let it flood

Rethinking Flood Resilience for Indigenous Homes and Heritage

by
Vani Goel

A thesis
presented to the
University of Waterloo
in fulfillment of
the thesis requirement
for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2024
© Vani Goel 2024

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Indigenous communities are not just the inhabitants of the land they live on, they are its stewards, storytellers and souls. Their homes, often passed down from one generation to another, hold the stories of their ancestors, struggles, and the rituals that define their sense of place. Yet, time and again, these communities are forced to evacuate due to flooding, temporarily uprooted from the lands they call home. Throughout Canada's colonial history, numerous Indigenous communities have been displaced onto remote, flood-prone land increasing their vulnerability to floods. The impact of these repeated displacements ripple through the communities, disrupting cultural heritage, age-old traditions, and the sacred connection between land, water and people. This creates a profound sense of loss—both tangible and intangible. Many communities have felt the impacts that some residents were never able to return home, faced with the difficult decision to abandon their multigenerational homes.

With floods growing in frequency and intensity, the urgency to address the impacts of climate change is more pressing than ever. Beyond the cultural, social and mental toll, the economic burden of rebuilding is staggering, with billions spent on recovery and reconstruction. Communities without access to substantial resources for protective measures often bear the brunt of the impact. But while the physical structure of a home can be rebuilt, can one really rebuild and recover a sense of belonging?

This thesis advocates for amphibious architecture as a resilience-in-place approach—a way for Indigenous communities to remain safe on their land, even when floods come. Unlike relocation, which severs the deep bonds between people and place, amphibious architecture allows homes to rise with the water and settle back once it recedes, offering the possibility of living in harmony with natural cycles, rather than in fear of them. By exploring how this architectural form can be applied across Canada and incorporated into policies and regulations, I argue for a future where Indigenous communities need not choose between safety and staying on their homeland. This work is about more than protecting homes from floods; it is about safeguarding the cultural continuity and the deep connection to land that relocation threatens to erase. Ultimately, it raises the question of how architecture can protect and preserve the sacred bonds between land, water, and people, fostering a more resilient and equitable tomorrow.

Territorial Acknowledgement

I acknowledge that the University of Waterloo is situated on the traditional territory of the Neutral, Anishinaabeg, and Haudenosaunee peoples. The university is located on the Haldimand Tract, land promised to the Six Nations, which includes six miles on each side of the Grand River.

As I engage in academic research and learning, I am mindful of the ongoing responsibilities I have as a guest on this land and recognize the deep connections Indigenous peoples hold to these territories. This thesis embraces decolonial thinking, recognizing the importance of dismantling colonial systems and centering Indigenous knowledge and perspectives. I express gratitude to the communities whose stewardship informs my work and aim to contribute to reconciliation and the preservation of Indigenous cultural heritage.

Acknowledgements

My deepest appreciation goes out to Dr. Elizabeth English, my supervisor, for her encouragement, insight and wisdom. You have been incredibly patient and kind in teaching new concepts and giving me so many opportunities to learn from you. Thank you for sharing your knowledge and experience, which have shaped not only this thesis but also raised questions that will stay with me long after. You are absolutely the best.

To David Fortin, my committee member, thank you for your positivity and encouragement throughout this process. I appreciate the time you took to engage with my work deeply, guiding me to explore new perspectives and refine my approach. I would also like to thank Jane Mah Hutton, my Internal examiner, for helping make the defense such a positive experience for me, and Andrea Spencer, my External examiner, for her invaluable insights and contributions.

This thesis was supported by the NFRF-E grant for the "Water is Our Friend Project." Thus, to the Buoyant Foundation Project for funding and the opportunity to make fieldwork possible. To Tracey Eve Winton, as my *Thesis Research and Development* studio professor, you were incredibly thoughtful and accommodating for my first semester here at Waterloo. Thank you for helping me shape this research in its initial stages and asking the difficult questions.

I am also indebted to the many community members who generously shared their conversations, stories, meals, trips on their land, and invaluable knowledge with me. Thank you to Saje and Peter from

Chawathil First Nation for welcoming us, walking with us, showing us the flooded homes, and sharing your experiences. My heartfelt thanks also go to Grant from the Musqueam Indian Band for taking the time to share your knowledge. Visiting both these communities in BC really helped define my research. To William and Bill from Peguis First Nation for the many meaningful conversations—both at the BFP workshop and over steak—that have profoundly shaped my work. I feel incredibly fortunate to have learned so much through listening to and spending time with so many individuals whose insight has influenced this work.

Also, to those whose wisdom and knowledge have shaped my understanding of Indigenous cultural heritage and informed my work. I extend my gratitude to Elder William Woodworth for his *Twelve Architectures* elective course, which allowed me to reconnect with my own heritage and dive deeply into the world of Indigenous teachings. To Mkmosé, Dr. Andrew Judge, I am thankful for your teachings on Anishinaabe land management practices during my time as a Teaching Assistant for your course. This journey has inspired me to decolonize my research and meaningfully engage with the land in multiple ways.

I would also like to acknowledge the University of Waterloo's Water Institute, as the *Collaborative Water Program* played a crucial role in shaping my interdisciplinary thinking. Engaging in conversations with faculty, lecturers, and students broadened my understanding of how water intersects with and transcends various boundaries.

...

My parents, Shishir and Seema, and my brother, Yash—everything that I have done and do is for you. You guys have shaped me into the person I am today. You are my heroes, role models and my heart in human forms. Papa, thank you for planting the seed of curiosity in us when we were young, and for inspiring me to follow my passion of science, art and creativity altogether. Thank you for letting me be your sidekick whenever there was a renovation project at home. Mumma, for always giving me endless love and hugs. You filled our house with love, fun, dance, art and books. Your selflessness, kindness and care for others have taught me everything I know about being generous. Talking to you guys every night—about both important and absolutely nonsensical—is my de-stressing hour. Yash, whether it was holding my hand and dropping me off to class in kindergarten or moving me to Cambridge for grad school, you have been my rock and guidepost along the way. Thank you for being my favourite roommate and reminding me to eat during those stressful final thesis moments. Thank you all three for listening to my thesis rants (or silence most of the days) and understanding when I want to talk about school and when I don't.

To my grandparents, thank you for sharing stories of resilience and strength that have shaped my values. Dadu, before you left, we talked long hours about history, spirituality, food, perfumes and my thesis. Thank you for teaching me how to follow what I believe in. Your unwavering spirit and sense of humour despite fighting the illness even in the last days was incredibly moving and inspiring. I love and miss you. I promise to carry your teachings, love and spirit with me in everything I do.

I cannot thank enough the friends and classmates I met throughout my architecture journey, both undergraduate and graduate. Vrinda, for being my first studio partner ever in undegrad, and navigating the meaning behind being an architecture student together. Studio never felt the same without you. Oshin, for the many conversations that became shared therapy and bubble tea breaks mid-thesis. Thank you both for all the dinner dates, carpools, thoughtful conversations, wine nights and so much more. Your willingness to read through my drafts and offer feedback made a big difference. To Asmi and Shreya, for dragging me out of my house and into spin classes and sunset picnics. I appreciated the breaks.

Many thanks to my Writing Group members: Leo and Alexa, for reading and critiquing some of the most important sections of my thesis. Your feedback was invaluable. Thank you for listening through my countless confusion filled rants and meltdowns; and being my voice of reason.

To the friendships that have spanned most of my life: Riya, Arushi, Priya, Ritvik, my cousin Manvi. We grew up together and I am grateful for you all always being just a call away, no matter what life throws at me—the good and the bad. Riya, for being my family away from family. I wouldn't know what to do if you weren't on the other side of the call listening to my daily thesis update, whether it was from Cambridge, Toronto or New Delhi. I don't know how I got so lucky to have you guys by my side for the past two decades. Here's to many more.

...

I started this exploration not knowing what the end result would be, but what I did know was that I cared about this issue, and had a deep desire to be able to contribute to society, to understand the problem and come up with possible solutions. I also want to thank everyone who cares about the people and the environment, who advocate for the climate crisis, and recognize its profound impacts on displacement, trauma and cultural heritage. Your dedication is invaluable.

Finally, thank you to all those who generously shared their knowledge with me throughout this journey. Any shortcomings in this work are due to my own interpretations and ignorance, and I remain committed to learning and growing from this experience.

...

Dedication:

To all those affected by displacement and environmental upheaval, whose resilience and strength inspire this work.

May we honor your stories and strive to protect cultural heritage while advocating for a more just and sustainable future.

Table of Contents

ii *Author's Declaration*
iii *Abstract*
v *Territorial Acknowledgement*
vi *Acknowledgements*
xi *Dedication*
xiv *List of Figures*
xx *Acronyms*

xxvii *Preface*

1 **Part 1** First Nations and Flooding

5 1.0 After the Floods
5 1.1 The Flood Myth
6 1.2 What is Flooding?
11 1.2.1 Flooding in Canada
19 1.2.2 Flooding and Climate Change
20 1.3 How to cope with floods?
26 1.4 Relocation or Resilience in Place?
28 1.5 Summary
29 *Endnotes*

33 2.0 This Used to be Our Home
37 2.1 Flooding in First Nations
43 2.2 How displacement affects First Nations?
44 2.2.1 Idea of Home
46 2.2.2 Relationship with Land and Water
51 2.2.3 Trauma
53 2.2.4 Loss of Heritage and Culture
57 2.3 Case Studies
57 2.3.1 Lake St. Martin First Nation
60 2.3.2 Chawathil First Nation
62 2.3.3 Peguis First Nation
65 2.4 Summary
66 *Endnotes*

73 **Part 2** Amphibious Architecture

74 3.0 When the House Floats
75 3.1 Resilience in Place Strategy for First Nations
77 3.2 What is Amphibious Architecture?
88 3.3 Case Studies
89 3.3.1 Old River Landing, Louisiana
94 3.3.2 Maasbommel, Netherlands
96 3.3.3 The Mekong River Delta, Vietnam
98 3.4 Summary
99 *Endnotes*

101 **Part 3** Policies, Regulation and Application of Amphibious Architecture

102 4.0 Bridging Policy and Water
103 4.1 Existing Policies and Regulations for Housing on Indigenous Reserves
104 4.1.1 Federal and Provincial Code
105 4.1.2 Indigenous Treaties and Regulations Affecting Housing
107 4.1.3 Government Funded Institutions
109 4.1.4 Land Ownership Structure On-Reserve
111 4.2 Existing Policies and Regulations for First Nation Housing in Flood-Prone Areas
112 4.2.1 Flood Insurance
114 4.3 Lack of Existing Policies to support Amphibious Architecture
122 4.4 Incorporation of Amphibious Architecture
134 4.5 Application of these considerations for First Nation communities
137 *Endnotes*

140 5.0 Living Between Land and Water
141 5.1 Modular vs Stick-Built Housing
146 5.2 How to “Amphibiate”?
158 5.3 Environmental Considerations and Sustainable Materials
159 5.4 Reciprocity and Community Engagement
164 *Endnotes*

166 *Epilogue*
170 *Bibliography*
187 *Appendix A*
188 *Glossary*

List of Figures

Part 1 First Nations and Flooding

xxii Frontispiece *Image by author.*

1.0 After the Floods

2 Figure 1.0 Flooding in Indigenous communities in Canada.
Collage by author. Incorporating Images from: (Left to Right)
Row 1: Langley Centennial Museum (Photo #2930), New Westminster Archives (IHP9347), The Agassiz-Harrison Historical Society (P7002), Government of Manitoba "Historic Flood Archives", PoCo Heritage Museum.
Row 2: Government of Edmonton "Flood of 1915", Dale Brazao (Toronto Star via Getty Images), Government of Manitoba "Historic Flood Archives", Aaron Vincent Elkaim (The Narwhal), PoCo Heritage Museum.
Row 3: Lisa Geddes (Global News), Government of Manitoba "Historic Flood Archives", Eugene Isaac (Oak Bay News), Elkaim (The Narwhal), Chilliwack Museum and Archives.

7 Figure 1.1 Nanaboozhoo during the Great Flood.
Source: R.C. Armour, North American Indian Fairy Tales Folklore and Legends (London: Gibbons & Co., 1905), 70.

8 Figure 1.2 A flooded village during the "Grote Mandrenke" in 1362.
Source: De Agostini, Biblioteca Ambrosiana. Retrieved from https://www.history.com/news/worlds-most-catastrophic-floods-in-photos

12 Figure 1.3 Architectural Flood Mitigation Strategies Precedents.
Collage by author. Incorporating Images from: (Left to Right)
Row 1: Elizabeth English, Tere Garcia (Architecture in Development Blog), S.P. Krasheninnikov, Stanislaus von Prowazek.
Row 2: UN Office for Disaster Risk Reduction (2021), Steven Bingler (ArchDaily), Sonja Peterson (Peterson Photography), Michael Smee (CBC News).
Row 3: Jaison Empson (CBC), Factor Architecten, Elizabeth English, Petar Stoyanov (Luxutour Destinations).

15 Figure 1.4 Number of historical flood events inventoried in Canada.
Adapted from Natural Resources Canada, Government of Canada. Retrieved from https://natural-resources.canada.ca/science-and-data/science-and-research/geomatics/topographic-tools-and-data/whats-new/new-major-flood-events-now-available-on-the-historical-flood-events-layer/25891

16 Figure 1.5 2013 southern Alberta Floods.
Source: Jordan Verlage, the Canadian Press. Retrieved from https://globalnews.ca/news/1338253/15-compelling-images-of-high-river-in-the-2013-flood/.

16 Figure 1.6 Fort McMurray flooded in 2020 after a 25-km ice jam, forcing 12,000 people from their homes.
Source: Greg Halinda, The Canadian Press. Retrieved from https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

17 Figure 1.7 A woman gets back into her flooded car in Toronto, 2013, after heavy rainfall caused widespread flooding.
Source: The Canadian Press. Retrieved from https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

18 Figure 1.8 Point Pelee National Park flooded by Lake Erie.
Source: Public Works and Government Services Canada, Richard Vroom, 1976. Retrieved from https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/causes-of-flooding.html.

18 Figure 1.9 The Impact of 1929 Tsunami on Newfoundland's Burin Peninsula.
Source: Queen Elizabeth II Library, Memorial University. Retrieved from https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

21 Figure 1.10 Predicted Flood Levels in Canada.
Collage by author. Incorporating Images from Western University [Flood Map Viewer]. Retrieved from https://www.floodmapviewer.com/maps

24 Figure 1.11 Different Flood Mitigation Approaches.
Image by author.

2.0 This Used to be Our Home

35 Figure 2.1 Population at risk of flood by provinces in Canada.
Source: Liton Chakraborty, Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada," International Journal of Disaster Risk Science 12 (2021): 821–838, https://doi.org/10.1007/s13753-021-00383-1

35 Figure 2.2 Residential properties at risk of flood by provinces in Canada.
Source: Liton Chakraborty, Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada," International Journal of Disaster Risk Science 12 (2021): 821–838, https://doi.org/10.1007/s13753-021-00383-1

37 Figure 2.3 The number of emergencies and evacuations in First Nations communities between 2009 and 2022.
Source: Office of Auditor General of Canada, "Report 8—Emergency Management in First Nations Communities," 2022, https://www.oag-bvg.gc.ca/internet/English/att__e_44162.html

38 Figure 2.4 Flood-prone areas in Indigenous reserves.
Source: Adapted from the 2016 census subdivisions cartographic boundary from Statistics Canada; and the 2018 flood hazard data from JBA Risk Management. Retrieved from: Liton Chakraborty, Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada," International Journal of Disaster Risk Science 12 (2021): 821–838, https://doi.org/10.1007/s13753-021-00383-1

41 Figure 2.5 A bridge collapses into the Nicola River near Nooaitch Indian Band territory, 2021.
Source: Lenora Starr, APTN News, 2021, Retrieved from https://www.aptnnews.ca/national-news/nooaitch-indian-band-isolated-after-massive-flooding-hits-b-c/

47 Figure 2.6 The ceremony.
Photo by author.

48 Figure 2.7 Offering tobacco to the land and giving thanks.
Photo by author.

55 Figure 2.8 Church of Sacred Heart, Chawathil First Nation.
Photo by author.

56 Figure 2.9 Church of Sacred Heart, Chawathil First Nation.
Source: Google Maps.

59 Figure 2.10 A child's drawing showing their home submerged by the floods.
Source: Myrle Ballard and Shirley Thompson, "Flooding Lake St. Martin First Nation Community: Impacts to and Future Community Plans for Sustainable Livelihoods," Canadian Journal of Nonprofit and Social Economy Research 4 (2013):43-65, https://doi.org/10.22230/cjnser.2013v4n1a129

61 Figure 2.11 One of the houses affected by 2021 AREs in Chawathil. Although the flood damage may not be immediately visible, the resident has since been displaced and continues to live in temporary accommodation, unable to return home.
Photo by author, 13th March 2024.

64 Figure 2.12 Aerial view of flooding in Peguis First Nation on April 9th, 2024.
Source: Snapshot by Douglas R. Thomas' Youtube Channel, Retrieved from https://outlook.office.com/mail/safelink.html?url=https://www.youtube.com/watch?v=E70h3UD75iA&ab_channel=douglasrthomas&corid=4a5127ae-b021-ea09-43c0-2d41bfd11167f

Part 2 Amphibious Architecture

3.0 When the House Float

78 Figure 3.1 Relocation vs Resilience-in-Place Approach.
Image by author.

81 Figure 3.2 Amphibious architecture, on land and water respectively.
Image by author.

82 Figure 3.3 Buoyancy Elements Materials Precedents.
Collage by author. Incorporating Images from: (Left to Right)
Row 1: Elizabeth English, Eco-Business, Buoyant Foundation Project (2018).
Row 2: Prithula Prosun (2011), Buoyant Foundation Project, Kim Colin (2014).

83 Figure 3.4 Vertical Guidance Post and Centering Device Precedents.
Collage by author. Incorporating Images from: (Left to Right)
Row 1: Buoyant Foundation Project (2018), Prithula Prosun (2011).
Row 2: Elizabeth English, Buoyant Foundation Project (2018).

84 Figure 3.5 Utility Connections.
Image by author.

85 Figure 3.6 Debris Screen.
Source: Elizabeth English.

90 Figure 3.7 Amphibious Architecture globally.
Image by author.

93 Figure 3.8 Amphibious homes in Old River Landing.
Source: Elizabeth English, Buoyant Foundation Project.

94 Figure 3.9 Section of the amphibious houses in Maasbommel.
Source: Factor Architecten, Retrieved from https://urbangreenbluegrids.com/projects/amphibious-homes-maasbommel-the-netherlands/

95 Figure 3.10 Amphibious houses in Maasbommel.
Source: Buoyant Foundation Project, Retrieved from https://www.buoyantfoundation.org/resources/maasbommel
Factor Architecten and Boiten Ingenieurs, Retrieved from https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands/11310092.pdf/@@download/file

97 Figure 3.11 Amphibious houses in Mekong River delta, Vietnaml.
Source: Elizabeth English and Pham Duy Tien.

Part 3 Policies, Regulation and Application of Amphibious Architecture

4.0 Bridging Policy and Water

116 Figure 4.1 Flowchart: Policy Gaps Leading to Displacement vs. Pathways to Flood Resilience.
Image by author.

118 Figure 4.2 Guidelines for Floating Construction Globally
Source: Artur Karczewski and Łukasz Piątek, "The Influence of the Cuboid Float's Parameters on the Stability of a Floating Building," Polish Maritime Research 27 (September 2020): 16-21, https://doi.org/10.2478/pomr-2020-0042

124 Figure 4.3 Summary of Policies and Regulations for Housing On-Reserve.
Image by author.

130 Figure 4.4 Table of Recommendations.
Table by author.

132 Figure 4.5 Table of Recommendations.
Table by author.

135 Figure 4.6 Two-Eyed Seeing.
Collage by author. Incorporating Image from: Institute for Integrative Science and Health, Retrieved from http://www.integrativescience.ca/Principles/TwoEyedSeeing/#:~:text=We%20often%20explain%20Etuaptmumk%20%2D%20Two,for%20the%20benefit%20of%20all.

5.0 Living Between Land and Water

142 Figure 5.1 Modular and Stick-Built Housing in First Nations.
Collage by author. Incorporating Images from: (Left to Right)
All Images from Google Maps unless specified.
[Modular] Row 1: (Image 2) Alexa Holder (2023), (3) Tim Fontaine (CBC News).
Row 2: (1) Bison Modular Homes, (2) Modular Building Solutions Inc., (3) Royal Homes.
Row 3: (1) Nomodic Modular Housing, (2) CBC News.
Row 4: (1) Nomodic Modular Housing, (2) Best Buy Homes, (3) Ian Ross (Northern Ontario Business).

[Stick Built] Row 1: (Image 1) *Photo by author* (2024).

146 Figure 5.2 Housing Typology. *Image by author.*

150 Figure 5.3 Floor Plan of the Box Beam Structure in the Amphibious Design Proposal for a Typical Type A House. *Image by author.*

151 Figure 5.4 Floor Plan of the Buoyancy Elements in the Amphibious Design Proposal for a Typical Type A House. *Image by author.*

152 Figure 5.5 An exploded axonometric of the amphibious design proposal. *Image by author.*

153 Figure 5.6 Schematic design of the box-beam structure. *Image by author.*

154 Figure 5.7 The house when floating. *Image by author.*

161 Figure 5.8 The three design principles of this amphibious design proposal. *Image by author.*

162 Figure 5.9 “Between Land and Water.”
Image by author.

Appendix

187 Figure A Diagram Illustrating the Inspection and Maintenance Process for Box Beams containing Buoyancy Blocks. *Image by author.*

Acronyms

AANDC: Aboriginal Affairs and Northern Development Canada

AFN: Assembly of First Nations

ARE: Atmospheric River Events

BFP: Buoyant Foundation Project

CBL: Common Band Land

CIRNAC: Crown-Indigenous Relations and Northern Affairs Canada

CMHC: Canada Mortgage and Housing Corporation

CP: Certificate of Possession

CRED: Centre for Research on the Epidemiology of Disasters

EMAP: Emergency Management Assistance Program

EM-DAT: Emergency Events Database

EPS: Expanded Polystyrene

FAFNLMA: Framework Agreement on First Nations Land Management Act

FEMA: US Federal Emergency Management Agency

FN: First Nation

FNLMA: First Nations Land Management Act

FNMHF: First Nations Market Housing Fund

FNNBOA: First Nations National Building Officers Association

FPE: Flood Protection Elevation

IPCC: Intergovernmental Panel on Climate Change

ISC: Indigenous Services Canada

NBC: National Building Code

NFIP: National Flood Insurance Program

NRC: National Research Council

PSE: Permanent Static Elevation

PTSD: Post-traumatic stress disorder

UN: The United Nations




"where the land meets the water"

“When we take care of the land and water, the land and water take care of us.”

(Sylix First Nations’ Water Declaration)

preface

This thesis began not with a design, but with a question: how do we create homes that honour the land, even when the land itself is vulnerable to change? As I reflect on the journey that led me here, I realize that this question is as much about architecture as it is about belonging, resilience, and the stories that shape us.

I have always been aware of the power of water—the way it carves landscapes, nourishes life, and yet, at times, devastates entire communities. Working on this thesis, I came to understand that designing for flood-prone Indigenous communities requires more than just technical expertise; it demands a deep respect for the lands and cultures that have withstood shifts and upheavals far beyond those I could ever fully know. Here, decolonizing research became not just a tool but a practice of humility. Throughout this thesis, I have grappled with the question of agency: what right do I have, as an outsider, to engage with land that is not my own? How can I respectfully engage with places that hold legacies of stewardship far deeper than my own understanding? This question has no definitive answer but invites an openness that, I believe, is essential to work of real value. I chose, therefore, to focus on moments of learning and re-learning, acknowledging that I am neither equipped nor entitled to derive a single answer to these questions.

I also want to clarify that in this thesis, I do not speak for the Indigenous, or even from the point of view of someone who has great knowledge of, rather I come from a space of relative knowledge that I gained while working on this thesis and interacting with the many people around me. This thesis is a contribution as an outsider—one position I am now familiar with, having lived among cultures and languages different than my own. This is my acknowledgement that I am stepping into someone else's territory, with a willingness to learn with and from those whose voices and histories ground this work.

As I delved deeper into the complexities of flooding in Indigenous communities in Canada, I came to understand that for Indigenous peoples, connection to land and water is not merely geographical—it is cultural, spiritual and ancestral. Evacuations and displacements caused by flooding, therefore, disrupt more than the physical. They uproot connections that ground identity and heritage. This thesis became a dialogue with these ideas of belonging and resilience. It is a way to ask: what if there were another choice? What if resilience could mean remaining in place, adapting rather than relocating, and continuing to belong even when waters rise?

Thus, it became clear that the solutions needed were not purely physical. They required a profound shift in how we think about building, policy, and most importantly the relationship between people and place. This thesis is an attempt to bridge these worlds—the world of structural resilience and that of cultural preservation. My personal background, coming from a culture that too views water as sacred, helped shape how I view our response to natural forces like flooding, pushing me to question conventional narratives. Often, we perceive flooding as a natural hazard—a force to resist or control. But what if, instead of resisting, we learned to adapt? This mindset is not only essential for climate resilience but holds the potential to shift our relationship with the land toward one that is collaborative, and grounded in possibility.

This thesis is a narrative of possibility. It is a call to rethink how we design for places where the land is in constant dialogue with water—a call to design with respect, and a deep awareness of the stories that flow through the rivers and roots of the lands we inhabit. Ultimately, this journey has been about more than architecture or research. It has been about discovering a new relationship with water—one that invites us to ask what is possible, to design with the confidence that adaptation is not surrender but strength, and to envision a future that embraces the rivers, rains, and rising waters. My hope is that this work reflects both my commitment to learning and my respect for those who call these lands home. I step forward with this thesis as both a visitor and a student, grateful to have been a part of these conversations, and ever willing to listen and learn.

This work is dedicated to the communities who have long endured the uncertainty of the waters, and to those who continue to imagine, with hope, what the future of their homes might be.

part 1

First Nations and Flooding



Fort Langley during the 1948 flood.



Flooded road in BC in 1948.



Hon



North Saskatchewan River in Edmonton, Flood of 1915.



Damaged homes in a Cree Village, northern Ontario, Flood of 1986.



Manitoba Legis



Siksika First Nation home flooded in 2014.



Residents sandbagging Winnipeg streets for the flood of 1950.



Musgamagw Dzawada'enux

Figure 1.0: Flooding in Indigenous com



nes flooded in BC, Flood of 1948.



Assiniboine Avenue, Winnipeg, flooded in 1950.



Coquitlam River, Flood of 1921.



lative Building flooded in 1950.



All the damaged homes in Peguis First Nation, Flood of 2022.



Aftermath of the Coquitlam River Flood in1921.



w First Nations in BC flooded in 2017.



Mould in the home of a couple who evacuated due to the extreme floods in Peguis First Nation, 2022.



Home, buildings, and floating debris on Chadsey Road, Chilliwack, BC, Flood of 1948.

mmunities in Canada (Collage by author).

CHAPTER 1

after the floods

1.1 The Flood Myth

Throughout time, people across the world told tales about how they came to be, those of heroes and monsters, stories of romance and tragedy, and folktales of death and rebirth. Such mythologies have shaped the world. Of these beliefs, those of floods have emerged as powerful narratives reminding us of the power of water. Nearly 200 different flood myths varying from different regions and periods exist[1]—from the Epics of Gilgamesh to Noah's Ark. It is an age-old scenario where a powerful deity finds Earth and humanity to have become corrupt, and decides to wipe the slate clean to begin anew. They send a great deluge that engulfs the entire known world in water, drowning everyone but a few survivors who then recreate the world. Similar narratives appear in Hindu, Greek, and Indigenous traditions, all sharing the notion of a great flood cleansing a corrupted world and paving the way for a new world.

Among the Indigenous peoples, flood myths hold significant cultural significance. For nearly all Indigenous communities of Canada, the creation story is a watery one. The Anishinaabe[i] creation story begins with the

i The *Anishinaabe* are a group of Indigenous peoples in the Great Lakes regions of North America. Their name translates into "the good humans," meaning those who were shown the right path by the Great Creator.

great Creator who made everything—the stars and planets, earth, land, water, plants, animals, and humans.[2] However, like the age-old scenario, over time humans grew selfish and fought with one another, pitting groups against each other.[3] The great Creator waited to see if "[we] would remember ourselves…but [we] didn't."[4] So, there was a flood, and everyone perished except those whom the great Creator favoured. Nanaboozhoo, a central figure in the story, survives on a log with select animals (Figure 1.1). Remembering old tales of creation he had heard, Nanaboozhoo seeks to recreate the world, aided by the muskrat's sacrifice, ultimately forming the *Turtle Island*, known today as North America.[5] Along similar line, the Squamish creation story describes that when their people saw the great flood coming, they made a giant cedar canoe which held children, and a man and woman as their guardians. So, when the floodwaters rose, everyone but those in the canoe drowned.[6] These Indigenous flood myths underscore the themes of interconnectedness, environmental stewardship, and the sacred relationship between the people and the water.

Like those in these myths, floods today come in many forms—through heavy rainfall, melting of glacial snow, tidal surges, storms, tsunamis, hurricanes, cyclones or ice and debris jams. They kill numerous people, both directly through drowning in the floodwaters or indirectly through the consequent exposure, starvation, or disease. From Indigenous perspectives to global narratives, these stories reflect on the power of water.

1.2 What is Flooding?

Floods, with their catastrophic power, have shaped Earth's landscape since time immemorial. People settled along rivers for water, food, and transport,[7] but the proximity to the water made it riskier and floods brought with it destruction. One of the earliest documented floods is a storm surge near the Netherlands in the North Sea in AD 838 when a "great wind



Figure 1.1: Nanaboozhoo during the Great Flood (Source: Illustration by R.C. Armour, from his book North American Indian Fairy Tales, Folklores and Legends, 1905).

whipped the sea into a sudden and terrifying flood that destroyed buildings and drowned nearly 2,500 people."[8] Similarly, the *Anglo-Saxon Chronicle* of 1099 described a flood that "rushed up so strongly and did so much damage that no one remembered anything like it before."[9] Some other major ancient floods included the Dutch flood in 1176, the 1287 flood in Zuiderzee region and the "Grote Mandrenke" [the Great Drowning of Men] in 1362 (Figure 1.2).[10] The Yellow River in China, known as "China's Sorrow," has flooded 1,500 times in the past 3,000 years.[11] Through effects of climate change and upriver development, floods nowadays occur more frequently and with greater severity causing widespread damage to property, infrastructure and livelihoods.



Figure 1.2: A flooded village during the "Grote Mandrenke" in 1362 (Source: De Agostini, Biblioteca Ambrosiana).

Over the past century, natural hazards have led to significant loss of life and widespread economic damage globally. Of these, flooding is one of the most dangerous and damaging forms of natural hazards in the world. The Government of Canada defines flooding as an event where the flow of water exceeds the capacity of a river or stream's channel, or when water levels rise along shorelines due to high runoff, storm surges, or intense wave activity.[12] As Parker (2000) discusses in detail, floods can take numerous forms varying in shapes and sizes, but roughly refers to an event where water rises or flows over a region that is normally not

submerged.[13] Some general causes of flooding include snowmelt, heavy rains, ice jams and other obstructions, glacial outbursts, coastal storms such as tsunamis, hurricanes, and cyclones, as well as changes in drainage patterns due to urbanization, where surface sealing increases runoff, raising river levels and the water table.[14] Globally, the leading cause of floods is heavy rains, of either long duration or high intensity, which leads to creation of high runoff in rivers or build-up of surface waters in low-lying areas.[15] At times when it rains over a long period of time, a rise in river levels can be observed that causes the water body to overflow on the surrounding land for days, sometimes weeks.[16] Intense rainfall can also cause water to overflow in urban areas where the storm water management system of drains is not sufficient to handle such capacities. Heavy rains as an aftermath of cyclones might produce intense runoff and rapid flash floods across the river valley regions.[17] While these types of floods are usually confined to a particular geographic area and are for short periods, the sudden and severe nature of the floods can be highly damaging and dangerous.[18]

Coastal areas are more vulnerable to flooding due to their proximity to the sea. The second major cause of flooding is tidal and wave extremes that lead to the sea water rising above typical high tide levels. Additionally, cyclonic storms can aggravate the situation by creating a "storm surge" condition, where the reduced atmospheric pressure lifts the surface of the sea while either high or strong winds drive the water to shore.[19] The wind circulation around the eye of a hurricane causes this lifting of the ocean surface, and once the storm reaches the shallow waters near the coast, this vertical circulation is disrupted causing it to rise.[20] In some regions, floods may also be associated with typical climatic conditions and weather patterns such as monsoons or annual periods of heavy rains.[21] While flooding is typically found to be associated with damage to property, trauma and loss of life, it is important to understand that it is a natural phenomenon and necessary for survival and health of the ecosystem. Not all consequences of flooding are negative; it is only hazardous when a flood reaches an

abnormal level and is considered an event negatively impacting the communities. The *Centre for Research on the Epidemiology of Disasters* (CRED) classifies an event as a "disaster" if at least one of the following occurs: 10 or more lives are lost or 100 or more people are affected directly or indirectly.[22] According to their data, flooding is the second deadliest natural hazard worldwide, second to drought/famine in recent years, accounting for more than half of the global population being impacted in some form or the other.[23] Today, according to *Intergovernmental Panel on Climate Change* (IPCC), flooding is the most widespread hydrometeorological hazard and with the change in climate, flood hazards are likely to increase in many different areas of the world.[24]

Flooding has been a constant problem throughout human history, prompting various communities to devise strategies in response to its devastating consequences. From ancient civilizations to modern societies today, the approach to managing and mitigating flood damage has reflected the diverse geographical conditions, cultural norms, availability of resources, and other socio-economic factors. Across different regions and throughout history, communities have adapted to flooding by developing innovative and resourceful architectural solutions that reflect their local environment, cultural practices, and available materials. These adaptive strategies range from raised stilt houses to floating dwellings, showcasing the diverse ways humans have responded to the challenges posed by flooding while maintaining their connection to the land and water. For example, in Thailand, construction projects are going back to using traditional building techniques and structures to deal with floods such as stilts or building on floating barges and rafts (Figure 1.3).[25] For instance, in 1850, 90 percent of the city was affected by flooding of one of the worst "climate-related disasters in Bangkok" and coped by living on barges.[26] Similarly, the Iraqi marshes have been characterised as "beautifully elaborated floating houses" made of reeds in southern Iraq.[27] The Indigenous ethnic group of the Kamchatka Peninsula in Russia—the *Itelmens*—live in raised houses in the winter months called *phem* (plural: *phemy*).[28] They use different houses in the summer and winter, and as the ground thaws in the summer, the floors of their homes begin to flood.[29] To prevent water from entering their dwellings,

the winter homes are built on raised platforms and shaped like pyramids.[30] Similarly, the Indigenous community of Assam in India—the *Mising*—have lived in close proximity to the river for centuries and have relied on architectural innovations and strategies to reduce disaster risk during the annual floods.[31] Typically, the Mising live in a *chang ghar* which is a traditional house on a raised platform supported by bamboo stilts that are at least 10 feet [3m] tall.[32] The village of Mechrey in Cambodia has relied on different strategies to manage the problem of flooding, by floating their village that can move from place to place if need be.[33] The entire village of 2,000 residents consists of traditional buildings floating on bamboo rafts or metal barrels with their own unique layout and style.[34]

In contrast, more contemporary examples of flood-adaptive architecture can be seen in places like Ladner, British Columbia. Canoe Pass Village is the country's first legalized floating home community.[35] Meanwhile, the Cowichan Tribes in British Columbia pile sandbags around their homes in low-lying areas and reports suggest that it takes up to 1,500 sandbags to protect one home.[36] In other parts of the world such as the Netherlands and Bangladesh, amphibious architecture is installed to mitigate flooding. For example, some amphibious homes in Old River Landing in Louisiana and Maasbommel in Netherlands are houses that can float when they need to during the event of a flood.[37] Thus, examining the various responses to flooding and adaptation strategies helps us to understand the intersection between design, environmental dynamics, and social values.

1.2.1 Flooding in Canada

Flooding in Canada is known to be a common phenomenon where an increase in streamflow beyond the capacity of normal stream channel causes water to overtop riverbanks and spread out along the adjoining floodplains.[38] The *International Disaster Database* recorded 22 dangerous floods in Canada between 2000 and 2015, which led to 18 deaths and 126,474 people being impacted.[39] In 2022, the most common natural hazard worldwide was floods with a total of 176 floods recorded in that year alone,



Vernacular Construction, Thailand





Brahmaputra Valley, Mising People,
"Chang Ghar", Assam, India



Mechrey Floating Village, Cambodi



First Nations, Canada, using sandbags



Maasbommel, Netherland
2005, Amphibious Hou

PREC

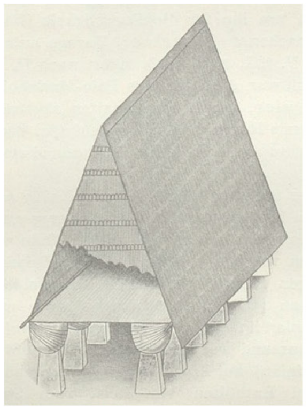
Figure 1.3: Architectural Flood Mitigation



A Marsh Village, Iraq, 1974



Kamchatka Peninsula, Russia,
Summer Family Dwellings



Latte Period Chamorro/
Haligi/Mariana Islands



Ladner's Canoe Pass Village,
Fraser River, BC, Canada



Toronto's Bluffer's Park/Small Floating
Community/Canada



Old River Landing, Louisiana, US,
Amphibious House



Vacation Resorts on Stilts/Maldives

EDENTS

Strategies Precedents (Collage by author).

and a total economic loss of 66 billion US dollars.[40] In that year, flooding caused the estimated death of 7,400 people around the world. In addition, approximately 54 million were impacted, including those who were injured, left homeless, or otherwise affected.[41] A 2022 climate report predicted that the global population exposed to flooding will rise by 24 percent in the case of an increase in global temperature of 1.5 degree Celsius.[42] Floods accounted for 16 percent of weather and climate related deaths recorded between 1970 and 2021, and in the last decade alone there were an accumulated 50,000 flood-related deaths around the world, which equals an average of 14 deaths per day.[43] As the statistics illustrate, flooding is not only a global concern but also a pervasive issue in Canada, where it emerges as the most frequently occurring natural hazard, impacting communities across the country.

Floods are the most frequently occurring natural hazard in Canada (Figure 1.4). The *Canadian Disaster Database* counts 241 flood disasters that occurred in Canada between 1900 and 2005, which is five times more than the second most frequent disaster—wildfires.[44] Flooding and its consequences are experienced in cities across Canada, with heavy rains causing widespread basement flooding in cities of Montreal, Hamilton, Toronto, and Thunder Bay in 2012, Mississauga in 2009, southern Alberta and southern Ontario in 2013 and Burlington in 2014 among many others.[45] There are several causes of flooding in Canada—spring snowmelt, upriver and torrential rains, and tsunamis in coastal areas.[46] Furthermore, climate change has been increasing the risk of devastating atmospheric river occurrences by at least 60 percent in certain regions of the country, as happened in the 2021 *Atmospheric River Events* (AREs) in British Columbia.[47]

As well as being the most frequent, floods are also one of the most costly types of natural hazards, especially in Canada.[48] Canadians are concerned about flooding and want to prepare for it to prevent the damage, since the costs of flood damage in the country are high, some losses being deeply personal and difficult to measure in dollars.[49] Although insurance companies and industries develop risk management practices, flood exposure and its consequences are often inadequately

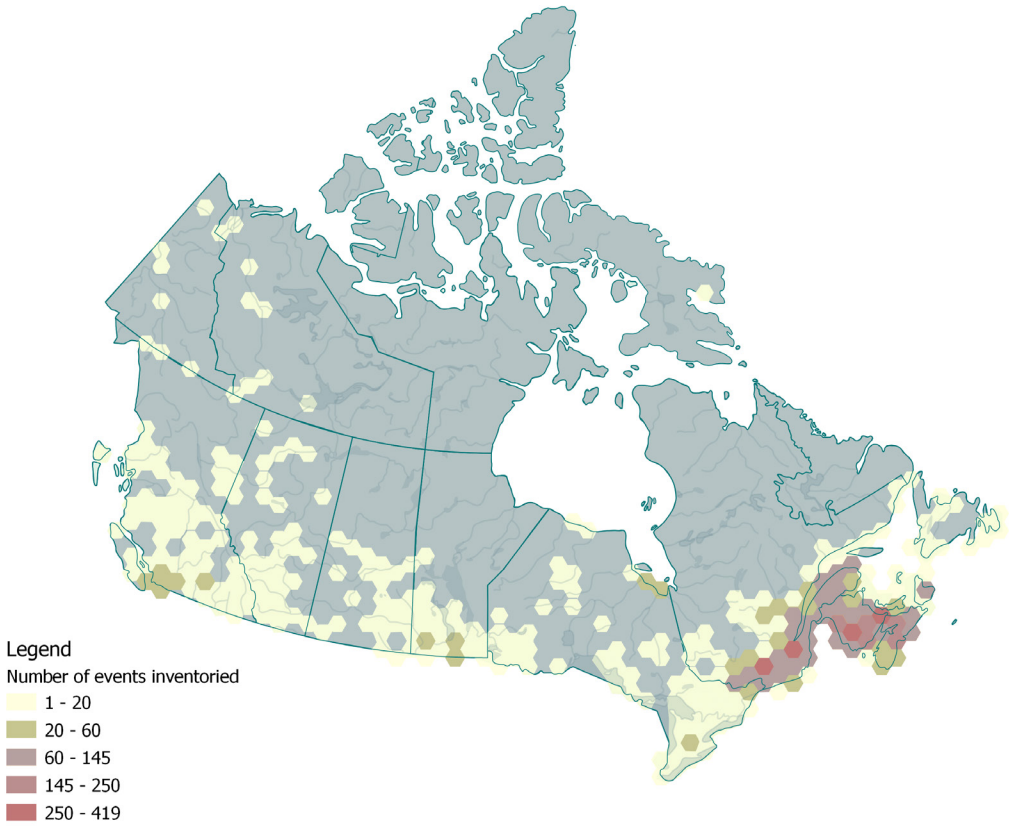


Figure 1.4: Number of historical flood events inventoried in Canada (Adapted from Natural Resources Canada, Government of Canada).

addressed. This oversight is significant, as flooding causes an average of 1.5 billion dollars' worth of damage to Canadian households, property and infrastructure annually, with the residential property owners bearing 75% of uninsured losses annually.[50]

The types of flooding in Canada can be categorized into four broad categories;[51]

a) Fluvial flooding (i.e. river or riverine flooding)
b) Pluvial flooding (i.e. heavy rainfall flooding)
c) Coastal flooding
d) Groundwater flooding

Fluvial flooding or riverine flooding occurs when "water overflows its banks from a river, stream, or creek"[52] (Figure 1.5). The common cause of such flooding is prolonged or heavy rainfall along with snow or ice melt—also called freshet.[53] It is a recurring event and can last for weeks at times, due to an increase in temperatures which causes the snow and ice to melt.[54] The strength, velocity, depth, and the duration of such flooding largely depends on the depth of the snowpack.[55] Additionally, ice jam floods can also be fluvial since they are caused by the temporary blockage of the waters from the build-up of floating ice[56] (Figure 1.6).



