

Straight Talk on Adapting to Floods

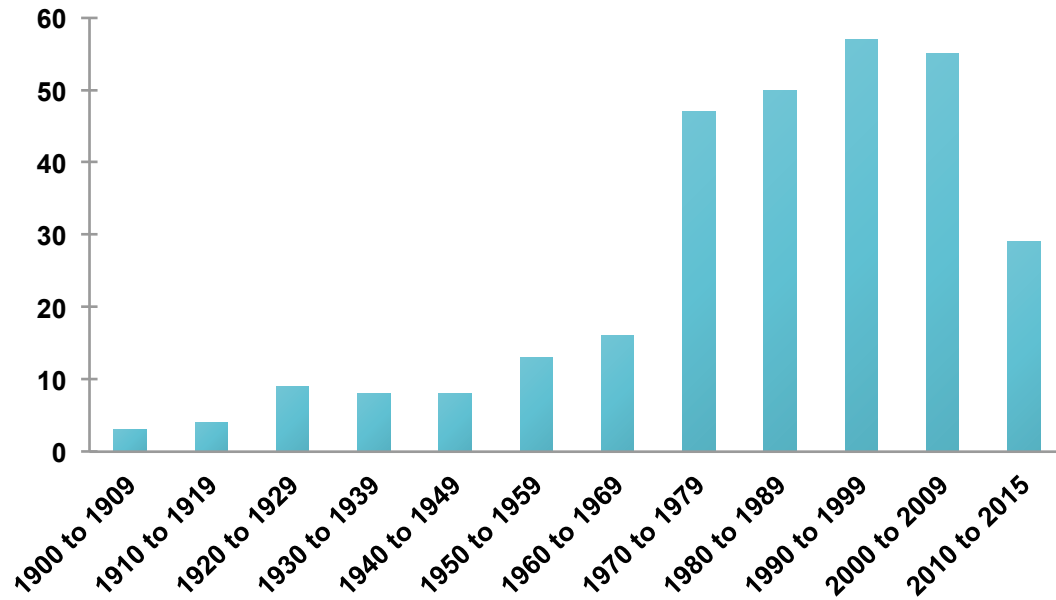
RAC, January 2018

Tamsin Lyle, P.Eng | Principal | Ebbwater Consulting

ebbwater
CONSULTING

THOUGHTFUL FLOOD MANAGEMENT

Floods are a problem not to be ignored

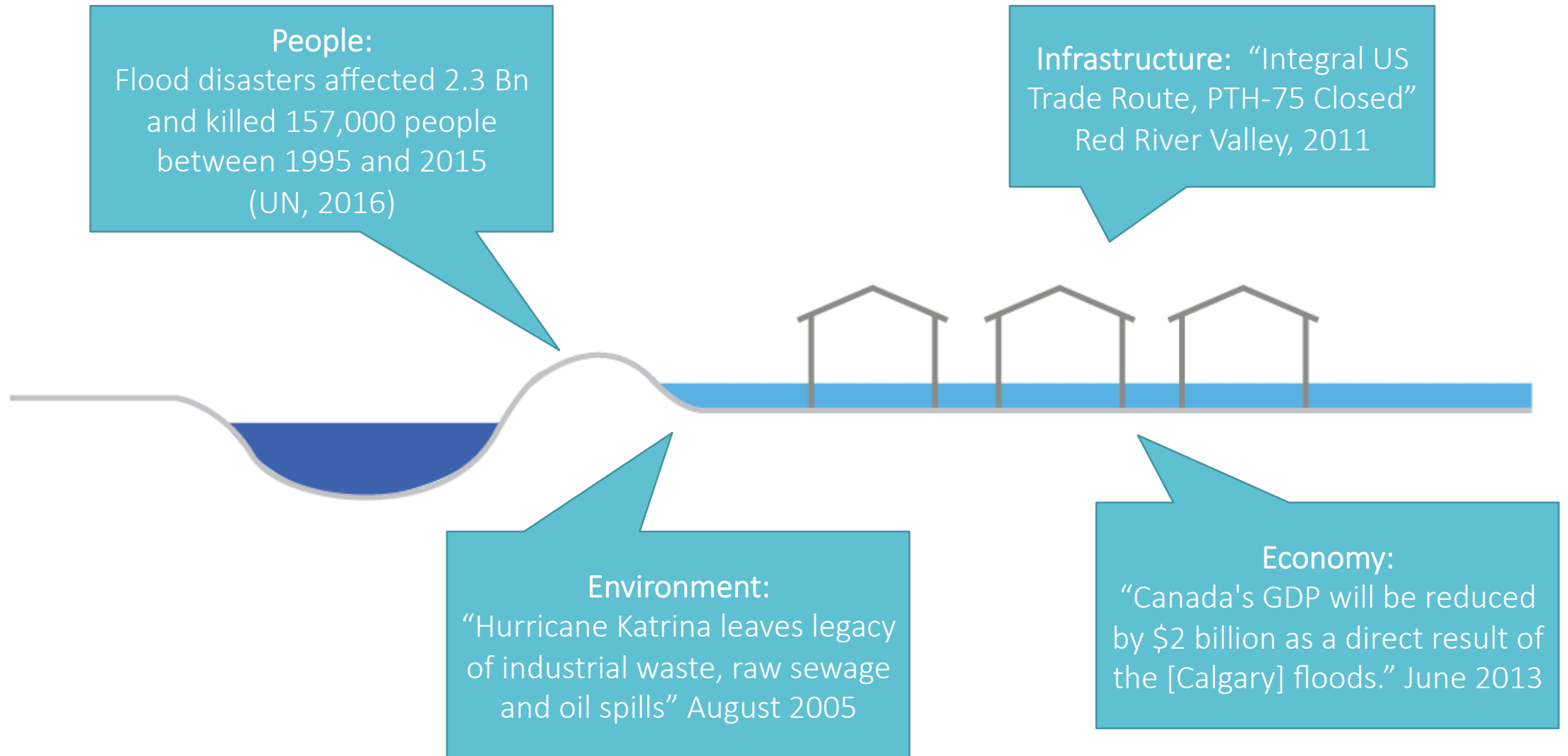


Flood Disaster Occurrences in Canada 1900-2015
(Canadian Disaster Database)

\$2.4Bn losses annually
\$673M paid by DFSA

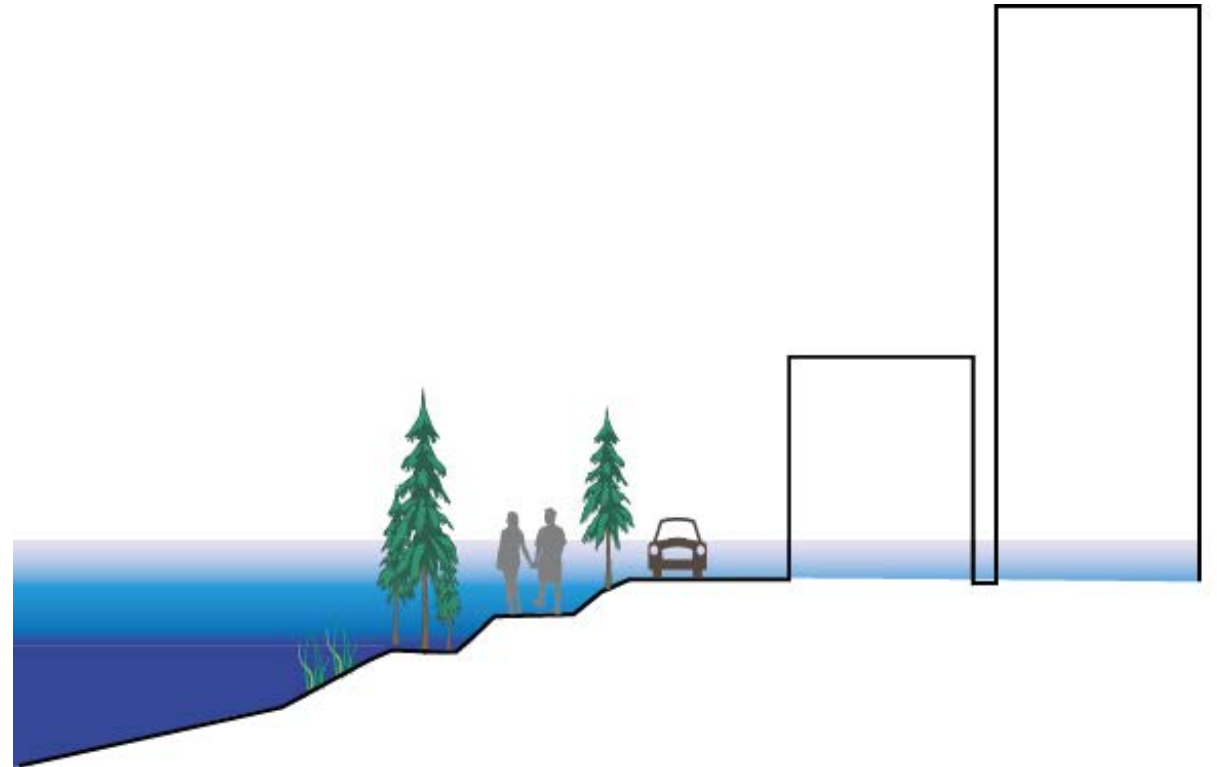
Annual Loss Estimate from Government of Canada
(Parliamentary Budget Office 2016)

That affect many things



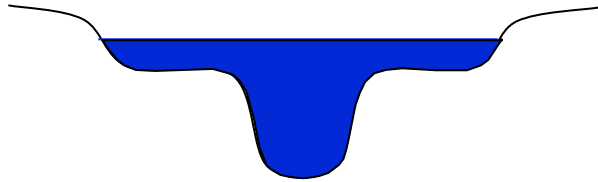
But...flood management is a wicked problem

- High degree of technical complexity
- Multiple dimensions of uncertainty
- Multiple objectives
- High stakes, high emotions
- Intense political scrutiny
- High expectations for quality and transparency
- Limited resources in terms of time, money and personnel.

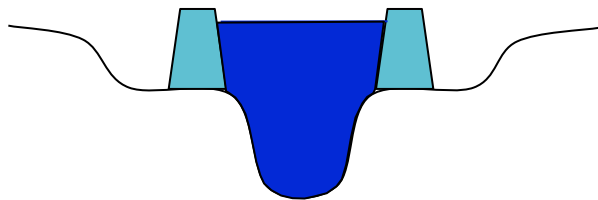


That historically we have managed with arrogance Man Will Conquer Nature

Natural Condition

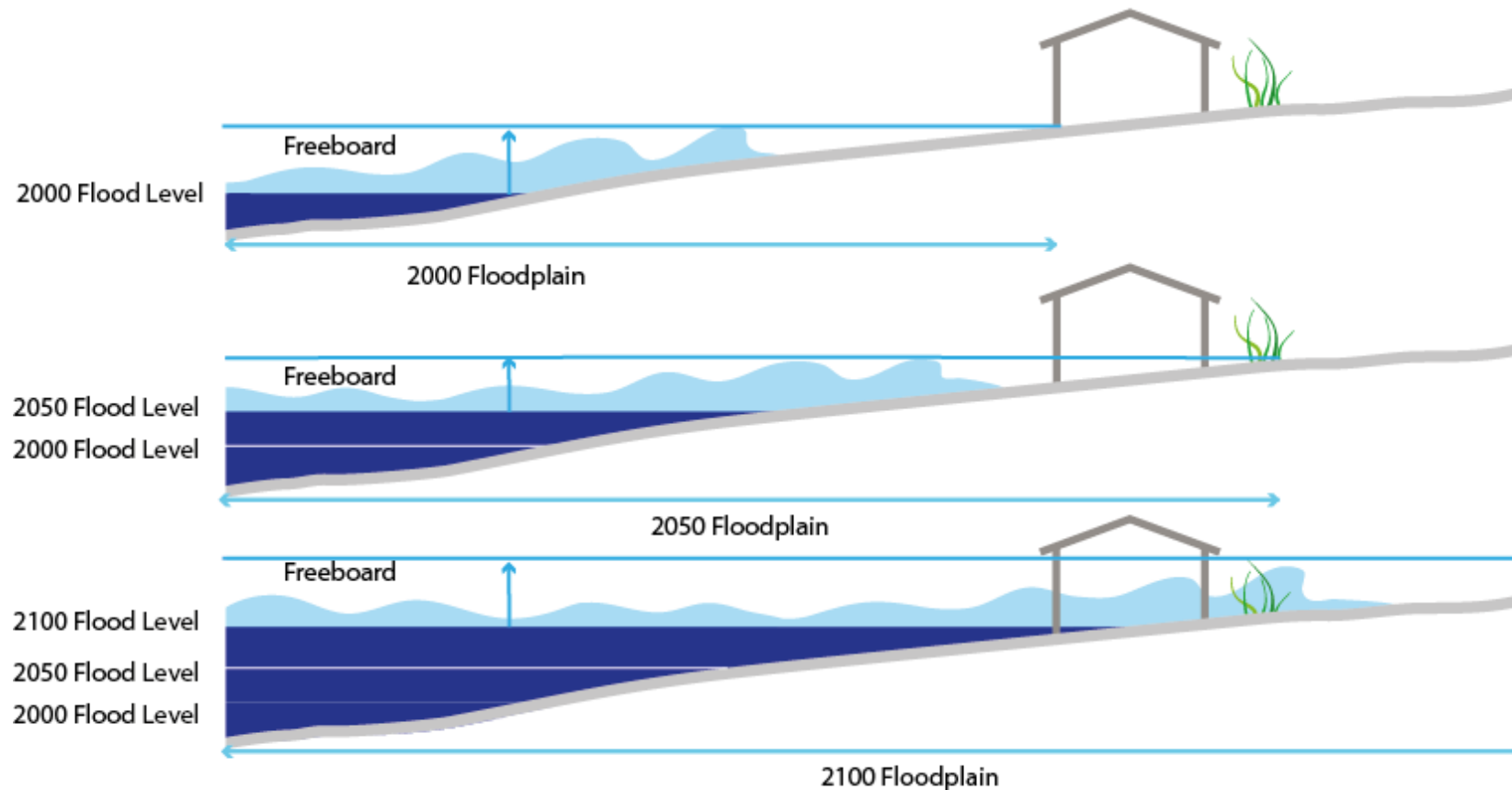


Dike Confinement



Philadelphia Ledger, May 3, 1927

Climate is a catalyst for change!



