsford
Flood Hazard
Exposed Population

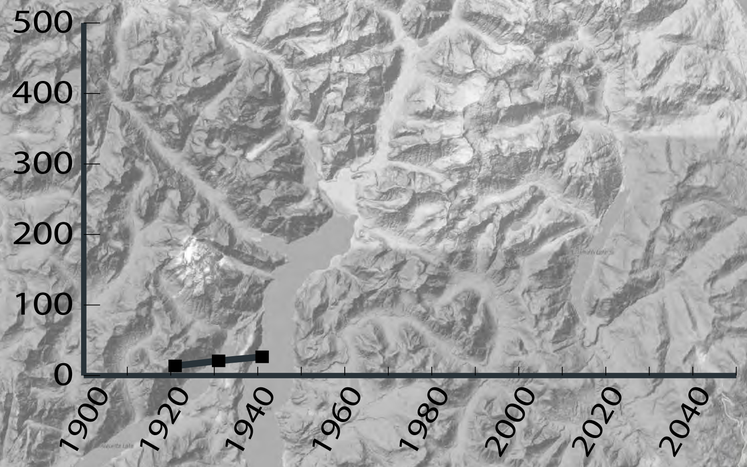
1931



Flood Hazard

Exposed Population

1941



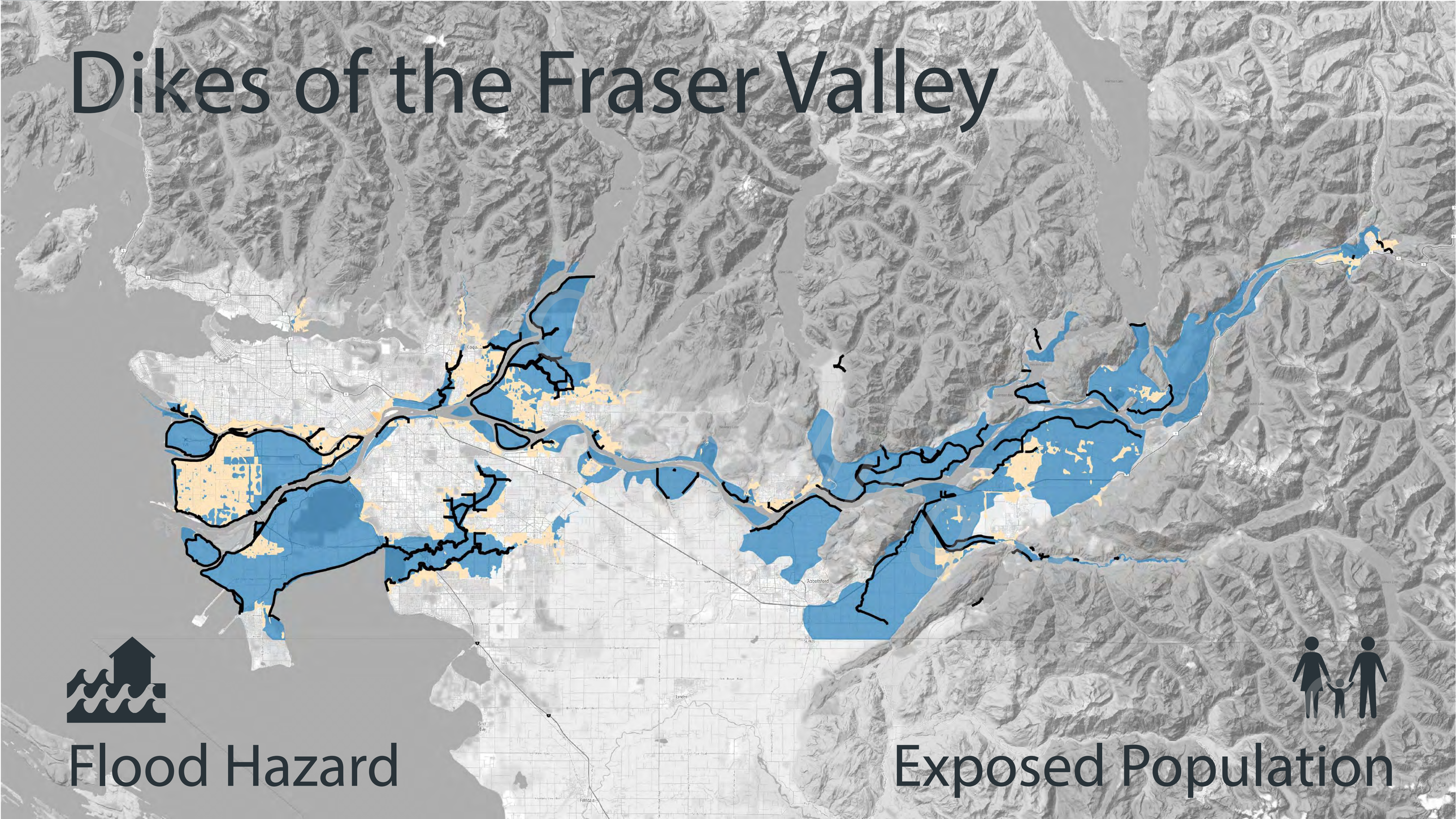
Flood Hazard

Exposed Population

1948

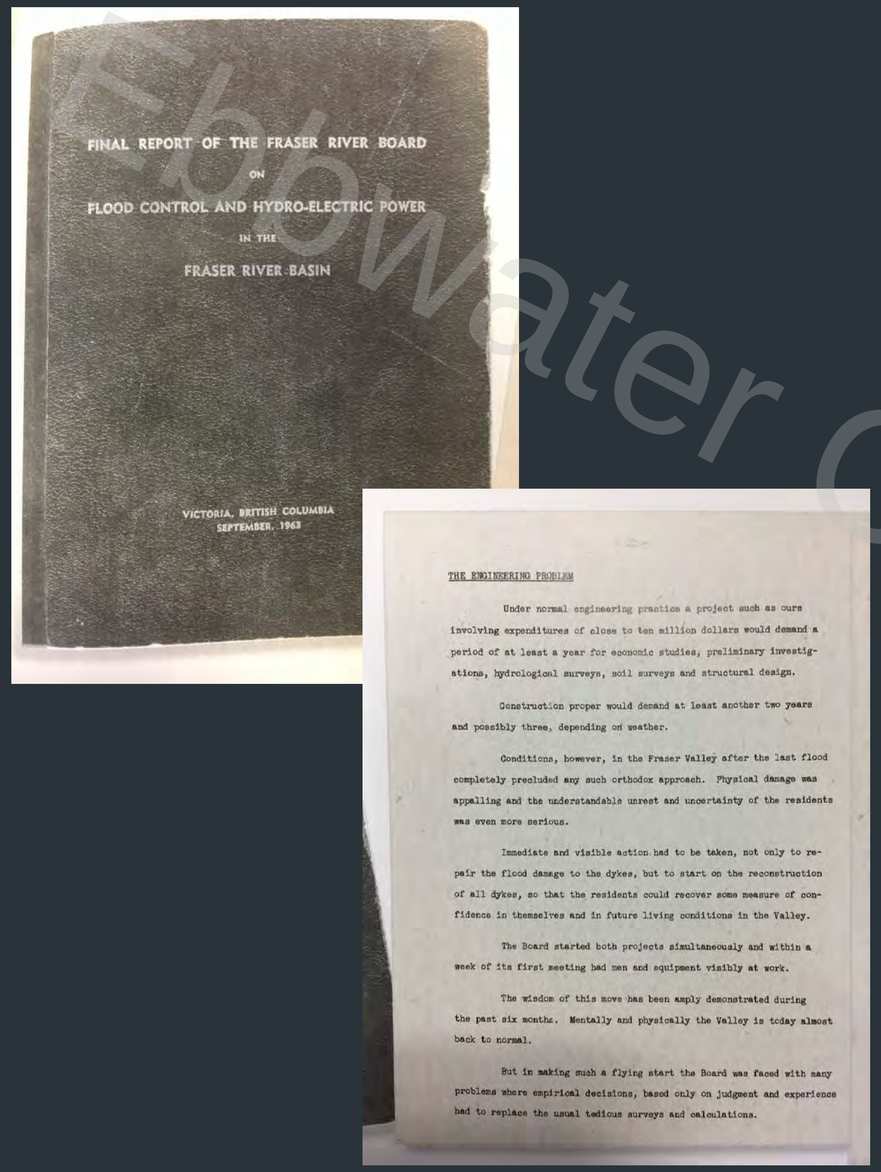
Flood Hazard

Dikes of the Fraser Valley



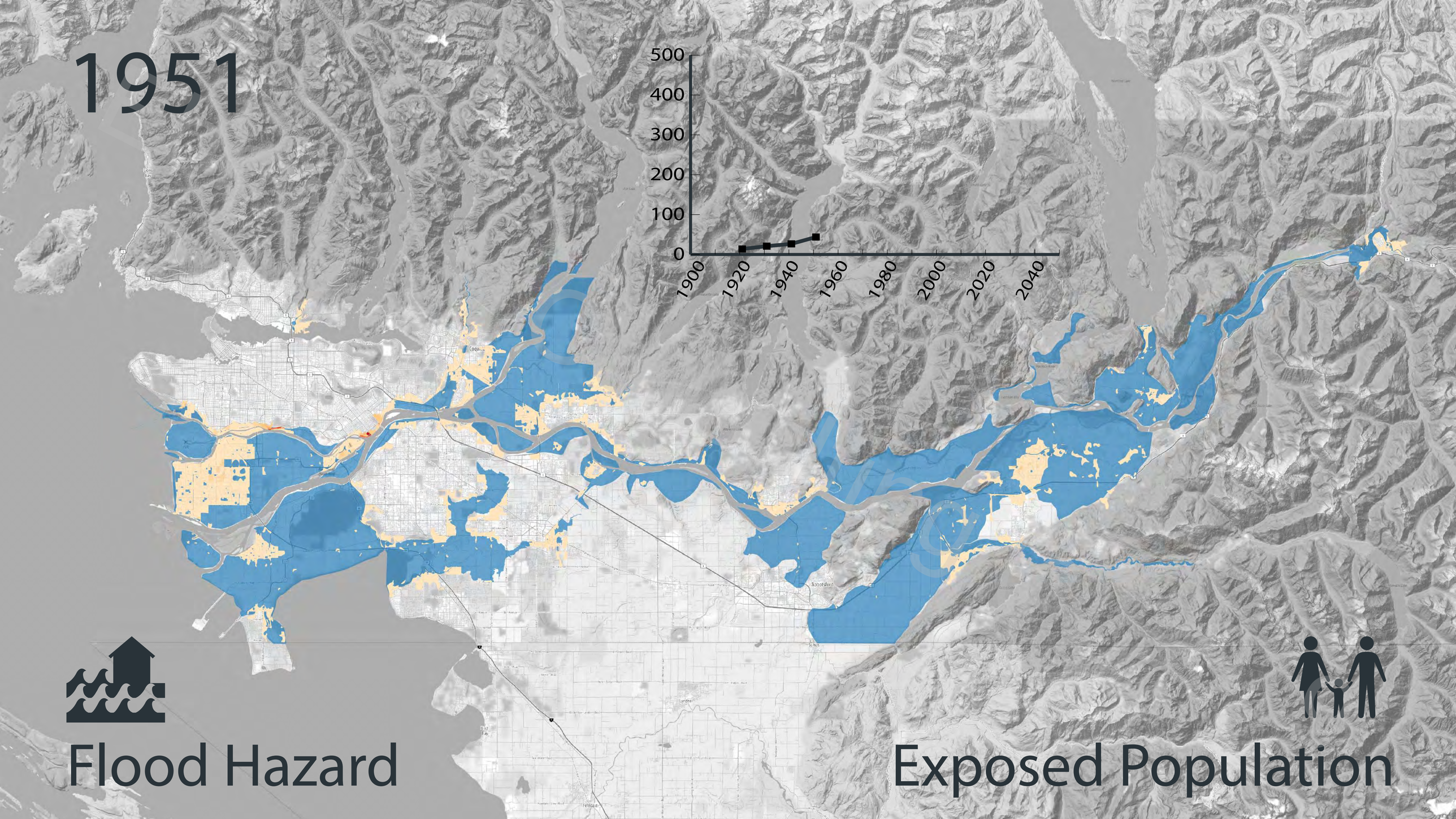
Flood Hazard

Exposed Population



“the Board was faced with many problems where empirical decisions, based only on judgment and experience, had to replace the usual tedious surveys and calculations”