Figure 1.5: 2013 southern Alberta Floods (Source: Jordan Verlage, the Canadian Press).



Figure 1.6: Fort McMurray flooded in 2020 after a 25-km ice jam, forcing 12,000 people from their homes. (Source: Greg Halinda, The Canadian Press).

Pluvial flooding or heavy rainfall flooding occurs when intense downpours affect a specific area within a short timeframe[57] (Figure 1.7). It is described as when a storm causes "flooding that is independent of an overflowing body of water."[58] Various factors including the volume of precipitation, saturation of soil, and the capacity of the drainage systems influence this type of flooding.[59] And unlike riverine flooding, these kinds of floods are less predictable and typically have shorter warning times.[60] It can also lead to flash flooding that can occur when heavy rainfall and storms trigger flooding within three to six hours and may cause catastrophic damages.[61] Urban flooding is another variant within this category of flooding. It is defined as "inundation caused by overland flows (such as stormwater runoff and riverine flooding)"[62] and is essentially "caused by excessive runoff in developed areas where water has no place to go, overloading both engineered and/or non-engineered drainage systems."[63]



Figure 1.7: A woman gets back into her flooded car in Toronto, 2013, after heavy rainfall caused widespread flooding (Source: The Canadian Press).

Coastal flooding can occur as a result of four major factors that include waves caused by heavy winds, tides, storm surges, and changes in the sea level[64] (Figure 1.8). It can take place both at ocean coasts as well as lake shorelines.[65] Coastal flooding is defined as when the "water inundates or covers normally dry coastal land as a result of high or rising tides of storm surges."[66] For example, tsunamis can be an extreme example of coastal flooding[67] (Figure 1.9). Rise in sea levels and the consequences of climate change will worsen coastal flooding in the future. According to *Canada's Changing Climate Report*,[68] coastal flooding is "expected to increase in many areas of Canada due to local sea level rise."[69]



Figure 1.8: Point Pelee National Park flooded by Lake Erie (Source: Public Works and Government Services Canada, Richard Vroom, 1976).



Figure 1.9: The Impact of 1929 Tsunami on Newfoundland's Burin Peninsula (Source: Queen Elizabeth II Library, Memorial University).

Groundwater flooding occurs in areas characterized by high water tables, chalky or sandy soils, and prolonged periods of rainfall.[70] This type of flooding is often associated with basement flooding and septic system overflows, and it can occur at both the community and individual structural levels.[71] It is exacerbated when soil becomes fully saturated from continuous rainfall, preventing further absorption of water, which causes excess water to accumulate. Groundwater flooding tends to worsen during the spring due to snow and ice melt, which raises groundwater levels.[72] On a smaller scale, individual buildings may experience this type of flooding when groundwater levels exceed the lowest point of the structure, allowing water to infiltrate basements through small cracks in foundation walls and floors.[73]

1.2.2 Flooding and Climate Change

In recent years, the frequency and severity of flooding events have increased due to the effects of climate change. The *United Nations* (UN) defines climate change as "long-term shifts in temperatures and weather patterns" and observes that recently human activities have become the driving force of climate change, mainly due to the burning of fossil fuels such as coal, oil, and gas.[74] This generates greenhouse gas emissions that trap the sun's heat, causing the temperatures to rise.[75] Scientists have reported that Earth's average temperature is 1.1ºC warmer than it was in the 19th century before the Industrial Revolution.[76] In Canada, the rate of temperature rise is approximately twice the global average, with the warming particularly pronounced in the northern regions of the country.[77] As global temperatures rise, the intensity of extreme weather events, including heatwaves, wildfires, droughts, cyclones and heavy rainfall, become more common. According to *Canada's Changing Climate Report* 2019, the annual mean precipitation of the country is projected to increase up to 24% by the end of the 21st century.[78] Extreme weather events that were expected once every 20 years are now expected to happen every 10 years by 2050

and, furthermore, every 5 years by 2100.[79] As discussed, coastal flooding is also projected to increase in many regions of Canada due to rising sea levels.[80] Reports suggest a projected increase in river flooding frequency by 10-20% and a sharp increase in the number of local flood events due to heavy rainfall, increasing by 40%.[81] Hence, it is crucial to recognize the influence of the changing climate when assessing risks and impacts of flooding (Figure 1.10). Addressing the impacts of flooding in the context of climate change requires an approach that not only includes investment in resilient infrastructure but also climate adaptation strategies.

1.3 How to cope with floods?

In addressing the challenges of flooding, various strategies have been developed to mitigate its impacts and safeguard communities and infrastructure (Figure 1.11). These range from traditional flood defense structures to innovative architectural designs. This section explores different approaches to cope with floods including:

Dikes, Levees, and Floodwalls are among the oldest and most common flood defense structures used across the globe. Ancient civilizations in the Indus Valley, ancient Egypt, China, and Mesopotamia built levees to protect their regions from catastrophic flooding.[82] Dikes and levees are both long walls or embankments erected to prevent flooding from an adjoining water body.[83] A floodwall is defined as a "freestanding, permanent, engineered structure designed to prevent encroachment of floodwaters."[84] While these structures effectively reduce flood risk, they can also increase the risk of catastrophic failure during extreme events.[85] The levee and floodwall failure following the aftermath of Hurricane Katrina in 2005 led to devastating flooding in New Orleans, causing approximately 80% of the city to flood resulting in at least 986 verified deaths[i] and over 600,000 households displaced.[86]

---

i While the verified, documented number of deaths from Hurricane Katrina was 986, estimates suggest that the actual death toll was much higher, with some sources, such as the *National Guard*, reporting over 1,600 fatalities.[87]



Canada—Flood Map, Current (source: Western University, https://www.floodmapviewer.com/maps)



Canada—Flood Map, Predicted Near Future 25 years (source: Western University, https://www.floodmapviewer.com/maps)

Figure 1.10: Predicted Flood Levels in Canada (Source: Western University [Flood Map Viewer], Collage by author).

Mounding is the same idea as building on higher ground. It is using mounds of sand, sediment or earth that elevate the individual structure to protect it from flooding.[88] In ancient Netherlands, settlements along the Dutch coast were built on artificial mounds to protect them from floods and their consequences.[89] Similarly, there have been studies conducted that concluded that the Indigenous population of Cahokia by the Mississippi River and within its floodplain built on earthen mounds to resist the destruction and consequences of the floodwaters.[90] This technique is still used today in modern flood mitigation strategies.

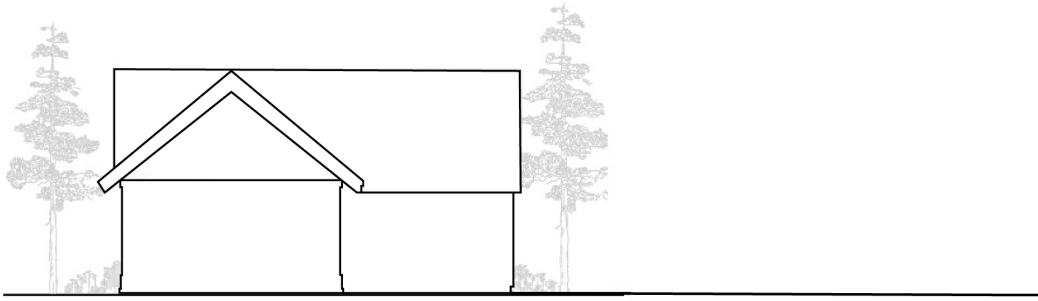
Floodproofing encompasses a range of measures aimed at making the building more resilient to flowing or standing water and reducing potential damages.[91] Dry floodproofing techniques include measures to keep the surface water out of the building and are preferred by homeowners since the inside of the structure and its contents are kept dry.[92] Unfortunately, due to feasibility issues when the floodwaters are strong and deep, dry floodproofing cannot prevent water intrusion.[93] On the contrary, wet floodproofing minimizes potential damage by allowing water to enter the building, which balances the water pressure both inside and outside, thereby reducing stress on the foundations and the walls of the house.[94] However, the homeowner must remove vulnerable possessions and contents inside the building and store them at a location above the flood elevation to prevent damage and clean-up afterwards.[95]

Relocation is moving or retreating communities from floodplains to alternative locations locations on higher grounds.[96] While it is the most effective approach, planned relocation for communities is generally "considered a measure of last resort."[97] It is still important to acknowledge that moving communities away from highly vulnerable regions in "a planned and anticipatory way" can prevent future forced displacement.[98] Clearing the floodplain location of homes and other structures also helps make room for the rivers to flow along their natural course.[99] It is a step towards "clearing the floodplain of developments and turning this land [back] into a natural area."[100] This

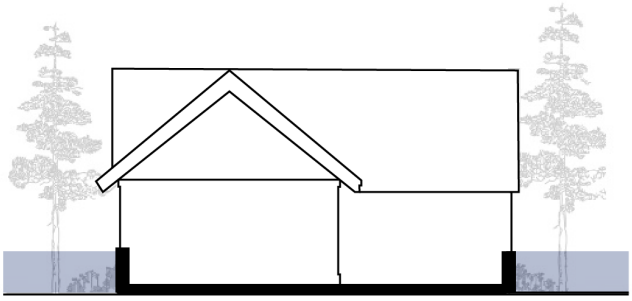
strategic relocation is usually achieved mainly through the public acquisition of land.[101] However, relocation brings challenges such as unemployment, food insecurity, psychological distress and the loss of heritage, as communities are forced to start over and rebuild their lives.

Permanent Static Elevation or elevating a house is when a house is raised to a "required or desired Flood Protection Elevation (FPE)."[102] As mentioned in Section 1.2 (pg. 38), permanently elevating houses has been a common practice around flood-prone communities for hundreds of years if not thousands. It involves elevating the building using structural supports—such as raising it up on stilts.[103] While raising houses on stilts permanently is one of the most commonly used flood prevention strategies, it has its limitations. For example, raising the house from street level invites a loss of neighbourhood character, and increased vulnerability to wind damage to the roof and on the building itself.[104] This method also adds more stairs to the house, posing mobility challenges for the elderly and accessibility difficulties. Additionally, even if a building is raised to a desired height above the FPE, it can still flood in an extreme event.[105] When it floods higher than the height of the stilts or the vertical structural members in an extreme event, this approach becomes ineffective still resulting in damages and displacement.[106]

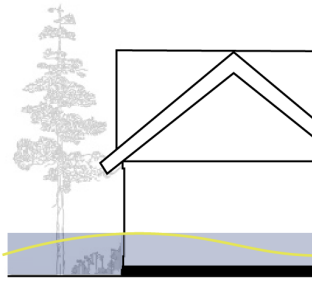
Amphibious Architecture is a strategy where a house is prepared to float when the floodwater comes while remaining on the ground under normal conditions.[107] English (2016) describes it as "an alternative flood mitigation strategy that allows an otherwise ordinary structure to float on the surface of rising floodwaters rather than succumb to inundation."[108] It incorporates design components [refer to Chapter 3.2, pg. 75] that provide support to the structure by using amphibious foundations that enable it to adapt to the changing water levels during a flood. Amphibious architecture can be seen in places such as the vacation homes in Maasbommel in the Netherlands, or recreational houses in Old River Landing in Louisiana.[109]



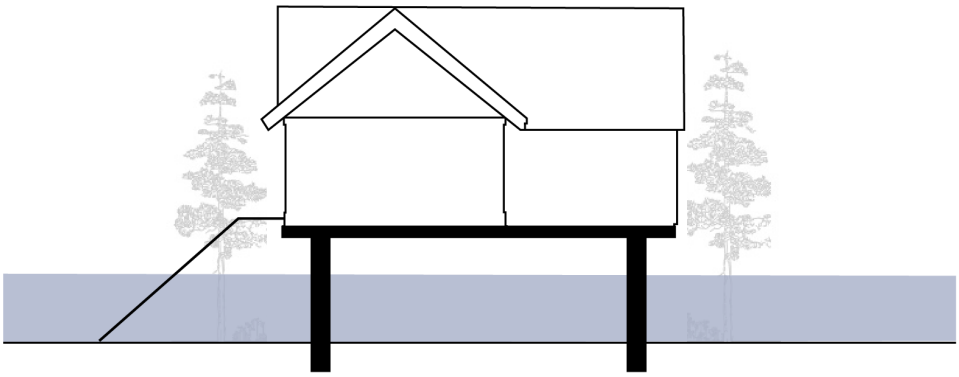
Dikes, Levees, and Floodwalls



Dry Floodproofing

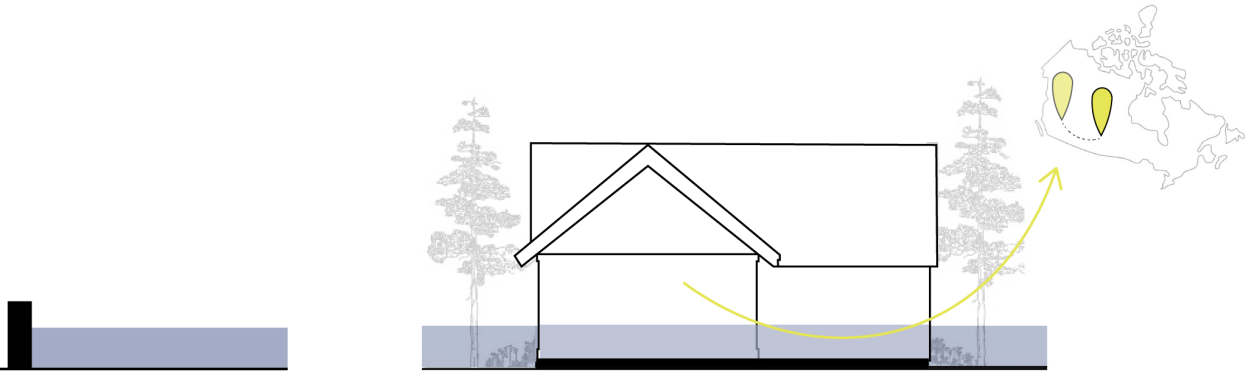


Wet Floo

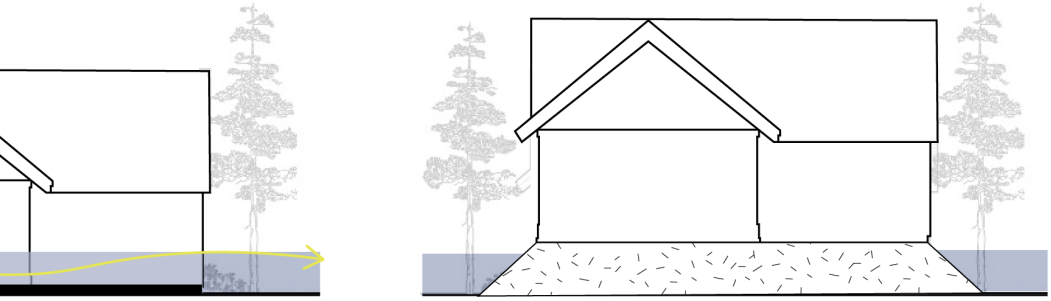


Permanent Static Elevation

Figure 1.11: Different Flood Mitiga

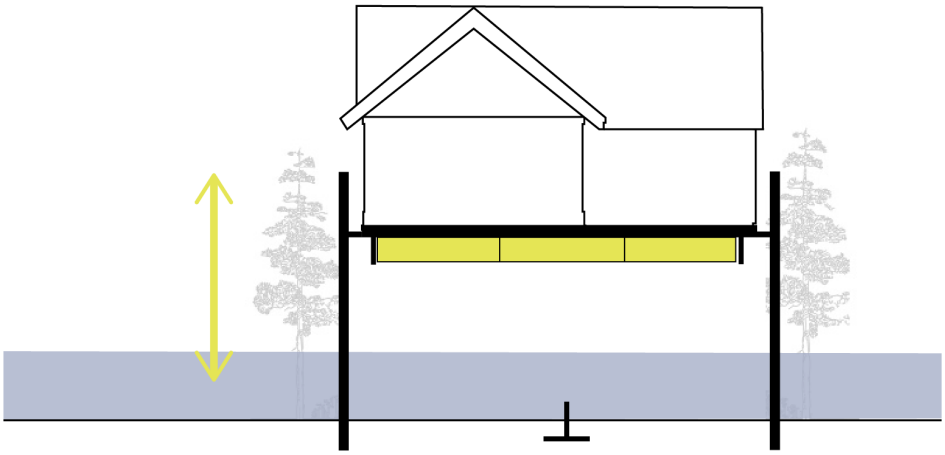


Relocation



dproofing

Mounding



Amphibious Architecture

tion Approaches (Image by author).

1.4 Relocation or Resilience in Place?

In addressing the challenges posed by flooding and its consequences, two primary approaches have emerged—**relocation** and **resilience in place.** Relocation can involve moving people and infrastructure either to higher grounds within their own land or to entirely new locations away from flood-prone areas. While relocation involves moving communities away from their homes to safer zones, resilience in place[i] offers an opportunity to implement strategies for existing communities to withstand and recover from the flooding events in their lands and homes. The usual approaches—some of which are mentioned above—such as dikes, levees, and floodwalls have been used to stop the water from entering populated areas, or "control" the water by redirecting it. Such flood mitigation strategies can lead to unintended catastrophic consequences over a time.[110] While barriers may provide temporary relief, they can fail due to wear and tear, exceed their design capacity during extreme flood events, or suffer from inadequate maintenance, breaching, and overtopping. When these systems fail, people may face not only the burden of the immediate devastation but also the challenges of recovery and rebuilding in increasingly compromised environments.[111] For example, the city of New Orleans suffered devastating aftereffects of the levee system failure during Hurricane Katrina in 2005. Although the levees were designed to protect the city, the storm surge overpowered them. The resulting breaches led to widespread flooding and extensive damage, illustrating how even flood defences can fall short under extreme conditions.[112] Additionally, reliance on such infrastructure can also create a false sense of security among residents, encouraging further development in floodplains, and thus increasing risk exposure.

---

i *Resilience in Place*: refers to strategies and measures implemented to improve a community's capacity to endure, adapt, and recover from flooding and other environmental challenges while remaining in their original location. This approach emphasizes strengthening local infrastructure, enhancing adaptive practices, and promoting sustainable land use to ensure that communities can withstand adverse conditions to thrive in their existing established environments.

The *Federal Emergency Management Agency* (FEMA) of the US describes resilience as preparing communities, reducing suffering, speeding up recovery.[113] It is the ability to bounce back from difficult experiences and successfully adapt in the face of adversity. Resilience-in-place approaches, such as amphibious architecture, accept the presence of floodwater and accommodate it. The concept of amphibious architecture accepts that flooding is inevitable and strives to work in harmony with nature to adapt to the changing environment. This strategy recognizes the value of water and its role in shaping the built environment and embraces water as an element that is "free to flow," fostering a deeper connection between the communities and the surroundings. The Government of Canada describes flood resilience in particular as "the ability of a system, community or society exposed to flood hazards to resist, absorb, accommodate, adapt to, transform, and recover from such events in a timely, efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management."[114]

The resilience in place approach holds particular significance for the Indigenous communities since they are deeply connected with their lands physically, emotionally, and spiritually. This strategy reflects deeper questions of cultural survival, identity, and justice. As Indigenous peoples grapple with the choice between leaving their homelands or finding ways to coexist with the changing environment, the stakes go far beyond physical safety. They touch on the preservation of traditions, the continuity of community life, and the resilience of people whose connection to their land is integral to their existence. Understanding the gravity of these choices requires us to look beyond the immediate impacts of flooding to the broader, often invisible, losses.

1.5 Summary

Flooding has long posed significant challenges, but with climate change intensifying the frequency and severity of these events, the stakes are higher than ever. Traditional mitigation approaches—such as dikes, levees, floodwalls, permanent static elevation, mounding, floodproofing and relocation—offer temporary protection but come with their own risks, often leading to unintended consequences and a false sense of security. As floods become more frequent and unpredictable, the need for resilient solutions becomes increasingly urgent. This chapter explored how communities can cope with the threat of flooding, moving beyond rigid defences to more adaptive strategies such as amphibious architecture. Each approach reflects a fundamental question at the heart of flood mitigation—do we retreat the communities, start building in another area, or do we raise them? Do we adapt to stay where we are, or do we move?

For Indigenous communities specifically, these questions carry unique weight. As its residents' grapple with the choice between leaving their homelands or finding ways to coexist with the changing environment, the stakes go far beyond physical safety. Thus, the choice between relocation and resilience in place is one that carries profound implications—shaping not only the future of the land but the continuation of community life. Amphibious architecture offers a way to live with water, rather than constantly battling against it in fear. It represents a forward-thinking approach that embraces the presence of floodwater, allowing structures to adapt to rising levels rather than resist them. As the climate continues to shift, these strategies provide a crucial framework for navigating the new realities of living with water.

1 Mark Isaak, "Flood Stories from around the World," *Talk Origins* (Blog), December 16, 1997, https://www.talkorigins.org/pdf/flood-myths.pdf

2 Patty Krawec, *Becoming Kin : An Indigenous Call to Unforgetting the Past and Reimagining Our Future* (Minneapolis, MN: Broadleaf Books, 2022).

3 Ibid.

4 Ibid.

5 Ibid.

6 Mark Isaak, "Flood Stories."

7 Jeanne Andrews, *Flooding : Canada Water Book* (Ottawa: Ecosystem Sciences and Evaluation Directorate, Economics and Conservation Branch, 1993).

8 John Withington, *Flood: [Nature and Culture]* (London: Reaktion Books, 2013).

9 Ibid.

10 Ibid.

11 Ibid.

12 Government of Canada, "Floods," Public Safety Canada, December 1, 2015, https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntrl-hzrds/fld-eng.aspx

13 D.J Parker, ed., *Floods* (Routledge, London, 2000).

14 Jeanne Andrews, *Flooding.*

15 Roger Few, Mike Ahern, Franziska Matthies and Sari Kovats, "Floods, Health and Climate Change: A Strategic Review," *Tyndall Centre for Climate Change Research* (November 2004).

16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.

20 "Storm Surge Overview," *National Hurricane Center and Central Pacific Hurricane Center,* https://www.nhc.noaa.gov/surge/#TIDE

21 Ibid.

22 Roger Few et al., "Floods, Health and Climate Change."

23 Ibid.

24 Ibid.

25 Young Post Reporter, "Thailand's floating homes fight flooding with science," *South China Morning Post*, December 9, 2019, https://www.scmp.com/yp/discover/lifestyle/features/article/3069581/thailands-floating-homes-fight-flooding-science

26 Ibid.

27 Tere Garcia, "The Floating Basket homes of Iraq: A Paradise almost Lost to Saddam," *Architecture in Development*, June 11, 2015, https://architectureindevelopment.org/news/120

28 Magritt Engel and Karen Willmore, *Steller's History of Kamchatka* (Fairbanks: University of Alaska Press, 2003).

29 Ibid.

30 Ibid.

31 Nabarun Guha, "India's mising community seeks to expand its Indigenous adaptation practices in response to climate change," *Prevention Web*, September 21, 2021, https://www.preventionweb.net/news/indias-mising-community-seeks-expand-its-indigenous-adaptation-practices-response-climate

32 Ibid.

33 Steven Bingler, "Climate lessons from the floating villages of Cambodia," *Common Edge*, November 29, 2023, https://commonedge.org/climate-lessons-from-the-floating-villages-of-cambodia/

34 Ibid.

35 "Canoe Pass Village," *International Marine Floatation Systems Ltd*., Accessed 10 April 2024, https://www.floatingstructures.com/gallery/floating-homes/canoe-pass-village/

36 Brendan Strain, "Cowichan Tribes sandbagging flood-prone homes as atmospheric river approaches Vancouver Island," *Vancouver Island*, November 3, 2022, https://vancouverisland.ctvnews.ca/cowichan-tribes-sandbagging-flood-prone-homes-as-atmospheric-river-approaches-vancouver-island-1.6138250

37 Elizabeth English, Natasha Klink, and Scott Turner, "Thriving with water: Developments in amphibious architecture in North America," *FLOODrisk 2016–3rd European Conference on Flood Risk Management* (2016), https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_13009.pdf

38 Jeanne Andrews, *Flooding*.

39 Hilary Burton, Felicia Rabito, Lisa Danielson and Tim K. Takaro, "Health effects of flooding in Canada: A 2015 review and description of gaps in research," Canadian Water Resources Journal/Re*vuecanadiennedesressources hydriques* 41 (2016):1-2, 238-249, doi: 10.1080/07011784.2015.1128854

40 Einar H. Dyvik, "Natural Disasters on the Continents by Nature of the Disaster," *Statista*, July 4, 2024, https://www.statista.com/statistics/269653/natural-disasters-on-the-continents-by-nature-of-the-disaster/

41 Ibid.

42 Ibid.

43 Dan Sandink, Paul Kovacs, Greg Oulahen and Glenn McGillivray, "Making Flood Insurable for Canadian Homeowners: A Discussion Paper," *Institute for Catastrophic Loss Reduction & Swiss Reinsurance Company Ltd.* (2010), https://www.iclr.org/wp-content/uploads/PDFS/making-flood-insurable-for-canadian-homeowners.pdf

44 Einar H. Dyvik, "Natural Disasters."

45 Dan Sandink et al., "Making Flood Insurable for Canadian Homeowners."

46 Ibid.

47 Nathan Gillett, Alex Cannon, Elizaveta Malinina, Markus Schnorbus, Faron Anslow, Qiaohong Sun, Megan Kirchmeier-Young, Francis Zwiers, Christian Seiler, Xeubin Zhang, Greg Flato, Hui Wan, Guilong Li and Armel Castellan, "Human Influence on the 2021 British Columbia Floods," *SSRN Scholarly Paper* (Rochester, NY, February 3, 2022). https://doi.org/10.2139/ssrn.4025205.

48 Jeanne Andrews, *Flooding*.

49 George Fan, "Tides of Change: Climate Change and Flooding in Canada," *Marsh*, January 3, 2023, https://www.marsh.com/ca/en/services/risk-consulting/insights/climate-change-and-flooding-in-canada.html.

50 Public Safety Canada, "Government of Canada Releases Report That Will Advance Work on Canada's First National Flood Insurance Program," Government of Canada, August 30, 2022, https://www.canada.ca/en/public-safety-canada/news/2022/08/government-of-canada-releases-report-that-will-advance-work-on-canadas-first-national-flood-insurance-program.html

51 "Focus on Types of flooding," *Institute for Catastrophic Loss Reduction*, 2021, https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

52 George Fan, "Tides of Change."

53 Ibid.

54 "Focus on Types of flooding," *Institute for Catastrophic Loss Reduction*.

55 Ibid.

56 Ibid.

57 Ibid.

58 George Fan, "Tides of Change."

59 Ibid.

60 Ibid.

61 "Focus on Types of flooding," *Institute for Catastrophic Loss Reduction*.

62 Ibid.

63 Ibid.

64 Ibid.

65 George Fan, "Tides of Change."

66 Federal Emergency Management Agency, "Coastal Flooding," National Risk Index, https://hazards.fema.gov/nri/coastal-flooding

67 George Fan, "Tides of Change."

68 Elizabeth Bush and Donald S. Lemmen, "Canada's Changing Climate Report," Government of Canada, 2019, https://publications.gc.ca/collections/collection_2019/eccc/En4-368-2019-eng.pdf

69 "Focus on Types of flooding," *Institute for Catastrophic Loss Reduction*.

70 Ibid.

71 Ibid.

72 Ibid.

73 Ibid.

74 "What Is Climate Change?" *United Nations*, Accessed April 11, 2024, https://www.un.org/en/climatechange/what-is-climate-change.

75 Ibid.

76 Ibid.

77 George Fan, "Tides of Change."

78 Elizabeth Bush and Donald S. Lemmen, "Canada's Changing Climate Report."

79 George Fan, "Tides of Change."

80 Elizabeth Bush and Donald S. Lemmen, "Canada's Changing Climate Report."

81 "From Flood Risk to Resilience: a B.C. Flood Strategy to 2035," Government of Canada, 2024, https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/bc_flood_strategy.pdf

82 Andreas N. Angelakis, Andrea G. Capodaglio, Mohammad Valipour, Jens Krasilnikoff, Abdelkader T. Ahmed, Laila Mandi, Vasileios A. Tzanakakis, Alper Baba, Rohitashw Kumar, Xiaoyun Zheng, Zhang Min, Mooyoung Han, Bashiru Turay, Esra Bilgic and Nicholos Dercas, "Evolution of Floods: From Ancient Times to the Present Times (ca 7600 BC to the Present) and the Future." *Land* 12, no. 6 (June 2023): 1211, https://doi.org/10.3390/land12061211.

83 "Focus on Types of flooding," *Institute for Catastrophic Loss Reduction*.

84 "Floodwalls," *Freie Universitat Berlin*, https://www.geo.fu-berlin.de/en/v/iwrm/Implementation/technical_measures/Flood-protection-measures/structural_measures/Floodwalls/index.html.

85 Washington University in St. Louis, "Humans Have Been Changing Chinese Environment for 3,000 Years: Ancient Levee System Set Stage for Massive, Dynasty-Toppling Floods," *ScienceDaily*, June 19, 2014, https://www.sciencedaily.com/releases/2014/06/140619125052.htm.

86 Allison Plyer, "Facts for Features: Katrina Impact," *The Data Center,* August 26, 2016. https://www.datacenterresearch.org/data-resources/katrina/facts-for-impact/.

87 "When the levees broke," *National Guard, United States Government,* https://www.nationalguard.mil/Resources/Image-Gallery/Historical-Paintings/Heritage-Series/When-the-Levees-Broke/https://www.nationalguard.mil/Resources/Image-Gallery/Historical-Paintings/Heritage-Series/When-the-Levees-Broke/

88 "Types of Flood Adaptation," Risk Factor, Accessed April 11, 2024, https://help.riskfactor.com/hc/en-us/articles/360051062333-Types-of-Flood-Adaptation.

89 Sean Cornell, Duncan Fitzgerald, Nathan Fey, Ioannis Georgiou, Kevin C. Hanegan, Li-San Hung, Mark Kulp, Diane Maygarden, David Retchless, Brent Yarnal and Tim Bralower,"The Netherlands-Terp Mounds," *Earth 107: Coastal Processes, Hazards, and Society,* Accessed April 11, 2024, https://www.e-education.psu.edu/earth107/node/1082.

90 Scott K. Johnson, "Ancient Native American City May Have Been Done in by Mississippi Floods," *Ars Technica*, May 4, 2015, https://arstechnica.com/science/2015/05/ancient-native-american-city-may-have-been-done-in-by-mississippi-floods/.

91 New Brunswick Department of Public Safety, "Floodproofing," Government of New Brunswick, January 2016, https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Flooding-Inondations/Floodproofing.pdf

92 Ibid.

93 Ibid.

94 Ibid.

95 Ibid.

96 Ibid.

97 Rob Jorden, "How to Move Communities Away from Flooding Risks with Minimal Harm," *PreventionWeb*, July 27, 2023, https://www.preventionweb.net/news/how-move-communities-away-flooding-risks-minimal-harm.

98 Ibid.

99 "Flood Mitigation: Relocation," *Alberta Water Portal Society,* December 17, 2013, https://albertawater.com/flood-mitigation/relocation/.

100 Ibid.

101 J. Thistlethwaite, Le Geyt, M., Martin, G., Cottar, S., and Whittaker, L, "Buying Out the Floodplain: Recommendations for Strategic Relocation Programs in Canada," *Partners for Action, University of Waterloo,* 2023, https://uwaterloo.ca/partners-for-action/sites/default/files/uploads/documents/buyingoutthefloodplainreport_en_1.pdf

102 "Elevating your house," *FEMA*, https://www.fema.gov/sites/default/files/documents/fema_elevating-your-house-chapter-5.pdf

103 Elizabeth English et al., "Thriving with water."

104 Elizabeth English, "Amphibious Foundations and the Buoyant Foundation Project: Innovative Strategies for Flood-Resilient Housing," *International Conference on Urban Flood Management by UNESCO-IHP and COST Action C22*, November 2009.

105 Ibid.

106 Elizabeth English et al., "Thriving with water."

107 Elizabeth English, "Amphibious Foundations and the Buoyant Foundation Project."

108 Elizabeth English et al., "Thriving with water."

109 Elizabeth English, "Amphibious Foundations and the Buoyant Foundation Project."

110 Elizabeth English et al., "Thriving with water."

111 Ibid.

112 Ibid.

113 "Resilience," *FEMA*, https://www.fema.gov/about/offices/resilience

114 "From Flood Risk to Resilience: a B.C. Flood Strategy to 2035," Government of Canada.

CHAPTER 2

this used to be our home

In 2021, British Columbia in Canada witnessed a "one in 100-year event that prompted evacuations and a local state of emergency"[1] called the *Atmospheric River Events* (AREs). It flooded multiple of reserves, swallowed homes, washed away roads and bridges, and displaced thousands of people from their homes. The 2021 AREs were a series of events that have unfolded across Canada over the years. For years flooding and its consequences have torn multiple such communities away from their homelands, uprooted age-old traditions and cultural heritage leaving community members displaced from their homes. Disasters occur when these hazards impact societies and livelihoods. In 2022 alone, the Emergency Event Database EM-DAT recorded 387 natural hazards worldwide, leading to a loss of 30,704 lives and overall affecting 185 million individuals globally.[2] The *Centre for Research on the Epidemiology of Disasters* (CRED) defines a disaster as "a situation or event which overwhelms local capacity, necessitating a request to national or international level for external assistance; an unforeseen and often sudden event that causes great damage, destruction and human suffering."[3] Similarly, Parker (2000) describes a disaster as an event that brings widespread disruption and loss to the community as a whole.[4] While disasters affect different communities in different ways, historically a trend of more severe effects has been observed on marginalized communities such

as the Indigenous communities of Canada. A 2013 report of the A*uditor General of Canada* assessed that emergencies related to flooding occur more often in First Nations communities than the rest of the country.[5] These communities are often left to fend for themselves, with people losing their homes and possessions—even those that were multi-generational.

Throughout Canada's colonial history, Indigenous communities were forced onto remote, flood-prone land, increasing their exposure to environmental and social vulnerability. As a result, nearly every year multiple floods and their associated impacts fracture many such communities, disrupting their traditional way of life. Twenty-two percent of the residential properties on the reserves are at risk of a 100-year flood event.[6] As per reports, Indigenous people across the entire country are affected by flooding either directly or indirectly.[7] A *University of Waterloo* study revealed that 80.7 percent of the 985 Indigenous reserves in Canada have some level of flood exposure in terms of either population or properties (Figure 2.1 and 2.2).[8]

Scholars have identified multiple factors that contribute to why the Indigenous communities are more at risk from climate change. These include being historically, ancestrally and spiritually tied to their traditional territories which makes them "less mobile to avoid environmental threats."[9] Furthermore, many of these communities are small and remote with insufficient access to resources making them even more vulnerable to the social, economic, psychological and spiritual consequences of flooding.[10] According to Ballard (2012), First Nations housing, land, and resource assets are economically limited, reducing their capacity for rebuilding.[11] Indigenous populations depend on the land and its resources for sustenance through hunting and fishing,[12] which can be hampered when this connection to the land and the water is interrupted. Additionally, many of these communities have been shifted to poor swampy lands by the government during colonization.[13]

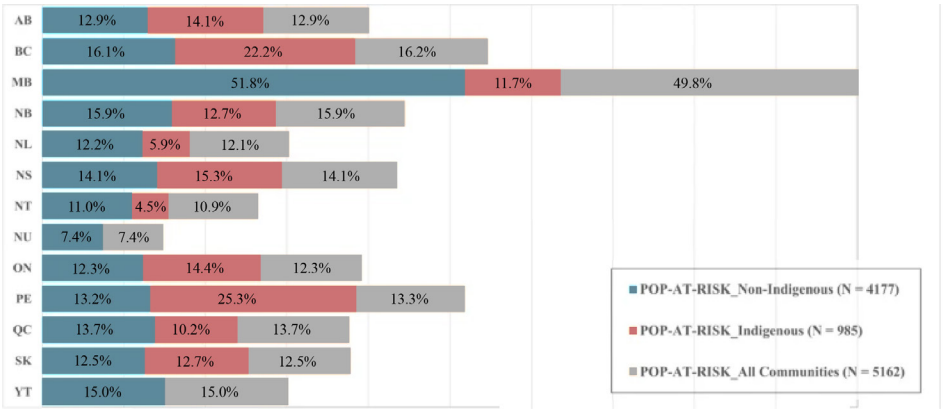


Figure 2.1: Population at risk of flood by provinces in Canada (Source: Chakraborty et al.).

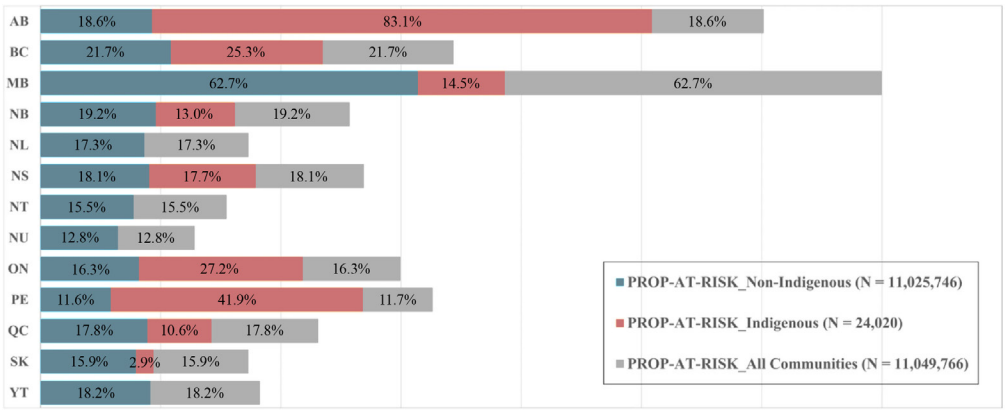


Figure 2.2: Residential properties at risk of flood by provinces in Canada (Source: Chakraborty et al.).

The flood-related challenges faced by Indigenous peoples highlight the "broader injustice of climate change," where those who have contributed the least to it are disproportionately impacted the most.[14] These findings are compatible with the Federal Cabinet report of 2016 which "warned that Indigenous reserve communities are disproportionately suffering from the impacts of climate change."[15] As a result, Indigenous people across multiple Canadian reserves are experiencing intensified climate-related disruptions on their homelands.[16] This disproportionate impact extends beyond Canada, as Indigenous communities worldwide face climate change-induced displacement at rates seven times higher than the global average.[17] The I*ntergovernmental Panel on Climate Change* (IPCC) estimates that by 2050, there will be 20 million people displaced due to climate change worldwide.[18]

This global urgency underscores the critical situation Indigenous communities in Canada already face. As climate change progresses, the risk of flooding in First Nations communities continues to rise—not just in frequency, but in scale and duration.[19] Indigenous peoples, who have long held close ties to the land, water, and natural resources that sustain their lives and culture, are among the first to experience these severe impacts directly[20] (Figure 2.4). This unique relationship makes them particularly sensitive to climate impacts like flooding, which reach beyond physical destruction to threaten their way of life. Recognizing these urgent threats, many communities and organizations have begun to declare climate change a state of emergency. For example, the Vuntut Gwitchin First Nation in Yukon formally issued a state of emergency in May 2019, stating that "their traditional way of life was under threat from the rapidly changing landscape."[21] The Chief at the time, Tizya-Tramm had expressed concern about the rapid changes impacting their territory, emphasizing that it will not be long before their grandchildren are living in a "completely different environment."[22] Hence, when floods sweep through Indigenous communities, they do not just wash away homes—they take with them generations of memories, traditions, and ties to the land.

2.1 Flooding in First Nations

Imagine living in harmony with the land and the environment for years, only one day to have your homelands vanish beneath rising floodwaters. This is not a dystopian future but a harsh reality for many Indigenous communities across Canada. Flooding threatens the Indigenous peoples' ways of life, resilience and cultural traditions, thereby fracturing communities as a whole. Between 2006 and 2016, approximately 67 Indigenous communities across the country were recorded to experience some form of flooding, where over 25 percent of these communities experienced number of floods with 10 percent experiencing three or more floods.[23] According to the statistics from the Government of Canada, there have been 1800 natural hazard emergencies affecting First Nations on reserves across Canada between 2009 and 2022 (Figure 2.3),[24] where the country witnessed an average of 39 floods per year impacting First Nations reserves between 2009 and 2014 alone. However, since 2018 this number has increased by 92 percent to an average of 75 floods per year.[25] These floods are not isolated events—they are a recurring nightmare.

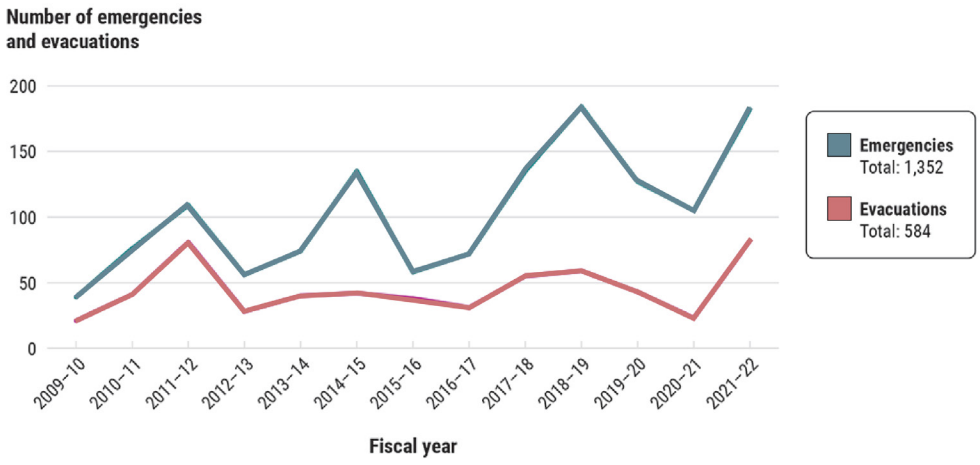


Figure 2.3: The number of emergencies and evacuations in First Nations communities between 2009 and 2022 (Source: Office of Auditor General of Canada).

