



A Climate Reckoning

The economic costs of BC's
extreme weather in 2021

BY MARC LEE & BEN PARFITT

November 2022



CCPA
CANADIAN CENTRE
for POLICY ALTERNATIVES
BC Office

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Summary

This study brings a climate justice lens to the economics of extreme weather disasters.

THIS STUDY EXAMINES THE THREE EXTREME WEATHER DISASTERS that beset British Columbia in 2021—the unprecedented heat dome in June, the devastating summer wildfires and the November atmospheric river and flooding—and provides a first-ever estimate of what the combined costs of those disasters were.

It concludes that the cumulative hit to the BC economy from the disasters was between \$10.6 and \$17.1 billion, which is equivalent to 3–5 per cent of provincial GDP.

The study brings a climate justice lens to the economics of extreme weather disasters and concludes that senior levels of government must invest billions of dollars to upgrade critical infrastructure like dikes to better handle future extreme weather events and therefore better protect all residents, in particular those most vulnerable.

Estimating the full cost of a disaster is not a straightforward exercise. In the immediate aftermath, the first (and often only) estimates are of insured damages to property. As our estimates show, insured damages are but the tip of a large iceberg of damages from extreme weather.

Our framework for the evaluation of economic impacts builds on previous literature in the Canadian context and includes costs associated with:

- Damages to assets and property, including insured and non-insured damages for households and businesses.
- Lost income for workers due to closures or damaged transportation linkages.
- Costs to the public sector, including immediate disaster response, relief and support, longer-term cleanup and recovery and rebuilding of infrastructure.
- Specific impacts on vulnerable and/or marginalized populations such as people with low incomes, renters, seniors, Indigenous people, immigrants and people with disabilities.

The report is also informed by interviews with people on the front lines of the 2021 extreme weather events and these are profiled throughout the full report.

June: The heat dome

The unprecedented heat dome that unfolded over four days in late June shattered temperature records and led to 619 heat-related deaths. Based on historical data, this was estimated to be a one-in-1,000-year event, but with a warming planet we have to assume such extreme heat will happen again and with growing frequency.

The heat dome led to severely damaged crops in the Okanagan and Kootenay regions as well as the Fraser Valley. In the Okanagan some 50–70 per cent of cherry crops were affected, with some orchards losing the entire crop. Over 650,000 chickens and other poultry died.

The heat dome was associated with widespread loss of income due to closures, particularly for those paid hourly wages and whose work was outdoors or in non-air-conditioned spaces. Across the most affected sectors, such as food services, construction, agriculture and manufacturing, we estimate that between \$205 million and \$328 million in income was lost. Heat waves are also associated with general productivity declines which, over the four days of maximum temperature, amount to an additional \$34–\$84 million in lost productivity.

Extreme heat events make bad conditions deadly for the most vulnerable workers. Farm workers, including large numbers of migrant workers, are particularly vulnerable to the heat, which intersects with long work days, difficult working conditions and substandard accommodations.

A key labour aspect of the government response is emergency services. During the peak days of the heat dome, 911 calls doubled relative to normal. Emergency services were overwhelmed, resulting in significant physical and mental health tolls on paramedics and related workers.

BC Hydro set the province's all-time summer peak hourly demand record on June 28, 2021. We estimate British Columbians spent an additional \$8–\$14 million on electricity for cooling homes and offices during the heat dome.

July to September: Summer wildfires

An abnormally dry spring in 2021 set the stage for the third-worst wildfire season in BC's history. The largest wildfires significantly affected BC's overall carbon balance, with the 2021 wildfires generating about 122 million tonnes (Mt) of CO₂, nearly double BC's official greenhouse gas tally of 64.6 Mt in 2020.

The wildfire starting June 30 that destroyed the town of Lytton caused \$102 million in insured damages. There has been ongoing criticism in BC over the slow cleanup and rebuild of Lytton. The White Rock Lake fire in the Okanagan destroyed the community of Monte Lake overnight, with insured damages estimated at \$77 million for 800 properties. Based on typical gaps in insurance industry coverage, we estimate non-insured damages at between \$179 and \$501 million.

"We lost 100 per cent of our crop. We didn't pick anything. It was just cooking, is what it was. The berries just cooked. I've never lost a complete crop ever in the 30 years we've been doing it. We just had to walk away from it. It was pretty devastating."
—Bob Nowoselski,
No's Orchard,
Creston, BC

Fires and smoke prompted 181 evacuation orders and 304 evacuation alerts, and displaced almost 33,000 people. We estimate the value of work time for those people displaced from their homes ranged from \$33 to \$99 million in lost income.

Supply chain impacts were substantial as fires affected both CN Railway and Canadian Pacific Railway networks causing a backlog of freight deliveries in early July, with a key transportation blockage in the Fraser Canyon between June 30 and July 5 which stranded thousands of rail cars. Workers were also affected by supply-related closures created by backlogs of shipping containers through the Port of Vancouver, and some shipments were rerouted outside Vancouver.

“You’ve got to recognize the damage that today’s fires are doing. The classic one-to-two-kilometre buffer won’t do anything now because today’s fires are moving so much quicker. So much more energy is being released and that energy can transport embers far greater distances than previously.”
— Bob Gray, wildland fire ecologist.

These labour market impacts are significant and we estimate \$281–\$463 million in losses due to work slowdowns in key affected sectors. Interestingly, the impacts in key industrial areas are fairly modest due to fewer numbers of workers affected. Less obvious, but perhaps more important, are economic losses for sectors with larger numbers of workers, such as retail trade and accommodation and food services.

The costs of the public response to wildfires falls mainly on firefighting efforts. A record \$719 million was spent on firefighting compared to a budgeted allocation of \$136 million. Going back to 2008, the average cost of fighting fires in BC is \$301 million per year. Compounding the challenges for those fighting the wildfires were shortages of critical equipment, including pumps and hoses, and an inability to staff crews due to the COVID-19 pandemic.

Indigenous people are particularly at risk from wildfires. Several First Nations reported inadequate communications on the part of the province during the wildfires. Due to their impact on traditional economic activities like fishing, hunting and trapping, uncontrolled wildfires have greater direct consequences for Indigenous communities. In situations where rapid evacuation is needed, low-income households, people without vehicles, or those who are unable to drive are made more vulnerable in areas affected by wildfire.

While the fires were largely in the interior of the province, smoke flowed down BC’s valleys, affecting air quality hundreds of kilometres away, including for about three million residents in the Lower Mainland. Particulate matter in wildfire smoke is bad for human health and has important economic ramifications: smoke adversely impacts outside workers and undermines productivity for other workers who do not have access to decent ventilation and/or who may have pre-existing conditions such as asthma.

November: Atmospheric rivers and the big flood

Wetter conditions prevailed in September and October with double the normal precipitation, setting the stage for a tragic November. Once dubbed the Pineapple Express, the South Coast experienced seven “atmospheric rivers” in November. The atmospheric river beginning November 13 unleashed massive amounts of rain over the next two days, with some places getting between 200 and 300 mm. The result was extensive flooding in the Fraser Valley near Abbotsford as well as in Princeton and Merritt in the Interior.

Public costs are still being tallied and will run into the billions of dollars. These costs were not stated in the 2022 BC Budget and some costs may be absorbed from the regular transportation and infrastructure budget. The most notable public infrastructure impacts include:

- Failure of dikes in the Fraser Valley, Merritt and Princeton areas.
- 24 highways closed including Highways 1, 3, 5 and 99 that connect Vancouver to the rest of Canada.
- Landslides on Highway 7, stranding some drivers between Agassiz and Hope, and on Highway 99 where five people were killed.
- Damage to five bridges and closure of 20 sections of the Coquihalla Highway 5, loss of bridges and large sections of roadway in 25 locations of Highway 8.
- Damage to the Malahat Highway (the principal connection between Victoria and mid-Island) and other flooding near Duncan on Vancouver Island.
- Damage to an unspecified number of secondary roads and highways.

In 2021/22, an additional \$522 million was spent on disaster and emergency assistance related to the November floods. BC Budget 2022 has committed \$400 million in 2022/23 and another \$1.1 billion over three years in contingencies for flood recovery. In addition, the federal government has promised \$5 billion for flood relief.

Insured damages are reported at \$675 million as of June 2022. The insurance industry pays about 12 cents per dollar of damage from overland flooding, implying about \$4.7 billion in non-insured damages. Even if we assume that private insurance covered a higher 30 per cent of total damages, non-insured damages would be approximately \$1.5 billion.

There were damages to private rail lines that serve as key transportation infrastructure for Canadian resource industries. CN Railway and Canadian Pacific Railway services didn't see a return to pre-flood productivity and capacity until December 21, more than a month after the washouts. Supply chain impacts from the loss of the rail network also led forestry companies to curtail production and hampered the export of Canadian grain.

The Trans Mountain Pipeline, which connects the Lower Mainland to Alberta crude oil and refined fuel supplies, was shut down during the immediate recovery period, leading the Parkland refinery in Burnaby to have down time between November 22 and December 15.

We estimate labour market impacts arising from the flooding based on known disruptions locally and supply chain impacts ranging from \$0.8 to \$1.4 billion, and only count BC workers not potential supply chain impacts outside the province. In addition to these losses, the flood-related displacement of 17,000 people translated to between \$68 and \$153 million in lost income.

Agriculture impacts were extensive to the more than 1,100 farms over 15,000 hectares in the Sumas Prairie in Abbotsford. Losses include 630,000 chickens, 12,000 pigs and 450 cows. Milk and egg production in the Lower Mainland was disrupted by the flooding, and some 2,500 acres of blueberry production were affected, almost one-tenth of the total 27,000 acres of land in BC

“We started at approximately 4:15 a.m. and we had the complete diking system around the building by 8:30 or 9. We would have lost it if we didn't.”
—Kevin Vilac, chief operator of the City of Merritt's water and wastewater systems, on the race to save some of the city's critical infrastructure during November 2021's intense rains and devastating floods.

for blueberry cultivation. About 200 farm workers from Mexico were displaced to Abbotsford and Chilliwack shelters and most were subsequently repatriated.

Part of this story is the failure of the BC government to invest in dike upgrades in spite of many warnings. The cost of upgrading dikes in the Lower Mainland has been estimated to be \$9–\$10 billion. This cost raises questions about whether some dikes should be replaced, improved or abandoned. Dikes are currently a municipal responsibility and local governments are hard-pressed to raise such large amounts of funding for dike upgrades.

Summary of economic costs

The costs of the devastating climate events sum to between \$10.6 and \$17.1 billion, equivalent to 3.1–4.9 per cent of provincial GDP.

The costs of the devastating climate events discussed in this report are summarized in Table S1. In all, they sum to \$10.6–\$17.1 billion, equivalent to 3.1–4.9 per cent of provincial GDP. The commonly reported statistic of insured damages sums to \$854 million, or only 5–8 per cent of the total. Based on industry statements about coverage, we estimate non-insured damages of \$1.7–\$5.1 billion. These are costs borne almost exclusively by households and businesses.

The BC government has spent a huge amount of public funds on fighting fires and other emergency responses. A large share of costs are government expenditures for replacement of infrastructure. Combined, these total some \$6.1–\$7.6 billion, or 46–60 per cent of total economic costs.

Table S1: Summary of economic costs		
	Low	High
millions of dollars		
Heat dome		
General productivity	\$34	\$84
Income losses	\$205	\$328
Incremental electricity consumption	\$8	\$14
Wildfires		
Insured damages	\$179	\$215
Non-insured damages	\$179	\$501
Income losses	\$314	\$562
Public expenditures	\$1,023	\$1,216
Atmospheric river flooding & landslides		
Insured damages	\$675	\$675
Non-insured damages	\$1,575	\$4,950
Income losses	\$897	\$1,531
Public expenditures	\$5,520	\$7,020
Total economic costs	\$10,609	\$17,097

In addition, the lost income of workers and businesses is substantial and under-reported. Our research also points to large labour market costs that are typically overlooked when damage reports are made. Totalling the estimates made above, we get a total labour market impact of \$1.5–\$2.6 billion or 15 per cent of total economic costs.

The 2022 BC Budget supports new planning efforts for adaptation, emphasizing prevention and protection, and a new Climate Preparedness and Adaptation Strategy was announced. However, just \$513 million in funding is allocated over four years, of which \$221 million was already spent in 2021/22. This funding had been previously announced, and much of the plan is still at the stage of data-gathering and the development of high-level principles.

Ideally, both federal and BC governments step up to commit substantial fiscal resources commensurate with the damages we have seen – from upgrading dikes to wildfire control to ensuring cooling systems are widespread. The fiscal implications are stark but doable: many billions of dollars in upgrades to infrastructure are needed so that they can better handle tomorrow’s extreme weather events, and better systems can be developed to minimize adverse impacts during disasters and accelerate rebuilding in the aftermath.

Continued failure to rein in greenhouse gas emissions globally guarantees that these extreme weather disasters will only get worse in the future. Just as extreme weather disasters are an outcome of our collective failure to limit emissions at a global level, the solution lies in collective action, solidarity and quickly ending the reign of fossil fuels.

“In November, we had about 45 people on staff that we had to lay off. The only person that we were actually able to retain was our finance person, and she worked remotely and made sure we kept paying our bills, because even though we were in a flood situation, people still needed to be paid.”
— Caroline Mosterman, Sumas Prairie farmer, on the fallout for farm workers post November 2021’s floods.

Introduction

BC's extreme weather events in 2021 show us that we no longer have the luxury of thinking that climate change is only something happening elsewhere or to our grandchildren.

IN RECENT YEARS, CLIMATE CHANGE HAS BECOME REAL for British Columbia. Extreme weather events are like historical weather patterns on steroids: devastating for the land base, displacing tens of thousands of people, destroying homes and critical infrastructure and disrupting the economy. The fingerprints of climate change are all over the surge of extreme weather, according to the Intergovernmental Panel on Climate Change:

Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability. Some development and adaptation efforts have reduced vulnerability. Across sectors and regions the most vulnerable people and systems are observed to be disproportionately affected. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt.¹

In this paper we bring a climate justice lens to the economics of natural disasters, with an in-depth look at the economic costs associated with BC's three major events in 2021: the June heat dome, the summer wildfires and the mid-November atmospheric river and flooding. Each of these three extreme weather events were very different in how they played out, but they are woven together: extreme heat preceded wildfires, which then made flooding worse. These new extremes of 2021 set the bar higher for future planning and adaptation.

Climate policy to date has largely focused on mitigation—policies and actions to reduce domestic greenhouse gas emissions causing climate change. BC's extreme weather events in 2021 show us that we no longer have the luxury of thinking that climate change is only something happening elsewhere or to our grandchildren. In the 2020s, nowhere is safe—your town could be flooded or destroyed by fire in a matter of hours, a heat wave could kill your loved ones.

Of course, some people and groups are safer than others. Pre-existing inequalities will be exacerbated by extreme weather. Low-income households and people with various physical or social disadvantages all face more serious consequences of extreme weather events. Those who have

¹ Pörtner, H-O., D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller and A. Okem (eds.). "Summary for Policymakers." *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel*. Cambridge, UK & New York: Cambridge University Press, 2022. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.

done the most to cause the problem — high-income and wealthy households — are typically not the ones to pay the price, or at least have greater capacity to buy their way out of danger.

The next section reviews our analytical framework for detailing the economic costs of extreme weather disasters. We then use the framework to organize widespread data and information to put numbers to each of the three extreme weather events that hammered BC in 2021: the late-June heat dome, the summer wildfires and the November floods and landslides. In the final section, we reconnect these stories to similar events occurring around the world, and summarize our main findings.

The economic costs of extreme weather disasters

Disasters pack a punch to the economy due to a sudden loss of productive capacity, output and income.