(as cited in Watt 2006)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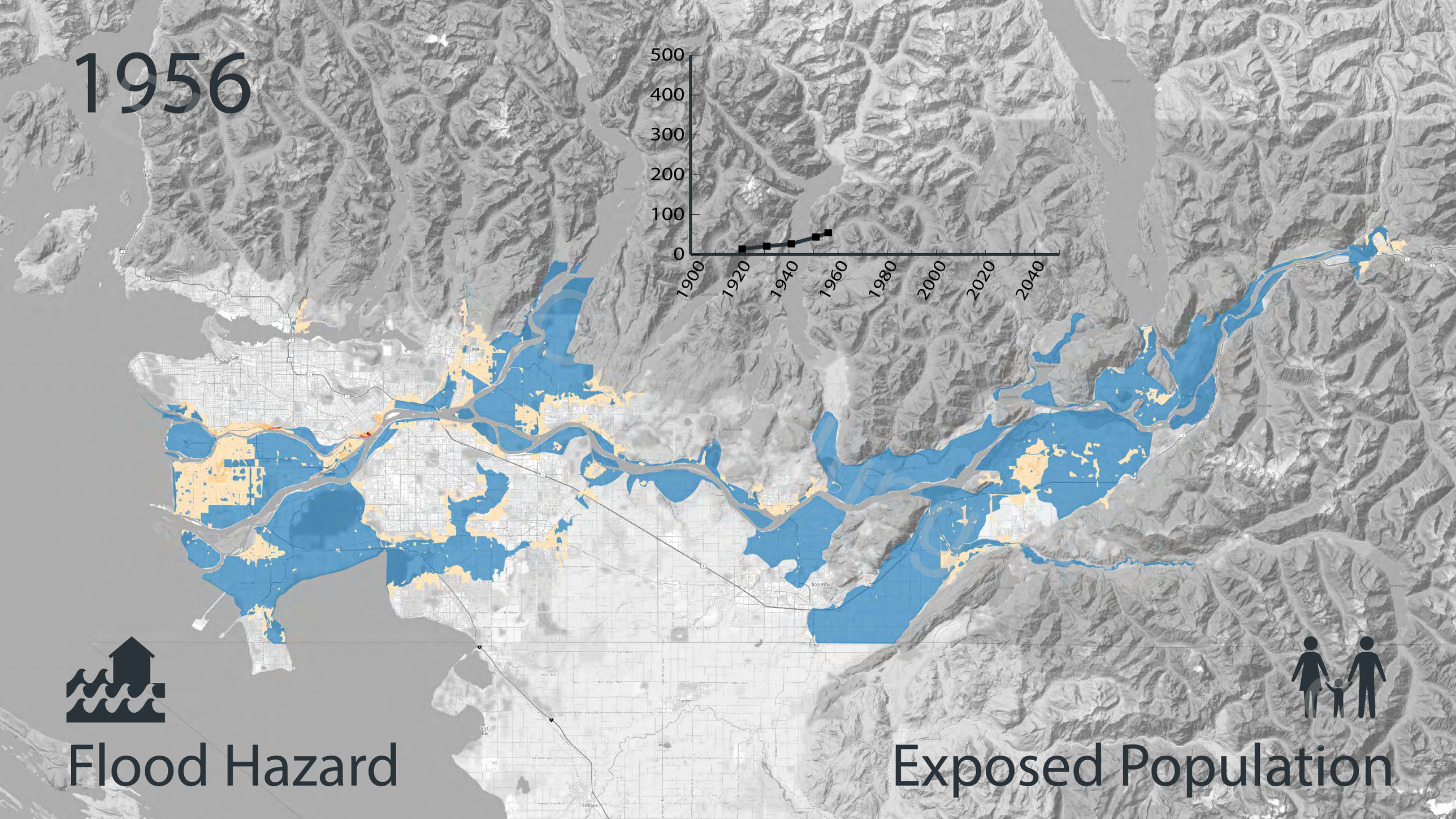
Flood Hazard
Exposed Population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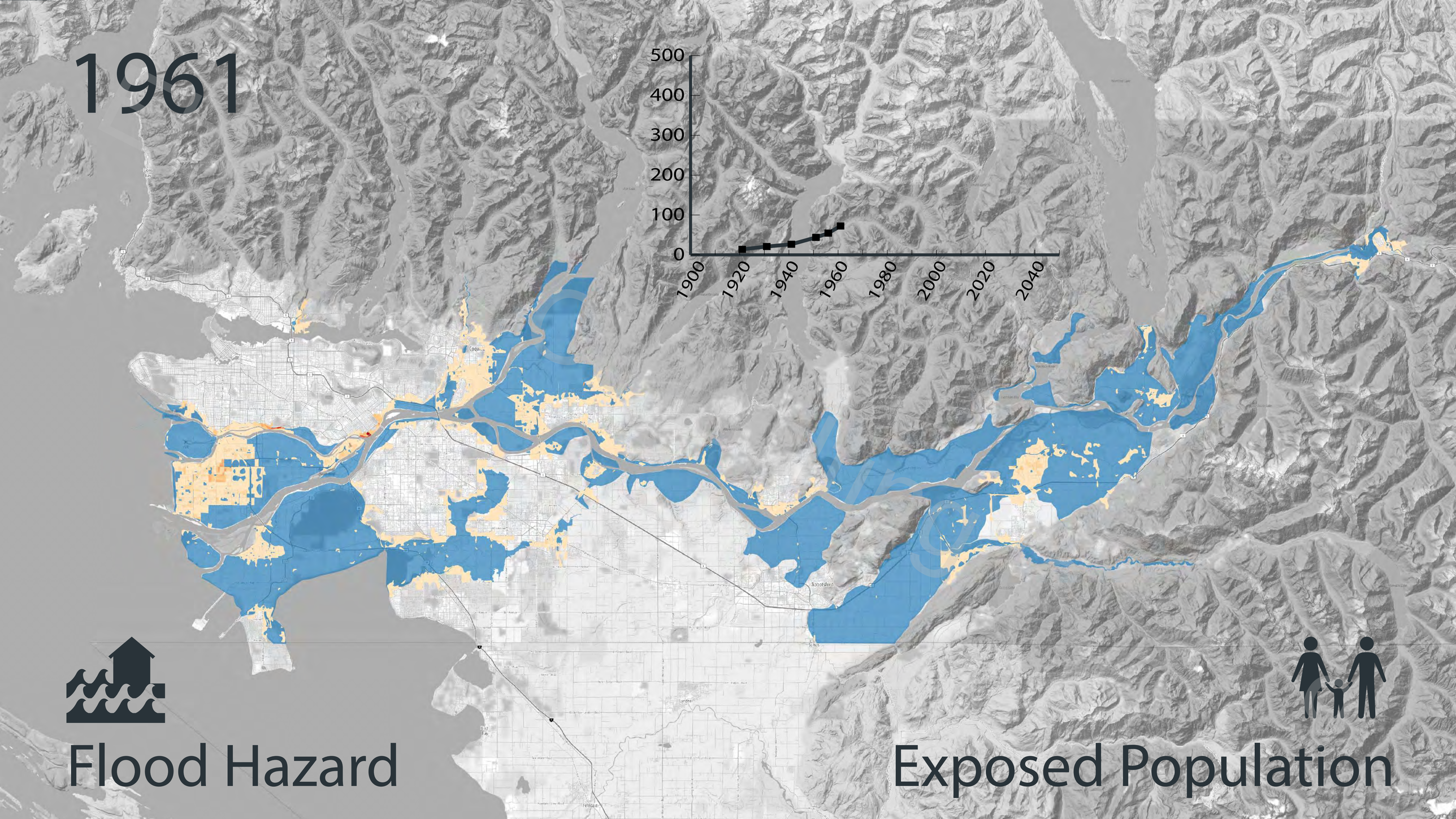
Flood Hazard
Exposed Population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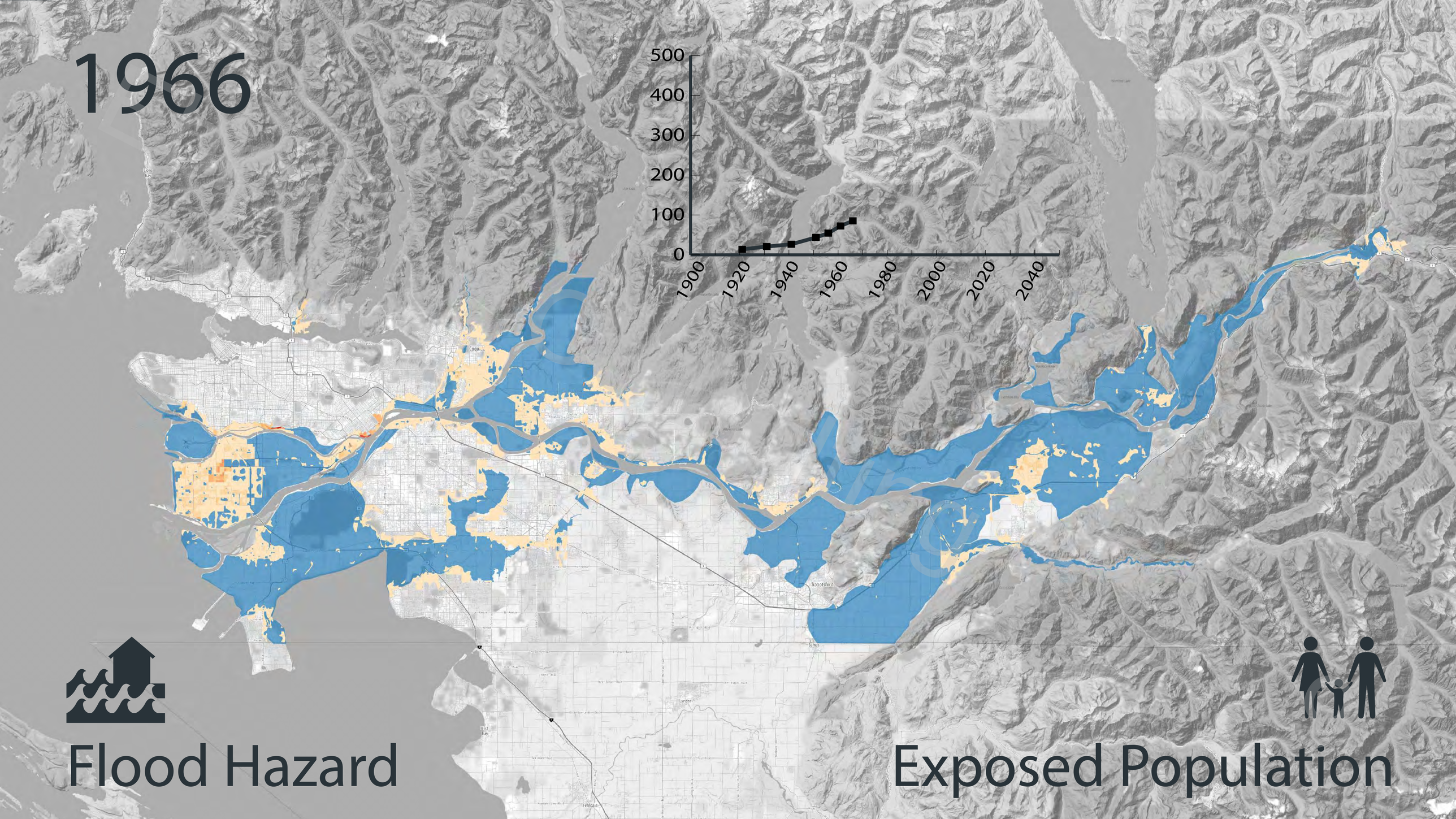
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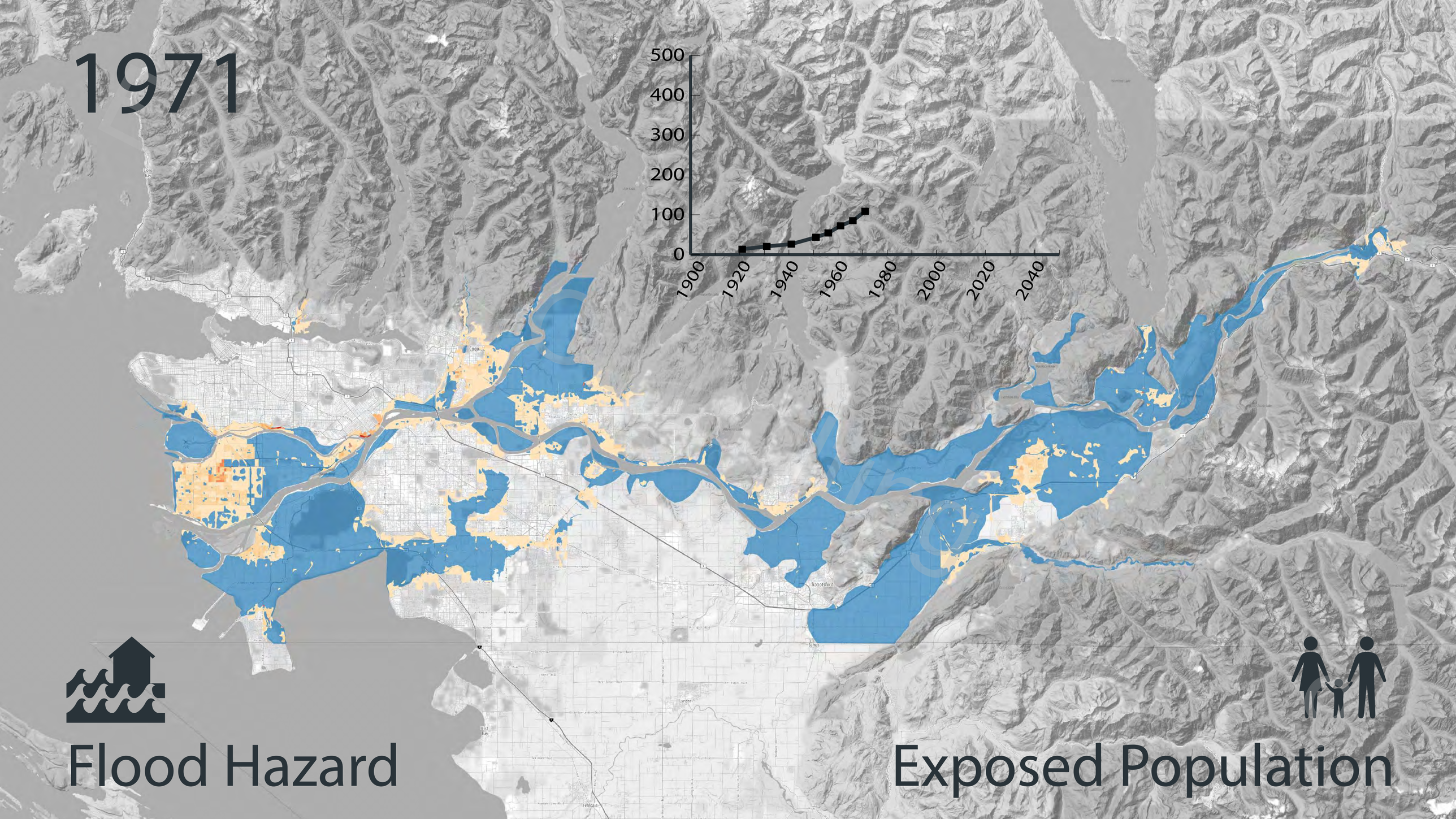
Exposed Population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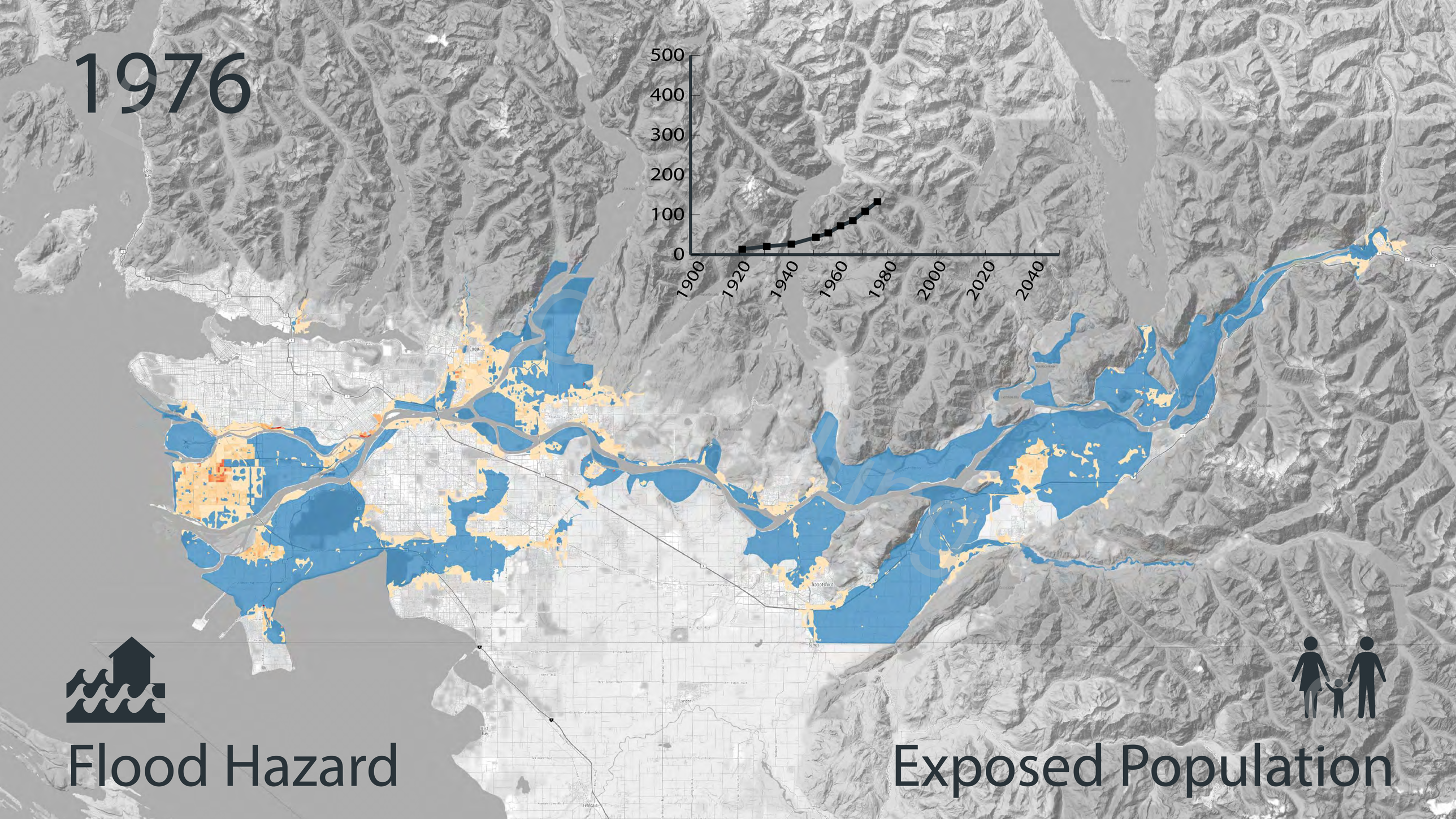
Flood Hazard
Exposed Population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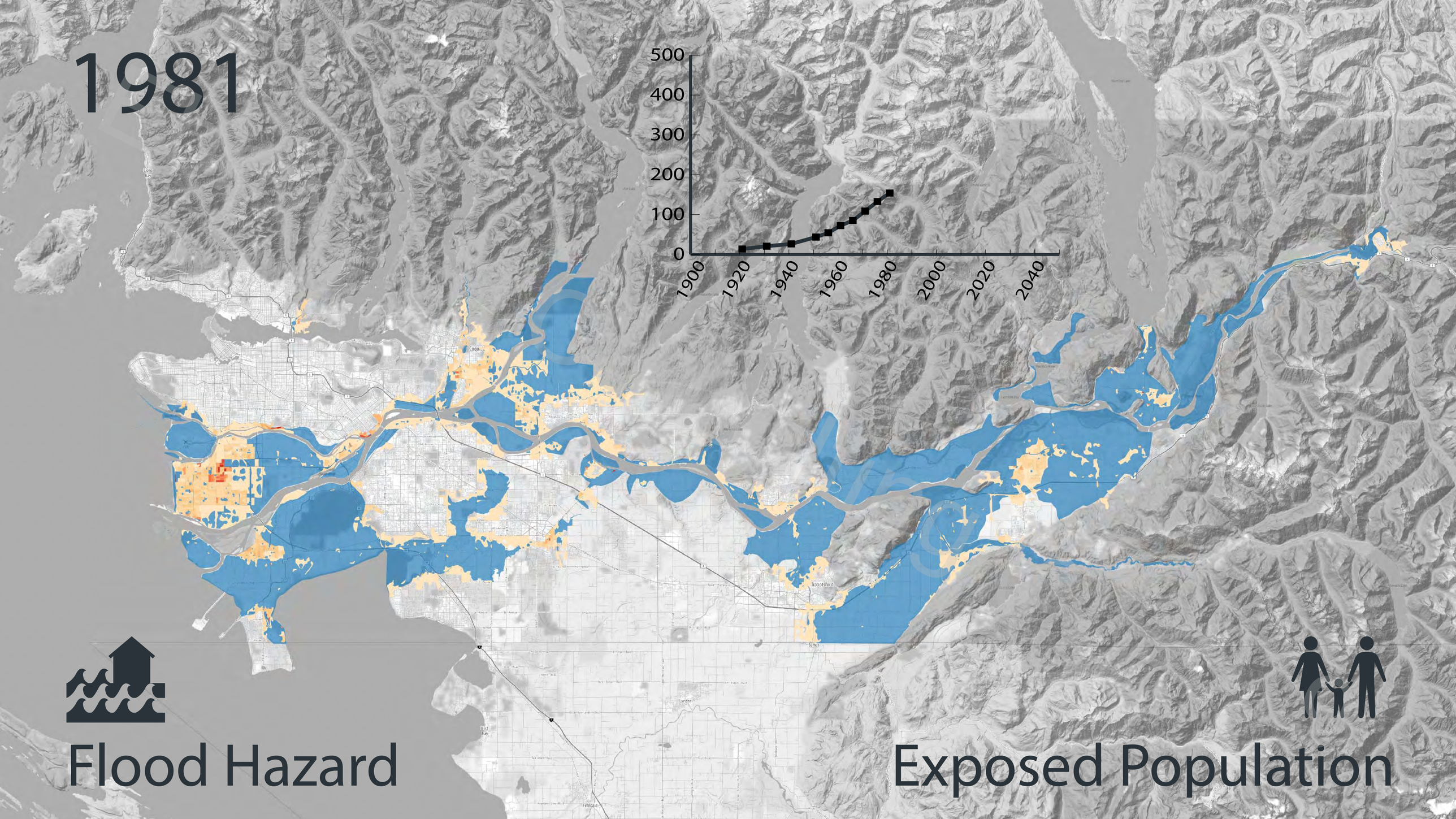
Flood Hazard
Exposed Population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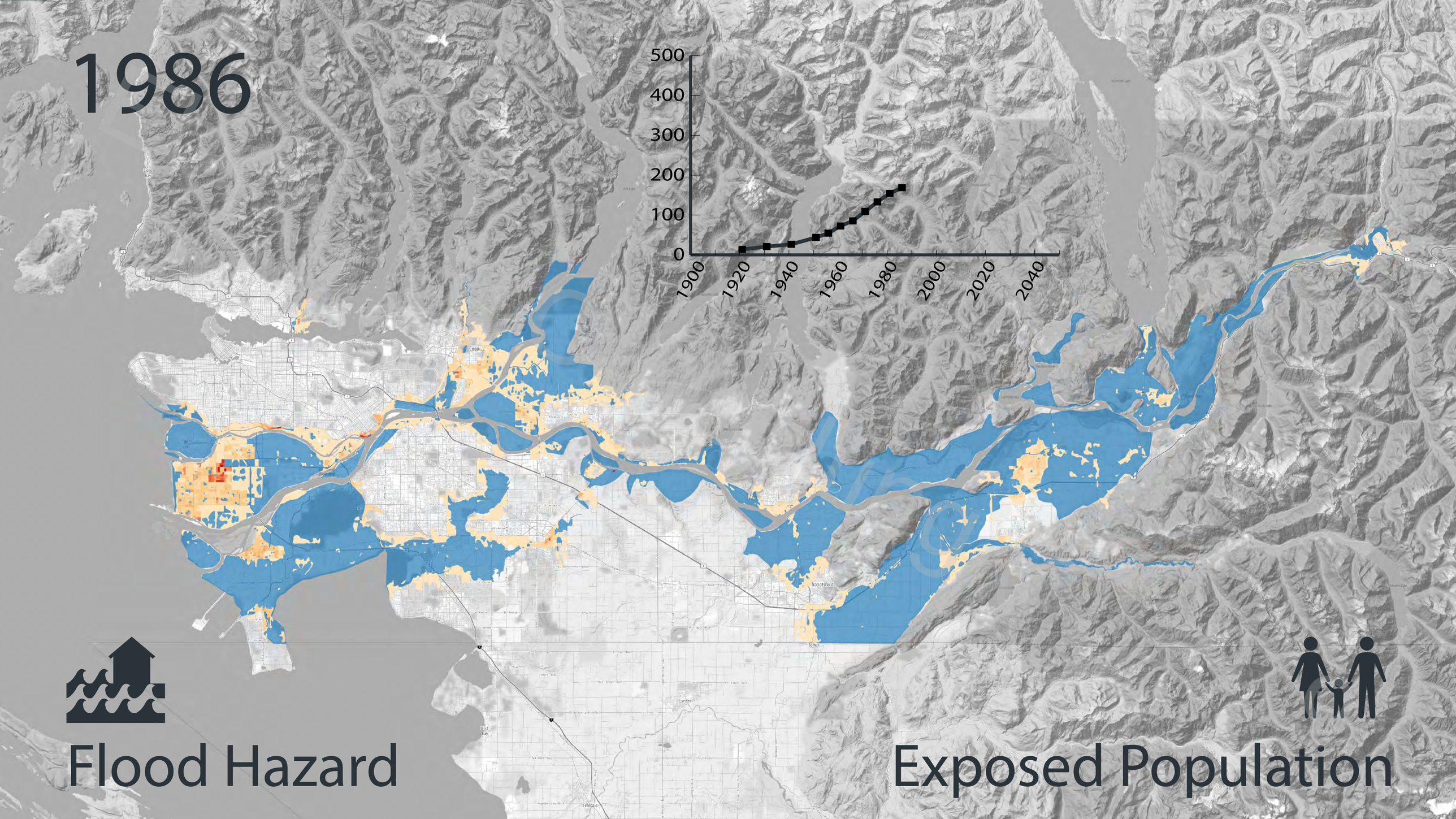
Flood Hazard
Exposed Population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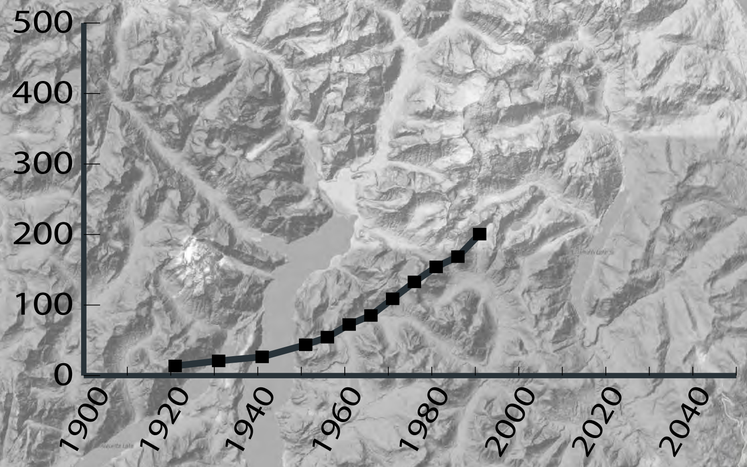
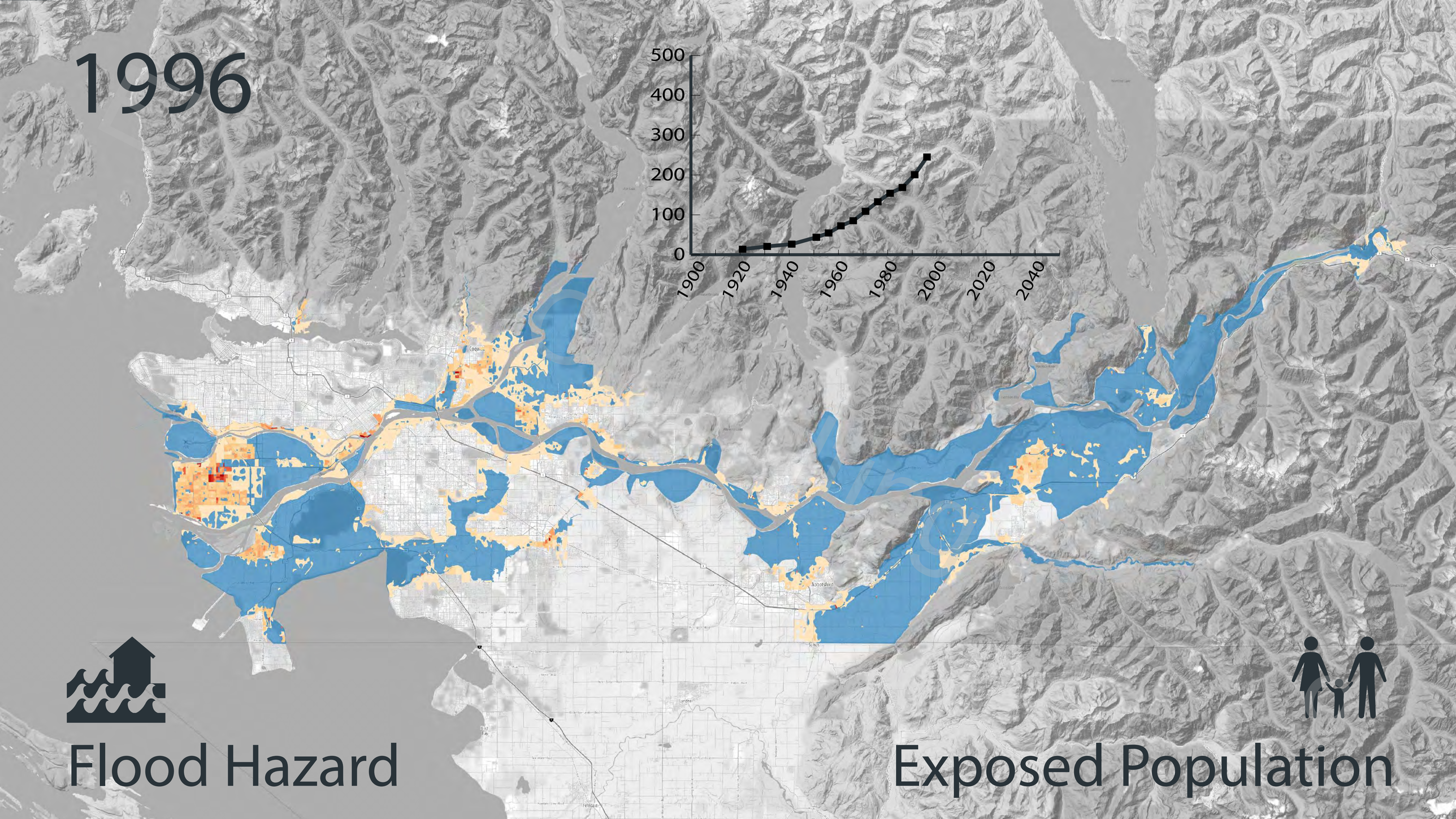
Flood Hazard
Exposed Population

