FORESTS & FLOODS

Natural Infrastructure for a Green Recovery

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FORESTS & FLOODS: NATURAL INFRASTRUCTURE FOR A GREEN RECOVERY

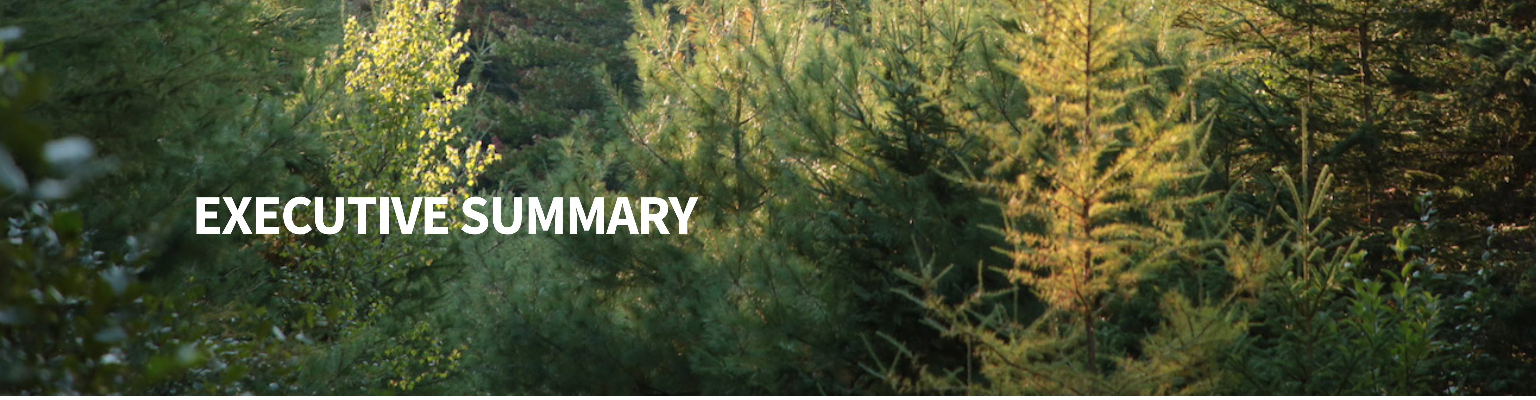
Contents

3 Executive Summary

6 Literature Review: Forests And Flooding

10 Forests: Our Greatest Assets In Climate Change Response

18 Next Steps



EXECUTIVE SUMMARY

> *"Pandemics and climate risk are similar in that they both represent physical shocks, which then translate into an array of socioeconomics impacts."*
>
> *— McKinsey & Company*

The necessity for transformational investments in Canada's COVID-19 response today runs parallel to the need for investment in climate change adaptation and green growth. Extreme weather linked to climate change continues to intensify — creating physical shocks that threaten the country's social and economic fabric in different but comparable ways to the ongoing pandemic. Economies around the world are already accelerating their transition to a low-carbon economy through COVID-19 recovery efforts. For Canada, investing in the vital natural infrastructure surrounding communities presents opportunities to contribute to near-term green economic recovery from the pandemic while achieving climate resilience and disaster risk reduction gains in the long-term.

In an open letter signed by more than 40 leading organizations in May 2020, Community Forests International encouraged Prime Minister Trudeau to embrace natural infrastructure strategies as a part of Canada's COVID-19 recovery plan.[1] The letter details pathways for a range of quick-start, medium-term, and sustained investments in natural infrastructure, leveraging complementary federal mandates and programs, including Infrastructure Canada's Disaster Mitigation and Adaptation Fund (DMAF). A key highlight — in addition to the unique combination of social, economic, and ecological benefits that natural infrastructure strategies offer — is the high volume and diversity of existing natural infrastructure initiatives including conservation and restoration of forests and wetlands that can be readily deployed across the country.

1 (2020). Nature conservation should be central to Canada's recovery from Covid-19. https://cpaws.org/wp-content/uploads/2020/07/Nature-Conservation-Letter-to-PM-July-10-2020-EN-3.pdf. Accessed September 11, 2020.

INVESTING IN FOREST INFRASTRUCTURE ADAPTATION

Since 2018, Community Forests International has been developing one such initiative, specifically targeting Canada's flood-prone Maritime Provinces: The Forest Infrastructure Adaptation (FORA) Project. The FORA Project aims to formalize the valuation, restoration, and financing of natural Acadian forest infrastructure for flood attenuation in New Brunswick. The aspiration of this pilot project is to create an investment-ready business case for mobilizing forest infrastructure solutions at scale and in similarly impacted regions throughout the Maritime provinces.

The financial impacts of flooding are significant for New Brunswick, and this case study of how forest infrastructure contributes to local climate adaptation builds on existing knowledge of natural infrastructure through new research and development inspired by Community Forests International's global climate mitigation and forest carbon storage work. Considering that a recent analysis by the Municipal Natural Assets Initiative (MNAI) indicated a flood attenuation replacement value approaching $30,250 per hectare for a forest within our study watershed where the average fair market value based on forest harvest revenues alone is only $1,000 per hectare, the financial case for exploring forests as natural infrastructure solutions couldn't be stronger.[2] Investors are also eager for projects that offer the co-benefits of contributing to both local resilience and global carbon drawdown as flooding is expected to increase in severity and frequency as the climate continues to change.