IN ANY DISASTER, FRONT AND CENTRE IS THE HUMAN IMPACT: people displaced from their homes or in need of rescue; deaths and injuries; and the need for basic health, food, shelter and security for those affected. Disasters also pack a punch to the economy due to a sudden loss of productive capacity, output and income. Emergency response activities by governments limit the extent of the disaster, and are then followed by a longer period of recovery, repair and restoration of lost capacity.

Estimating the full cost of a disaster is not a straightforward exercise. In the immediate aftermath, the first (and often only) estimates are of insured damages to property, and only with the passage of time are more comprehensive estimates made. Set against these economic losses are increases in economic activity in the rebuilding stage as payouts from insurance companies and disaster assistance from governments flow into a region. Response and recovery spending typically necessitates workers and equipment coming in from other regions.²

While rebuilding and recovery may boost GDP and employment, some caution is required in treating these actions as positive economic impacts. Rebuilding requires labour and resources from other economic activities, and over a longer period of time those financial flows into a region would be balanced by outward financial flows in the form of premiums to insurance companies and taxes paid to governments. Government recovery funds are still a cost associated with the disaster, not a benefit, as those funds must come from either increased debt or from displacing other expenditures.

Our framework for the evaluation of economic impacts builds on previous literature in the Canadian context,³ and includes costs associated with:

2 Hallegatte, S. *The Indirect Cost of Natural Disasters and an Economic Definition of Macroeconomic Resilience*. World Bank Group, 2015. <https://openknowledge.worldbank.org/bitstream/handle/10986/22238/The0indirect0coeconomic0resilience.pdf;sequence=1>.

3 In particular, the analysis by University of Western Ontario's JB Davies: "Economic Analysis of the Costs of Flooding." *Canadian Water Resources Journal / Revue canadienne des ressources hydriques*. 41:1-2(2016): 204-219. <https://doi.org/10.1080/07011784.2015.1055804>.

- Damages to assets and property, including insured and non-insured damages, for households and businesses.
- Lost income for workers due to closures or damaged transportation linkages.
- Costs to the public sector, including immediate disaster response, relief and support, and longer-term cleanup and recovery, and rebuilding of infrastructure.
- Specific impacts on vulnerable and/or marginalized populations, such as people with low incomes, renters, seniors, Indigenous people, immigrants and people with physical or mental disabilities.

Economic losses also intersect with health-related losses as disasters cause death, illness and physical injury. Associated displacement and property losses can place a heavy toll on mental health for those affected. That said, putting a price tag on such impacts is a fraught exercise. This paper does not look at personal health costs except when directly related to the labour market (such as the case of extreme heat or wildfire smoke). Costs of injury and other health impacts are real economic costs and including them would increase the overall estimated costs of a disaster.

Economic losses also intersect with health-related losses as disasters cause death, illness and physical injury.

In all, disasters have multi-dimensional and complex economic impacts, including distributional impacts, that point to limitations in deriving one large number from our analysis of economic costs. Data limitations also restrict our ability to peer more closely at particular dimensions of impact for different groups in BC. To the extent possible, this report aims to tease out these complexities to provide the necessary context to our estimates of the economic costs of climate change in BC.

Damages to assets and property

In the aftermath of a catastrophic disaster the most widely reported cost estimates are for *insured damages*. Published by the Insurance Bureau of Canada (IBC), a disaster is deemed catastrophic when estimated insured damages top \$25 million, triggering a process of data collection from individual insurance companies.⁴ Many private insurers provide a preliminary estimate of insured damages after 30 days, as insurers must put aside funds based on claims received to that point (although individual claims will be adjusted later on). Four updated estimates are then provided over the course of a year as more claims are filed, and up to two years for larger events.

As provided by IBC, insured damages (as of June 15, 2022) for the three BC extreme weather events are:⁵

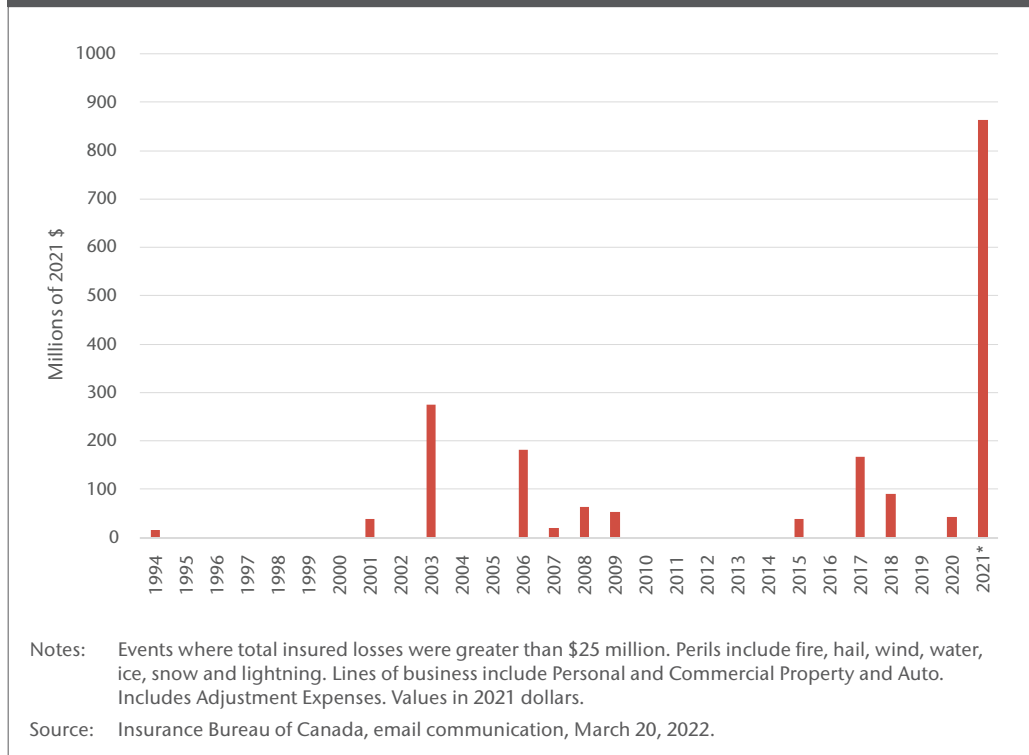
- Destruction of Lytton by wildfire: \$102 million (original estimate \$78 million).
- Wildfire damage in the White Rock Lake area: \$76.8 million.
- Flooding from the atmospheric river: \$675 million (original estimate \$450 million).

Figure 1 shows IBC historical data on insured damages and it's clear that 2021 vastly exceeded any previous year. The previous two record fire seasons in 2017 and 2018 are relatively small in comparison. The spike in 2003 reflects a major wildfire hitting near more populous Kelowna.

⁴ Collected from insurance companies by boutique research firm Catastrophe Indices and Quantification Inc. (CatIQ).

⁵ Email communication with Chris Rol, Insurance Bureau of Canada, September 13, 2022.

Figure 1: Insured damages from catastrophic events in BC



There are limits to the coverage of private insurance for wildfires, flooding and landslides, meaning the total damages will be much larger than reported insured damages. In remote areas only a handful of cabins/structures might be affected by wildfires but these are generally not eligible for insurance unless someone lives there year-round. In the case of overland flooding, private insurance has only existed since 2015 in Canada, and in the highest-risk areas it would be very costly if available at all. In part this is due to the lack of modern flood maps that would provide more data upon which to price insurance policies.

Insured damages to assets and property are just the tip of the iceberg. Inevitably, there are costs borne by households and businesses above and beyond the insured damages recovered from insurance companies. Some property owners may choose not to purchase insurance or buying insurance may not be possible at all or at reasonable cost. Households may also be under-insured relative to the replacement cost for damages incurred, and deductibles, co-payments and limits to coverage put some of the burden on those affected by damage. Non-monetary damages also arise, such as people who are displaced losing the ability to cook their own meals and provide caregiving to members of their household.

Income losses for workers

Income losses experienced by workers and businesses are often overlooked in media coverage but can constitute large costs of disasters. For businesses there is overlap with damaged assets as discussed above because any asset has a stream of income associated with it. Some caution is required not to double-count the loss of the asset (which may or may not be insured) and the corresponding loss of income from that asset.

For this paper, we focus on lost wages for workers. To evaluate impacts, we develop high and low-cost estimates, drawing on BC wage and employment data, broken down by sector and region. In addition to paid work, other volunteer and unpaid care work could also be affected, although we do not make estimates in this area.

Income losses begin during the disaster and can potentially last weeks or months. The closure of businesses and workplaces, the inability to work or access work sites, compromised transportation linkages and slowdowns in business activity are all sources of income losses, which will be disproportionate for certain sectors and occupations in the region of the disaster. Damage to key infrastructure can have supply chain effects that impact other sectors and regions beyond the disaster area. Supply chain effects include curtailment of production, shipping delays and losses of perishable commodities. They can also have impacts on supplies purchased from other regions.

These costs will be mitigated by accumulation of inventories (or drawing down, depending on which side of the blockage) during and after the disaster, rerouting of shipments to different routes and ports, and a recovery period with greater-than-normal capacity utilization to clear backlogs. Short-term shocks can be more easily accommodated with these practices but longer-term shocks will lead to reductions in total work and compensation. How quickly economic activity and incomes can be restored is thus a key component of macroeconomic resilience and something that can be supported by public expenditures.

Public infrastructure and other costs

Governments face a range of costs from immediate disaster response (e.g., sandbagging, fire suppression, sheltering displaced people) through to cleanup and rebuilding efforts. Damage to public infrastructure is a central element of total disaster costs. This is because the economic impacts of lost infrastructure — such as highways, bridges or other lifeline systems like electricity, water and sewers — can vastly exceed its replacement value. Because infrastructure underpins a wide range of economic activity, its loss can cause supply chain problems that extend well beyond the immediate disaster area.

The BC government allocates “contingencies” in the annual budget that can be drawn down if needed. In practice, public costs can vastly exceed budgeted amounts and require additional expenditures. For example, the 2021 BC Budget allocated \$200 million for various emergency measures.⁶ However, the 2021 extremes led to an additional \$522 million in disaster and emergency assistance related to the November floods and landslides, and an additional \$665 million fighting the summer wildfires.⁷ Additional amounts spent as part of the health care system budget during the heat dome and wildfires are not known, but most likely represent diversion of funds from elsewhere in the health care system.

The provincial Disaster Financial Assistance (DFA) program, administered by Emergency Management BC, helps individuals, small businesses, charities and farm owners with uninsurable losses (insurable damages are not covered). Coverage is 80 per cent of eligible claims above

Damage to public infrastructure is a central element of total disaster costs.

6 Government of British Columbia. *Budget 2021: Budget and Fiscal Plan 2021/2022–2023/2024*. April 20, 2021. https://www.bcbudget.gov.bc.ca/2021/pdf/2021_Budget%20and%20Fiscal%20Plan.pdf.

7 Government of British Columbia. *Budget 2022: Budget and Fiscal Plan 2022/2023–2024/2025*. https://www.bcbudget.gov.bc.ca/2022/pdf/2022_budget_and_fiscal_plan.pdf.

\$1,000 to a maximum claim of \$300,000.⁸ The focus is on helping communities to repair and restore damaged homes and to re-establish or maintain the viability of small businesses and working farms.

In light of climate change, a more comprehensive understanding of risks to essential infrastructure is needed, and how various investments and expenditures can reduce that risk.

Public funds are required to pay for cleanup, restoration and rebuilding of public infrastructure. Cost-sharing among governments shifts as the size of a disaster grows. Local governments have initial responsibility for infrastructure, but the provincial DFA program is available to help pay for the restoration of essential infrastructure. In the aftermath of the November 2021 floods and landslides the BC government loosened the criteria for DFA, capping the local government contribution at 10 per cent of the total (and as low as 5 per cent for more costly disasters), down from 20 per cent previously.⁹ As the cost of damages increases further, a progressively larger share gets paid by the federal government under the Disaster Financial Assistance Arrangements (DFAA) program, administered by Public Safety Canada.¹⁰

As climate-related disasters get worse, more fundamental questions arise beyond the cost to replace infrastructure to pre-disaster condition. This includes decisions to upgrade for resiliency against future extremes (although upgrades should not be counted as costs of a disaster) or alternatively to abandon reconstruction. In light of climate change, a more comprehensive understanding of risks to essential infrastructure is needed, and how various investments and expenditures can reduce that risk.

Distributional impacts

Climate change embodies injustice: those who have done the most to cause the problem—high-income and wealthy households—are typically not the ones to pay the price. Or they at least have greater capacity to buy their way out of danger. As climate change has loaded the dice toward more powerful storms and more weather extremes, those with the greatest vulnerabilities—and the smallest carbon footprints—must live with the consequences.

Each of the three principal areas above—damages to assets and property, income losses for workers, and public costs to governments—intersect with distributional issues. Pre-existing inequalities are exacerbated by extreme weather disasters. Low-income households and people with various physical or social disadvantages all face more serious consequences of extreme weather events. They typically lack the financial resources to adapt, whether that is air conditioning in a home or a vehicle to leave the impacted area, although they may have better practical skills than wealthier people and may be more likely to help each other in the aftermath of a disaster.

8 Government of British Columbia. "Financial assistance in a disaster." Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/safety/emergency-management/preparedbc/evacuation-recovery/disaster-financial-assistance>.

9 Government of British Columbia. "Province strengthens Disaster Financial Assistance." News release. April 28, 2022. <https://news.gov.bc.ca/releases/2022PSSG0026-000664>.

10 Under the federal DFAA program formula for 2022, expenditures up to \$3.38 per capita (of provincial population) is 100 per cent covered by the province. Expenditures of \$3.38–\$6.78 per capita are split 50-50 federal-provincial; \$6.78–\$13.56 per capita are split 75-25 federal-provincial; and above \$13.56 per capita are split 90-10 federal-provincial. Public Safety Canada. "Disaster Financial Assistance Arrangements (DFAA)." Accessed October 12, 2022. <https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/rcvr-dsstrs/dsstr-fnncl-sstnc-rngmnts/index-en.aspx>.

While extreme weather disasters have disproportionate impacts on low-income and other vulnerable populations, the nature of government responses matters a great deal, from emergency response to rebuilding to future planning. A slow and uncoordinated response from the BC government during the heat dome in particular came at the cost of hundreds of lives, largely borne by vulnerable people.¹¹

11 British Columbia Coroners Service. *Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021*. June 7, 2022. https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf.

Late June: The heat dome

Daytime highs were 15°C to 25°C above normal with little reprieve at night as the mercury could not fall much below 20°C. The dome would not budge and only expanded eastward. From June 24 to July 4, the inferno-like heat blew past 1000 daily temperature records over 11 days, with over 100 records between 40°C and 50°C and some by 12 degrees, not decimals. One eminent American climatologist claimed no other heat wave in the world had ever broken more temperature records than the Canadian heat wave. The blistering heat also occurred along the Pacific Coast, and on June 28, Victoria recorded an unfathomable extreme near 40°C, an all-time record a staggering 20°C above average. This beat the previous all-time record by a significant 3 degrees! Kamloops had 6 days of greater than 40°C temperatures in June, significant because the city had never seen 40°C in June before.¹²

THE UNPRECEDENTED HEAT DOME EVENT that unfolded in late June 2021 was not limited to BC but also extended east to the Prairies, north to the Territories and south to California. Environment Canada describes a heat wave as three or more days of temperature above 32°C. Temperatures during the heat dome spiked far beyond that level. Locally, over the four-day peak period, temperatures ranged from the low- to high-30s depending on the area of Metro Vancouver, with higher temperatures up the Fraser Valley and inland reaching into the 40s. By comparison, the average daily maximum temperature in July in Vancouver has been only 22.2°C¹³ and further inland in Abbotsford, 22.7°C.¹⁴ Prior to late June, the previous Canadian land temperature record was 45°C, recorded 84 years earlier.¹⁵ Lytton beat the record for three days in a row — 46.6°C on June 27, 47.9°C on June 28 and 49.6°C on June 29 — before the tinder-dry town burned down on June 30 when a wildfire raced through the area (we look at Lytton in the next section on wildfires).

