



# Newsletter *Fall 2023*

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## EDITORIAL

A recent visit to the islands of Haida Gwaii has presented an opportunistic lens through which to inspect the ecosystems of the southern interior of British Columbia. Though Haida Gwaii experienced and continues to be subject to major logging programs, between the hard-earned forest protections and the very sparse population impacting the islands there is much land that is in a still near pristine state. To follow a very uplifting narrative concerning some of these issues you are referred to *Raven Walks Around the World: Life of a Wandering Activist* by Thom Henley (2017, Harbour Publishing Company Ltd.)

Of course, viewing such a treasure also allows one to become aware of the difficulties and foibles experienced by such environments as the Okanagan, Similkameen and the Boundary County. Among the many take-aways of a visit to such a generally natural, or at least less abused, location, one of the most obvious is the ever-present natural diversity of plants, insects, birds, and sea-life. Though signs of previous logging, even some clear cutting, are evident there are vast forests consisting of multiple species of coniferous trees, various deciduous trees, bushes, and shrubs. One cannot hike far without locating an array of fungi, ferns or spreading root systems. Similarly, the creatures that call these islands home are many and varied. The vegetation and other attributes of habitat have been colonized over millennia to provide just the right ecosystems for the life that inhabits them.

Though different in nature, there was a time when much of the southern interior was also

covered in biodiverse environments and biomes. That, unfortunately, is no longer the case. Even the few forests that have been legally logged and 'replenished' with seedlings to government standards, have fallen to the false belief that monoculturally appropriate plantations are 'best practice'. One glance at the gorgeous stands of trees around Massett will confirm that nature grows a variety of trees with bushes and low standing shrubs as a matter of course. And should fiber harvesting still be necessary, as even some island inhabitants claim, some very large trees can be taken without destroying the surrounding undergrowth and neighbouring arboreal species.

Take, for instance, the great increase in wildfires generated over the past decade or so. Granted that the coastal climate does not lend itself to many runaway wildfires, however the human driven environmental and biological destruction contributing to fires in the Okanagan Similkameen, and other southern interior regions, does not have to occur either. Readers that have followed this newsletter's editorials in the past will recognize that there are systems at work that contribute to the likelihood of conditions conducive to wildfires and their consequent disasters. When trees are logged in a manner known as clear cutting, that destroys not only all of the vegetation, but also the top layers of soil present in a large 'cut block', there is nothing left to capture and retain moisture, rain or snow. (Snow has been shown to melt faster on clearcut areas than on surrounding vegetation) The water simply forms 'rivulets' and runs off of the area. Much of this water has contributed to flooding and scouring that

has occurred in and around our creeks, rivers and lakes in recent years. This process does not allow the soil to become habitable for the young seedlings, all of one specie, that are 'planted' in the devastated aftermath of the style of logging practiced in the Okanagan and Similkameen today. Dry conditions cannot be combatted when there is little or no water in the ground. Likewise, in such plantations, vegetation of different ages and species cannot protect the young who are susceptible not only to drying out, but also to contracting predators, and diseases. And yet we are talking about thinning or poisoning alternate species.

If or when monocultural tree plantations do begin to mature they are by and large the vegetation most susceptible to wildfires. The nature of these 'forests' means that they were designed to be easily harvested in the future however, it also means that fire can easily rampage through them. We have experienced such fires in a variety of regions in B.C. Large and old trees do not restrict the growth of some of the bushes and alternate varieties in such forests and as such fire rampages through consistent biomasses. These fires are difficult to restrict and control.

There is no reason that our Okanagan Similkameen region cannot protect our lands and harvest if we must in a sustainable manner consistent with our climate and needs. While we do not have an insignificant population footprint there are areas that can be placed off limits to fiber harvesting exporting companies. We need to start sometime, the Haida Nation and their allies did and now they have a truly livable habitat.