The FORA initiative is backed by the Intact Foundation at Intact Financial, the largest property and casualty insurer in Canada and an organization that proactively invests in the research and development of natural infrastructure solutions to protect people and communities from increasing floods, wildfires, extreme heat, and wind storms.

The aspiration of this pilot project is to create an investment-ready business case for mobilizing forest infrastructure solutions at scale and in similarly impacted regions throughout the Maritime provinces.

2 MNAI. (2020). Cohort 2 National Project Final Technical Report; Town of Florenceville-Bristol, New Brunswick. https://mnai.ca/media/2020/02/MNAI_Florenceville.pdf. Accessed May 12, 2020.

As an applied research and development effort with the stated goal of replicability and scalability, one of the main aspirations of Community Forests International's FORA initiative is to produce a formal prospectus for green finance institutions and aligned government programs — such as the $2 billion DMAF or the recently announced $631 million Nature Smart Climate Solutions Fund — that offers concrete pathways for expanding forest-based flood risk reduction measures to the landscape scale. Although the completion date for the FORA initiative and the publication of an investment-ready business case is projected for the fall of 2021, Community Forests International has opted to produce this midterm learnings document in advance to share current findings and trajectories with the wider community of practitioners at this pivotal moment of public spending, infrastructure investment, and recovery planning.

LITERATURE REVIEW: FORESTS AND FLOODING

FLOODING IN CANADA AND THE MARITIME PROVINCES

Catastrophic insurable losses from extreme weather events have escalated in Canada over the past decade, primarily driven by flood damages. As per the Insurance Bureau of Canada, average catastrophic insurable losses exceeded $1.8 billion between 2009 and 2017, and nearly 10% of Canadians live in areas at high risk of flooding, making it one of the most significant climate change-related threats to the country.[3] In addition to its economic impacts, flooding has long-lasting, negative impacts on the social and mental health for those affected.[4]

In recent years, extreme storms have become more frequent and more intense in New Brunswick — the focal province for the FORA initiative — leading to severe flooding and damages alongside a range of other contributing factors linked to climate and environmental changes.[5] [6] As a result, the province has been forced to access federal disaster relief funding more than any other jurisdiction in Canada.[7] Recent data shows that in 2014 alone flooding damages exceeded $39 million for the province.[8] These storms and floods are predicted to become even more frequent and severe as the climate continues to warm, which will further drive up costs.[9] [10] Flood attenuation is therefore of highest priority for disaster mitigation efforts in this region.

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3 Moudrak, N., Feltmate, B., Venema, H., Osman, H. (2018). Combating Canada's Rising Flood Costs: Natural infrastructure is an underutilized option. Waterloo, Ontario: Intact Centre on Climate Adaptation, University of Waterloo.

4 Fernandez, A., Black, J., Jones, M., Wilson, L., Salvador-Carulla, L., Astell-Burt, T., & Black, D. (2015). Flooding and mental. heal.th: a systematic mapping review. *PloS one*, *10*(4), e0119929.

5 New Brunswick Department of Environment and Local Government (NB DELG). (2014). New Brunswick Climate Change Action Plan 2014-2020. Fredericton, New Brunswick: Province of New Brunswick.

6 *Ibid.*

7 *Ibid.*

8 NB DELG. (2020). Environment and Local Government Flood Search Data. https://www.elgegl.gnb.ca/0001/en/Flood/Search. Accessed July 6 2020.

9 Flato, G., Gillett, N., Arora, V., Cannon, A. and Anstey, J. (2019). Modelling Future Climate Change. In E. Bush and D.S. Lemmen (Eds.), Canada's Changing Climate Report (pp. 74–111). Ottawa, Ontario: Government of Canada.

10 Claessens, L., Hopkinson, C., Rastetter, E., & Vallino, J. (2006). Effect of historical changes in land use and climate on the water budget of an urbanizing watershed. Water Resources Research, 42(3).

GREY INFRASTRUCTURE VS GREEN INFRASTRUCTURE

In the context of flooding, "grey infrastructure" refers to any human-made construction designed to prevent or minimize damages by safely diverting or storing excess water. Examples of grey infrastructure for flood mitigation include seawalls, culverts, constructed reservoirs, and flood gates. Though relatively quick to implement and fast-acting, grey infrastructure solutions may also have a limited lifespan, require ongoing maintenance, or exhibit a low adaptability to changing climate conditions.[11]

Natural infrastructure, also called "green infrastructure" or "natural assets," refers to natural systems such as forests and wetlands which contribute to flood attenuation and need relatively little further management once established.[12] The Municipal Natural Assets Initiative (MNAI) — a leading authority for municipalities seeking to increase the quality and resilience of services by working with their natural infrastructure — defines these assets simply as ecosystem features that are nature-based and provide tangible services that would otherwise require equivalent engineered or grey infrastructure solutions to sustain.[13] Popular examples of natural infrastructure for flood mitigation include wetlands, naturalized storm water ponds, and rainwater gardens.