12 Government of Canada. "Canada's top 10 weather stories of 2021." Website accessed October 12, 2022. <https://www.canada.ca/en/environment-climate-change/services/top-ten-weather-stories/2021.html>.

13 Weather and Climate. "Average weather in July in Vancouver (British Columbia), Canada." Accessed November 2, 2022. <https://weather-and-climate.com/vancouver-july-averages>.

14 Weather and Climate. "Average weather in July in Abbotsford (British Columbia), Canada." Accessed November 2, 2022. <https://weather-and-climate.com/abbotsford-british-columbia-ca-july-averages>.

15 Government of Canada. "Canada's top 10 weather stories of 2021."

A new subsector of climate science looks at the attribution of extreme events to climate change. Historically, a disaster could be viewed and planned for in terms of probabilities. A hundred-year flood is one so extreme that it could be expected to occur only once every hundred years. An analysis of the heat dome by a team of climate scientists found the late June heat dome event to be considered, in historical terms, a once-in-a-thousand-year event, one that was “virtually impossible without human-induced climate change.”¹⁶ The authors comment further:

There are two possible sources of this extreme jump in peak temperatures. The first is that this is a very low probability event, even in the current climate which already includes about 1.2°C of global warming — the statistical equivalent of really bad luck, albeit aggravated by climate change. The second option is that nonlinear interactions in the climate have substantially increased the probability of such extreme heat, much beyond the gradual increase in heat extremes that has been observed up to now.

If the latter possibility is taken seriously, we must plan for more heat domes in the future. Before June 2021 few would have considered that such extreme heat was even possible in places like Vancouver. Now that we have the lived experience, we have to assume it could happen again and with growing frequency.

Relatively cool summers compared to inland areas or other parts of Canada mean Vancouver has been less prepared for dealing with extreme heat events at a household level. In 2015, only 31 per cent of British Columbians had access to air conditioning, compared to 60 per cent nationally and 85 per cent in Ontario.¹⁷ This figure may be even less for Metro Vancouver as relatively more households in the Interior have already invested in cooling due to much greater summer heat historically.

Just as important was a lack of preparedness at an institutional level in terms of planning and outreach to vulnerable populations. The *Extreme Heat Death Review* by the BC Coroners Service reported 619 heat-related deaths from June 25 to July 1 (and separately and previously reported another 43 the following week of July 2). Almost all of the deaths (98 per cent) occurred indoors, due to lack of adequate cooling and poor ventilation, and two-thirds (67 per cent) of the fatalities were of people over the age of 70. Those who had more material privilege in terms of income and wealth fared better as did those with stronger social networks. According to the BC Coroner’s report, “28% of decedents lived in neighbourhoods that were most materially deprived and 33% lived in neighbourhoods that were most socially deprived.”¹⁸

There was a lack of preparedness at an institutional level in terms of planning and outreach to vulnerable populations.

Damages to assets and property

The heat dome was severely damaging to crops in the Okanagan and Fraser Valley. In the Okanagan, some 50-70 per cent of the cherry crop was affected, according to the BC Fruit Growers Association, with lesser damages to other tree fruit crops. Raspberries and blueberries

16 World Weather Attribution. “Western North American extreme heat virtually impossible without human-caused climate change.” July 7, 2021. <https://www.worldweatherattribution.org/western-north-american-extreme-heat-virtually-impossible-without-human-caused-climate-change>.

17 Natural Resources Canada. “7.1 Air Conditioning of Dwellings.” *2015 Survey of Household Energy Use*. Accessed October 12, 2022. <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=SH§or=AAA&juris=CA&rn=26&page=2>.

18 British Columbia Coroners Service. *Extreme Heat and Human Mortality*.

crops were affected in the Fraser Valley.¹⁹ Many farmers are covered by provincial crop production insurance for various environmental perils, including heat stress. The Ministry of Agriculture received 50 loss claims from Lower Mainland berry farmers and 31 from tree fruit growers in the Okanagan.²⁰

Over 650,000 chickens and other poultry died during the heat dome, compared to an average weekly chicken slaughter of 2.2 million birds.²¹ At \$5 per live chicken, this amounts to \$3 million in losses.²² In addition, the BC government reports egg-laying birds producing at only 30 per cent of normal capacity, while dairy production “was reduced by nearly twenty percent, with large quantities of remaining milk produced having to be discarded due to the inability to maintain it at a cool temperature.”²³

By the sea, the heat dome affected production from BC’s shellfish industry, oysters in particular.²⁴ And while not representing a financial loss per se, it was estimated that one billion ocean creatures above the low-tide line were killed as very low tides coincided with the heat dome event.²⁵

Income losses for workers

Productivity losses across an entire economy can occur due to oppressive heat. The International Labour Organization notes: “Excessive heat during work creates occupational health risks; it restricts a worker’s physical functions and capabilities, work capacity and productivity. Temperatures above 24–26 °C are associated with reduced labour productivity. At 33–34 °C, a worker operating at moderate work intensity loses 50 per cent of his or her work capacity.”²⁶ Workers respond to extreme heat by taking longer breaks, working fewer hours and slowing down work, all of which undercut productivity. Work in extreme heat also increases the risk of injury.

Worldwide, the ILO puts lost working hours to extreme heat at 1.5–2 per cent of total hours worked, with agriculture and construction bearing the greatest burden. These amounts add up and would be much higher over the duration of the heat dome event, although some tasks can be shifted to times when it is less hot. A study of GDP impacts of heat waves in Europe found

19 Gomez, M. “BC heat wave ‘cooks’ fruit crops on the branch in sweltering Okanagan and Fraser valleys.” CBC News. July 6, 2021. <https://www.cbc.ca/news/canada/british-columbia/heat-fruit-crops-okanagan-fraser-valley-1.6092155>.

20 Luymes, G. “BC farmers feeling the heat as their crops and animals took a hit.” *Vancouver Sun*. July 2, 2021. <https://vancouversun.com/news/local-news/b-c-farmers-feeling-the-heat-as-their-crops-animals-took-a-hit>.

21 Ryan, D. “Heat dome caused heartbreaking losses for BC livestock farmers, documents show.” *Vancouver Sun*. September 26, 2021. <https://vancouversun.com/news/heatwave-animal-deaths>.

22 Average weight of 2.5 kg per live chicken at Chicken Marketing Board live price of \$2.20 per kg. British Columbia Chicken Marketing Board. “Pricing Order #168.” June 30, 2022. <http://bcchicken.ca/wp-content/uploads/2022/07/A-177-Mainstream-Pricing-Order.pdf>.

23 Government of British Columbia. *Extreme Heat: Preparedness for Provincial Ministries and Agencies*. May 2022. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/provincial-emergency-planning/extreme_heat_preparedness_for_ministries_and_agencies.pdf.

24 Baker, R. “West Coast heat wave burned B.C.’s shellfish sector.” *National Observer*. July 12, 2021. <https://www.nationalobserver.com/2021/07/12/news/west-coast-heat-wave-bc-shellfish>.

25 Baker, R. “A billion tidal creatures likely baked to death in BC heat wave.” *National Observer*. July 8, 2021. <https://www.nationalobserver.com/2021/07/08/news/billion-tidal-creatures-baked-to-death-bc-heat-wave>.

26 Kjellstrom, T., N. Maître, C. Saget, M. Otto, and T. Karimova. *Working on a warmer planet: The effect of heat stress on productivity and decent work*. International Labour Organization. July 1, 2019. https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf.

Workers respond to extreme heat by taking longer breaks, working fewer hours and slowing down work, all of which undercut productivity. Work in extreme heat also increases the risk of injury.

that “the total estimated damages attributed to heatwaves amounted to 0.3–0.5% of European gross domestic product (GDP)” in heat wave years when compared to the 1981–2010 reference period, and 1–2 per cent of annual GDP for severely-affected regions.²⁷

Total employee compensation in BC is \$420 million per day.²⁸ In the case of the BC heat dome, if we assume lost productivity in the order of 2–5 per cent over the four days of maximum temperature this amounts to \$34–\$84 million. In part, this is due to the large number of people in the Southwest who do not have access to residential cooling, and the large number of people working at home—versus in an air-conditioned office—due to COVID-19. Compensation for salaried employees may not have changed but productivity would still be lost to the economy.

The heat dome was associated with losses of income due to workplace closures. These impacts would be felt more severely by workers paid an hourly wage, or whose work was directly outside or inside in non-air-conditioned spaces (or heated spaces, as in factories and kitchens). Although there was no tracking of labour market disruptions due to the heat dome, media reports point to closures of construction sites, restaurants, golf courses and even pools due to the heat.^{29,30}

To get a sense of the magnitude of the labour market impact, Figure 2 looks at BC employment data broken out by sectors most likely to have been affected by closures in order to derive a low and a high estimate of wages lost. For example, if 40–60 per cent of the total hours worked by farmworkers over the four-day period was lost, that would lead to wage losses of \$5–\$7.4 million. The sector breakdowns are from the System of National Accounts and represent just over one-quarter of BC jobs that are relatively more vulnerable to heat stress.

Across the sectors we estimate that between \$205 million and \$328 million in income was lost. More research into this area would help refine these estimates, and this type of data should be collected in the future (for example, as supplemental questions to the Labour Force Survey) to show impacts broken down by gender and race.

We can add to this number the general productivity decline estimated above. This yields a total labour market loss of \$239–\$412 million. A caution here is that the heat dome was of limited duration, including part of a weekend. While severe, overall losses may be reduced due to shifts in the timing of work and consumption (e.g., working before or after the event, starting work early). For many workers, air-conditioned offices and vehicles (or basements or coffee shops) enabled normal work to take place in the face of excess heat. That said, our estimate is a good indication of how costly the labour market impacts of an extreme heat event can be.

Across the sectors we estimate that between \$205 million and \$328 million in income was lost.

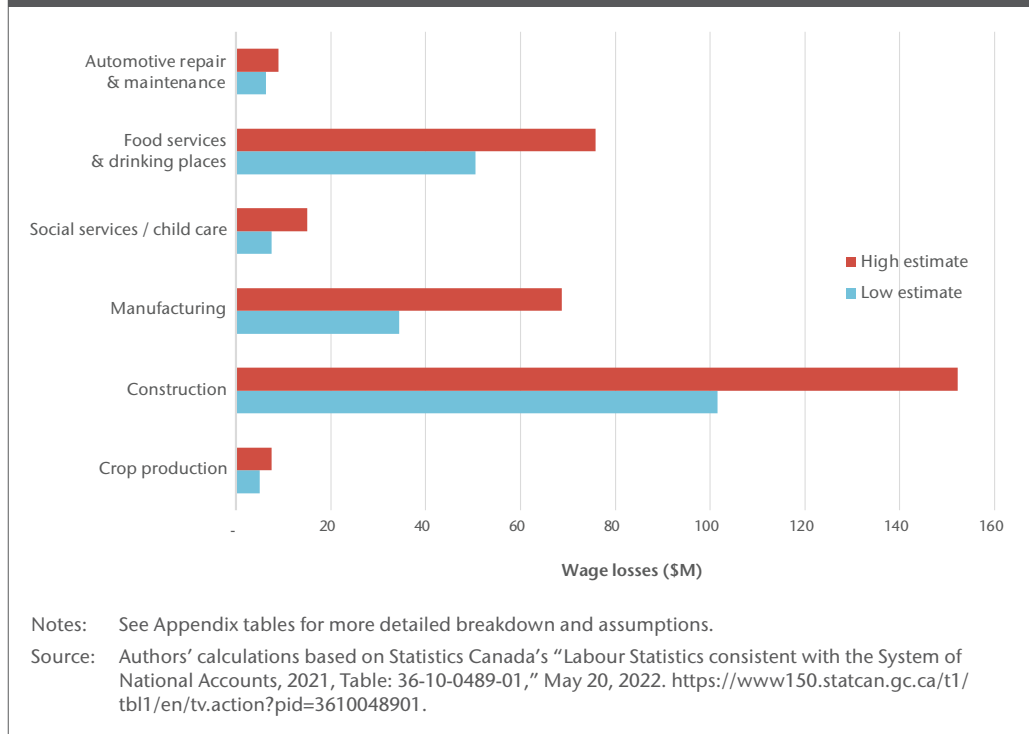
27 García-León, D., A. Casanueva, G. Standardi, A. Burgstall, A. Flouris and L. Nybo. “Current and projected regional economic impacts of heatwaves in Europe.” *Nature Communications*, 12: 5807 (2021). <https://www.nature.com/articles/s41467-021-26050-z>.

28 BC’s employee compensation in 2019 was \$152.6 billion. Government of British Columbia. *2021 British Columbia Financial and Economic Review*. <https://www2.gov.bc.ca/assets/gov/british-columbians-our-governments/government-finances/financial-economic-review/financial-economic-review-2021.pdf>.

29 Ghossoub, M. “Workers swelter in B.C.’s hottest jobs as heat dome blasts province.” CBC News. June 30, 2021. <https://www.cbc.ca/news/canada/british-columbia/bc-hottest-jobs-heat-wave-heat-dome-1.6084703>.

30 Judd, A. “BC businesses close their doors due to extreme heat.” Global News. June 28, 2021. <https://globalnews.ca/news/7986877/bc-businesses-closing-monday-extreme-heat/>.

Figure 2: Estimated wage losses by sector—heat dome



Public costs

A key labour aspect of the government response is emergency services. There was a doubling in 911 calls relative to normal during the peak days of the heat dome. Emergency services like ambulances were overwhelmed leading to a physical and mental health toll on paramedics and related workers. Staffing issues with the BC Ambulance Service had been noted in the lead up to the heat dome.³¹ While no health authority data are available, it would be worthwhile to investigate hospital emergency services and staffing impacts to better understand the impact of the heat dome on the health care system.

Heat waves can have material impacts on property and can push the physical capabilities (or tolerances) of public infrastructure, from rail lines to roads and sidewalks. Such impacts have been noted in a handful of Pacific Northwest locales during the heat dome, including sidewalks buckling in Kamloops,³² though these do not appear to be significant. Future planning for infrastructure needs to consider these extremes.

While not a public cost per se, keeping British Columbians cool during the heat dome consumed additional resources and energy relative to normal. The main public electricity utility, BC Hydro, set BC's all-time summer peak hourly demand record on June 28, 2021. Electricity demand reached 8,568 megawatts, shattering the previous record by more than 600 megawatts, an

31 St. Denis, J. "Inside June's Deadly Heat Dome. And Surviving the Next One." *The Tyee*. March 14, 2022. <https://thetyee.ca/News/2022/03/14/Inside-June-Deadly-Heat-Dome>.

32 Wallace, J. "Kamloops sidewalks buckling in record-breaking heat." *Kamloops This Week*. June 30, 2021. <https://www.kamloopsthisweek.com/local-news/kamloops-sidewalks-buckling-in-record-breaking-heat-4448832>.

Emergency services like ambulances were overwhelmed during the heat dome.

amount equivalent to 600,000 portable air conditioners. Assuming an excess demand of between 800 to 1,200 MW over 4–5 days at a supply cost of \$100/MWh means British Columbians spent an additional \$8–\$14 million on electricity during the heat dome event. Beyond the four days of heat dome, BC Hydro also reports that summer 2021 included “19 of its top 25 all-time summer daily peak hours for system load.”³³

Vulnerable populations

Extreme heat events make bad conditions deadly for the most vulnerable workers. One major study on temperature, workplace safety and labour markets comments, “Due to the fact that lower wage workers are more likely to work in dangerous occupations, more likely to live and work in places with greater heat exposure, and experience larger marginal increases in risk on hotter days, the net effect on injuries is far greater for low-income groups.”³⁴

Many workers were not able to escape the heat due the nature of their jobs, and this led to heat stress injuries. According to WorkSafeBC, during the heat dome “there were 71 claims due to heat stress between June 25 to July 7th out of the 115 claims. By sector: Health Care and Social Services (15); Transportation and Related Services (12); Accommodation, Food, and Leisure Services (7); Professional, Scientific, and Technical Services (5).”³⁵ In addition to heat stroke, higher temperatures significantly increase the risk of injuries from related impacts (e.g., falling from a ladder, mishandling heavy machinery).³⁶

Migrant farm workers in BC are particularly vulnerable to the heat due to their long work days, difficult working conditions and substandard accommodations. The heat dome exacerbated existing vulnerabilities—such as the lack of basic protections through employment standards, limited control over work schedules, no labour representation and the prospect of repatriation. In addition to outside workers, those inside greenhouses, packing sheds and warehouses also faced extreme heat stress.³⁷

A central lesson from the heat dome is the need for a more coordinated government response including outreach to vulnerable populations.³⁸ Both Oregon and Washington state fared better in terms of heat dome mortality: in Oregon 107 people died from heat-related deaths and in Washington state, 157.³⁹ Both jurisdictions were better prepared than BC by proactively opening 24/7 cooling centres.