1991



Flood Hazard

Exposed Population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Flood Hazard
Exposed Population

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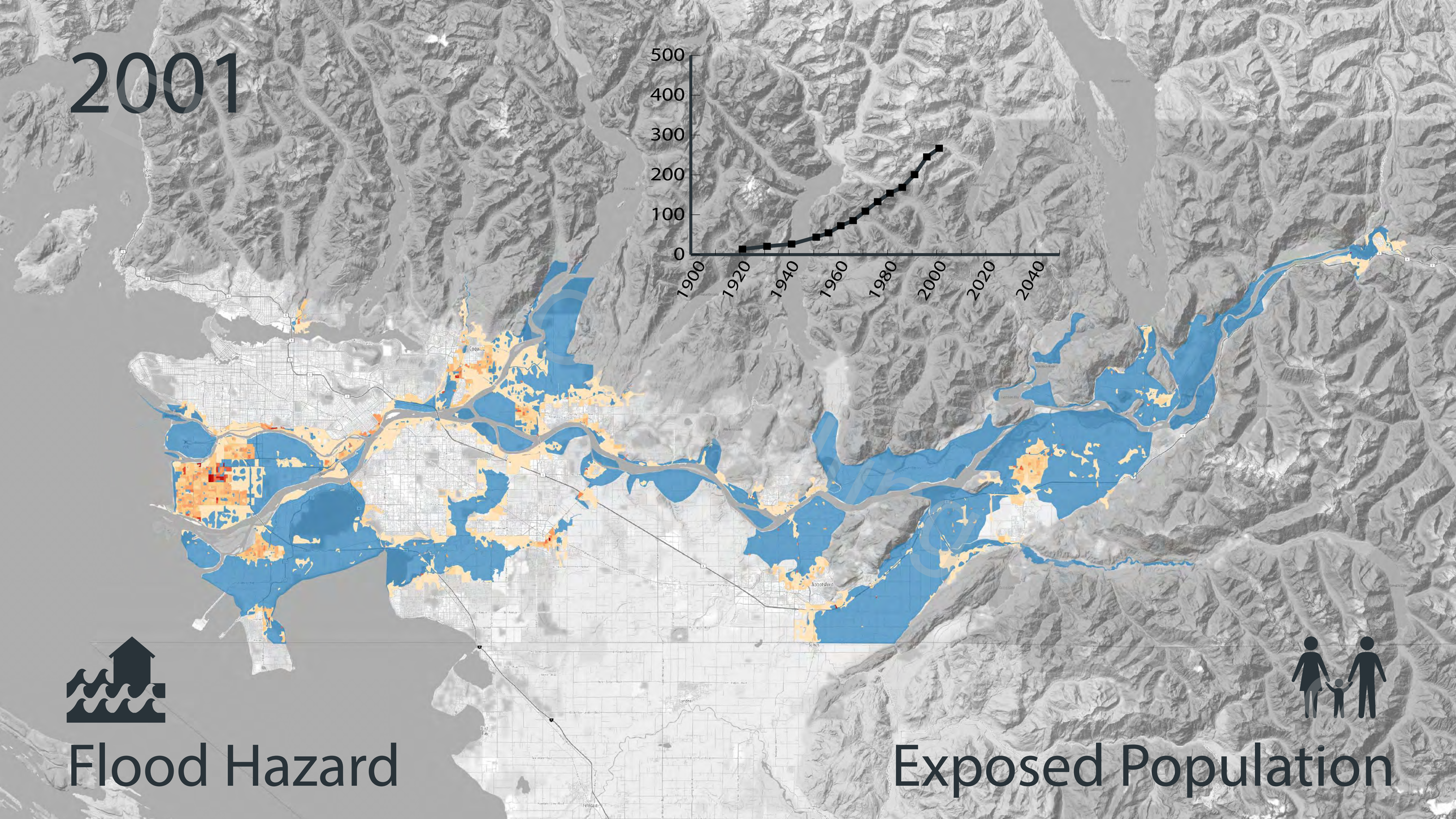
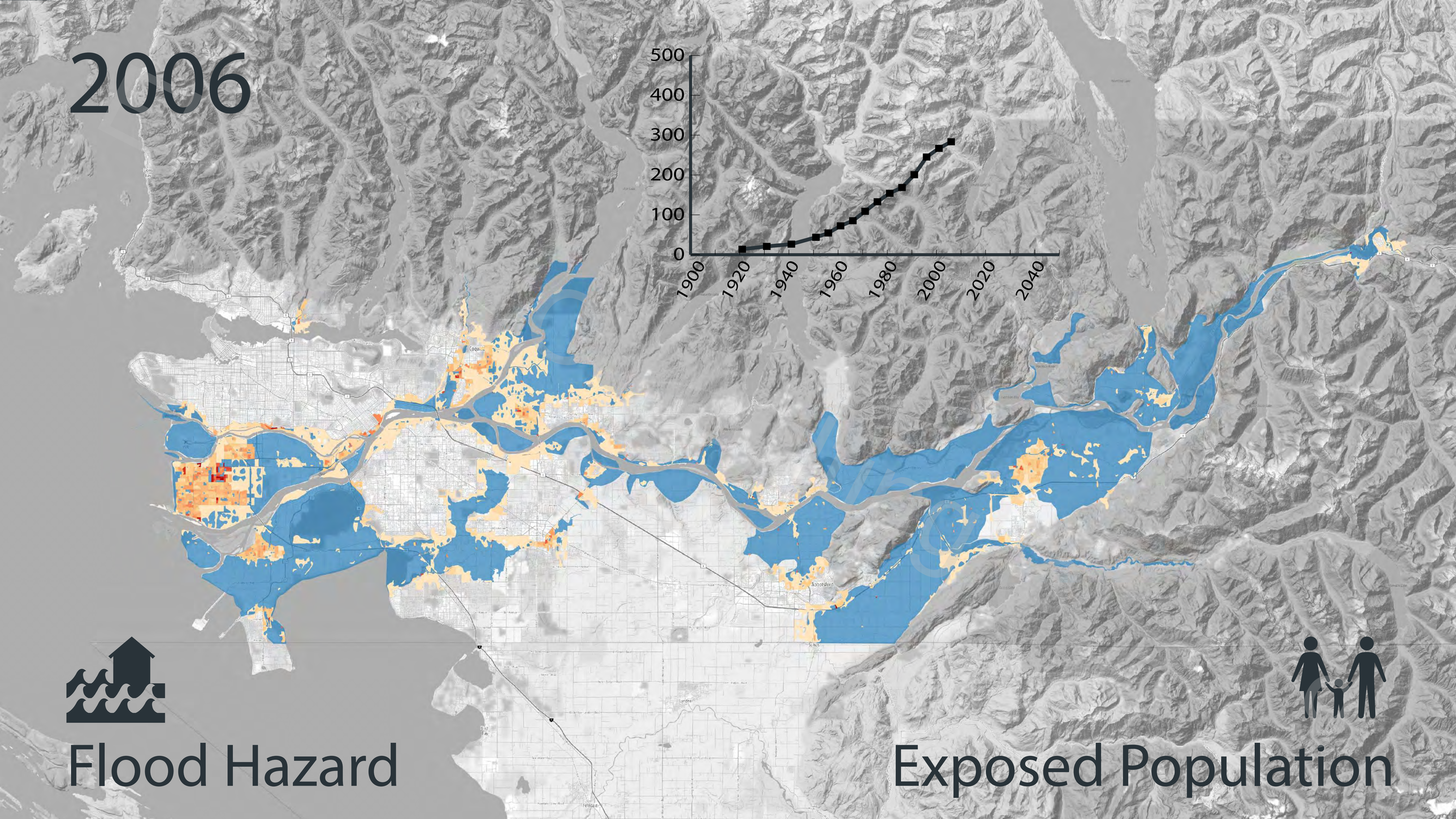