In the US, a 45% increase in spatial extent of the 100-Year floodplains is projected by the year 2100 (NFIP 2014).

Good Flood Management

Tackling a “Wicked Problem” with good decision making informed by good science and good people



Are you an Ostrich or a Meerkat?

Why be a meerkat?

It's the right thing (and might be the prudent thing)

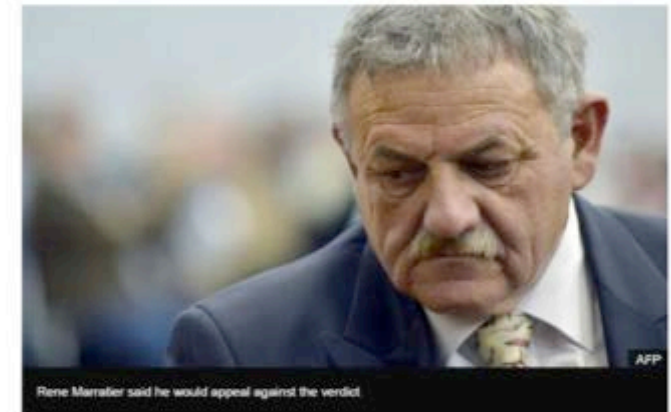
The screenshot shows the CBC News Toronto website. The main headline reads: "Muskoka residents launch \$900M suit against province over flood damage". Below the headline is a photograph of a flooded road with a car's side-view mirror in the foreground. To the right of the photo is a weather forecast for the next four days: Saturday (25°C), Sunday (25°C), Monday (26°C), and Tuesday (22°C). Below the weather is a "More Weather" link. At the bottom left, there are social media sharing options for Facebook and Twitter, with 67 shares listed. A small text block below the photo reads: "People living on Lakes Muskoka, Lake Joseph and Lake Rousseau say they suffered extensive damage during this year's spring thaw because of high water." (CBC News)

The screenshot shows the BBC News website. The main headline reads: "French mayor Rene Marratier jailed for role in deadly flood". Below the headline is a date and location: "12 December 2014 | Europe". To the right of the headline is a "Share" button. Below the headline is a large photograph of Rene Marratier, a man with a mustache, wearing a suit and tie, looking down with a serious expression. Below the photo is a caption: "Rene Marratier said he would appeal against the verdict".

French mayor Rene Marratier jailed for role in deadly flood

12 December 2014 | Europe

Share



Rene Marratier said he would appeal against the verdict

The former mayor of a French seaside town has been sentenced to jail for four years for ignoring flood risks before a storm that killed 29 people.

Rene Marratier hid the risks to La Faute-sur-Mer to avoid putting off property developers, the court said.

The storm Xynthia hit western Europe in early 2010. The storm knocked down seawalls in La Faute-sur-Mer, leading to severe flooding.

Marratier called the verdict "unjust" and said he would appeal.

On Friday, the court said that Marratier knew La Faute-sur-Mer, a west coast resort in the Pays de la Loire region, was at risk of flooding.

However, he "deliberately hid" the risk so that he could benefit from the "cash-cow"

Let's Go to Meerkat School!



Meerkats Plan

Do the right project

(before even thinking about getting the project right)



What are we trying to achieve?

What options are available to achieve it?



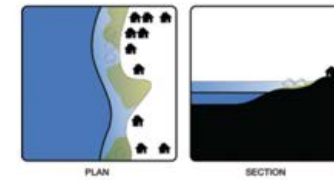
How can we measure success?

Meerkats Consider Focus on the decision process not the solution

False Creek
Location: **Impacts by Flood Scenario**

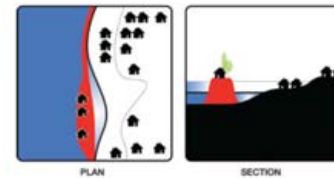
	Scale	Dir	PROTECT	PROTECT	PROTECT	ADAPT
			Sea Barrier	Raised Seawall	Partial Dike	Planning Tools
PEOPLE						
People Displaced - Flood Events	# of people displaced	L	Best	Best	Worst	Worst
People Displaced - Permanently	# of people displaced	L	Best	Best	Worst	Worst
at risk' people impacted	SVI weighted displacement	L	Best	Best	Worst	Worst
Park and Recreational Amenity Value	Value-weighted area affected per event	L	Best	Best	Worst	Worst
Loss of critical services	# of pieces of infrastructure impacted	L	Best	Best	Worst	Worst
Aesthetics	-2 to 2	H	Worst	Worst	Worst	Worst
ENVIRONMENT						
Risk of Contaminant Release	# of sites w/ potential contaminants	L	Best	Best	Worst	Worst
Environmental Benefits	-2 to 2	H	Worst	Worst	Worst	Worst
ECONOMY						
Damage to Infrastructure	Value-weighted km of roads impacted	L	Best	Best	Worst	Worst
Damage to buildings	\$M	L	Best	Best	Worst	Worst
Business disruption	# employees in impacted businesses	L	Best	Best	Worst	Worst
Loss of inventory	\$M	L	Best	Best	Worst	Worst
Emergency response costs	\$M	L	Best	Best	Worst	Worst
IMPLEMENTATION						
Capital Costs	\$M	L	Worst	Best	Best	Best
Maintenance costs	\$M	L	Worst	Best	Best	Best
Adaptability	1 to 4	H	Worst	Best	Best	Best
Ease Of Implementation	1 to 5	H	Worst	Best	Best	Best

Best performance
Worst Performance

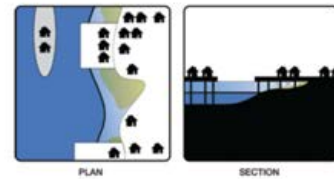


Scenario Building
(Institute of Civil Engineers 2010)

RETREAT?



DEFEND?



ATTACK?

Example Structured Decision Making Consequence Table
(For City of Vancouver 2015, with Compass Resource Management)

Meerkats Consider

Focus on the decision process not the solution

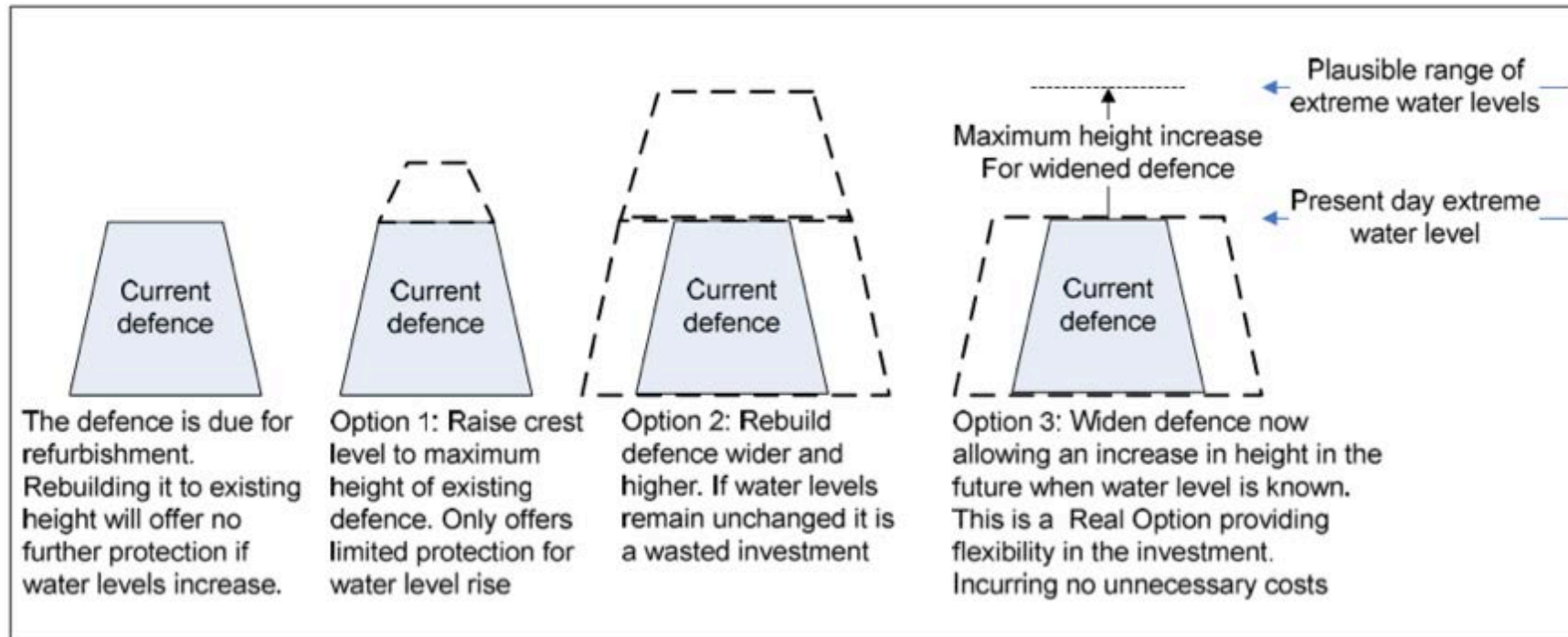
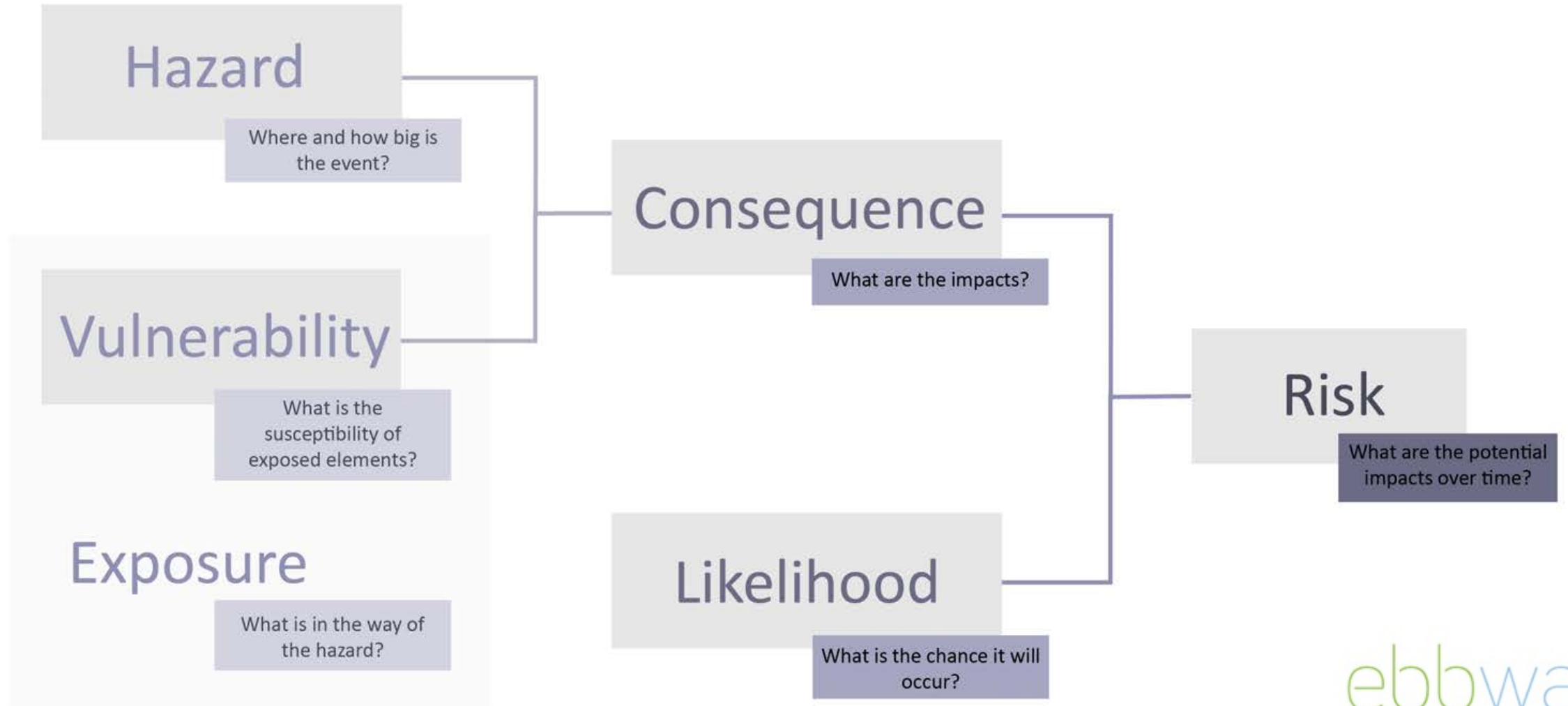