Though the province issued a news release on June 25, “Tips to stay safe, cool during extreme heat wave,”⁴⁰ the release did not direct people to cooling centres and there was little proactive

Migrant farm workers in BC are particularly vulnerable to the heat due to their long work days, difficult working conditions and substandard accommodations.

33 BC Hydro. 2021: A record-breaking year for electricity demand and extreme weather. January 2022. <https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/2021-demand-report.pdf>.

34 Jisung Park, R., N. Pankratz and A.P. Behrer. *Temperature, Workplace Safety, and Labor Market Inequality*. Bonn, DE: IZA Institute of Labour Economics, July 2021. <https://docs.iza.org/dp14560.pdf>.

35 Email communication with the author, June 9, 2022.

36 Jisung Park, R., N. Pankratz and A.P. Behrer. *Temperature, Workplace Safety, and Labor Market Inequality*.

37 Aronoff, K. “Work Really Sucks When It’s Hot.” *The New Republic*. July 1, 2021. <https://newrepublic.com/article/162896/pacific-northwest-heat-wave-workers>.

38 St. Denis, J. “Inside June’s Deadly Heat Dome.”

39 St. Denis, J. “Inside June’s Deadly Heat Dome.”

40 Government of British Columbia. “Tips to stay safe, cool during extreme heat wave.” Information bulletin. June 25, 2021. https://archive.news.gov.bc.ca/releases/news_releases_2020-2024/2021PSSG0043-001226.htm.

Additional outreach strategies to ensure awareness and access may be required.

outreach to vulnerable populations. On June 28, several days into the heat dome, WorkSafeBC put out an advisory to employers “to consider closing down their workplaces if workers cannot be protected from the risk of heat stress,” noting that they require employers to conduct heat stress assessments, and had about 100 reported cases of heat stress in the past three years.⁴¹

The BC government has since published an *Extreme Heat Preparedness Guide*⁴² for the general public and a more detailed guide for provincial ministries and agencies.⁴³ A Heat Alert and Response System to notify the public of heat risks has also been established, with two trigger points for “Heat Warning” and “Extreme Heat Emergency.”⁴⁴ That said, additional outreach strategies to ensure awareness and access may be required. A report on the lived experience of the heat dome event found that, “Cooling centres were largely not used due to lack of awareness and availability, mobility and transportation challenges, lack of welcoming and safe spaces, concerns of discrimination, and inability to bring pets and belongings.”⁴⁵

ON THE GROUND

The 2021 heat dome: When fruit cooked on the trees and there were no cherries at No’s Orchard

When Don and Mary Nowoselski moved from Dawson Creek in northeast British Columbia to the Creston valley, they were looking for four distinct seasons, a little less winter and a bit more summer. A bit of land tucked near the US border in a fertile valley in the province’s East Kootenay region seemed to fit the bill.

Don had landed a job teaching mechanics at the local school and the couple opted to purchase a house on three acres of land with hundreds of fruit trees on it. Don recalls they liked the idea of having a small patch of land but didn’t think then that they’d become full-time orchardists.

“I don’t know what happened,” Don recalls. “It just kind of grew on us. We were not intending to get big, but it ended up being that.”⁴⁶

Over the years, the couple amassed 23 acres of fruit trees which is relatively small by orchard standards but still amounts to 14,000 trees, most of which are four varieties of cherry: early season bings and lapins, and later season staccatos and sentennials. They called it No’s Orchard. At school the students called him Mr. No instead of Nowoselski, so No’s it was.

41 WorkSafeBC. “WorkSafeBC advising employers to consider workplace closures during heat wave.” News release. June 28, 2021. <https://www.worksafebc.com/en/about-us/news-events/news-releases/2021/June/worksafebc-advising-employers-to-consider-workplace-closures-during-heat-wave>.

42 Government of British Columbia. *Extreme Heat Preparedness Guide*. June 2022. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/preparedbc/preparedbc-guides/preparedbc_extreme_heat_guide.pdf.

43 Government of British Columbia. *Extreme Heat: Preparedness for Provincial Ministries and Agencies*.

44 Government of British Columbia. *BC Provincial Heat Alert and Response System (BC HARS): 2022*. <http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/Provincial-Heat-Alerting-Response-System.pdf>.

45 Yumagulova, L., T. Okamoto, E. Crawford and K. Klein. *Lived Experience of Extreme Heat in B.C., Final Report to the Climate Action Secretariat*. April 2022. https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/lived_experience_of_extreme_heat_in_bc_final_report.pdf.

46 Phone interview with Don Nowoselski by Ben Parfitt, November 8, 2022.

Over the decades, Don says there were challenging years when a preponderance of rain and cooler temperatures or its opposite resulted in lower crop yields. But he and Mary could handle that. Then came 2021 and the heat dome that changed everything.

“We lost 100 per cent of our crop. We didn’t pick anything. It was just cooking, is what it was. The berries just cooked. I’ve never lost a complete crop ever in the 30 years we’ve been doing it. We just had to walk away from it. It was pretty devastating,” Don recalls.

And then there were all the *trees* that died.

Successful commercial orchardists constantly invest in new trees to replace aging stock. They also carefully select what trees they plant with an eye to the competition and markets. For BC cherry producers in the Okanagan and Kootenay regions, the big competition is across the border in the US. By having more BC cherry trees producing fruit later in the season, BC cherry growers gain some marketing advantage when US production starts to fall off.

“They overload the market with a whole bunch of fruit, and we just hope to go later and later and later from them so that we have a place to market our cherries,” Don says. But the heat dome ended some of that hope. Not only was an entire crop wiped out, but half of the trees in the orchard were young. And of those young trees, half were killed.

Adding to the woes of the Creston valley’s cherry growers, great numbers of the best-producing older trees sustained major damage to their buds due to heat stress. So when 2022’s crop came on, many orchards in the region had yields that were far below normal. Don and Mary got off comparatively easy. “We were probably down 20 per cent this year. But that’s not bad compared to what others were down.”

The sudden, near-total collapse of the 2021 BC cherry harvest also had a serious economic impact on the legion of seasonal farm laborers, many of whom travel to BC each year from Québec to tree-plant on logging sites before turning to picking fruit.

At No’s Orchard, picking starts in mid-July before ramping up to an intense month-long harvest throughout August. At its peak, a crew that typically rotates through several of Creston’s smaller orchards might number between 50 and 100 pickers. On a given day, the more experienced pickers earn \$300 to \$400 per day or more, Don says. But good pickers can only make that kind of money if there’s plentiful fruit to pick.

And according to Don, one brutal season followed by another not so great one is taking a wider toll on the orchard industry.

Climate change is manifesting itself in labor shortages.

“Pickers are really hard to find now. It’s temporary labour. It’s hard to fill. And it’s worse with the heat.”

“We just had to walk away from it. It was pretty devastating.”
— Don Nowoselski,
cherry grower

July to September: Summer wildfires

In British Columbia, wildfires started up in late June and continued into September... The province had its warmest summer since records began in 1948. Furthermore, in the already dry Interior, warm-season rainfall was record low. Some places had not seen rain for 5 weeks or more. Adding to the hot and dry conditions, there was frequent dry lightning, gusty winds, low humidity and bright sunshine that made for a long, busy, intense and challenging fire season. Fires were often fast-moving and aggressive which prompted 50,000 evacuations and a province-wide state of emergency for the third year out of the last five. Notable fires in the province became larger and uncontrollable and essentially went wherever the winds took them. British Columbia fire crews were supplemented by others from across Canada, Mexico and the Canadian military, totaling 5,300 wildfire fighters.⁴⁷

Prior to 2000, wildfires simply did not happen at this scale.

OVER THE PAST DECADE WILDFIRES HAVE BECOME a prominent regional consequence of climate change in BC, Washington, Oregon and California. In BC, a record 1.35 million hectares was burned in wildfires in 2018, which came on the heels of 1.2 million hectares burned in 2017.⁴⁸ Beginning with an abnormally dry spring, BC experienced its third worst wildfire season in 2021, with 1,642 wildfires that burned 869,279 hectares.⁴⁹ The years 2017, 2018 and 2021 stand head and shoulders above all previous years for hectares burned. Indeed, prior to 2000, wildfires simply did not happen at this scale.

A state of emergency was declared on July 20 and stayed in effect until September 14, 2021. Cooler and wetter weather that set in by late-August greatly slowed the spread of the 2021 wildfires. While the fires were largely in the interior of the province, smoke flowed down BC's valleys, affecting air quality hundreds of kilometres away, including about 3 million residents in the Lower Mainland.

⁴⁷ Government of Canada. "Canada's top 10 weather stories of 2021."

⁴⁸ Government of British Columbia. "Wildfire Averages." Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-statistics/wildfire-averages>.

⁴⁹ Government of British Columbia. "Wildfire Season Summary." Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary>.

Wildfires demonstrate the potential of feedback loops to exacerbate climate impacts and warming. Higher temperatures and lengthy periods of drought result in more wildfires, which represent significant pulses of carbon dioxide into the atmosphere. The largest wildfires significantly affect BC's overall carbon balance, making forests a *source* of carbon dioxide rather than a *sink* that, on balance, absorbs carbon dioxide from the atmosphere. Based on the carbon emissions per hectare from 2017 and 2018, the 2021 wildfires generated about 122 million tonnes of CO₂, nearly double BC's official greenhouse gas tally of 64.6 Mt in 2020.⁵⁰

Higher temperatures and lengthy periods of drought result in more wildfires, which represent significant pulses of carbon dioxide into the atmosphere.

Damages to assets and property

Wildfires that reach human settlements are very costly. The wildfire starting on June 30 that destroyed the town of Lytton caused \$102 million in insured damages. Some 97 per cent of properties were damaged. Two weeks later the White Rock Lake fire in the Okanagan destroyed the community of Monte Lake overnight, with insured damages estimated at \$77 million for 800 properties.⁵¹

Both of these fires were among the largest of the summer wildfires, and both were deemed catastrophic (total insured damages over \$25 million). There may be many other cases where damages did not reach that threshold for reporting and there is no tracking of those who do not have insurance. In remote areas, only a handful of cabins might be affected but these generally are not eligible for insurance as someone must live there year-round.

Because of this reporting anomaly we add a high estimate of insured damages that is 20 per cent higher to cover other wildfires that did not meet IBC's \$25 million catastrophic threshold. We can also estimate non-insured damages based on typical industry coverage and assume a low estimate of 30 per cent of damages being covered by insurance and a high estimate of 50 per cent of damages covered. This range puts non-insured damages at between \$179 and 501 million.

Income losses for workers

Impacts on tourism have been notable in previous heavy fire seasons in BC: \$139 million in 2017 (438 jobs affected) and \$34 million in 2018 (104 jobs affected).⁵² In June 2021 tourism was still well down due to COVID-19 restrictions relative to 2019 and earlier. Nonetheless, the wildfires impacted hotels and motels, restaurants and wineries, attractions, outside adventuring and fishing. However, because demand was lower due to COVID-19, many rooms were able to accommodate displaced people.

Fires affected both CN Railway and Canadian Pacific Railway networks causing a backlog of freight deliveries in early July. Supply chain impacts included a key transportation blockage in the Fraser Canyon, with rail lines via Lytton closed between June 30 and July 5, stranding thousands of rail

50 Extrapolated by authors based on stated 163 million tonnes of CO₂ in 2017 and 200 million in 2018 divided by wildfire area burned in each respective year. GHG data from: Government of British Columbia. "BC Greenhouse Gas Inventory" Accessed October 17, 2022. <https://www2.gov.bc.ca/gov/content/environment/climate-change/data/provincial-inventory>.

51 Email communication with Chris Rol, Insurance Bureau of Canada, September 13, 2022.

52 Lions Gate Consulting, et al. *2017 Wildfires – Opportunities to Minimize Rural Impacts*. Kamloops, BC: Ministry of Forests, Lands, Natural Resource Operations and Rural Development, 2018. <https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/2017-wildfires-opportunities-to-minimize-rural-impacts.pdf>.

cars.⁵³ More than 4,000 rail cars of crops were affected, according to the Agriculture Transport Coalition.⁵⁴ In early July CN Railway told its customers “all intermodal traffic (transport between trucks and trains) and carload traffic north and eastbound from Vancouver was affected by the wildfires, as was traffic coming into Vancouver from east and north of Kamloops,” while CPR reported shipping delays of 72–96 hours in early July.⁵⁵

Workers were also affected by closures created by supply backlogs for shipping containers through the Port of Vancouver, and some shipments were rerouted outside Vancouver. Teck Resources, the dominant mining company in the Kootenays, estimated between 300,000 and 500,000 fewer tonnes of coal sales due to the rail disruption, and shifted deliveries to Prince Rupert.⁵⁶ Two Canfor mills closed for two weeks due to rail bottlenecks, with production loss of 115 million board feet of lumber.⁵⁷ (Impacts on mills were much larger during the 2017 fires.)

Figure 3 presents a range of estimates of the impact of wildfires on the labour market. We can again look at employment data, in this case broken out by both sector and region.⁵⁸ The range of estimates of \$281–\$463 million in losses was reflected in media coverage of work slowdowns in key affected sectors. They demonstrate that labour market impacts can be significant.

These results represent a pure short-term labour market effect. In practice, companies respond to supply chain issues by seeking alternative transportation routes, stockpiling inventories and only then curtailing production, much of which may be made up in the weeks and months following the disaster. Interestingly, the impacts in key industrial areas are fairly modest due to fewer numbers of workers affected. Less obvious, but perhaps more important economically, are sectors with larger numbers of workers, such as retail trade (where we estimated only a modest 20-30 per cent reduction in hours over 15 affected days). More detailed survey results to get a better understanding of actual impacts would be useful for future research and advising policy.

As a low estimate, we consider 10 days and 40 per cent of the population affected at a daily wage of \$250 would be \$33 million in lost income.

In addition, the value of work time for those people displaced from their homes could also be estimated. Fires and smoke prompted 181 evacuation orders and 304 evacuation alerts.⁵⁹ The wildfires also displaced almost 33,000 people, including 340 people who were still homeless in October 2021.⁶⁰ As a low estimate, we consider 10 days and 40 per cent of the population affected at a daily wage of \$250 would be \$33 million in lost income. As a high estimate, 20 days at 60 per cent of the population (roughly the provincial employment rate) yields \$99 million in lost income.

53 Leslie, J. “How Climate Change Is Disrupting the Global Supply Chain.” *Yale Environment 360*. March 10, 2022. <https://e360.yale.edu/features/how-climate-change-is-disrupting-the-global-supply-chain>.

54 Evans, P. “BC wildfires damaged key rail lines, backlogging Canada’s freight supply chain.” *CBC News*. July 8, 2021. <https://www.cbc.ca/news/business/rail-lines-wildfires-b-c-1.6094394>.