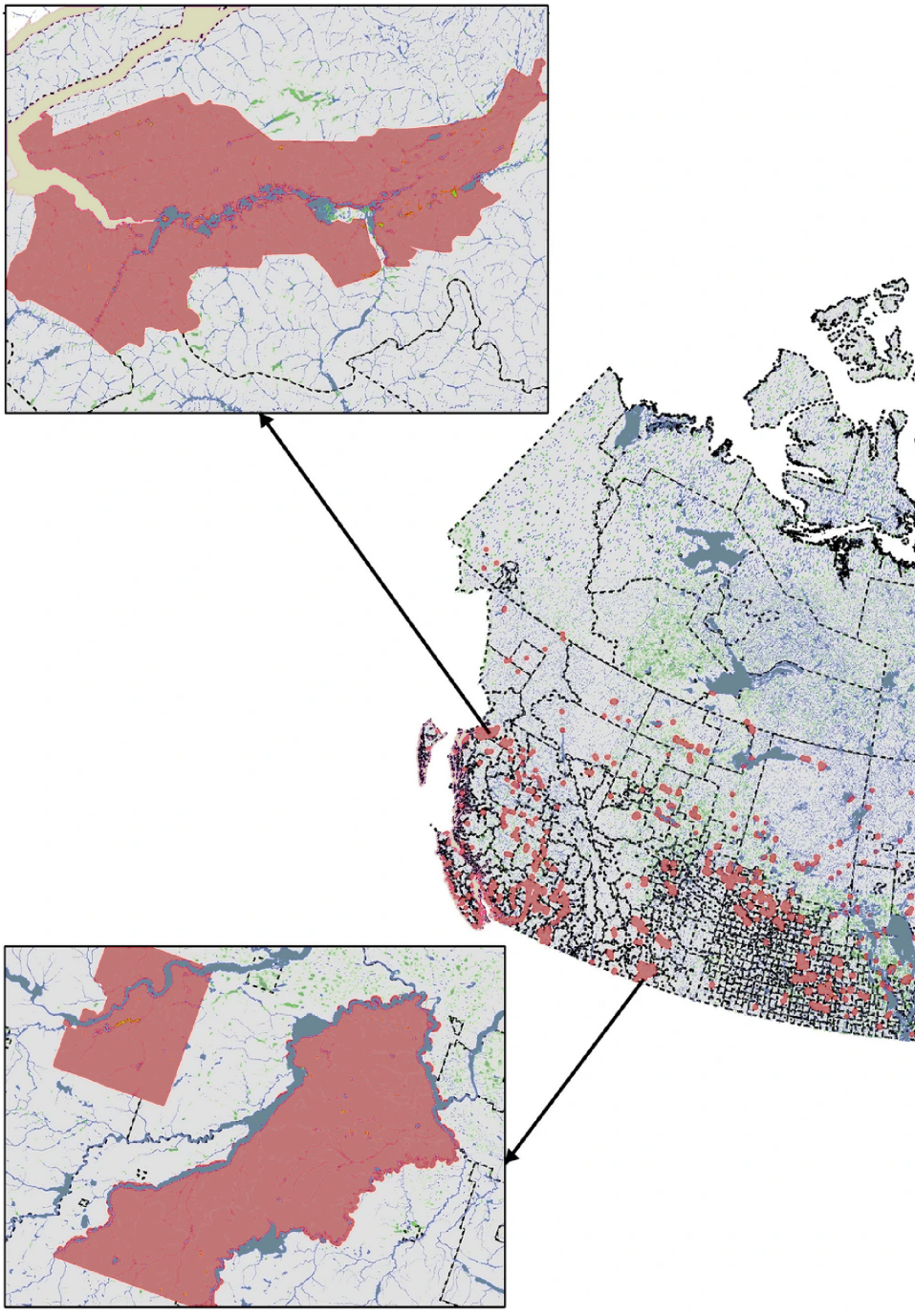
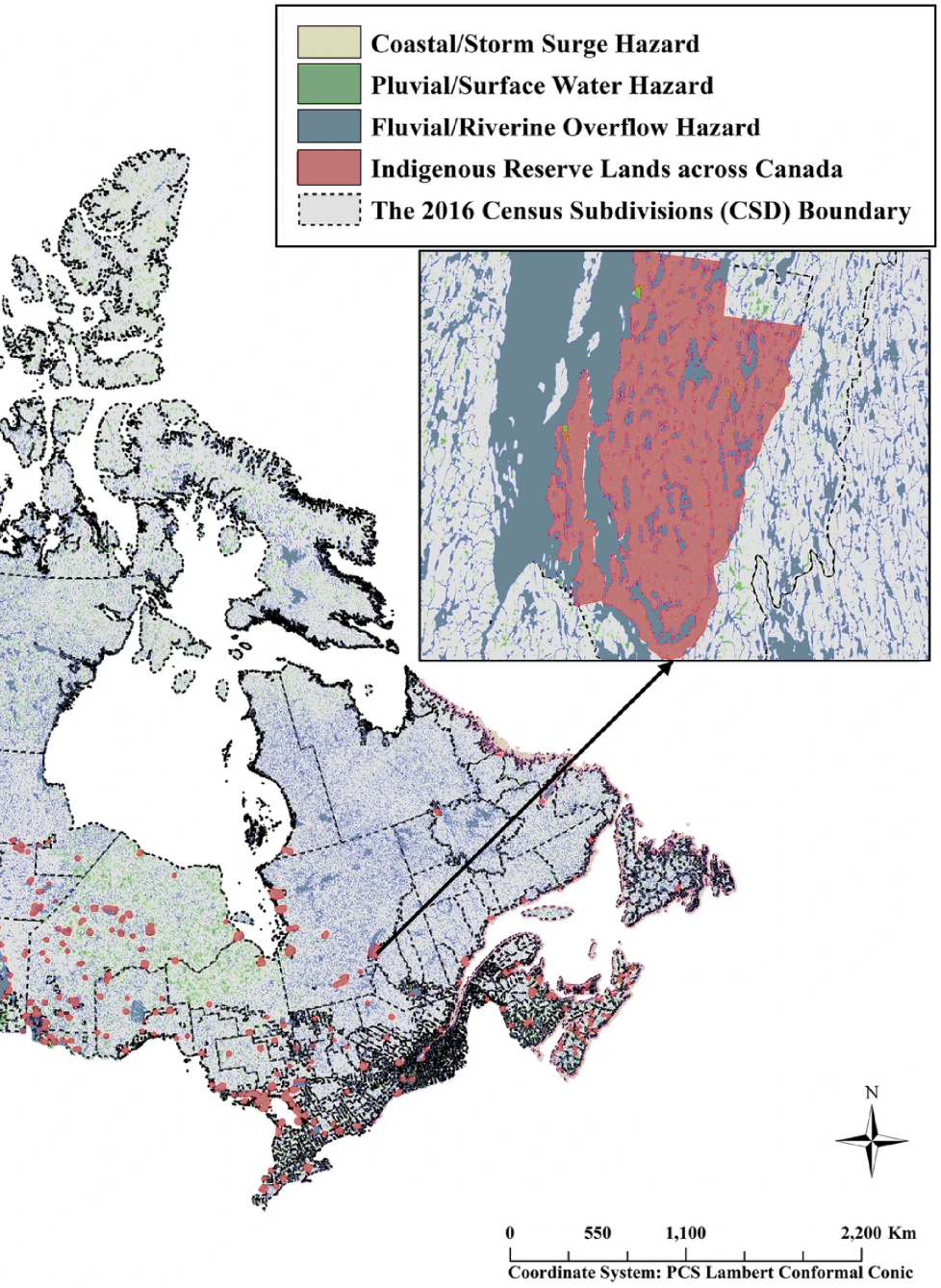


Figure 2.4: Flood-prone areas in Indigenous reserves (Adapted from the 2016 census subdivisions carto



ographic boundary from Statistics Canada; and the 2018 flood hazard data from JBA Risk Management).

In 2011, the Lake St. Martin First Nation in Manitoba faced one of the most devastating floods in recent history. The entire community of 2,000 people was displaced from their lands, their homes lost to the floods.[26] This tragic event exemplifies a broader crisis impacting Indigenous communities across Canada.

In British Columbia, the 2021 AREs wreaked havoc on several communities, such as the Nooaitch First Nation, where a critical bridge collapsed and floodwater engulfed essential roads, leaving the community "completely cut off from the rest of the country"[27] (Figure 2.5). Similarly, Cook's Ferry Indian Band along the Nicola River witnessed a chunk of the highway swept away, leaving residents devastated and anxious about their future.[28] Roads and bridges connecting the Shackan First Nation to the rest of the province were also destroyed in the 2021 AREs and local officials claimed that many of its residents will "never be able to return home."[29]

The 2021 AREs brought widespread devastation to British Columbia, impacting seventy-one First Nations communities, with nine experiencing severe damage.[30] Among them, the Cowichan Tribes, situated on southeast Vancouver Island, experienced extensive flood damage, with hundreds of homes affected and around 120 people evacuated from the reserve.[31] In the interior of BC, Coldwater Indian Band near Merritt grappled with relentless flooding. Houses were impacted by groundwater flooding and overflowing septic systems, which also contaminated the well water.[32] Access to the reserve was limited for almost a month,[33] compounding the community's isolation. Meanwhile, 11 homes in Musqueam Indian Band situated near the mouth of Fraser River were also damaged with one family relocated to a hotel for over a month.[34] Members of the Penelakut Tribe located on Penelakut Island were affected by an 8-inch flood depth for approximately a week, with members reporting "trauma within the community".[35] In Fraser Valley, Chawathil First Nation suffered from overland flooding of about 1.6 feet [500mm] in depth—roughly knee height—flooding 13 homes and creating blockages on the road that disrupted travel.[36]



Figure 2.5: A bridge collapses into the Nicola River near Nooaitch Indian Band territory, 2021. (Photo by Lenora Starr, APTN News, 2021).

The ongoing threat of rising waters looms large, with communities like the Kwantlen Nation facing an alarming reality: McMillan Island, their cherished home, is expected be completely underwater by 2100.[37] These examples highlight not just the immediate destruction caused by flooding, but how climate change does more than just destroy land and property; it erodes cultural identity, community cohesion, and the deep connections Indigenous peoples have with their lands.

For communities like the Kashechewan First Nation in northern Ontario, the impact of flooding goes beyond occasional evacuations. Each spring, families are forced to leave their homes due to flooding—a cycle of displacement that has repeated for over twenty-two years.[38,39,40] This relentless pattern disrupts family life and frays community ties, as each evacuation uproots residents from their everyday lives and traditions.

Similarly, the James Cree and Inuit of Quebec have faced forced relocations their reserves due to flooding caused by hydro development projects.[41] In Manitoba, the 2011 floods displaced over 7,100 residents[42] from Indigenous communities, including, Little Saskatchewan, Ebb and Flow, Dauphin River and Pinaymootang First Nations.[43] For Peguis First Nation residents, evacuations have become tragically routine; for instance, in May 2022, 2,100 community members were evacuated, with over 800 still unable to return five months later.[44] A resolution by the Southern Chief's Organization in 2012 recorded that nearly 2,427 evacuees from eight affected communities in Manitoba remained displaced, "unable to return to their respective community" even a year after the 2011 flood.[45]

The toll extends beyond the immediate loss of homes. In some communities, such as the Cheslatta Carrier Nation in BC, the sacred burial sites of their ancestors have been submerged due to hydroelectric dam operations.[46] These dams, often constructed without proper consultation with Indigenous communities, disrupt traditional land use, sever cultural ties, and lead to long-term environmental damage, further marginalizing the First Nation communities. The manipulation of natural waterways has also affected communities like the South Indian Lake First Nation and Nelsen House First Nation in Manitoba, where fishing, a vital source of food and livelihood, has been severely impacted.[47] Once able to sustain themselves through land and water, they now struggle to survive. Indigenous communities have relied on their lands as a primary food source for thousands of years. Flooding and its impacts fracture this relationship to the land. These floods do more than displace, they unsettle the very foundation of Indigenous community and culture. To be displaced from this land is to be torn away from their very source of cultural survival. Thus, floods have led not only to their homelands slipping away but also to their traditions hanging in the balance.

2.2 How displacement affects First Nations?

Traditional territories have sustained Indigenous communities for generations, many since "time immemorial." But now they are under threat from the increase in rising water, which jeopardizes not only their homes but also their cultural heritage, pushing them away from their lands. This climate induced displacement replicates the colonial practices of forcible removing the Indigenous people from their land, resources and way of life.[48] For example, when a Native tribe of Louisiana in the US—Isle de Jean Charles Band of Biloxi-Chitimacha-Choctaw Indians—were relocated due to impacts of climate change, one of its residents vocalized how that land "was the only place that [he had] ever known as home…and where all his life experiences were."[49] This forced separation from their homelands disrupts the deep-rooted connections Indigenous communities have with their environment, further compounding the emotional and cultural losses that accompany physical displacement.

The Isle de Jean Charles Band of the Biloxi-Chitimacha-Choctaw tribe in Louisiana has faced a long history of environmental and social challenges. For generations, this land has been their home, providing not just a place to live but a foundation for cultural practices, community rituals, and traditional livelihoods. However, due to rising sea levels, coastal erosion, and extreme weather driven by climate change, their island has lost nearly 98% of its landmass since the 1950s.[50] The community's forced relocation, funded in part by federal grants, represents one of the first climate-induced displacements of an entire Indigenous community within the United States. Yet, even with governmental support, relocation has not fully addressed the profound cultural loss that losing land comes with losing a piece of history, culture and self.

According to Pearce (2017), displacement results in social isolation, lack of access to traditional food, multiple relocations, inconsistent access to education and poor psychological health outcomes.[51] Moreover, the economic toll that flooding and its impacts take on communities is manifold,

with billions of dollars spent on recovery and rebuilding. Minorities and vulnerable communities often lack resources to implement such measures and bear the brunt of the impact. But it also raises the question that while one can rebuild the physical constraints of what constitutes a home, can one really rebuild and recover a sense of belonging.

2.2.1 Idea of Home

As someone who has lived in multiple cities, I have always wondered what is a home and why is it so central to our being. My first home was in the city of New Delhi. It was the house by the swings in the big park—or so it seemed to me as a child. I moved out of that house when I moved to Canada at the age of 18. Ever since that move I have always felt a little "homeless." But why? Why is the idea of home so intrinsic to who we are? Each city that I have lived in since has provided different experiences. But somehow when I think of home, I still think of the house in New Delhi by the swings in the big park. Those swings are not there anymore, neither does that house belong to my family. But when I think of it, even today, I think of memories, nostalgia, familiarity and history. This ache I feel—perhaps it is a form of solastalgia, a longing not only for physical space but for the comfort, memory, and stability it once offered. Hence, I have decided that beyond the tangible measures of what constitutes a home—a shelter—it also holds intangible treasures such as memories, nostalgia, history and traditions. It echoes with personal narratives. So, what happens when one loses a home? Especially, one that holds generations worth of memories.

Indigenous homes are often passed down from one generation to another and are imbued with stories of ancestors, struggles and the rituals that defines the community's sense of place. While my personal idea of home is wrapped in childhood memories and familiar spaces, for many Indigenous families, the concept of a home extends far beyond the walls of a single house. Home, for them, is inseparable from the land itself. It is where their traditions are passed down, where rituals connect the past, present and

future, and where ancestors still linger in the stories, the rivers, and the landscape. When these homes are lost, it is not just the physical structures that are damaged and belongings that are washed away, but a deep-rooted connection to the land that holds generations of culture and identity is lost as well.

Flooding of homes strikes at the very core of being. It can affect people's wellbeing and relationships and, in many cases, if not all, the loss of a home translates into the loss of identity. That is why, as Pearce (2017) notes, family photographs hold great significance for many individuals, and when asked about their most impactful losses post-disaster, they often mention "the loss of family photographs"[52]—a reflection of how these images preserve memories, connections, and a sense of self. Additionally, many Indigenous homes contain generations worth of cultural artifacts and traditional items that can get damaged during a flood. First Nations homes can "resemble museums," often housing sacred objects and traditional artwork handed down from ancestors.[53] Moreover, the aftermath of flooding often involves the displacement of communities, forcing them to confront the challenges of relocation and the potential loss of their historical ties to the land. What might seem like material loss is, in fact, a profound spiritual and emotional displacement.

Thistle (2017) defines Indigenous homelessness as a human condition that describes the First Nations, Métis and Inuit individuals, families or communities as "lacking stable, permanent, appropriate housing, or the immediate prospect, means or ability to acquire such housing."[54] Unlike the commercialized western definition of homelessness, Indigenous homelessness is looked at from the lens of Indigenous worldviews. This includes when communities are isolated from their relationships to the land and water.[55] The impact of such loss is not easily quantified and the act of rebuilding is more about reclaiming a sense of place and belonging, something that cannot easily restored when ancestral lands and homes are submerged.

2.2.2 Relationship with Land and Water

In the summer of 2024, I had the unique opportunity to assist Dr. Andrew Judge (*Mkomose*) as a Graduate Teaching Assistant for a course on *Indigenous Land Practices* at the University of Waterloo. Going into this experience, I expected it to be like any other teaching role that focused on sharing knowledge and learning. However, what I gained was far more profound: a deeper understanding and insight into the sacred relationship between Indigenous peoples and their land and water. Before this course, my relationship with land had always been through the lens of an architect, where land was a site for construction or a backdrop for design. As a student of architecture, I am frequently on site, but never had I looked at the land as an entity of its own. But that summer, I learned to see land as more than just a passive entity waiting to be manipulated by human hands. It was more than that, it was about the stories, spirits and connections.

While I have participated in many "cultural traditions" throughout my life, there have only been a handful number of times that have made me feel the way offering tobacco to the land on that day did—asking permission and giving thanks to the land on which we stood (Figure 2.7). By offering flowers to the sacred fire, we gave respect to those who came before us. I remember standing there, holding the tobacco, unsure of what to expect (Figure 2.5). Dr. Judge had said words that have stayed with me since, "our land and villages are the places where our hearts gather."[56] When I released the tobacco onto the soil, I felt like I was a part of something bigger and ancient. It was the first time I looked at the land not as an architect but as a someone still learning. Since starting this thesis, I have grappled with the question of agency and how I can talk about a land that I am not from. However, on that day as I sat across the fire during ceremony and watched the smoke spiral, I felt a deeper understanding of this relationship [as much I as an outsider can]. I realized that it is not about ownership, it is about respect. The land is not just a resource or a commodity, it is where stories live and where history is made. The land holds the memories of those who

came before us, and it asks for respect in return. This land, even though it is not my own, reminded me that the relationship between people and place is not something that can be measured, it is felt and honoured. These experiences helped bridge the understanding of the spiritual significance of land and water as an integral part of Indigenous identity. It is where the people's hearts gather, and hence, it needs to be treated with the utmost respect and care.



Figure 2.6: The ceremony (Photo by author).



Figure 2.7: Offering tobacco to the land and giving thanks (Photo by author).

Certain First Nations believe that their history starts when the great Creator came on Earth walking and talking to the people. One day, the Creator told those he favoured of "a great deluge coming upon Earth" and instructed each family on how to prepare for the incoming floodwater.[57] Like predicted, the great deluge came and everyone but those the great Creator favoured, drowned. As the floodwaters receded, the survivors emerged from their safe spaces, stepping into what would be known as the "places of descent."[58] Consequently, these sacred grounds came to be of great significance for the people. According to Squamish oral stories, this is how the First Nations communities came to be. This led to the birth of this sacred relationship of the Indigenous peoples with their lands and water. Both land and water are seen to be sacred gifts from the Creator because the peoples' survival depend on them. According to the history through stories told by ancient myths, water is the first thing that the Creator made, "a gift" and also a feature of many creation stories of these communities, a reference for how the world came to be. It is seen as a sacred life force, where the water flowing through the land is often seen as the "blood flowing in your veins."[59] While this Squamish Creation story is one account, there are many other stories across diverse First Nations that speak to the sacred relationship among land, water, and people, each emphasizing the deep connection between the natural world and the survival, identity, and spirituality of Indigenous communities.

According to these stories passed down from one generation to other, the people do not simply belong to the land, the water and the living beings, they "*are* those places and beings."[60] The land is where they are said to emerge as people and develop their political systems and cosmologies, which in turn helped shape these distinct identities.[61] Land is the "root of all creation, the heart of the universe" and the essence of their being.[62] As I reflect on these stories, I realize that land and water are not just physical entities in Indigenous worldviews, they are the very source of life. I have also come to understand that this connection is not just symbolic—it is fundamental. Hence, when communities lose their homes due to floods and are separated

from their land by evacuation, they lose far more than just property, they lose their sense of identity and connection to the ancestors. This strikes me deeply because I understand now the weight of what it means to design for or rebuild these spaces. The very act of design must respect this sacred bond. This understanding is at the core of my thesis, which examines how architecture can preserve these ties, especially in flood-prone areas.

While the colonial settlers saw the land as something to be "used, exploited, owned and occupied," Indigenous people everywhere share a sacred connection with the land and the water.[63] Wolfe (2006) considers colonialism an ongoing process in Canada rather than a historical event.[64] Land was seen as means to property, real-estate, capital or natural resources in settler mentality, but to the Indigenous, it was "everything."[65] It was the source of their identity, the connection to their ancestors, their home, as well as the library.[66] Indigenous views saw the land as a "gift" and not a "commodity." Throughout the country's colonial history, many communities were forcibly relocated from their vast homelands to tiny reserves, "often swampy and non-desirable."[67] Although Indigenous peoples' connection to the land has changed over time, this spiritual connection remained the same. Whether it was their native lands, or the new land that was forced upon them, land in common meant strength and it gave them "something to fight for."[68]

The land is not only a source of identity for Indigenous peoples but also a primary means of survival. Many Indigenous communities rely on their traditional territories as their primary food source. Thistle (2017) describes the basis of the traditional land uses of Indigenous people on the reciprocity of the relations to the animals, land and water.[69] Disruption to this reciprocity to the land forced Indigenous peoples to adapt their hunting, fishing and food gathering practices, resulting in new harvesting patterns.[70] Cultural ceremonies and traditions that are so closely connected to the land are also affected.[71] The land is not merely a resource but a living entity with its own spirit—a sacred space intricately woven into their identity, traditions

and way of being. The land is viewed as a provider, offering sustenance, shelter and resources. The people recognize that they are custodians of their land, entrusted with responsibility for preserving its integrity.

In addition to the community Elders and Knowledge Keepers, the land too tells the stories and history of the communities.[72] Cajete (2000) defines the Indigenous worldview through a perspective of understanding this intertwined relationship and interconnectedness between the people and nature.[73] According to scholars, Indigenous knowledge systems are established from ancient and ongoing relationship with the land.[74] Understanding this relationship has also highlighted the profound impact that the loss of land can have on Indigenous peoples. As a consequence of a flood, these communities become more socio-economically and environmentally vulnerable and "disconnected from the land" that they rely on for their survival.[75] For me, this understanding has underscored the need to rethink architectural practices, particularly in how we approach flood mitigation. How can we design in a way that respects the land as more than just a foundation for buildings? How can we ensure that architecture aligns with Indigenous values and the spiritual importance of place?

2.2.3 Trauma

Displacement is also a profound source of trauma for Indigenous communities. Many residents never return home after such events, their ties to their ancestral lands permanently disrupted. Situations like these take a toll on its members who are faced with decisions of abandoning the home that their families have inhabited for generations. Rebuilding is a difficult task that not only deals with physical reconstruction but also the intricate process of restoring a sense of belonging. O'Sullivan and Handal (1988) note that both land destruction and displacement are associated with severe psychological distress and a cultural identity crisis.[76] For many Indigenous people, this loss is comparable to "a death in the immediate family."[77]

The emotional toll of living through a flood extends far beyond property damage and the loss of personal belongings. The psychological impact can be profound, leading to mental health disorders such as post-traumatic stress disorder (PTSD) and anxiety.[78] The *American Psychiatric Association* describes PTSD as a "severe and complex disorder precipitated by exposure to psychologically distressing events," where memories of the trauma persist and continue to cause distress.[79] Many First Nations people, having faced previous experiences of displacement, develop PTSD, which triggers flashbacks, feelings of anger, helplessness, and deep sadness.[80] The psychological effects of flooding, for these communities, aggravate the trauma of historical and ongoing displacement they have faced.

Glenn and Myre (2022) describe the mental health impacts of flooding as both short-term and chronic,[81] with displacement and its consequences leading to issues such as stress, depression, family break-ups, increased family violence, drug use, alcoholism, youth involvement in gangs, and even suicide.[82] It is also reported that the majority of post-flood morbidity is related to the psychosocial stress from not just the flood event but also from the subsequent loss, disruption and lack of security that followed it.[83] In addition to the psychosocial well-being, the trauma that follows flooding has negative impacts on the physical well-being as well. Studies show that displacement is linked with a variety of chronic health conditions such as heart disease, hypertension and diabetes, as well as premature death in some cases.[84] After experiencing flooding, residents have to face uncertainty and chaos, which include lack of security, both emotionally and economically. The overwhelming uncertainty of post-flood reality makes recovery even more difficult.

Glenn and Myre (2022) also write that a lack of funding to rebuild further adds to the prolonged negative psychosocial impacts.[85] Communities and their displaced residents cannot just go back to the way of life they knew before, they have to get used to the "new normal."[86] This sometimes could mean increase in domestic conflicts, intimate partner violence, economic stress, substance abuse and child behavioral and school performance were

challenges.[87] Residents having to relocate to hotels, sometimes for months on an end or even years, is a common practice in such flood-prone Indigenous communities. This further leads to social isolation and lack of access to education and traditional food, which further adds to the trauma of coping.[88] The example of Little Saskatchewan First Nation, where members were given 24-hours to evacuate before the 2011 "super-floods,"[89] is a stark reminder of the long-term impact. The displaced residents claimed that their traditional lifestyle was disturbed and "it was lonely" being away from home.[90] There were many members who were displaced for years, hopping from one hotel to another, finally being able to return home after eight long years.[91] The documentary *Flood Children: Eight Years Displaced from Little Saskatchewan First Nation* showcases how people who were kids when they were displaced were now returning back years later "with babies of their own."[92] Mushkegowuk Council Grand Chief Jonathan Solomon describes this pattern of shifting from hotels during evacuations as a "total displacement" where people have to "live in a cell block room."[93] Additionally, many times pets were not allowed in hotels and temporary housing, thus they had to be taken away to the humane society for adoption out of necessity which created further stress among family members.[94] Relocations not only fracture communities by displacing people from their homes but also "[uproot] their memories."[95] Hence, displacing Indigenous people from their native lands directly impacts their cultural survival. It is clear that displacement from traditional territories does more than remove people from their homes—it severs the sacred connection among people, land, water and their means of survival.

2.2.4 Loss of Heritage and Culture

As floodwaters encroach upon ancestral territories, they bring about not only physical devastation but also profound cultural and spiritual upheaval. It harms both the tangible and intangible bond between the people and their

environment. Homes and livelihoods are not the only casualties—areas of deep cultural significance such as burial sites and ceremonial grounds—are submerged as well. Glenn and Myre (2022) note that the destruction of community gathering places, like the community centres where weddings and other family events took place, devastated the members because "there was no place to physically come together after the flood."[96] For example, the sacred territory of burial sites in Cheslatta Carrier Nation in BC were submerged due to flooding.[97] The Williams Lake First Nation in BC witnessed heritage sites that date back 4,000 years being swept away as the Chilcotin River flooded in 2024, further damaging the salmon migration routes.[98] The community expressed being "deeply saddened by the potential loss of irreplaceable Secwépemc[i] history."[99] Similarly, the *Church of Sacred Heart* in Chawathil First Nation in BC also flooded during the 2021 AREs (Figure 2.8). Built in 1926 by community members themselves, the church is seen as a "labour of love" that "[their] grandfathers had built."[100] Seen as a symbol of heritage, the floods of 2021 caused the floodwater to ascend as high as the bottom of the windows (Figure 2.9). Thus, the church now stands uninhabitable due to the damages caused by the floods. These kinds of losses resonate deeply, as they represent not just physical structures but the embodiment of cultural continuity, memories and heritage.

In addition to causing structural damage, natural resources, which are also integral to cultural practices, are often impacted during such events. In BC, many First Nations communities depend on wild salmon, not just for sustenance but as a central element of their cultural identity and traditions. The flooding disrupted salmon runs, creating consequences that touched both the spiritual and physical well-being of the people.[101] Similarly, the traditional lands of First Nations in Manitoba were once home to abundant bison that are now dispersed due to the changing landscape.[102]

---

i *Secwépemc* refers to the First Nations people residing in the interior of British Columbia.



Figure 2.8: Church of Sacred Heart, Chawathil First Nation (Photo by author).



Figure 2.9: Church of Sacred Heart, Chawathil First Nation (Source: Google Maps).

The loss of heritage also extends to cultural artifacts and traditional belongings. There has been a loss of valuable cultural artifacts such as masks, carvings, blankets. For example, a number of traditional weavers from the Penelakut Tribe in BC lost wool used to make button blankets—an essential part of their ceremonial regalia—for the community's famous Cowichan sweaters, a renowned traditional garment of the Coast Salish peoples.[103] Similarly, members of Peguis First Nation recounted how their ceremonial regalia and items used in rituals floated away during the floods of 2021 when their homes were flooded.[104] While there is an urgent need for preserving these historic traditions, both tangible and intangible, as well as intergenerational knowledge, it is harder to estimate the loss of heritage and culture that comes with displacement. While we can count for

comes with displacement. While we can account for the physical attributes lost, can one quantify the memories lost, the loss of language, land, culture and identity? Though intangible, these elements represent the essence of the community's heritage, and displacement fundamentally fractures this sacred connection.

2.3 Case Studies

2.3.1 Lake St. Martin First Nation

In 2011, the Canadian province of Manitoba experienced unprecedented flooding. To protect provincial urban areas, cottages, and agricultural properties, government officials diverted the floodwater towards Lake St. Martin First Nation.[105] The floodwater was redirected into Lake Manitoba to protect properties on provincial lands that were considered "high property value," while the Indigenous reserve of Lake St. Martin First was categorized as federal Crown land "without value." This artificial flood devastated the community, destroying homes and infrastructure permanently.[106] The aftermath of this event reveals the deep-seated issues of marginalization, colonialism, and inadequate support systems faced by Indigenous communities in Canada, so much so that many members expressed feeling like refugees in their own homelands—lands that these Anishinaabe people had inhabited for over 140 years.[107]

The flood's immediate impact on the Lake St. Martin First Nation community was profound. All members were evacuated, and many resided in temporary accommodations such as hotels in Winnipeg. This displacement disrupted their lives significantly. As Ballard (2016) notes, the government's decision to implement a structural flood risk reduction approach without consulting the affected Indigenous communities is perceived as a form of sabotage. This approach, which involved building engineered structures like dikes, failed to consider the voices and needs of the Indigenous peoples.[108]

The chaos following the evacuation was compounded by a lack of necessary services and infrastructure. Evacuees faced inadequate housing, lack of counseling services, and insufficient access to traditional foods.[109] Some families were relocated up to 12 times, moving from one hotel to another, which was deeply destabilizing.[110] The stress and uncertainty of these conditions led to significant mental health issues, including anxiety, depression, PTSD, and suicides.[111] The long-term impacts of the displacement have been equally severe. As Thompson and Ballard (2013) document, the community has struggled to develop a sustainable living model post-flood.[112] The forced relocation has disrupted social support networks, leading to a cultural identity crisis and increased dependency on government support.[113] This dependency, coupled with experiences of overt racism and negative portrayals in the media, has further marginalized the community.[114] Then-Chief Adrian Sinclair highlighted how community members were derogatorily called "freeloaders," and elders faced physical and verbal assaults, intensifying the community's trauma and sense of victimization.[115]

Lake St. Martin First Nation was environmentally and developmentally displaced during the floods of 2011, its lands submerged underwater and the province deeming it uninhabitable. Indigenous communities have a deep spiritual connection to their land, which is integral to their identity and way of life. As of 2020—nine years after the evacuations—there are still members of the community who have not been able to find their way back home.[116] The government's failure to recognize and honor this connection in its flood management strategies has resulted in severe and lasting consequences for the Lake St. Martin First Nation community. As Ballard (2016) argues, the influence of colonial powers has magnified the community's vulnerability, often pushing them onto flood-prone lands, hence highlighting the need for a shift towards more sustainable and culturally sensitive approaches to disaster management and support for Indigenous communities.[117]

In conclusion, the case of Lake St. Martin First Nation illustrates the devastating impacts of environmental displacement on Indigenous communities. The 2011 flood and the subsequent displacement have not only caused significant physical and mental health issues but have also disrupted the community's cultural and social fabric. Members talk about "how beautiful it was [there] growing up" but now "that will never happen again, it's *gone*"[118] (Figure 2.10). Through the video *Flooding Hope* by Ballard, community members expressed that they "not only lost their traditional way of life, but also their culture."[119]

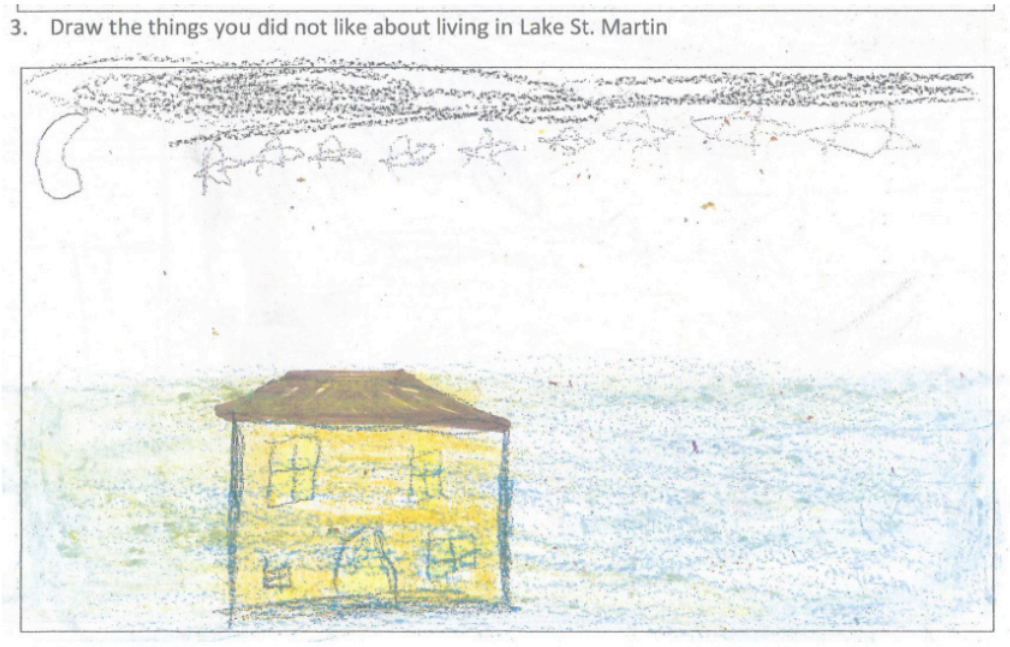


Figure 2.10: A child's drawing showing their home submerged by the floods (Source: Flooding Hope, Myrle Ballard and Shirley Thompson).

2.3.2 Chawathil First Nation

In 2021, the Chawathil First Nation, a community of 360 members, experienced significant trauma during the Atmospheric River Events (AREs) that caused extensive flooding in British Columbia. These floods left the community completely isolated without internet, power, or any connection to the outside world.[120] Many families were separated and unable to contact each other due to the lack of communication infrastructure. The Canadian Armed Forces had to intervene to provide food and supplies.[121] Then-Chief Rhoda Peters, a 70-year resident of the community, stated how "she had never seen anything like this."[122] This sentiment was echoed by another community member who expressed how he "did not trust the water anymore."[123]

The Chawathil community, whose name in the Halq'emeylem language means "people of the river,"[124] has had a long history of interaction with their environment. Archaeological evidence indicates that the Sto:lo people inhabited Chawathil as far back as 750 BCE.[125] The community's decision to move to Chawathil's present location in 1894 following the "great flood" illustrates their historical resilience and adaptability.[126] As per Sto:lo oral history, Governor Douglas promised the Chawathil site as a reserve sometime in the 1850s.[127] Between the late nineteenth and early twentieth centuries, about sixty people lived in Chawathil IR4.[128] The Halq'emeylem word for Chawathil territory literally translates to "where the land meets the water" but has a more vivid meaning of "the land right here and it suited us."[129] Lyall (2020) discusses how Chawathil resident Patricia John talks about "time and place" and how she [and other community members] are connected to their ancestors, underlining this intimate relationship that their people have with their land.[130] Hence, in order to achieve a true sense of reconciliation, it is necessary for settlers—xwelitem, translating to "the hungry people" in Halq'emeylem—to understand that Indigenous knowledge is "embedded in their homelands."[131]

The community's responses to these floods also highlight the intersection of Indigenous knowledge and contemporary adaptation strategies. John emphasized the importance of understanding Indigenous knowledge in its proper context, noting that it is deeply intertwined in their homelands. This intimate connection to the land underscores the need for adaptive strategies that respect and incorporate Indigenous perspectives. During my visit to the Chawathil First Nation in March of 2024, I witnessed first-hand the damage caused by the 2021 AREs. Many homes had been significantly impacted by floodwater, forcing residents to seek temporary housing in nearby towns and cities (Figure 2.11). Some houses bore a red string tied, around a pole-like structure, at about three feet high, near the exterior of the house, marking the flood levels from the 1948 flood [as a point of reference]. This marker serves as a reminder of the community's ongoing vulnerability to such events, emphasizing the profound impact of flooding on the Chawathil and the need for sustainable, culturally respectful responses.



Figure 2.11: One of the houses affected by 2021 AREs in Chawathil. Although the flood damage may not be immediately visible, the resident has since been displaced and continues to live in temporary accommodation, unable to return home. (Photo by author).

2.3.3 Peguis First Nation

Peguis First Nation, located approximately 122 miles [196 kilometres] north of Winnipeg, has faced significant challenges due to its geographical location in a flood-prone area in Manitoba. Their history is marked by displacement and hardship. Originally, the community, led by Chief Peguis, migrated from present-day Sault Ste. Marie, Ontario, to a Cree settlement at Netley Creek, Manitoba and later to present-day East Selkirk—a fertile farmland—in the late 1700s.[132] In 1871, the St. Peter's Indian Reserve (as it was then called) signed Treaty One with the belief that their claims to their homeland would be protected. However, in a controversial and coerced land surrender in 1907, they were relocated to the swampy and flood-prone area along the Fisher River, an event described as "ethnic cleansing" by Sinclair & Cariou (2011).[133] Government agents and "land-hungry settlers"[134] had conspired to remove them from this fertile land through bribery, whiskey and trickery as documented in *Chief Peguis and his Descendants*.[135]

Many Peguis members were not made aware of the meeting for the land surrender, as most men were away hunting, and notices were written only in English rather than the native Cree and Ojibwe language.[136] Despite protests from the community, the illegal surrender was executed, and the residents were ordered to move to "northern swampy" lands of the Peguis Reserve inadequate for farming, hunting and prone to flooding.[137] This relocation was led by Chief Peguis and the residents had to leave behind their homes and fertile lands for an area that provided none of the essential resources they once had. Unlike their previous lands, their new "home" had no houses, neither schools nor churches.[138] Once it became known what had happened to the community, depression settled on the now "homeless people."[139] In their native language, the land of Peguis—the land they now occupy—is referred to as "the land that nobody wants,"[140] reflecting their deep sense of loss and displacement that still permeates the community's relationship with their new territory, underscoring a justified sense of betrayal rooted in a legacy of distrust.

Former Chief Albert Thompson, a descendant of Chief Peguis, noted that more funds have historically been allocated to post-disaster recovery than to proactive measures to prevent flooding in Peguis.[141] This approach has left the community vulnerable to repeated floods, as evidenced by subsequent floods in 2006, 2009, 2011, 2014, 2022, 2023 and 2024. Present Chief Stan Bird has also expressed similar concerns, stating that too much effort is spent to recover from past Fisher River floods rather than preventing damage from future events.[142]

The flood of 2011 was particularly devastating for Peguis First Nation. By 2020—nine years later—there were 91 evacuees who were still unable to return to their homes, living in temporary accommodations due to the extent of the damage.[143] In response, Indigenous Services Canada (ISC) implemented several measures, including the repair of 61 houses, purchasing 9 new homes, and raising 10 houses to higher heights. While these efforts provided some relief, they fell short of addressing the long-term challenges posed by repeated flooding in the community[144] (Figure 2.12).

Many residents, despite the threat of recurring floods, remain attached to their homeland and do not wish to leave. Some residents are still displaced from the 2014 floods, as repaired homes continue to flood soon after the residents return. The persistent floods and inadequate housing have broader social and health impacts on the community. The housing shortage has contributed to increased mental health crises, domestic abuse, and educational disruptions.[145] A resident described their "love-hate" relationship with the river.[146] People used to depend on the river for fishing and hunting and recall drinking and swimming in the water as children many years ago, but now "no one drinks the water."[147] It is also believed that signs from nature are a more reliable source than forecasts regarding flooding. For example, when the muskrats build nests adjacent to the river, it is seen as a sign that it will not flood severely.[148] Animals such as rabbits, foxes and squirrels move away from the rivers when floodwaters are about to come.[149] Following these indications is difficult when people are displaced and forced to relocate to the city.