Natural infrastructure typically costs a small fraction of grey infrastructure to implement, often has a longer lifespan, and generally requires limited upkeep or maintenance investments.[14] Natural infrastructure can also provide a variety of other valuable ecosystem and community benefits such as carbon storage, air and water filtration, wildlife habitat, and recreation.

11 Moudrak, N., Feltmate, B., Venema, H., Osman, H. (2018). Combating Canada's Rising Flood Costs: Natural infrastructure is an underutilized option. Waterloo, Ontario: Intact Centre on Climate Adaptation, University of Waterloo.

12 *Ibid.*

13 MNAI. (2019). What are Municipal Natural Assets: Defining and Scoping Municipal. Natural. Assets. https://mnai.ca/media/2019/07/SP_MNAI_Report-1-_June2019-2.pdf. Accessed May 12, 2020.

14 *Ibid.*

FOREST HEALTH AND FLOOD RISK

Although theoretical support for natural infrastructure solutions to reduce climate risk is growing, there is currently an undersupply of diverse working examples and associated cost-benefit analyses available to enable more widespread application – particularly for the forest sector. The FORA project strives to advance working examples of forest protection and restoration for flood attenuation specifically, and at the same time to present a clear business case for their expansion. The project activities include both direct forest protection and physical hydrologic analyses to quantify how active forest conservation efforts affects flood levels as well as economic analyses to determine the avoided damages and return-on-investment of these measures.

Though relatively unexplored compared to wetlands, forests show great promise for acting as natural infrastructure to mitigate flood damage. Studies done within New Brunswick and surrounding areas agree that forest loss, when in excess of 50% removal from the landscape, results in significant increases in peak flow and permanent changes to stream morphology or structure.[15] [16] Additionally, several studies within the same geographic area show that when as little as 20% of the forested area is harvested this can result in significant increases in streamflow and peak flow, however existing literature is not as unanimous at this threshold.[17] [18] [19] [20] Peak flow and streamflow are directly representative of the amount of water in a stream at any given moment, so as these values increase, so too do flooding risk and flooding.

Streamflow rates generally begin recovering the year following forest clearing as vegetation starts to grow back, with rates returning to normal after 10-12

15 Guillemette, F., Plamondon, A. P., Prévost, M., & Lévesque, D. (2005). Rainfall generated stormflow response to clearcutting a boreal forest: peak flow comparison with 50 world-wide basin studies. Journal of Hydrology, 302(1-4), 137-153.

16 Tremblay, Y., Rousseau, A. N., Plamondon, A. P., Lévesque, D., & Jutras, S. (2008). Rainfall peak flow response to clearcutting 50% of three small watersheds in a boreal forest, Montmorency Forest, Québec. Journal of hydrology, 352(1-2), 67-76.

17 Buttle, J. M., & Metcal.fe, R. A. (2000). Boreal forest disturbance and streamflow response, northeastern Ontario. Canadian Journal of Fisheries and Aquatic Sciences, 57(S2), 5-18.

18 Monteith, S. S., Buttle, J. M., Hazlett, P. W., Beall, F. D., Semkin, R. G., & Jeffries, D. S. (2006). Paired-basin comparison of hydrologic response in harvested and undisturbed hardwood forests during snowmelt in central Ontario: II. Streamflow sources and groundwater residence times. Hydrological Processes: An International Journal, 20(5), 1117-1136

19 Caissie, D., Jolicoeur, S., Bouchard, M., & Poncet, E. (2002). Comparison of streamflow between pre and post timber harvesting in Catamaran Brook (Canada). Journal of Hydrology, 258(1-4), 232-248.

20 Tremblay, Y., Rousseau, A. N., Plamondon, A. P., Lévesque, D., & Jutras, S. (2008). Rainfall peak flow response to clearcutting 50% of three small watersheds in a boreal forest, Montmorency Forest, Québec. Journal of hydrology, 352(1-2), 67-76.

years on average.[21] However, impacts of forest clearing on snowmelt rates may last for more than 15 years.[22] [23] Downstream, this increases the water flow and flood risk during the spring freshet and seasonal swelling of water levels for periods of time extending beyond this 15 year timeframe.[24] [25]

The longer the intensive forest management cycle continues, the worse the underlying soil conditions become, leaving the soil structure less able to slow flooding from significant rainfall events.[26] [27] With intensive harvesting, the cover of leaf litter and organic humus on the forest floor is removed or destroyed, which exposes the underlying mineral soil and thereby increases overland water flow and erosion, which, in turn, contributes to higher risk of flooding downstream.[28] [29] There is a need for additional research on the longevity of increased water flow under these circumstances as many studies focus on the following year only and very few track streamflow changes over the following decades post-harvest.[30]

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21 Jewett, K., Daugharty, D., Krause, H. H., & Arp, P. A. (1995). Watershed responses to clear-cutting: effects on soil solutions and stream water discharge in central. New Brunswick. Canadian Journal of Soil Science, 75(4), 475-490.