Flood Hazard

Exposed Population

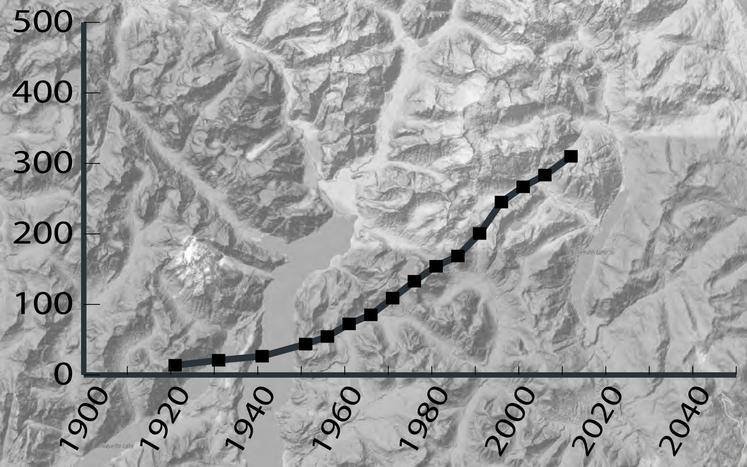
2006



Flood Hazard

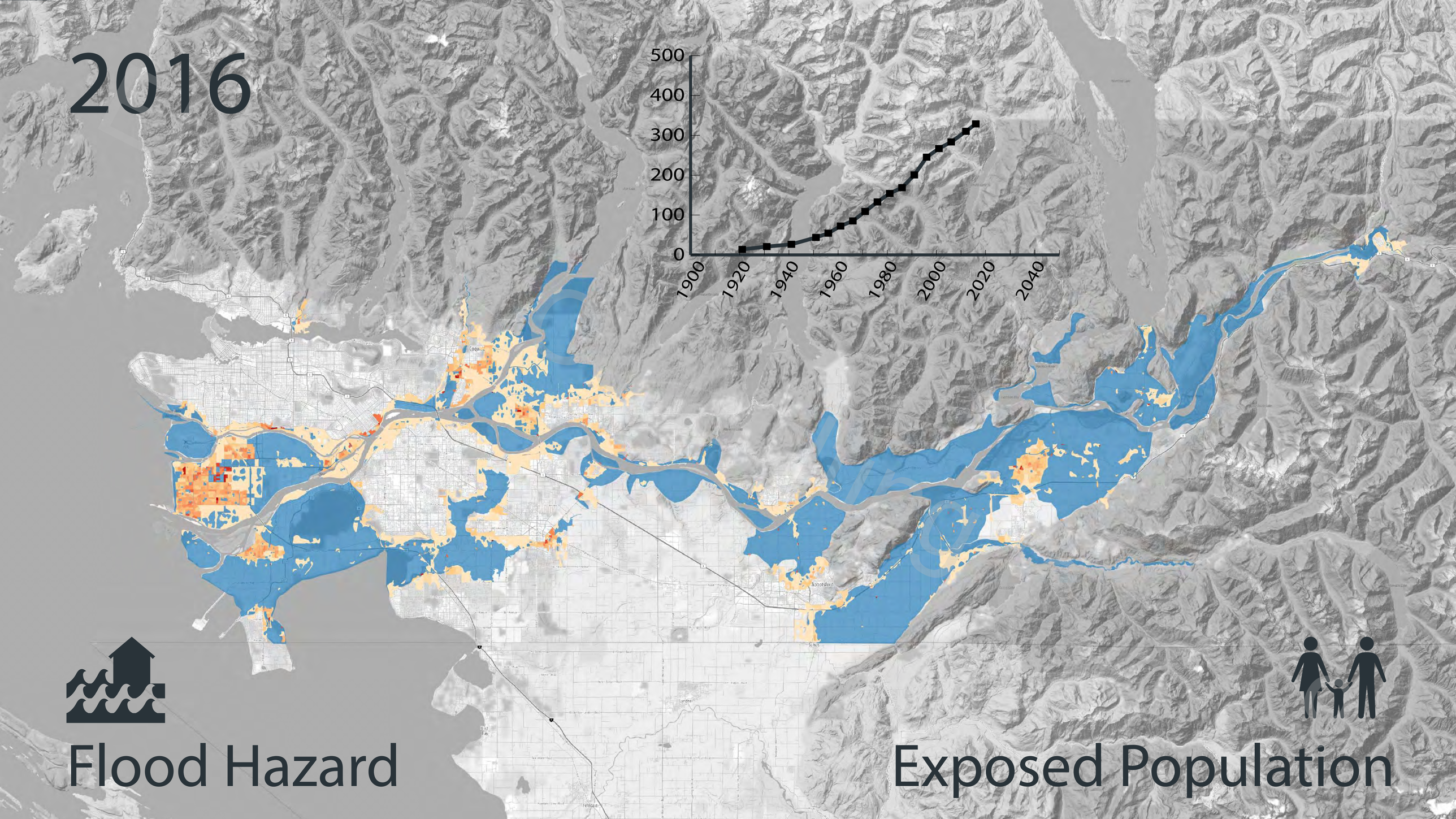
Exposed Population

2012



Flood Hazard

Exposed Population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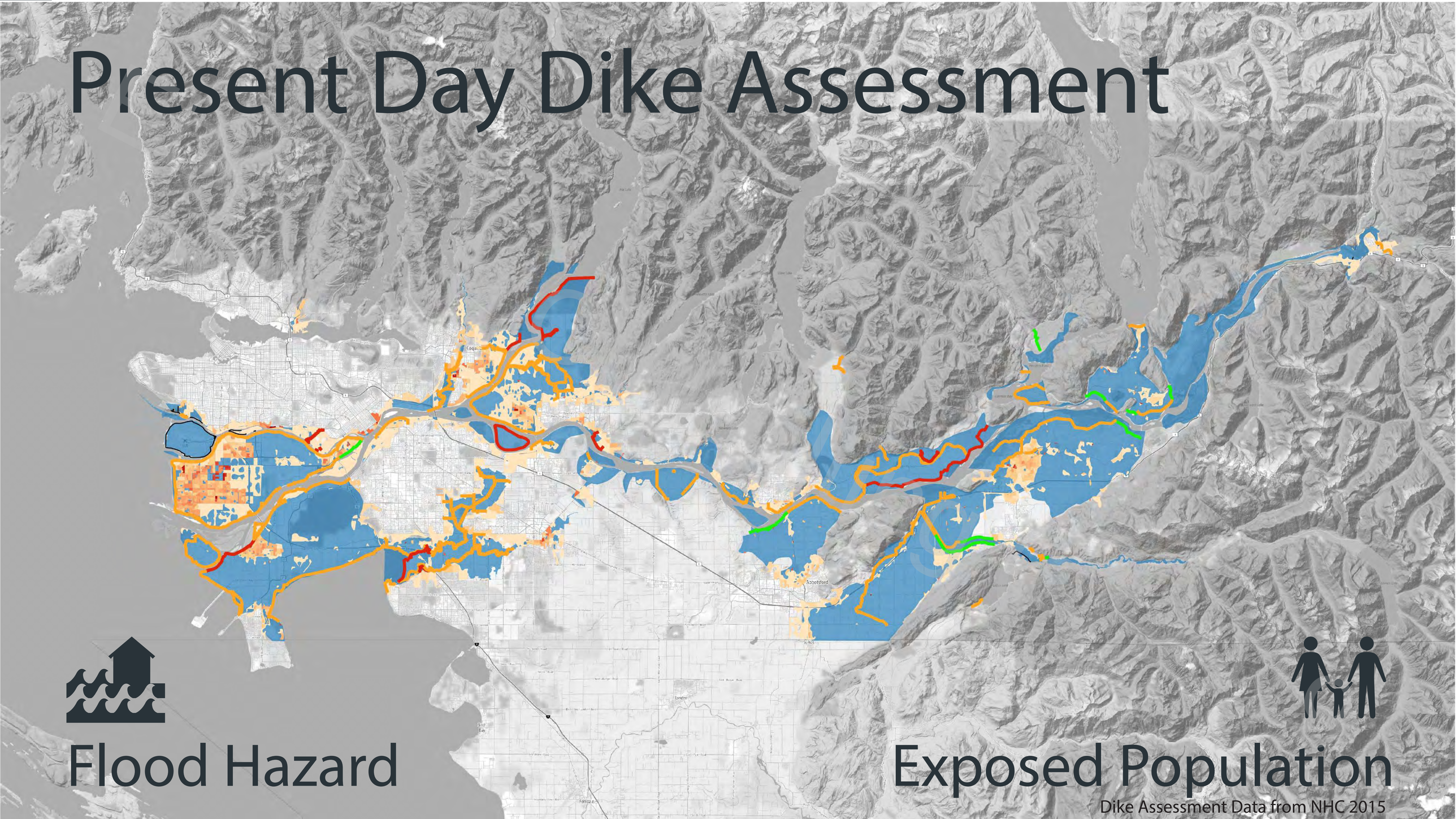
Flood Hazard
Exposed Population

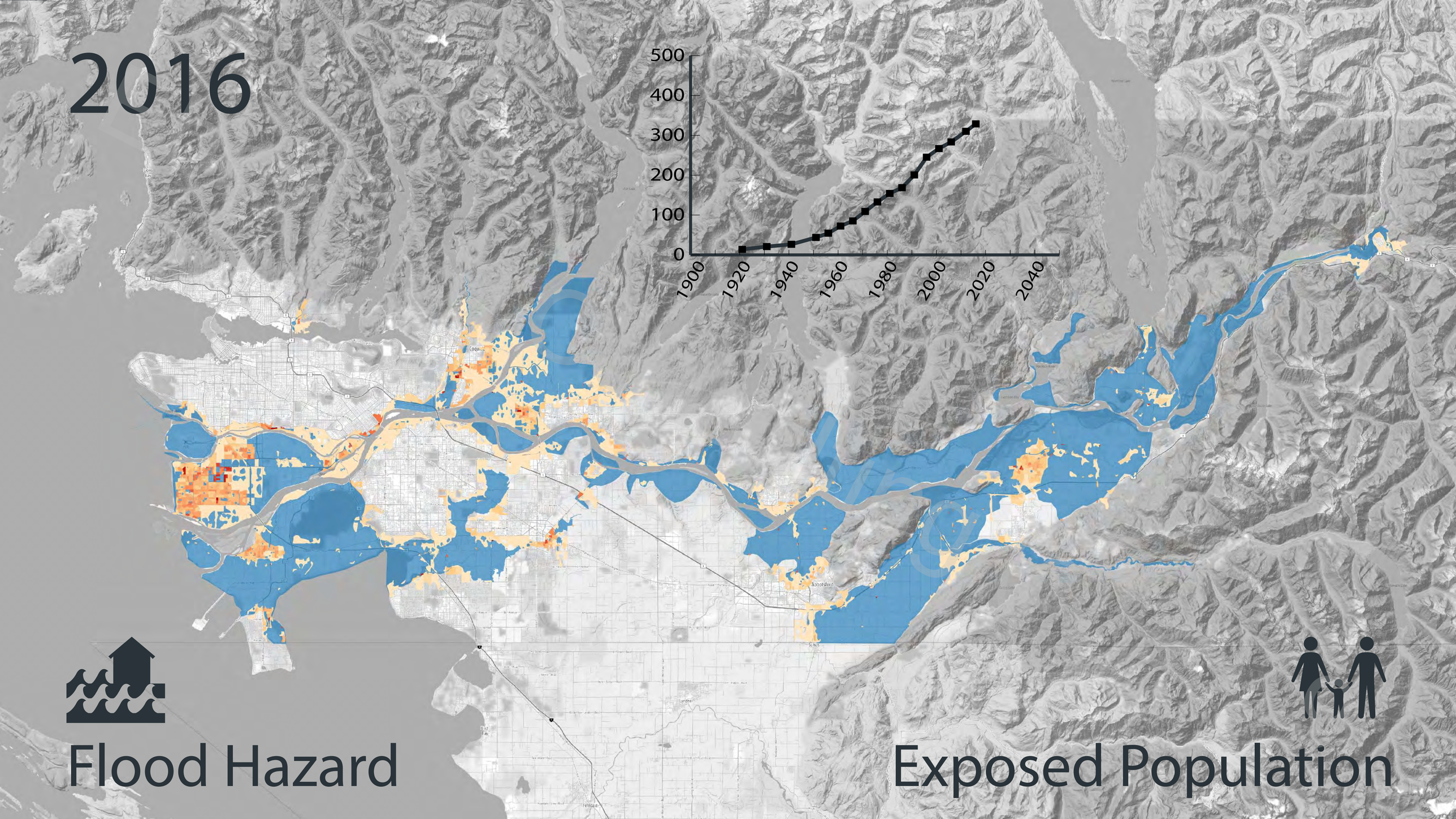
Present Day Dike Assessment



Flood Hazard

Exposed Population

Dike Assessment Data from NHC 2015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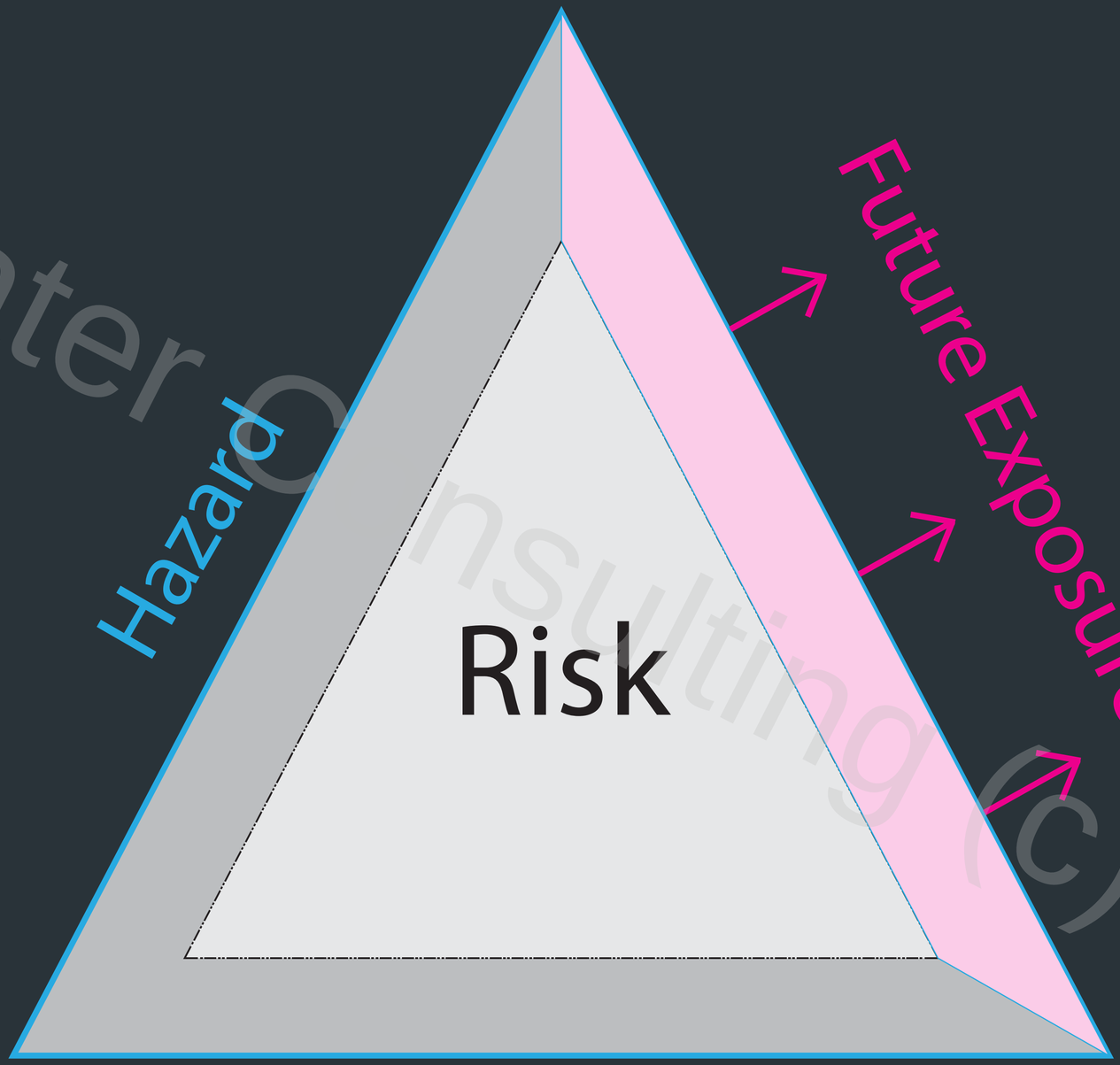
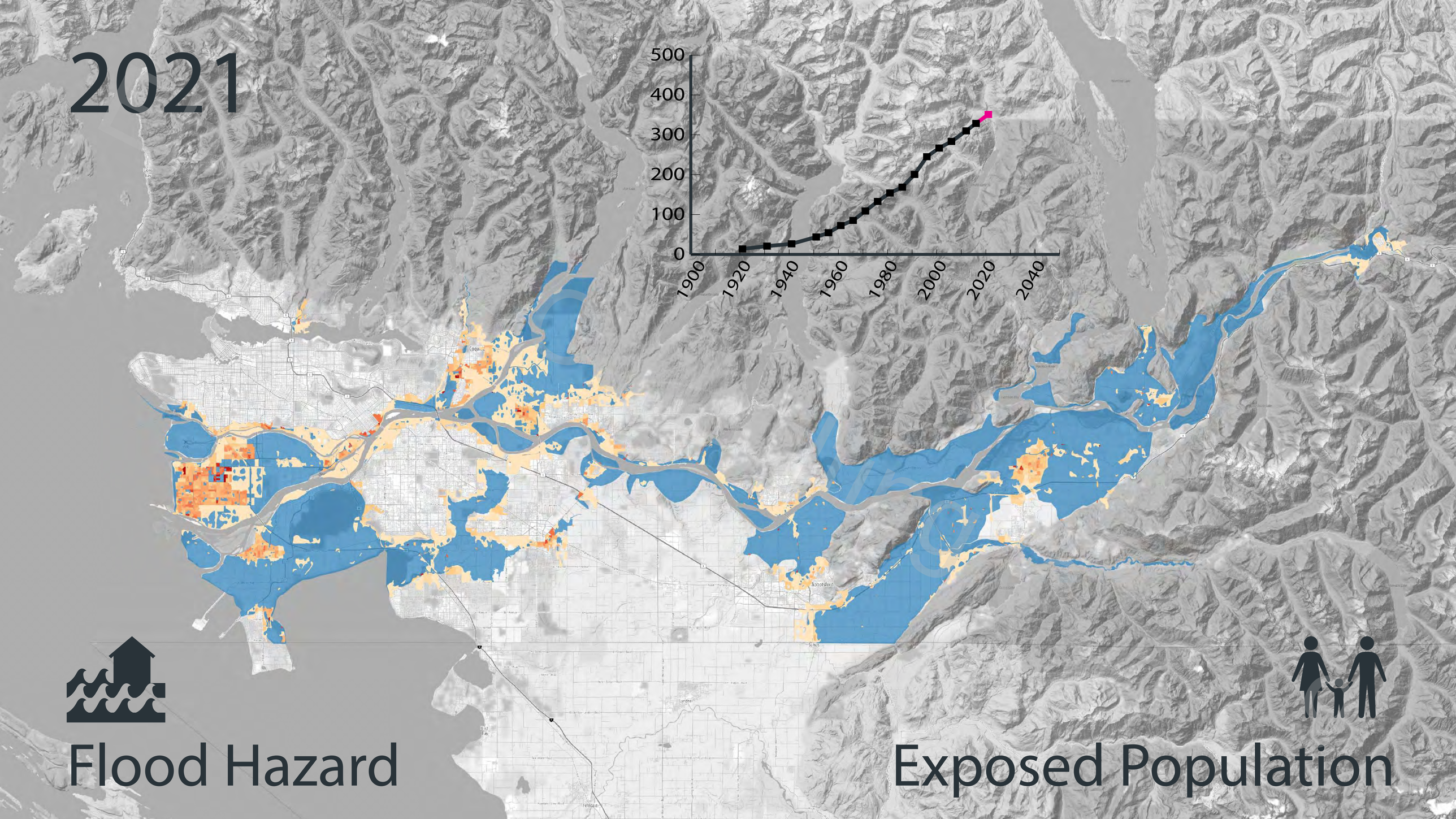
Flood Hazard
Exposed Population


Agricultural Land Reserve
Abbotsford
Flood Hazard
Exposed Population

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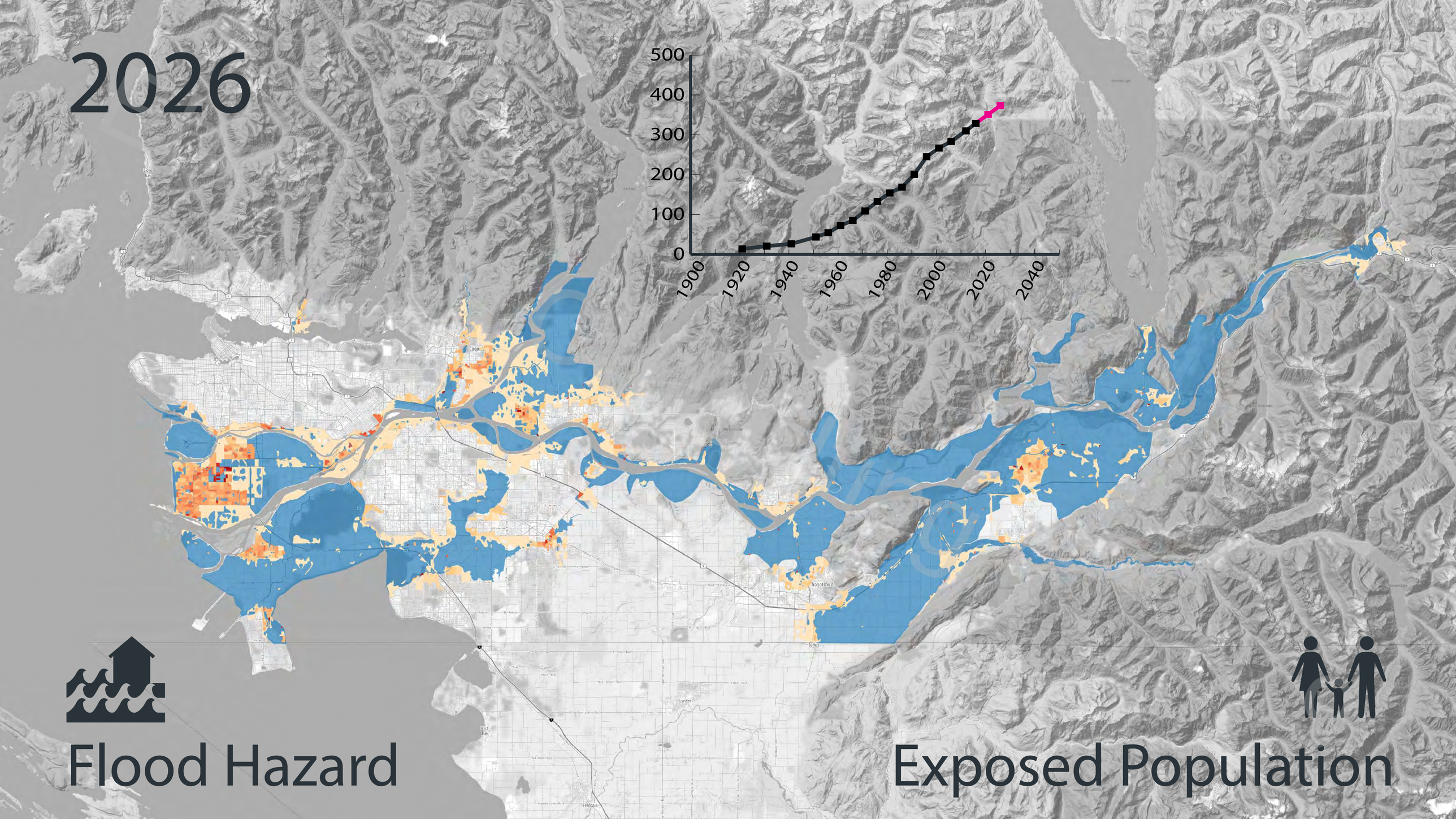
Flood Hazard
Exposed Population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Flood Hazard
Exposed Population