55 Evans, P. “BC wildfires damaged key rail lines, backlogging Canada’s freight supply chain.”

56 Teck Resources. “Teck Provides Update on Wildfire Impacts in B.C.” *Global News Wire*. News release. July 6, 2021. <https://www.globenewswire.com/news-release/2021/07/06/2258510/0/en/Teck-Provides-Update-on-Wildfire-Impacts-in-B-C.html>.

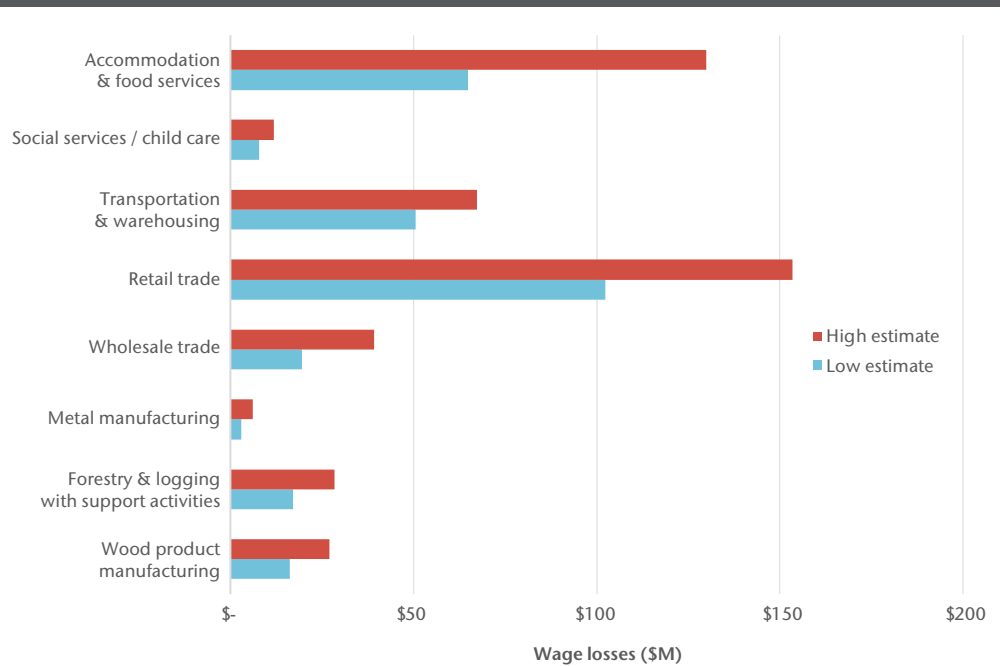
57 Link, R. “Canfor mill re-opens after two-week closure.” *Houston Today*. August 10, 2021. <https://www.houston-today.com/news/canfor-mill-re-opens-after-two-week-closure/>.

58 Labour Force Survey data of this sort are lower quality than the data in the heat dome estimates, but the LFS data have a regional distribution that is useful for our purposes here.

59 Government of British Columbia. “Wildfire Season Summary.”

60 Labbé, S. “Nearly 33,000 British Columbians displaced by wildfire in 2021.” *New Westminster Record*. October 22, 2021. <https://www.newwestrecord.ca/highlights/nearly-33000-british-columbians-displaced-by-wildfire-in-2021-4539572>.

Figure 3: Estimated wage losses by sector—wildfires



Notes: See Appendix tables for more detailed breakdown and assumptions.

Source: Authors' calculations based on Statistics Canada, Employment and Unemployment Rate by Detailed Industry, 15 years and over, annual (employment in thousands of persons), Labour Force Survey, Custom Tabulation, prepared by BC Stats, February 2022, https://www2.gov.bc.ca/assets/gov/data/statistics/employment-labour-market/lfs_employment_and_unemployment_rate_by_industry_and_development_region.xls.

Public costs and government response

The public response to wildfires falls mainly on firefighting efforts. Nearly 4,000 personnel were involved in wildfire response efforts, including 917 out-of-province personnel and 625 from the Canadian Armed Forces.⁶¹ In budgetary terms, the 2021 BC budget allocated a mere \$136 million for firefighting expenditures compared to the final cost of \$719 million.⁶² This is a new record for firefighting, topping the \$615 million spent in 2018/19 and \$649 million in 2017/18. Going back to 2008 the average cost of fighting fires in BC is \$301 million per year.

Increasingly, BC will need to look to a range of fire suppression activities to reduce the risk of wildfires spreading near to human settlements. Internal government documents point to serious resource shortages during the White Rock Lake fire. Based on a Freedom of Information request, Global News reports that, even before the White Rock Lake fire, equipment such as pumps and hoses was in short supply and staffing shortages were limiting fire suppression efforts. These issues were compounded by COVID-19.⁶³

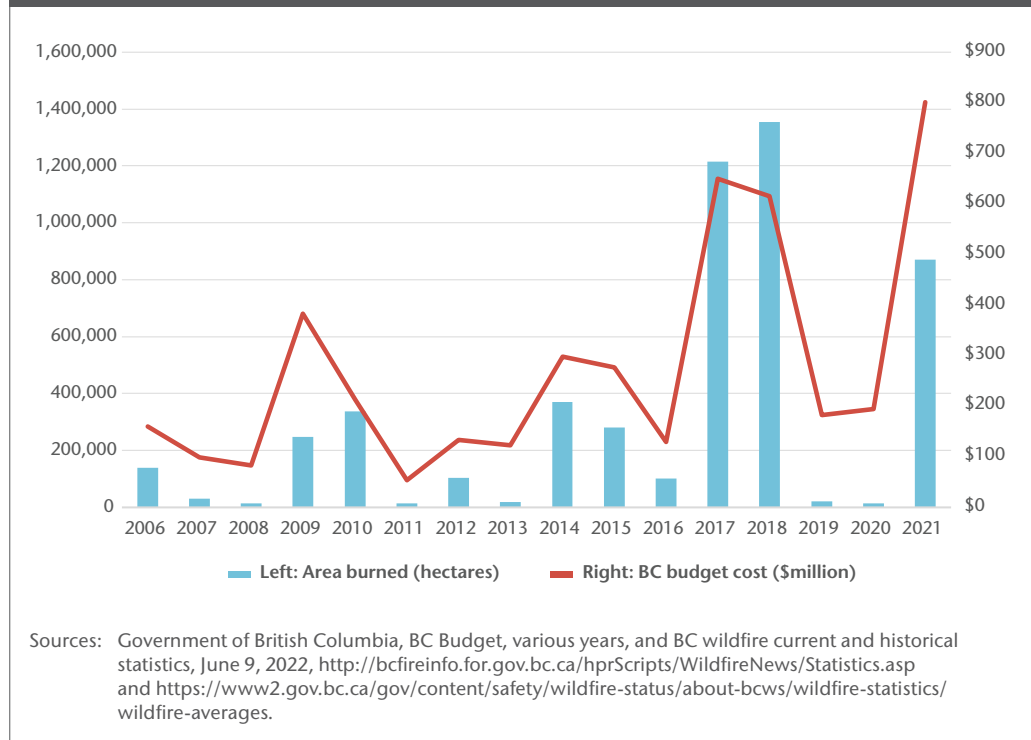
The final firefighting cost was \$719 million, almost \$600 million more than budgeted for 2021.

61 Government of British Columbia. "Wildfire Season Summary."

62 Government of British Columbia. "Wildfire Season Summary."

63 Turcato, M. "Documents raise questions about review of 2021's White Rock Lake wildfire." Global News. August 26, 2022, <https://globalnews.ca/news/9083465/foi-bcws-white-rock-lake/>.

Figure 4: BC wildfires—forest area burned and firefighting costs



There has also been ongoing criticism in BC over the slow cleanup and rebuild of Lytton.

There has also been ongoing criticism in BC over the slow cleanup and rebuild of Lytton. In June 2022, the federal government announced an advance payment of \$207 million to BC under the FDAA, about half of the provincial request. The federal government will also contribute \$77 million to Lytton toward new fire-resistant public buildings and homes.⁶⁴

In addition, a \$20 million cost-shared program (60 per cent federal, 40 per cent provincial), the Wildfire and Drought AgriRecovery Initiative, was launched to help agricultural producers with extraordinary expenses necessary for recovery and to help the return to production as soon as possible.⁶⁵

Vulnerable populations

Indigenous people are particularly at risk from wildfires. Some 1,871 First Nations reserves (60 per cent of the total) are located within or intersect the “wildland-human interface.”⁶⁶ According to Natural Resources Canada researcher Amy Christianson, who runs the Canadian Wildland Fire Evacuation Database, only one in 20 (5 per cent) of people are categorized as Indigenous, and

64 Schmunk, R. “Feds spending \$77M to help rebuild Lytton, BC, with fire-resistant buildings.” CBC News. June 14, 2022. <https://www.cbc.ca/news/canada/british-columbia/ottawa-spending-77-million-on-lytton-rebuild-1.6488227>.

65 Ministry of Agriculture. “\$20M to help BC ranchers, farmers recover from drought, wildfires.” News release. September 3, 2021. <https://news.gov.bc.ca/releases/2021AFF0054-001739>.

66 Christianson, A., and H. Asfaw. *First Nations Wildfire Evacuation (FNWE) Partnership*. Presentation to the Canadian Institute of Forestry. November 1, 2017. <https://www.cif-ifc.org/wp-content/uploads/2017/10/20171101-E-Lecture.pdf>.

more than one-third (34 per cent) of wildfire evacuation events between 1980 and 2020 were on First Nations reserves.⁶⁷

Several First Nations have reported inadequate communications on the part of the province during the wildfires.⁶⁸ The impact of fire is also of greater direct consequence for Indigenous communities due to their impact on traditional economic activities like fishing, hunting and trapping.

In situations where rapid evacuation is needed, low-income households and other people without a vehicle or who are not able to drive are inherently more vulnerable in areas affected by wildfire.

Particulate matter in wildfire smoke is bad for human health. This is primarily a health impact but one with important economic linkages. Smoke will have an adverse impact on outside workers who may be hundreds of kilometres from the actual fire, and will likely undermine productivity for other workers who do not have access to decent ventilation and/or who may have pre-existing conditions such as asthma.

Several First Nations have reported inadequate communications on the part of the province during the wildfires.

ON THE GROUND

Will Lytton finally be the fiery wakeup call?

When virtually the entire town of Lytton burned down in 2021, Bob Gray⁶⁹ was not surprised. But it's the characterization of that horrendous event as a climate change wakeup call that has the respected wildland fire ecologist shaking his head.

"2017 and 2018 should have been wakeup calls too," Gray says, citing the unprecedented, back-to-back wildfire seasons that forced tens of thousands of people to flee their communities during emergency evacuations and that made breathing the very air dangerous.

"Those two fire seasons probably cost \$10 billion each, if you start looking at the additional costs, the indirect costs. If you interrupt the rail schedule it's \$1 million an hour. If you block highways for days, it does significant damage to the economy," notes Gray.

For decades, Gray has advocated for a proactive approach to safeguard vulnerable communities from wildfires, which climate scientists predict will burn more often and more severely due to increasingly dry conditions across much of Western Canada.

According to Gray, the most effective way to reduce the threat of an uncontrolled wildfire that might one day approach your community, is to thin perimeter forests. That means chopping down a lot of trees so that there are far fewer of them and much more space between them. Then, those treated forests should be "prescribe-burned," with fires deliberately set to reduce fuel loads. The end result is a landscape with far fewer trees and brush, making it difficult for a wildfire to race through the tree canopy or along the ground.

67 Christianson, A. Twitter post. July 1, 2021. <https://twitter.com/ChristiansonAmy/status/1410770260714790923>.

68 Canadian Press. "'Abysmal attempt': BC wildfire response criticized by Indigenous leader." CTV News. July 3, 2021. <https://bc.ctvnews.ca/abysmal-attempt-b-c-wildfire-response-criticized-by-indigenous-leader-1.5495760>.

69 Phone interview with Bob Gray by Ben Parfitt, October 12, 2022.

Government can either respond by continuing the status quo and only funding immediate problems or it can get proactive and revamp forest policy.

If you picture a donut, the hole in the donut is the community and the donut itself is the perimeter or buffer zone that separates the community from the denser forest beyond. But here's the rub, that donut is getting bigger. And the funding to do that work, through programs such as the Community Resiliency Investment program,⁷⁰ is nowhere near enough, providing communities access to perhaps \$150,000 when what's needed is in the tens of millions.

"You've got to recognize the damage that today's fires are doing. The classic one-to-two-kilometre buffer won't do anything now, because today's fires are moving so much quicker. So much more energy is being released, and that energy can transport embers far greater distances than previously," Gray says.

We may now need 10-kilometre-wide buffers or more. And that becomes an order of magnitude more expensive to deal with.

In a September 2022 opinion piece Gray authored with Robin Gregory,⁷¹ a research scientist and adjunct professor at the University of BC's Institute of Resources, Environment and Sustainability, the two argued that repeated, disastrous wildfire seasons are doing more than just physical damage:

The crisis is also leading to unprecedented levels of public anger, frustration and distrust toward the forest industry and government institutions. This ranges from public demonstrations against forest management policy (on such issues as old growth, endangered species, post-wildfire salvage) to dangerous acts of disobedience during wildfires (for example, refusal to evacuate).⁷²

Government can either respond by continuing the status quo and only funding immediate problems such as fighting the wildfires themselves and committing funds to help rebuild damaged or destroyed communities. Or it can essentially walk away from rural communities that are not just vulnerable to wildfires but vulnerable to the loss of the traditional resource industries that once supported them. Or it can get proactive and revamp forest policy:

That means bringing back the open grasslands, retaining the natural hardwood forests of aspen, birch and cottonwood, encouraging larger riparian areas. It means building on the knowledge of Indigenous stewardship, which over thousands of years had used cultural burning to create a landscape where small fires were common but large fires could not prosper and grow.

Perhaps the biggest hurdle to overcome is a pervasive mindset in the provincial government and the forest industry it regulates that places a premium on "timber supply" over everything else. Successive provincial governments have been loath to say that not all forests are the same and that some should be treated differently than others out of fear that different sets of rules in different places would lower industry profits and government stumpage revenues.

"There's been no policy change. We still maximize timber supply, and there's no special policies around communities," Gray says.

70 See <https://www.ubcm.ca/cri>.

71 Gray, R and R. Gregory. "Solving B.C.'s wildfire crisis requires us to make hard choices." *The Globe & Mail*. September 8, 2022. <https://www.theglobeandmail.com/opinion/article-solving-bcs-wildfire-crisis-requires-us-to-make-hard-choices/>.

72 Gray, R and R. Gregory. "Solving B.C.'s wildfire crisis requires us to make hard choices."

November: Atmospheric rivers, floods and landslides

Parts of the Trans-Canada Highway were no longer drivable. British Columbia Highway 8 essentially fell into the Nicola River, and sections of the Coquihalla Highway—the major route connecting Vancouver to the British Columbia Interior and the rest of Canada—closed until 2022. Flooding submerged entire towns and parts of cities. Merritt’s 7000 residents were evacuated for the second time this year, when rising waters disabled the wastewater treatment plant. Dikes were breached, leaving sections of downtown Princeton under water. Rural communities and First Nations communities became isolated when swollen rivers washed away the only roads into town and all connecting bridges. Several communities came under a state of local emergency, and everyone was in a province-wide emergency for at least 2 weeks—the third this year. The largest port in Canada was closed in Vancouver, worsening the already taxed supply chain situation across the country. Cell and internet services were interrupted by multiple severed fibers, making rescue efforts challenging. Valuable farm fields turned into wetlands. Approximately 1.3 million animals died in flooded fields, isolated by floods in a real agricultural disaster.⁷³

AFTER RAGING FOR MORE THAN TWO MONTHS, cooler temperatures and wetter weather later in the summer put an early end to 2021’s wildfire season, but that eventually came with its own set of problems. In September and October, precipitation was double the normal, setting the stage for a tragic November. Once dubbed the “Pineapple Express,” BC’s South Coast experienced seven “atmospheric rivers” in November. Rain falling onto parched and burned land made conditions worse, as otherwise the trees, shrubs and living soil would have absorbed some of the rain.