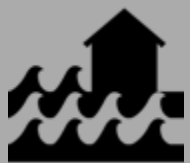
Figure 1 - Description of a flood risk management Real Option

Real Options Analysis
(Woodward et al. 2009)

Meerkats Consider Risk not Hazard



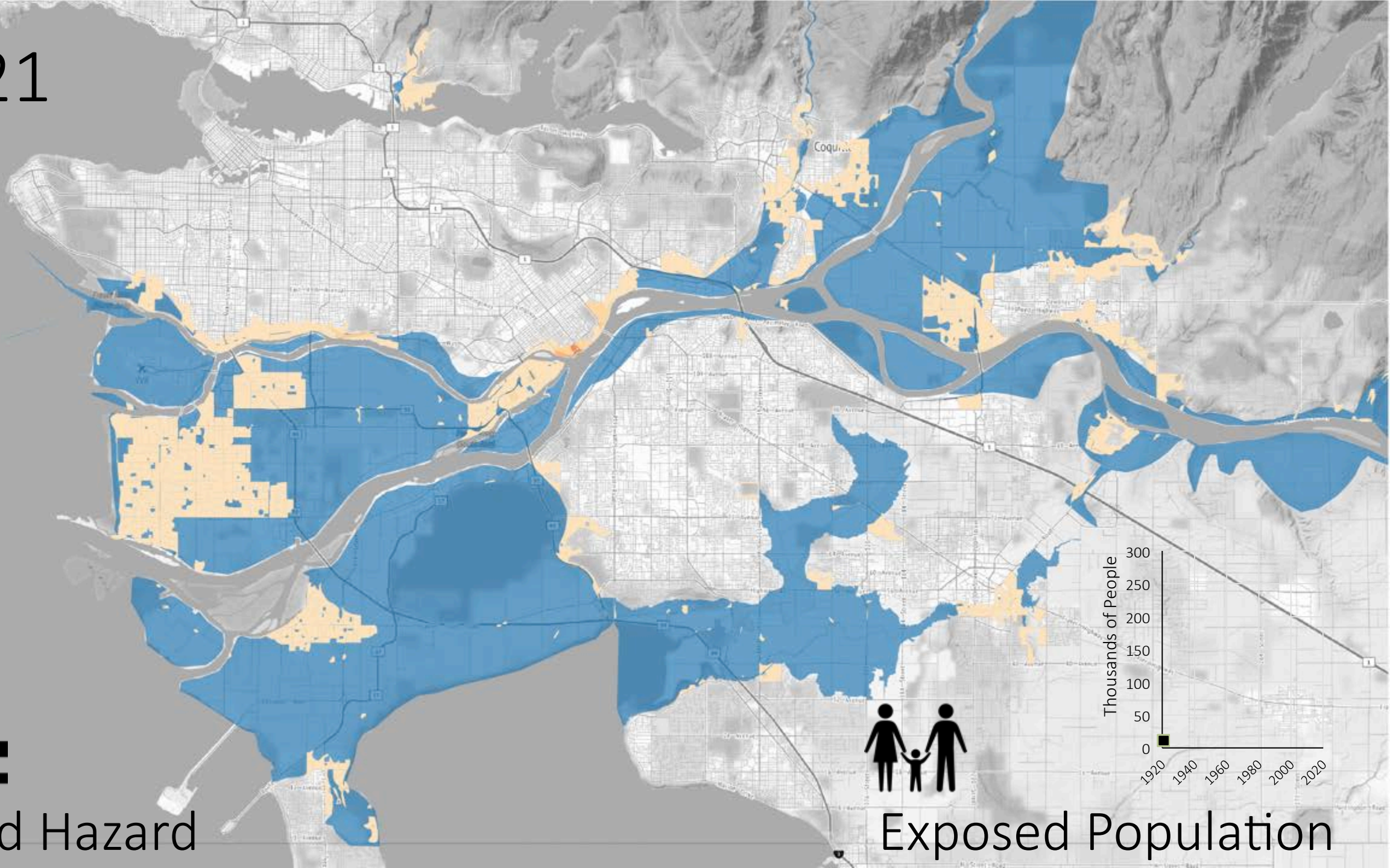
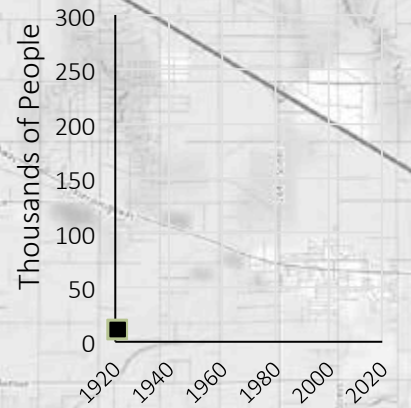
1921



Flood Hazard



Exposed Population



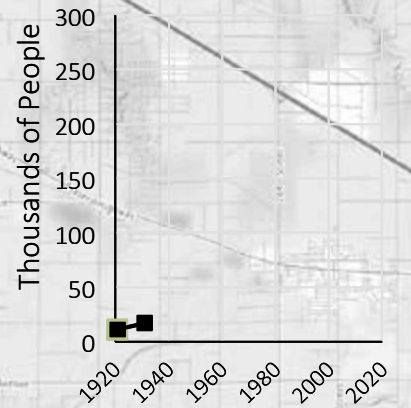
1931



Flood Hazard



Exposed Population



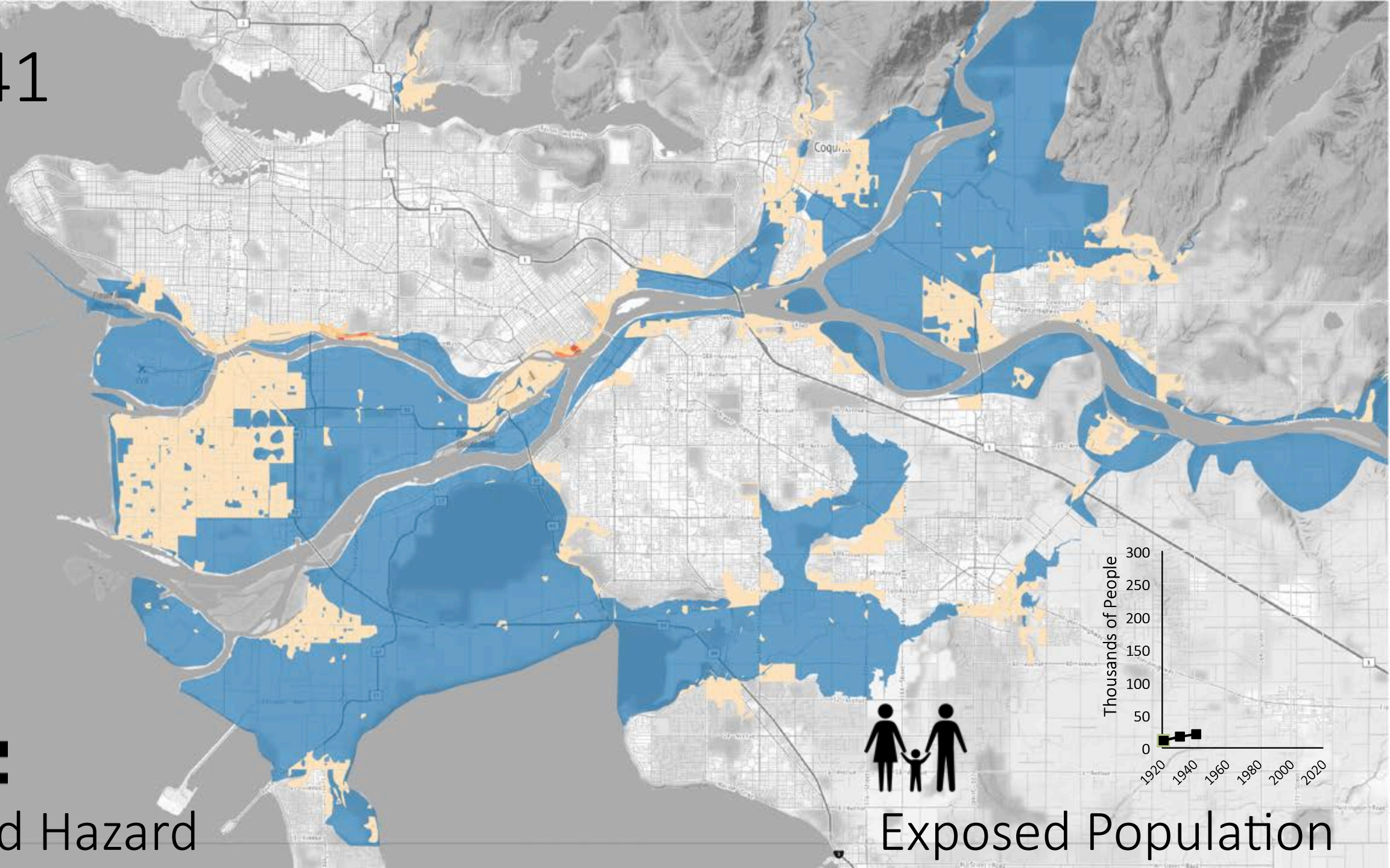
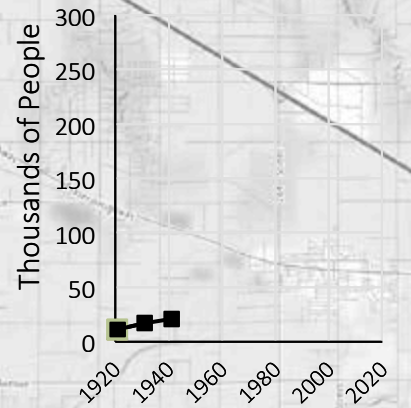
1941