In May 2022, another major flood led to the evacuation of 2,100 community members, with more than 800 people still displaced five months later.[150] The cumulative effect of repeated flooding has exacerbated a housing crisis in Peguis First Nation. Hundreds of homes have been condemned due to mould and structural damage, while many others require significant repairs or replacement.[151] The shortage of adequate housing has forced some residents to live in substandard conditions. For instance, eight people were housed in a condemned former school with a leaky roof and mould issues. Alice Thomas, an elder community member, expressed her hardship of repeatedly living in hotels during floods and the instability it caused.[152] She exclaimed that it was "chaos" having to move every time she "settled in her room."[153] The experience of Peguis First Nation underscores the urgent need for effective flood mitigation strategies and adequate housing solutions. The history of the community and its struggle with displacement serves as a powerful reminder that land is not just a place to live, but an irreplaceable part of a community's identity. The repeated cycles of flooding, loss and insufficient recovery efforts reveal a deeper need to reimagine how Indigenous communities can remain rooted in their homelands, and how architecture can support that process.



Figure 2.12: Aerial view of flooding in Peguis First Nation on April 9th, 2024 (Source: Snapshot by Douglas R. Thomas' YouTube channel).

2.4 Summary

The exploration of flooding's impacts on Indigenous communities in Canada reveals profound narratives of loss, resilience, and identity. he stories from Lake St. Martin First Nation, Chawathil First Nation, and Peguis First Nation paint a vivid picture of how environmental challenges intersect with historical injustices, shaping the lived experiences of these communities. Flooding is more than just an environmental challenge for First Nations communities; it's a profound disruption that echoes through their identities, cultures, and histories. The impact of these natural hazards is intricately tied to the legacies of colonization, which have left deep scars of displacement and trauma. As I reflect on the narratives that emerge from these experiences, it becomes clear that land is not just a physical space for Indigenous peoples—it is a sacred entity, woven into the very fabric of their existence.

When floods strike, they disrupt not only the landscape but also the community's sense of belonging. The forced evacuations and displacement experienced by these communities often sever vital connections to their homes and traditional practices. This loss creates a ripple effect, compounding feelings of vulnerability. Understanding these stories is essential, as they highlight the urgency of addressing the systemic issues that exacerbate these challenges.

To navigate the challenges posed by flooding in First Nations communities, we must embrace transformative and innovative solutions that prioritize the unique experiences and cultural identities of Indigenous peoples. As we move forward, it is essential to rethink our strategies in a way that not only addresses the physical impacts of flooding but also cultivates a sense of belonging and agency among those affected. Such an approach encourages collaboration and co-creation, ensuring that solutions are rooted in the values and aspirations of the communities they serve.

1 Canadian Press, "Study Identifies Indigenous Communities That Are Hotspots for Flooding Risk," V*ancouver Is Awesome,* January 4, 2022, https://www.vancouverisawesome.com/highlights/study-identifies-indigenous-communities-that-are-hotspots-for-flooding-risk-4913674.

2 CRED, "2022 Disasters in numbers," Centre for Research on the Epidemiology of Disasters, 2023, https://cred.be/sites/default/files/2022_EMDAT_report.pdf.

3 Debrati Guha-Sapir, Philippe Hoyois and Regina Below, "Annual Disaster Statistical Review 2014: The numbers and trends," CRED, 2015, http://www.cred.be/sites/default/files/ADSR_2014.pdf

4 D.J Parker, ed., *Floods* (Routledge, London, 2000).

5 Auditor General of Canada, "Chapter 6: Emergency Management on Reserves." In Report of the Auditor General of Canada — Fall 2013, Appendix A, 16–18,, 2013, Ottawa, ON: Minister of Public Works and Government Services. http://publications.gc.ca/collections/collection_2013/bvg-oag/FA1-2013-2-0-eng.pdf

6 Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Indigenous Reserve Lands in Canada Face High Flood Risk, Policy Brief No. 159," Centre for International Governance Innovation, April, 2020, https://www.cigionline.org/publications/indigenous-reserve-lands-canada-face-high-flood-risk/.

7 Kelsie McNeill, Andrew Binns and Ashutosh Singh, "Flood History Analysis and Socioeconomic Implications of Flooding for Indigenous Canadian Communities," Paper presented at the Annual Conference of the Canadian Society for Bioengineering, Winnipeg, MB, 2018, www.csbe-scgab.ca/docs/meetings/2017/CSBE17137.pdf.

8 Liton Chakraborty, Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada," *International Journal of Disaster Risk Science* 12 (2021): 821–838, https://doi.org/10.1007/s13753-021-00383-1

9 Shirley Thompson, Myrle Ballard and Donna Martin, "Lake St. Martin First Nation Community Members' Experiences of Induced Displacement: 'We're like refugees,'" *Refuge* 29, 2 (2014): 75–86, https://refuge.journals.yorku.ca/index.php/refuge/article/view/38168

10 Christopher Furgal and Jacinthe Seguin, "Climate Change, Health, and Vulnerability in Canadian Northern Aboriginal Communities," *Environmental Health Perspectives* 114, 12 (July 2006): 1964–70, doi:10.1289/ehp.8433.

11 Myrle Ballard, "Flooding Sustainable Livelihoods of the Lake St Martin First Nation: The need to Enhance the Role of Gender and Language in Anishinaabe Knowledge Systems," (PhD diss., University of Manitoba, 2012), https://mspace.lib.umanitoba.ca/server/api/core/bitstreams/b1121cdb-39c6-40bc-bf30-ad3659ae8e45/content

12 Shirley Thompson et al., "Lake St. Martin First Nation."

13 Ibid.

14 Justin Brake, "'Literally life and death': Indigenous climate leaders critical of Canada's response to climate change report." *Aboriginal People's Television Network News*, October 17, 2018. https://aptnnews.ca/2018/10/17/ literally-life-and-death-indigenousclimate-leaders-critical-of-canadasresponse-to-climate-change-report/

15 Marie-Danielle Smith, "First Nations communities suffering 'more intense' impact of climate change, secret briefings say," *National Post*, June 2, 2016, https://nationalpost.com/news/politics/first-nations-communitiessuffering-more-intense-impact-ofclimate-change-secret-briefings-say

16 Aarti Lila Ram and Eric Shahzar, "Land, Loss and Liberation: Why Indigenous Communities Face Climate Displacement Challenges," *World Economic Forum*, February 9, 2024, https://www.weforum.org/agenda/2024/02/indigenous-challenges-displacement-climate-change

17 Aarti Lila Ram et al.,"Land, Loss and Liberation."

18 Leela Viswanathan, "Climate-Forced Indigenous Migration: Humanizing the Impact of Climate Change," *Indigenous Climate Hub* (blog), February 15, 2021, https://indigenousclimatehub.ca/2021/02/climage-forced-indigenous-migration/.

19 Jason Thistlethwaite et al., "Indigenous Reserve Lands in Canada Face High Flood Risk."

20 National Collaborating Centre for Indigenous Health (NCCIH), *Climate Change and Indigenous Peoples' Health in Canada. In P. Berry & R. Schnitter (Eds.), Health of Canadians in a Changing Climate: Advancing our Knowledge for Action* (Ottawa, ON: Government of Canada, 2022), https://doi.org/10.4095/329528.

21 Ibid.

22 Ibid.

23 Kelsie McNeill et al., "Flood History Analysis."

24 "Emergency Management Assistance Program - key statistics," Government of Canada, 2023, https://www.sac-isc.gc.ca/eng/1685047435261/1685047540188

25 Ibid.

26 Myrle Ballard and Shirley Thompson, "Flooding Hope: The Lake St. Martin Story," *Culture Unplugged* (video), 2012, https://cultureunplugged.com/documentary/watch-online/play/53590/flooding-hope-the-lake-st-martin-story

27 "BC First Nations Climate Strategy and Action Plan", First Nations Leadership Council, 2022, https://www.bcafn.ca/sites/default/files/2022-04/BCFNCSAP%20Final%20Draft%20%2822April2022%29.pdf.

28 Wendy Stueck, "With Climate Disasters on the Rise, B.C.'s Indigenous Communities Find Themselves at High Risk of Displacement," *The Globe and Mail*, November 19, 2021, https://www.theglobeandmail.com/canada/british-columbia/article-with-climate-disasters-on-the-rise-bcs-indigenous-communities-find/.

29 Dan Fumano, "'We have nowhere': B.C. First Nations, rural residents say storm permanently changed the land," *Vancouver Sun*, November 15, 2021, https://vancouversun.com/news/local-news/we-have-nowhere-b-c-first-nations-rural-residents-say-storm-permanently-changed-the-land

30 "Interactive Map | First Nations in BC," British Columbia Assembly of First Nations, https://www.bcafn.ca/first-nations-bc/interactive-map.

31 Elizabeth English, "ICLR Quick Response BC Report: BC Communities Affected by the November 2021-February 2022 Atmospheric River Events," *Prepared for The Institute of Catastrophic Loss Reduction,* unpublished manuscript, 2024, used by permission.

32 Ibid.

33 Ibid.

34 Ibid.

35 Ibid.

36 Ibid.

37 Christopher Cheung, "How a 'Perfect Storm' Could Flood the Musqueam Reserve," *The Tyee*, June 17, 2022, https://thetyee.ca/News/2022/06/17/How-Perfect-Storm-Could-Destroy-Musqueam-Reserve/.

38 Josh Dehaas, "Northern Ontario First Nation Could Face 'Catastrophic Flooding': MP," *CTV News*, April 14, 2019, www.ctvnews.ca/canada/northern-ontario-first-nation-couldface-catastrophic-flooding-mp-1.4379671.

39 Lydia Chubak, "Evacuation underway in Kashechewan, Ont., due to spring flooding of Albany River," *Northern Ontario News*, April 12, 2024, https://northernontario.ctvnews.ca/evacuation-underway-in-kashechewan-ont-due-to-spring-flooding-of-albany-river-1.6845347

40 The Canadian Press, "Hundreds evacuate as floods hit northern Ontario First Nation," *Global News*, April 27, 2023, https://globalnews.ca/news/9656123/spring-flooding-northern-ontario-first-nation-evacuation/

41 James H. Marsh, "James Bay Project," *The Canadian Encyclopedia*, January 31, 2011, https://www.thecanadianencyclopedia.ca/en/article/james-bay-project

42 Kelsie McNeill et al., "Flood History Analysis."

43 "Manitoba flood diversion plan raises ire of First Nation leaders," *CBC News*, August 12, 2015, https://www.cbc.ca/news/canada/manitoba/manitoba-flood-diversion-plan-raises-ire-of-first-nation-leaders-1.3189092

44 Shirley Thompson and K. Suzuki, "Displacement of Indigenous People in Canada under the Indian Act: Participatory Video with Lake St. Martin and Little Saskatchewan First Nations on Flood Impacts," *Journal of Geoscience and Environment Protection* 10, (2022):242-264, https://www.scirp.org/journal/paperinformation?paperid=121526.

45 Shirley Thompson et al., "Lake St. Martin First Nation."

46 "Cheslatta Carrier First Nation sign reconciliation agreement with province," *CBC News*, September 13, 2016, https://www.cbc.ca/news/canada/british-columbia/cheslatta-carrier-nation-1.3759220

47 Shirley Thompson et al., "Lake St. Martin First Nation."

48 Shirley Thompson et al., "Displacement of Indigenous People."

49 Megan Thompson and Melanie Saltzman, "Native tribe in Louisiana highlights challenges of climate-driven relocation," *PBS News*, April 15, 2023, https://www.pbs.org/newshour/amp/show/native-tribe-in-louisiana-highlights-challenges-of-climate-driven-relocation

50 "Isle de Jean Charles," *The Red Road Project,* https://redroadproject.com/isle-de-jean-charles/

51 Laurie Pearce, Brenda Murphy and Annette Chrétien, "From Displacement to Hope: A Guide for Displaced Indigenous Communities and Host Communities," March 2017, https://www.researchgate.net/publication/320609014_From_Displacement_to_Hope_A_Guide_for_Displaced_Indigenous_Communities_and_Host_Communities.

52 Ibid.

53 "B.C. First Nations Salvaging the Sacred from Climate Disaster," *Victoria News*, April 14, 2023, https://www.vicnews.com/news/b-c-first-nations-salvaging-the-sacred-from-climate-disaster-113344.

54 Jesse Thistle, "Definition of Indigenous Homelessness in Canada", Canadian Observatory on Homelessness, 2017, York University Press, https://homelesshub.ca/IndigenousHomelessness.

55 Ibid.

56 Andrew Judge, "ARCH 243: Indigenous Practices," Lecture, School of Architecture, University of Waterloo, 2024.

57 Doreen Jensen and Cheryl Brooks, *In Celebration of our Survival: The First Nations of British Columbia* (Vancouver: UBC Press, 1991).

58 Ibid.

59 Andrew Judge, "ARCH 243."

60 A. Nelson-Moody, G. George and Joseph, T, *People of the Land: Legends of the Four Host First Nations* (2009).

61 Patty Krawec, *Becoming Kin: An Indigenous Call to Unforgetting the Past and Reimagining Our Future* (1517 Media, 2022), https://doi.org/10.2307/j.ctv29sfz3r.

62 Chelsey Luger and Thosh Collins, *The Seven Circles: Indigenous Teachings for Living Well: First edition* (New York, NY: HarperOne, 2022).

63 Ibid.

64 Patrick Wolfe, "Settler colonialism and the elimination of the native," *Journal of Genocide Research* 8, 4 (2006):387–409, https://doi.org/10/bxsx9z

65 Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (London: Penguin Books, 2020).

66 Ibid.

67 Library and Archives Canada, "Reports of the Royal Commission on Aboriginal Peoples," Royal Commission on Aboriginal Peoples, August 26, 1991, http://data2.archives.ca/e/e448/e011188230-01.pdf.

68 Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (London: Penguin Books, 2020).

69 Jesse Thistle, "Definition of Indigenous Homelessness in Canada."

70 "Climate Change and Emergency Management for Indigenous Communities," *Indigenous Corporate Training Inc.*, April 30, 2024, https://www.ictinc.ca/blog/climate-change-and-emergency-management-for-indigenous-communities.

71 Ibid.

72 Shirley Thompson et al., "Lake St. Martin First Nation."

73 Gregory Cajete, *Native Science: Natural Laws of Interdependence* (Santa Fe, New Mexico: Clear Light Publishers, 2000).

74 Shirley Thompson et al., "Lake St. Martin First Nation."

75 Kelsie McNeill et al., "Flood History Analysis."

76 Michael J. O'Sullivan and Paul J. Handal, "Medical and Psychological Effects of the Threat of Compulsory Relocation for an American Indian Tribe. American Indian and Alaska Native Mental Health Research," *Centers for American Indian and Alaska Native Health* 2 (1988):3-2, https://doi.org/10.5820/aian.0201.1988.3

77 Ibid.

78 Jason Thistlethwaite et al., "Indigenous Reserve Lands in Canada Face High Flood Risk."

79 Shirley Thompson et al., "Lake St. Martin First Nation."

80 Laurie Pearce et al., "From Displacement to Hope."

81 Nicole Glenn and Maxine Myre, "Post-flooding community-level psychosocial impacts and priorities in Canada: A preliminary report," National Collaborating Centre for Environmental Health, November, 2022, https://ncceh.ca/sites/default/files/Post%20flooding%20community%20level%20psychosoical%20impacts%20Nov%2021%202022_0.pdf

82 Shirley Thompson et al., "Lake St. Martin First Nation."

83 Hilary Burton, Felicia Rabito, Lisa Danielson and Tim K. Takaro, "Health effects of flooding in Canada: A 2015 review and description of gaps in research," *Canadian Water Resources Journal / Revue canadienne des ressources hydriques* 41, 1-2 (2016):238-249, DOI: 10.1080/07011784.2015.1128854

84 Jason Thistlethwaite et al., "Indigenous Reserve Lands in Canada Face High Flood Risk."

85 Nicole Glenn et al., "Post-flooding community-level psychosocial impacts."

86 Ibid.

87 Ibid.

88 Laurie Pearce et al., "From Displacement to Hope."

89 Myrle Ballard, "Wounded Spirit: Forced Evacuation of Little Saskatchewan First Nation Elders," YouTube (video), January 22, 2016, https://www.youtube.com/watch?v=PQTubc1LIjY.

90 Ibid.

91 Eco-Health Learning Circle, "Flood Children: Eight Years Displaced from Little Saskatchewan First Nation," YouTube (video), April 7, 2022, https://www.youtube.com/watch?v=BxsG5q1cAGY.

92 Ibid.

93 Jason Thistlethwaite et al., "Indigenous Reserve Lands in Canada Face High Flood Risk."

94 Shirley Thompson et al., "Lake St. Martin First Nation."

95 Elizabeth C English, Meiyi Chen, Rebecca Zarins and Iryna Humenyuk, "An Innovative Strategy to Increase the Resilience of Flood-Vulnerable Communities While Reducing Risk of Population Displacement and Psychological Trauma," 8th International Conference on Build*ing Resilience–ICBR Lisbon 2018, Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages,* November 2018, https://www.researchgate.net/publication/349440264_An_innovative_strategy_to_increase_the_resilience_of_flood-vulnerable_communities_while_reducing_risk_of_population_displacement_and_psychological_trauma.

96 Nicole Glenn et al., "Post-flooding community-level psychosocial impacts."

97 Cheslatta Carrier First Nation sign reconciliation agreement with province," *CBC News*, September 13, 2016, https://www.cbc.ca/news/canada/british-columbia/cheslatta-carrier-nation-1.3759220

98 The Canadian Press, "BC First Nations say Chilcotin River landslide, flood hit heritage sites, salmon," *CTV News*, August 8, 2024, https://bc.ctvnews.ca/b-c-landslide-and-flood-damages-cultural-sites-says-williams-lake-first-nation-1.6993696

99 Ibid.

100 Vani Goel, Site Visit to BC, March 2024, *Personal Communication*.

101 Wendy Stueck, "With Climate Disasters on the Rise."

102 Shirley Thompson et al., "Lake St. Martin First Nation."

103 Rochelle Baker, "Salvaging the Sacred from Climate Disaster," *Mother Jones*, April 16, 2023, https://www.motherjones.com/environment/2023/04/salvaging-the-sacred-from-climate-disaster/

104 Alexa Holder, Site Visit to Peguis First Nation, Manitoba, December 2023, *Personal Communication.*

105 Shirley Thompson et al., "Lake St. Martin First Nation."

106 Ibid.

107 Ibid.

108 Myrle Ballard and Shirley Thompson, "Flooding Hope: The Lake St. Martin Story," Culture Unplugged (video), 2012, https://cultureunplugged.com/documentary/watch-online/play/53590/flooding-hope-the-lake-st-martin-story

109 Shirley Thompson et al., "Displacement of Indigenous People."

110 Ibid.

111 Hilary Burton et al., "Health effects of flooding in Canada."

112 Myrle Ballard and Shirley Thompson, "Flooding Lake St. Martin First Nation Community: Impacts to and Future Community Plans for Sustainable Livelihoods," *Canadian Journal of Nonprofit and Social Economy Research* 4 (2013):43-65, https://doi.org/10.22230/cjnser.2013v4n1a129

113 Shirley Thompson et al., "Lake St. Martin First Nation."

114 Ibid.

115 Ibid.

116 Jill Macyshon, "Families still displaced nine years after First Nation flood," *CTV News*, June 8, 2020, https://winnipeg.ctvnews.ca/families-still-displaced-nine-years-after-first-nation-flood-1.4975266?cache=wpwecmoua%3FcontactForm%3Dtrue%3FclipId%3D1930095

117 Myrle Ballard et al., "Flooding Hope."

118 Ibid.

119 Ibid.

120 "Impacted Indigenous Communities Report #20," BCAFN, December 5, 2021, https://www.bcafn.ca/sites/default/files/docs/reports-presentations/05DEC2021_%20IndigenousImpactsReport.pdf

121 Tara Orange, "First Nations communities left in shambles following catastrophic flooding in the southern region of British Columbia," *Catalyst*, December 8, 2021, https://catalystmcgill.com/first-nations-communities-left-in-shambles-following-catastrophic-flooding-in-the-southern-region-of-british-columbia/

122 Ibid.

123 Vani Goel, Site Visit to Chawathil First Nation, British Columbia, March 2024, *Personal Communication*.

124 Gordon Robert Lyall, "'They smashed it right through our reserve': The Problem of Settler Consultation for Infrastructure on Chawathil IR4," *BC Studies* 207 (2020): 67-99, https://go.gale.com/ps/i.do?id=GALE%7CA643640884&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=00052949&p=AONE&sw=w&userGroupName=anon%7Eb7e1b992&aty=open-web-entry

125 Ibid.

126 Ibid.

127 Ibid.

128 Ibid.

129 Ibid.

130 Ibid.

131 Ibid.

132 Warren Cariou and Niigaanwewidam James Sinclair, eds., *Manitowapow: Aboriginal Writings from the Land of Water* (Winnipeg, Manitoba: HighWater Press, 2011).

133 Ibid.

134 Ibid.

135 Albert Edward Thompson, *Chief Peguis and His Descendants* (Winnipeg: Peguis Publishers, 1973).

136 Ibid.

137 Warren Cariou et al., *Manitowapow.*

138 Albert Edward Thompson, *Chief Peguis and His Descendants.*

139 Ibid.

140 Alexa Holder, Site Visit to Peguis First Nation, Manitoba, December 2023, *Personal Communication.*

141 Tim Fontaine, "'It gets tiring': Manitoba First Nation wants long-term solution to flooding," *CBC News*, April 4, 2017, https://www.cbc.ca/news/indigenous/peguis-first-nation-manitoba-flood-1.4053712

142 Bartley Kives, "Peguis First Nation Declares State of Emergency over Flood-Induced Housing Shortage," *CBC News*, April 30, 2024, https://www.cbc.ca/news/canada/manitoba/peguis-state-emergency-housing-1.7188794.

143 "Archived: 2011 Manitoba flood: status of community rebuilding and numbers of displaced persons," *Government of Canada*, October 18, 2022, https://www.sac-isc.gc.ca/eng/1392046654954/1535122238673.

144 Ibid.

145 Bartley Kives, "Peguis First Nation Declares State of Emergency."

146 Alexa Holder, Site Visit to Peguis First Nation, Manitoba, December 2023, *Personal Communication.*

147 Ibid.

148 Ibid.

149 Ibid.

150 Rachel Bergen, "Peguis First Nation Members Thankful for Community Meal after Difficult Year of Flooding, COVID-19," *CBC News*, October 9, 2022, https://www.cbc.ca/news/canada/manitoba/peguis-first-nation-flooding-update-thanksgiving-1.6611751

151 Bartley Kives, "Peguis First Nation Declares State of Emergency."

152 Ibid.

153 Ibid.

part 2

Amphibious Architecture

CHAPTER 3

when the house floats

Indigenous communities are not just the inhabitants of the land they live in, they are its stewards, storytellers, and souls. Their lands and homes are passed down from one generation to another and are imbued with stories of their ancestors, struggles, and the rituals that define the community's sense of place. Flooding disrupts and disables this, severing this connection. The forced displacement and relocation rupture this sacred connection among the land, water, and people, which leads to a sense of loss, both tangible and intangible. Employing resilience measures that allows such communities to remain on their homelands, not only to protect their physical being but also to preserve their cultural heritage and identity. Thus, this thesis advocates for a resilience-in-place strategy without displacement through the implementation of amphibious architecture, specifically for the Indigenous communities. This is done by recognizing that it is an opportunity for innovation and collaboration by reimagining our built environment to co-exist with water to create more resilient communities that are better equipped to recover from a flood event.

3.1 Resilience in Place Strategy for First Nations

For Indigenous communities, the struggle to remain on their homelands while facing increasing flood risks is not just a technical challenge—it is an expression of resilience and cultural survival. As discussed previously in Chapter 2, the consequences of displacement extend far beyond the physical sphere, affecting both the cultural and psychological well-being of Indigenous peoples. These narratives of resilience in place are intertwined with the ongoing fight to preserve the cultural heritage, community identity, and the sacred connection to the water and land. It is not simply about relocating homes and rebuilding lives in a new location; it is much more than that. The land is more than a geographical place—it is a living entity that holds the stories, memories, and spirits of the ancestors. For many such communities, the land is intricately linked to their practices, languages, and spiritual beliefs, forming the bedrock of their identity. This connection is not easily replaceable or transferrable. When these communities are forced to leave their traditional territories permanently, they are not just leaving behind their houses, but a significant part of their cultural identity and themselves. Additionally, the residents on Indigenous reserves who are facing damage to their homes because of floods usually do not have anywhere else to go. For them, the stakes are high, and the conventional approach of relocating communities to safer ground fails to address the unique needs and cultural values of such communities. Remaining on their land, if they wish, is not only a matter of survival but also an assertion of their right to protect and nurture their heritage, culture and identity in the face of environmental threats.

Thus, the **resilience-in-place** strategy emerges as a vital approach, offering a way for communities to confront environmental challenges while maintaining their deep-rooted connections to the land. This approach allows for these communities to remain on their homeland, preserving their

cultural heritage and ensuring that future generations can continue to practice their traditions in these places where their ancestors once walked.[i] Hence, amphibious architecture surfaces as a solution within the resilience-in-place approach. This innovative strategy of flood mitigation architecture does not seek to control or resist the floodwater [as do strategies discussed in Chapter 1.3, pg. 22], but rather to embrace it and adapt to it. Unlike customary flood mitigation strategies that rely on barriers and levees to keep the water out—often with disastrous consequences when they eventually fail—amphibious architecture acknowledges that flooding will happen and offers a way to coexist with the floodwater (Figure 3.1).

Additionally, the principles of amphibious architecture align with the Indigenous worldviews, which emphasize living in harmony with the environment. For many First Nations, the land and water are not something to be conquered but sacred elements of a balanced ecosystem. Traditional teachings often speak of the importance of respecting the natural world, and

---

i The *Royal Commission on Aboriginal People* summarizes colonialism with one word—displacement.[1] Due to colonization, many Indigenous communities were forcibly relocated from their ancestral lands, disrupting their connection to place and culture. Prime land occupied by Indigenous peoples was confiscated for settler use, while Indigenous communities were relocated to "swampy and other non-desirable land." Forced relocation of Indigenous reserves occurred throughout Canada. For example, the James Cree and Inuit of Quebec were forced to relocate their reserves due to hydro development that caused flooding of their lands. Similarly, many Innu communities in Labrador were forced to relocate in 1948, when Newfoundland joined Canada.[2]

Others, however, remain on their homelands, where they continue to uphold their traditions and cultural practices. For these communities, staying on their land represents a powerful act of resilience and cultural continuity, allowing them to maintain a deep connection to their environment and pass down their heritage to future generations. The resilience-in-place strategy emerges as a fitting approach for both communities who have stayed on their land and those forced to relocate, enabling them to confront environmental challenges while preserving their connection to their cultural roots.

understanding that people are but one part of a bigger, interconnected web of life. Hence, the synergy between amphibious architecture and Indigenous worldviews is a reaffirmation of resilience. For centuries, Indigenous people have adapted to the changing environmental conditions through sustainable practices that respect the power of nature. Similar in many ways, amphibious architecture is a modern extension of these ideas, offering a way to navigate the challenges of climate change without displacement. By choosing to implement amphibious architecture, First Nations can assert their right to determine how they will respond to the threats posed by flooding in their own homelands, in a manner that aligns with their cultural beliefs. Hence, amphibious architecture, when implemented with respect for Indigenous knowledge and values, can become a powerful tool for resilience, cultural survival, and self-determination. Thus, the resilience-in-place strategy, in the form of amphibious architecture, offers a transformative approach to addressing the unique challenges faced by First Nations in flood-prone areas while ensuring that their connection to the land remains unbroken.

3.2 What is Amphibious Architecture?

Amphibious architecture is an adaptive approach to building design that challenges traditional flood mitigation methods. The concept allows "otherwise-ordinary structures to float in place temporarily"[3] when flooding occurs. It allows for architecture and urban planning to work with nature and combat these issues while reducing the risk of displacement when the floodwaters are not accompanied by high flow speeds. During a flood, the house rises to the necessary height to stay safely above the water and then returns to its original position as the water recedes.[4] Hence, it is a strategy that lets the house float when it needs to and remain on the ground otherwise, unlike floating houses that are always floating or traditional houses that are always on the land. It is *amphibious*—suited for both land and water.

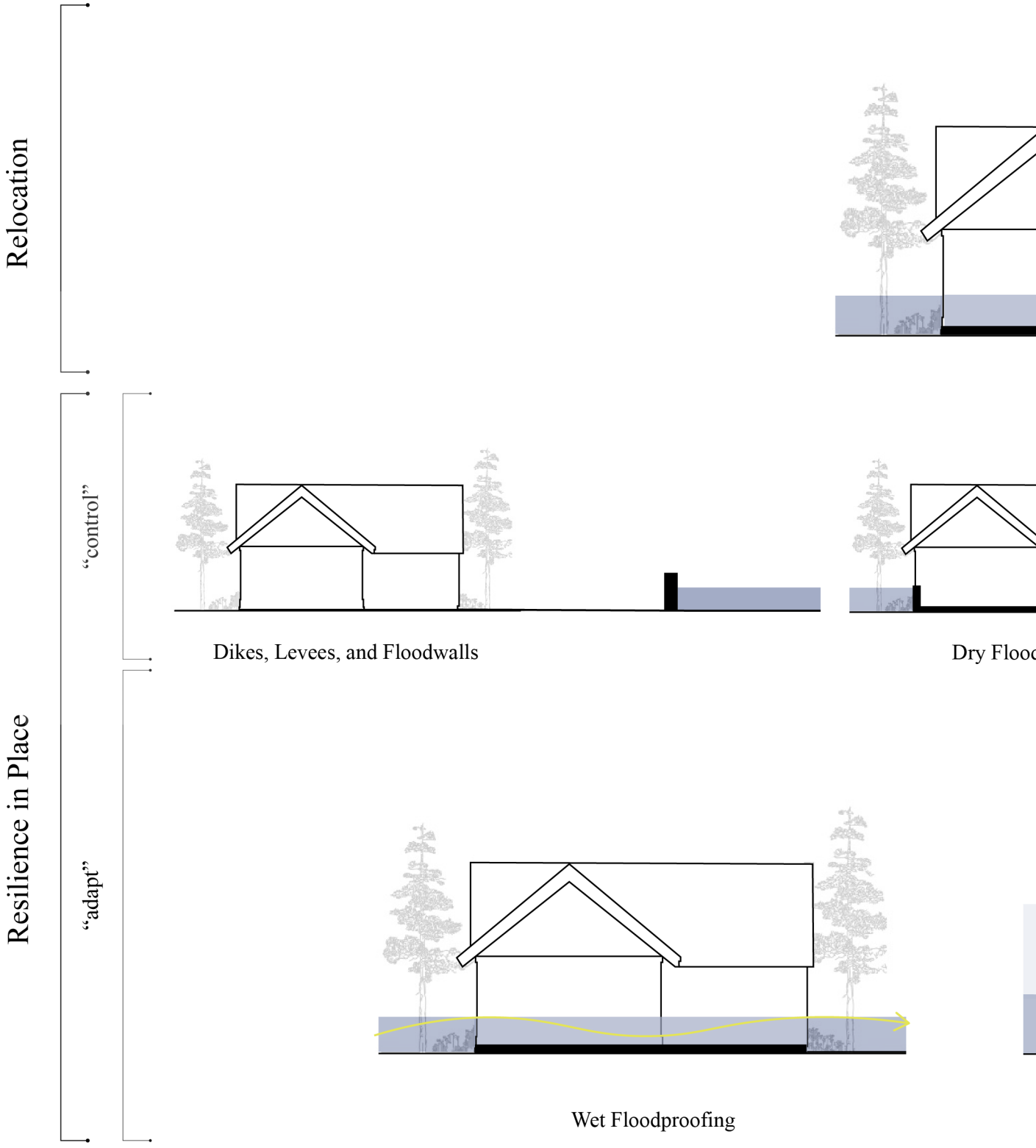
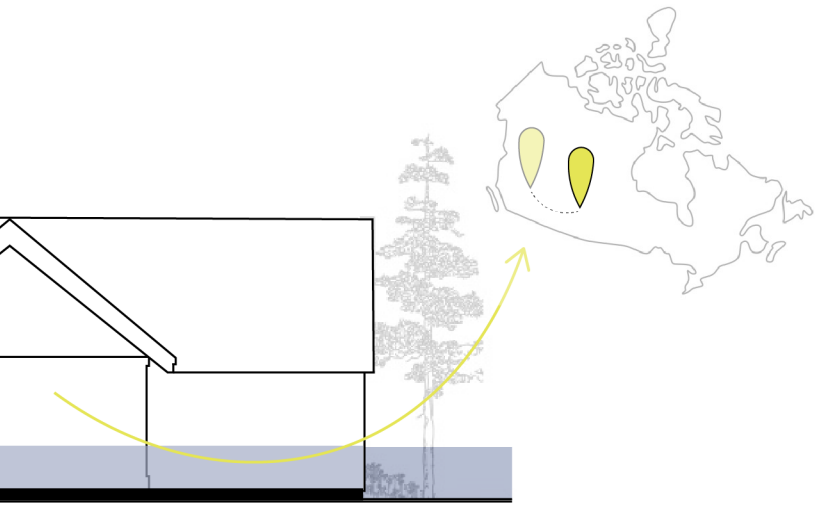
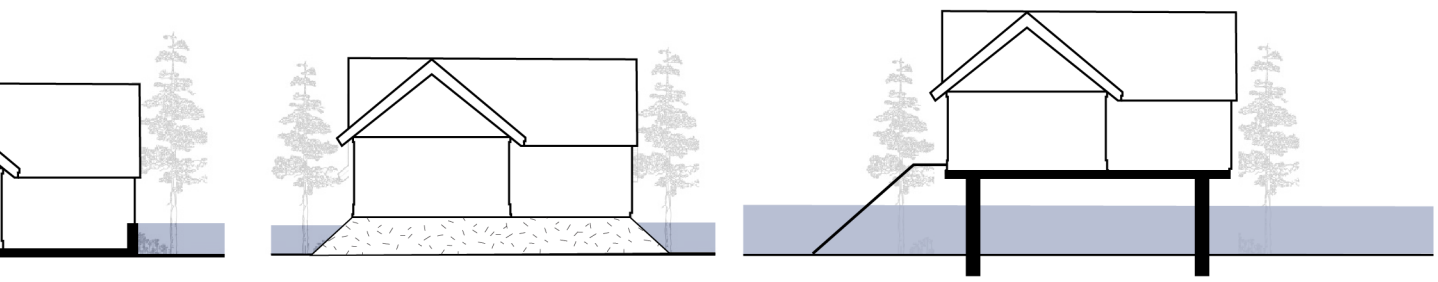


Figure 3.1: Relocation vs Resilience-



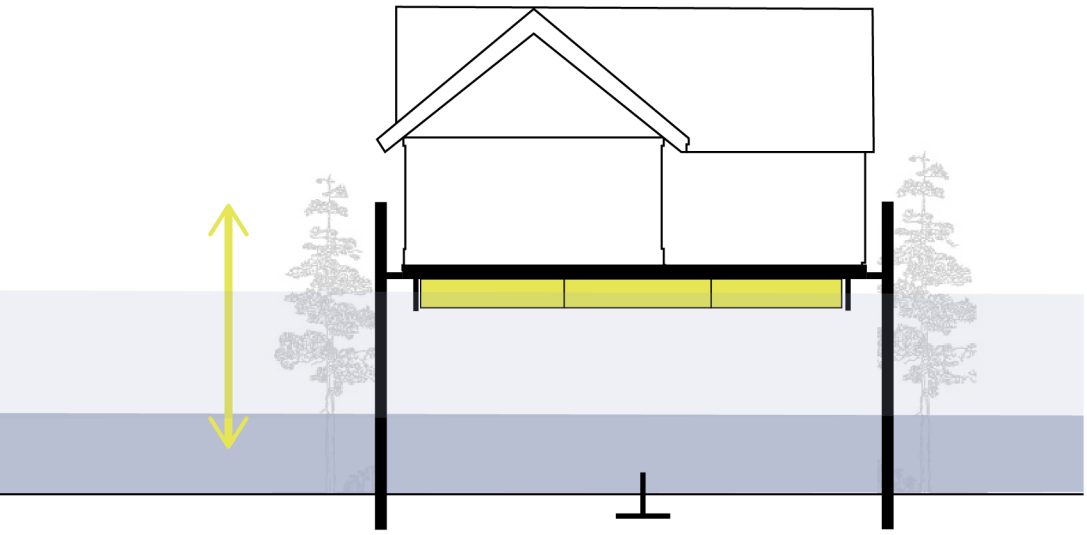
Relocation



dproofing

Mounding

Permanent Static Elevation



Amphibious Architecture

in-Place Approach (Image by author).

Amphibious architecture relies on Archimedes' principle, which states that an object submerged in a fluid experiences a buoyant force equal to the weight of the fluid it displaces. Consequently, the house floats because the floodwater beneath it exerts an upward force. When the water level rises during a flood event, the house displaces water equal to its own weight, which in turn creates a buoyant force that lifts the house, allowing it to float. This phenomenon is made possible by four components of the amphibious construction (Figure 3.2), which are:

1) buoyancy elements

2) vertical guidance posts

3) flexible utility connections

4) debris screen (occassionally necessary)

The components are described in detail in the following pages.

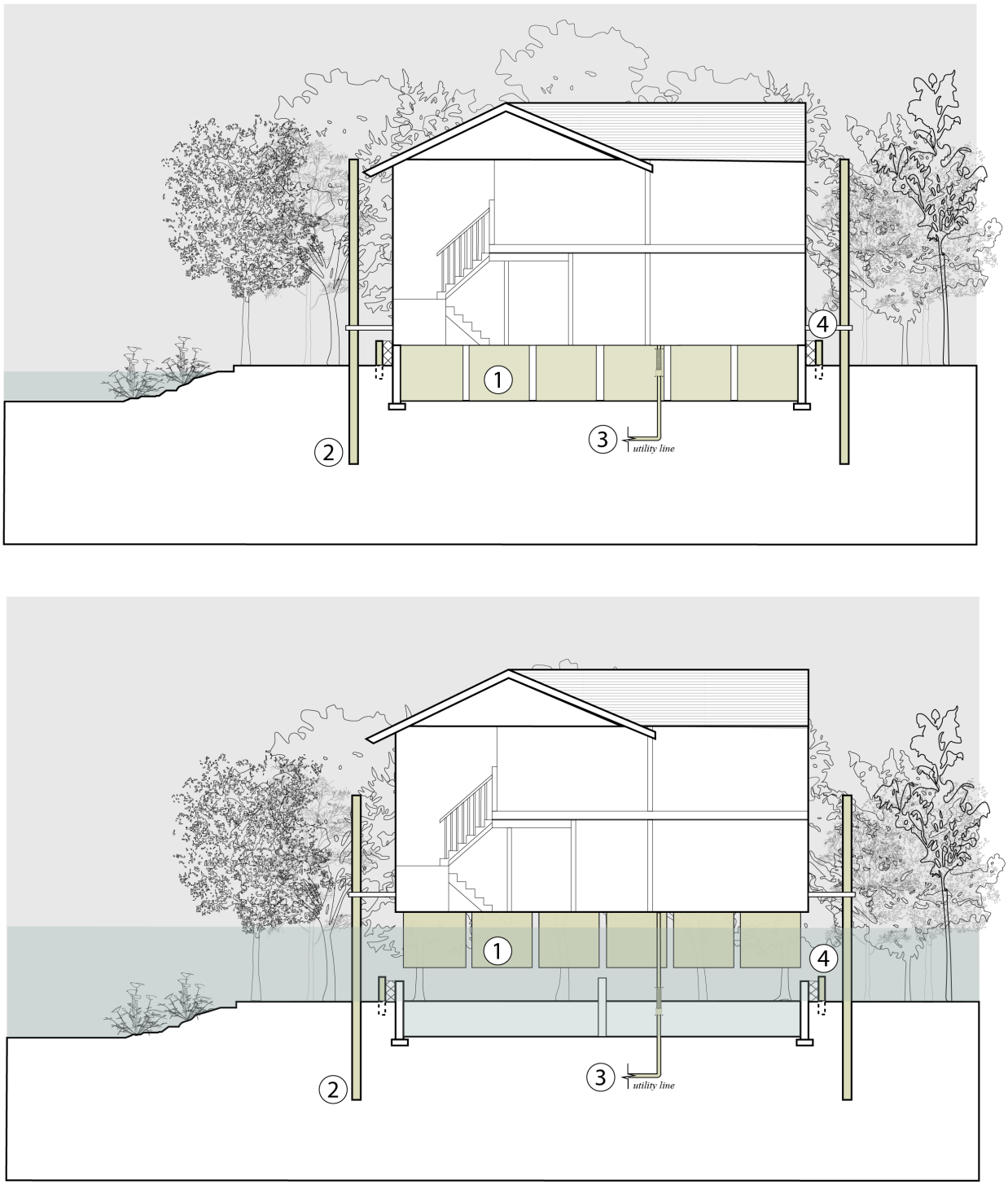


Figure 3.2: Amphibious architecture, on dry land and water respectively (Image by author).

An amphibious foundation contains a system of **buoyancy elements** underneath the building that provides the flotation. Its purpose is to displace enough water to support the weight of the building.[5] It is usually made of buoyant lightweight and waterproof materials such as foam blocks, wood logs, manufactured dock floats, airtight barrels or recycled plastic water bottles (Figure 3.3).[6] For designing an effective buoyant foundation, dead loads, live loads, load path for the uplift, safety measures, quantity of buoyancy elements, and their distribution are important considerations.[7]



Figure 3.3: Buoyancy Elements Materials Precedents (collage by author).

The **vertical guidance posts** ensure that the building moves solely up and down when it floats during a flood, and comes back to its original location after the floodwaters recede. They are connected to the building using sleeves that enable the building to slide up and down freely.[8] They can be designed to the height required depending on the specific site and flood predictions. Typically, the vertical guidance posts are evenly distributed near the corners of the building. To design an effective vertical guidance system, it is crucial to consider factors such as water velocity, wind load, flood depth, flood duration.[9] Additionally, a centering device can be utilized to ensure that the building has returned to exactly the same position when back on the ground[10] (Figure 3.4).



Figure 3.4: Vertical Guidance Post and Centering Device Precedents (collage by author).