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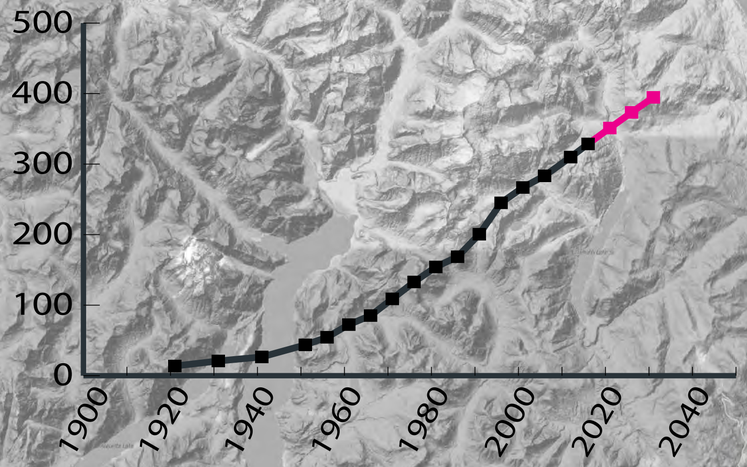
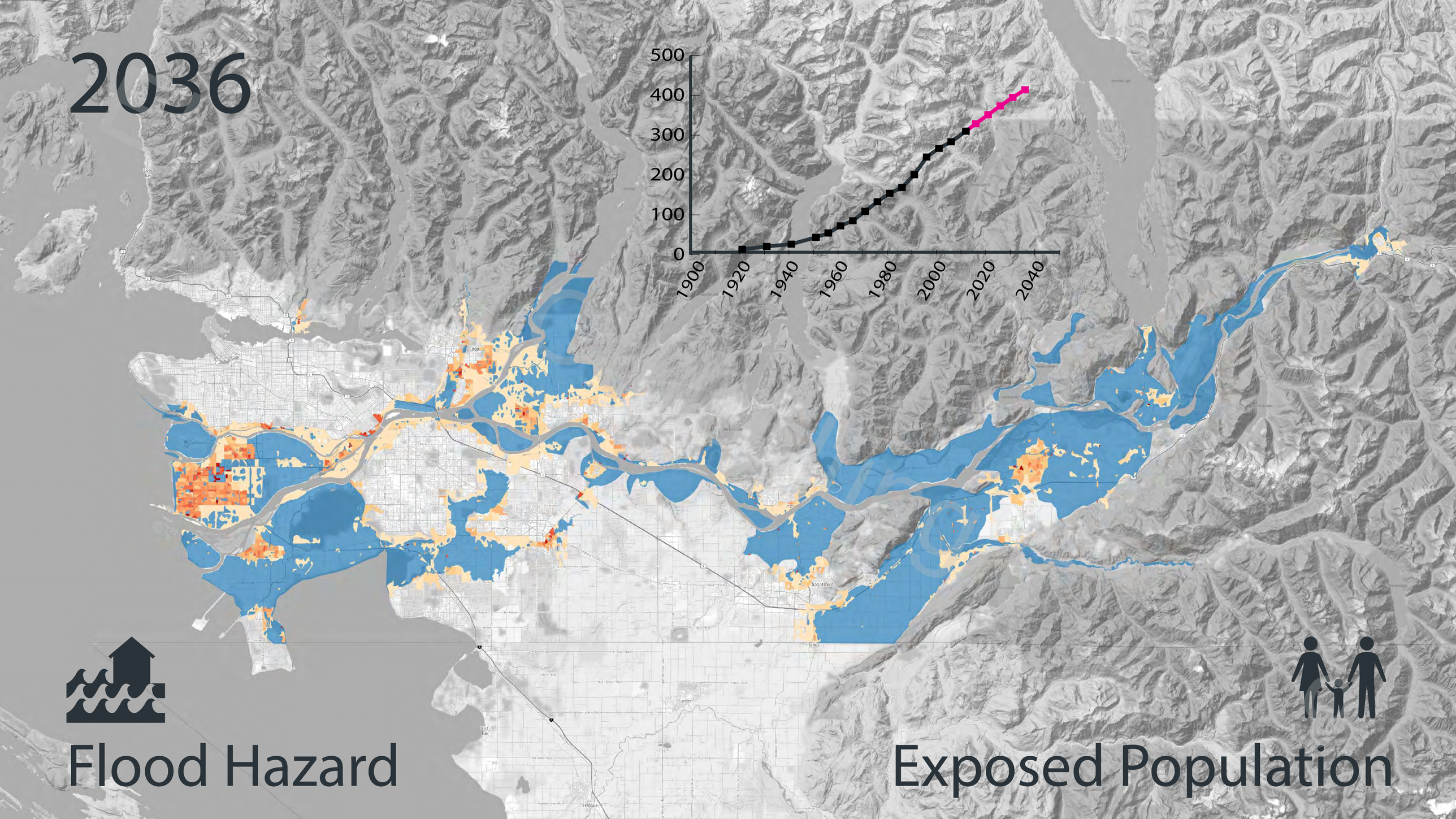


Flood Hazard

Exposed Population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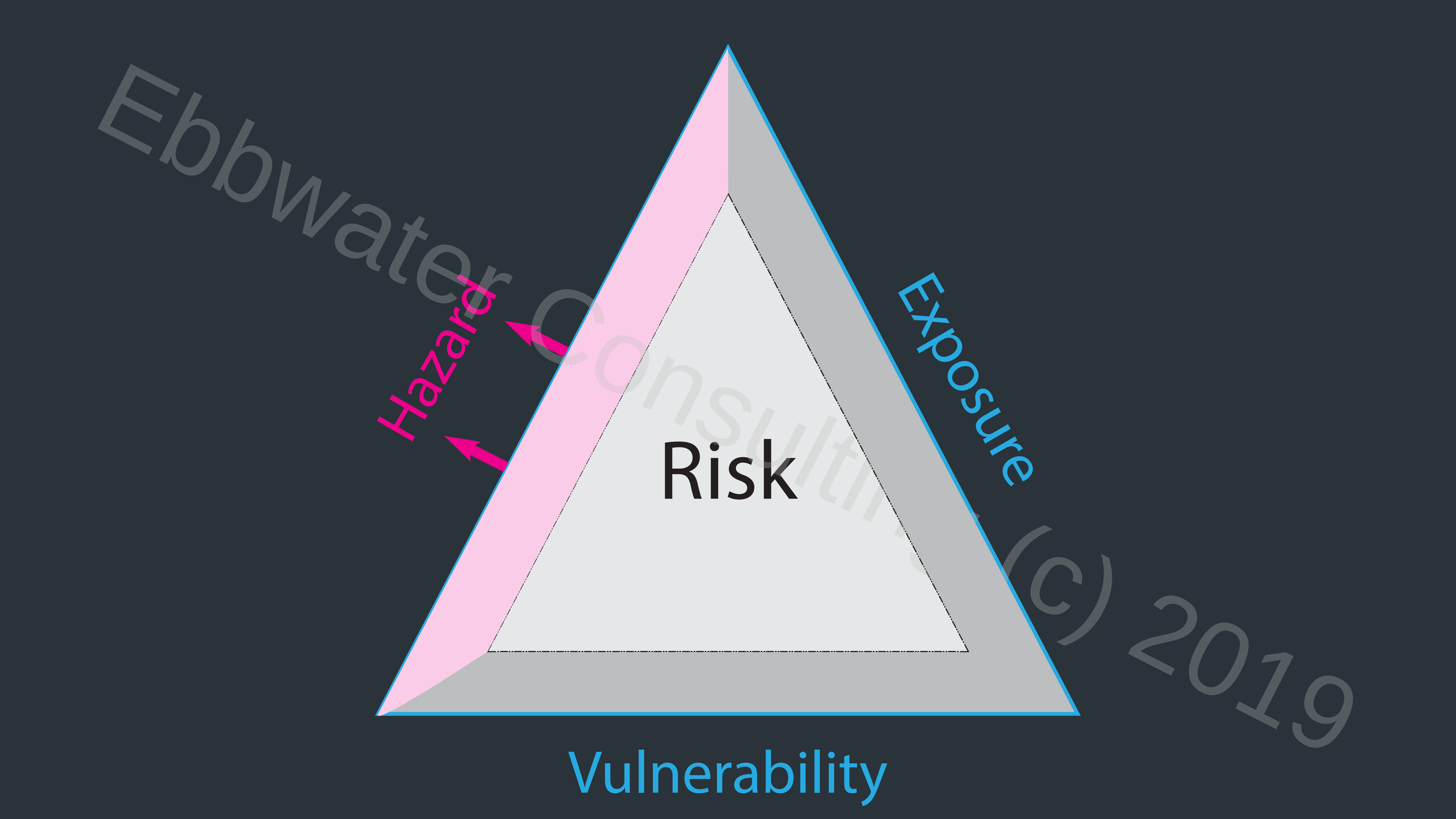
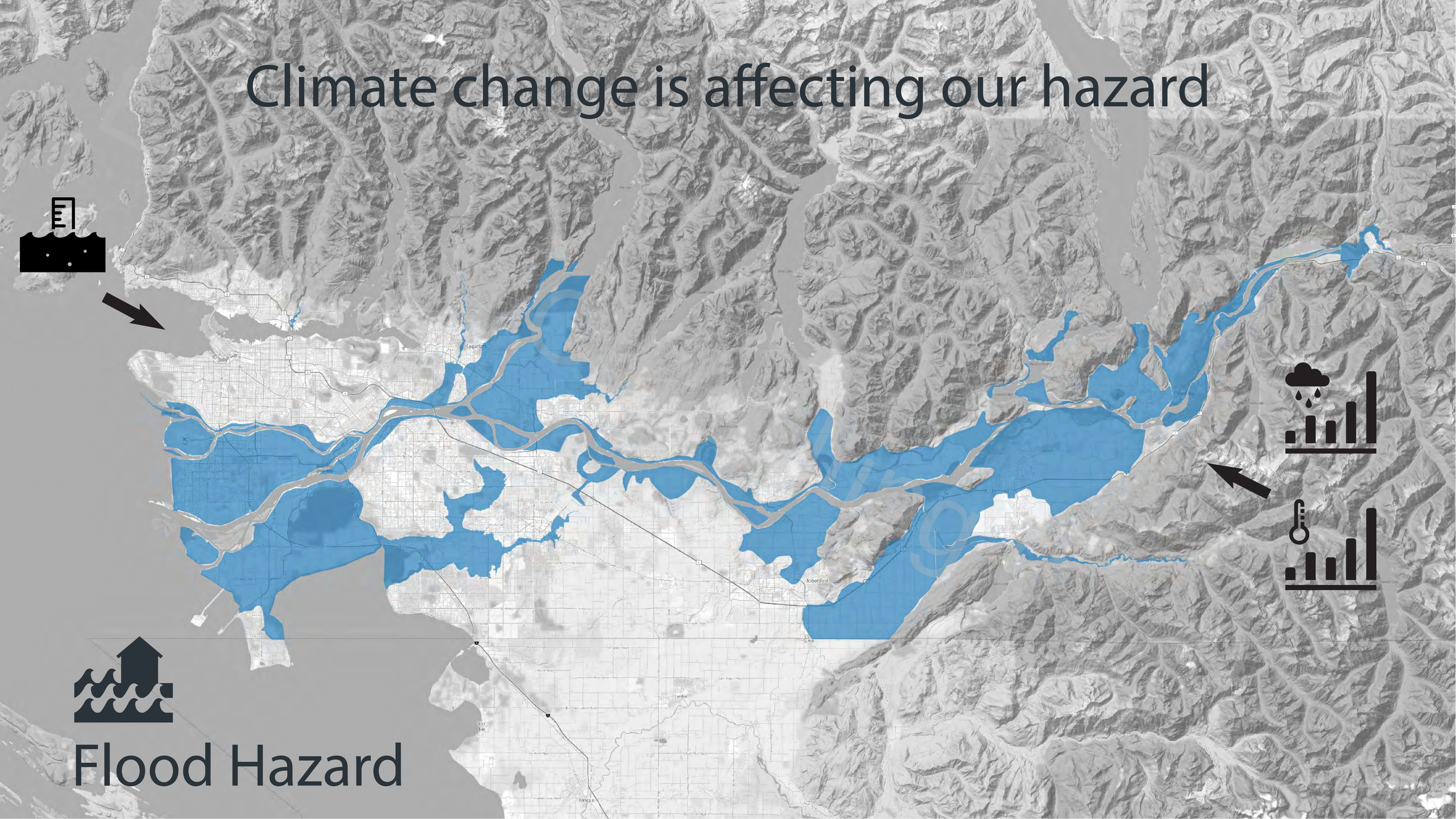
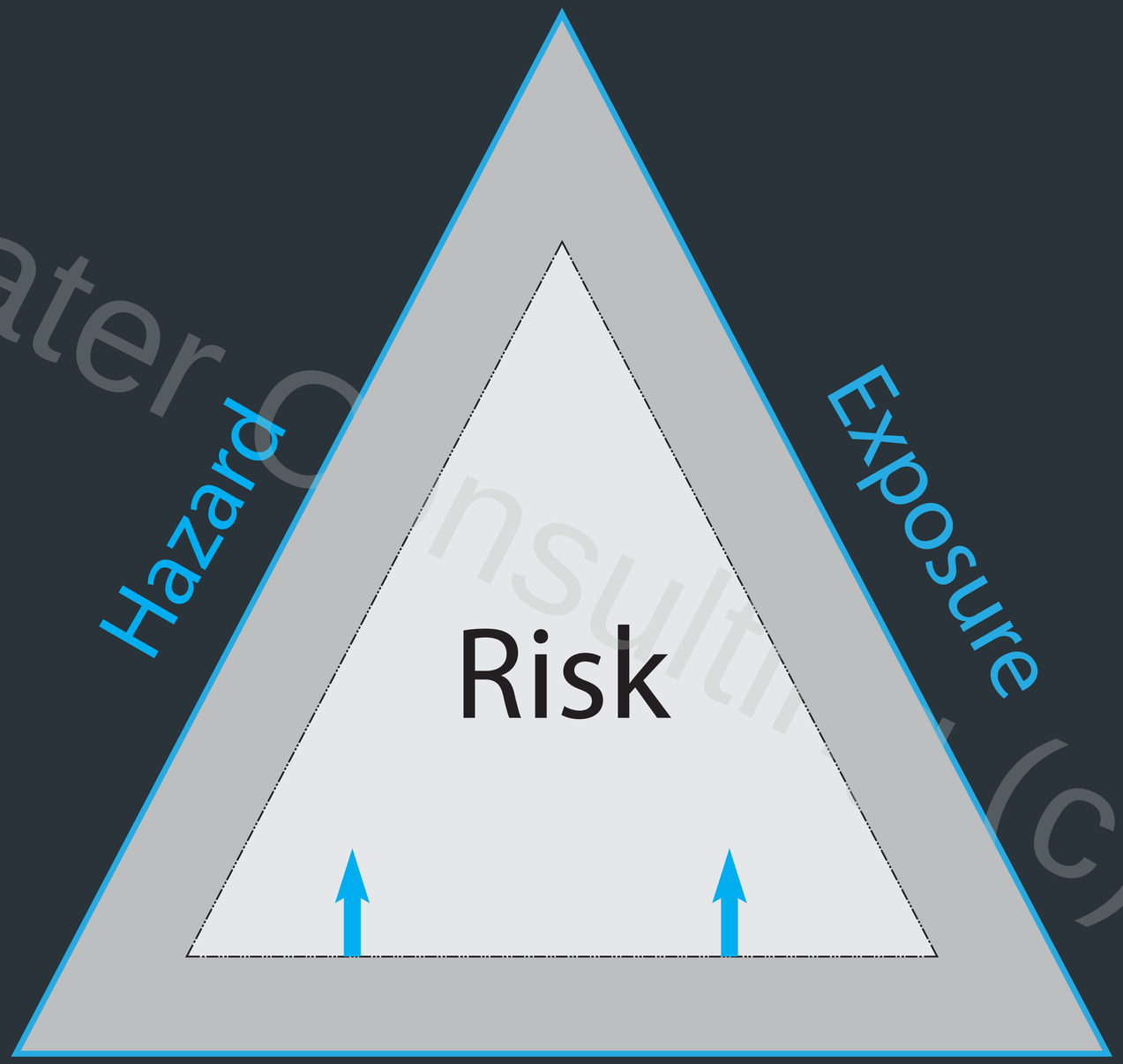
Flood Hazard
Exposed Population