Flood Hazard



Exposed Population



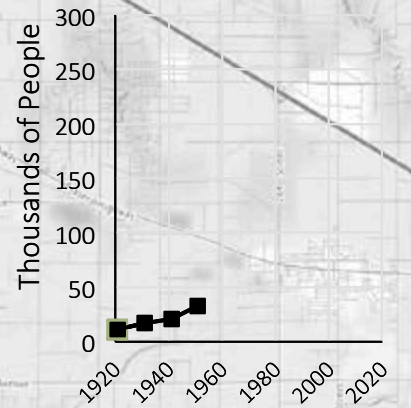
1951



Flood Hazard



Exposed Population



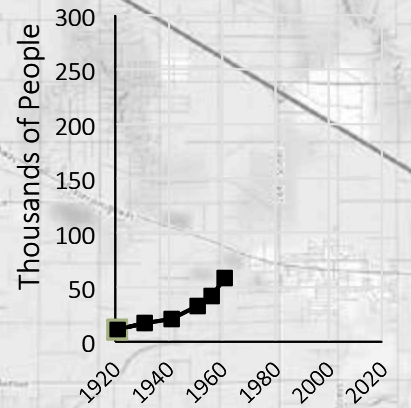
1961



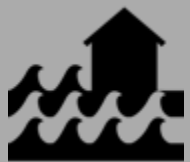
Flood Hazard



Exposed Population



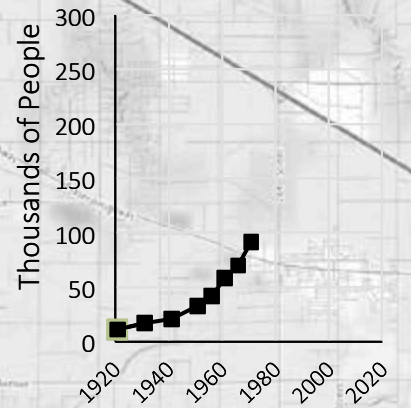
1971



Flood Hazard



Exposed Population



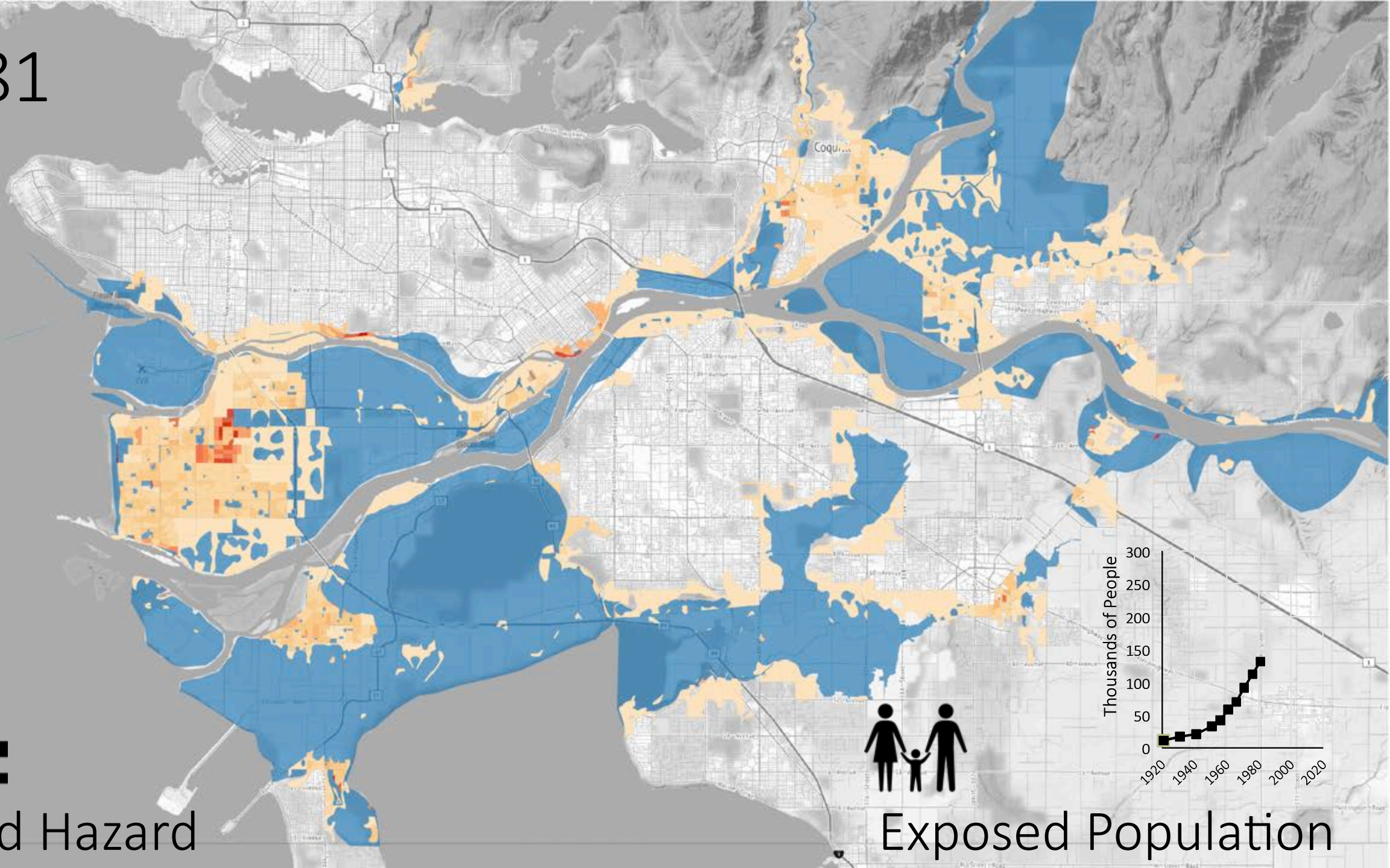
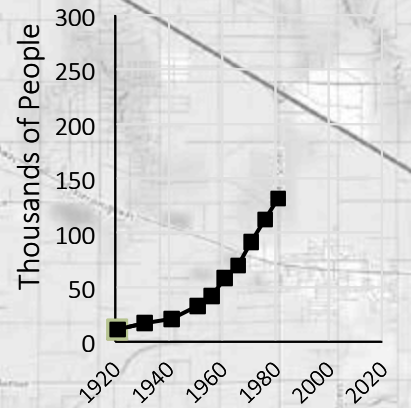
1981



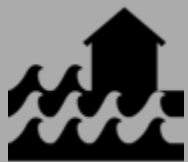
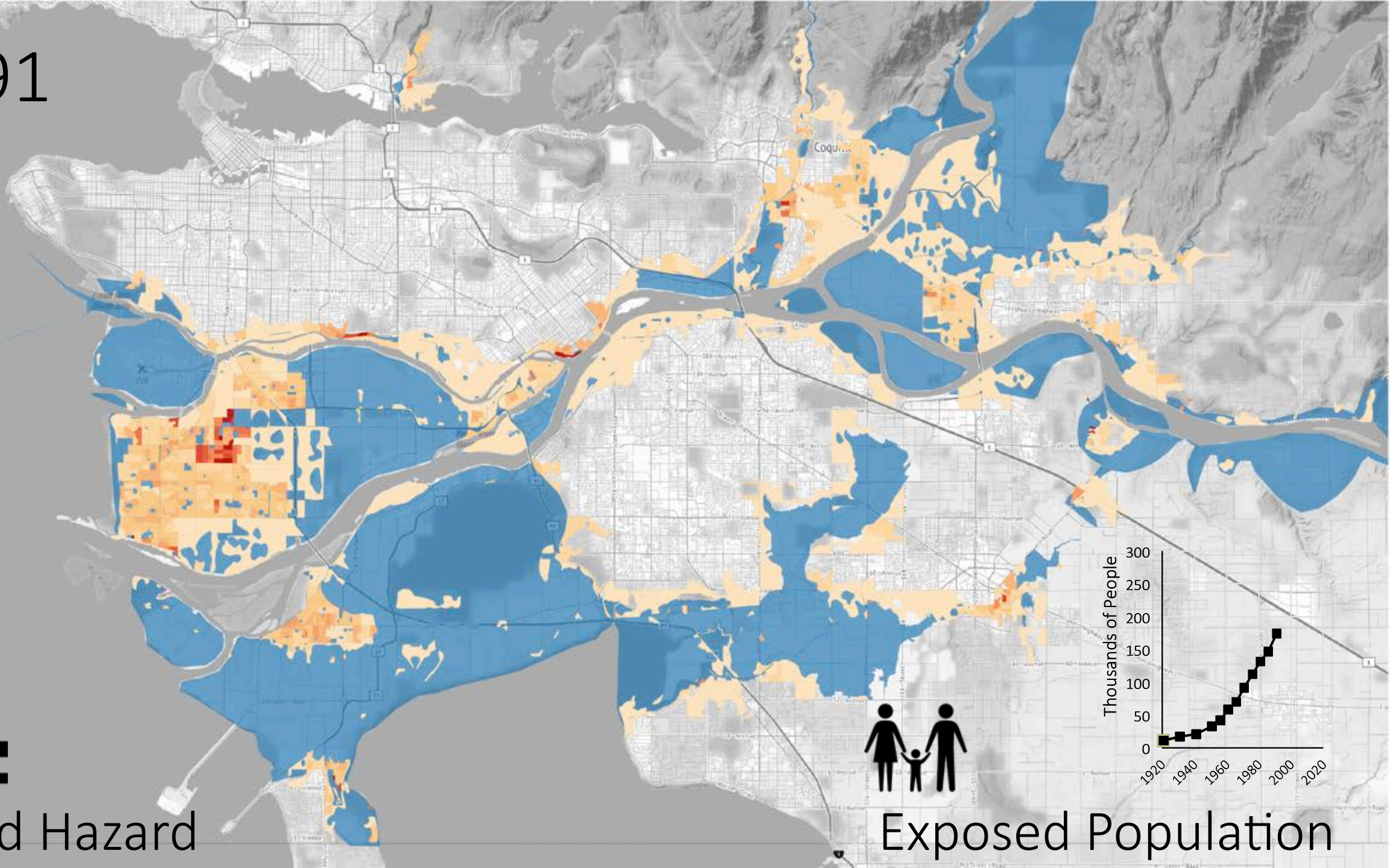
Flood Hazard



Exposed Population



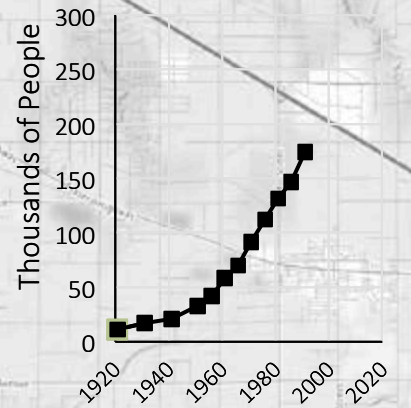
1991



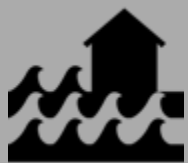
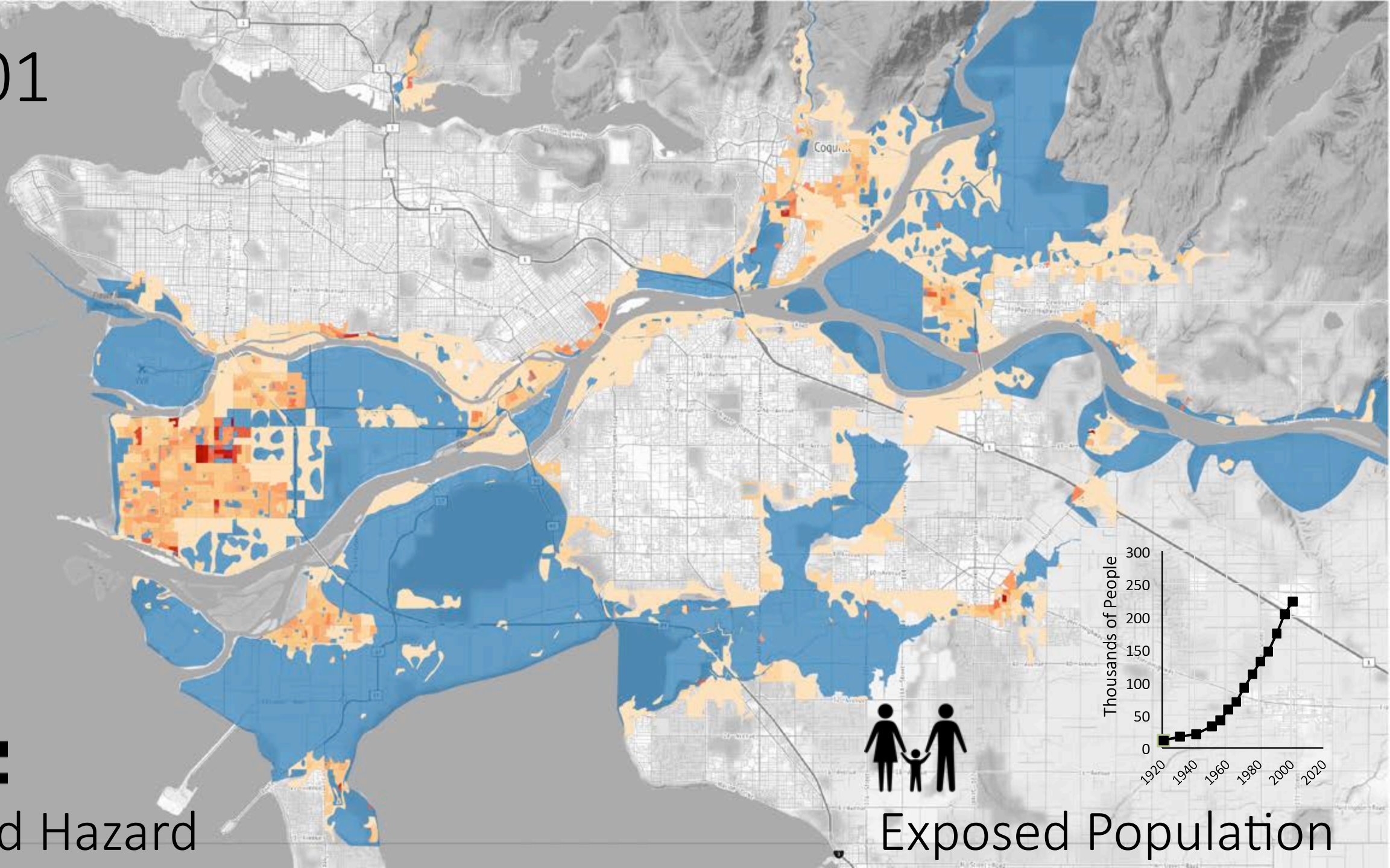
Flood Hazard