Another important aspect to be considered is the **utility connections** while the house is floating. Utilities need to be designed keeping in mind both of the conditions, when the house is on land and when it is floating. This can be done by either manually disconnecting, providing flexible piping or self-sealing "breakaway" connections that disconnect themselves when the house rises and would have to be reconnected once the house is back on the ground (Figure 3.5). These self-sealing connections can be used for sewer and gas lines that disconnect when the house starts to rise, whereas water and electricity lines are replaced with long, flexible, coiled connections that can extend when the house rises.[11]

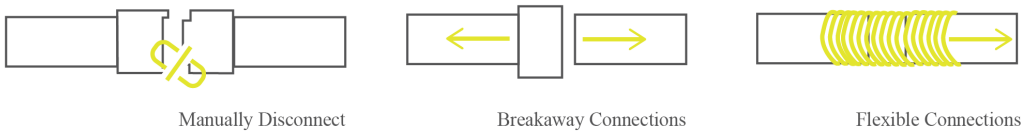


Figure 3.5: Utility Connections (Image by author).

Additionally, under some circumstances, it is recommended for amphibious construction to have a **debris screen** around the perimeter of the building as a line of defense for any large pieces of branches, tree trunks or debris that come with the flood during an event. A debris screen is made of porous materials designed to filter out unwanted debris while allowing water to flow freely (Figure 3.6). This prevents larger objects from accumulating against the building, which could potentially cause damage or hinder the structure's ability to float effectively. However, the necessity of debris screens depends on the specific characteristics of the house and the surrounding area, as well as the local flood conditions



The debris screens—both lower (water) and upper (wind)—at the base of an amphibious home in Old River Landing, Louisiana

DEBRIS SCREEN

Figure 3.6: Debris Screens (Source: The Buoyant Foundation Project).

What are the advantages of amphibious architecture?

Amphibious architecture offers a promising solution to the challenges faced by communities in flood-prone areas compared to customary flood mitigation alternatives. One of the major advantages of this strategy is its adaptability to rising water levels, as opposed to approaches such as permanent static elevation. When houses are elevated on stilts permanently, extreme floodwaters can exceed the raised height, leaving the structure vulnerable. In contrast, amphibious construction offers a flexible solution, adjusting to varying water levels by floating with the rising floodwaters.[12] The vertical guidance posts can also be adjusted if need be through adding extensions to the top of the posts when height adjustments are needed, allowing for smooth adaptability. Additionally, amphibious architecture is a less disruptive option for residents. According to current best practices, residents would be required to evacuate[i] during a flood event for safety. The design of amphibious homes ensures that when they return, their houses and belongings have remained intact.[13] This is in contrast to the usual approaches, where floods often lead to intensive water damage, destroying the residents' personal belongings and requiring significant time and resources for repairs. This means that in an amphibious home, the residents can return home without the burden of extensive clean-up or the emotional toll of losing their possessions and sentimental valuables. This ability to maintain the integrity of their home not only reduces the physical disruption, but also provides peace of mind, knowing that their spaces and belongings are protected.

i *Evacuation* is necessary as a precautionary measure, even in amphibious homes, to ensure the safety of residents during extreme flood events. While amphibious architecture is designed to protect the structure and its contents, unpredictable environmental conditions—such as rapidly rising water, strong currents, or debris—can still pose significant risks. Evacuating ensures that residents are out of harm's way until they can return.

Amphibious architecture not only minimizes long-term displacement and provides social benefits for the residents, but also offers significant economic advantages. Unlike the costly process of permanently elevating a house, which requires replacement of the entire foundation system, amphibious architecture allows for retrofitting the existing foundation with the amphibious components.[14] Cost comparisons indicate that an amphibious retrofit may range from 20% to 45% of the cost of permanent static elevation renovations.[15] Thus, this approach not only reduces expenses but also enables a more efficient and less invasive solution to flood resilience, helping communities protect their homes with minimal disruption possible.

What are the limitations of amphibious architecture?

While amphibious architecture offers innovative solutions for flood-prone areas, it also comes with a few limitations that must be considered. The first limitation is the type of flooding. Amphibious architecture is suitable for overland flooding, which occurs when water rises slowly without exerting significant force. This makes it ideal for areas prone to rising floodwaters but not for situations where floods involve high-speed water currents. This is because rapid water currents could compromise the stability of the structure, and can potentially lead to structural damage or failure.

The second limitation is the type of foundation on which amphibious architecture can be implemented effectively. It is unsuitable for slab-on-grade foundations because these systems do not accommodate the integration of essential buoyancy elements. For such homes, the building would need to be lifted off the slab, provided it is structurally sufficient. Alternatively, a new floor with buoyancy components would need to be constructed, making the process more complex and expensive. On the other hand, amphibious architecture is best suited for structures with unused crawlspaces, where there is enough room to install the buoyancy elements. While amphibious construction can be adapted for structures with basements, it is not preferred. This is

because it renders the basement unusable, and compromises the functional space within the building which may not be acceptable for homeowners or residents who rely on the basement space for storage or additional living space.

However, despite its limitations, amphibious architecture still remains an appropriate and effective strategy due to its adaptability, minimal disruption to the ecosystem, land, preservation of cultural heritage and spiritual connection to the environment. It provides a culturally empowering and innovative approach for First Nations housing in flood-prone areas supporting the long-term safety and well-being of the communities.

3.3 Case Studies

The concept of amphibious housing, while gaining attention in modern flood resilience strategies recently, has historical roots that stretch back centuries. Communities around the world have long adapted their homes to survive in flood-prone areas. For instance, in Thailand, vernacular amphibious construction techniques[16] involved placing bundles of bamboo under houses and tying the houses to the nearby trees to protect the structure from the damage of incoming floods. Similarly, the residents of Old River Landing in Louisiana have developed innovative amphibious foundations over the past fifty years,[17] demonstrating how vernacular knowledge can inform contemporary solutions.

In 2006, Elizabeth English founded the *Buoyant Foundation Project* (BFP) to support the recovery of New Orleans after the tragic aftermath of Hurricane Katrina. It started as a project aimed to develop practical, affordable, and sustainable amphibious retrofit solutions for the shotgun houses in New Orleans to prevent further flood damage and the destruction of neighbourhood character.[18] Since then, BFP has evolved to address

flood resilience in other vulnerable locations around the world as well. It has expanded its focus beyond post-Katrina New Orleans, exploring applications of amphibious architecture in various regions such as the communities in the Mekong Delta in Vietnam.

Furthermore, amphibious architecture has been explored more recently in different parts of the world such as New Orleans, Netherlands, the UK, Bangladesh, Thailand, Vietnam, Poland, India, and now in Canada (Figure 3.7). Each of these regions offers unique challenges and opportunities for implementing amphibious strategies, reflecting local environmental conditions, cultural practices, and community needs.

To illustrate the adaptability and effectiveness of this strategy, the following case studies highlight the diverse applications and successes of amphibious housing in these regions. By examining these examples, we can gain valuable insights into how amphibious architecture can play a vital role in contemporary flood resilience efforts.

3.3.1 Old River Landing, Louisiana

This is a recreational community situated along one of the oxbow lakes formed by the Mississippi River in Louisiana in the United States, sitting outside of the protected side of Louisiana's levee system, exposing it to severe flooding. Due to frequent flooding, residents of the community have employed innovative solutions to protect their homes from the floodwater for over fifty years.[19] Residents in this areas adopt amphibious architecture as a practical solution for flood resilience. The absence of enforcements of building codes allows them to design homes that can effectively adapt to their environment, prioritizing safety and resilience without the constraints of conventional regulations.[20] The homes are raised to an elevation of 3-4 feet [1-1.3m] above the ground level and have buoyant elements (such as large blocks of EPS) underneath them as the amphibious foundation,



Figure 3.7: Amphibious architec



cture globally (Image by author).

attached using a steel frame, and long posts or pipes are put in the ground near the corners of the house serving as the vertical guidance system[21] (Figure 3.8). These retrofits were conceptualized and constructed by the homeowners in the community, some of whom empirically determined the effectiveness of their designs by observing what worked and what failed.[22] Utility connections are also hooked up with detachable connections that can be disconnected before the floods arrive, and put back together once the floodwaters have receded.[23] Most of these are seasonal homes in which the residents do not stay during the flood; however, the homes are safe and sound when they come back with minimal damage to their property and belongings. This process of preparing the house to float by disconnecting it can be accompalished in under a half hour in some cases, such as the Old River Landing restaurant[24] depending on various factors. However, the actual time required may vary based on the specific circumstances and conditions at the time.

While the customary approach is raising the homes on stilts in the community, some residents felt the cost and the changes to their lifestyle were not worth it.[25] The Old River Landing's mainstay bar and restaurant, owned by Jacques LaCour, also floats when the floods come. This approach has greatly benefited his business, as the building floats during floods, preventing any water damage. As a result, no post-flood repairs are necessary, allowing for immediate reoccupancy where LaCour can reopen his business almost immediately after the waters recede.[26] Hence, these amphibious solutions in the community are designed to be low cost and as effective as possible with a DIY (do-it-yourself) approach.



Figure 3.8: Amphibious houses in Old River Landing (Source: The Buoyant Foundation Project).

3.3.2 Maasbommel, Netherlands

The Netherlands has a long-standing history of mitigating flooding. With 60% of the country lying below sea level, the development and implementation of flood-resilient infrastructure have become integral to Dutch culture.[27] The "Room for the River" program is a comprehensive initiative addressing flood risks. As part of this larger effort, 14 floating houses and 32 amphibious homes were constructed in 2005 in Maasbommel, Gelderland province, along the Maas River, highlighting innovative strategies for flood resilience.[28] The houses are made of light timber-frame construction with concrete boxes at the bottom (Figures 3.9 and 3.10); they can survive water level fluctuations up to 18 feet [5.5 metres].[29] They have steel columns planted into the ground which extend up to 12 meters above the NAP level[i] (Normaal Amsterdams Peil).[30] The houses have flexible utility connections and pipelines, long enough to remain connected even when the water rises.[31] In 2011, the houses floated during their first flood since construction, demonstrating the successful implementation of the technology of amphibious architecture. However, the project encountered legal challenges after construction, stemming from ambiguities in the legislation and non-compliance with zoning regulations,[32] which prevented individuals from obtaining building permits. These issues were unrelated to the construction or the building itself.

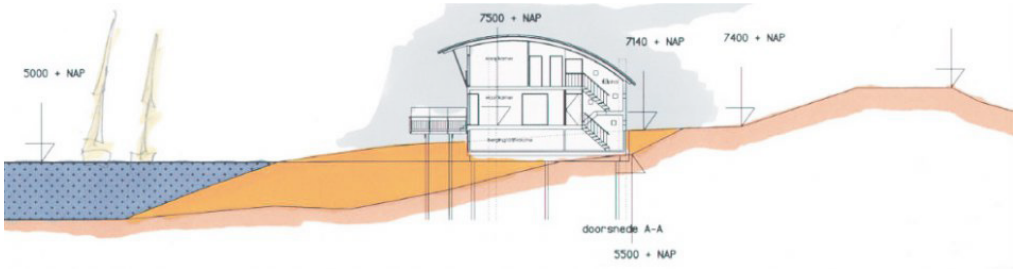


Figure 3.9: Section of the amphibious houses in Maasbommel (Source: Factor Architecten).

i *Normaal Amsterdams Peil:* It is a reference level used in the Netherlands for measuring elevation and flood risk. The NAP serves as the baseline for determining the height of land, buildings, and other structures concerning sea level and flooding.



Figure 3.10: Amphibious houses in Maasbommel (Source: The Buoyant Foundation Project [top], Factor Architecten and Boiten Ingenieurs [bottom]).

3.3.3 The Mekong River Delta, Vietnam

In Vietnam, water plays a crucial role in daily life, with a network of rivers and canals supporting transportation and floating markets, as well as community activities. However, the country faces significant climate change challenges, making flood mitigation strategies a priority. The Mekong Delta is a low-lying plain, located up to three meters above sea level, and is highly susceptible to frequent and severe flooding.[33] Specialists have predicted that sea levels will rise by 2.6 feet [0.8 m] by 2100, which would cause 40 percent of the Mekong Delta to be submerged, affecting one-third of the regional population.[34] In response to these challenges, the BFP developed and constructed four amphibious retrofits in the Mekong Delta for their rice farmer residents in 2018 (Figure 3.11). The buoyancy was achieved using barrels or bundled recycled jugs and tied up to the underside the house using ropes. Additionally, centering devices were installed, ensuring that the house could not shift horizontally and would return back to its exact original position after flooding.[35] Each of the four retrofits were slightly different in design features and materials utilized to allow for comparisons of their robustness and overall performance. Four months after construction, during the monsoon season of 2018, all four houses floated as anticipated, as the floodwaters rose. This project in Vietnam not only successfully demonstrated the technology of amphibious architecture but has also highlighted the potential of simple, locally-sourced materials and local labour to provide effective, sustainable flood protection for vulnerable communities.



Figure 3.11: Amphibious houses in Mekong River Delta, Vietnam (Photo by Elizabeth English [top] and Pham Duy Tien [bottom]).

3.4 Summary

Amphibious architecture, as a resilience-in-place strategy, offers a transformative approach to flood mitigation, especially for Indigenous communities whose cultural identity is deeply tied to their lands. This architecture not only preserves physical spaces but also safeguards the intangible heritage that defines these communities. By allowing homes to rise with the incoming floodwaters and later return to their original position safely, this strategy embraces a harmonious relationship with water and the environment, aligning with Indigenous worldviews that see land and water as "gifts from the Creator." Thus, amphibious architecture acknowledges that it is going to flood, but we do not need to be afraid.[37] By accommodating for potential floods, it reduces displacement, trauma, and the loss of cultural heritage.

Through case studies from Louisiana, the Netherlands, and Vietnam, we have seen how amphibious architecture has successfully adapted across different contexts—whether it is vacation homes in Maasbommel, or low cost retrofits using recycled materials in the Mekong Delta—demonstrating its effectiveness and versatility. It has time and again proved itself not only for the technical feasibility, but also for the cultural sensitivity and economic advantages of this approach. However, the full potential of this strategy will only be realized once it can easily be adapted and adopted across the globe. That will only happen once it is supported by appropriate policies and legislation. Hence, as we move forward, it is important to facilitate the integration of these innovative solutions into broader flood resilience and mitigation strategies, ensuring that at-risk communities, such as the Indigenous communities, can continue to thrive on their homelands.

1 Royal Commission on Aboriginal Peoples, "Reports of the Royal Commission on Aboriginal Peoples," *Library and Archives Canada* 1 (1996): 132, http://data2.archives.ca/e/e448/e011188230-01.pdf

2 Shirley Thompson and K. Suzuki, "Displacement of Indigenous People in Canada under the Indian Act: Participatory Video with Lake St. Martin and Little Saskatchewan First Nations on Flood Impacts," *Journal of Geoscience and Environment Protection* 10, (2022):242-264, https://www.scirp.org/journal/paperinformation?paperid=121526.

3 Elizabeth C. English, Carol J. Friedland and Fatemeh Orooji, "Combined Flood and Wind Mitigation for Hurricane Damage Prevention: The Case for Amphibious Construction," *Journal of Structural Engineering* 143, 6 (2017), https://doi.org/10.1061/(ASCE)ST.1943-541X.000175

4 Ibid.

5 Łukasz Piątek and Elizabeth C. English, "Amphibious Structures for Smart Flood Risk Reduction and Climate Change Adaptation." In *The Routledge Companion to Smart Design Thinking in Architecture & Urbanism for a Sustainable, Living Planet*, edited by Mitra Kanaani (London: Routledge, 10 November 2024), 511-526. https://doi.org/10.4324/9781003384113

6 Ibid.

7 Elizabeth English, The Buoyant Foundation Project, "Draft of the Guidance Document for Amphibious Construction," *Prepared for The National Research Council of Canada* (publication pending, used by permission).

8 Łukasz Piątek and Elizabeth C. English, "Amphibious Structures for Smart Flood Risk Reduction."

9 Elizabeth English, The Buoyant Foundation Project, "Draft of the Guidance Document."

10 Elizabeth C. English, Lee Chan, Brent Doberstein and Teresa Tran, "Development of Amphibious Homes for Marginalized and Vulnerable Populations in Vietnam," WW216 Final Report—Executive Summary for the Global Resilience Partnership, July 2020.

11 Elizabeth C. English et al., "Combined Flood and Wind Mitigation."

12 Elizabeth English, Natasha Klink, and Scott Turner, "Thriving with water: Developments in amphibious architecture in North America," *FLOODrisk 2016–3rd European Conference on Flood Risk Management* (2016), https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_13009.pdf

13 Elizabeth C. English et al., "Combined Flood and Wind Mitigation."

14 Elizabeth English, Michelle Li, Rebecca Zarins, Tobias Feltham, "The Economic Argument for Amphibious Retrofit Consruction," Paper Presented at the 8th International Conference on Building Resilience, 2018.

15 Ibid.

16 Elizabeth English, Meiyi Chen, Rebecca Zarins, Poorna Patange and Jeana C. Wiser, "Building Resilience through Flood Risk Reduction: The Benefits of Amphibious Foundation Retrofits to Heritage Structures," *International Journal of Architectural Heritage*, 2019, https://doi.org/10.1080/15583058.2019.1695154

17 Ibid.

18 "The Origins of the Buoyant Foundation Project," *The Buoyant Foundation Project*, https://www.buoyantfoundation.org/about-us

19 "Old River Landing," *The Buoyant Foundation Project*, https://www.buoyantfoundation.org/old-river-landing

20 Elizabeth English, "Amphibious Foundations and The Buoyant Foundation Project: Innovative Strategies for Flood Resilient Housing," *International Conference on Urban Flood Management, UNESCO-IHP and COST Action C22*, Paris, France, November 25-27, 2009.

21 Ibid.

22 "Old River Landing," *The Buoyant Foundation Project*.

23 Ibid.

24 Ibid.

25 Saskia De Melker, "Louisiana Fishermen Pioneer Floating Architecture," *PBS Newshour*, https://www.pbs.org/video/pbs-newshour-louisiana-fishermen-pioneer-floating-architecture/

26 Ibid.

27 Mattijs Loor, "Amphibious housing in Maasbommel, the Netherlands," *Climate ADAPT*, June 7, 2016, https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands

28 Ibid.

29 "Maasbommel," *The Buoyant Foundation Project*, https://www.buoyantfoundation.org/maasbommel

30 Factor Architecten, "Project Review: Floating Homes 'De Gouden Kust' Maasbommel, the Netherlands, 1998-2005," *Climate ADAPT*, February 2011, https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands/11310092.pdf/@@download/file

31 Ibid.

32 "Maasbommel," *The Buoyant Foundation Project*.

33 Elizabeh English et al., "An innovative strategy to increase the resilience of flood-vulnerable communities while reducing risk of population displacement and psychological trauma," *Proceedings of 8th International Conference on Building Resilience – ICBR Lisbon 2018 Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages,* March, 2019, 278-285, https://3a5cb13e-4d06-41e6-9768-4b9fc2524ae2.filesusr.com/ugd/954133_d7043527605f40d69d220d1345c724a7.pdf

34 Ibid.

35 Ibid.

36 Elizabeth English et al., "Development of Amphibious Homes for Marginalized and Vulnerable Populations in Vietnam."

37 Ibid.

part 3

Policies, Regulation and Application of Amphibious Architecture

CHAPTER 4

bridging policy and water

According to the *Assembly of First Nations* (AFN), Indigenous communities are twenty-three times more likely to experience homelessness than any other population in Canada,[1] highlighting a significant disparity in housing stability and access. Housing and its related resources are key to the economic and social well-being of a community. Shaw A-in-chut Atleo, former National Chief of the AFN, described the situation as "substandard and deplorable," with current housing programs unable to meet the growing demands and plagued by issues such as overcrowding and deterioration that is due to "poor construction and impacts from mould."[2] This alarming reality underscores the urgent need for comprehensive and effective housing policies that not only address the unique challenges faced by Indigenous communities in Canada but also bridge this tremendous housing gap.

Policies, legislation, and regulations are central in shaping the housing landscape worldwide. These frameworks are not merely administrative tools, but essential instruments that ensure the safety, dignity, and cultural preservation of a community. For First Nations, Métis, and Inuit in Canada—the three distinct Indigenous groups formally recognized—these structures are vital in framing their relationship with government, especially around land and housing.

In Canada, only individuals registered with Indigenous Services Canada (ISC) and holding "Indian Status" are permitted to live on reserves—the parcels of land designated by the federal government to be used and occupied by the Indigenous people.[3] Although Inuit and Métis are recognized as Indigenous, they are not eligible to register with ISC, meaning on-reserve housing is specifically designated for registered First Nations.[4] According to the 2021 census, 40.6% (over two-fifths) of First Nation peoples live on-reserve,[5] emphasizing the importance of addressing housing needs within these areas.

As the community's housing needs evolve, it is essential that plans to address these needs adapt accordingly.[6] Effective housing policies can bridge the gap between traditional practices and changing modern needs, fostering environments where the heritage and the contemporary can coexist harmoniously. Integrating strategies like amphibious architecture offers a promising solution to the unique challenges faced by First Nations on floodplains [refer to Chapter 2.1, pg. 37]. By examining current policies and exploring improvements, we can create housing that respects and upholds the rich cultural heritage of Indigenous peoples while addressing challenges such as climate change.

4.1 Existing Policies and Regulations for Housing on Indigenous Reserves

In 2019, the Government of Canada released the National Housing Strategy, declaring housing to be a fundamental right, and acknowledging that having an affordable and safe place to live provides individuals and families with the environment necessary to thrive, develop, and maintain their dignity.[7] Effective housing policy in Indigenous communities is essential for Indigenous land development and the well-being of the communities. There are some existing policies and regulations in place, with responsibility for regulating housing on reserves shared by First Nations communities,

the federal government, and agencies such as the former *Aboriginal Affairs and Northern Development Canada* (AANDC) and *Canada Mortgage and Housing Corporation* (CMHC). However, there is no clarity in the respective roles and responsibilities of each of these stakeholders concerning housing. In the following sections, we will examine some of the relevant policies and strategies for housing on Indigenous reserves.

4.1.1 Federal and Provincial Building Code

While the First Nations are responsible for providing and managing housing on-reserve, the federal government supports many housing programs through funding.[8] However, it is the responsibility of each community to ensure compliance with applicable building codes.

The **National Building Code** (NBC) of Canada serves as a model code, offering guidelines to ensure the safety and health of occupants by regulating building construction and materials. While NBC is a federal model, it only holds legal status when adopted by the provinces.[9] For example, provinces like Ontario and British Columbia have developed their own codes based on the NBC, while others, such as Nova Scotia and Manitoba, have adopted NBC with supplementary laws and regulations.[10] In CMHC-funded projects, NBC serves as the minimum standard of compliance. Since April 2014, First Nations must submit certificates of code compliance to CMHC at three key stages of construction.[11] However, adherence and enforcement during construction requires the active participation of First Nations communities. AANDC maintains that it is up to the First Nation's chief and council to ensure that housing is built according to building code standards.[12] CMHC representatives emphasize that it is the First Nation who has the jurisdiction with authority and is thus responsible for enforcing the said guidelines.[13]

In addition to federal and provincial building code compliance, CMHC-funded on-reserve housing programs require buildings also to meet the **Local Zoning and Building Bylaws and Regulations**,[14] which can vary by

province, municipality, land use, and construction practices. First Nations communities have the flexibility to adapt these local regulations to fit their specific contexts, ensuring that housing development respects both legal requirements as well as cultural practices.

Despite this framework, a report from the *First Nations National Building Officers Association's* (FNNBOA) highlights that only a small number of First Nations communities have enacted building codes, adopted housing and fire safety bylaws, and begun to enforce inspections.[15] Many communities do not perceive these responsibilities as within their jurisdiction. There is also ambiguity surrounding where the responsibility for maintenance of housing lies—the resident, First Nation's leadership, or the federal government.[16] Furthermore, the absence of clear technical specifications on how the NBC should be applied to First Nations communities adds to this uncertainty. This regulatory gap and lack of clarity on responsibilities have contributed to the persistent housing crisis in many Indigenous communities.

4.1.2 Indigenous Treaties and Regulations Affecting Housing

Indigenous treaties and land management laws shape housing policies on reserve, recognizing Indigenous peoples' rights to land, resources, and self-governance. The Government of Canada describes treaties as a "key component of Canadian nation-building" where a specific agreement tells a story of the relationship between the Crown and the Indigenous communities.[17] These treaties and agreements continue to evolve and adapt as Canada's commitment to a "new relationship" with the Indigenous peoples progresses.

Historically, it has been seen that the British Empire asserted its belief in the superiority of the British ideals and society during colonization, which forced the First Nations to abandon their traditional ways of life and conform to the British lifestyle. *The British North American Act of 1867*

was passed (also known as the Constitution Act, 1867), which made the federal government solely responsible for "Indians and land reserved for Indians."[18] This hindered their ability to self-govern and self-determine. After a long struggle, it was not until the passing of the **Indian Act of 1985** that First Nations regained the ability to self-govern on their own lands and make decisions for their own homes. Under Section 81 of the *Indian Act*, First Nations are provided bylaw-making authority for "the regulation of the construction, repair, and use of buildings, whether owned by the band or by individual members of the band."[19] However, not all reserve lands are administered under the Indian Act. Some communities have opted for the **First Nations Land Management Act of 1999** (FNLMA) to manage land independently. These communities are called Land Code First Nations.[20] They can develop land use bylaws under which they can adopt or adapt the existing building codes to create their own distinctive guidelines, with approval from Indigenous Services Canada (ISC). In December of 2022, the **Framework Agreement on First Nations Land Management Act** (FAFNLMA) replaced the FNLMA[21] to streamline land management and address inconsistencies with federal laws. The FAFNLMA also introduces clearer rules for dispute resolution and ensures that the Framework Agreement[i] takes precedence over conflicts.

In 1996, the **On-Reserve Housing Policy** was introduced, giving First Nations greater control over how, where, and when the housing funds are invested. While some First Nations opted out, such as many in British Columbia, others embraced the policy, receiving annual capital allocation based on population and remoteness of the community.[22] These funds cover various housing needs such as construction, renovation, maintenance,

i The *Framework Agreement* is a 1996 government-to-government agreement between Canada and the thirteen First Nations who wanted to take over the management of reserve lands from the federal government.

insurance, etc. BC First Nations that opted out of this policy became part of the Housing Support Program, which gives them access to housing funds.[23] These policies were introduced as a means to provide flexibility to target funding for specific housing needs that First Nations communities have. Hence, while national policies help provide funding mechanisms and regulatory structures, it is the self-determination of First Nations, through tools such as the FAFNLMA, that ensures housing solutions align with their distinct needs and traditions. This emphasizes the importance of continuing to develop housing strategies that respect Indigenous rights and promote self-governance in land and housing management.

While these policies aim to recognize Indigenous rights, their practical impact remains limited. First Nations face persistent challenges, including limited funding and jurisdictional ambiguities, which often hinder the full implementation of these frameworks. As a result, while these policies and agreements represent positive steps toward Indigenous self-determination, their capacity to fully address on-reserve housing remains an ongoing challenge.

4.1.3 Government Funded Institutions

The provision and management of housing on-reserve also involves the collaboration of several key government-funded institutions. These institutions are responsible for funding, policy development, and support services for essential housing needs of First Nations communities in Canada. The key players involved are CMHC and what was formerly known as Aboriginal Affairs and Northern Development Canada (AANDC), now split into Indigenous Services Canada (ISC) and Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC).

Canada Mortgage and Housing Corporation (CMHC) is responsible for administering the National Housing Act and maintains several programs specifically designed to improve housing conditions in Indigenous communities across the country. It provides specific programs to fund the construction, renovation, and management of social housing, even providing the First Nations communities with capacity development and training tools to assist in all stages of building construction.[24] CMHC also works in collaboration with national Indigenous organizations to offer support, autonomy, and control of Indigenous housing, by Indigenous peoples.[25] Additionally, CMHC's On-Reserve Non-Profit Housing Program supports First Nation communities by providing financial assistance to build affordable housing on-reserve as well as to apply for subsidies and loans to help finance it.[26] CMHC's involvement aims to ensure that the communities have access to the financial tools and resources needed to develop and sustain their housing infrastructure. While CMHC'S programs aim to improve housing conditions on reserve, communities still face housing shortages and encounter barriers in accessing adequate funding and support.

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) focuses on establishing and maintaining nation-to-nation relationships between Indigenous communities and the Canadian government.[27] CIRNAC plays a strategic role in policy development and legislative initiatives that impact housing on reserves. The institution is involved in land management, treaty negotiations, and other legal frameworks that influence the way housing projects are planned and executed within Indigenous communities.

Indigenous Services Canada (ISC) plays a central role in supporting First Nations housing initiatives on reserves. ISC provides direct funding to First Nations for the construction, renovation, and maintenance of housing.[28] It works closely with CMHC to administer housing and support housing projects in First Nations communities including new builds, retrofits, and renovations. ISC does not cover the full cost of housing; First Nations

communities and their residents are also expected to secure funding from other sources.[29] However, First Nations are only eligible to receive this funding from ISC if the construction complies with NBC along with other national building codes such as electric and plumbing.

While these programs and entities, such as the *First Nations Market Housing Fund* (FNMHF) and advocacy organizations like the Assembly of First Nations (AFN), are presented as solutions, the reality on the ground tells a different story. Despite decades of funding programs, partnerships, and advocacy, housing on reserves remains in a state of crisis. Overcrowding, substandard construction, and a chronic lack of resources are persistent issues that these programs have failed to resolve.

For instance, while the FNMHF promotes market-based housing through loan guarantees and capacity-building,[30] it assumes that residents have the financial stability to access loans—an assumption that ignores the economic disparities faced by many First Nations individuals. Similarly, while the AFN advocates for Indigenous housing rights[31], its capacity to enforce change is often limited by systemic barriers and a lack of sustained government accountability.

Thus, while these entities may highlight their efforts in glowing terms, the lived experiences of First Nations communities reveal a stark disconnect between policy and practice. The question remains: how much of this funding and advocacy actually translates into tangible improvements in housing conditions? Too often, these initiatives fall short of delivering the safe, quality housing that First Nations communities not only deserve but are entitled to.

4.1.4 Land Ownership Structure On-Reserve

Each First Nation has its own method of dealing with land and land tenure. Traditional land tenure means different things in different communities. Most First Nations communities in Canada have a mix of band-owned homes,

rental housing, and privately owned homes.[32] However, it is important to define what land ownership means in terms of Indigenous communities. Under the *Indian Act*, reserve lands are held by the Crown "for the use and benefit of the respective bands for which they were set apart."[33] Thus, "ownership" of lands on reserve is different than how it is characterized off-reserve. Under this Act, transfer of reserve lands to any entity other than the band or band members is also prohibited.[34]

In some First Nations communities, individuals can have a **Certificate of Possession** (CP) for their lands, while other land parcels are under what is known as **Common Band Land** (CBL). CP land is when an individual member of the community has been given an allotment by the Band Council.[35] However, the Government of Canada retains the legal title to the land, hence, the CP holder cannot get a mortgage.[36] Nevertheless, the CP holder is entitled to the use of their land. For example, Peguis First Nation in Manitoba has two types of land distinctions on-reserve—CP and CBL. There are about 7,500 acres of swamp land in the reserve, which was turned into CP land by the community leadership, i.e. the Chief and Council.[37] CMHC only provides a mortgage for a home in Peguis if it is on CBL.[38] In a discussion with members of the community, it was observed that ninety percent of the CP homes are in floodplains and its residents have "no place else to go".[39] CP lands are not exclusive to Peguis, there are many First Nations communities across the country that have similar land tenure structures. For example, the pre-colonization Cowichan Tribe in British Columbia had a practice of allotting parcels of land to individual families.[40] According to the AFN, it is pivotal for each community to have an internal system for transferring, selling, and buying land among community members.[41] This should be set out in the housing policy, or guidelines by the Lands Department. AFN also maintains that an effective housing policy must include the First Nation's governance model,[42] that is, their chief and council structure.

4.2 Existing Policies and Regulations for First Nation Housing in Flood-Prone Areas

Flooding poses a significant and recurring threat to many First Nations reserves across the country [refer to Chapter 2.1, pg. 37]. These communities, often located in low-lying, swampy, or remote areas, are particularly vulnerable to the impacts of flooding due to a combination of geographical, historical, and socio-economic factors.[43] As discussed in Chapter 2, flood risks not only threaten the physical safety of residents but also undermine the stability of housing and infrastructure, leading to long-term social, economic, and cultural challenges. While earlier chapters have delved into the specifics of flood risks, this section focuses on the existing policies and regulations that aim to address these challenges.

Indigenous Services Canada (ISC) regional offices work closely with First Nations at risk of flooding to ensure that emergency preparedness and response plans are set in place to carry out such procedures.[44] In 2021, ISC and AFN launched the Steering Committee on First Nations Home Flood Insurance Needs to examine the specific flood insurance needs for residents on-reserve.[45] This initiative is presented as an effort to empower to First Nations and promote self-governance. ISC also provides funding for structural mitigation projects such as dikes, sea walls, erosion-control measures, and drainage improvements.[46] It also administers the Emergency Management Assistance Program (EMAP) as the main source of federal funding for flood mitigation, preparedness, response, and recovery on-reserve.[47]

On paper, these measures seem promising. However, the effectiveness of these policies in practice is another matter entirely. Communities, such as Peguis First Nation, have criticized the reactive rather than proactive nature of flooding responses.[48] For instance, ISC's suggestion of mounding homes in the community as a flood-mitigation strategy[49] comes with challenges, including high costs and time-intensive processes, particularly in areas where suitable soil is not readily available. Additionally,

alterations to the structure would have to be made with the basement being removed to potentially mound the home to a sufficient elevation.

Despite claims of progress, the actual outcomes indicate a different reality. Flood mitigation measures are only effective if implemented in a timely, consistent, and culturally appropriate manner—something that many communities have yet to experience. While initiatives like EMAP and structural mitigation projects are highlighted as solutions, their actual impact remains limited by underfunding, logistical hurdles, and a lack of community-specific strategies. It is necessary to ask: do these policies truly address the root causes of flooding and its impacts, or are they merely patchwork solutions that fail to account for the unique circumstances of Indigenous communities? Unless these programs go beyond surface-level efforts and bring real change, First Nations reserves will continue to face the disproportionate burden of flooding's consequences.

4.2.1 Flood Insurance

Another challenging yet essential component of housing policies for First Nations communities in flood-prone areas is the role of flood insurance. Given the increasing frequency and severity of flooding partly due to climate change, having adequate flood insurance is beneficial for ensuring the financial stability of communities. While it would not prevent flood damage, it would provide homeowners with the necessary financial support for rebuilding and recovery, helping to mitigate the economic impacts of floods. However, the unique legal and logistical challenges associated with on-reserve land and housing create complexities in accessing and implementing flood insurance policies. Institutions like CMHC, ISC and AFN work together to help address these challenges, yet certain significant gaps remain.

One of the primary issues arises from the increasing cost of property and flood insurance on Indigenous lands due to the increase in the number of floods annually.[50] Canadian economists and researchers have attributed this rise in insurance costs to climate change. This has exposed the standardized risk assessment method of government policies that neglect the distinctive characteristics of Indigenous reserves. For example, insurers use risk assessment based on a region's flooding history and existing resilience measures, but these assessments fail to account for the specific situation of reserves. Residents on reserve lands often have no choice but to remain in flood-prone areas, as relocation is not feasible. This leads to the communities being forced to accept higher property insurance rates, while many others remain uninsured.[51]

Another complication is homeownership on reserves. As only a small portion of residents own their homes, individuals looking to secure insurance must first obtain a Certificate of Possession or a Band Council Resolution.[52] This is because the Insurance Bureau of Canada says the homeowner "must be able to prove they own the property and have a financial interest."[53] However, the reserve land is held by the Crown or the community itself, complicating access to conventional insurance options.[54] Under Sections 28 and 89 of the *Indian Act*, assets and properties on reserves cannot be seized in the event of a default, which further discourages mortgages, leading to limited private insurance availability.[55] Furthermore, even in cases where flood coverage exists, it is often too expensive, and residents may not fully understand its limitations.

For example, during the 2021 AREs in British Columbia, an elderly couple from the Penelakut Tribe on Vancouver Island had to abandon their family home, which they had built in 1985, when floodwaters rose on their property.[56] After the waters receded, their home was deemed uninhabitable due to the extent of the damages. Initially housed by the Red Cross for a

"short stay," they were later moved to a motel in Duncan, BC, arranged by their Tribe as disaster relief support ended.[57] Their home had been financed by the CMHC, but the insurance lapsed once the mortgage was paid off, something they had been unaware of.[58] Years later, they are still waiting for a resolution from their community or the government.[59] This case highlights that, even when in the rare cases where insurance is available for housing on-reserve, community members are often misinformed or unaware of the extent and terms of their coverage.

The lack of accessible and affordable flood insurance for First Nations communities is particularly concerning, given that flooding is the most frequent and expensive natural hazard in Canada, with over 289 floods recorded between 1900 and 2022.[60] The gaps in insurance coverage, coupled with the rising costs and the limitations imposed by existing policies and regulations, leave many on-reserve homes and their inhabitants vulnerable to severe financial and social repercussions. Addressing these gaps is important, not only for the immediate safety and resilience of these communities, but also for the long-term sustainability of Indigenous housing in the country's flood-prone regions (Figure 4.1).

4.3 Lack of Existing Policies to support Amphibious Architecture

As climate change continues to amplify flooding in vulnerable regions, particularly in Indigenous communities, the need for innovative and resilient housing solutions becomes increasingly urgent. Amphibious architecture is one such strategy that offers a practical and sustainable approach to mitigating flood risks. Despite its potential to reduce the significant damage caused by floods and its consequences, there are currently no direct policies or guidelines in Canada that support the development and implementation of amphibious architecture. Although there are some international policies

for floating architecture, it is important to note that floating and amphibious structures are not the same. Floating architecture remains buoyant at all times, while amphibious architecture only floats during floods, resting on the ground during normal conditions. Hence, the absence of such regulations for amphibious architecture poses a critical challenge, as it hinders the adoption of these adaptable housing solutions that could provide much-needed protection and resilience for flood-prone Indigenous communities.

The NBC includes comprehensive guidelines for how to deal with and defend structures against wind, snow, rain, and earthquakes, recognizing the need to protect communities from these threats. However, despite the increasing frequency and severity of flooding in the country, the code lacks specific provisions for flood-resilient construction. This omission is particularly concerning for flood-prone Indigenous communities, where the absence of clear guidelines leaves them vulnerable to the devastating impacts of floods. While other natural hazards are addressed with detailed regulatory frameworks, the exclusion of floods from the NBC highlights a significant gap in the approach to disaster resilience, particularly in the context of housing on reserves.

Keeping this in mind, the *National Research Council* (NRC) has recently produced a technical guidance document—the *Guide for Design of Flood-Resistant Buildings*—to design flood-resistant buildings in Canada. Since floodplain mapping and associated bylaws are developed at a provincial level in the country, there are no national standards in place that guide how flood risk is analysed and designed. The NRC document intends to address this issue at a national level.[61] The document is intended to determine parameters such as flood elevation, future climate effects, flood construction level, flood depth, and velocity, but does not provide guidelines for floating construction.