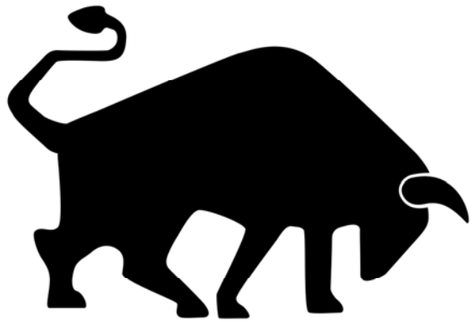
Climate change is affecting our hazard

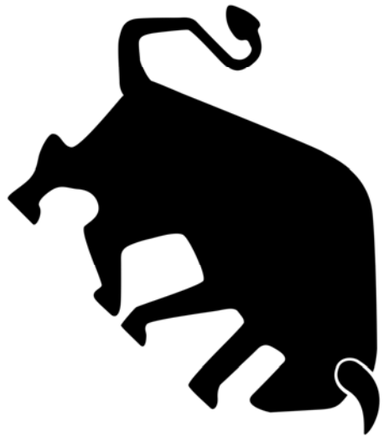


Flood Hazard

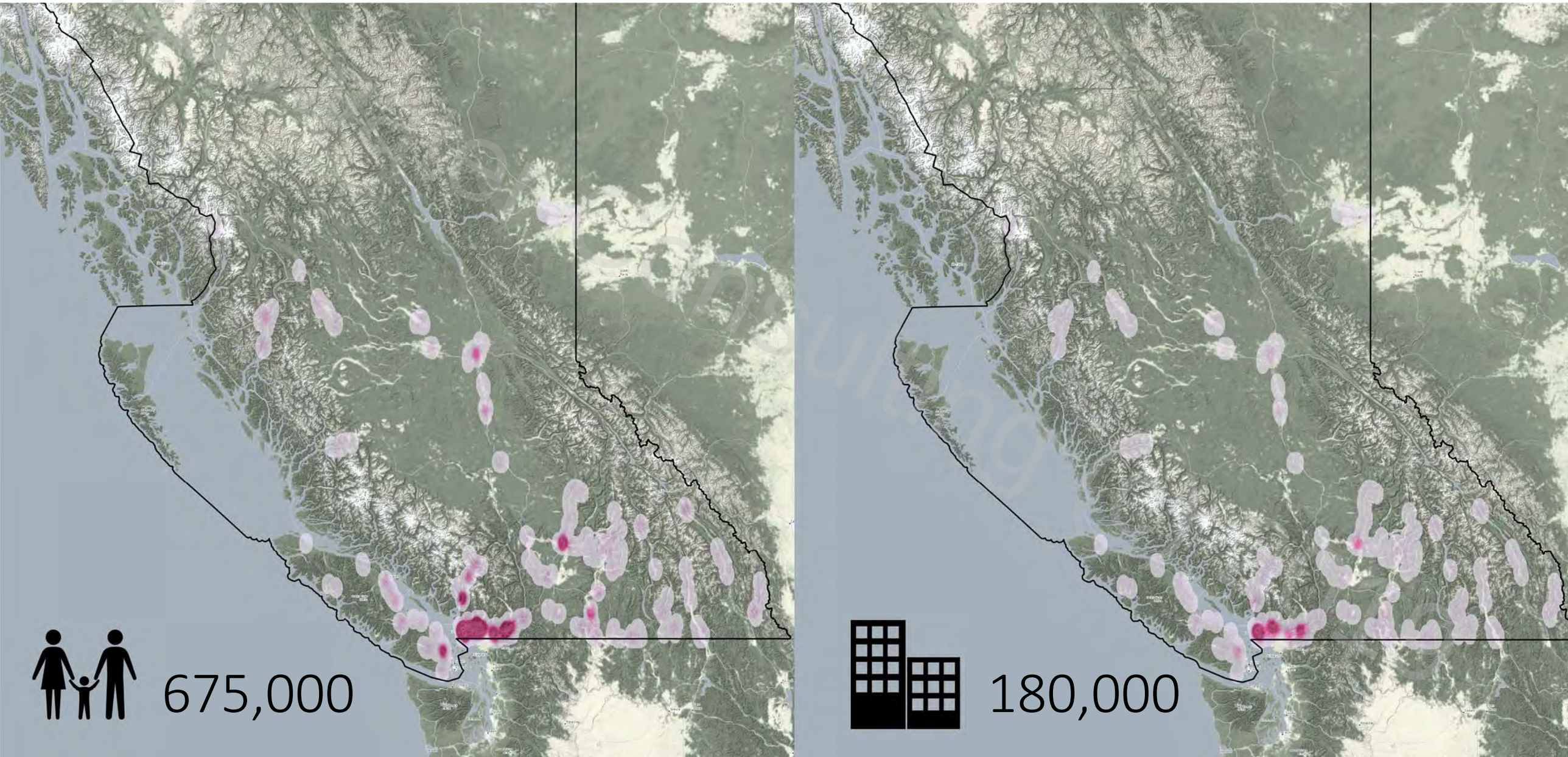


Let’s flip this problem on its head





Exposure = Opportunity for Risk Reduction

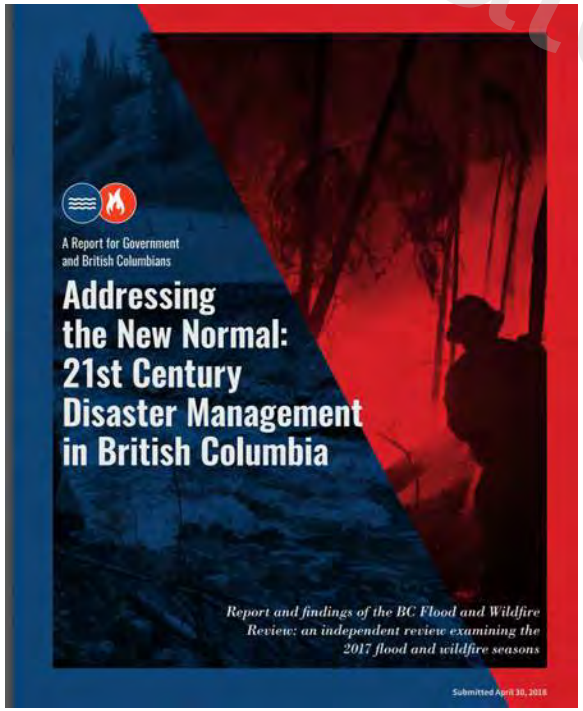


An Evolution in Flood Management

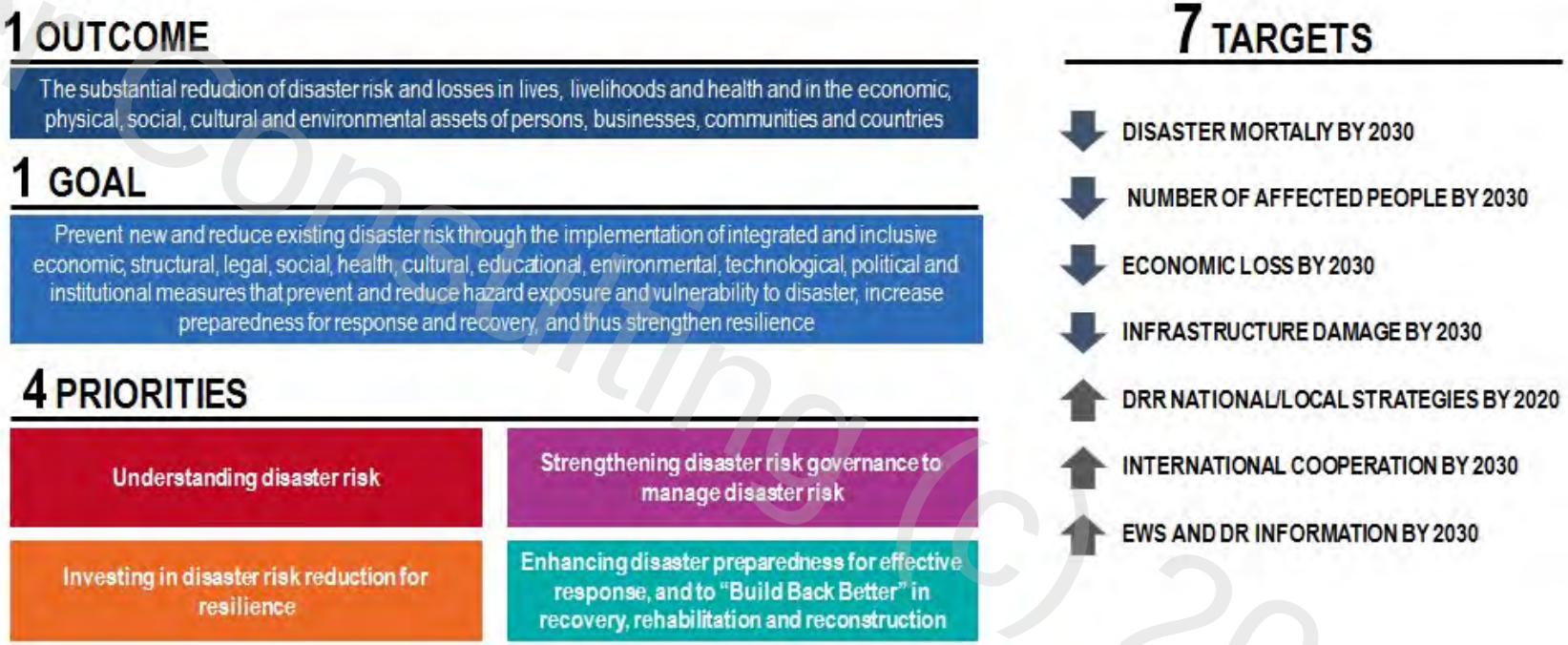
Sayers et al. 2014

A willingness to live with floods	•Individual and small communities adapt to natures rhythm.
A desire to use the floodplain	•Fertile land in the floodplain is drained for food production. •Permanent communities are established on the floodplain. •Local (uncoordinated) levees start to be constructed.
A desire to control flood flows and defend against flooding	•Large scale structural approaches (levees ,dams and other controls) are planned and implemented through organized governance.
A desire to reduce flood damages	•A recognition that engineering alone has limitations. •Effort is devoted to increasing the resilience of communities should a flood occur. •Effort is devoted to mitigate lost of ecosystem services.
A desire to manage risks efficiently	•A recognition that budgets are limited and not all problems are equal. •Risk management is seen as a means to target limited resources.
A desire to promote opportunities and manage risks adaptively	•Adaptive management is seen as effective in managing the severe uncertainties in future climate change, funding and demographics. •Working with natural processes is encouraged to both reduce risks efficiently and achieve gains in ecosystem services.

Big Picture Optimism in BC
A movement towards risk-based planning



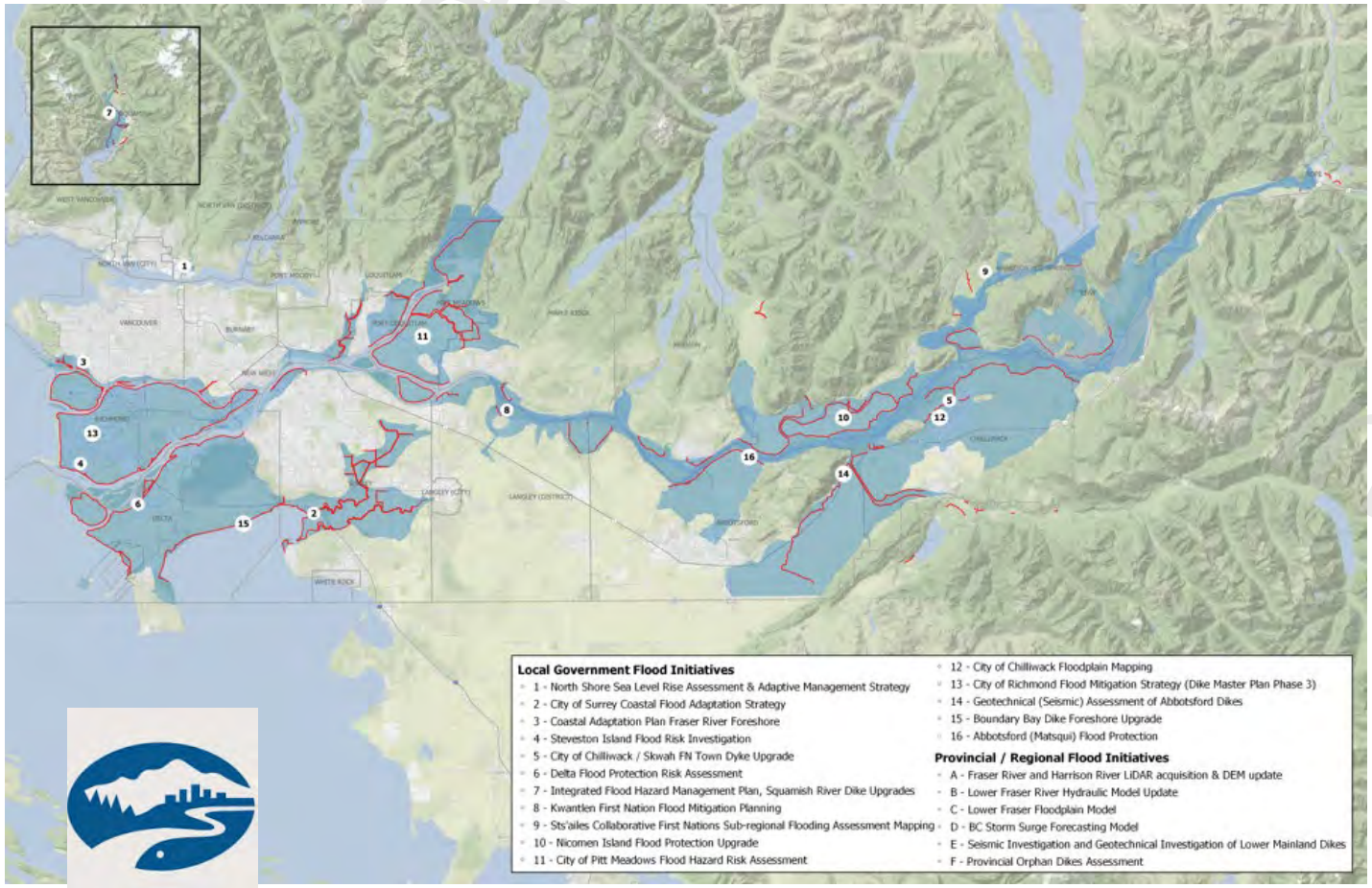
Abbott and Chapman Report, Spring 2018



Province becomes signatory to Sendai, Fall 2018

On the Ground Optimism

Lower Mainland Flood Management Strategy and other initiatives



Map provided by Fraser Basin Council

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BC in 2019:

We're on the cusp of big things

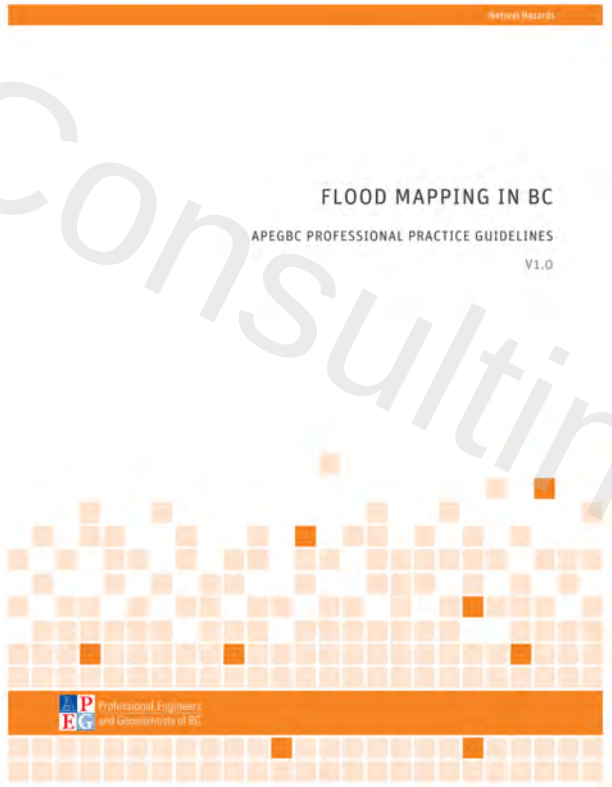
A fair amount of activity stuck in the anthropocene….

But, strong signals from senior government and local governments that we need to evolve

And yet…we have many obstacles

$ ≠ Capacity

From river to map…requires data and expertise (and in my opinion, bathymetry)



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THOUGHTFUL FLOOD MANAGEMENT

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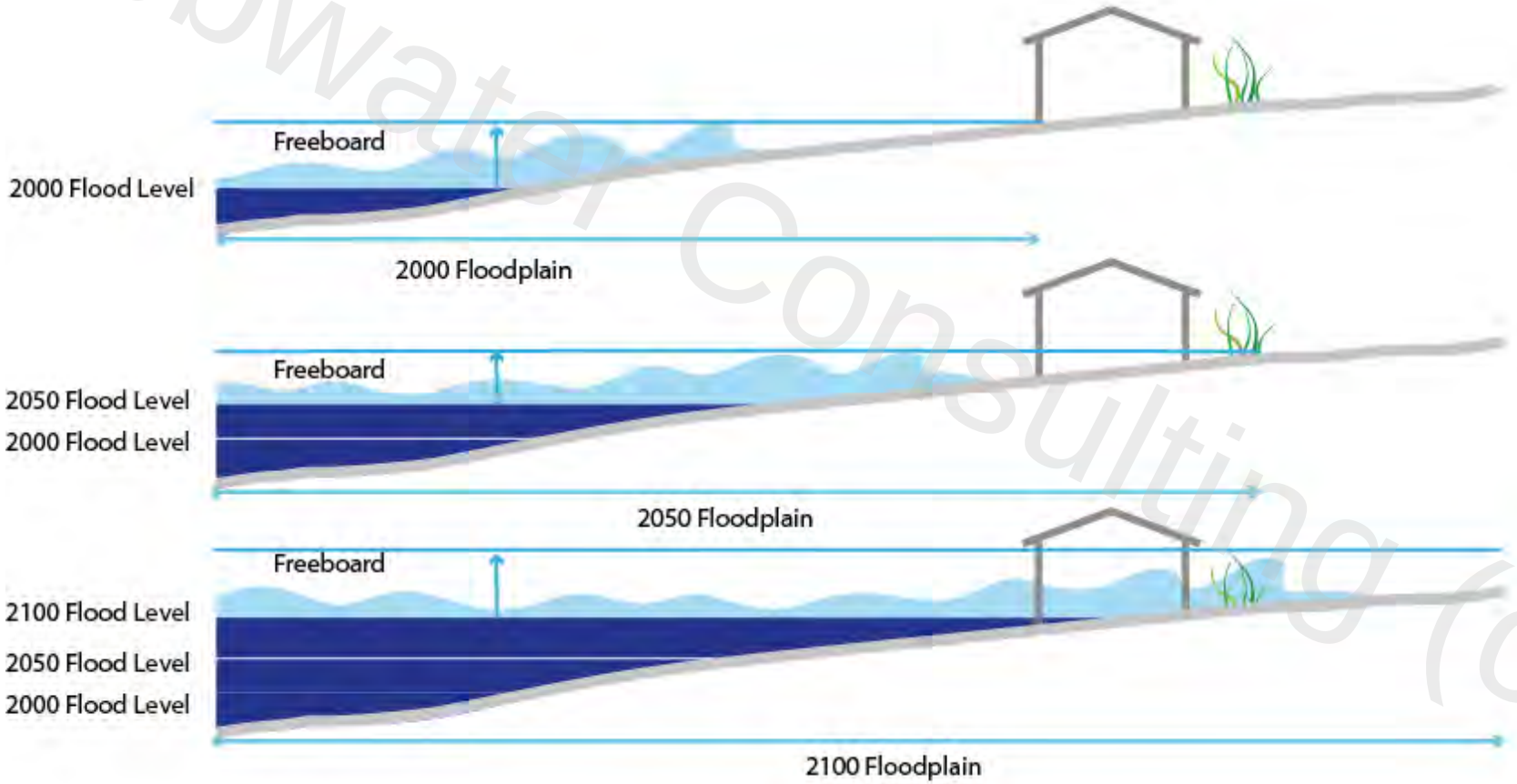
BC in 2019:

Also home to internationally recognized approaches to flood and climate adaptation

And an engineer who will shamelessly plug a project she thoroughly enjoyed working on

Climate change: forcing a paradigm shift



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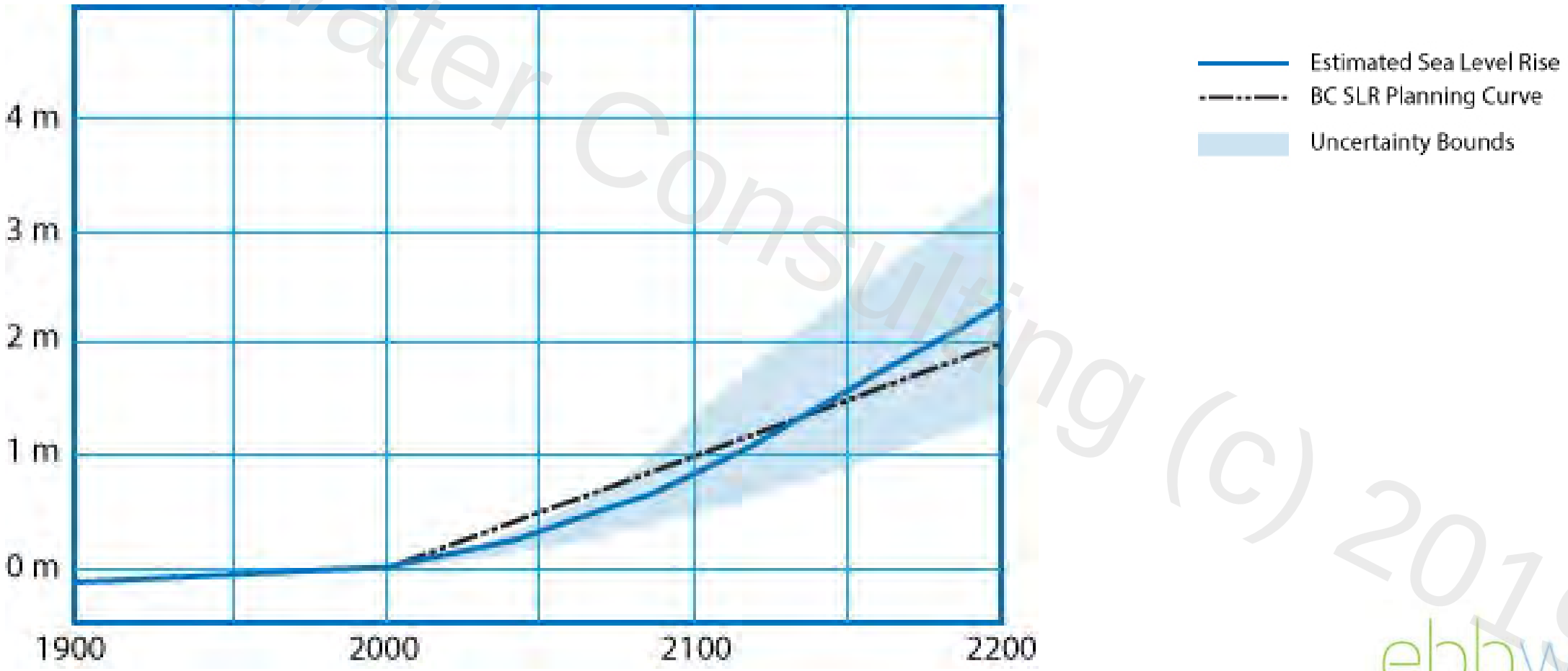
THOUGHTFUL FLOOD MANAGEMENT

An uncertain and messy third dimension



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THOUGHTFUL FLOOD MANAGEMENT

Which in Vancouver, has big implications

Flood hazard extents from City of Vancouver CFRA Phase 1 (NHC 2014)

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THOUGHTFUL FLOOD MANAGEMENT

Vancouver has been working at this for a while…

2012	Phase 1 2013–2014	Phase 2 2014–2015	Phase 3 2017-2018
City of Vancouver Climate Adaptation Plan Identifies Coastal Flood as a Priority	Improved Understanding of Flood *Hazard* and preliminary understanding of Flood *Vulnerability* and *Impacts*	Deep Dig into Flood *Impacts* and process to scope out preferred options for 11 Flood Zones in the City	Working with *risk tolerance* and *risk* to improve our understanding of when to act.