22 Talbot, J., & Plamondon, A. P. (2002, June). The diminution of snowmelt rate with forest regrowth as an index of peak flow hydrologic recovery, Montmorency Forest, Quebec. In Proceedings of the 59th annual Eastern snow conference. (pp. 85-91).

23 Prepas, E. E., Burke, J. M., Whitson, I. R., Putz, G., & Smith, D. W. (2006). Associations between watershed characteristics, runoff, and stream water quality: Hypothesis development for watershed disturbance experiments and modelling in the Forest Watershed and Riparian Disturbance (FORWARD) project. *Journal of Environmental Engineering and Science*, *5*(S1), S27-S37.

24 Talbot, J., & Plamondon, A. P. (2002, June). The diminution of snowmelt rate with forest regrowth as an index of peak flow hydrologic recovery, Montmorency Forest, Quebec. In Proceedings of the 59th annual Eastern snow conference. (pp. 85-91).

25 Prepas, E. E., Burke, J. M., Whitson, I. R., Putz, G., & Smith, D. W. (2006). Associations between watershed characteristics, runoff, and stream water quality: Hypothesis development for watershed disturbance experiments and modelling in the Forest Watershed and Riparian Disturbance (FORWARD) project. *Journal of Environmental Engineering and Science*, *5*(S1), S27-S37.

26 Likens, G. E., Bormann, F. H., Johnson, N. M., Fisher, D. W., & Pierce, R. S. (1970). Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem. Ecological monographs, 40(1), 23-47.

27 Lull, H. W., & Reinhart, K. G. (1972). Forests and floods in the eastern United States (Vol. 226). US Northeastern Forest Experiment Station.

28 Likens, G. E., Bormann, F. H., Johnson, N. M., Fisher, D. W., & Pierce, R. S. (1970). Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem. Ecological monographs, 40(1), 23-47.

29 Lull, H. W., & Reinhart, K. G. (1972). Forests and floods in the eastern United States (Vol. 226). US Northeastern Forest Experiment Station.

30 Pike, R., & Scherer, R. (2003). Overview of the potential effects of forest management on low flows in snowmelt-dominated hydrologic regimes. Journal of Ecosystems and Management, 3(1).

FORESTS: OUR GREATEST ASSETS IN CLIMATE CHANGE RESPONSE

THE SPECIAL ACADIAN FOREST OF EASTERN CANADA

The Acadian Forest Region (AFR) spans New Brunswick, Nova Scotia, and Prince Edward Island, and is one of the most diverse forest types in Canada—it is also one of the most endangered. The AFR is a unique transition zone between the Northern Hardwood Forest to the south, and the Boreal Forest to the north.[31] This, combined with diverse underlying geology, a mosaic of soil types, and the unique maritime effect from the Atlantic Ocean, creates an especially diverse forest ecosystem found nowhere else in Canada.[32] However, this state of transition means most species are either at their northernmost or southernmost extent, making the AFR particularly susceptible to reduced diversity due to climate change and the impacts of intensive land use.[33]

Healthy Acadian forests provide essential water purification and flood mitigation services by slowing and filtering snow-melt and rain run-off. In the last 25 years however, more than a third of the forest in New Brunswick alone has been cut, leaving it patchy and young, which has caused a decline in the local climate change resiliency and ecosystem services.[34] Without the protective cover of trees, snow can melt faster and rain flows into waterways and built environments unchecked.[35]

The Strategic Climate Risk Assessment conducted by the Government of British Columbia identifies that forest management plays a key role in a majority of the largest climate risks affecting communities, including flooding.[36] The Government of the United Kingdom recognizes forests as a

31 Noseworthy, J., & Beckley, T. M. (2020). Borealization of the New England-Acadian Forest: A Review of the Evidence. *Environmental Reviews*.

32 *Ibid*.

33 Taylor, A. R., Boulanger, Y., Price, D. T., Cyr, D., McGarrigle, E., Rammer, W., & Kershaw Jr, J. A. (2017). Rapid 21st century climate change projected to shift composition and growth of Canada's Acadian Forest Region. *Forest ecology and management*, *405*, 284-294.

34 de Graaf, M. (2017). Private Land Forestry in Canada's Maritime Provinces: A Common Practice Scenario. Community Forests International.

35 Caissie, D., Jolicoeur, S., Bouchard, M., & Poncet, E. (2002). Comparison of streamflow between pre and post timber harvesting in Catamaran Brook (Canada). Journal of Hydrology, 258(1-4), 232-248.

36 Wood, Peter. (2021). Intact forests, safe communities: Reducing community climate risks through forest protection and a paradigm shift in forest management. Sierra Club BC.

key component in flood risk management.[37] In an evidence-based guiding document for working with natural processes, the importance of healthy forests throughout the entire landscape is stressed: from catchment forests during rainfall; to cross-slope woodlands for slowing water as it moves toward rivers and streams; to floodplain and riparian forests where large amount of what would otherwise be floodwater can be slowed and stored during significant rainfall events.[38] The shift away from business-as-usual forest management must too be prioritized in the AFR if we hope to realize the enormous potential our forests have for flood risk mitigation.