73 Government of Canada. “Canada’s top 10 weather stories of 2021.”

The atmospheric river that began on November 13 unleashed massive amounts of rain over the next two days, with some places getting 200–300 mm. The result was extensive flooding in the Fraser Valley near Abbotsford from the overflow of the Nooksack River south of the border and dike failures in what was revealed to be reclaimed land of the former Sumas Lake.⁷⁴ Flooding was also significant in the Interior, including surges of the Tulameen River in Princeton and the Coldwater River in Merritt. November 15 marked the second time in the year that Merritt had been evacuated. Three months earlier, on August 15, an evacuation alert was issued due to wildfires in the area, whereas the November evacuation came as high flood water made the city’s wastewater treatment plant inoperable.

A state of emergency was declared on November 17, 2021. For several days, the region of Metro Vancouver was cut off from the rest of Canada via land connections. There is little doubt that the mid-November atmospheric river will be BC’s most costly natural disaster to date. This includes major damages to property from flooding but also the much larger costs for repairing and replacing dikes, bridges, sections of highways and other public infrastructure. These losses had substantial impacts on goods movement for trade and supply chains (discussed below) and have more profound economic costs than just replacing the infrastructure.



Source: BC Ministry of Transportation and Infrastructure. “2021 BC Highway Flood Recovery Projects.” Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/transportation-projects/bc-highway-flood-recovery>. Used with permission.

74 Olsen, T. “Sumas Lake, the Nooksack River, and the historic roots of a 21st Century disaster.” *Fraser Valley Current*. November 17, 2021. <https://fvcurrent.com/article/sumas-lake-flooding-history/>.

Damages to assets and property

In the case of flooding, private insurance has only existed since 2015 in Canada, and is still not available in high-risk areas, so coverage is still relatively low. As the Insurance Bureau of Canada (IBC) itself notes, “While the insurance damage stemming from these flood events is significant, the sad reality is that many residents impacted were located in high-risk flood areas and floodplains where flood insurance coverage is not available. As a result, the overwhelming majority of costs for this disaster will be borne by government and taxpayers.”⁷⁵ The insurance industry pays about 12 cents per dollar of damage from overland flooding, according to a senior IBC officer.

Insured damages are reported at \$675 million as of the end of June 2022, and up from an initial estimate of \$450 million.⁷⁶ If this is only 12 per cent of the total damages, this means non-insured damages are \$4.7 billion. Even if we assume that private insurance covered a higher 30 per cent of total damages, non-insured damages would be approximately \$1.5 billion.

There were damages to private rail lines that serve as key transportation infrastructure for Canadian resource industries. According to CN Railway, the company “mobilized over 400 employees and contractors and over 110 pieces of heavy equipment, operating 24 hours a day, seven days a week to get the rail line back into service. 282,000 cubic yards of rock, earth, and backfill materials were moved to rebuild damaged locations, the equivalent of over 25,000 truckloads.”⁷⁷ Given the extent of damage, rail infrastructure was restored quickly. CN Railway services had some limited service restored within eight days (as of November 23) but then proactively shut down six days later (November 29) for the next atmospheric river, with a reopening on December 5 and a return to previous productivity and capacity by December 21.⁷⁸ This affected CP Railway as well, which shares the CN tracks for part of the route.⁷⁹

Agriculture impacts were extensive with more than 1,100 farms over 15,000 hectares from the Sumas Prairie in Abbotsford. Losses include 630,000 chickens, 12,000 pigs and 450 cows, with reports of farms on higher ground taking in animals.⁸⁰ Some 2,500 acres of blueberry production were affected, almost one-tenth of the total 27,000 acres of land in BC for blueberry cultivation.⁸¹ In many cases it will take a decade for the fruit bushes and trees to come back to previous productive levels.

In many cases it will take a decade for the affected fruit bushes and trees to come back to previous productive levels.

75 Insurance Bureau of Canada. “British Columbia floods cause \$450 million in insured damage.” News release. December 9, 2021. <http://www.ibc.ca/bc/resources/media-centre/media-releases/british-columbia-floods-cause-450-million-in-insured-damage>.

76 Insurance Bureau of Canada. “Insured Losses from 2021 Floods in BC Now \$675 million.” News release. June 15, 2022. <http://www.ibc.ca/bc/resources/media-centre/media-releases/insured-losses-from-2021-floods-in-bc-now-675-million>.

77 CN Railway. “BC Washouts: CN Network Productivity Returns to Normal Range, Community Support and Assistance Remains Ongoing.” News release. December 21, 2021. <https://www.cn.ca/en/news/2021/12/bc-washouts-cn-network-productivity-returns-to-normal-range-comm/>.

78 CN Railway. “BC Washouts.”

79 Reynolds, C. “Backlogs build as CN trains start to roll again after BC tracks repaired.” *BNN Bloomberg*. December 6, 2021. <https://www.bnnbloomberg.ca/backlogs-build-as-cn-trains-start-to-roll-again-after-b-c-tracks-repaired-1.1692027>.

80 Kelly, A. “BC farms take in rescued cows as milk supply chain cut off.” *Alaska Highway News*. November 17, 2021. <https://www.alaskahighwaynews.ca/highlights/bc-farms-take-in-rescued-cows-as-milk-supply-chain-cut-off-4769938>.

81 BC Blueberry Council. “BC Blueberry Council Releases Statement Regarding Recent Floods.” News release. November 29, 2021. <https://www.bcblueberry.com/bc-blueberry-council/news/bc-blueberry-council-releases-statement-regarding-recent-floods>.

Milk and egg production in the Lower Mainland was disrupted by the flooding. The BC Milk Marketing Board advised producers to dispose of their milk by dumping it into manure piles with some 70 to 80 per cent of milk production not able to be picked up. Egg production in BC also comes from two areas in the Fraser Valley that were heavily flooded: Sumas Prairie and the Yarrow district of Chilliwack.⁸²

The flooding raised concerns about contamination by chemicals, waste and other toxics in the soil post-flood. Thankfully, soil testing in the spring by BC Ministry of Agriculture, Food and Fisheries officials found that “the sampled agriculture lands were not compromised during the flooding, and the integrity of the agricultural food supply production for this area remains strong.”⁸³

Income losses for workers

Income losses for workers stem from a slowing down of shipments due to delays, backlogs and rerouting via other infrastructure.

Income losses for workers stem from a slowing down of shipments due to delays, backlogs and rerouting via other infrastructure. The Port Authority of Vancouver reported longer “dwell times” (the time that goods sit in container terminals before being moved to warehouses).⁸⁴ Coal exports were also affected: Teck Resources stated that its coal sales in the fourth quarter of 2021 were down about 24 per cent due to rail shipment disruptions in the Lower Mainland. However, the company also stated it will be able to recover much of the delayed sales in the first half of 2022.⁸⁵

Supply chain impacts from the loss of the rail network also led forestry companies to curtail production, “causing price increases and shortages of lumber, paper pulp, and other wood products in the United States.”⁸⁶ Lumber shipments dropped 25 per cent to 30 per cent, and pulp shipments through the Port of Vancouver were at just one-fifth of normal volumes in the second half of November. Canfor cut back production for four weeks in its Taylor and Prince George mills due to supply chain impacts,⁸⁷ while West Fraser curtailed timber and pulp production in Western Canada, as did Paper Excellence in Crofton and Powell River. In Merritt, Aspen Planers was shut down due to floods and evacuation of the town.⁸⁸

Rail closures affected a key time for the export of Canadian grain (wheat and canola in particular), some of which was rerouted to Prince Rupert or the United States. Because of the scale of goods movement it can take months to clear backlogs. It was reported at the end of November that some 24 grain vessels were waiting at the Port of Vancouver for deliveries of up to 1.4 million tonnes of wheat, canola and barley.⁸⁹ This has a knock-on impact on the cash flow of Canadian

82 Kelly, A. “BC farms take in rescued cows as milk supply chain cut off.”

83 Luymes, G. “Is it safe to eat food grown after BC fields flooded?” *Vancouver Sun*. May 29, 2022. <https://vancouver.sun.com/news/local-news/is-it-safe-to-eat-food-grown-after-bc-fields-flooded>.

84 Galea, I. and B. Jang. “Shipping container prices fall but the global supply chain crisis persists.” *The Globe and Mail*. June 1, 2022. <https://www.theglobeandmail.com/business/article-container-shipping-prices-fall-but-congestion-remains-in-global-supply/>.

85 Reynolds, C. “Backlogs build as CN trains start to roll again after BC tracks repaired.” *BNN Bloomberg*. December 6, 2021. <https://www.bnnbloomberg.ca/backlogs-build-as-cn-trains-start-to-roll-again-after-b-c-tracks-repaired-1.1692027>.

86 Leslie, J. “How Climate Change Is Disrupting the Global Supply Chain.”

87 Alaska Highway News. “Canfor curtails Taylor pulp mill.” December 2, 2021. <https://www.alaskahighwaynews.ca/regional-news/taylor/canfor-curtails-taylor-pulp-mill-4824766>.

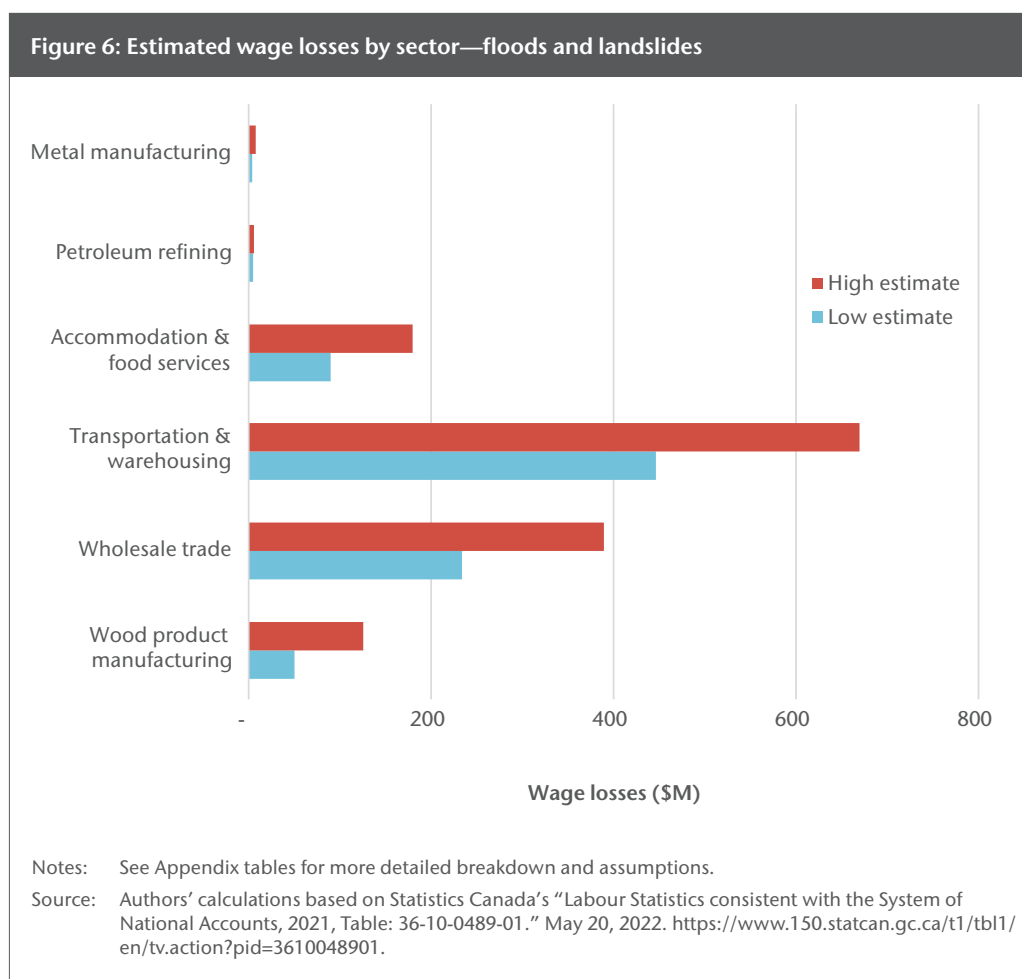
88 Bennett, N. “Forestry sector hit hard by fallout from November floods.” *Business in Vancouver*. December 9, 2021. <https://biv.com/article/2021/12/forestry-sector-hit-hard-fallout-november-floods>.

89 Reynolds, C. “Backlogs build as CN trains start to roll again after BC tracks repaired.”

farm exporters and there was a small but notable increase in the price of wheat in the aftermath of the floods and landslides.⁹⁰

The Trans Mountain Pipeline, which connects the Lower Mainland with Alberta crude and refined fuels, was shut down during the immediate recovery period, leading the Parkland refinery in Burnaby to have down time between November 22 and December 15. According to the Parkland Corporation, the disruption cost the company \$35 million in profits.^{91,92} The BC government stepped in to cap gasoline price increases and prevent price gouging in the period after the flooding.

Figure 6 estimates a plausible range of labour market impacts arising from the flooding and landslides based on known local disruptions and supply chain impacts. The short-term labour market losses here are more substantial, ranging from \$0.8 to \$1.4 billion, and only count BC workers, not potential supply chain impacts outside the province. Some of the total impact is



90 Macrotrends. "Wheat Prices — 40 Year Historical Chart." Accessed June 25, 2022. <https://www.macrotrends.net/2534/wheat-prices-historical-chart-data>.

91 Stephenson, A. "Parkland's profit hurt by refinery pause in aftermath of BC floods." *BNN Bloomberg*. March 4, 2022. <https://www.bnnbloomberg.ca/parkland-s-profit-hurt-by-refinery-pause-in-aftermath-of-b-c-floods-1.1732482>.

92 Chase, D. "Parkland's Burnaby refinery initiates restart." *Argus Media*. December 15, 2021. <https://www.argusmedia.com/en/news/2283463-parklands-burnaby-refinery-initiates-restart>.

reduced by increased inventories or later production to make up the downtime of the disaster. More research is needed to better understand these dynamics.

In addition to these losses, some 17,000 displaced people would represent about \$68–\$153 million in lost income (at employment rates of 40 per cent and 60 per cent and a wage rate of \$250 per day times 40 and 60 days). Merritt alone has a population of more than 7,000 people and the entire city was evacuated on November 15, 2021. Over the coming months various evacuation orders were removed by the municipality, but there would be additional losses for some people over many months after that would swell this estimate.

Public costs and government response

Emergency Management of BC and its River Forecast Centre issued flood warnings much later than its US counterparts.

Like the heat dome, the extreme nature of the atmospheric river seems to have caught the BC government flatfooted, as evidenced by Emergency Management BC and its River Forecast Centre, which issued flood warnings much later than its US counterparts.⁹³

As noted earlier, in 2021/22 an additional \$522 million was spent on disaster and emergency assistance related to the November floods and landslides, and BC Budget 2022 committed \$400 million in 2022/23 and another \$1.1 billion over three years in contingencies for flood recovery. In addition, the federal government has promised \$5 billion for flood relief (an application from BC has been submitted). For short term relief the Red Cross partnered with the BC government to distribute \$2,000 each to eligible households.⁹⁴ The Red Cross reports it raised \$124.8 million in supports for the disaster including \$41.5 million in individual donations, \$50 million from the BC government and \$33.3 million from the federal government. Of this amount, almost \$38 million had been provided to individuals and families up to May 31, 2022.⁹⁵

Cleanup will be expensive and time-consuming. As one report summarized,

November’s storms left British Columbia’s Tulameen River full of junk: mobile homes, travel trailers, pieces of concrete culverts and a destroyed train bridge, a yellow bus, a blue truck, a white SUV and something that might be an ATV. Elsewhere, on the Coldwater, the Nicola, the Similkameen, the Coquihalla, the Thompson and the Fraser rivers, the province has identified 270 clusters of storm debris.⁹⁶

Public costs are still being tallied and will run into the billions of dollars. These costs were not stated in the 2022 BC budget and some of their cost may be absorbed from the regular transportation and infrastructure budget. The most notable public infrastructure impacts include:

93 Parfitt, B. “A flood of questions: As southern BC reels from epic flood, former provincial flood official says independent expert needs to investigate.” *Policy Note*. December 1, 2021. <https://www.policynote.ca/flood-of-questions/>.