Exposed Population



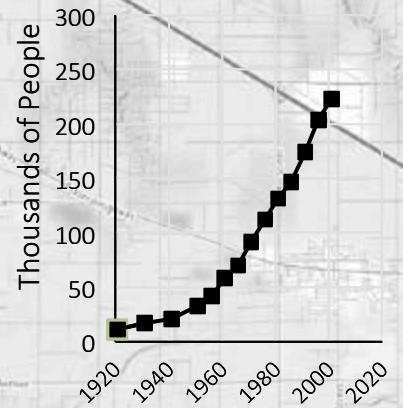
2001



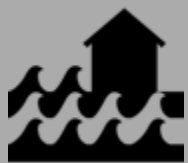
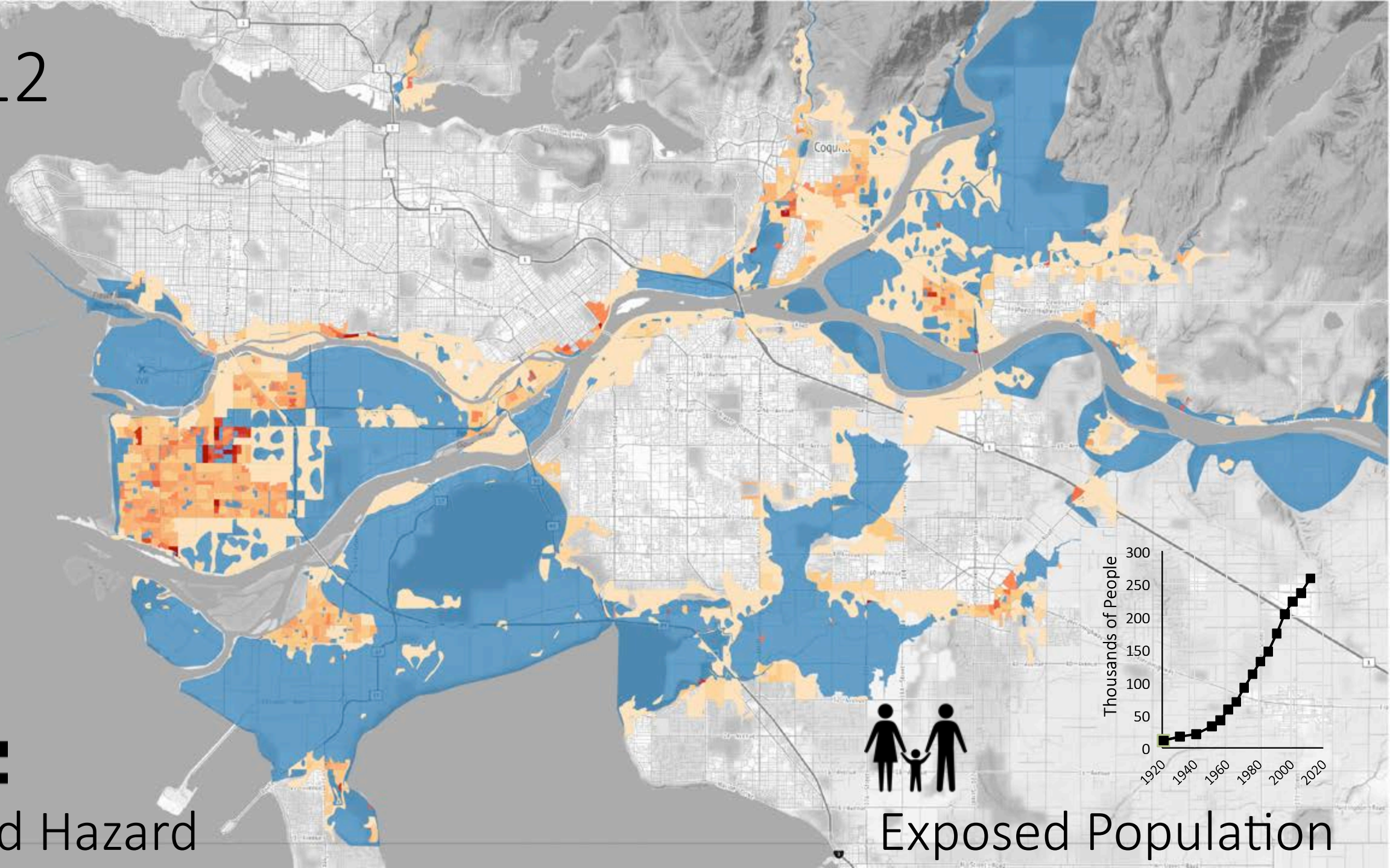
Flood Hazard