The pilot project described here is actively protecting, enhancing, and studying the peak flow attenuation services of approximately 143 hectares of strategic natural infrastructure in the Canaan-Washademoak Watershed (CWW; Figure 1), one of New Brunswick's most flood-prone regions draining into the Lower Wolastoq-Saint John River.

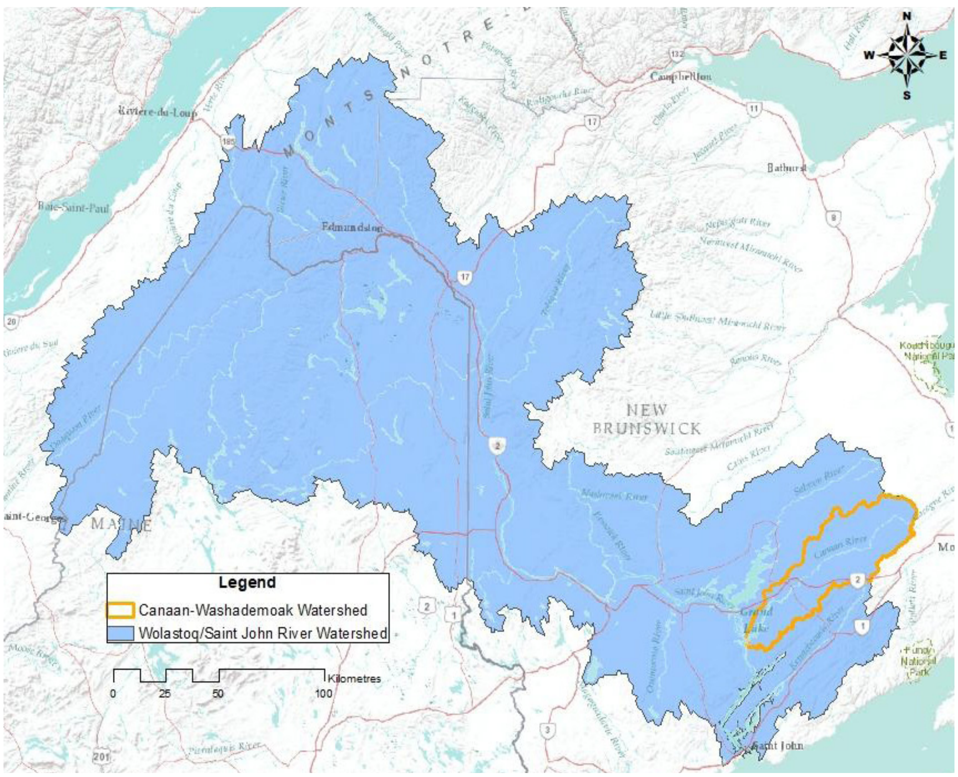


Figure 1
Map of the Canaan-Washademoak Watershed from the 2019 report *Forest Infrastructure Adaptation in the Canaan-Washademoak Watershed.*[39]

37 Burgess-Gamble, L., Ngai, R., Wilkinson, M., Nisbet, T., Pontee, N., Harvey, R., Kipling, K., Addy, S., Rose, S., Maslen, S., Jay, H., Nicholson, A., Page, T., Jonczyk, J., Quinn, P. (2018, February). Working with Natural processes – Evidence Directory. Environment Agency.

38 *Ibid.*

39 Barry, S., Bondza, K., Holder, K., and Karamanos, A. (2019) Forest Infrastructure Adaptation in the Canaan-Washademoak Watershed. A report submitted to Community Forests International towards completion of ENV 6007 at the University of New Brunswick.

FINANCING CLIMATE ACTION: COMBINING CARBON STORAGE WITH LOCAL RESILIENCE INVESTMENTS

In 2012, Community Forests International established one of Canada's first forest carbon offset projects. By quantifying and valuing the carbon stored in healthy, intact forests this pilot program has enabled the purchase and protection of more than 1,300 acres of endangered Acadian forest in New Brunswick and sequestered more than 35,000 tons of CO2e emissions while generating approximately $750,000 in new private sector conservation revenues.

In 2019, Community Forests International's carbon offset program financed the purchase of the special 143 hectare Robinson Conservation Forest to serve as a living research and development site for the new FORA initiative. Located in Cambridge-Narrows, more than half of the Robinson Conservation Forest is covered by 80 to 100-year-old trees and includes a significant riparian floodplain adjacent to the flood-prone Washademoak River. As a result of the region's aging demographics and dominant wood product markets, a clear trend has emerged in rural New Brunswick wherein a majority of small family forest owners are nearing retirement and are pressured to clearcut their land to access the equity tied up in their forests. Without intervention, this was the most likely alternative scenario for the Robinson Conservation Forest.