94 Government of British Columbia. “B.C. flooding evacuees to get additional financial support.” News release. November 23, 2021. <https://news.gov.bc.ca/releases/2021EMBC0073-002246>.

95 Canadian Red Cross. “Your generosity at work: British Columbia Floods and Extreme Weather Update.” May 31, 2022. <https://www.redcross.ca/crc/documents/CRC-BC-floods-update-May-31-2022-financials.pdf>.

96 Hunter, J. “Spring thaw will test BC flood barriers that the ‘atmospheric river’ ruined and covered in debris.” *The Globe and Mail*. April 6, 2022. <https://www.theglobeandmail.com/canada/british-columbia/article-spring-thaw-will-test-bc-flood-barriers-that-the-atmospheric-river/>.

- Failure of dikes in the Fraser Valley.
- 24 highways closed at peak including Highways 1, 3, 5 and 99 that connect Vancouver to the rest of Canada.
- Landslides on Highway 7, stranding some drivers between Agassiz and Hope, and on Highway 99 where five people were killed.
- Damage to five bridges and closure of 20 sections of the Coquihalla Highway 5.
- Loss of bridges and large sections of roadway in 25 locations along Highway 8.
- Damage to the Malahat highway (the principal connection between Victoria and mid-Island) and other flooding near Duncan on Vancouver Island.

BC's Ministry of Energy, Mines and Low Carbon Innovation responded with emergency authorizations for quarries to operate outside permit conditions to deliver rock for transportation repairs and to protect areas from future damages.⁹⁷ Highway connections on most routes were restored fairly quickly (Highway 8 is a major exception) but in all cases long-term repairs are still under way. Long-term repair costs are still unknown but in the billions. Repair costs stated publicly to date include the Malahat Tunnel Hill washout at \$24 million (\$15 million contract awarded in May 2022, with completion by summer 2023).⁹⁸

Part of this story is the failure of the BC government to invest in dike upgrades in spite of many warnings.

The BC Building Trades Council reports hundreds of workers being pulled from other sites, including outside of BC, to contribute to the rebuilding process in November and December.⁹⁹ Repair work continued through 2022 even though highways were reopened with several spots on Highways 1, 3 and 5 experiencing delays of as much as 30–50 minutes on what is normally a 180-minute journey from Hope to Kamloops on Highway 5. Highway 8 only reopened on November 9, 2022, almost a year after the flooding and landslides.¹⁰⁰

Service on Highways 1 and 3 was restored within a couple weeks and Highway 99 between Pemberton and Lillooet was restored shortly after. Remarkably, Highway 5 service was restored for commercial vehicles and intercity buses by December 20, and to the general public on January 19. There is still major permanent work to be done to replace temporary fixes and restore full capacity. More than 300 workers were engaged in making temporary repairs.¹⁰¹

Part of this story is the failure of the BC government to invest in dike upgrades in spite of many warnings. Five years before the 2021 flood a team of engineers hired by the BC government to review Lower Mainland dikes called the crest (or height) of the Sumas dike “unacceptable” (the lowest possible grade) and commented, “Overtopping is expected during Nooksack River overflow.”¹⁰² This is precisely what occurred in November 2021 when the Sumas dike failed in

97 Ministry of Energy, Mines and Low Carbon Innovation. “Flood Response” in Estimates Notes, p. 170. March 17, 2022. http://docs.openinfo.gov.bc.ca/Ministry_of_Energy_Mines_and_Low_Carbon_Innovation_Estimates_Notes_2022.pdf.

98 Government of British Columbia. “2021 BC Highway Flood Recovery Projects - Highway 1 - Malahat Tunnel Hill Washout.” Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/transportation-projects/bc-highway-flood-recovery/2021-flood-road-recovery-projects-highway-1-malahat>.

99 Hogben, D. “A river runs through it: Construction unions, workers respond after floods from atmospheric river devastate province.” *Trade Talk*. Spring 2022. <https://bcbuildingtrades.org/tradetalk-spring-2022/>.

100 Government of British Columbia. “2021 BC Highway Flood Recovery Projects - Highway 8.” Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/transportation-projects/bc-highway-flood-recovery/2021-flood-road-recovery-projects-highway-8>.

101 Little, S. “‘Welcome, just drive slow’: B.C.’s storm-ravaged Coquihalla Highway reopens to the public.” *Global News*. January 20, 2022. <https://globalnews.ca/news/8525609/bc-coquihalla-highway-reopens-to-public/>.

102 Olsen, T. “A doomed Sumas dike failed as predicted. Many other levees could be next.” *Fraser Valley Current*. November 22, 2021. <https://fvcurrent.com/article/fraser-valley-unacceptable-dikes/>.

three locations, one of which was 100 metres long. A smaller flood of the same type happened in 1990.

The Sumas dike failure is indicative of concerns raised for many years about the state of dike infrastructure, much of which was put in place a hundred years ago. The engineering review discussed above looked at 118 segments along 74 dikes in the region and warned that large parts of the region's existing flood protections were likely to fail (only 13 per cent were rated "fair to good" compared to 69 per cent "poor to fair" and 18 per cent "unacceptable to poor."¹⁰³ In all, more than 100 kilometres of dikes across the region were deemed too low to protect from floods. Similar deficiencies were noted for seismic stability in the face of an earthquake.¹⁰⁴

A 2016 engineering review found that more than 100 kilometres of dikes across the region were deemed too low to protect from floods.

An iconic moment during the atmospheric river was when dozens of volunteers showed up to sandbag and protect the Barrowtown pump station. Had the pump station failed even more water would have flowed down to the former Sumas Lake, which would have made the severity of the flooding much worse.

The cost of upgrading dikes in the Lower Mainland has been estimated to be \$9–\$10 billion.¹⁰⁵ This raises questions about whether some dikes should be replaced, improved or abandoned. Dikes are currently a municipal responsibility and local governments are hard-pressed to raise such large amounts of funding for dike upgrades. In June 2022 the City of Abbotsford tabled a new flood management plan with four options ranging from \$209 million to \$2.8 billion.¹⁰⁶ A 2020 report estimated a cost of \$865 million to fix orphaned dikes built by the province many decades ago and transferred to local governments.¹⁰⁷

The federal and provincial governments announced a \$228-million Canada-BC Flood Recovery Program for Food Security to help flooded farms return to production. This program includes AgriRecovery and federal Disaster Financial Assistance Arrangements (DFAA).¹⁰⁸ The 2021 floods and landslides have also led to changes to BC's Disaster Financial Assistance program, including expanding eligibility, increasing the provincial contribution for infrastructure recovery, and provision of some cash support up front. As of May 2021, more than 2,200 applications for assistance have been made from affected individuals, small businesses, farms, charitable organizations and local governments.¹⁰⁹

103 Northwest Hydraulic Consultants. *Lower Mainland Dike Assessment*. Surrey: Ministry of Forests, Lands and Natural Resource Operations, 2015. https://www.fraserbasin.bc.ca/_Library/Water_Flood_Strategy/Lower_Mainland_Dike_Assessment.pdf.

104 Northwest Hydraulic Consultants. *Lower Mainland Dike Assessment*.

105 CBC News. "Metro Vancouver dike upgrades to cost billions." December 11, 2012. <https://www.cbc.ca/news/canada/british-columbia/metro-vancouver-dike-upgrades-to-cost-billions-1.1220516>.

106 City of Abbotsford. "Long-term Flood Mitigation Project." Accessed November 1, 2022. <https://letstalkabbotsford.ca/abbotsfordfloodresponse>.

107 Kerr Wood Leidal Associates Ltd. *Risk Assessment of BC's Orphan Dikes: Summary Report*. Vancouver: Fraser Basin Council, 2020. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/kwl_riskassess_orphandikes-summaryreport-20201209.pdf.

108 According to the BC government, "The program helps farmers return to production by reimbursing them for uninsured expenses they incurred on activities such as: cleanup, repair and restoration of land, barns and animal shelters, and water and waste systems; returning flood-affected land and buildings to a safe state for agricultural production; repairing uninsurable essential farm infrastructure; repairing structures such as livestock-containment fences; renting temporary production facilities; installing drainage ditches and land-stabilization materials; animal welfare activities such as replacing feed, transporting livestock, veterinary care and mortality disposal; and replacing perennial plants not grown for sale." Government of British Columbia. "Province extends deadline for flood-recovery help for farmers." Information bulletin. May 25, 2022. <https://news.gov.bc.ca/releases/2022AF0035-000798>.

109 Government of British Columbia. "Province strengthens Disaster Financial Assistance."

Vulnerable populations

Some 17,000 people were displaced from 7,000 homes; many hundreds were left stranded when bridges and highways failed.¹¹⁰ About 200 farm workers from Mexico were displaced into Abbotsford and Chilliwack shelters and most were subsequently repatriated. A minority of workers were able to relocate to a new farm for the final month of their contract. Initially, migrant agricultural workers were deemed ineligible for Red Cross relief payments, but community members rallied to support them in accessing the payments.¹¹¹

More than 60 First Nations communities were affected. Members of the Shackan First Nation near Merritt were displaced for three months and this was after one month of displacement in summer due to wildfires.¹¹² Many First Nations communities were not warned and people from the Nooaitch First Nation were trapped on their lands west of Merritt along Highway 8.¹¹³

Many First Nations communities were not warned and people from the Nooaitch First Nation were trapped on their lands west of Merritt along Highway 8.

ON THE GROUND

Triage at a Sumas Prairie farm

Fraser Valley farmer Caroline Mosterman¹¹⁴ is certain about one thing. If she and her husband Paul had been warned early enough they could have saved much that was later destroyed in the flood that turned Sumas Prairie back into a lake.

“We could have moved mountains in two days,” Mosterman says. “A hill is less than five minutes away. Our friends could easily have accommodated our inventory (wine and spirits), equipment and machinery. That would have mitigated the damage considerably, easily in the hundreds of thousands of dollars.”

But flood warnings from the provincial government came too late, according to a respected former civil servant who once headed the provincial River Forecast Centre.¹¹⁵ That’s one reason why Caroline and Paul are now plaintiffs in a proposed class action that names the provincial government among others for failing to provide timely alerts of the dangers lying ahead to homeowners and businesses in the Sumas Prairie.¹¹⁶

110 Kulkarny, A. “Public Safety Minister Mike Farnworth pledges to ‘rebuild better’ after floods.” CBC News. November 18, 2021, <https://www.cbc.ca/news/canada/british-columbia/bc-floods-media-conference-thursday-1.6254773>.

111 Grochowski, S. “B.C. residents fight to get migrants who lost work during floods \$280,000 payout.” *Vancouver Sun*. February 4, 2022. <https://vancouvernews.com/news/local-news/b-c-residents-fight-to-get-migrants-who-lost-work-during-floods-280000-payout>.

112 Canadian Press. “Members of B.C.’s Shackan First Nation to return home, more than 90 days after flood.” *Vancouver Sun*. February 17, 2022. <https://vancouvernews.com/news/local-news/members-of-the-shackan-first-nation-to-return-home-more-than-90-days-after-flood>.

113 Garcha, N. and E. McSheffrey. “‘Pretty emotional’: Nooaitch First Nation grapples with isolation, impact of B.C. floods.” *Global News*. November 19, 2021, <https://globalnews.ca/news/8389037/pretty-emotional-nooaitch-first-nation-grapples-with-isolation-impact-of-b-c-floods/>.

114 Phone interview with Caroline Mosterman by Ben Parfitt, August 29, 2022.

115 Parfitt, B. “Where Was the Warning?” *The Tyee*. December 1, 2021. <https://thetyee.ca/News/2021/12/01/Where-Was-Warning/>.

116 See Little, S. and E. McSheffrey. “Sumas Prairie residents file class action lawsuit over damage caused by B.C. floods.” *Global News*. January 1, 2022. <https://globalnews.ca/news/8483516/bc-flood-class-action-lawsuit/>.

At the height of last November's floods, Caroline says their property was under six feet of water.

Caroline and Paul have farmed for 41 years. For 25 of them, they ran a livestock business before transitioning into greenhouse and nursery wholesale operations, then blueberry-growing, and from that into wine and spirit-making, using blueberries and other fruit. They also expanded services by opening a wine-tasting room and lounge and turning their farm into a destination point for weddings and other events. That diversification allowed them to build a business that supported three families full-time, and 50 seasonal employees during the busier summer months, all drawn from the local region.

At the height of last November's floods, Caroline says their property was under six feet of water. But they never evacuated. Sumas Prairie, which was once a lake before the lake was drained and diked, was back to being a lake again, and many residents stayed put to help one another.

Paul, an avid boat collector, had a similar vessel to that used by armies to offload troops and equipment onto beaches. With its front, hinged hull that could be lowered to become a ramp, it was perfect for rescuing his neighbors' stressed cows that were at imminent risk of drowning.

Caroline says that when the floodwaters receded from their property "triage" guided their thinking. What could be saved? What must go? The nursery, which was geared to all things aquatic—pumps, liners, water plants, seeds and fish like koi for backyard ponds—was gone. So too was much of their farm equipment. Even three seasons after the flood, the couple discovered something new that had been damaged (in August Caroline recalled Paul walking into the house to say, "Well, that tractor is #@@!")

Their 12 acres of blueberries, however, turned out to not be as damaged as first feared. Caroline believes that pruning and kelp fertilization the year before helped many of the plants survive the flood. While one-quarter of them were lost, the remaining plants, of which there were three varieties, showed promising signs of recovery. About a third of them actually produced a reasonable crop of berries only nine months or so after the floodwaters receded.

The extensive damage to their property and equipment took a corresponding toll on the farm's workers, Caroline says.

"In November we had about 45 people on staff that we had to lay off. The only person that we were actually able to retain was our finance person, and she worked remotely and made sure we kept paying our bills, because even though we were in a flood situation, people still needed to be paid."

Of those 45 seasonal employees, Caroline says only five returned to work this summer. "You can't indefinitely be on Employment Insurance. We had no idea how long it would take to recover and people moved on. The training of new staff has been a huge cost."

Caroline and Paul had no flood insurance and would have been in even more dire straits were it not for "donations of equipment and supplies and the physical labour to help us clean up. I also had a very good friend, who is a contractor, who helped us with finding tradespeople." The couple was also able to arrange to defer their mortgage and interest payments for a number of months.

"I am not going to lie," she says. "It's going to be years before we recover financially. This has been taxing mentally, emotionally and physically."

ON THE GROUND

Wakeup call—the race to save Merritt’s wastewater treatment plant

Kevin Vilac’s phone rang at 4 o’clock in the morning on November 15th, 2021.¹¹⁷ Tom Harrington, the City of Merritt’s utilities foreman, was on the line. There was trouble down at the wastewater treatment plant. Vilac needed to get over there right away.

After scrambling into his clothes and driving in the dark through intense rain, Vilac arrived at the city’s public works yard to find four to six inches of water flowing through the yard and increasing in depth by the minute.

There was no time to lose if the treatment plant was to be saved, recalls Vilac, who is the chief operator of both the city’s water and wastewater systems.

“The first course of action was to build a dike to try to prevent the water from running into the treatment plant. The first place we started building a dike was around our loading bay, which is below grade. Once we got a small dike built around that to keep the water flowing through the yard and not into the plant, then we built a dike around the north side of the facility to protect the electrical room and the blower room and our basement,” Vilac says.