Exposed Population



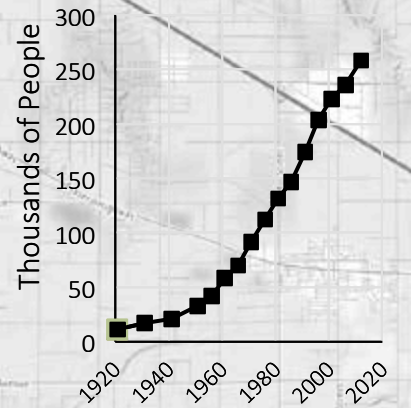
2012



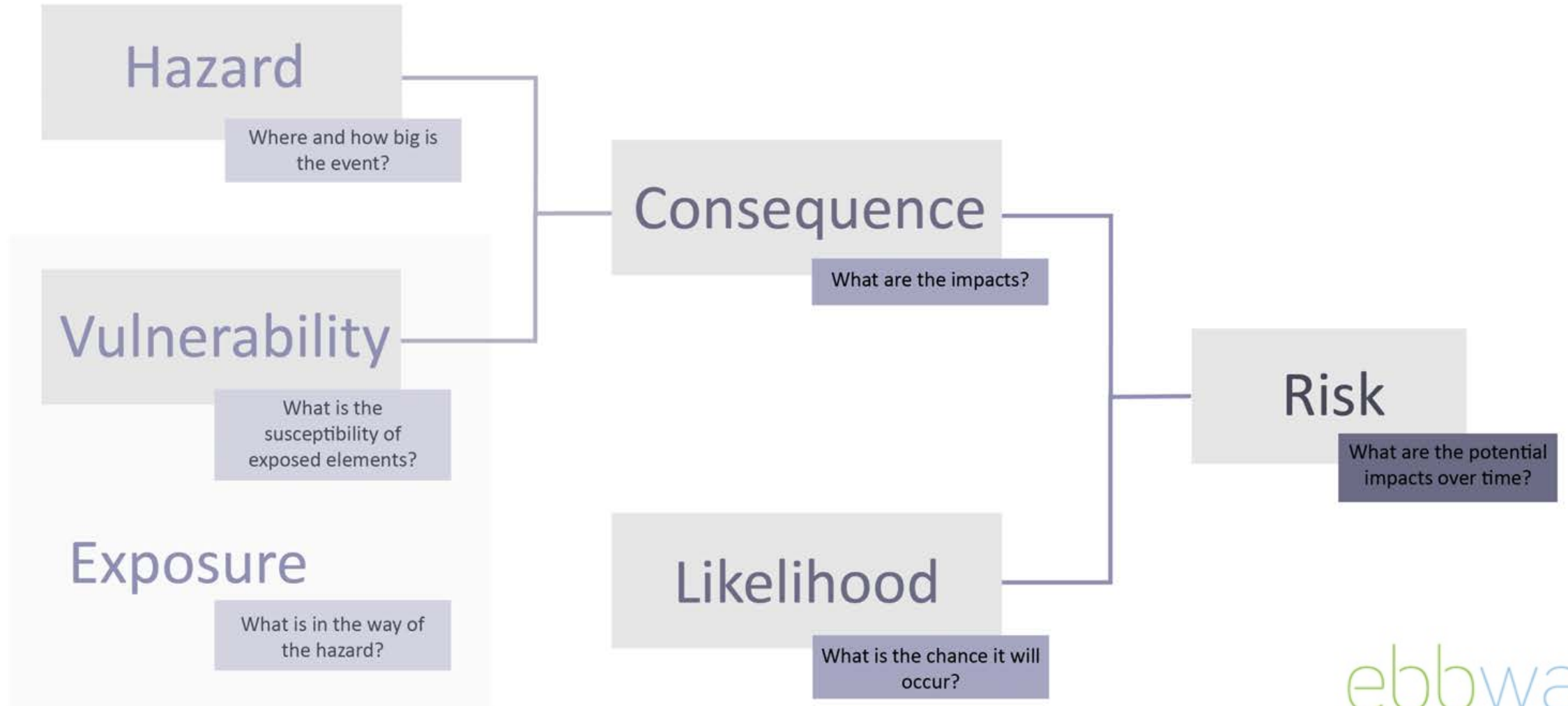
Flood Hazard



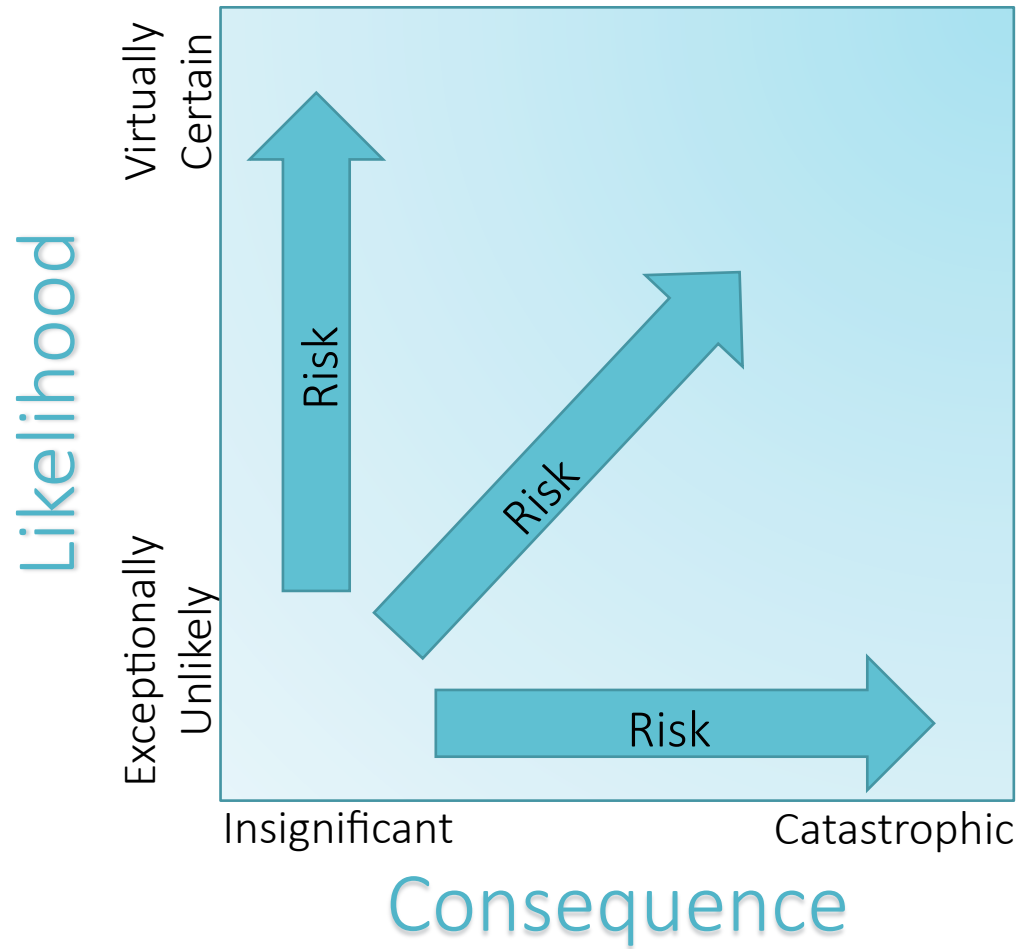
Exposed Population



Meerkats Consider Risk not Hazard

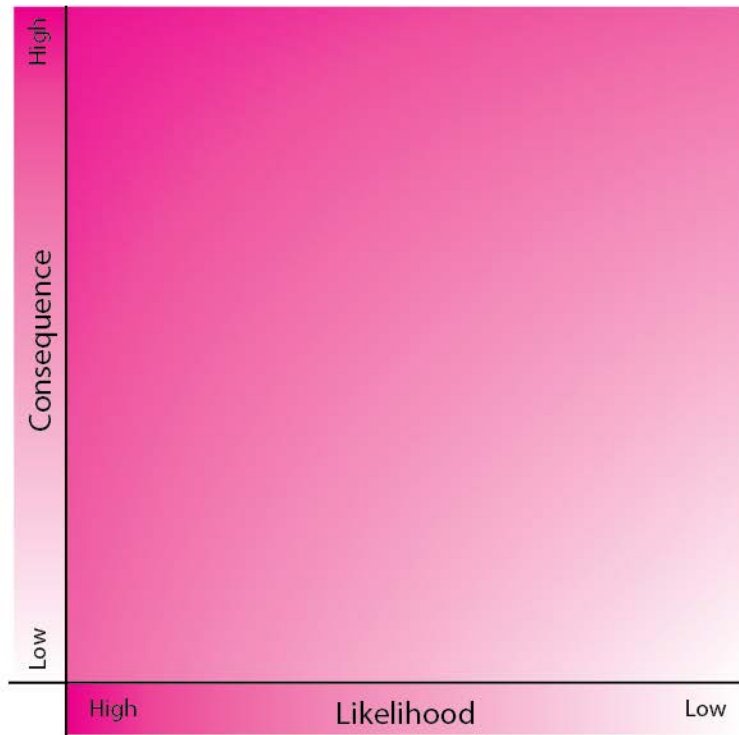


Risk is good for strategic planning

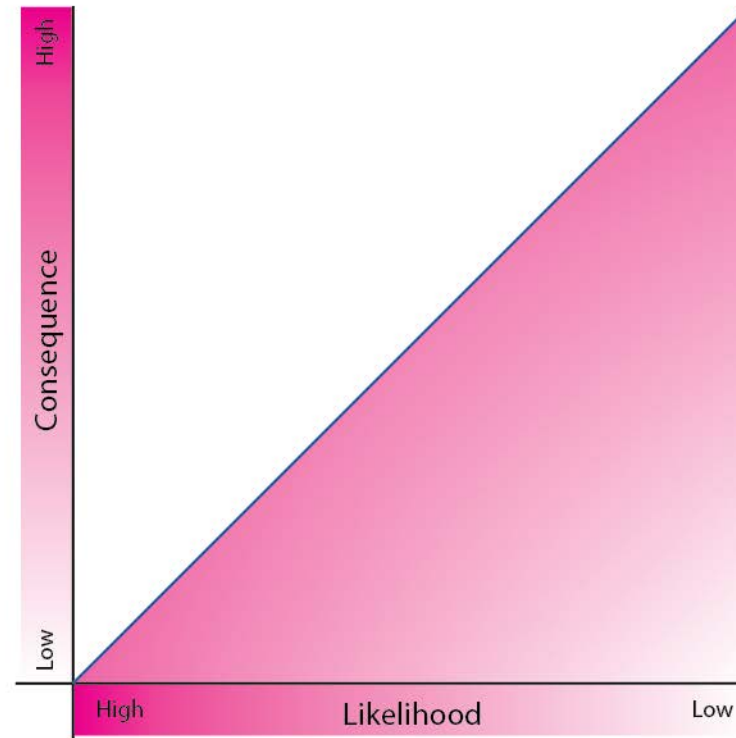


Real risk, not colloquial risk

1. Risk

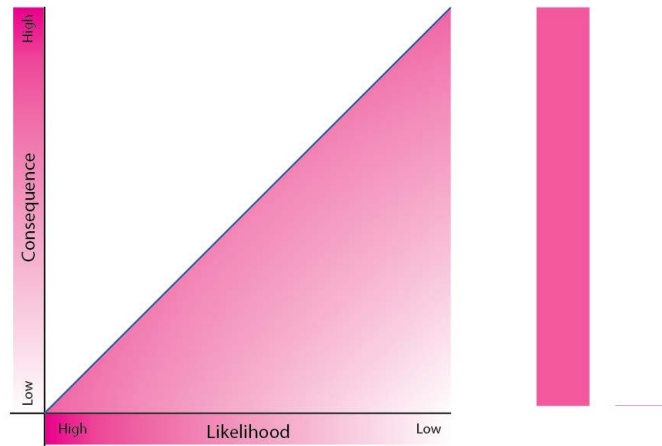


2. Flood Risk

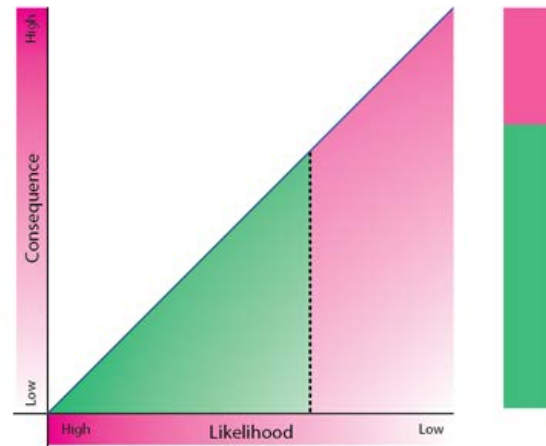


How does that change what we do?

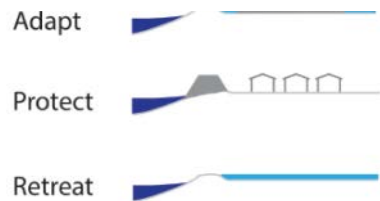
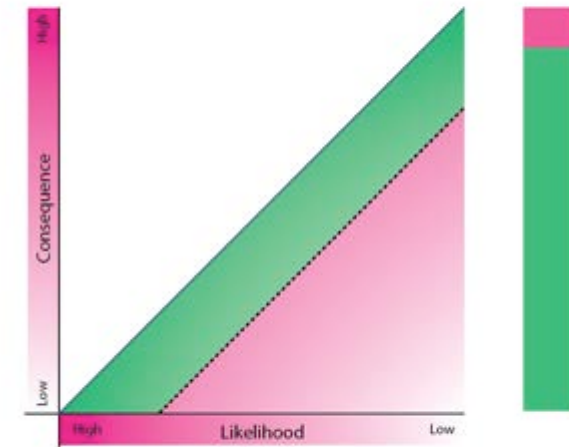
2. Flood Risk



3. Flood Risk - Protect



4. Flood Risk - Adapt



Meerkats Listen to People and Consider Values (...And stop thinking like engineers)



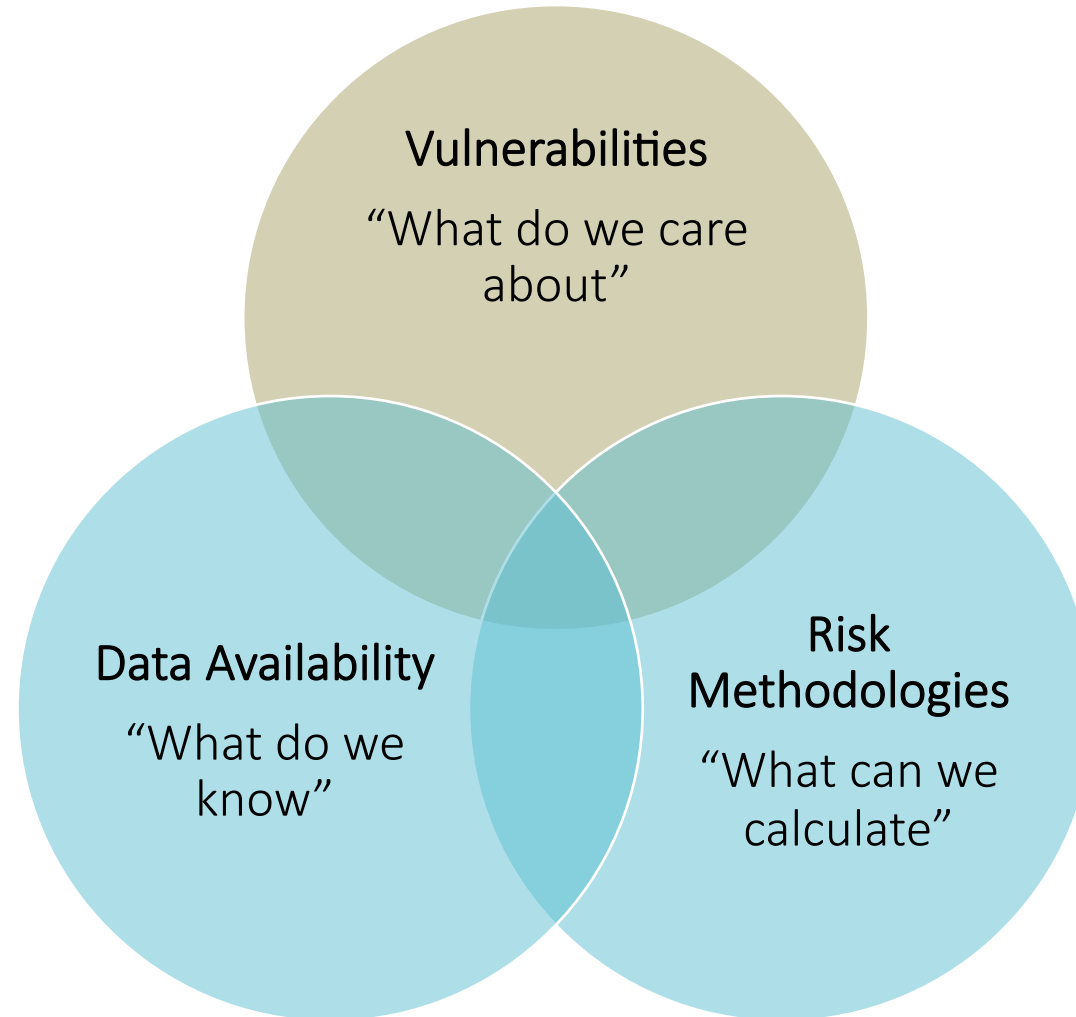
Talk to people; not just those you like

Image sources: West Coast Environmental Law

What Do We Care About?

Infrastructure	Economy	People (Community)	People (Recreation and Culture)	Environment
<ul style="list-style-type: none"> ▪ Major rail lines ▪ Rapid transit tunnels ▪ Electricity substations and transmission lines ▪ Water and sewer pump stations, overflows and pipes ▪ Neighbourhood energy infrastructure ▪ City yards, fire halls and police stations ▪ Commercial and residential towers ▪ Commercial and residential low-rise buildings, some with basement suites ▪ Industrial buildings 	<ul style="list-style-type: none"> ▪ Transport hubs (train stations and yards, bus station, rapid transit stations) ▪ Port ▪ Tourist destinations (parks, beaches, major restaurants, hotels and hostels, cruise ship terminal, parks, beaches, Granville Island) ▪ Commercial service centres ▪ Industrial zones including “green jobs zone” and produce depots ▪ Water dependant industry including marinas ▪ High-value real estate 	<ul style="list-style-type: none"> ▪ Community centres ▪ Homeless shelters ▪ Non-market housing ▪ Emergency shelters and mass refuges ▪ Seniors housing and day-centres ▪ Childcare and pre-schools ▪ Schools and educational facilities (including libraries) ▪ Food banks ▪ Social service centres ▪ Animal shelters 	<ul style="list-style-type: none"> ▪ Pools, rinks, sports fields ▪ Museums and archives ▪ Galleries and cultural destinations ▪ Heritage sites 	<ul style="list-style-type: none"> ▪ Ecological value of shoreline areas ▪ Potential contamination from hazardous waste storage and infill soils ▪ Biodiversity hotspots in parks

What can we calculate?



What Do We Use to Make Decisions?

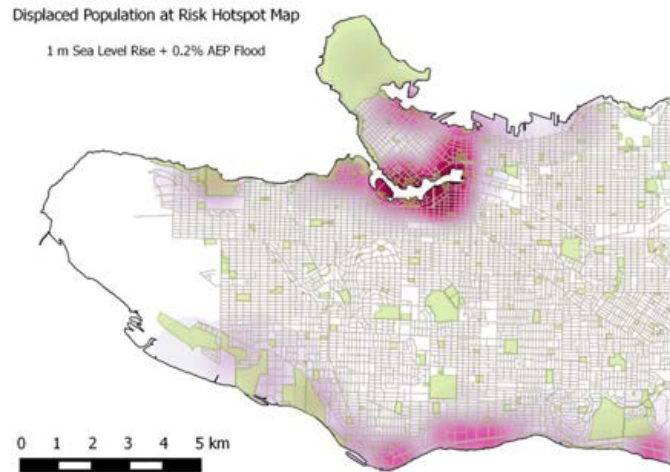
Infrastructure	Economy	People (Community)	People (Recreation and Culture)	Environment
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Let's Tell a Fuller Story

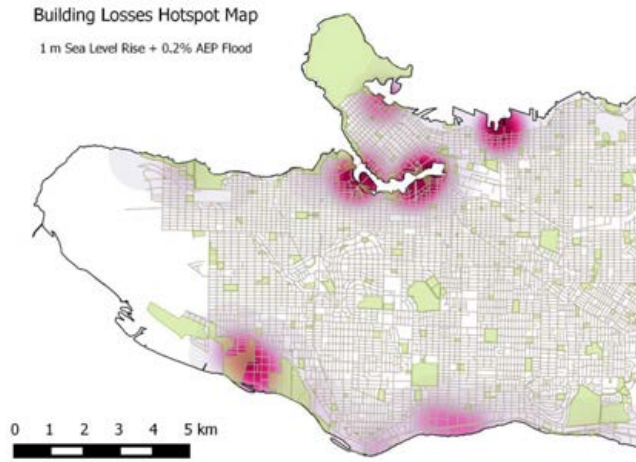
PEOPLE	
People Displaced	# of people displaced from flood events
People Displaced	# people displaced permanently
'at risk' people impacted	Social Vulnerability Index (SVI) weighted displacement
Park and Recreational Amenity Value	Value-weighted area affected per event
Loss of critical services	# of pieces 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.

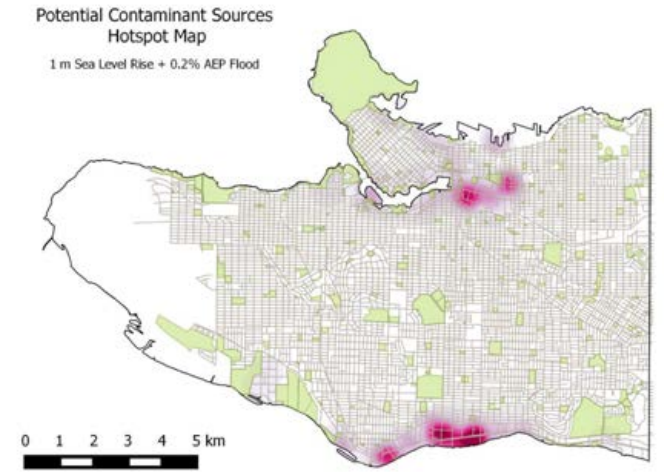
Because, the Story Changes the Question...