CITY OF VANCOUVER

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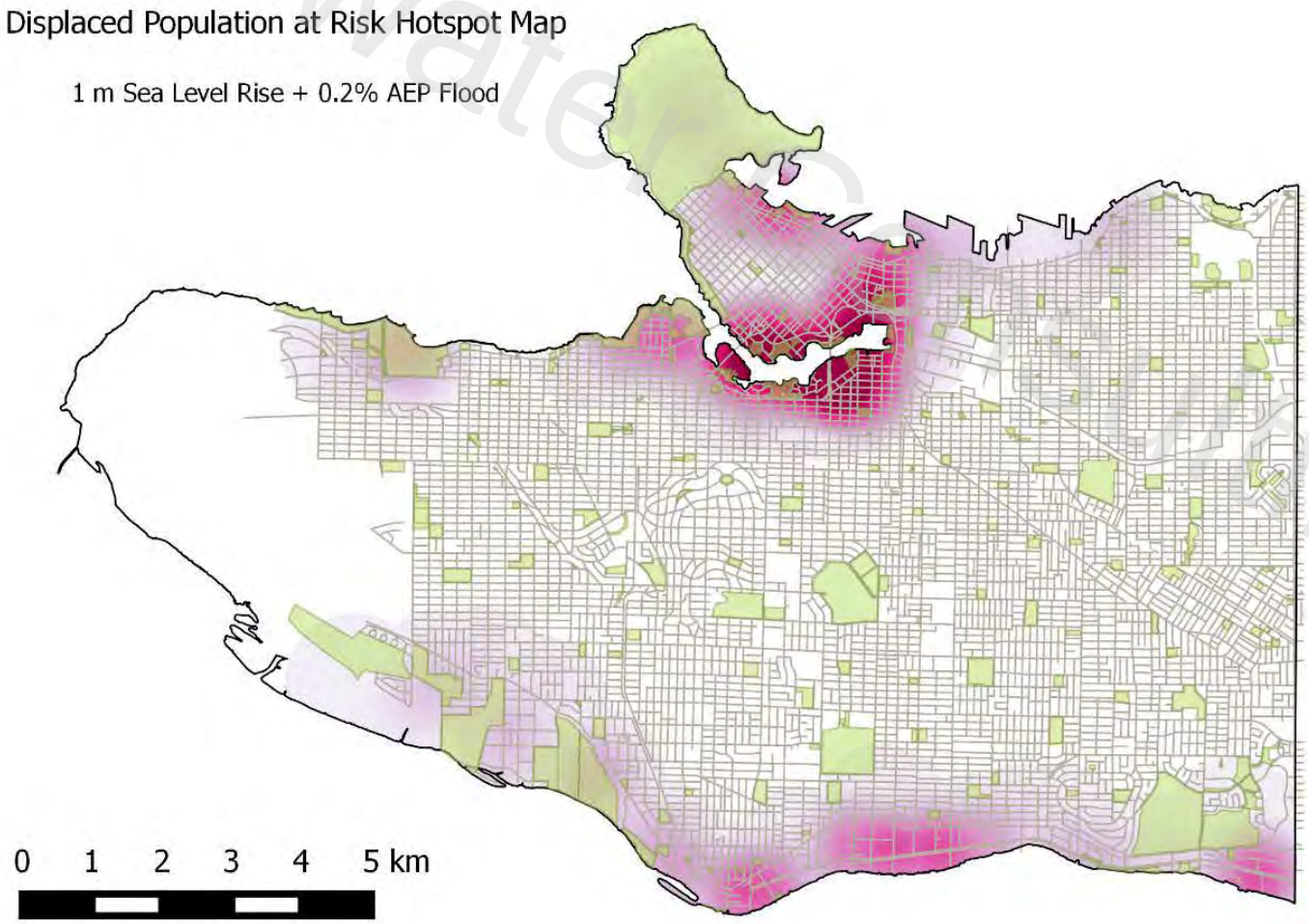
THOUGHTFUL FLOOD MANAGEMENT

The What?

Making decisions about how to act

People: 'At Risk' Population Displaced



Measure: Social Vulnerability Indexed Affected Population

Summary: Quantitative assessment of at-risk population displacement during flood events. This is a function of People Displaced (separate measure based on hazard and population from 2011 census tract) and a Social Vulnerability Index by census tract as developed by Western University.

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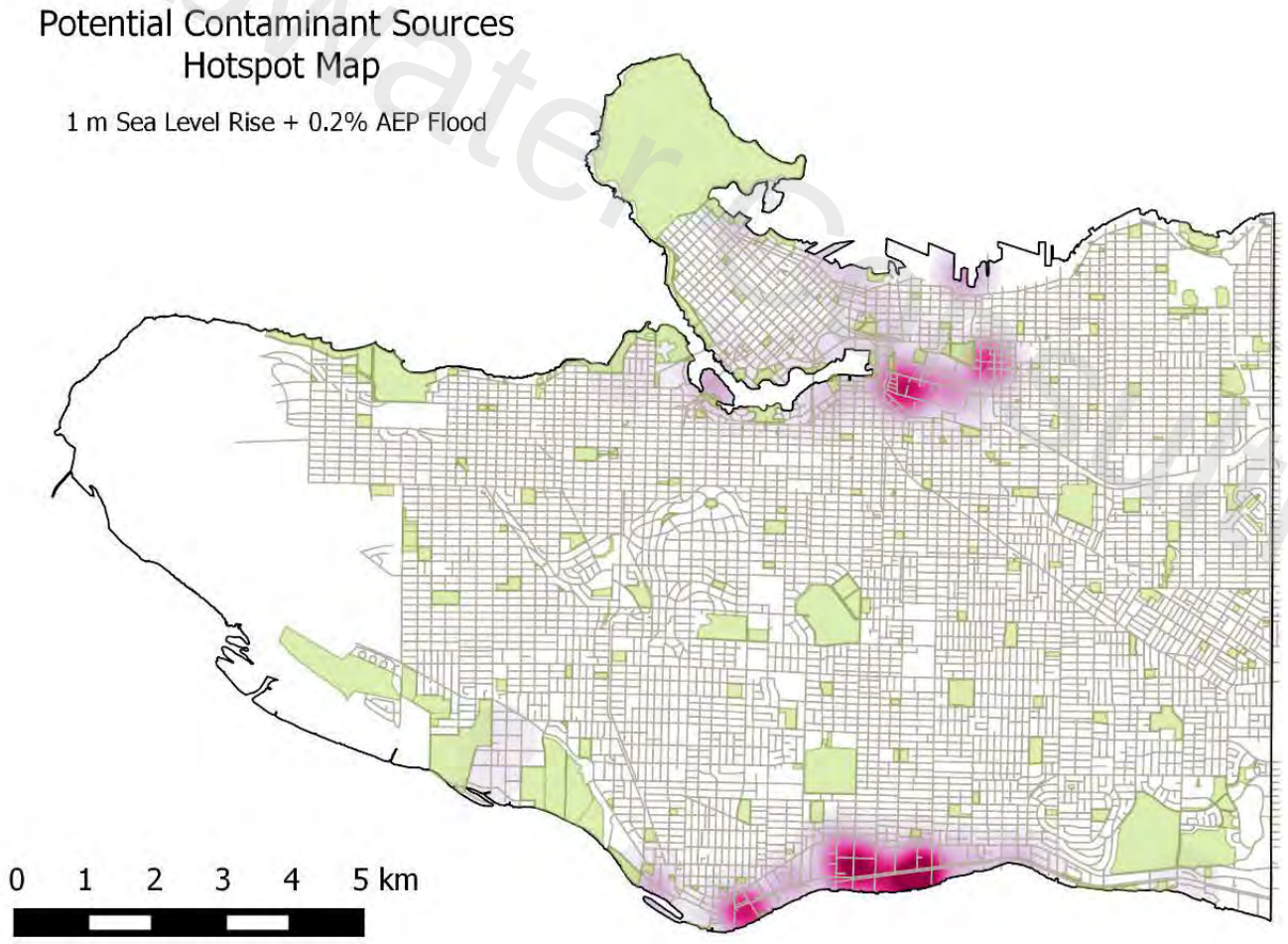
THOUGHTFUL FLOOD MANAGEMENT

Environment: Contaminants



Measure: Risk of contaminant release.

Summary: Quantitative assessment of the number of businesses that might be a contamination source within the floodplain. City of Vancouver Business Licenses were assessed using GIS.

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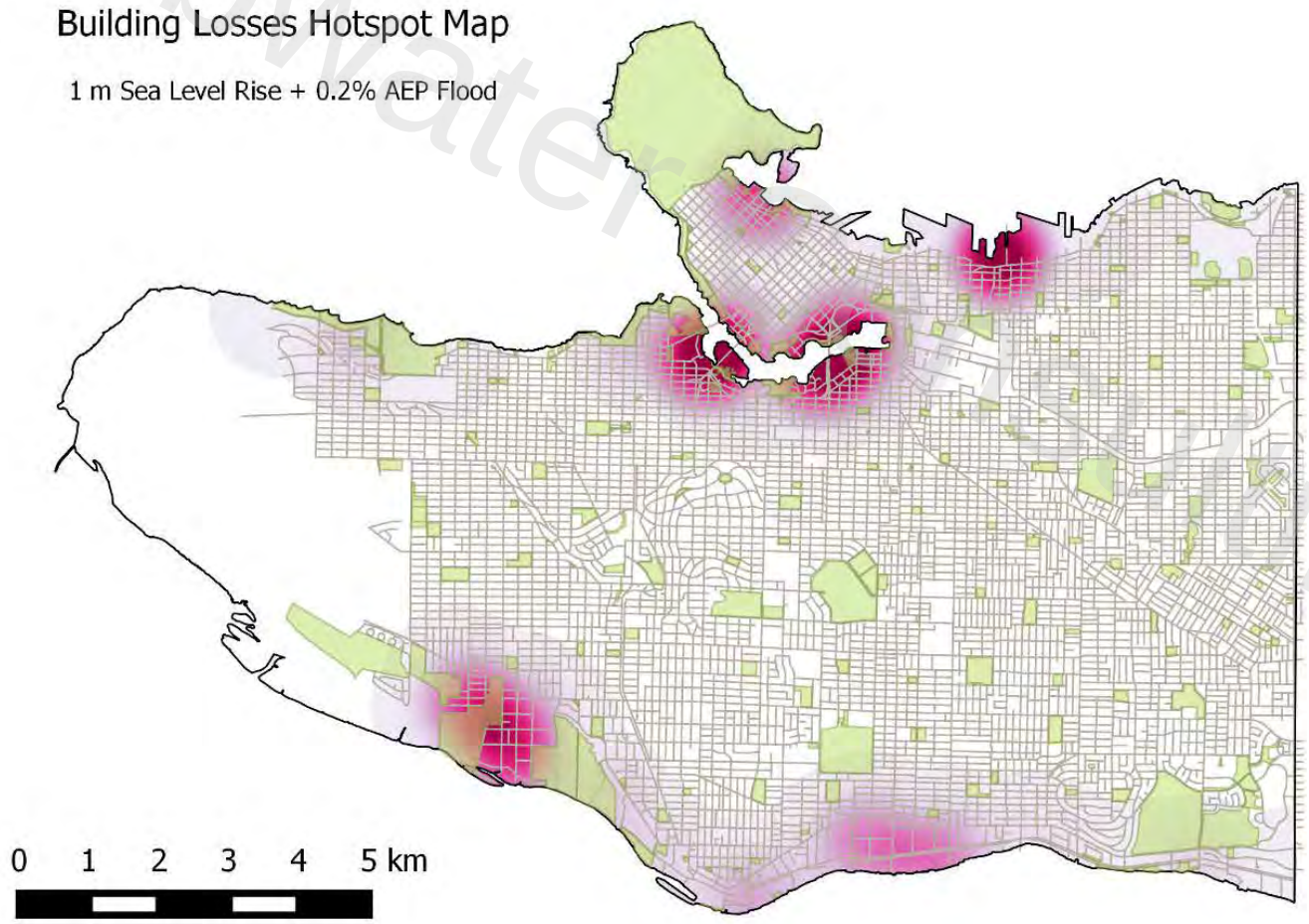
Economy: Building Losses



Measure: Millions of Dollars

Summary: Quantitative assessment of the dollar cost of building damage based on Hazus modelling

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Decisions based on varied values

PEOPLE	
People Displaced	# of people displaced from flood events
People Displaced	# people displaced permanently
'at risk' people impacted	Social Vulnerability Index (SVI) weighted displacement
Park and Recreational Amenity Value	Value-weighted area affected per event
Loss of critical services	# of pieces of infrastructure impacted
Aesthetics	-2 to 2
ENVIRONMENT	
Risk of Contaminant Release	# of sites with potential contaminants
Environmental Benefits	-2 to +2
ECONOMY	
Damage to Infrastructure	Value-weighted km of roads impacted
Damage to buildings	$M
Business disruption	# of employees working in impacted businesses
Loss of Inventory	$M
Emergency Response costs	Estimated cost per event
IMPLEMENTATION	
Capital Costs	$M
Maintenance costs	$M
Adaptability	1 to 4
Ease Of Implementation	1 to 5

Example measures for City of Vancouver, 2015. Developed with **Compass Resource Management**.

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To get to preferred options by neighbourhood

Impacts from Flood Event (Per Event – 1 m SLR +0.2% AEP Flood Event)

Measure	Scale	BASELINE	PROTECT Park Dike	PROTECT Road Dike	ADAPT Multiple Tools	RETREAT
PEOPLE						
People displaced temporarily	# of people displaced	461	0	231	124	0
"At risk" people impacted	Social Vulnerability Index (SVI) weighted displacement	231	0	185	62	0
Park and recreational amenity value	Area affected per event (km^2)	0.6	0.04	0.34	0.6	0.6
Loss of critical services	# of pieces of infrastructure impacted	8	6	7	0	0
ENVIRONMENT						
Risk of contaminant release	# of sites with potential contaminants	0	0	0	0	0
ECONOMY						
Damage to infrastructure	Value-weighted km of roads impacted	4.9	0.0	0.5	1.3	0
Damage to buildings	$M	4	1.1	1.3	1	0
Loss of inventory	$M	10	5.4	6.7	3	0
Business disruption	# of employees working in impacted businesses	124	107	121	33	0
Emergency response costs	$M	0.3	0	0.2	0.1	0

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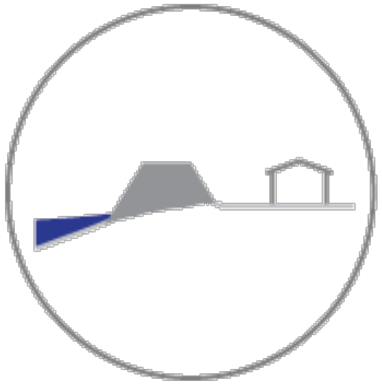
Complementary Design with Co-Benefits