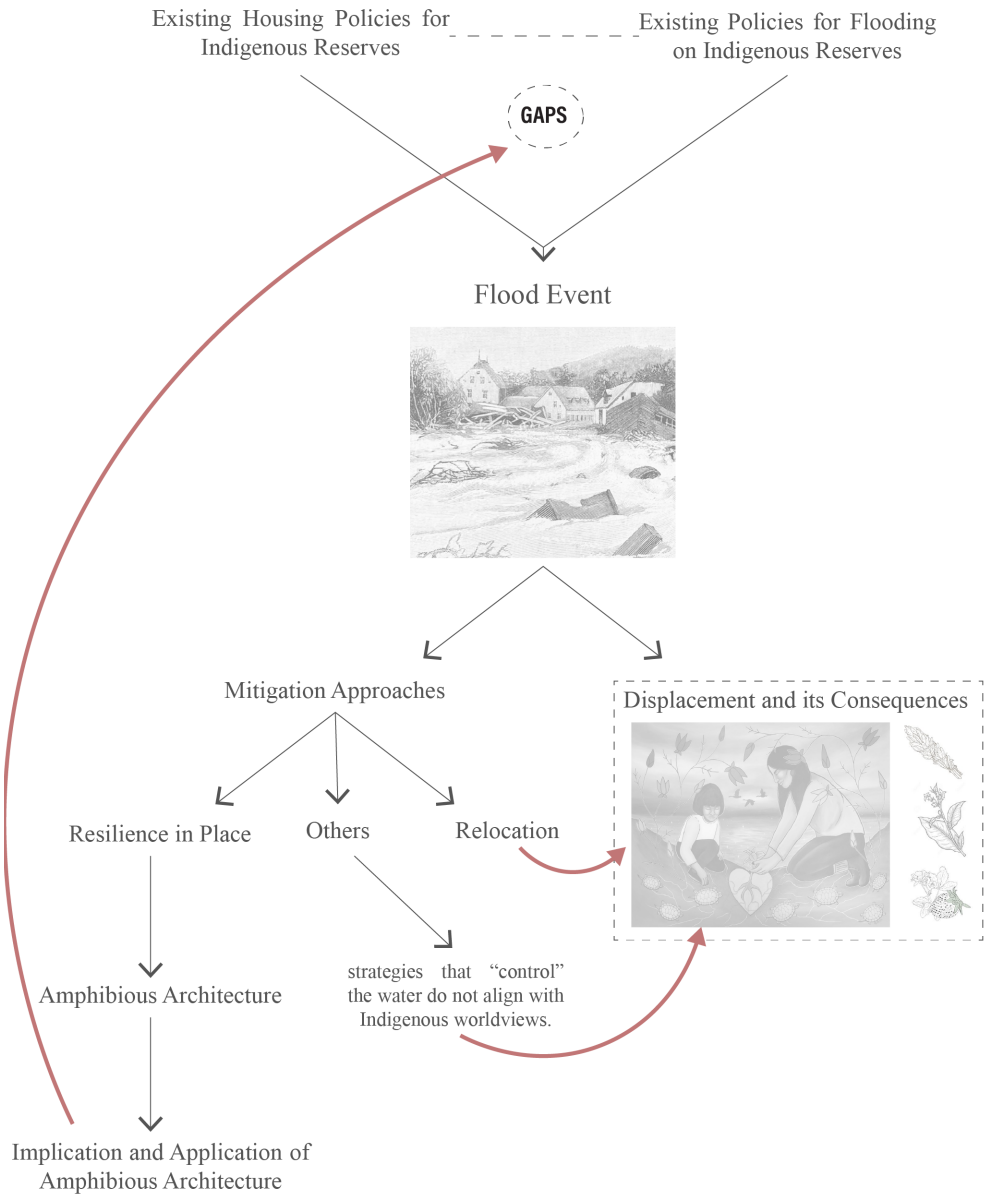
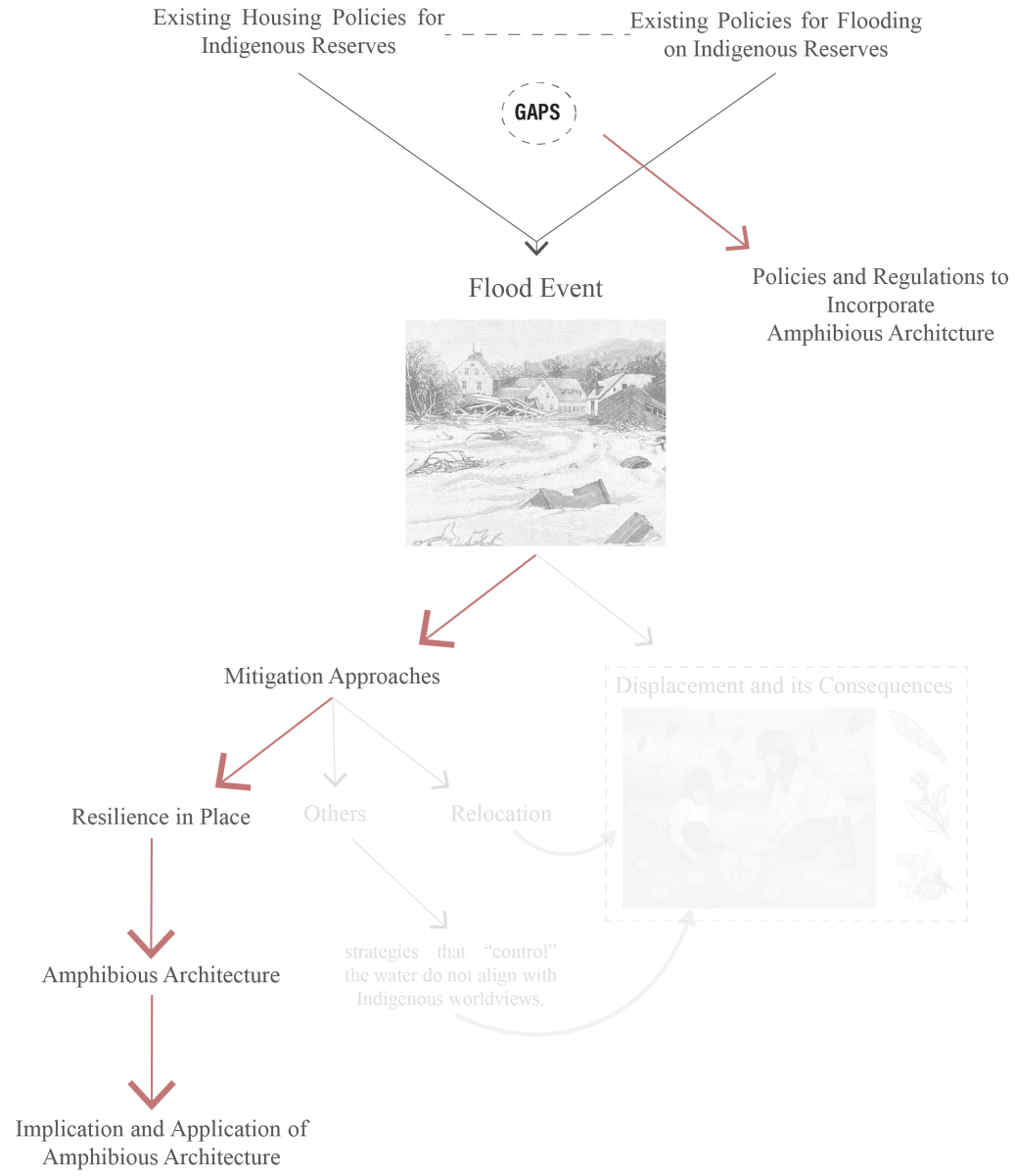


Figure 4.1: Flowchart: Policy Gaps Leading to Displacer



ment vs. Pathways to Flood Resilience (Image by author).

While Canada lacks national guidelines for floating construction, some other countries around the world have recognized the importance of establishing standards for floating homes to address flood risks effectively (Figure 4.2). In the Netherlands, for instance, floating homes are regulated under specific guidelines that ensure their safety and sustainability in flood-prone areas. Similarly, other nations prone to flooding have developed robust policies to facilitate the construction and maintenance of floating homes, recognizing their potential to protect communities from rising waters.[62]

Title	Region
Building Code for Float Homes	Alaska, USA
Regulation of the Construction and Maintenance of Floating Homes	California, USA
British Columbia Float Home Standard	British Columbia, Canada
Technical Regulation on the Stability, Buoyancy, etc. of Houseboats and Floating Structures	Denmark
Queensland Development Code. MP 3.1 Floating Buildings	Queensland, Australia
NTA 8111 Drijvende bouwwerken [Floating constructions]	Netherlands
AS 3962-2001 The Australian Standard: Guidelines for Design of Marinas	Australia
PN-EN 14504: 2010 Inland navigation vessels – Floating landing stages and floating bridges on inland waters - Requirements, tests	EC
Guidelines for Floating Platforms for Yacht Marinas	Poland

Figure 4.2: Guidelines for Floating Construction Globally (Source: Karczewski and Piątek).

According to *Building Code for Float Homes in Alaska*, USA, floating structures must comply with safety regulations, including those for stability, anchoring, and utilities like electricity and sewage. Additionally, the code also requires that float homes have proper flotation devices and are inspected regularly to ensure safety and compliance with environmental standards.[63] Similarly, the guidelines for California's floating construction—*Regulation of the Construction and Maintenance of Floating Homes*—discusses the stability and safety requirements for floating homes in Marin County, outlining methods to calculate the balance and stability, considering both dead and live loads. It also includes guidelines for measuring the buoyancy and stability when subjected to uneven weight distribution or wind pressure.[64]

Denmark also produced its own guidelines—*Technical Regulation on the Stability, Buoyancy, etc. of Houseboats and Floating Structures*—iterating its criteria for ensuring these structures are safe and stable, addressing load distribution, balance, and stability under various conditions.[65] Similarly, *The Australian Standard: Guidelines for Design of Marinas* emphasizes the importance of environmentally sustainable practices, safety regulations, and community engagement. It discusses key considerations such as adequate buoyancy, minimizing ecological impact during site selection, and implementing waste management practices.[66]

Meanwhile, Canada's approach remains fragmented, with no comprehensive national code to guide the development of floating structures. BC, in particular, has a *Float Home Standard,* which covers the design and construction of float homes. These standards address critical aspects of floating construction, such as buoyancy, anchoring, and floodproofing, providing a framework for safe and resilient floating homes in the province. However, the absence of a unified national standard leaves other regions without the necessary guidelines to develop similar housing solutions, limiting the broader adoption of this innovative approach to flood resilience.

While amphibious architecture is not synonymous with floating architecture, the same concerns of safety and security apply. Municipalities in BC have expressed concern that many floating homes have inadequate safety provisions including access for ambulance and firefighter crews.[67] Similarly, in the Netherlands, where amphibious architecture has become a reality in places like Maasbommel, these innovative structures still face significant challenges. Under the "Room for the River" program, implemented in 1997, Maasbommel became the site for the first amphibious houses in the country in 2005.[68] The houses floated during the flood of 2011, proving the successful implementation of amphibious architecture technology. However, years later today, it is still not as widely adopted and accepted. While the technology is available, it is difficult to obtain a building permit because of the "unfamiliarity with the concept in regulation and hesitance to build in areas that were considered dangerous."[69] Essentially, this reflects the absence of provisions for amphibious housing in existing building codes, which effectively prohibits its implementation.

The challenges faced by amphibious architecture are not unique to Canada and the Netherlands. In the United States, particularly in New Orleans after Hurricane Katrina in 2005, the adoption of alternative flood-resilient housing solutions faced significant obstacles. When Hurricane Katrina hit, storm surges overwhelmed the inadequate levees, and 80% of New Orleans was submerged[70]. The devastation was immense, with a large number of homes being damaged and residents displaced. In the aftermath, the US *Federal Emergency Management Agency* (FEMA) recommended that homes be elevated to mitigate future flood risks. However, this approach raised concerns as well. Dr. English noted that intermittent elevation of the homes in a neighbourhood might lead to a decline in community cohesion and pose accessibility issues for residents in neighbourhoods characterized by strong social connections.[71] This observation underscores the potential drawbacks of elevating structures, particularly in close-knit communities.

Despite the potential of amphibious architecture as an alternative, FEMA expressed reservations. FEMA prioritizes relocating residents away from flood-prone areas and withholds flood insurance through the *National Flood Insurance Program* (NFIP) for new amphibious houses, citing technical concerns about the lack of adequate anchoring to prevent flotation.[72] Municipalities were warned that they risked losing their good standing with the NFIP if they issued building permits for amphibious construction. This would pose a critical challenge for homeowners, as banks in the US require flood insurance as a prerequisite for providing mortgages in flood-prone areas.[73] Since 2014, FEMA has permitted amphibious construction as retrofits for existing homes, yet these structures remain ineligible for NFIP coverage.[74] These restrictions highlight how existing regulatory frameworks and insurance policies hinder the adoption of innovative housing solutions like amphibious architecture.

Increasing confidence in the potential of amphibious housing could stimulate further developments in the market, provided that these innovations are supported through appropriate regulations. Experience in the Netherlands and the US underscores that while amphibious architecture offers a promising solution to flood resilience, to be widely implemented, it requires careful consideration of safety standards and infrastructure support to ensure its effectiveness. The lack of comprehensive guidelines and policies addressing these concerns limits the widespread adoption of such innovative housing solutions, both in Canada and globally.

4.4 Incorporation of Amphibious Architecture

The successful implementation of amphibious architecture in Canada requires more than just technical innovation; it demands a comprehensive integration into existing regulatory frameworks and guidelines (Figure 4.3). This integration is essential for ensuring the long-term viability and safety of amphibious structures, as well as for encouraging their adoption on a broader scale. The three major barriers for the inclusion of this strategy[75] are:

1) lack of inclusion in the National Building Code

2) lack of government policies supporting amphibious architecture

3) lack of insurance coverage for amphibious structures

Addressing these issues through targeted recommendations is essential for advancing the use of amphibious architecture in the country. The following recommendations are proposed as a phased approach to overcoming these barriers, encouraging the successful incorporation and maintenance of amphibious structures within Indigenous communities (Figure 4.4 and 4.5).

Recommendation #1: Integrate Amphibious Architecture into the National Building Code

To enhance flood resilience in Indigenous communities situated in flood-prone areas, incorporating amphibious architecture into the NBC would be beneficial. Integrating these design strategies would not only enhance the safety and resilience of these communities but also align with ISC's support for innovative housing that adheres to established regulations. This can be done in a phased approach as mentioned below.

Phase 1: Developing Amphibious Design Standards and Guidelines

Before amphibious architecture can be incorporated into the code, establishing a set of guidelines and standards tailored to Canada's unique climate and flood conditions is necessary. These standards could address the construction and technical feasibility of amphibious design, ensuring that the design is not only safe, but also practical and resilient. Detailed design parameters for amphibious structures can be developed, which define load capacities, buoyancy requirements, and materials as well as response to the Canadian climate. This foundational work will set the stage for broader implementation and will guide the integration of these innovative solutions into existing regulatory frameworks.

The *Buoyant Foundation Project*, in March of 2021, prepared a *Guidance Document for Amphibious Construction*,[76] which was then submitted as a draft to the NRC. The document covers the technical guidelines for designing an amphibious construction including its major components—the buoyancy system, the vertical guidance posts, and the connections to the utilities.

These guidelines serve as a valuable starting point for developing these standards for the Canadian context. By adapting and expanding upon these guidelines, Canada can establish region-specific standards that ensure the practicality and resilience of amphibious architecture across the country. Additionally, this existing document can be adapted specifically for Indigenous communities integrating community-specific needs, cultural values, and preferences in the design and construction of amphibious architecture.

Phase 2: Pilot Projects

A series of pilot projects could be implemented in First Nations communities to test and refine amphibious housing designs. These projects could involve close monitoring and community engagement, with feedback

EXISTING POLICIES AND REGULATIONS FOR HOUSING ON-RESERVE

NATIONAL BUILDING CODE
Since 2014, First Nations are required to submit certificates of code compliance for CMHC funded projects.

PROVINCIAL CODE
Provinces can adopt NBC or create their own versions of the codes based off it, with its own supplementary laws and regulations.

LOCAL ZONING AND BY-LAWS
On-reserve housing must follow these local by-laws. However, they might vary from one province or municipality to another.

FEDERAL AND PROVINCIAL BUILDING CODES

LAND
ST

GOVERNMENT FU
INSTITUTIONS

INDIGENOUS TREATIES AND REGULATIONS

CROWN-INDIGENOUS RELA
NORTHERN AFFAIRS CANA

ASSEMBLY OF FIRST NATIO

INDIGENOUS SERVICES CA

CANADA MORTGAGE AND
CORPORATION (CMHC)

THE INDIAN ACT, 1985
First Nations regained the ability to self-govern on their own lands and make decisions for their own homes.

ON-RESERVE HOUSING POLICY, 1996
It allows for First Nations to play a crucial role in how, where and when the housing funds are invested. FNs have a choice whether they want to opt into this policy or not.

FRAMEWORK AGREEMENT ON FIRST NATIONS LAND MANAGEMENT ACT, 2022
Replaced FNLMA, and streamlined land managament. Framework Agreement will take precedence over conflicts.

Gaps:

- Only a small fraction of con
enacted the codes, and beg
inspections.
- Many FN do not see this as their
on whose responsibility this is?
- Lack of technical specifications
cases of housing on-reserve.

Figure 4.3: Summary of Policies and Regulation

EXISTING POLICIES AND REGULATIONS FOR FLOOD MITIGATION ON-RESERVE

FLOOD INSURANCE
Most FN houses remain uninsured, while the few that do have flood insurance have higher property insurance rates due to increasing frequency and severity of flooding.

OWNERSHIP
TRUCTURE

NDED
S

POLICIES AND INITIATIVES

CERTIFICATE OF POSSESSION (CP)

COMMON BAND LAND (CBL)

STEERING COMMITTEE ON FIRST NATIONS HOME FLOOD INSURANCE NEEDS
Launches by ISC and AFN, it is an emergency management initiative.

EMERGENCY MANAGEMENT ASSISTANCE PROGRAM
Under ISC, it administers the main source of federal funding for flood mitigation, preparedness, response and recovery on-reserve.

ATIONS AND
DA (CIRNAC)

N (AFN)

NADA (ISC)

HOUSING

Gaps:

- Lack of flood insurance for housing on-reserve.
- Insurers use risk assessment based on a region's flooding history and existing resilience measures, but these assessments fail to account for the specific situation of reserves.
- Home ownership on-reserve also brings with it complications in terms of obtaining flood insurance.

mmunities have
gun to enforce

role. Ambiguity

s for the unique

Overall Gaps:

- Lack of inclusion in the National Building Code.
- Lack of government policies supporting Amphibious Architecture.
- Lack of insurance coverage for Amphibious structures.

ns for Housing On-Reserve (Image by author).

collected on both technical performance and community experiences. A monitoring framework can be set up involving local environmental experts and community members to track performance and gather feedback. Collaborating with local environmental experts and community members would allow for a comprehensive evaluation of the pilot projects, informing potential adjustments to the NBC.

Such projects would test the practical application of amphibious housing in real-world conditions, providing a valuable basis for further consideration. These projects would contribute insights into the performance, maintenance, and community acceptance of amphibious structures, serving as a critical proof of concept for wider adoption and integration into the NBC.

Recommendation #2: Develop a Comprehensive Policy Framework

Establishing a well-structured policy framework could significantly support the integration of amphibious housing solutions across Canada. Such a framework might include guidance on implementing amphibious designs to ensure these solutions are both safe and compliant with current standards. Financial mechanisms, including government grants, subsidies, and potential incentives like tax credits or rebates, could also be outlined to help offset initial costs and encourage the adoption of innovative flood mitigation strategies by First Nations communities. A streamlined, accessible application process for communities seeking funding support, along with assistance in navigating the application steps, could further promote engagement.

Collaboration among the federal, provincial, and other governmental agencies would be vital in designing specific funding programs that support the development of flood-resilient housing on-reserve. Additionally, allocating a portion of the existing disaster relief funds towards the construction of amphibious homes can proactively protect communities from flooding and

reduce long-term disaster recovery costs. This proactive approach not only safeguards communities but also mitigates the financial burden of reactive crisis management that communities usually face.

Recommendation #3: Establish a Long-Term Maintenance Plan

A well-planned, sustainable maintenance strategy can help ensure the long-term functionality and safety of amphibious housing structures. Periodic inspections—ideally scheduled annually and around significant flood events—would help assess the readiness of these structures. This could include pre- and post-flood checks to confirm that all components are in working condition. Alongside inspections, a general maintenance schedule focused on the key components of amphibious designs, such as buoyancy elements and guidance posts, would help communities manage upkeep effectively without undue burden.

To support this, developing a standardized maintenance manual could offer clear, accessible guidance on managing routine tasks. This approach not only extends the lifespan of the amphibious home but also allows for adjustments, such as extending the vertical guidance posts if needed as projected flood water levels rise, ensuring that structures can adapt to the changing climate. Protocols could also be established in case an emergency repair needs to be made in the event of significant damage caused by flooding or other extreme conditions.

Recommendation #4: Develop Tailored Insurance Products for On-Reserve Housing

Supporting amphibious housing in flood-prone First Nations communities could benefit from insurance products designed to address the specific risks associated with this type of construction. Incorporating Indigenous insurance brokers and specialized resources may help with effective risk

assessment and planning within these communities. Currently, many floodplain communities lack access to flood insurance, as traditional providers often decline coverage due to the high flood risks involved, leaving these communities financially vulnerable.

Although achieving affordable, adequate coverage may require subsidies or additional support mechanisms that are not presently available, developing an insurance framework tailored to amphibious housing could offer a foundation for future policies. In the long term, these products could help reduce financial vulnerability and encourage the broader adoption of flood-resilient housing. Given that the federal government forcibly relocated many First Nations onto flood-prone lands, ISC could contribute to the premiums as well. Through incremental steps, such as pilot insurance programs, this approach could address some of the unique challenges faced by on-reserve communities as they adapt to changing environmental conditions.

To initiate tailored insurance options, conducting specialized risk analysis specific to amphibious housing in First Nations communities would be helpful. This analysis could evaluate the unique components of amphibious designs, such as buoyancy systems and guidance posts, along with potential risks that set these structures apart from traditional housing. Data gathered from pilot programs could provide valuable insights for this assessment, helping to identify which coverage aspects are most crucial.

Partnerships between government agencies and insurance providers could form an additional layer of support, potentially establishing a safety net for First Nations communities facing flood risks. Although extensive government subsidies are unlikely at present, small-scale initiatives might encourage gradual adoption of amphibious housing, enhancing both community resilience and recovery capabilities in flood-prone areas.

Recommendation #5: Community Education and Capacity Building

For amphibious architecture to be effective in Indigenous communities, active participation from community members is crucial. Engaging the community through workshops and consultations can provide valuable insights into local housing needs and preferences, helping to build consensus around design choices for flood-resilient housing. This includes engaging with community members, leaders, and local organizations to confirm that amphibious architecture aligns with their cultural values and practical requirements.

Educational campaigns within the communities could further support this engagement by raising awareness about the benefits and functionality of amphibious structures. Through workshops, informational materials, and hands-on demonstrations, community members can better understand how these designs work and how they can be maintained. Involving community members in the construction process and offering training programs for local builders could also build essential skills, empowering communities to manage and maintain these homes independently over time.

Moreover, this initiative offers opportunities for economic reconciliation. By involving community members in construction, training, and maintenance roles, new pathways for local employment and skill development can emerge, strengthening the community's economic resilience.

Community engagement must be approached with cultural sensitivity and respect for traditional practices. Hence, incorporating Indigenous knowledge and perspectives into the design and implementation of amphibious architecture plays a key role. By focusing on community education and capacity building, First Nations communities will certainly be well-prepared to implement, maintain, and manage amphibious architecture.

Recommendation	Why/Gap
#1: Integrate Amphibious Architecture into National Building Code	• NBC currently lacks provisions not only for innovati designs such as amphibious architecture, but also flood-resilient architecture. • There are no established guidelines or standards constructing amphibious structures in the Canadi context, particularly for Indigenous communities. [standardized guidelines for floating structures as well]. • Aligns with ISC's support for innovative housing th adheres to established regulations. Hence, could get IS on board in terms of helping finance these housi structures on-reserve.
#2: Develop a Comprehensive Policy Framework	• There is a need for a well-structured policy framework flood-resilient architecture, as well as for the integrati of amphibious housing in Canada, particularly flood-prone First Nations communities. • Limited access to financial support systems, such as gra and subsidies, hinders the implementation of innovati housing solutions.
#3: Establish a Long-Term Maintenance Plan	• There is a need for a comprehensive, long-te maintenance plan to ensure the ongoing functionality a safety of amphibious housing structures in First Nati communities. • A long-term maintenance plan is helpful to sustain community trust and confidence in amphibious hous solutions.

Figure 4.4: Table of Reco

	How	Stakeholders
ve for for an No nat SC ng	***Phase 1: Developing Amphibious Design Standards and Guidelines*** A universal set of guidelines and standards could be established for the Canadian context, addressing the construction and technical feasibility of the amphibious design. ***Phase 2: Pilot Projects*** Implement pilot projects in First Nations communities to test and refine amphibious housing designs, incorporating community feedback and expert evaluation to inform the NBC.	• ISC • CMHC • NRC • Provincial Govt. • AFN • First Nations • Band Council • BFP
for on for nts ve	Establishing a well-structured policy framework could significantly support the integration of amphibious housing. Financial mechanisms, including government grants, subsidies, and potential incentives like tax credits or rebates, could also be outlined to help offset initial costs and encourage the adoption of innovative flood mitigation strategies by FN.	• ISC • CIRNAC • CMHC • Provincial Govt. • First Nations • Band Councils • Financial Institutions
erm and ons ing ing	Develop a comprehensive maintenance strategy for amphibious housing that includes periodic inspections, ideally conducted annually and around significant flood events, to assess the readiness of structures. Protocols to emergency repairs to address potential significant damage from flooding or extreme weather events can also be outlined. Additionally, a manual that communities can use to manage these structures effectively over time could be produced.	• ISC • First Nations • Architects and Engineers • BFP • Environmental Experts [to assess climate-related risks]

ommendations (by author).

Recommendation	Why/Gap
#4: Develop Tailored Insurance Products for On-Reserve Housing	• Currently, there is no flood insurance available on-reserve housing in First Nations communities, leavi them financially at risk in the event of flooding due to damages. • Regular insurance providers often refuse coverage due the high frequency and severity of flooding in these are which exacerbates the financial vulnerability of th communities.
#5: Community Education and Capacity Building	• First Nations communities are not always invovled in decision making, leading to a misalignment with th needs and values. • There may be a lack of understanding about amphibi architecture and its benefits. • Local builders and community members might not ha the skills required for constructing or maintaini amphibious structures. • Current flood mitigation approaches may not fully resp or integrate Indigenous cultural values and traditio practices.

Figure 4.5: Table of Reco

	How	Stakeholders
for ing the e to eas, ese	A specialized risk analysis can be conducted specific to amphibious architecture in First Nations communities, utilizing data from pilot programs to identify and assess the unique risks associated with this housing. Incorporate Indigenous insurance brokers and resources to improve risk assessment and planning, addressing the current lack of flood insurance coverage in many floodplain communities.	• First Nations • Indigenous Insurance Brokers • Private Insurance Companies • ISC • CIRNAC
the heir ous ave ing ect nal	Workshops and consultations to gather input and build consensus on design and implementation could be conducted with the community members. Specifically for amphibious architecture and its benefits, informational materials could be produced and distributed. Additionally, training programs for local builders and community members can be created to gain skills in constructing and maintaining amphibious homes.	• First Nations • Band Council • Local Builders • Indigenous Knowledge Keepers • Local Organizations • AFN

ommendations (by author).

4.5 Application of these considerations for First Nation communities

The successful implementation of amphibious architecture in First Nations communities goes beyond technical innovation and requires a holistic approach that integrates cultural, social, and environmental considerations. Hence, it is crucial to collaborate with First Nations communities in policy-making to ensure that these solutions not only address flood risks but also respect and support cultural heritage. These solutions must be co-developed with community members, prioritizing their voices and reflecting their knowledge, practices, and relationships with the land and water. First Nations communities share an intrinsic and irreplaceable bond with water, experiencing it as a sacred entity that is vital to their spiritual and cultural existence. This relationship is not merely significant, it is fundamental and inseparable from their identity and way of life [refer to Chapter 2.2.2, pg. 45]. Amphibious architecture, through its adaptive design that accommodates flooding, can resonate with these worldviews that emphasize harmony with water. This approach speaks to the Indigenous principles of stewardship and the protection of the land, ensuring that development does not come at the expense of the ecological balance.

Indigenous people have a vast array of wisdom, knowledge, and tradition entwined with the past and the places they call home. Traditional Knowledge offers invaluable insights into ways of sustainable living through adaptive, resource-conserving strategies that stem from intimate knowledge of the land and its ecosystems. This knowledge can help inform modern practices such as climate change mitigation in the form of amphibious architecture. This is where the principle of “Two-Eyed Seeing” plays an important role. This concept, introduced by Mi’kmaq Elder Albert Marshall, emphasizes the importance of seeing the world through both Indigenous and Western perspectives. It refers to “learning to see from one eye with the strengths of Indigenous knowledge and

ways of knowing, and from the other eye with the strengths of Western knowledge and ways of knowing…and learning to use both these eyes together"[77] (Figure 4.6). By applying this principle, policy-makers, architects, and engineers can develop solutions that incorporate the strengths of both knowledge systems. In the context of amphibious architecture, this means integrating Indigenous knowledge of land and water with modern architectural practices to create housing solutions that are not only functional but also deeply respectful of the community's cultural and spiritual connections to the environment.

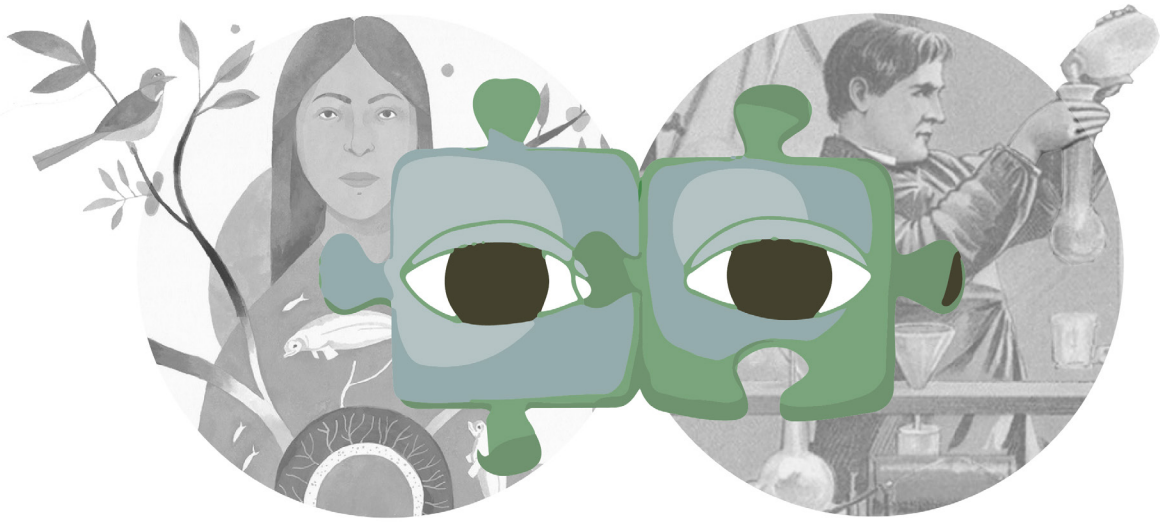


Figure 4.6: Two-Eyed Seeing (collage by author, Logo Source: Institute for Integrative Science and Health, used by permission).

Amphibious architecture, when developed in partnership with First Nations communities, has the potential to reflect and celebrate their cultural identity. This collaboration should be evident not only in the physical design of the structures but also in the policies that support their implementation. Moreover, the preservation of cultural heritage must be a central consideration in this development since the Indigenous people are so deeply connected to the land on which they live. This approach not only strengthens the resilience of First Nations communities in the face of climate change but also reaffirms their identity and this sacred relationship to the land and water. By doing so, we are not only building homes that rise during a flood but also constructing a future where modern innovation and ancient wisdom rise together.

An Indigenous-led approach to amphibious architecture does more than protect communities from the floods that threaten their homes and wellbeing, it reinforces their heritage, identity, and ways of knowing amidst a changing world. This approach goes beyond resilience; it honours traditions while fostering a future grounded in cultural values that can adapt to the challenges ahead.

1 "Housing & Homelessness," *Assembly of First Nations*, February 26, 2024, https://afn.ca/community-services/housing-and-homelessness/.

2 Ibid.

3 Joonsoo S. Lyeo, Michael D. Wong, Natalie Clyke, Becky Big Canoe, Penny Kinnear, Helen Stopps, Nicholas D. Spence and Sarah R. Haines, "Ten questions concerning First Nations on-reserve housing in Canada," *Building and Environment* 257 (2024), https://doi.org/10.1016/j.buildenv.2024.111544

4 Ibid.

5 Ibid.

6 "First Nations Guide to Housing Policy," *Assembly of First Nations*, June, 2010. https://www.afn.ca/uploads/files/housing/housing-policy-guide.pdf

7 "Housing Conditions among First Nations People, Métis and Inuit in Canada from the 2021 Census," *Statistics Canada*, September 21, 2022. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-X/2021007/98-200-X2021007-eng.cfm.

8 "Implementing Effective Housing Policy for First Nations Peoples | FNMHF Blog," *First Nations Market Housing Fund*, March 19, 2024, www.fnmhf.ca/implementing-effective-housing-policy-for-first-nations-peoples/.

9 Karen L. Weslowski, "Construction on First Nations Land: Determining the Applicable Building Code," *Lexology, Miller Thomson LLP*, October 3, 2018, https://www.lexology.com/library/detail.aspx?g=f07c8e61-ca12-4e9b-b02f-6a13fdb3bc1e.

10 Ibid.

11 "Housing on First Nation Reserves: Challenges and Successes," *Senate Canada*, February, 2015, https://sencanada.ca/content/sen/committee/412/appa/rep/rep08feb15b-e.pdf

12 Ibid.

13 Ibid.

14 "Building Code Compliance for First Nation Housing," *Canada Mortgage and Housing Corporation*, 2024, https://www.cmhc-schl.gc.ca/professionals/industry-innovation-and-leadership/industry-expertise/indigenous-housing/develop-manage-indigenous-housing/building-code-compliance-first-nation-housing.

15 "Housing on First Nation Reserves: Challenges and Successes," *Senate Canada*.

16 Ibid.

17 "Implementation of Modern Treaties and Self-Government Agreements," *Government of Canada*, 2018, https://publications.gc.ca/collections/collection_2019/rcaanc-cirnac/R31-34-2018-eng.pdf

18 Ibid.

19 *Indian Act*. R.S.C. 1985, c. I-5, s. 81, https://laws-lois.justice.gc.ca/eng/acts/I-5/section-81.html

20 Karen L. Weslowski, "Construction on First Nations Land."

21 "First Nation Land Management: Policy and Legislation," *Government of Canada*, August 1, 2023, https://www.rcaanc-cirnac.gc.ca/eng/1686318557963/1686318775639

22 "Housing on First Nation Reserves: Challenges and Successes," *Senate Canada*.

23 "First Nations Housing," *Government of Canada*, https://www.sac-isc.gc.ca/eng/1100100010715/1521125087940

24 "Housing on First Nation Reserves: Challenges and Successes," *Senate Canada*.

25 "Indigenous Insurance," *Canada Mortgage and Housing Corporation,* March, 2022, https://assets.cmhc-schl.gc.ca/sf/project/archive/research_6/indigenous-home-insurance-literature-review.pdf

26 "On-Reserve Non-Profit Housing Program (Section 95)," *Canada Mortgage and Housing Corporation*, https://www.cmhc-schl.gc.ca/professionals/project-funding-and-mortgage-financing/funding-programs/all-funding-programs/on-reserve-non-profit-housing-program-section-95

27 "Crown-Indigenous Relations and Northern Affairs Canada," *Government of Canada*, https://www.canada.ca/en/crown-indigenous-relations-northern-affairs.html

28 "First Nations Housing," *Government of Canada*, https://www.sac-isc.gc.ca/eng/1100100010715/1521125087940

29 "First Nations Housing," *Government of Canada*, https://www.sac-isc.gc.ca/eng/1100100010715/1521125087940

30 *First Nations Market Housing Fund,* https://www.fnmhf.ca/

31 *Assembly of First Nation*, https://afn.ca/

32 "Housing on First Nation Reserves: Challenges and Successes," *Senate Canada*.

33 Ibid.

34 Ibid.

35 Evaluation of the Administration of ReserveLandSub-program(PAA#3.2.3)," *Government of Canada*, September, 2015, https://www.rcaanc-cirnac.gc.ca/eng/1481214401553/1537878979594

36 "Certificate of Possession," *Cowichan Tribe*, https://cowichantribes.com/about-cowichan-tribes/land-base/certificate-possession#:~:text=Certificate%20of%20Possession%20is%20documentary,legal%20title%20to%20the%20land.

37 "Water is Our Friend Workshop #1," *Workshop*, The Buoyant Foundation Project, University of Waterloo, Waterloo, Ontario, April 10-11, 2024.

38 Ibid.

39 Ibid.

40 "Certificate of Possession," *Cowichan Tribe.*

41 "First Nations Guide to Housing Policy," *Assembly of First Nations*.

42 Ibid.

43 Liton Chakraborty, Jason Thistlethwaite, Andrea Minano, Daniel Henstra and Daniel Scott, "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada," *International Journal of Disaster Risk Science* 12 (2021): 821–838, https://doi.org/10.1007/s13753-021-00383-1

44 "Flooding in First Nations communities," *Government of Canada*, https://www.sac-isc.gc.ca/

45 Ibid.

46 Ibid.

47 Ibid.

48 "Water is Our Friend Workshop #2," *Workshop*, The Buoyant Foundation Project, University of Waterloo, Cambridge, Ontario, May 25-26, 2024.

49 "Water is Our Friend Workshop #1," *Workshop*, The Buoyant Foundation Project, University of Waterloo, Waterloo, Ontario, April 10-11, 2024.

50 "Indigenous Insurance," *Canada Mortgage and Housing Corporation*.

51 Ibid.

52 Julia Wong and Terry Reith, "As natural disasters ravage Indigenous land, uninsured residents struggle to rebuild," *CBC News*, June 16, 2023, https://www.cbc.ca/news/canada/insurance-indigenous-communities-1.6876059

53 Ibid.

54 "Indigenous Insurance," *Canada Mortgage and Housing Corporation*.

55 Ibid.

56 Julia Wong and Terry Reith, "As natural disasters ravage Indigenous land, uninsured residents struggle to rebuild."

57 Ibid.

58 Ibid.

59 Ibid.

60 "Indigenous Insurance," *Canada Mortgage and Housing Corporation*.

61 William L. Coulbourne, David L. Kriebel, Randall L. Behm and Kimberly K. McKenna, "Guide for Design of Flood-Resistant Buildings," *National Research Council of Canada*, 2021, https://doi.org/10.4224/40002704.

62 Artur Karczewski and Łukasz Piątek, "The Influence of the Cuboid Float's Parameters on the Stability of a Floating Building," *Polish Maritime Research* 27 (September 2020): 16-21, https://doi.org/10.2478/pomr-2020-0042

63 City and Borough of Sitka, Alaska, *Home Rule Charter of the City and Borough of Sitka*, Chapter 19.15 Building Code for Float Homes, 2019, https://sitka.municipal.codes/SGC/19.15

64 Marin County, California, *California Municipal Code,* Chapter 19.18, Regulation of the Construction and Maintenance of Floating Homes, 2016, http://marincounty-ca.elaws.us/code/coor_title19

65 Danish Maritime Authority, T*echnical Regulation on the Stability, Buoyancy, etc. of Houseboats and Floating Structures*, 2007, https://www.dma.dk/Media/637720424603885615/Technical%20regulation%20on%20the%20stability%20buoyancy,%20etc%20of%20houseboats%20and%20floating%20structures.pdf

66 Standards Australia, *AS 3962-2001 The Australian Standard: Guidelines for Design of Marinas. Sydney*, 2001, https://hamiltonislandproperty.wordpress.com/wp-content/uploads/2012/06/as_3962-2001_guidelines_for_design_of_marinas.pdf

67 BC Government, *British Columbia Float Home Standard*, https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/2003_float_home_standard.pdf

68 "Amphibious Housing in Maasbommel, the Netherlands," *Climate ADAPT*, June 7, 2016, https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands

69 Ibid.

70 "Hurricane Katrina- August 2005," *National Weather Service*, https://www.weather.gov/mob/katrina

71 Elizabeth English, Natasha Klink, and Scott Turner, "Thriving with water: Developments in amphibious architecture in North America," *FLOODrisk 2016–3rd European Conference on Flood Risk Management* (2016), https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_13009.pdf

72 Ibid,

73 Ibid.

74 Ibid.

75 Elizabeth English, "The Greatest Impediment to Amphibious Construction is Policy, Not Technology," *International Conference on Amphibious Architecture,* 2015.

76 Elizabeth English, The Buoyant Foundation Project, "Guidance Document for Amphibious Construction," *Prepared for The National Research Council of Canada,* unpublished manuscript, March 31, 2021, used by permission.

77 "Guiding Principles (Two Eyed Seeing)," *Integrative Science*, http://www.integrativescience.ca/Principles/TwoEyedSeeing/#:~:text=We%20often%20explain%20Etuaptmumk%20%2D%20Two,for%20the%20benefit%20of%20all.

CHAPTER 5

living between land and water

As climate change continues to impact Indigenous communities, flooding remains one of the most pressing concerns. For First Nations communities residing in flood-prone areas, there is an urgent need for innovative housing solutions that can safeguard their homes while preserving cultural heritage. Amphibious architecture offers a promising way forward, allowing homes to rise with the floodwaters only when needed, providing resilience in place without the need for relocation. In addition to preventing long-terrm displacement due to flooding, amphibious architecture offers several other significant benefits for First Nations communities [refer to Chapter 3.1, pg. 73]. One of the key advantages is the reduction of damage to both belongings and the house itself. Since these homes float in response to rising water levels, they remain intact during floods, sparing residents the costly and time-consuming process of post-flood repairs. From an economic perspective, this approach allows for immediate re-occupancy, allowing residents to return to their homes as soon as they can get there safely, avoiding prolonged downtime and minimizing the expenses associated with damage control and cleanup operations. Architecturally, amphibious architecture also maintains visual coherence within the landscape, in contrast to structures raised on tall stilts or high foundation walls, which can disrupt the aesthetic and social harmony of the community's built environment.

Building on the conceptual and policy frameworks from previous chapters, this chapter shifts focus toward the practicalities of adapting commonly used housing typologies—modular and stick-built homes—into amphibious structures. These housing typologies are widely used in First Nations communities, offering an ideal starting point for reimagining flood-resilient design for Indigenous communities. Through the process of amphibiating these homes, the goal is to create spaces that offer not only physical safety but also maintain cultural continuity. This chapter presents schematic designs for amphibious housing, considering the specific needs of First Nations communities while addressing structural integrity, environmental sustainability, and heritage preservation.

5.1 Modular vs Stick-Built Housing

Housing in First Nations communities is a major aspect of cultural identity and community resilience, reflecting on the diverse needs of Indigenous peoples across the country. Traditionally, housing in these communities has been closely tied to the land and its resources, with structures often designed to harmonize with the natural environment. Today, the two major housing typologies observed in many such communities across Canada are **modular** and **stick-built homes** (Figure 5.1). Modular housing offers affordability, flexibility and efficiency, while stick-built homes are rooted in conventional construction practices. In communities like Peguis First Nation, there has been an interest at the leadership level in promoting stick-built housing, aiming to expand local employment opportunities and support the revitalization of standard construction practices.[1] Meanwhile, many other communities, such as Yale First Nation in BC, are leaning towards modular housing as a strategic response to tackle the housing crisis within their community.[2,3] This contrast underscores the need to explore both modular and stick-built approaches, as each offers distinct benefits and challenges suited to the diverse goals of First Nations communities.



Figure 5.1: Modular and Stick-Built Hou

EXAMPLES OF STICK-BUILT HOUSING FOUND IN FIRST NATIONS



Chawathil First Nation, BC.



Shackan Indian Band, BC.



Cook's Ferry Indian Band, BC.



Douglas First Nation, BC.



Musqueam Indian Band, BC.



Fort Albany First Nation, Ontario.



Nipissing First Nation, Ontario.



Six Nations of the Grand River, Ontario.



Sagkeeng First Nation, Manitoba.



Carry the Kettle Nakoda Nation, Saskatchewan.



Cowessess First Nation, Saskatchewan.



Sandy Bay First Nation, Manitoba.

ısing in First Nations (collage by author).

Modular Housing is a type of construction that involves building a house in a factory setting in multiple parts and then transporting it to the building site. While modular homes are often perceived as a modern innovation, they actually have a long history in North America. Housing kits were introduced to the east coast in the seventeenth century, and entire homes began to be transported in the late nineteenth century.[4] The method offers several advantages, including cost-efficiency, ease of construction, speed of installation and scalability, which makes them particularly attractive for use in housing developments across Indigenous communities. Modular homes can be built according to a predictable timeline in a controlled environment, ensuring that timing and quality are less affected by weather conditions.[5] Furthermore, modular construction is less likely to be impacted by labour shortages compared to on-site construction methods.[6] Another significant benefit of modular housing is sustainability; the construction process typically generates reduced material waste, contributing to greater energy efficiency.[7]

Despite these advantages, there are challenges associated with modular construction. For instance, transporting units to remote sites can be costly and may lead to damage during transit. Additionally, machinery, such as cranes, is often required to lift the homes off the trucks used for transportation, which can add to project costs.[8] On-site integration can also pose difficulties, as units may sustain damage while connecting essential utilities such as electrical, mechanical and plumbing systems.[9] Moreover, a significant challenge with modular housing in flood-prone areas is its vulnerability to water damage; if these homes are not specifically designed to withstand and adapt to flooding, they can be at high risk during extreme weather events.