People



Economy



Environment

....And the Response

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

Example consequence table for City of Vancouver, 2015. Developed with Compass Resource Management.

Especially if you consider the action itself

Impacts from Flood Management Action (or Inaction)

Measure	Scale	BASELINE	PROTECT Park Dike	PROTECT Road Dike	ADAPT Multiple Tools	RETREAT
PEOPLE						
People displaced permanently	# of people displaced permanently (by SLR or action)	0*	0	0	0	461
Aesthetics	-2 to +2 (constructed scale)	0	0	-0.5	2	0.5
ENVIRONMENT						
Environmental benefits	-2 to +2 (constructed scale)	0	-1	0	0	0
IMPLEMENTATION						
Capital costs	\$M	0	7 to 25	10 to 20	60	620
Maintenance costs	\$M/Year	0	0.02	0.15	0.06	0
Adaptability	1 to 4 (constructed scale)	4	1	1	3	4
Ease of implementation	1 to 5 (constructed scale)	1	2	3	2	4


Example consequence table for City of Vancouver, 2015. Developed with Compass Resource Management.

* Methodology used to calculate baseline case is coarse and based on Census Block areas. No displacement was calculated using standard methodology, however some households with between 10-20 people would be expected to be displaced.


Meerkats Enable Resilience



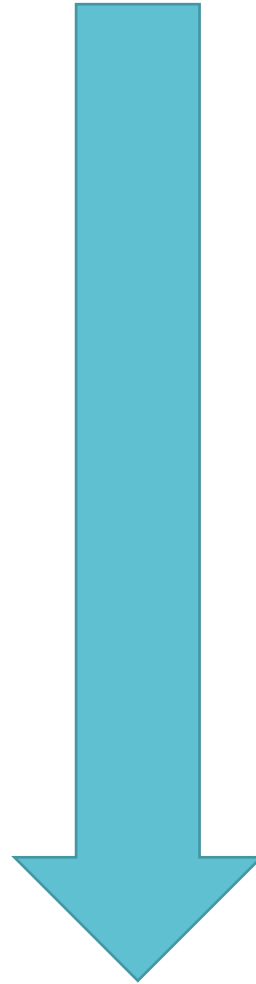
Reduce the Hazard
Block the water



Reduce Exposure
Stop things/people you care about getting wet



Reduce Sensitivity
Reduce impact of getting wet



- We can't fight nature
- We can't sterilise our floodplains
- We can reduce sensitivity to our built environment
- We can speed up our recovery
- We can safely fail instead of striving for the fail-safe solution

High Level Options

The Basics



Do Nothing



Adapt



Protect



Retreat



Engineering

Reduce the Hazard (Protect)



Armouring: Holding the Line

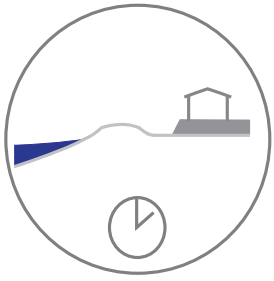
(Clockwise: Ring Dike, Sea Barrier, Seawall, Superdike, Traditional dike)

Moderation: Slow the Erosion

(Clockwise: Groins & Breakwaters, Rip-rap, Dune Construction, Mixed/natural erosion control)

Restoration: Replace what is destroyed

(Land reclamation, beach nourishment, constructed wetlands)



Building Controls

Reduce Exposure or Sensitivity (Adapt)



Elevation



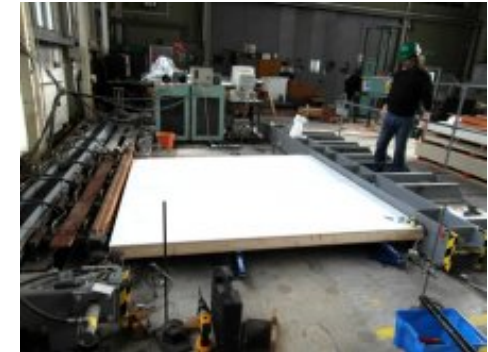
Permanent Resistance



Temporary Resistance



Dry Floodproofing



Resilience

Wet Floodproofing

Regulatory Options For the Planners



- Acquisition (developed and undeveloped land)
- Relocation (property and infrastructure)
- Retreat
- Transfer of development potential
- Regulation of land use
- Covenant on title
- Right to flood
- Building code

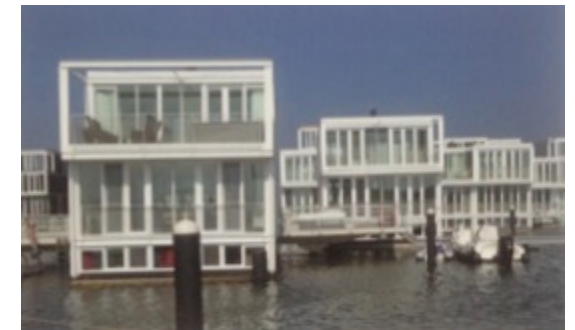
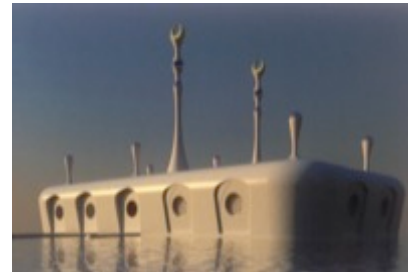
Emergency Management Increased Resilience

- Warning system
- Evacuation and response planning
- Education (public and media)
- Recovery plans

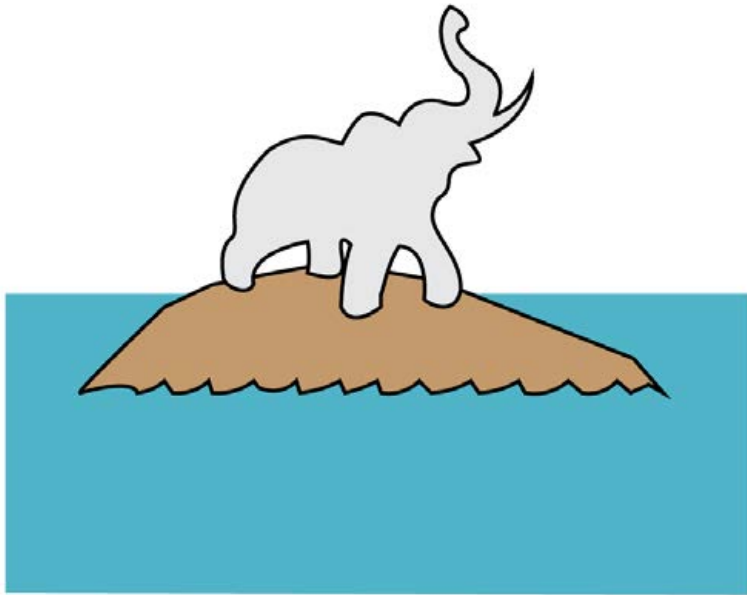


Creative Ideas

For your Imagination



Creative...not useless



What are *White Elephants* you ask?

Noun

a possession that is useless or troublesome, especially one that is difficult to maintain or dispose of

Meerkats Have a Back-Up Plan

Complementary Design with Co-Benefits

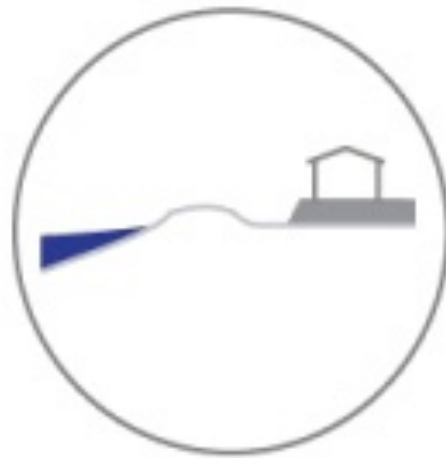
Cornerstone Idea



e.g. A dike



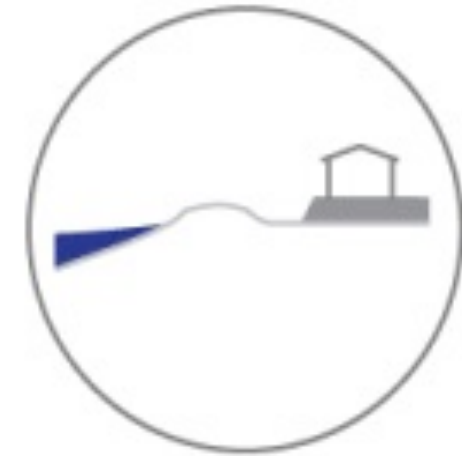
Brick Idea



complemented with
property-level-protection



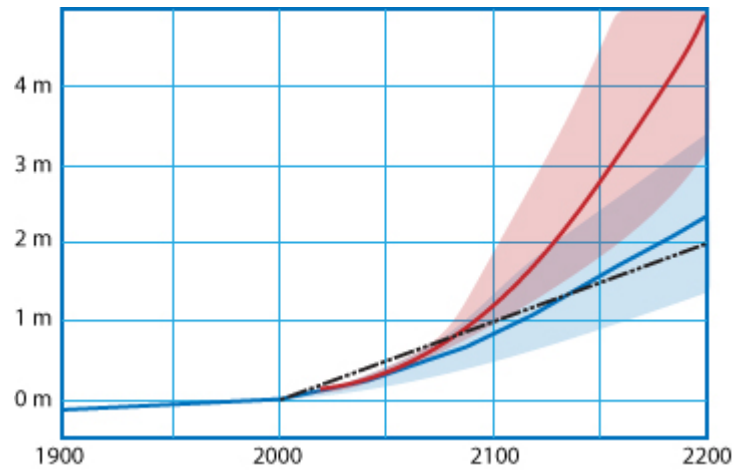
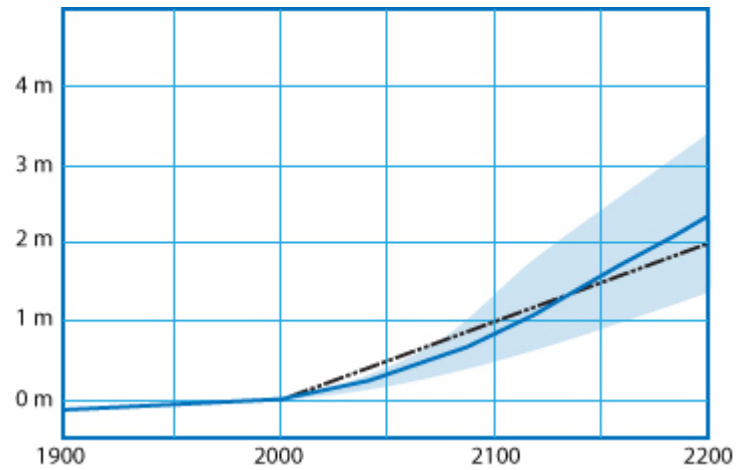
Brick Idea



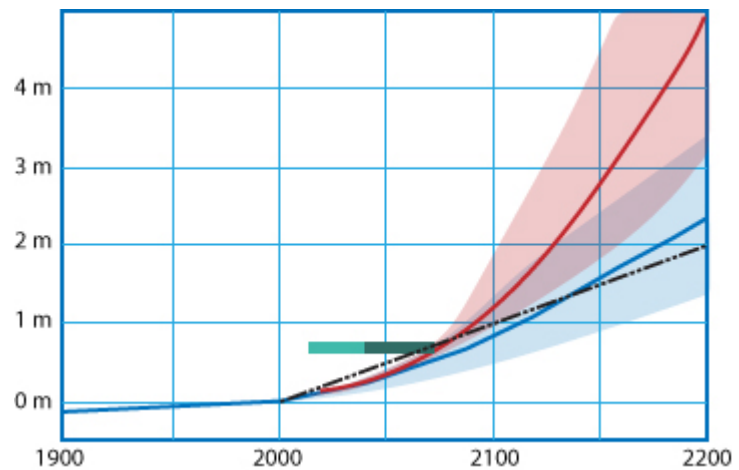
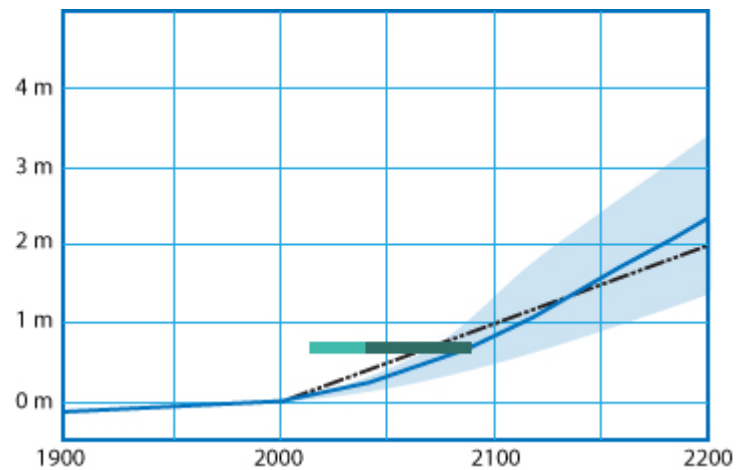
improved with habitat
enhancement and a bike path