It was good fortune that there was a backhoe and a supply of three-quarter-inch gravel on site to build those temporary emergency dikes, Vilac recalls. But with so much water flowing in from the engorged Coldwater River, Vilac knew that even bigger gravel would have to be brought in. So he ordered trucks to come in with more substantial three-inch rock because the smaller-size gravel was washing away. Vilac then moved the dike line out further from the building and increased their height from an initial two to five feet.

“We started at approximately 4:15 a.m. and we had the complete diking system around the building by 8:30 or 9:00. We would have lost it if we didn’t,” Vilac recalls of the frantic but critical four hours of work.

As it was, the plant narrowly escaped destruction. There was two inches of water on the floor in the main control room. Had water levels climbed another few inches, \$7–\$8 million in critical infrastructure would have been lost. What was not spared, however, was the city’s drinking water wells and wastewater treatment rapid infiltration basins, which were destroyed by the flooding and forced the evacuation of the city’s 7,000-plus residents. It would take months to repair the rest of the city’s wastewater treatment infrastructure, which consisted of a settling pond and four infiltration basins.

“Those had to be cleaned out because they were overridden with silt and debris brought in by the flood. 2,600 truckloads of that debris had to be hauled away. Then we had to reestablish the walls of the basins because they were breached by the floodwaters. Then we had to build a new settling pond and recreate the settling basins. And then we had to install a distribution pipeline to the infiltration basin from the settling pond,” Vilac says.

The city’s drinking water wells and wastewater treatment rapid infiltration basins were destroyed by the flooding and forced the evacuation of the city’s 7,000-plus residents.

¹¹⁷ Phone interview with Kevin Vilac by Ben Parfitt, August 31, 2022.

The whole system was finally restored eight months after the floods.¹¹⁸ Now attention is turning to the much bigger infrastructure issues if the city is to avoid the kind of devastation unleashed in November 2021.

City mayor Mike Goetz says the biggest such need is to build new dikes to replace those destroyed by the rising waters of the Coldwater River in November 2021.

“The projected cost that we’re looking at is between \$165 million and \$169 million. And that involves a lot of dike-building on both sides of the Coldwater River, three miles on one side and about 1.5 miles on the other,” Goetz says, adding that such work can only be achieved with funds from the provincial and federal governments. “The city, on average, pulls in through taxes about \$9.5 million annually. So when you throw in a number of \$169 million, it’s virtually impossible for us to deal with.”

Goetz added that the city still faces the grim reality that an estimated 400 people are without homes that were either destroyed or damaged by the floods.

Luckily, he says, an “all-hands-on-deck” effort by RCMP, city workers, fire crews and search and rescue ensured that no local residents lost their lives during the floods.

118 Auer, M. “Merritt’s wastewater system back to full operation.” *Merritt Herald*. August 16, 2022. <https://www.merritherald.com/merritts-wastewater-system-back-to-full-operation/>.

Summary of economic costs

THE COSTS OF CLIMATE CHANGE IDENTIFIED IN THIS REPORT for 2021 are summarized in Table 1. In all, they sum to \$10.6–\$17.1 billion, equivalent to 3.1–4.9 per cent of provincial GDP. The commonly reported statistic of insured damages sums to \$854 million, or only 5-8 per cent of the total. Based on industry statements about coverage, we estimate non-insured damages of \$1.7–\$5.1 billion. These are costs borne almost exclusively by households and businesses.

The BC government has spent a huge amount of public funds fighting fires and other emergency response. A large share of costs are government expenditures for replacement of infrastructure. Combined, these total some \$6.1–\$7.6 billion, or 46–60 per cent of total economic costs. Final costs for reconstruction of destroyed bridges and sections of highways may be several years away. The federal-provincial funding formula ensures that federal dollars will help contribute to cleanup and restoration. Further research could identify additional costs to the public health care system, which are not generally included in tallies of public costs.

In addition, the lost income of workers and businesses is substantial and under-reported. Our research also points to large labour market costs that are typically overlooked when damage reports are made. Totalling the estimates made above, we get a total labour market impact of \$1.5–\$2.6 billion or 15 per cent of total economic costs. This estimate does not count agriculture and other business losses, some of which will be insured, nor does it include the knock-on effects of reduced expenditures by those who lost income (resulting in reductions in spending on food and other necessities, which in turn reduces someone else's income).

We note some limitations of our estimates due to data availability and measurement issues associated with complex, multi-dimensional economic impacts. One important area is supply chain disruptions that can reach well beyond the impacted area, and we do not estimate any supply chain impacts for producers outside of BC. In addition, our tally does not include most health costs (including loss of life), the inclusion of which would make total economic costs even higher. Future research to directly measure such costs would be helpful but even sketching out the range of possible impacts adds up to meaningful numbers.

We estimate the costs of climate change in 2021 to be \$10.6–\$17.1 billion, equivalent to 3.1–4.9 per cent of provincial GDP.

Table 1: Summary of economic costs		
	Low	High
Heat dome	millions of dollars	
General productivity	\$34	\$84
Income losses	\$205	\$328
Incremental electricity consumption	\$8	\$14
Wildfires		
Insured damages	\$179	\$215
Non-insured damages	\$179	\$501
Income losses	\$314	\$562
Public expenditures	\$1,023	\$1,216
Atmospheric river flooding & landslides		
Insured damages	\$675	\$675
Non-insured damages	\$1,575	\$4,950
Income losses	\$897	\$1,531
Public expenditures	\$5,520	\$7,020
Total economic costs	\$10,609	\$17,097
Source: Authors' calculations.		

The province was arguably caught underprepared by the new extremes of 2021. New investments will be needed to upgrade BC's physical infrastructure and emergency preparedness. A 2020 report from the Insurance Bureau of Canada and the Federation of Canadian Municipalities estimated that "an average annual investment in municipal infrastructure and local adaptation measures of \$5.3 billion is needed to adapt to climate change."¹¹⁹ Governments are ultimately on the hook for marshalling the resources needed to limit income losses and speed up recovery.

Based on BC's share of the Canadian population (just over 13 per cent), the province should be spending about \$700 million per year to upgrade municipal infrastructure. However, the province is arguably more vulnerable to climate change impacts, and the case could be made that BC should be spending well more than its population share.

119 Insurance Bureau of Canada and Federation of Canadian Municipalities. *Investing in Canada's future: The cost of climate adaptation at the local level*. Ottawa: Federation of Canadian Municipalities, 2020. <https://data.fcm.ca/documents/reports/investing-in-canadas-future-the-cost-of-climate-adaptation.pdf>.

The 2022 BC Budget supports new planning efforts for adaptation, emphasizing prevention and protection, and a new Climate Preparedness and Adaptation Strategy was announced.¹²⁰ However, only \$513 million in funding is allocated over four years, of which \$221 million was already expended in 2021/22. This funding had been previously announced, and much of the plan is still at the stage of data-gathering and the development of high-level principles.

Ideally, both the federal and BC governments will step up to commit substantial fiscal resources commensurate with the damages we have seen — from upgrading dikes to wildfire control to ensuring cooling systems are widespread. The fiscal implications are stark but doable: many billions of dollars in upgrades to infrastructure are needed so that they can better handle tomorrow’s extreme weather events, and better systems can be developed to minimize adverse impacts during disasters and accelerate rebuilding in the aftermath.

As for reducing BC’s greenhouse gas emissions, the 2022 BC budget allocated \$1.2 billion to the province’s CleanBC plan but this funding is over three years and more than half of the total is earmarked for 2024/25. Climate economist Nicholas Stern has argued that nations should aim for investing 2 per cent of their total income or GDP toward climate solutions — about \$7 billion per year in the case of BC. This mix of public and private investment would also create plenty of green jobs. The CCPA’s Climate Justice Project has long identified infrastructure upgrades toward climate adaptation as an important source of green jobs in transition off of fossil fuels.¹²¹

Ideally, both the federal and BC governments will step up to commit substantial fiscal resources commensurate with the damages we have seen.

120 Government of British Columbia. “Climate preparedness and adaptation.” Accessed October 12, 2022. <https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation>.

121 For example: Lee, M. and A. Card. *A Green Industrial Revolution: Climate Justice, Green Jobs and Sustainable Production in Canada*. Ottawa: Canadian Centre for Policy Alternatives, 2012. <https://policyalternatives.ca/publications/reports/green-industrial-revolution>. <https://policyalternatives.ca/sites/default/files/uploads/publications/National%20Office/2012/06/Green%20Industrial%20Revolution.pdf>.

Conclusion

We must prepare and plan for adaptation to a warmer world.

WHILE CLIMATE POLICY TO DATE HAS LARGELY FOCUSED ON MITIGATION — policies and actions to reduce domestic greenhouse gas (GHG) emissions contributing to global climate change— we must prepare and plan for adaptation to a warmer world. In the 2020s nowhere is safe—your town could be flooded or destroyed by fire in a matter of hours, a heat wave could kill your loved ones. Today’s extreme weather is a prelude to what we should anticipate in the future. Events that were previously considered improbable or less damaging are now part of the realm of the possible. Heat waves will come, forests will burn, rivers and valleys will flood, and other extreme storms form our new baseline.

With the province still reeling from the previous year’s calamities, in January 2022 a windstorm hit the Lower Mainland causing logs—that had been loosened from containment by the November atmospheric rivers—to slam into and partially destroy Vancouver’s Stanley Park seawall and Jericho Pier. Related flooding caused damages to Kitsilano Pool. These events entailed costly repairs at a local government level, prompting calls for governments to “sue Big Oil” for compensation.¹²² Insured damages were estimated at \$42 million by the Insurance Bureau of Canada,¹²³ but based on the analysis above full costs would have been much higher.

Spring 2022 was abnormally cool and wet, delaying the onset of wildfires. A heavy snowpack accumulation and delay of warmer temperatures caused a number of flooding alerts but no massive damages on the scale of November 2021. Crews continued to repair infrastructure damage. Nonetheless, by mid-July 2022 there were powerful echoes of the previous year. Another wildfire near Lytton blazed out of control and smoke from fires up the Fraser Valley and Washington State covered Vancouver skies. A heat wave hit at the end of July that did not come near the temperature peaks of the 2021 heat dome, but lasted a week followed by subsequent waves that were not as severe but still well beyond historical norms. Summer lasted well into October with a long but eery run of sunny, warm weather with several communities experiencing severe drought conditions.¹²⁴

122 West Coast Environmental Law. “BC municipalities must Sue Big Oil to fight climate change: new campaign.” News release. June 15, 2022. <https://www.wcel.org/media-release/bc-municipalities-must-sue-big-oil-fight-climate-change-new-campaign>.

123 Insurance Bureau of Canada. “January Storm Caused Over \$42 million in Insured Damage in BC.” News release. May 28, 2022. <http://www.ibc.ca/bc/resources/media-centre/media-releases/january-storm-caused-over-42-million-in-insured-damage-in-bc>.

124 EmergencyInfoBC. “Severe Drought: Multiple Communities in BC.” October 14, 2022. <https://www.emergencyinfobc.gov.bc.ca/severe-drought/>.

Outside of BC, extreme weather in 2022 is top of mind: there were heat waves, wildfires and record drought in Europe, a 40-degree temperature record reached in the United Kingdom, and other record-breaking heat waves in China and Japan and large parts of the southeastern United States. Record temperatures in India and Pakistan in May received little coverage in North America, nor did massive floods that devastated Sydney, Australia earlier in the year. A slew of fall 2022 flooding events devastated Pakistan, Florida, Puerto Rico and Atlantic Canada. It is fair to say no part of the world has escaped the impacts of climate change.

Continued failure to rein in emissions globally guarantees that these extreme weather disasters will only get worse in the future. How many more warnings are needed before strong actions across the world really take hold? There has long been a powerful moral case for wealthy jurisdictions like BC—who have benefitted the most from the use of fossil fuels, as well as their extraction and production—to do more of the heavy lifting. Just as extreme weather disasters are an outcome of our collective failure to limit emissions at a global level, the solution lies in collective action, solidarity and quickly ending the reign of fossil fuels.

How many more warnings are needed before strong actions across the world really take hold?

Appendix: Tables

Table A1: Estimates of labour market losses from the heat dome

Employment sector	Total number of jobs	Wage rate, 2021 (\$/hr)	Four-day wage total	Share of workers impacted (low)	Share of workers impacted (high)	Wage loss (low)	Wage loss (high)
Crop production	19,295	\$22.90	\$641.20	40%	60%	\$4,948,782	\$7,423,172
Construction	233,550	\$38.81	\$1086.68	40%	60%	\$101,517,646	\$152,276,468
Manufacturing	169,200	\$36.24	\$1014.72	20%	40%	\$34,338,125	\$68,676,250
Social services / child care	49,385	\$27.22	\$762.16	20%	40%	\$7,527,854	\$15,055,709
Food services & drinking places	201,720	\$22.36	\$626.08	40%	60%	\$50,517,143	\$75,775,715
Automotive repair & maintenance	20,155	\$31.73	\$888.44	35%	50%	\$6,267,278	\$8,953,254
Subtotal	693,305					\$205,116,827	\$328,160,568

Source: Authors' calculations based on Statistics Canada's "Labour Statistics consistent with the System of National Accounts," Table: 36-10-0489-01. May 20, 2022. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048901>.

Table A2: Estimated labour market losses from wildfires

Employment sector	Total number of jobs			Wage rate, 2021	Duration in days	Share of workers impacted (low)	Share of workers impacted (high)	Labour market loss (low)	Labour market loss (high)
	Thompson/Okanagan	Cariboo	Kootenay						
Wood product manufacturing	7,400	4,300	—	\$41.02	15	30%	50%	\$16,197,773	\$26,996,288
Forestry & logging with support activities	2,900	3,700	1,900	\$38.32	30	30%	50%	\$17,071,560	\$28,452,600
Metal manufacturing	—	—	1,700	\$52.38	15	30%	60%	\$3,005,303	\$6,010,605
Wholesale trade	8,700	2,300	1,400	\$39.56	30	20%	40%	\$19,582,200	\$39,164,400
Retail trade	32,200	10,400	10,000	\$26.69	60	20%	30%	\$102,329,460	\$153,494,190
Transportation & warehousing	15,100	3,800	1,900	\$39.56	30	30%	40%	\$50,468,670	\$67,291,560
Social services / child care	10,200	2,700	1,800	\$27.22	15	20%	30%	\$7,900,605	\$11,850,908
Accommodation & food services	19,300	5,900	5,100	\$22.90	60	25%	50%	\$64,921,500	\$129,843,000
Subtotal	95,800	33,100	23,800					\$281,477,070	\$463,103,550

Source: Authors' calculations based on Statistics Canada's "Employment and Unemployment Rate by Detailed Industry, 15 years and over, annual (employment in thousands of persons)," Labour Force Survey, Custom Tabulation, prepared by BC Stats, February 2022, https://www2.gov.bc.ca/assets/gov/data/statistics/employment-labour-market/lfs_employment_and_unemployment_rate_by_industry_and_development_region.xls.

Table A3: Estimated labour market losses from atmospheric river and flooding

	Number of jobs	Wage rate, 2021	Duration in days	Share of workers impacted (low)	Share of workers impacted (high)	Labour market loss (low)	Labour market loss (high)
Wood product manufacturing	27,340	\$41.02	30	20%	50%	\$50,393,070	\$125,982,675
Wholesale trade	104,975	\$39.56	25	30%	50%	\$233,651,250	\$389,418,750
Transportation & warehousing	150,535	\$39.56	25	40%	60%	\$446,533,500	\$669,800,250
Accommodation & food services	174,420	\$22.90	20	15%	30%	\$89,859,600	\$179,719,200
Petroleum refining	295	\$92.97	30	80%	90%	\$4,936,707	\$5,553,795
Metal manufacturing	1,700	\$52.38	20	30%	60%	\$4,007,070	\$8,014,140
Subtotal						\$829,381,197	\$1,378,488,810

Source: Authors' calculations based on Statistics Canada, Labour Statistics consistent with the System of National Accounts, Table: 36-10-0489-01, May 20, 2022, <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610048901>.



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living wage
employer