Building on these achievements in forest carbon valuation and financing, Community Forests International now endeavors to repeat its success by evaluating and financing the local climate change resilience services — and specifically local flood attenuation outcomes — of these same forestlands. Applying the organization's extensive and unique experience and expertise in forest-based carbon storage accounting to forest-based flood protection accounting is one of the core activities of the FORA initiative.

As a result of the region's aging demographics and dominant wood product markets, a clear trend has emerged in rural New Brunswick wherein a majority of small family forest owners are nearing retirement and are pressured to clearcut their land to access the equity tied up in their forests.

GAPS IN KNOWLEDGE: MODELING THE FLOOD PROTECTION SERVICES OF ACADIAN FOREST

Canaan-Washademoak Watershed

The CWW has seen significant land use changes in modern history, where mature forest cover has been cleared for agriculture, settlement, and transportation. This forest loss may partially explain decreased water flow in the hot summer months, and increased peak flows and flood risk in the spring and following large rainfall events, which are becoming more frequent and intense.[40] [41]

Most studies agree that when forest harvesting is in excess of 50% of the land base, increases in streamflow and peak flow occur, with peak flow being the first observed response, thus increasing the risk of flooding downstream.[42] However, there is less agreement between studies done on watersheds where less than 50% of the land base has been harvested.

Discussions with hydrology researchers at the University of New Brunswick has made it clear that there are still many gaps in knowledge that need to be filled to conduct effective forest and flood modelling exercises in this region. According to Antoin O'Sullivan, Doctoral candidate at the Canadian Rivers Institute at the University of New Brunswick, to date there hasn't been sufficient research in New Brunswick specifically on the relative roles of surficial geology (and its conductivity for sub-surface water flows), topography, surficial deposits, wetlands and fluxes in climate (at intra and inter annual scales), and land use in determining their relative influence on the scale and intensity of flooding. Several researchers in New Brunswick have begun to scratch the surface of this subject, however most feel it's pre-mature to attempt a modelling of the impacts of forest use in a single sub-watershed when the full range of contributing factors in that watershed are still largely unknown.[43]

Some bio-geographic features of the CWW are *suspected* to be the greater drivers of flooding in that sub-watershed. For example, the CWW has a relatively low elevation change across the watershed (from sea-level to a maximum of 180 m above sea-level) and the Canaan River (the largest watercourse of the CWW) flows northeast-to-southwest and drains into

40 Likens, G. E., Bormann, F. H., Johnson, N. M., Fisher, D. W., & Pierce, R. S. (1970). Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook watershed-ecosystem. Ecological monographs, 40(1), 23-47.

41 Lull, H. W., & Reinhart, K. G. (1972). Forests and floods in the eastern United States (Vol. 226). US Northeastern Forest Experiment Station.

42 Caissie, D., Jolicoeur, S., Bouchard, M., & Poncet, E. (2002). Comparison of streamflow between pre and post timber harvesting in Catamaran Brook (Canada). Journal of Hydrology, 258(1-4), 232-248.

43 Antoin O'Sullivan. (2019). Pers. Comm., Nov. 1.

the Lower Wolastoq-Saint John River. The Wolastoq-Saint John River itself is prone to seasonal flooding, and therefore much of the flooding in the Canaan-Washademoak system may be explained by floodwaters backing up the Canaan River into the relatively shallow "bathtub" of the CWW during flooding of the Lower Wolastoq-Saint John River.[44] Coupled with the fact that the CWW is still dominated with naturally pervious landcover; deforestation and land-use change may not be the greatest drivers of flooding in this watershed — but as discussed below they may be important contributors.

Wolastoq-Saint John River Watershed

Until recently, research on the Wolastoq-Saint John River watershed has focused on characterizing features of flooding (e.g. peak flow, overland flow, etc.) rather than the quantities of water in flood periods and flood areas of the watershed. Dr. Charles Bourque, a researcher at the University of New Brunswick specializing in hydrologic modelling, has now two research projects that are examining flood water data from the Wolastoq-Saint John River.

The first objective of Dr. Bourque's research is to identify and characterise the primary variables and system components that are responsible for the spring flooding of the Wolastoq-Saint John River over the past thirteen years (2007-2019). Preliminary results show that the most important variable related to flooding in the Wolastoq-Saint John Watershed is day-to-day variations in ambient air temperature (by way of cumulative snow degree-days), which contribute the most to the production of snowmelt and changes in downstream water level.

Preliminary results also show that the amount of snow-on-the-ground and the percentage of forest loss are the second and third most important variables in the calculation of water level. Not surprisingly, Dr. Bourque's models also show that increased snow-on-the-ground in the headwaters of the upper Wolastoq-Saint John River (typically in March) results in increases in snowmelt and surface runoff during the subsequent month (typically in April), leading to flooding of the upper Wolastoq-Saint John River. Most recently, this ongoing research effort confirms causality of cumulative forest loss on water levels in the region.

The final results of these research projects will provide clarity on the more precise role of climate, forest cover, and land use on flood patterns and intensity. Community Forests International looks forward to incorporating the results of this complementary and leading-edge research into the final analysis

44 Barry, S., Bondza, K., Holder, K., and Karamanos, A. (2019) Forest Infrastructure Adaptation in the Canaan-Washademoak Watershed. A report submitted to Community Forests International towards completion of ENV 6007 at the University of New Brunswick.

of the FORA initiative, and moving to a finer resolution analysis of forest loss as likely not the greatest contributor to regional flooding but possibly among the top three factors.