Stick-Built Housing is a type of construction that uses conventional methods of building where each part of the structure is constructed on-site. It allows for greater customization and adaptability to specific site conditions and to reflect cultural and community-specific preferences. This method also has deep roots in North America, where it has been the standard approach to residential construction for centuries. One of the

primary advantages of stick-built homes is their ability to be tailored to individual preferences, reflecting local culture and heritage. This flexibility is important in First Nations communities, where housing often serves not just as a shelter but as a space for maintaining social and cultural ties. Additionally, stick-built construction often fosters community engagement, as local labour and materials are usually utilized, which can strengthen ties within the community and create employment opportunities. The on-site construction process allows for greater flexibility in design changes, enabling builders to address challenges as they arise during the build.

However, stick-built homes also present certain challenges. The construction timeline is generally longer than that of modular homes, making them more susceptible to delays caused by weather or labour shortages. This can impact both project costs and overall efficiency. Moreover, the reliance on skilled labour for on-site construction can make it more difficult to maintain consistent quality, particularly in areas experiencing shortages of labour. Similar to modular homes, stick-built houses are also vulnerable to flooding unless innovative adaptations are incorporated.

Thus, the main difference between both types of building practices is the construction and delivery process. In conventional stick-built housing, building materials are brought to the site and the house is built there, whereas for modular homes, three-dimensional modules are constructed in a factory and then moved to the site, typically on a flatbed truck. Once they arrive on site, they are placed on a foundation and completed.[10]

While both approaches aim to alleviate the issues of housing availability, the persistent threat of flooding still remains a critical concern. The challenge lies in finding a way to appropriately adapt these homes to flood-prone areas. By equipping modular and stick-built homes with amphibious foundations, these houses can float during the floods, reducing the risk of damage and displacement of occupants. In both cases, the incorporation of amphibious elements could offer a sustainable and culturally sensitive approach to addressing the unique housing challenges faced by First Nations in flood-prone areas.

5.2 How to “Amphibiate”?

For the purpose of this research, I am using a simple rectangular house model [Type A] (Figure 5.2) as a starting point to illustrate the fundamental concepts of amphibious design. By focusing on a basic structure, I aim to demonstrate buoyancy calculations and orientation strategies that can be applied to a wide variety of housing types, including both modular and stick-built homes. While this model is straightforward, it serves as a foundation for understanding the principles behind amphibiation, offering insights that can be adapted to other housing typologies. By drawing from these familiar designs, the proposals not only remain relevant to current construction practices but also reflect the architectural patterns already in use, making the transition to amphibious architecture more feasible.

Stick-built homes, often featuring complex shapes and intersecting roof design, present additional challenges due to their more intricate load-bearing paths [Type B and C]. By starting with a simple structure—that could apply to both modular and stick-built homes, this research provides a clear entry point for understanding the core design strategies of amphibious architecture. Once these principles are established, they can be expanded and customized to suit other housing styles.

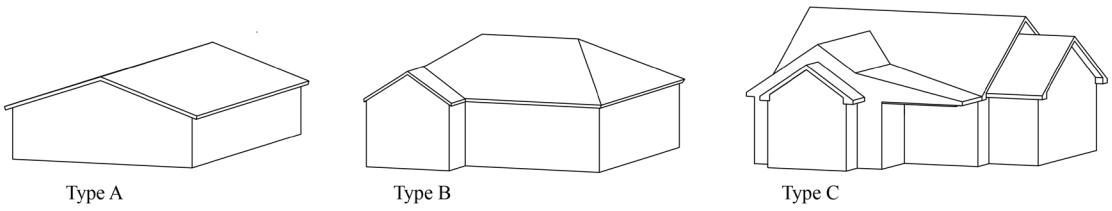


Figure 5.2: Housing Typology (Image by author).

The process of amphibiation can be adapted to both new construction and retrofitting projects, making amphibious architecture a flexible and inclusive solution for flood-prone areas. Key elements—such as amphibious foundations, vertical guidance posts, and flexible utility systems—remain consistent across designs, allowing for a replicable method that can be tailored to the unique needs of each community. One of the goals of this thesis is to provide a replicable method that communities and designers can follow to modify different housing styles that are appropriate for amphibiation. Whether applied to new constructions or as retrofits, the same design principles can be customized to reflect the specific needs and preferences of each community.

To implement amphibious design successfully, one of the key considerations is determining the amount of buoyancy required to lift the structure during a flood event. Understanding the weight of the house and the uplift capacity of the buoyancy is important to ensure that the home is sufficiently buoyant to float. This section outlines the process for calculating the necessary buoyancy for the house, along with a design option for integrating buoyant elements effectively.

In this design, a box beam structure is used to encase the buoyancy materials and provides support to the central beam. This structural approach contributes to the stability of the amphibious system. While the current design demonstrates the principles of buoyancy, it represents the maximum buoyancy elements that may be needed. The design, developed in consultation with Dr. English, provides an adaptable framework that can be refined as needed to reflect house-specific weight and buoyancy requirements.

Buoyancy Calculations:

The typical house used is a representative example for the purpose of this analysis. We assume a typical housing size, structural load, and material composition based on standard design practices. The following calculations provide an estimate of the amount of buoyancy material required to ensure that the house can safely rise and float during flood events. The formula provides a baseline to calculate how much buoyancy material is necessary for the specific prototype housing.

The suggested formula for estimating quantity of buoyancy required is as follows:

Design Load = Factored Load + Factor of Safety[i]

= [(1.25 x Dead Load) + (1.5 x Live Load)] + [0.25 x Dead Load]

Through the calculations presented in the following pages, we can determine the amount of buoyancy material required. Once the necessary buoyancy is established, the next step is to design these buoyant elements to fit into the crawlspace. Moreover, adjustments to the calculations and designs can be made for varying site conditions, or housing configurations, which would require re-determination of the amount of buoyancy needed.

i This additional Factor of Safety is added to the Factored Load by the recommendation from the *Draft of the Guidance Document for Amphibious Construction* prepared by the Buoyant Foundation Project.[11] Unlike static foundations, an amphibious foundation is subject to dynamic loads, introducing additional uncertainty. Underestimating the dead load in such systems poses a significant safety risk, as it directly affects the foundation's ability to remain afloat. Given this elevated uncertainty, adding a safety factor is a precautionary measure to mitigate the significant consequences that could arise from underestimating the structure's weight—consequences that are far more critical than with standard foundations.

Buoyancy Calculations for a Typical Type A House

To estimate the amount of buoyancy required for the prototype house, we assume the following parameters:

Area of the house (A) = 1380 ft^2

Live Load (LL) = 40 lbs/ft^2

Dead Load (DL) = 40 lbs/ft^2

Density of water (D_w) = 62.4 lbs/ft^3

Density of EPS foam (D_f) = 1 lb/ft^3

Buoyancy for EPS foam (B) = 61.4 lbs/ft^3

Design Load = Factored Load + Factor of Safety

= [(1.25 x DL) + (1.5 x LL)] + [0.25 x DL]

= [(1.25 x 40) + (1.5 x 40)] + [0.25 x 40]

= 120 lbs/ft^2

Next, we calculate the total load on the structure by multiplying the design load by the area of the house:

Calculated Load = Design Load × Area

= 120 lbs/ft^2 × 1380 ft^2

= 165,600 lbs

To determine the required volume of buoyancy material (EPS foam), we divide the total load by the buoyancy provided by the EPS foam per cubic foot:

V = 165,600 lbs / 61.4 lbs/ft^3

V = 2697.06 ft^3

Assuming we use standard EPS foam blocks with dimensions 2 feet by 4 feet by 3 feet, each block has a volume of:

V_f = 24 ft^3

Thus, the number of buoyancy blocks required is:

n = 2697.06 ft^3 / 24 ft^3

n = 112 units

Now that we have calculated the required volume of buoyancy material, we need to design these elements to fit accordingly into the structure (Figures 5.3-5.7).

Schematic Design for Amphibiating a Typical Type A Home

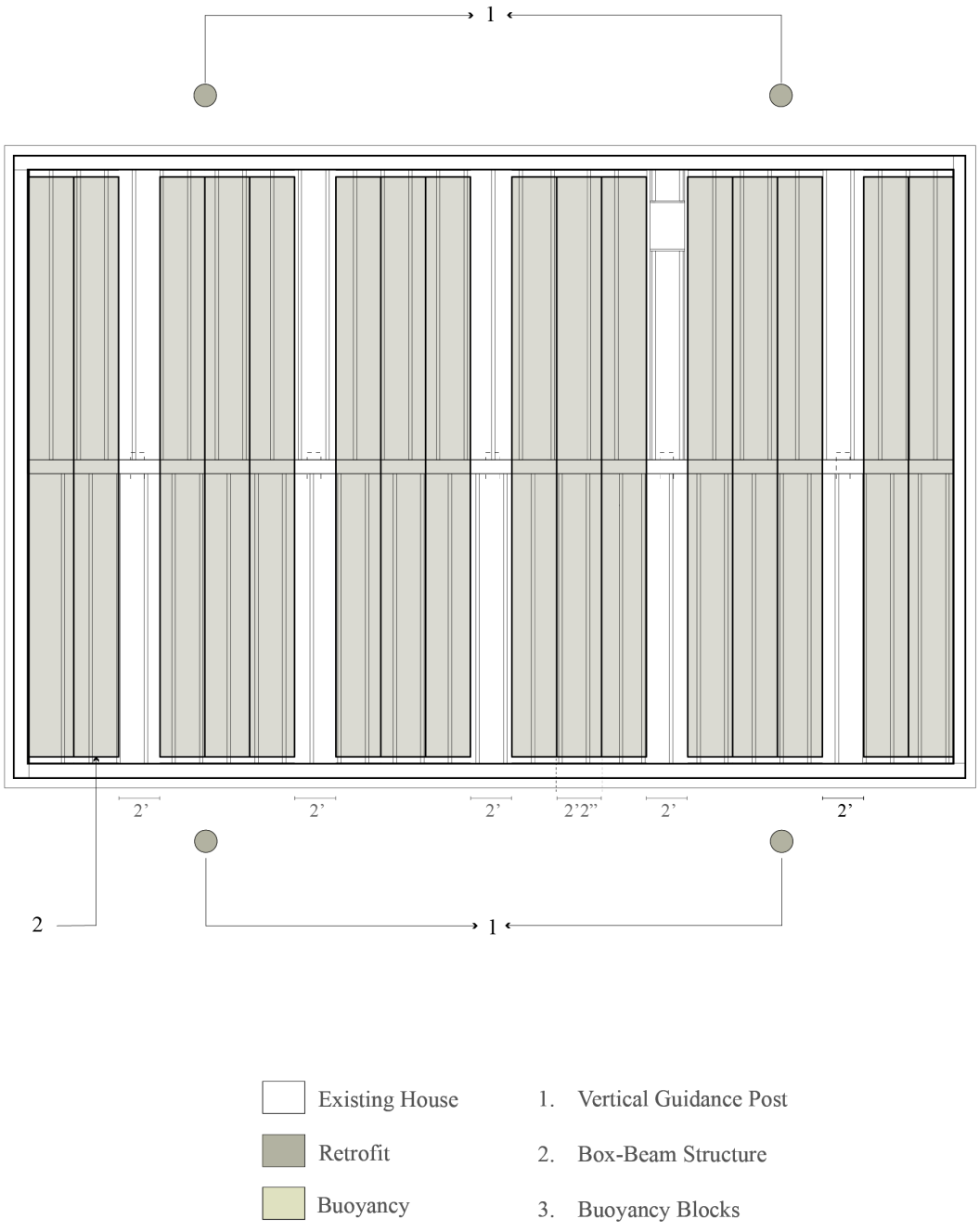


Figure 5.3: Floor Plan of the Box Beam Structure in the Amphibious Design Proposal for a Typical Type A House (Image by author).

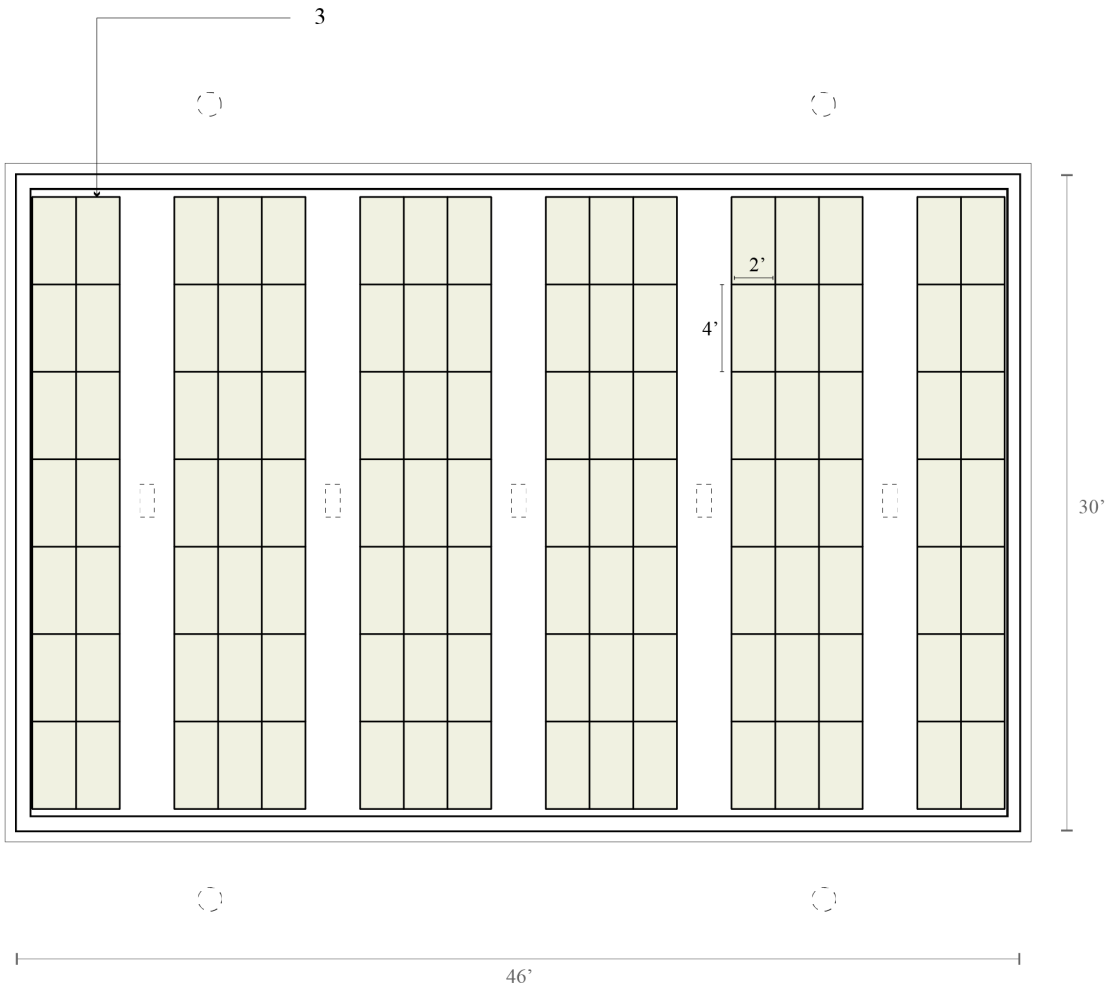
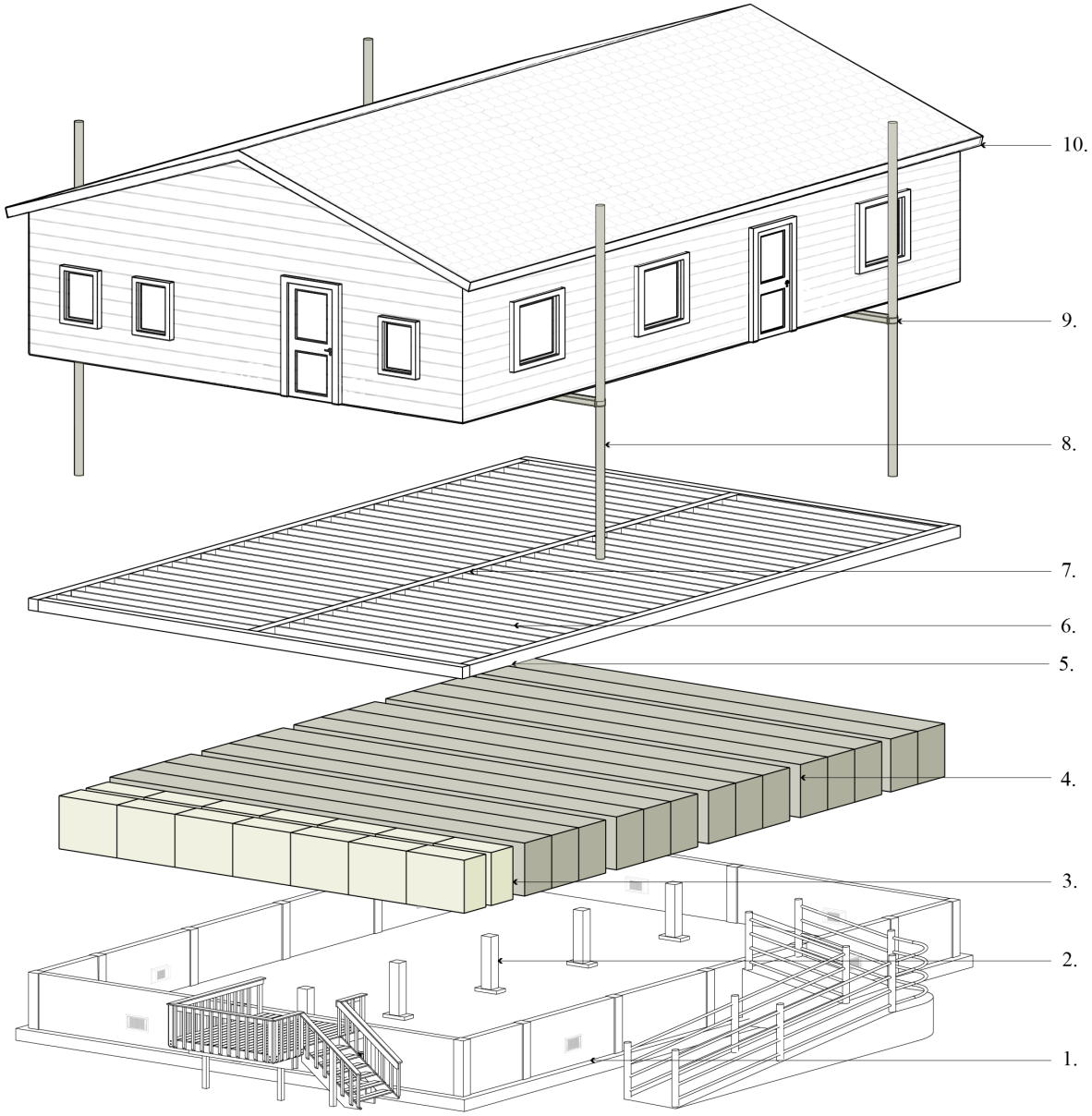


Figure 5.4: Floor Plan of the Buoyancy Elements in the Amphibious Design Proposal for a Typical Type A House (Image by author).



1. Crawlspace Foundation
2. Piers to Support the Central Beam
3. Buoyancy Elements
4. Box-Beam Structure for the Buoyancy Elements
5. Sill Beam
6. Floor Joists
7. Central Beam
8. Vertical Guidance Posts
9. Sleeves
10. House

Existing House

Retrofit

Buoyancy

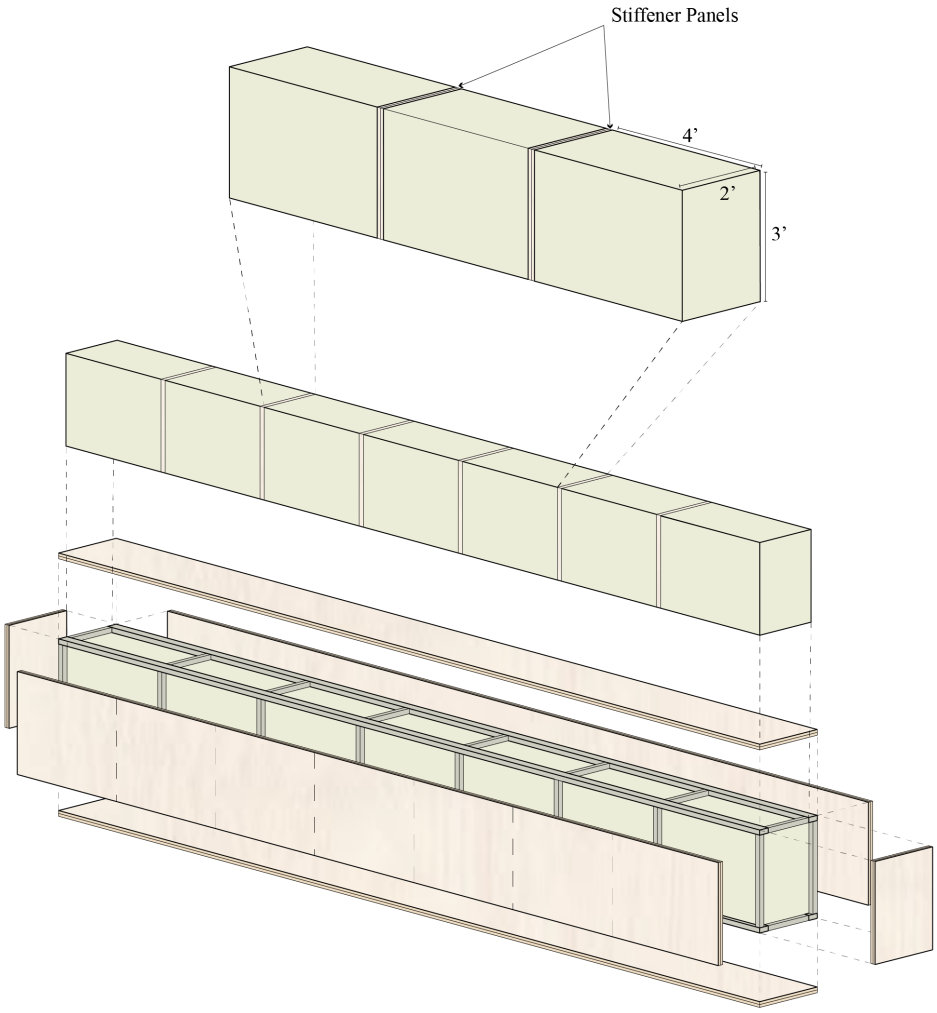


Figure 5.5: An Exploded Axonometric of the Amphibious Design Proposal (Image by author). [Left]

Figure 5.6: Schematic Design of the Box Beam Structure (Image by author). [Right]



Existing House

Figure 5.7: The house whe



Retrofit Buoyancy

n floating (Image by author).

The "Amphibiation" Process

Amphibiating a home involves a detailed and methodical approach to ensure safety and resilience. Below is an outline of the key steps involved, but does not represent all of the necessary steps in transforming a traditional home into an amphibious home.

1. Structural Considerations and Flood Risk Assessment

The process involves calculating key structural components of the home, focusing on elements critical to determining the load-bearing capacity to ensure it can be supported by an amphibious foundation during flood events. This includes the weight of the existing house, the load paths and documenting the size of the structural members.

Simultaneously, flood risk assessment is conducted. This assessment evaluates factors such as water levels, flood frequency and water and wind velocities. Together, these assessments guide the design of an amphibious foundation that will enable the house to rise safely with the floodwater.

2. Designing the Amphibious Foundation

The amphibious foundation serves as the core element that allows the home to float during a flood. Calculating the necessary buoyancy required to lift the home relies on formulas outlined in the previous sections [refer to pgs. 174 and 176]. In this design, EPS foam blocks serve as buoyancy elements and are positioned within the crawlspace beneath the existing joists. To secure the buoyancy elements as well as support the central beam during the float, the blocks are encased within a structural layer of beams, creating a box-like frame. There are multiple other ways to do so as well, including the use of straps.

Additionally, an access aisle might be incorporated within the crawlspace between the buoyancy blocks. This enables inspections and maintenance when needed.

3. Installing Vertical Guidance Posts

These posts ensure that the home rises vertically and does not drift, float away or shift laterally during a flood event. The posts are anchored deep into the ground and placed near the corners or along the sides of the house.

Centering devices can be integrated to ensure that, once the floodwaters recede, the house returns to its exact original position without any horizontal misalignment.

4. Flexible Utility Connections

Utility systems must be modified to accommodate the vertical movement of the home during flood events. This can be done by manually disconnecting them, installing pull-apart, self-sealing breakaway connections, or using flexible connections [refer to Chapter 3.2, pg. 82].

5. Debris Screen as a Protective Measure

To prevent unwanted materials, such as tree trunks, branches, and other debris, from entering and impacting the components of the amphibious foundation causing damage, a debris screen could be installed around the perimeter of the house. While not a universally implemented component of amphibious construction, debris screens are beneficial in cases where floating debris is prevelant.

6. Post-Flood Evaluation and Ongoing Maintenance

A post-flood inspection can be conducted to assess any damage to the system and identify necessary adjustments [refer to Appendix A, pg. 183]. Establishing a maintenance schedule can help ensure the long-term integrity of the structure, including inspections of the guidance posts, centering devices and the buoyancy elements. This type of maintenance supports the readiness of the house for the next flood.

5.3 Environmental Considerations and Sustainable Materials

Environmental considerations play an important role in designing amphibious architecture, especially for Indigenous communities, where the land is deeply intertwined with the cultural identity of the community. The design must honour this relationship between the people and the land. Designing homes that are not only resilient but also environmentally responsible ensures that construction respects the natural ecosystems and supports long-term sustainability. This includes a careful selection of materials that simultaneously minimize environmental harm while maximizing durability.

Wherever possible, using renewable materials like sustainably sourced timber or cedar can significantly reduce the carbon footprint. First Nations have a rich history of using traditional building materials that are adapted to the local environment and available resources. The choice of materials often depends on the specific needs of the community, the climate, and its location. For example, many such communities in BC have historically relied on materials like cedar for building their longhouses and canoes, as well as crafting tools and other artifacts.[12] Locally sourced materials not only reduce transportation emissions but also support local economies and align with cultural values.

Various amphibious projects around the world have employed a range of buoyancy materials, including recycled plastic water bottles, bamboo, and concrete open caissons [refer to Chapter 3.2, pg. 80]. Each material is selected based on cost, local availability, sustainability and suitability for buoyancy, demonstrating that diverse materials can be successfully adapted to meet the unique environmental and cultural needs of different communities. Vertical guidance posts can be made of steel or locally sourced wood. Depending on the community and its local environment, these posts can be made using materials that reduce the ecological footprint while maintaining the necessary

structural integrity. For the buoyancy elements, sustainable options like wood or recycled materials can be considered to lower environmental impacts. However, for the purpose of this proposal, I have chosen EPS foam because of its unique advantages: it provides excellent buoyancy, is lightweight, and offers long-term stability in water. While there are environmental concerns regarding its lack of biodegradability, its benefits contribute to the effectiveness of amphibious design. Moreover, foam is readily available, make it a cost-effective option that allows for scalability, which is important for communities requiring housing solutions. Its adaptability also makes it ideal for retrofits, as it integrates easily into the existing structures. In the future, as more sustainable materials become available and scalable, the aim would be to shift towards more environmentally friendly options.

5.4 Reciprocity and Community Engagement

Community engagement is a vital component of this project, grounded in the principle of reciprocity. For amphibious architecture to be effective and this process to be successful, it must be developed in close collaboration with the community it seeks to serve. This ensures that the solutions not only address flood resilience but also reflect the community's cultural values and ideas. This project is not about telling people what they should do, but rather creating a space for collaboration. For amphibious architecture to effectively meet the community's needs, the design process must involve ongoing communication based on mutual respect, collaboration, and understanding.

Engaging with the community means recognizing that they are the experts of their own land, traditions, and experiences. Their knowledge of the environment, local climate, and historical flood patterns is crucial in shaping housing solutions that work for them, not just technically, but culturally and practically.

Furthermore, incorporating Traditional Knowledge[i] strengthens the process by honouring Indigenous ways of knowing and wisdom [refer to Chapter 4.5, pg. 130].

As Indigenous communities across the country grapple with the intensifying consequences of climate change, particularly for areas prone to flooding, the necessity of adapting housing strategies becomes even more critical. The design proposal outlined in this chapter offers a blueprint for resilient, adaptable homes that not only respond to environmental challenges but also respect the cultural and social dimensions of Indigenous life (Figure 5.9). However, the process of amphibiating homes for Indigenous communities extends far beyond the technical considerations. It requires a deeper understanding of the communities' relationship with the land, the water and its architecture. This process must be participatory, involving collaboration with Indigenous leaders, designers, and community members to ensure that the final product is what the people want and need.

By considering environmental impacts, sustainable materials, and Indigenous knowledge, this design proposal through amphibious architecture aims not only to protect the communities from the damages of flooding but also to strengthen the connection between architecture, people, land and cultural heritage. Thus, three major design principles of amphibious architecture for Indigenous homes could be categorized as (Figure 5.8):

a) safety of life and security of property

b) heritage preservation

c) promotion of traditional materials and sustainable building practices

i Traditional Knowledge is also at times referred to as Traditional Ecological Knowledge (TEK).

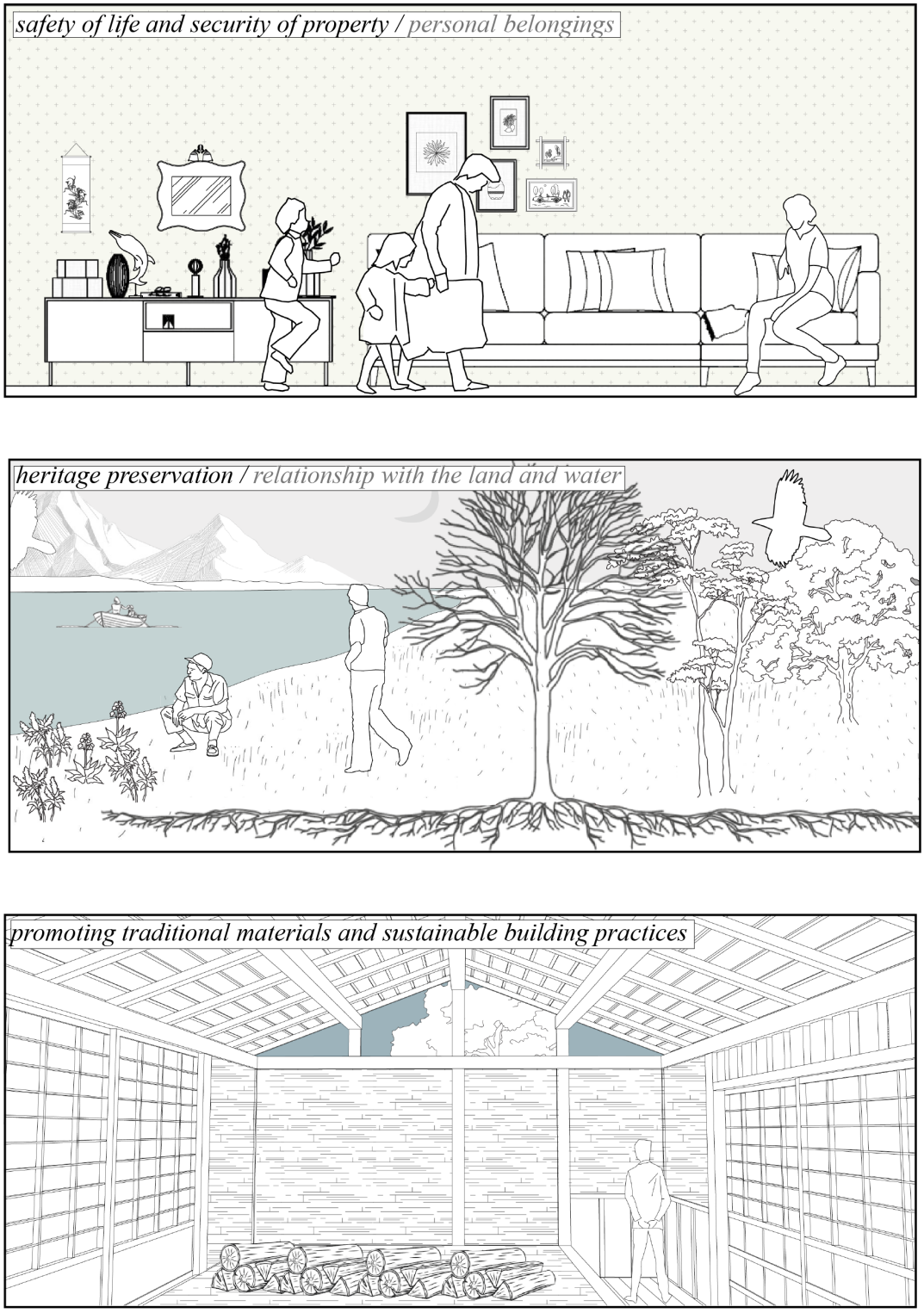
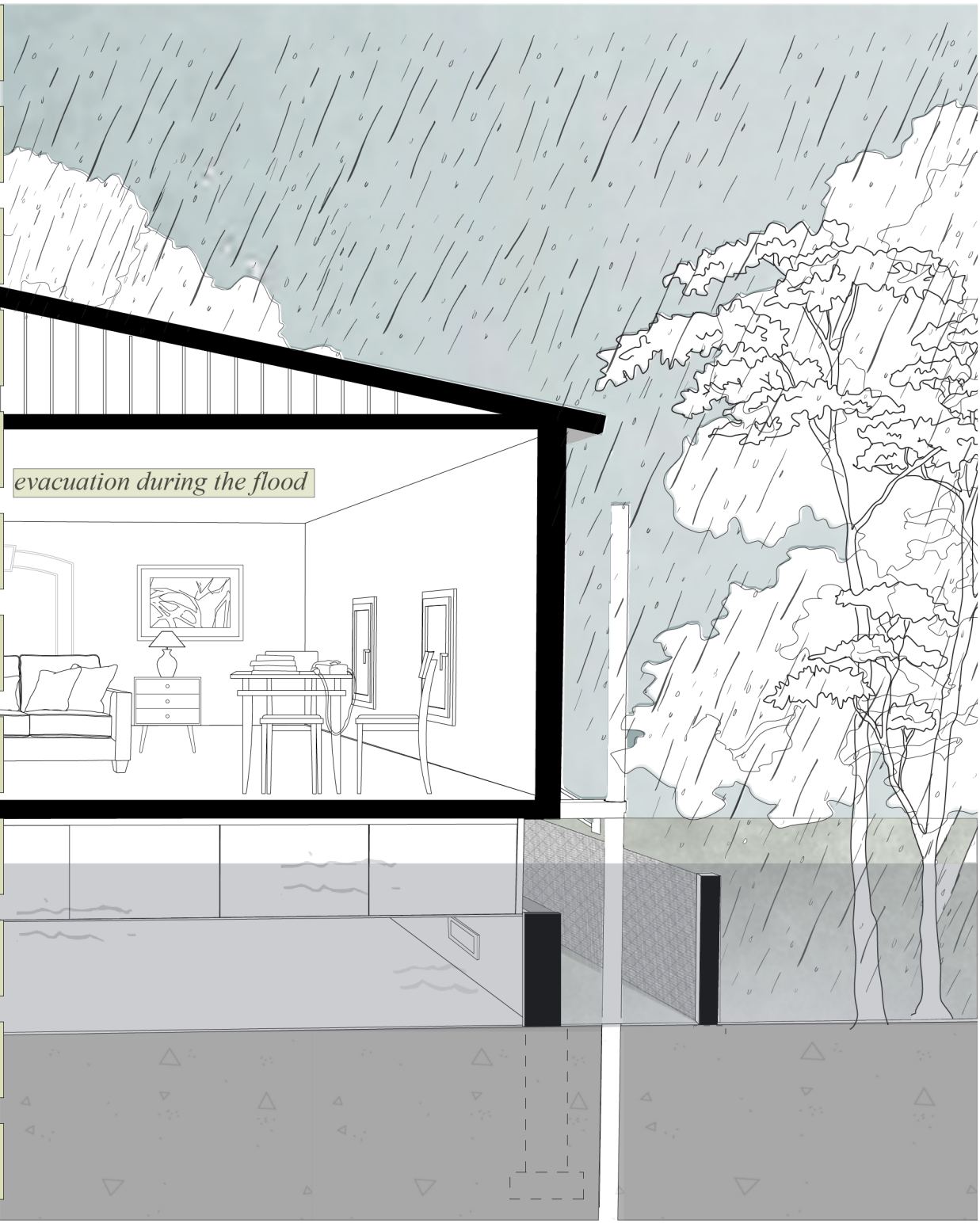


Figure 5.8: The three design principles of this amphibious design proposal (Image by author).



Figure 5.9



between land and water

1 "Water is Our Friend Workshop #2," *Workshop*, The Buoyant Foundation Project, University of Waterloo, Cambridge, Ontario, May 25-26, 2024.

2 Tim Fontaine, "First Nations housing: thinking outside the box," *CBC News*, April 11, 2017, https://www.cbc.ca/news/indigenous/first-nations-innovations-housing-1.4064715

3 "Yale First Nation and Britco team up to create a new generation of energy efficient housing," *BC Rural Centre*, https://bcruralcentre.org/yale-first-nation-britco-team-create-new-generation-energy-efficient-housing/

4 "Modular and Prefabricated Housing: Literature Scan of Ideas, Innovations, and Considerations to Improve Affordability, Efficiency, and Quality," *BC Housing*, 2014, https://www.bchousing.org/publications/Modular-Prefabricated-Housing-Literature-Scan.pdf

5 Lia Tramontini and Elizabeth English, "Amphibiating Prefabricating Housing," Proceedings of the First International *Conference on Amphibious Architecture, Design and Engineering (ICAADE 2015),* Bangkok, Thailand, August 26-29, 2015; 285-293.

6 Government of Ontario, "Building a modular home," *Ministry of Municipal Affairs and Housing*, 2021, https://files.ontario.ca/mmah-building-a-modular-house-en-202-12-06.pdf

7 "Stick-Built vs Modular Construction: A comparison," *Converge*, June 19, 2023, https://www.converge.io/blog/modular-vs-traditional-construction#:~:text=To%20conclude%2C%20both%20stick%2Dbuilt,and%20eco%2Dfriendly%20building%20solutions.

8 "Modular and Prefabricated Housing," *BC Housing*.

9 Ibid.

10 Government of Ontario, "Building a modular home."

11 Elizabeth English, The Buoyant Foundation Project, "Draft of the Guidance Document for Amphibious Construction," *Prepared for The National Research Council of Canada* (publication pending, used by permission).

12 "Cedar," *First Nations and Indigenous Studies at the University of British Columbia*, https://indigenousfoundations.arts.ubc.ca/cedar/

epilogue

As this journey of research and exploration draws to a close, what remains is the ever-present truth that for First Nations communities, the land is more than a place—it is identity, heritage, and home. To design for such a space is not just to build, but to understand the intricate layers of relationship among people, water, and earth. It is to acknowledge histories of displacement, dispossession, and resilience that have shaped Indigenous experiences with land and flooding. But it also means recognizing the weight of trauma—felt deeply by communities who are repeatedly uprooted from their homes and forced to endure the heartbreak of uncertainty.

This thesis was shaped by my visit to British Columbia during the initial exploration, where I stood among homes scarred by rising floodwaters. In these moments, I listened to community members share their stories, their struggles, and their determination to explore new possibilities. What I saw was not defeat but a persistent search for options—a collective will to remain rooted, to safeguard their traditions, and to look for solutions that honour their connection to the land. This work is, in part, a response to that search.

The adoption of amphibious architecture within Indigenous communities offers one such option in the broader toolkit of flood resiliency measures. It is not just a practical response to flooding; it signals a shift towards resilience in place. By allowing homes to float when necessary and settle back on the land when floodwaters recede, amphibious architecture upholds the principles of living in harmony with the water cycles and nature—a value deeply embedded in Indigenous worldviews. In reflecting on this thesis, what resonates most is the pressing need to ensure that any approach to housing in flood-prone reserves goes beyond resilience in place. It must foster continuity of culture, honour the stories of the land, and amplify Indigenous voices. With every step toward "amphibiating" housing, the future of these communities can hold the promise of safety without sacrificing the sacred connections that tie people to the land.

As we move forward, it is crucial that governments, architects, and policymakers not only acknowledge the technical aspects of these design solutions but also engage with the cultural sphere. The integration of amphibious architecture into policies, the National Building Code, and Indigenous housing strategies requires not only technical innovation but cultural understanding, continuous dialogue, and community leadership.

It is important to clarify that this thesis does not assert amphibious architecture as the definitive solution or the only path forward. The best choice will ultimately depend on the specific circumstances, priorities, and needs of each community. Instead, what this thesis offers is an option—a form of resilience in place. It provides a way for First Nations communities to remain connected to their homelands, rather than being forced to abandon them due to the increasing threat of floods. By offering the possibility of staying rooted in place, amphibious architecture allows for communities to preserve their ties to the land and continue their cultural traditions, even as they adapt to changing environmental conditions of today.

This work began with the waters—those that rise in floods, threatening the homes and lives of so many. Yet, it also began with the voices of Indigenous participants, whose insights and guidance have shaped its foundation. To them, I offer my deepest gratitude. Their wisdom, courage, and commitment to seeking solutions are a testament to the resilience and strength that defines their communities.

Perhaps there is no singular solution, no perfect blueprint. Instead, there is a collective movement towards something deeper: a way of living with the land, where even when the waters rise, the people stay rooted.

Bibliography

Alberta Water Portal Society. https://albertawater.com/flood-mitigation/relocation/.

"Amphibious Housing in Maasbommel, the Netherlands." *Climate ADAPT.* June 7, 2016. https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands

Andrews, Jeanne. *Flooding : Canada Water Book.*. Ottawa: Ecosystem Sciences and Evaluation Directorate, Economics and Conservation Branch, 1993.