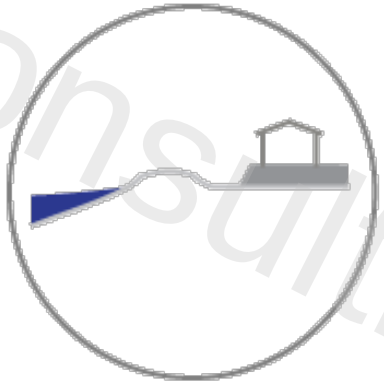
Cornerstone Idea



e.g. a dike

+

Brick Idea



complemented with property-level-protecton

+

Brick Idea

improved with habitat enhancement and a bike path

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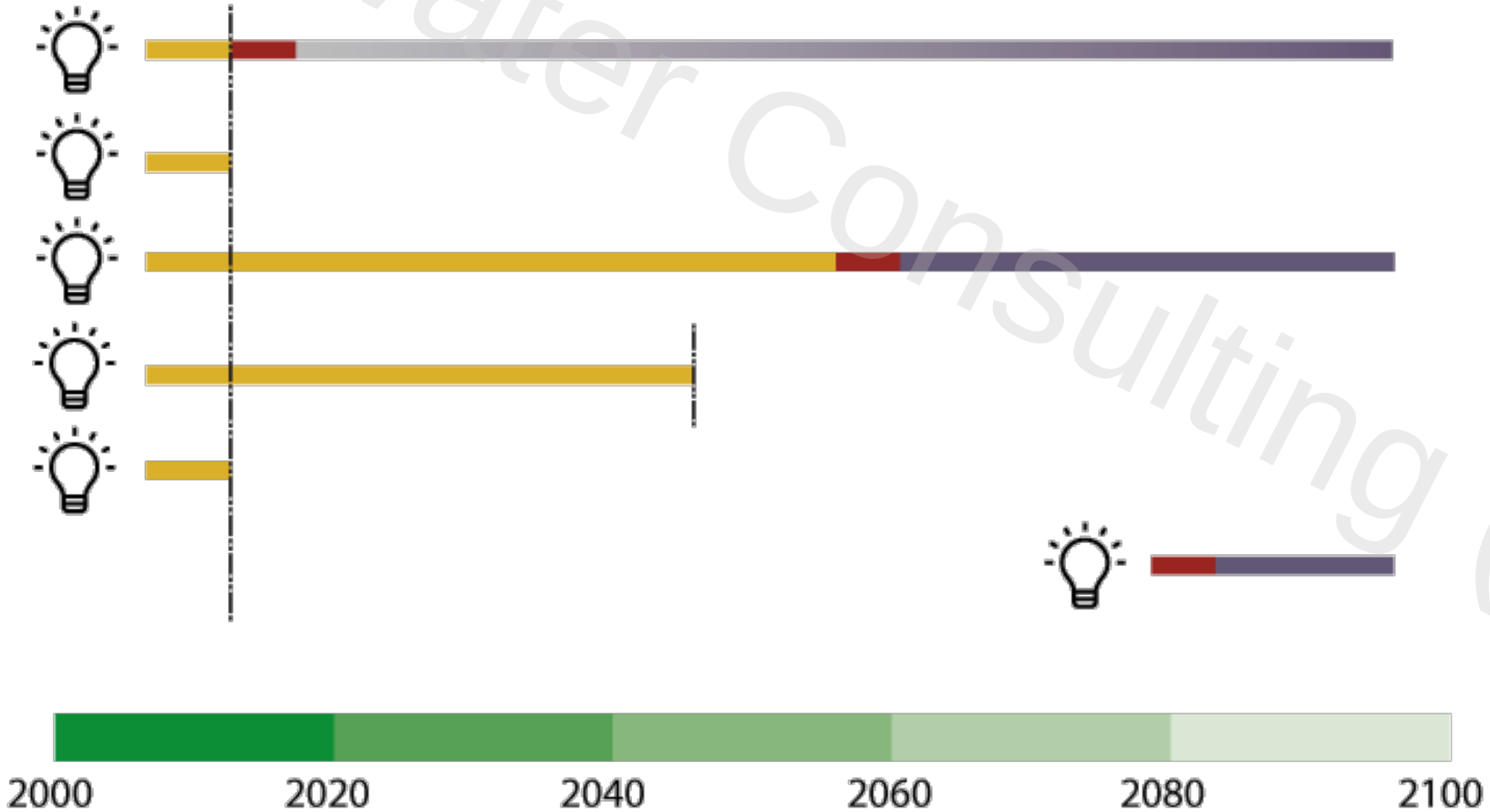
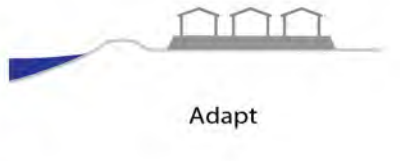
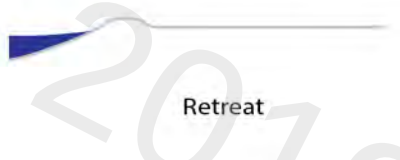
Phase 2 Results

Preserve Options, Ideally Adaptive Ones. Act thoughtfully.







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Some questions are still unanswered:

When to take action?

We know that we need to adapt, but we struggle with when.

Too early will mean wasted resources, distrust or perceptions of fiscal irresponsibility, or abrupt, potentially wrenching, changes in our communities.

Too late and we risk being unprepared and suffering unduly from climate extremes.

Finding the sweet spot on the timeline is a key component of adaptation planning.

The When?

Making decisions about how soon to act.

Phase 3 Objective

To develop a transparent, repeatable and adaptive process to support decision-making related to the prioritization and timing for implementation of mitigative measures for sea level rise that is:

- *Risk-based (i.e. considers both the local hazard and local consequences of flooding).*
- *Scientifically robust and based on best available information for the City on flood hazard, flood impacts and flood risk.*
- *Mindful of other strategic planning processes being undertaken at the City.*
- *Responsive to new planning and/or development directions and new sea level rise science.*

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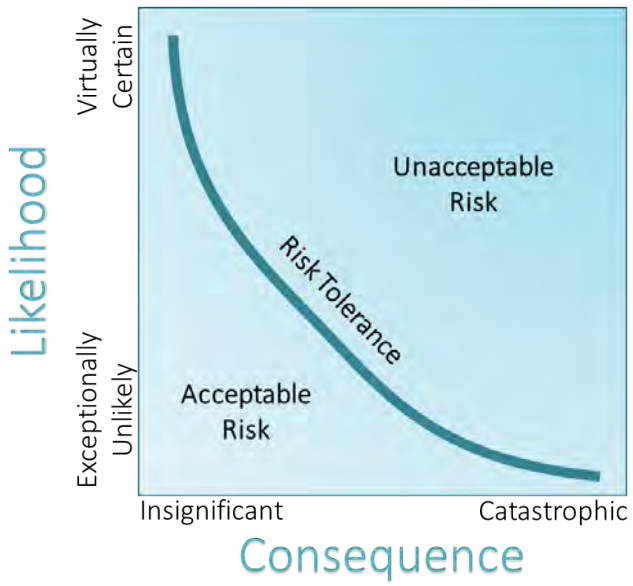
Understanding risk is the start…risk tolerance is the key



Future Risk

Existing Risk

Tolerable Risk

- Can be tolerated to realise a benefit
- Not negligible
- Should be reviewed and reduced as warranted

Acceptable Risk

- Broadly acceptable to public
- No further effort to reduce risk warranted

(After DNV 2009)

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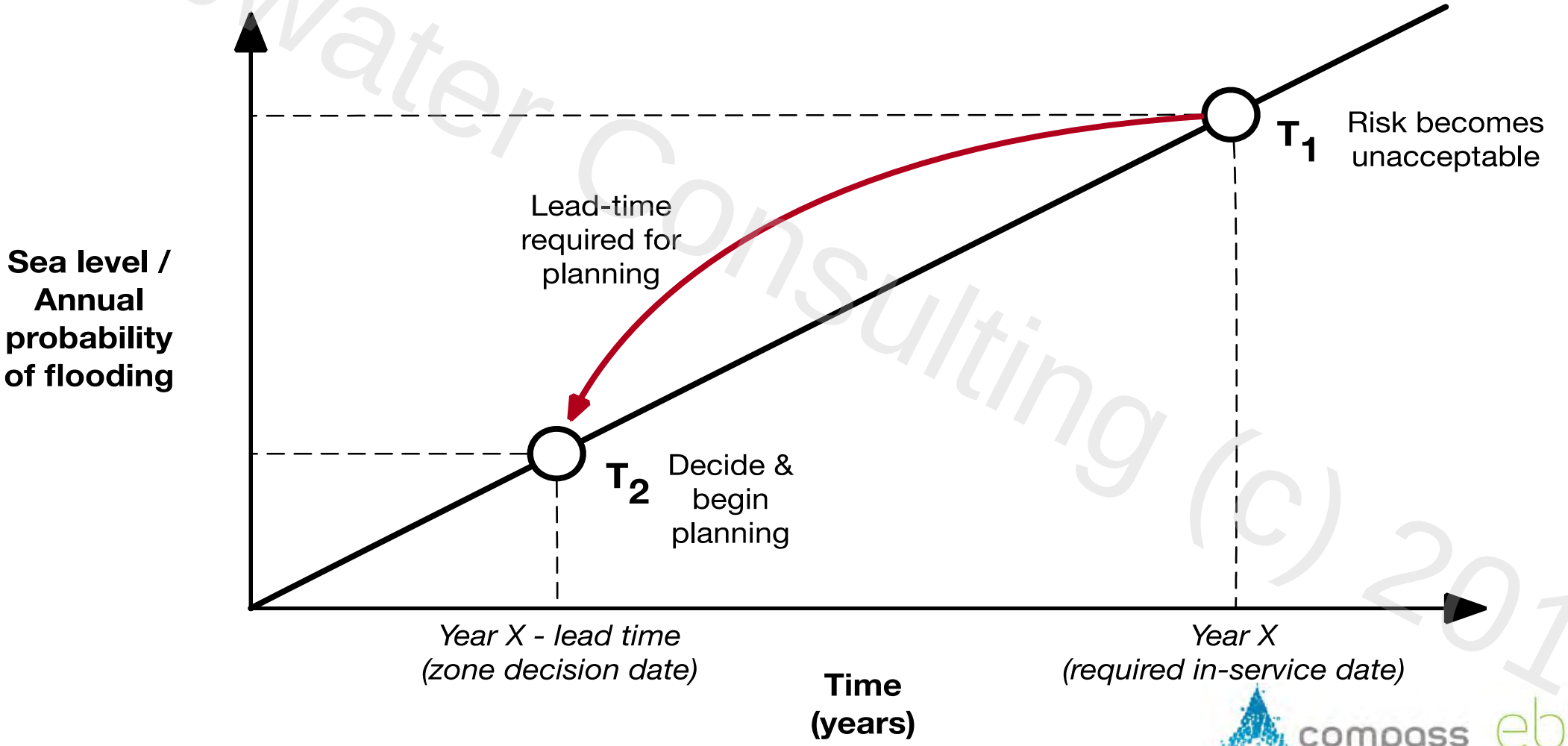
Because it tells you when you need to be ready



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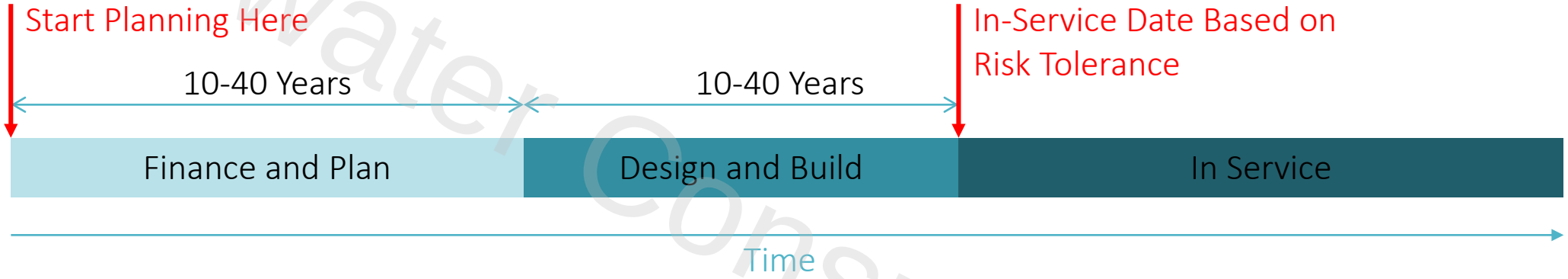
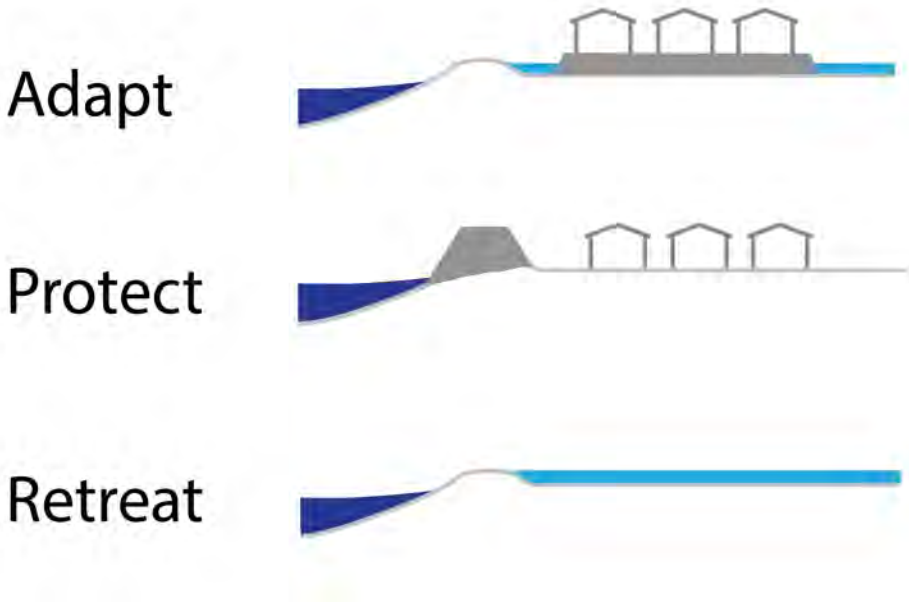
But we also need time to implement actions





35 + Years for Redevelopment Cycle

25 + Years for Financing/Engineering/Etc.

35 + Years for Redevelopment Cycle

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We need to prioritise
But be mindful of other opportunities and changes

- Planning processes and redevelopment
- Funding programs
- Political lens
- Flood events
- Changing rates of sea level rise

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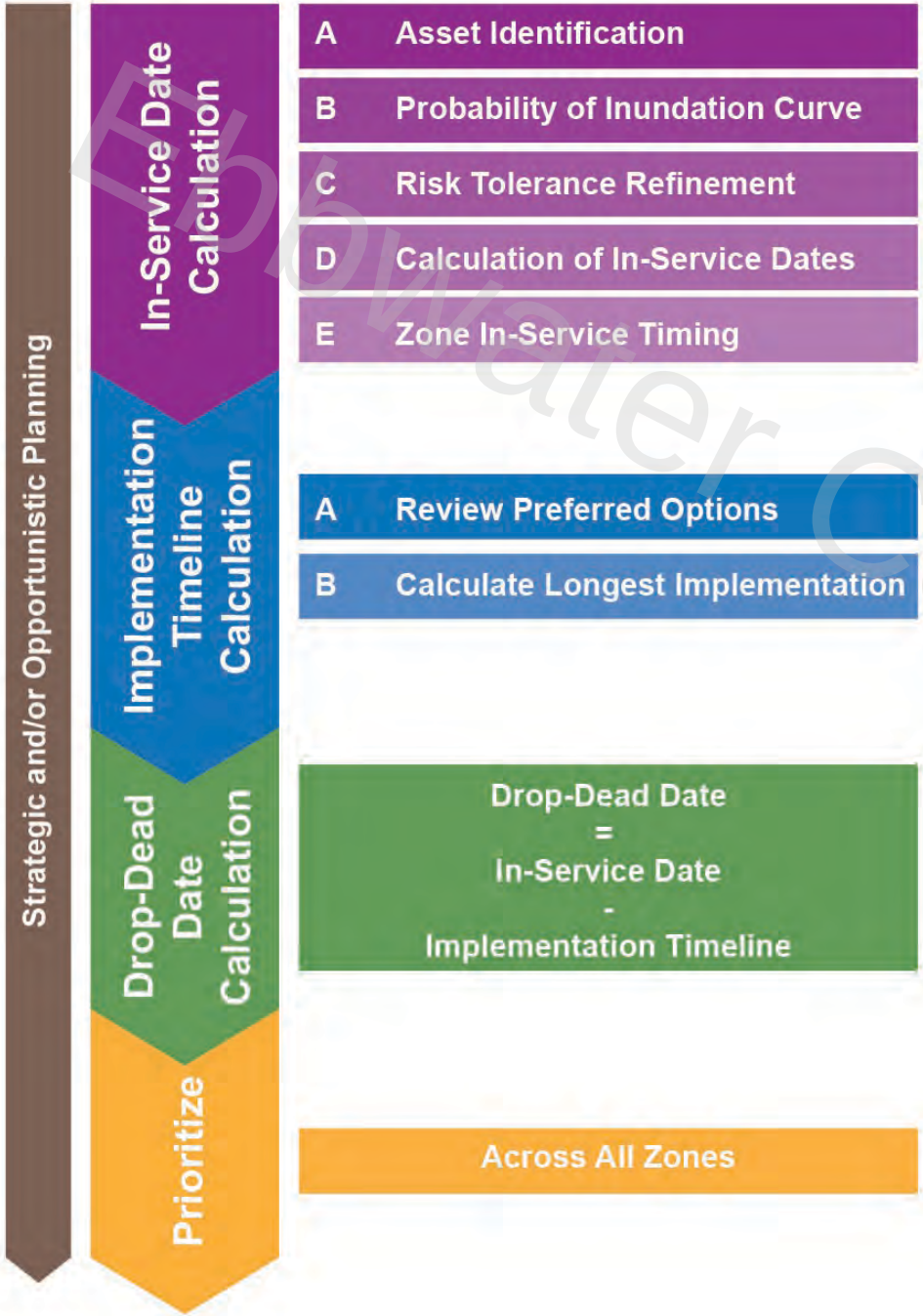

And so – a proposed framework

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What?

1. We are surprisingly risk intolerant; maybe this will change as we see more water on the ground
2. We are reliant on our present-day lens to make decisions about a changing future; this is never going to be perfect.
3. These are never going to be easy conversations.

604now.com image. 2018 King Tides Initiative

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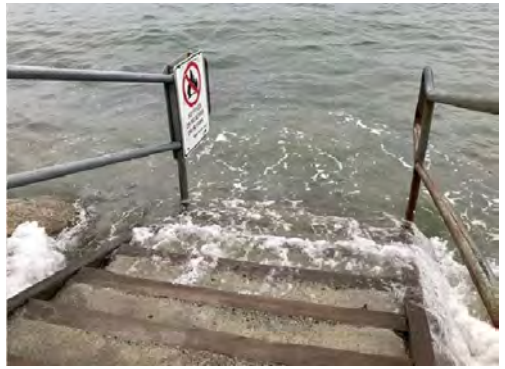
So What?

1. The longer we can [justifiably] put off adaptation decisions, the better our understanding of risk-tolerance to climate change will be.
   - The Vancouver sea level rise framework is not a bad place to start ☺
   - Also a strange statement for an ardent climate adaptation activist.
2. Being scared of the conversation isn't helpful, being armed with lots of different tools is.



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Acknowledgements

Clients and Funders

CITY OF VANCOUVER | GREENEST CITY

Natural Resources Canada | Ressources naturelles Canada

Canada

Research Team

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Ontario: Where do you see yourselves?

A willingness to live with floods	•Individual and small communities adapt to natures rhythm.
A desire to use the floodplain	•Fertile land in the floodplain is drained for food production. •Permanent communities are established on the floodplain. •Local (uncoordinated) levees start to be constructed.
A desire to control flood flows and defend against flooding	•Large scale structural approaches (levees ,dams and other controls) are planned and implemented through organized governance.
A desire to reduce flood damages	•A recognition that engineering alone has limitations. •Effort is devoted to increasing the resilience of communities should a flood occur. •Effort is devoted to mitigate lost of ecosystem services.
A desire to manage risks efficiently	•A recognition that budgets are limited and not all problems are equal. •Risk management is seen as a means to target limited resources.
A desire to promote opportunities and manage risks adaptively	•Adaptive management is seen as effective in managing the severe uncertainties in future climate change, funding and demographics. •Working with natural processes is encouraged to both reduce risks efficiently and achieve gains in ecosystem services.

Where do we go from here?

Recent Events

+

Climate Change

+

Loose Direction from Senior Governments

=

Opportunity for Change!

Acknowledgements

Natural Resources Canada | Ressources naturelles Canada

Canada

Contact

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An Evolution in Flood Management:
An optimistic view from the left coast

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CONSULTING INC

CWRA | March 2019 | Toronto, Ontario

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