PLACING A DOLLAR VALUE ON THE FLOOD PROTECTION SERVICES OF FOREST INFRASTRUCTURE

Community Forests International's FORA initiative received an unanticipated boost in early 2020 when several leading organizations convened in New Brunswick under the guidance of the Municipal Natural Assets Initiative (MNAI) to complete a forest infrastructure valuation for the community of Florenceville-Bristol. The analysis focused on the replacement value and flood-risk mitigation services of natural infrastructure around the town and employed the MNAI approach to assessing and highlighting novel considerations for local natural assets and associated services.[45]

The MNAI analysis targeted a relatively small but important 182 hectare forest catchment area and "[t]he results demonstrate that a cost of roughly $3.5 million would be required to replace the peak flow attenuation services provided by forest cover. Furthermore, if climate change increases the intensity of rainfall of a 1:100 year event by 20%, the value of peak flow attenuation services increase by $600,000 to $4.1 million." This equates to a flood attenuation replacement value of $30,250 per hectare for forest in that watershed where the average fair market value based on forest harvest revenues alone is only $1,000 per hectare.[46] Clearly the forest is more valuable conserved as a safeguard against flooding.

Expanding on this work in Florenceville-Bristol, Community Forests International consulted with involved organizations including the engineering firm that provided the underlying hydrologic analysis and has now completed a similar assessment for the 143 hectare Robinson Conservation Forest at the centre of the FORA initiative. Flood severity was compared between conditions in which the current forested area is maintained or cleared. Five different storm scenarios were then analyzed alongside these changes in natural infrastructure, two of which incorporated storm severity increases due to climate change.

45 MNAI. (2020). Cohort 2 National Project Final Technical Report; Town of Florenceville-Bristol, New Brunswick. https://mnai.ca/media/2020/02/MNAI_Florenceville.pdf. Accessed May 12, 2020.

46 *Ibid.*

In all storm scenarios, peak water flow is projected to noticeably increase if the forest were lost. For the 1:100 year storm event where climate change increases rainfall intensity by 20%, built infrastructure in the form of catchment ponds would need to exceed 25,900 cubic meters to replace the peak flow attenuation services of the forest in the study area alone. Taking this one step further, a cost analysis revealed that four catchment ponds would be necessary to capture this amount of water across this landscape, and their construction would cost a total of $1,042,526.76. Considering the focal forested area is an exceedingly small portion of the overall CWW, the volume and cost of catchment ponds required to replace the role of forest infrastructure in the wider watershed exceeds the scope of reasonable built infrastructure projects.

During rainfall events, forests act like sponges by storing water within the ecosystem and releasing it slowly into streams and rivers. Natural climate solutions like forests are less expensive than built-infrastructure and their flood attenuation value is significant.

143
HECTARE
Mature Acadian forest

25,900
CUBIC METERS
Flood attenuation capacity of forest

$1.04M
Replacement value of the forest

$285K
Value of timber on the forest

NEXT STEPS

The next steps for the FORA project are to merge the hydrological data and climate change scenarios noted above into a detailed natural infrastructure replacement-value model, and then to develop a larger economic analysis. The valuation process is envisioned to include both market costs, such as building and street damage, and non-market costs, such as the benefits of vegetation to a watershed, including water quality, flood mitigation and carbon storage provided by forest.[47] [48]

Forty percent of the endangered Acadian forest in the Maritime region is owned privately by more than 80,000 families in small, disaggregated parcels like the Robinson Forest dotted across the landscape. Together these small private forests offer great opportunities for engaging individual citizens in climate action and natural infrastructure protection and restoration with the right incentives and government programs in place. Community Forests International will merge the FORA valuations with complimentary strategies for citizen-led, landscape-level forest protection and develop a business case for mainstreaming forest infrastructure investments that result in sizeable carbon storage and local flood risk reduction outcomes.

With the right incentives and government programs in place, engaging with small family forest owners could offer great opportunities for natural infrastructure protection and restoration, and community-level climate action.

47 Lantz, V., Trenholm, R., Wilson, J., & Richards, W. (2012). Assessing market and non-market costs of freshwater flooding due to climate change in the community of Fredericton, Eastern Canada. *Climatic change*, *110*(1-2), 347-372.

48 Trenholm, R., Lantz, V., Martínez-Espiñeira, R., & Little, S. (2013). Cost-benefit analysis of riparian protection in an eastern Canadian watershed. *Journal of environmental management*, *116*, 81-94.