Angelakis, Andreas N., Andrea G. Capodaglio, Mohammad Valipour, Jens Krasilnikoff, Abdelkader T. Ahmed, Laila Mandi, Vasileios A. Tzanakakis, Alper Baba, Rohitashw Kumar, Xiaoyun Zheng, Zhang Min, Mooyoung Han, Bashiru Turay, Esra Bilgic, and Nicholos Dercas. "Evolution of Floods: From Ancient Times to the Present Times (ca 7600 BC to the Present) and the Future." *Land* 12, no. 6 (June 2023): 1211. https://doi.org/10.3390/land12061211.

Armour, R.C. *North American Indian Fairy Tales Folklore and Legends*. London: Gibbons & Co., 1905. Photograph.

Assembly of First Nations. https://afn.ca/

Auditor General of Canada. http://publications.gc.ca/collections/collection_2013/bvg-oag/FA1-2013-2-0-eng.pdf

Baker, Rochelle. "Salvaging the Sacred from Climate Disaster." *Mother Jones*. April 16, 2023. https://www.motherjones.com/environment/2023/04/salvaging-the-sacred-from-climate-disaster/

Ballard, Myrle. "Flooding Sustainable Livelihoods of the Lake St Martin First Nation: The need to Enhance the Role of Gender and Language in Anishinaabe Knowledge Systems." (PhD diss., University of Manitoba, 2012). https://mspace.lib.umanitoba.ca/server/api/core/bitstreams/b1121cdb-39c6-40bc-bf30-ad3659ae8e45/content

Ballard, Myrle, and Shirley Thompson. "Flooding Lake St. Martin First Nation Community: Impacts to and Future Community Plans for Sustainable Livelihoods." *Canadian Journal of Nonprofit and Social Economy Research* 4 (2013):43-65. https://doi.org/10.22230/cjnser.2013v4n1a129

Ballard, Myrle, and Shirley Thompson. "Flooding Hope: The Lake St. Martin Story." *Culture Unplugged* (video). 2012. https://cultureunplugged.com/documentary/watch-online/play/53590/flooding-hope-the-lake-st-martin-story

Ballard, Myrle. "Wounded Spirit: Forced Evacuation of Little Saskatchewan First Nation Elders." YouTube (video). January 22, 2016. https://www.youtube.com/watch?v=PQTubc1LIjY.

"BC First Nations Climate Strategy and Action Plan." *First Nations Leadership Council*. 2022. https://www.bcafn.ca/sites/default/files/2022-04/BCFNCSAP%20Final%20Draft%20%2822April2022%29.pdf.

"B.C. First Nations Salvaging the Sacred from Climate Disaster." *Victoria News*. April 14, 2023. https://www.vicnews.com/news/b-c-first-nations-salvaging-the-sacred-from-climate-disaster-113344.

BC Government. *British Columbia Float Home Standard*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/2003_float_home_standard.pdf

Bergen, Rachel. "Peguis First Nation Members Thankful for Community Meal after Difficult Year of Flooding, COVID-19." *CBC News*. October 9, 2022. https://www.cbc.ca/news/canada/manitoba/peguis-first-nation-flooding-update-thanksgiving-1.6611751

Bingler, Steven. "Climate lessons from the floating villages of Cambodia." *Common Edge*. November 29, 2023. https://commonedge.org/climate-lessons-from-the-floating-villages-of-cambodia/

Brake, Justin. "'Literally life and death': Indigenous climate leaders critical of Canada's response to climate change report." *Aboriginal People's Television Network News*. October 17, 2018. https://aptnnews.ca/2018/10/17/ literally-life-and-death-indigenousclimate-leaders-critical-of-canadasresponse-to-climate-change-report/

British Columbia Assembly of First Nations. https://www.bcafn.ca/first-nations-bc/interactive-map.

"Building Code Compliance for First Nation Housing." *Canada Mortgage and Housing Corporation*. 2024. https://www.cmhc-schl.gc.ca/professionals/industry-innovation-and-leadership/industry-expertise/indigenous-housing/develop-manage-indigenous-housing/building-code-compliance-first-nation-housing.

Burton, Hilary, Felicia Rabito, Lisa Danielson, and Tim K. Takaro. "Health effects of flooding in Canada: A 2015 review and description of gaps in research." *Canadian Water Resources Journal / Revue canadienne des ressources hydriques* 41 (2016):1-2, 238-249. doi: 10.1080/07011784.2015.1128854

Bush, Elizabeth, and Donald S. Lemmen. "Canada's Changing Climate Report." Government of Canada. 2019. https://publications.gc.ca/collections/collection_2019/eccc/En4-368-2019-eng.pdf

Cariou, Warren, and Niigaanwewidam James Sinclair, eds. *Manitowapow: Aboriginal Writings from the Land of Water.* Winnipeg, Manitoba: HighWater Press, 2011.

Cajete, Gregory. *Native Science: Natural Laws of Interdependence.* Santa Fe, New Mexico: Clear Light Publishers, 2000.

Canadian Press. "A woman gets back into her flooded car in Toronto on July 8, 2013, after heavy rainfall caused widespread flooding." Photograph. Retrieved from https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

Canadian Press. "BC First Nations say Chilcotin River landslide, flood hit heritage sites, salmon." *CTV News*. August 8, 2024. https://bc.ctvnews.ca/b-c-landslide-and-flood-damages-cultural-sites-says-williams-lake-first-nation-1.6993696

Canadian Press. "Hundreds evacuate as floods hit northern Ontario First Nation." *Global News*. April 27, 2023. https://globalnews.ca/news/9656123/spring-flooding-northern-ontario-first-nation-evacuation/

Canadian Press. "Study Identifies Indigenous Communities That Are Hotspots for Flooding Risk." V*ancouver Is Awesome.* January 4, 2022. https://www.vancouverisawesome.com/highlights/study-identifies-indigenous-communities-that-are-hotspots-for-flooding-risk-4913674.

"Cedar." *First Nations and Indigenous Studies at the University of British Columbia*. https://indigenousfoundations.arts.ubc.ca/cedar/

"Certificate of Possession." *Cowichan Tribe*. https://cowichantribes.com/about-cowichan-tribes/land-base/certificate-possession#:~:text=Certificate%20of%20Possession%20is%20documentary,legal%20title%20to%20the%20land.

Chakraborty, Liton, Jason Thistlethwaite, Andrea Minano, Daniel Henstra, and Daniel Scott. "Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada." *International Journal of Disaster Risk Science* 12 (2021): 821–838. https://doi.org/10.1007/s13753-021-00383-1

"Cheslatta Carrier First Nation sign reconciliation agreement with province." *CBC News*. September 13, 2016. https://www.cbc.ca/news/canada/british-columbia/cheslatta-carrier-nation-1.3759220

Cheung, Christopher. "How a 'Perfect Storm' Could Flood the Musqueam Reserve." *The Tyee*. June 17, 2022. https://thetyee.ca/News/2022/06/17/How-Perfect-Storm-Could-Destroy-Musqueam-Reserve/.

Chubak, Lydia. "Evacuation underway in Kashechewan, Ont., due to spring flooding of Albany River." *Northern Ontario News*. April 12, 2024. https://northernontario.ctvnews.ca/evacuation-underway-in-kashechewan-ont-due-to-spring-flooding-of-albany-river-1.6845347

City and Borough of Sitka, Alaska. *Home Rule Charter of the City and Borough of Sitka*. Chapter 19.15 Building Code for Float Homes. 2019. https://sitka.municipal.codes/SGC/19.15

"Climate Change and Emergency Management for Indigenous Communities." *Indigenous Corporate Training Inc.* April 30, 2024. https://www.ictinc.ca/blog/climate-change-and-emergency-management-for-indigenous-communities.

Colin, Kim. "Floating Home Float Construction–The Log Float Method. Portland Waterfont Properties, LLC–Willametter River Floating Homes." November 21, 2014. Photograph. kim-colin.squarespace.com/.

Coulbourne, William L., David L. Kriebel, Randall L. Behm, and Kimberly K. McKenna. "Guide for Design of Flood-Resistant Buildings." *National Research Council of Canada*. 2021. https://doi.org/10.4224/40002704.

Cornell, Sean, Duncan Fitzgerald, Nathan Fey, Ioannis Georgiou, Kevin C. Hanegan, Li-San Hung, Mark Kulp, Diane Maygarden, David Retchless, Brent Yarnal, and Tim Bralower. "The Netherlands-Terp Mounds." *Earth 107: Coastal Processes, Hazards, and Society.* https://www.e-education.psu.edu/earth107/node/1082.

CRED. "2022 Disasters in numbers," *Centre for Research on the Epidemiology of Disasters*. 2023. https://cred.be/sites/default/files/2022_EMDAT_report.pdf.

"Crown-Indigenous Relations and Northern Affairs Canada." *Government of Canada*. https://www.canada.ca/en/crown-indigenous-relations-northern-affairs.html

Danish Maritime Authority. *Technical Regulation on the Stability, Buoyancy, etc. of Houseboats and Floating Structures*. 2007. https://www.dma.dk/Media/637720424603885615/Technical%20regulation%20on%20the%20stability%20buoyancy,%20etc%20of%20houseboats%20and%20floating%20structures.pdf

De Agostini. Biblioteca Ambrosiana. Photograph. Retrieved from https://www.history.com/news/worlds-most-catastrophic-floods-in-photos

Dehaas, Josh. "Northern Ontario First Nation Could Face 'Catastrophic Flooding': MP." *CTV News*. April 14, 2019. www.ctvnews.ca/canada/northern-ontario-first-nation-couldface-catastrophic-flooding-mp-1.4379671.

Dyvik, Einar H. "Natural Disasters on the Continents by Nature of the Disaster." *Statista*. July 4, 2024. https://www.statista.com/statistics/269653/natural-disasters-on-the-continents-by-nature-of-the-disaster/

Eco-Health Learning Circle. "Flood Children: Eight Years Displaced from Little Saskatchewan First Nation." YouTube (video). April 7, 2022. https://www.youtube.com/ watch?v=BxsG5q1cAGY.

Empson, Jaison. "Crews in Peguis First Nation ramp up flood protection in anticipation of more rain." *CBC News*. May 9, 2022. Photograph. https://www.cbc.ca/news/canadamanitoba/peguis-first-nation-more-flooding-preparation-1.6447104

Engel, Magritt, and Karen Willmore. *Steller's History of Kamchatka*. Fairbanks: University of Alaska Press, 2003.

English, Elizabeth. "Amphibious Foundations and the Buoyant Foundation Project: Innovative Strategies for Flood-Resilient Housing." *International Conference on Urban Flood Management by UNESCO-IHP and COST Action C22*. November 2009.

English, Elizabeth. "ICLR Quick Response BC Report: BC Communities Affected by the November 2021-February 2022 Atmospheric River Events." *Prepared for The Institute of Catastrophic Loss Reduction,* unpublished manuscript. 2024. used by permission.

English, Elizabeth. "Louisiana Fishermen Pioneer Floating Architecture." *YouTube*. https://www.youtube.com/watch?v=D8prRSK2rmM

English, Elizabeth. "The Greatest Impediment to Amphibious Construction is Policy, Not Technology." *International Conference on Amphibious Architecture*. 2015.

English, Elizabeth. The Buoyant Foundation Project. "Draft of the Guidance Document for Amphibious Construction." *Prepared for The National Research Council of Canada* (publication pending, used by permission).

English, Elizabeth C., Carol J. Friedland, and Fatemeh Orooji. "Combined Flood and Wind Mitigation for Hurricane Damage Prevention: The Case for Amphibious Construction." *Journal of Structural Engineering* 143, 6 (2017). https://doi.org/10.1061/(ASCE)ST.1943-541X.000175

English, Elizabeth C., Lee Chan, Brent Doberstein, and Teresa Tran. "Development of Amphibious Homes for Marginalized and Vulnerable Populations in Vietnam." WW216 Final Report—Executive Summary for the Global Resilience Partnership. July 2020.

English, Elizabeth, Meiyi Chen, Rebecca Zarins, and Iryna Humenyuk. "An Innovative Strategy to Increase the Resilience of Flood-Vulnerable Communities While Reducing Risk of Population Displacement and Psychological Trauma." 8th International Conference on Build*ing Resilience–ICBR Lisbon 2018, Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages.* November 2018. https://www.researchgate.net/publication/349440264_An_innovative_strategy_to_increase_the_resilience_of_flood-vulnerable_communities_while_reducing_risk_of_population_displacement_and_psychological_trauma.

English, Elizabeth, Michelle Li, Rebecca Zarins, and Tobias Feltham. "The Economic Argument for Amphibious Retrofit Consruction." Paper Presented at the 8th International Conference on Building Resilience. 2018.

English, Elizabeth, Natasha Klink, and Scott Turner. "Thriving with water: Developmentscin amphibious architecture in North America." *FLOODrisk 2016–3rd European Conference on Flood Risk Management* (2016). https://www.e3s-conferences.org/articles/e3sconf/pdf/2016/02/e3sconf_flood2016_13009.pdf

"Evaluation of the Administration of Reserve Land Sub-program (PAA# 3.2.3)." *Government of Canada*. September, 2015. https://www.rcaanc-cirnac.gc.ca/eng/1481214401553/1537878979594

Factor Architecten. "Project Review: Floating Homes 'De Gouden Kust' Maasbommel, the Netherlands, 1998-2005." *Climate ADAPT*. February 2011. https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands/11310092.pdf/@@download/file

Fan, George. "Tides of Change: Climate Change and Flooding in Canada." *Marsh*. January 3, 2023. https://www.marsh.com/ca/en/services/risk-consulting/insights/climate-change-and-flooding-in-canada.html.

Federal Emergency Management Agency. https://hazards.fema.gov/nri/coastal-flooding

Few, Roger, Mike Ahern, Franziska Matthies, and Sari Kovats, "Floods, Health and Climate Change: A Strategic Review." *Tyndall Centre for Climate Change Research* (November 2004).

FEMA, https://www.fema.gov/about/offices/resilience

FEMA. https://www.fema.gov/sites/default/files/documents/fema_elevating-your-house-chapter-5.pdf

"First Nations Guide to Housing Policy." *Assembly of First Nations*. June, 2010. https://www.afn.ca/uploads/files/housing/housing-policy-guide.pdf

"First Nations Housing." *Government of Canada*. https://www.sac-isc.gc.ca/eng/1100100010715/1521125087940

"First Nation Land Management: Policy and Legislation." *Government of Canada*. August 1, 2023. https://www.rcaanc-cirnac.gc.ca/eng/1686318557963/1686318775639

First Nations Market Housing Fund. https://www.fnmhf.ca/

Flood Map Viewer. https://www.floodmapviewer.com/maps

"Flooding in First Nations communities." *Government of Canada*, https://www.sac-isc.gc.ca/

Fontaine, Tim. "'It gets tiring': Manitoba First Nation wants long-term solution to flooding." *CBC News*. April 4, 2017. https://www.cbc.ca/news/indigenous/peguis-first-nation-manitoba-flood-1.4053712

Freie Universitat Berlin. https://www.geo.fu-berlin.de/en/v/iwrm/Implementation/technical_measures/Flood-protection-measures/structural_measures/Floodwalls/index.html.

Furgal, Christopher, and Jacinthe Seguin. "Climate Change, Health, and Vulnerability in Canadian Northern Aboriginal Communities." *Environmental Health Perspectives* 114, 12 (July 2006): 1964–70. doi:10.1289/ehp.8433.

Fumano, Dan. "'We have nowhere': B.C. First Nations, rural residents say storm permanently changed the land." *Vancouver Sun*. November 15, 2021. https://vancouversun.com/news/local-news/we-have-nowhere-b-c-first-nations-rural-residents-say-storm-permanently-changed-the-land

Garcia, Tere. "The Floating Basket homes of Iraq: A Paradise almost Lost to Saddam." *Architecture in Development*. June 11, 2015. https://architectureindevelopment.org/news/120

Gillett, Nathan, Alex Cannon, Elizaveta Malinina, Markus Schnorbus, Faron Anslow, Qiaohong Sun, Megan Kirchmeier-Young, Francis Zwiers, Christian Seiler, Xeubin Zhang, Greg Flato, Hui Wan, Guilong Li, and Armel Castellan. "Human Influence on the 2021 British Columbia Floods." *SSRN Scholarly Paper*. Rochester, NY, February 3, 2022. https://doi.org/10.2139/ssrn.4025205.

Glenn, Nicole, and Maxine Myre. "Post-flooding community-level psychosocial impacts and priorities in Canada: A preliminary report." *National Collaborating Centre for Environmental Health*. November. 2022. https://ncceh.ca/sites/default/files/Post%20flooding%20community%20level%20psychosoical%20impacts%20Nov%2021%202022_0.pdf

Goel, Vani. Site Visit to BC. March 2024. *Personal Communication*.

Goel, Vani. Site Visit to Chawathil First Nation, British Columbia. March 2024. *Personal Communication*.

GovernmentofCanada.2023.https://www.sac-isc.gc.ca/eng/1685047435261/1685047540188

Government of Canada. October 18, 2022. https://www.sac-isc.gc.ca/eng/1392046654954/1535122238673.

Government of Canada. 2024. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/bc_flood_strategy.pdf

Government of Canada, "Floods," Public Safety Canada. https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntrl-hzrds/fld-eng.aspx

Government of Ontario. "Building a modular home." *Ministry of Municipal Affairs and Housing.* 2021. https://files.ontario.ca/mmah-building-a-modular-house-en-202-12-06.pdf

Government of New Brunswick, January 2016, https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Flooding-Inondations/Floodproofing.pdf

Guha, Nabarun. "India's mising community seeks to expand its Indigenous adaptation practices in response to climate change." *Prevention Web*. September 21, 2021. https://www.preventionweb.net/news/indias-mising-community-seeks-expand-its-indigenous-adaptation-practices-response-climate

Guha-Sapir, Debrati, Philippe Hoyois, and Regina Below. "Annual Disaster Statistical Review 2014: The numbers and trends.." *CRED.* 2015. http://www.cred.be/sites/default/files/ADSR_2014.pdf

"Guiding Principles (Two Eyed Seeing)." *Integrative Science*. http://www.integrativescience.ca/Principles/TwoEyedSeeing/#:~:text=We%20often%20explain%20Etuaptmumk%20%2D%20Two,for%20the%20benefit%20of%20all.

Halinda, Greg. "Keyano College and Fort McMurray Composite High School surrounded by flood waters from the Clearwater River on Tuesday, April 28, 2020, after a 25-km ice jam caused major flooding and forced 12,000 people from their homes." *The Canadian Press*. Photograph. Retrieved from https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

Holder, Alexa. Site Visit to Peguis First Nation, Manitoba. December 2023. *Personal Communication*.

"Housing & Homelessness." *Assembly of First Nations*. February 26, 2024. https://afn.ca/community-services/housing-and-homelessness/.

"Housing Conditions among First Nations People, Métis and Inuit in Canada from the 2021 Census." *Statistics Canada*. September 21, 2022. https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-X/2021007/98-200-X2021007-eng.cfm.

"Housing on First Nation Reserves: Challenges and Successes." *Senate Canada*. February, 2015. https://sencanada.ca/content/sen/committee/412/appa/rep/rep08feb15b-e.pdf

"Hurricane Katrina- August 2005." *National Weather Service*. https://www.weather.gov/mob/katrina

"Impacted Indigenous Communities Report #20." BCAFN. December 5, 2021. https://www.bcafn.ca/sites/default/files/docs/reports-presentations/05DEC2021_%20IndigenousImpactsReport.pdf

"Implementation of Modern Treaties and Self-Government Agreements." *Government of Canada*. 2018. https://publications.gc.ca/collections/collection_2019/rcaanc-cirnac/R31-34-2018-eng.pdf

"Implementing Effective Housing Policy for First Nations Peoples | FNMHF Blog." *First Nations Market Housing Fund*. March 19, 2024. www.fnmhf.ca/implementing-effective-housing-policy-for-first-nations-peoples/.

Indian Act. R.S.C. 1985, c. I-5, s. 81. https://laws-lois.justice.gc.ca/eng/acts/I-5/section-81.html

"Indigenous Insurance." *Canada Mortgage and Housing Corporation*. March, 2022. https://assets.cmhc-schl.gc.ca/sf/project/archive/research_6/indigenous-home-insurance-literature-review.pdf

Institute for Catastrophic Loss Reduction. https://www.iclr.org/wp-content/uploads/2021/04/ICLR_Flooding_2021.pdf

International Marine Floatation Systems Ltd. https://www.floatingstructures.com/gallery/floating-homes/canoe-pass-village/

Isle de Jean Charles." *The Red Road Project*. https://redroadproject.com/isle-de-jean-charles/

Jensen, Doreen, and Cheryl Brooks. *In Celebration of our Survival: The First Nations of British Columbia*. Vancouver: UBC Press, 1991.

Judge, Andrew. "ARCH 243: Indigenous Practices." Lecture. School of Architecture, University of Waterloo, Cambridge, ON. 2024.

Johnson, Scott K. "Ancient Native American City May Have Been Done in by Mississippi Floods." *Ars Technica*. May 4, 2015. https://arstechnica.com/science/2015/05/ancient-native-american-city-may-have-been-done-in-by-mississippi-floods/.

Jorden, Rob. "How to Move Communities Away from Flooding Risks with Minimal Harm." *PreventionWeb*. July 27, 2023. https://www.preventionweb.net/news/how-move-communities-away-flooding-risks-minimal-harm.

Karczewski, Artur, and Łukasz Piątek. "The Influence of the Cuboid Float's Parameters on the Stability of a Floating Building." *Polish Maritime Research* 27 (September 2020): 16-21. https://doi.org/10.2478/pomr-2020-0042

Kimmerer, Robin Wall. *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants.* London: Penguin Books, 2020.

Kives, Bartley. "Peguis First Nation Declares State of Emergency over Flood-Induced Housing Shortage." *CBC News*. April 30, 2024. https://www.cbc.ca/news/canada/manitoba/peguis-state-emergency-housing-1.7188794.

Krawec, Patty. *Becoming Kin : An Indigenous Call to Unforgetting the Past and Reimagining Our Future.* Minneapolis, MN: Broadleaf Books, 2022. https://doi.org/10.2307/j.ctv29sfz3r.

Library and Archives Canada. "Reports of the Royal Commission on Aboriginal Peoples." Royal Commission on Aboriginal Peoples. August 26, 1991. http://data2.archives.ca/e/e448/e011188230-01.pdf.

Loor, Mattijs. "Amphibious housing in Maasbommel, the Netherlands." *Climate ADAPT*. June 7, 2016. https://climate-adapt.eea.europa.eu/en/metadata/case-studies/amphibious-housing-in-maasbommel-the-netherlands

Luger, Chelsey, and Thosh Collins. *The Seven Circles: Indigenous Teachings for Living Well: First edition.* New York, NY: HarperOne, 2022.

Lyall, Gordon Robert. "'They smashed it right through our reserve': The Problem of Settler Consultation for Infrastructure on Chawathil IR4." *BC Studies* 207 (2020): 67-99. https://go.gale.com/ps/i.do?id=GALE%7CA643640884&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=00052949&p=AONE&sw=w&userGroupName=anon%7Eb7e1b992&aty=open-web-entry

Lyeo, Joonsoo S., Michael D. Wong, Natalie Clyke, Becky Big Canoe, Penny Kinnear, Helen Stopps, Nicholas D. Spence, and Sarah R. Haines. "Ten questions concerning First Nations on-reserve housing in Canada." *Building and Environment* 257 (2024). https://doi.org/10.1016/j.buildenv.2024.111544

"Maasbommel." *The Buoyant Foundation Project*. https://www.buoyantfoundation.org/maasbommel

Macyshon, Jill. "Families still displaced nine years after First Nation flood." *CTV News*.. June 8, 2020. https://winnipeg.ctvnews.ca/families-still-displaced-nine-years-after-first-nation-flood-1.4975266?cache=wpwecmoua%3FcontactForm%3Dtrue%3FclipId%3D1930095

"Manitoba flood diversion plan raises ire of First Nation leaders." *CBC News*. August 12, 2015. https://www.cbc.ca/news/canada/manitoba/manitoba-flood-diversion-plan-raises-ire-of-first-nation-leaders-1.3189092

Marin County, California. *California Municipal Code,* Chapter 19.18, Regulation of the Construction and Maintenance of Floating Homes. 2016. http://marincounty-ca.elaws.us/code/coor_title19

Mark Isaak. *Talk Origins* (blog). https://www.talkorigins.org/pdf/flood-myths.pdf

Marsh, James H. "James Bay Project." *The Canadian Encyclopedia*. January 31, 2011. https://www.thecanadianencyclopedia.ca/en/article/james-bay-project

McNeill, Kelsie, Andrew Binns, and Ashutosh Singh. "Flood History Analysis and Socioeconomic Implications of Flooding for Indigenous Canadian Communities." Paper presented at the Annual Conference of the Canadian Society for Bioengineering. Winnipeg, MB. 2018. www.csbe-scgab.ca/docs/meetings/2017/CSBE17137.pdf.

Melker, Saskia De. "Louisiana Fishermen Pioneer Floating Architecture." *PBS Newshour*. https://www.pbs.org/video/pbs-newshour-louisiana-fishermen-pioneer-floating-architecture/

"Modular and Prefabricated Housing: Literature Scan of Ideas, Innovations, and Considerations to Improve Affordability, Efficiency, and Quality." *BC Housing*. 2014. https://www.bchousing.org/publications/Modular-Prefabricated-Housing-Literature-Scan.pdf

National Collaborating Centre for Indigenous Health (NCCIH). *Climate Change and Indigenous Peoples' Health in Canada. In P. Berry & R. Schnitter (Eds.), Health of Canadians in a Changing Climate: Advancing our Knowledge for Action*. Ottawa, ON: Government of Canada, 2022. https://doi.org/10.4095/329528.

Natural Resources Canada. Retrieved from https://natural-resources.canada.ca/science-and-data/science-and-research/geomatics/topographic-tools-and-data/whats-new/new-major-flood-events-now-available-on-the-historical-flood-events-layer/25891

National Hurricane Center and Central Pacific Hurricane Center. https://www.nhc.noaa.gov/surge/#TIDE

"Old River Landing." *The Buoyant Foundation Project*. https://www.buoyantfoundation.org/old-river-landing

"On-Reserve Non-Profit Housing Program (Section 95)." *Canada Mortgage and Housing Corporation*. https://www.cmhc-schl.gc.ca/professionals/project-funding-and-mortgage-financing/funding-programs/all-funding-programs/on-reserve-non-profit-housing-program-section-95

Orange, Tara. "First Nations communities left in shambles following catastrophic flooding in the southern region of British Columbia." *Catalyst*. December 8, 2021. https://catalystmcgill.com/first-nations-communities-left-in-shambles-following-catastrophic-flooding-in-the-southern-region-of-british-columbia/

O'Sullivan, Michael J., and Paul J. Handal. "Medical and Psychological Effects of the Threat of Compulsory Relocation for an American Indian Tribe. American Indian and Alaska Native Mental Health Research." *Centers for American Indian and Alaska Native Health* 2 (1988):3-2. https://doi.org/10.5820/aian.0201.1988.3

Parker, D.J ed. *Floods*. Routledge, London, 2000.

Pearce, Laurie, Brenda Murphy, and Annette Chrétien. "From Displacement to Hope: A Guide for Displaced Indigenous Communities and Host Communities." March 2017. https://www.researchgate.net/publication/320609014_From_Displacement_to_Hope_A_Guide_for_Displaced_Indigenous_Communities_and_Host_Communities.

Piątek, Łukasz., and English, Elizabeth C. "Amphibious Structures for Smart Flood Risk Reduction and Climate Change Adaptation." In *The Routledge Companion to Smart Design Thinking in Architecture & Urbanism for a Sustainable, Living Planet,* edited by Mitra Kanaani, 511-526. London: Routledge, 10 November 2024. https://doi.org/10.4324/9781003384113

Plyer, Allison. "Facts for Features: Katrina Impact." *The Data Center.* August 26, 2016. https://www.datacenterresearch.org/data-resources/katrina/facts-for-impact/.

Prosun, Prithula. "The LIFT House: An amphibious strategy for sustainable and affordable housing for the urban poor in flood-prone Bangladesh." Master of Architecture Thesis, University of Waterloo, 2011. https://uwspace.uwaterloo.ca/items/fd5d5729-5f56-46ea-b1fa-23b38fff49da

Public Safety Canada. "Government of Canada Releases Report That Will Advance Work on Canada's First National Flood Insurance Program." Government of Canada. August 30, 2022. https://www.canada.ca/en/public-safety-canada/news/2022/08/government-of-canada-releases-report-that-will-advance-work-on-canadas-first-national-flood-insurance-program.html

Ram, Aarti Lila, and Eric Shahzar. "Land, Loss and Liberation: Why Indigenous Communities Face Climate Displacement Challenges." *World Economic Forum*. February 9, 2024. https://www.weforum.org/agenda/2024/02/indigenous-challenges-displacement-climate-change

Risk Factor. https://help.riskfactor.com/hc/en-us/articles/360051062333-Types-of-Flood-Adaptation.

Royal Commission on Aboriginal Peoples. "Reports of the Royal Commission on Aboriginal Peoples." *Library and Archives Canada* 1 (1996): 132. http://data2.archives.ca/e/e448/e011188230-01.pdf

Sandink, Dan, Paul Kovacs, Greg Oulahen, and Glenn McGillivray. "Making Flood Insurable for Canadian Homeowners: A Discussion Paper." *Institute for Catastrophic Loss Reduction & Swiss Reinsurance Company Ltd.* (2010). https://www.iclr.org/wp-content/uploads/PDFS/making-flood-insurable-for-canadian-homeowners.pdf

Smee, Michael. "Why owners of floating homes at Scarborough Bluffs are worried about neighbourhood's future." *CBC News*. May 23, 2022. Photograph. https://www.cbc.ca/news/canada/toronto/floating-homes-leases-scarborough-bluffs-1.6461182

Smith, Marie-Danielle. "First Nations communities suffering 'more intense' impact of climate change, secret briefings say." *National Post*. June 2, 2016. https://nationalpost. com/news/politics/first-nations-communitiessuffering-more-intense-impact-ofclimate-change-secret-briefings-say

Standards Australia. *AS 3962-2001 The Australian Standard: Guidelines for Design of Marinas. Sydney*. 2001. https://hamiltonislandproperty.wordpress.com/wp-content/uploads/2012/06/as_3962-2001_guidelines_for_design_of_marinas.pdf

"Stick-Built vs Modular Construction: A comparison." *Converge*. June 19, 2023. https://www.converge.io/blog/modular-vs-traditional-construction#:~:text=To%20conclude%2C%20both%20stick%2Dbuilt,and%20eco%2Dfriendly%20building%20solutions.

Strain, Brendan. "Cowichan Tribes sandbagging flood-prone homes as atmospheric river approaches Vancouver Island." *Vancouver Island*. November 3, 2022. https://vancouverisland.ctvnews.ca/cowichan-tribes-sandbagging-flood-prone-homes-as-atmospheric-river-approaches-vancouver-island-1.6138250

Stueck, Wendy. "With Climate Disasters on the Rise, B.C.'s Indigenous Communities Find Themselves at High Risk of Displacement." *The Globe and Mail*. November 19, 2021. https://www.theglobeandmail.com/canada/british-columbia/article-with-climate-disasters-on-the-rise-bcs-indigenous-communities-find/.

Thistle, Jesse. "Definition of Indigenous Homelessness in Canada." Canadian Observatory on Homelessness. 2017. York University Press. https://homelesshub.ca/IndigenousHomelessness.

Thistlethwaite, J., M. Le Geyt, G. Martin, S.. Cottar, and L.Whittaker. "Buying Out the Floodplain: Recommendations for Strategic Relocation Programs in Canada." *Partners for Action, University of Waterloo.* 2023. https://uwaterloo.ca/partners-for-action/sites/default/files/uploads/documents/buyingoutthefloodplainreport_en_1.pdf

Thistlethwaite, Jason , Andrea Minano, Daniel Henstra and Daniel Scott. "Indigenous Reserve Lands in Canada Face High Flood Risk, Policy Brief No. 159." *Centre for International Governance Innovation*. April, 2020. https://www.cigionline.org/publications/indigenous-reserve-lands-canada-face-high-flood-risk/.

Thompson, Albert Edward. *Chief Peguis and His Descendants.* Winnipeg: Peguis Publishers, 1973.

Thompson, Megan, and Melanie Saltzman. "Native tribe in Louisiana highlights challenges of climate-driven relocation.." *PBS News.* April 15, 2023. https://www.pbs.org/newshour/amp/show/native-tribe-in-louisiana-highlights-challenges-of-climate-driven-relocation

Thompson, Shirley, and K. Suzuki. "Displacement of Indigenous People in Canada under the Indian Act: Participatory Video with Lake St. Martin and Little Saskatchewan First Nations on Flood Impacts." *Journal of Geoscience and Environment Protection* 10 (2022):242-264. https://www.scirp.org/journal/paperinformation?paperid=121526.

Thompson, Shirley, Myrle Ballard, and Donna Martin. "Lake St. Martin First Nation Community Members' Experiences of Induced Displacement: 'We're like refugees.'" *Refuge* 29, 2 (2014): 75–86. https://refuge.journals. yorku.ca/index.php/refuge/article/view/38168

Tramontini, Lia, and Elizabeth English. "Amphibiating Prefabricating Housing." Proceedings of the First International *Conference on Amphibious Architecture, Design and Engineering (ICAADE 2015).* Bangkok, Thailand. August 26-29, 2015; 285-293.

United Nations. https://www.un.org/en/climatechange/what-is-climate-change.

Verlage, Jordan. "Submerged cars sits in the flood waters in High River, Alta on June 20, 2013 after the Highwood River overflowed its banks." *The Canadian Press.* Photograph. Retrieved from https://globalnews.ca/news/1338253/15-compelling-images-of-high-river-in-the-2013-flood/.

Viswanathan, Leela. "Climate-Forced Indigenous Migration: Humanizing the Impact of Climate Change." *Indigenous Climate Hub* (blog). February 15, 2021. https://indigenousclimatehub.ca/2021/02/climage-forced-indigenous-migration/.

Washington University in St. Louis. "Humans Have Been Changing Chinese Environment for 3,000 Years: Ancient Levee System Set Stage for Massive, Dynasty-Toppling Floods." *ScienceDaily*. June 19, 2014. https://www.sciencedaily.com/releases/2014/06/140619125052.htm.

"Water is Our Friend Workshop #1." *Workshop*. The Buoyant Foundation Project, University of Waterloo, Waterloo, ON. April 10-11, 2024.

"Water is Our Friend Workshop #2." *Workshop*. The Buoyant Foundation Project, University of Waterloo, Cambridge, ON. May 25-26, 2024.

Weslowski, Karen L. "Construction on First Nations Land: Determining the Applicable Building Code." *Lexology, Miller Thomson LLP*. October 3, 2018. https://www.lexology.com/library/detail.aspx?g=f07c8e61-ca12-4e9b-b02f-6a13fdb3bc1e.

"When the levees broke." *National Guard, United States Government*. https://www.nationalguard.mil/Resources/Image-Gallery/Historical-Paintings/Heritage-Series/When-the-Levees-Broke/https://www.nationalguard.mil/Resources/Image-Gallery/Historical-Paintings/Heritage-Series/When-the-Levees-Broke/

Withington, John. *Flood: [Nature and Culture]*. London: Reaktion Books, 2013.

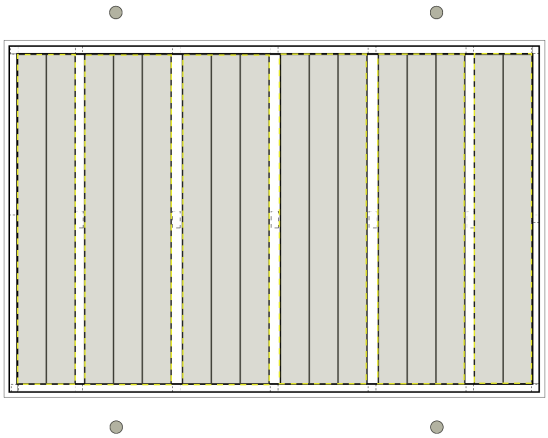
Wolfe, Patrick. "Settler colonialism and the elimination of the native." *Journal of Genocide Research* 8, 4 (2006):387–409. https://doi.org/10/bxsx9z

Wong, Julia, and Terry Reith. "As natural disasters ravage Indigenous land, uninsured residents struggle to rebuild." *CBC News*. June 16, 2023. https://www.cbc.ca/news/canada/insurance-indigenous-communities-1.6876059

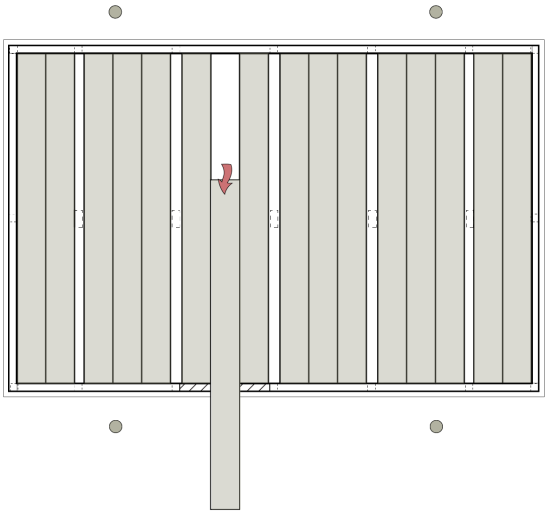
"Yale First Nation and Britco team up to create a new generation of energy efficient housing." *BC Rural Centre*. https://bcruralcentre.org/yale-first-nation-britco-team-create-new-generation-energy-efficient-housing/

Young Post Reporter. "Thailand's floating homes fight flooding with science." *South China Morning Post*. December 9, 2019. https://www.scmp.com/yp/discover/lifestyle/features/article/3069581/thailands-floating-homes-fight-flooding-science

Appendix A: Proposed Maintenance Strategy



All Box Beams in Place: The box beams, containing buoyancy blocks, are secured in their positions, supporting the structure during floating conditions.



Single Box Beam Pulled Out: One box beam is pulled out through a potential access point, allowing direct access to its buoyancy blocks for detailed inspection or maintenance.

Figure A: Diagram Illustrating the Inspection and Maintenance Process for Box Beams containing Buoyancy Blocks (Image by author).

Glossary

100-Year Flood Event: A flood event that has an average of 1 in 100 chance (1% probability) of occurring in any given year.

Amphibious Architecture: A design strategy that enables buildings to adapt to rising water levels by floating when needed while remaining on the ground at other times, preventing flood damage.
[Amphibiate / Amphibiating]

Atmospheric River Events: A type of storm characterized by narrow bands of concentrated moisture in the atmosphere, leading to heavy rainfall.

Buoyancy: The ability of an object to float in water or other fluids.

Climate Adaptation: Proactively understanding and preparing for the changing climate and reducing climate-related risks.

Colonialism: The policy or practice of establishing control over a territory and its people, often through settlement, resource exploitation, and cultural imposition, resulting in significant social and economic disparities.

Decolonizing Thinking: An approach that seeks to challenge and dismantle the colonial frameworks and biases in knowledge production and practices. It emphasizes the importance of incorporating Indigenous perspectives, values, and experiences, promoting self-determination while recognizing and addressing the historical and ongoing impacts of colonialism.
[Decolonizing Research]

Displacement: The forced movement of individuals or communities from their homes or traditional lands, often due to environmental changes or hazards.

Elders: Respected members of Indigenous communities who hold traditional knowledge and wisdom, guiding cultural practices and community decisions through a lifetime of learned teachings and earned respect.

Environmental Justice: The fair treatment and meaningful involvement of all people in environmental decision-making processes, ensuring that vulnerable communities are not disproportionately burdened by environmental hazards.

Environmental Stewardship: The responsible use and protection of the natural environment through conservation and sustainable practices, emphasizing the importance of maintaining ecological balance.

Factor of Safety: The ability of a system's structural capacity to perform safely beyond its expected or actual loads.

First Nation: A term that came into common usage in Canada during the 1970s to replace the word "Indian", but still does not have a legal definition. The term "First Nations peoples" typically refers to the Indian peoples of Canada (status and non-status). Some Indian Act bands have also adopted the term "First Nation" to replace the word "band" in the name of their community.

Flood Resilience: The ability of a structure or community to withstand and recover from flooding events.

Freeboard: In the context of amphibious construction, the term refers to the vertical distance between the water's surface and the top of the lowest floor when floating during flood conditions. This usage is derived from its definition in naval architecture, where it denotes the distance from the water's surface to the lowest point where water can enter a vessel, typically the lowest deck.

Indigenous Rights: The collective and individual rights of Indigenous peoples, including land rights, cultural preservation, and the right to self-determination.

Knowledge Keepers: Individuals in Indigenous communities who preserve and share traditional knowledge, cultural practices, and histories, often through oral traditions and community engagement.

Off-Reserve: Refers to any location outside the boundaries of reserve lands.

On-Reserve: A reserve is land set aside by the Canadian government for use by First Nations.

Resilience in Place: Strategies and measures implemented to improve a community's capacity to endure, adapt, and recover from flooding and other environmental challenges while remaining in their original location. This approach emphasizes strengthening local infrastructure, enhancing adaptive practices, and promoting sustainable land use to ensure that communities can withstand adverse conditions to thrive in their existing established environments.

Reciprocity: A principle that emphasizes mutual respect and responsibility in the relationship between Indigenous peoples and the land, water, and beings.

Regulatory Framework: A system of rules and regulations that governs the management of housing and land use, crucial for ensuring compliance and safety.

Relocation: The process of moving individuals, families, or entire communities from one location to another. In the context of flood mitigation, an approach where homes and communities are moved to higher ground to avoid flood risk.

Risk Assessment: The process of identifying and evaluating the potential risks associated with flooding in a specific area, used to inform insurance policies and emergency preparedness.

Two-Eyed Seeing: A principle that encourages integrating Indigenous and Western perspectives to create more comprehensive solution. It emphasizes valuing both knowledge systems equally in decision-making processes.

Vulnerability: The characteristics of a person or group and their situation that influences their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard, such as floods, as well as the conditions determined by physical, social, economic, and environmental factors or processes that increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.