A Meerkat Dilemma

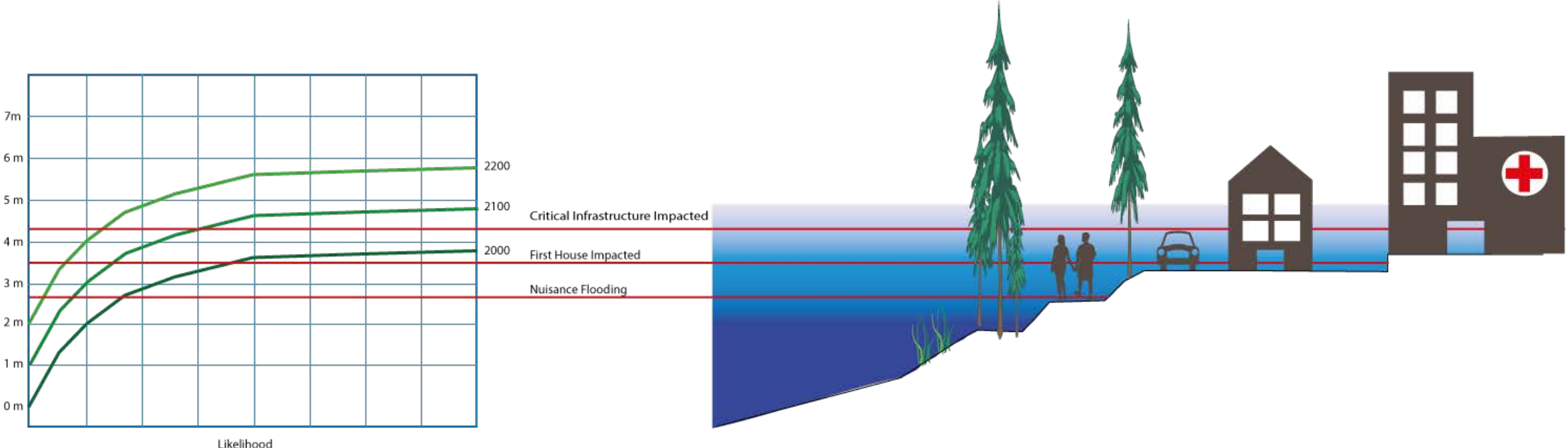
Our Design Targets are Moving



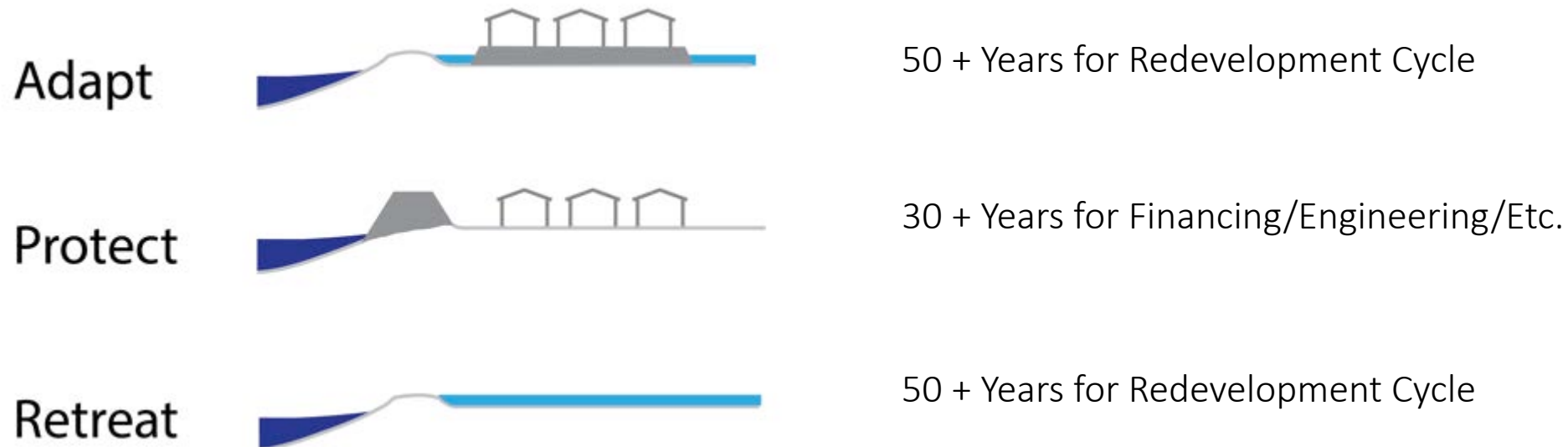
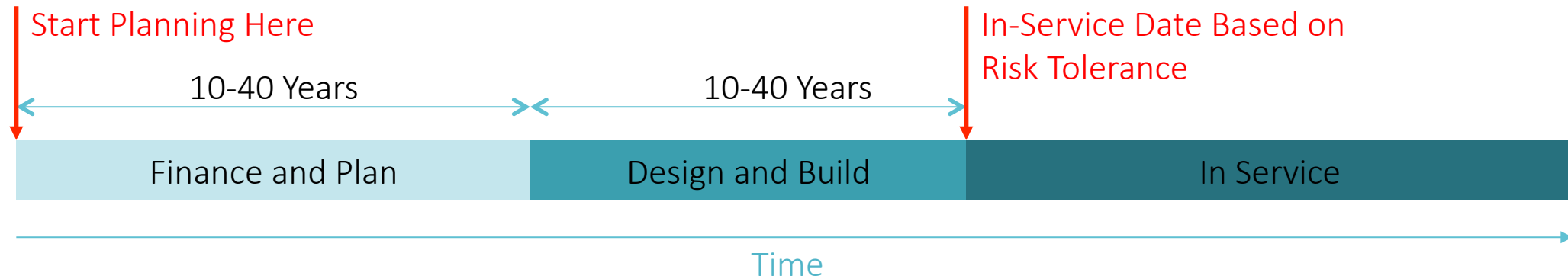
- Estimated Sea Level Rise
- - - BC SLR Planning Curve
- Uncertainty Bounds



Which affects when we need to act?



And also the time it will take to implement actions



Meerkats Embrace Uncertainty

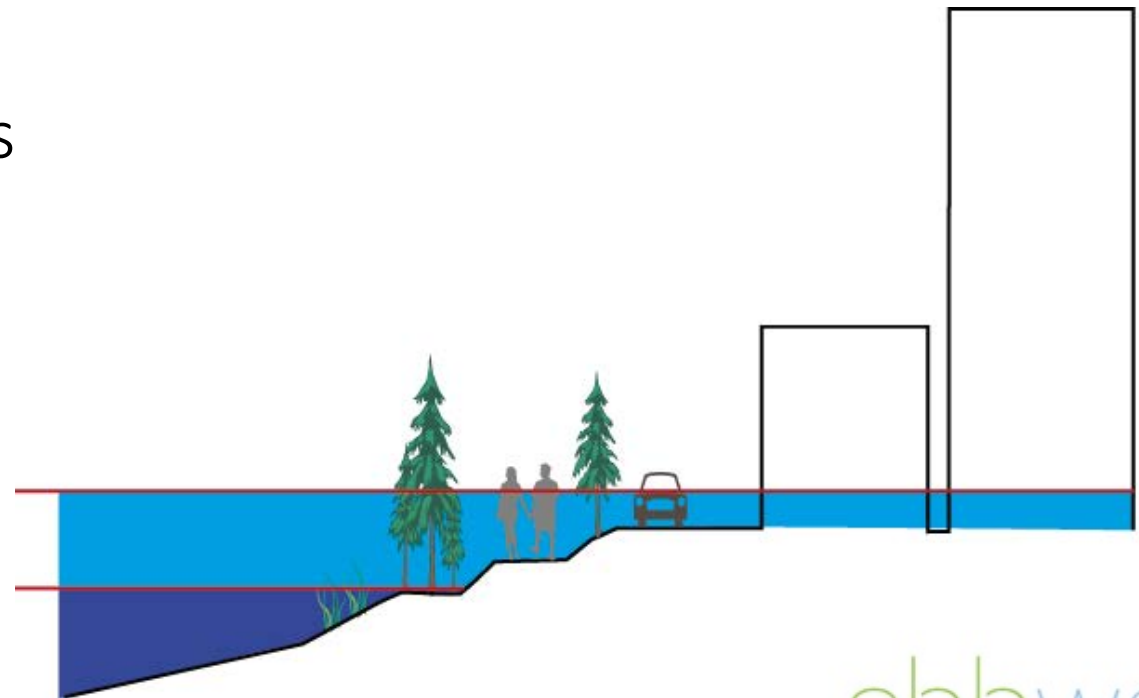
- Strive for adaptive solutions that will work under many climate and development futures
- Avoid solutions that are single-minded or that remove future options
- Consider infrastructure lifecycles

High end of range:

Overinvestment in protection

Low end of range:

Potential catastrophic impacts



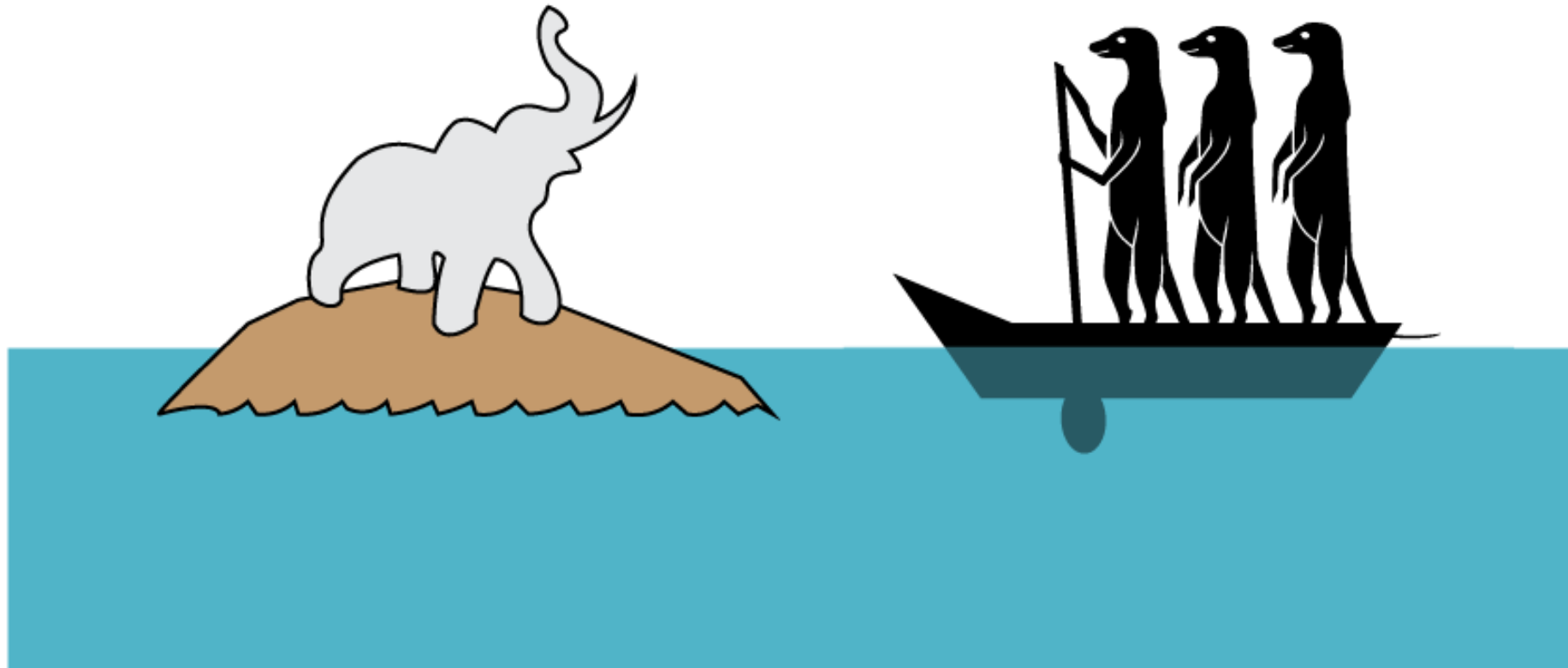
Meerkat School – What did we learn?

How to Do the Right Thing

- Focus on the opportunities and be brave (climate change can be good)
- Plan for risk not hazard
 - Consequences matter
- Enable resilience
 - Focus on recovery
- Embrace uncertainty
 - Strive for adaptive solutions that will work under many climate and development futures
 - Avoid solutions that are single-minded or that remove future options
- Listen to other species

Meerkats Unite!

White Elephants Be Gone! (Ostriches Too)



Contact

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