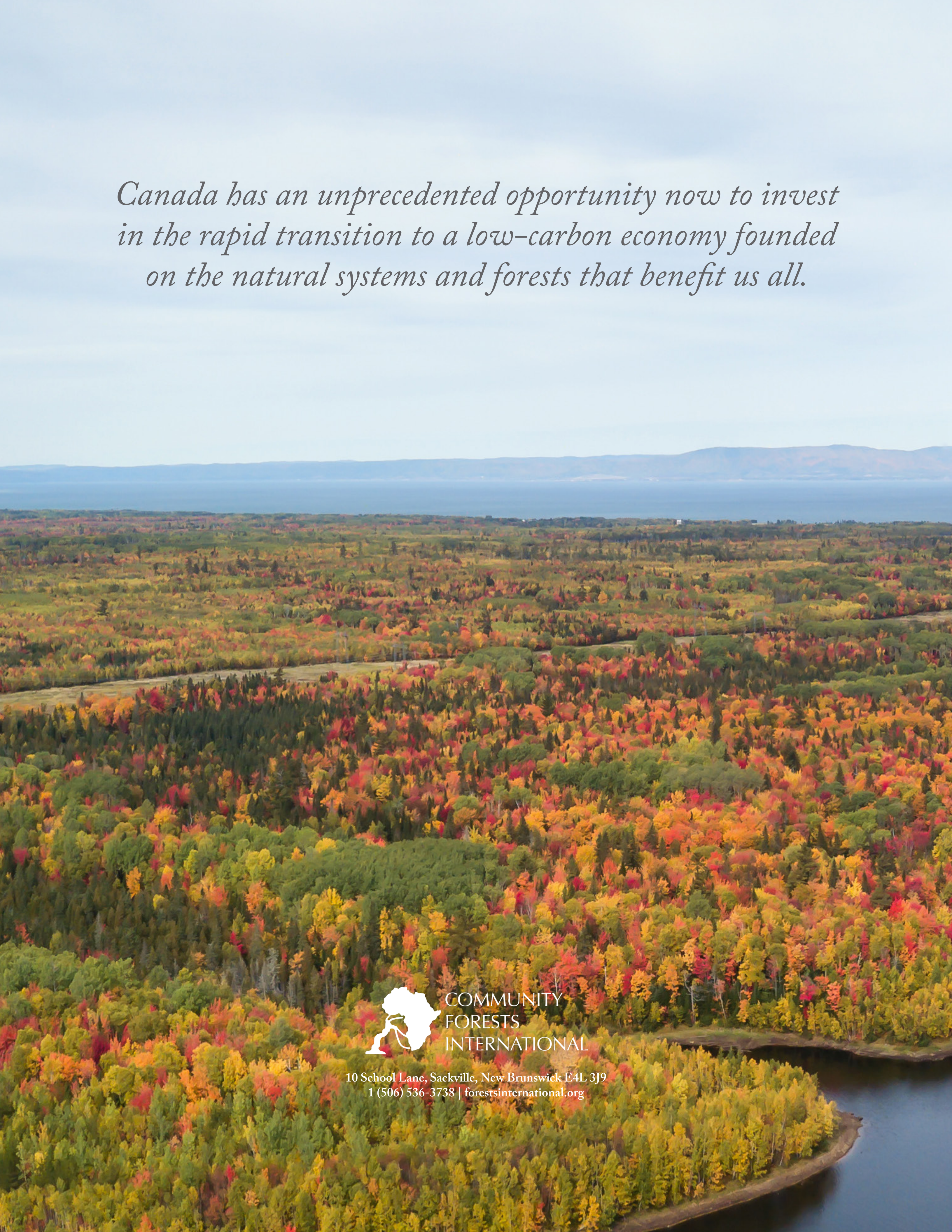
NATURAL INFRASTRUCTURE FOR A GREEN RECOVERY

Canada is at a decisive crossroads. The COVID-19 pandemic is not only causing deep suffering and loss of human life but has eliminated millions of jobs and businesses, cost billions of dollars to the national economy, and continues to exacerbate underlying inequalities in our society. At the same time, climate change continues to accelerate largely unchecked and poses increasing physical threats to the wellbeing of all Canadians.

In July 2020, an independent task force of finance, policy and sustainability experts from across Canada joined to develop key recommendations for Canada's COVID-19 recovery. The Task Force For Resilient Recovery emphasized that investing in the nature that protects and sustains us is vital. Implementing these vital measures effectively requires not only theoretical support but also living examples which address the practical challenges and offer emerging lessons on the true cost and benefits of these investments.

At the same time, while we strive to match the pace and dynamic of our response and recovery efforts to the pace and multiplicity of both COVID-19 and climate change — and to identify truly new solutions to these parallel crises — embracing not only "shovel-ready" but also "shovel-worthy" ideas and strategies such as the forward work outlined in this report will be crucial. What these innovations might lack in comparable historical precedent they make up for in their potential for unprecedented future performance and positive impact.

We cannot wait to move towards a just and green economy any longer. Canada has an unprecedented opportunity now to invest in the rapid transition to a low-carbon economy founded on the natural systems and forests that benefit us all, and the learnings highlighted in this report further demonstrate that the direct benefit to communities would be diverse and unmatched.



Canada has an unprecedented opportunity now to invest in the rapid transition to a low-carbon economy founded on the natural systems and forests that benefit us all.

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