**Please use the enclosed membership form on the back page to help us carry out our mission.**

## A BOOK REVIEW

# Richard Rhodes explains how the development of energy got us to this point in history.

As we progress through the twenty-first century with the environmental, climatic, and social problems that we as a species encounter, it becomes clearer and clearer that much of our consternation can be traced back to our pursuit of energy that we believe is required to provide us with a happy life or keeping up with the Joneses or Smiths. The debate, and often the conflict, arrives when the nonmonetary value and procession of the energy is in dispute. Certainly, even within the conservation and environmental communities there are major arguments over the balance of access and harm that accompanies energy exploration, development, or use.

A very valuable resource for those trying to make sense of how we got to where we are has come to the attention of our newsletter staff. *Energy: A Human History*, a twenty-eight book by the Pulitzer Prize-winning author, Richard Rhodes is a valuable and enjoyable read. The four hundred and sixty-four pages include three hundred and forty-three pages of well written prose, end notes, and an extensive bibliography. *Energy*, pub-

lished by Simon & Schuster is broken into three categorical sections containing twenty chapters between them.

As the fly-cover states, “People have lived and died, businesses have prospered and failed, and nations have risen to world power and declined, all over energy challenges.” We would add that, in fact, the whole physical world has been changed and shaped by human use of energy. An additional argument that appears to be more and more based on reality is that a great many of the changes are detrimental to our planet and the species that inhabit it. However, this may be where the value of Rhodes’ history is apparent. To argue in favour of the curtailment of some sources of energy and the cessation of hunting for additional sources, knowing the story of forms of energy, where and when they were developed and what the catalyst for development was, is a very valuable tool. Rhodes provides this.

Knowing how the oil, coal, and natural gas industries began and what their rises meant for other industries and the world’s environ-

ment, may aid in some creative methods to assist our species to understand the great threat that they are to us now. Rhodes makes these stories clear and relevant for the reader. He also assails wind, water, nuclear, and other forms of energy. The research done for this book has been extensive.

In the final section, the author attempts to layout a possible solution to our dilemma but veers a little too much into the nuclear lane in our opinion. While arguing for a combination of energy production forms Rhodes attempts to have his cake and eat it too since dialing back some of our consumption is not a point that he strongly makes. He seems to be very sure of radioactive safety and tries to downplay previous and possible future nuclear disasters.

All in all, though, this read is a must for individuals and groups concerned with human energy production and the global climate changes brought on by it. As we work hard to save this world it is good to know how we got to where we are. Understanding history goes at least a little way toward not repeating it. Rhodes greatly assists in this quest and would make a wonderful gift for someone needing to learn.

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## Judge probes eight-month wait in federal minister’s owl protection recommendation

Crown lawyer said the delay was necessary because the Canadian Species at Risk Act should be interpreted “in a way that the minister can make an informed recommendation to cabinet.”

*The Canadian Press: Chuck Chiang*  
OCT 20, 2023

A Federal Court judge said he’s wrestling with why the minister responsible for saving B.C.’s northern spotted owl waited eight months to recommend an emergency protection order to cabinet with only one wild-born bird remaining.

Judge Yvan Roy questioned federal government lawyer Aileen Jones during a hearing on

Thursday over Ottawa’s effort to protect the endangered species, asking why Environment Minister Steven Guilbeault made his recommendation to cabinet in late September despite saying he would take that action in January. Jones replied that the delay was necessary because the Canadian Species at Risk Act should be interpreted “in a way that the minister can make an informed recommendation to cabinet.”

Jones told the court that using only scientific evidence on a potential emergency order “undermines” the collaboration needed between the federal and provincial governments to protect the owls, and Guilbeault needed to balance other factors such as social-economic considerations that are “equally

relevant. “It’s not as simple as taking a recommendation and turning it into an order,” she said. “The imminence of the threat is not the only thing guiding the timeline. The complexity of the order requires additional time, even if some of the imminent threat have begun to materialize.”

There is only one known wild spotted owl, a female, in the area of B.C.’s Fraser Canyon that was being considered for protection. Two male owls raised in captivity were also recently released. The hearing was in response to a legal challenge by the environmental group Wilderness Committee, which argued Guilbeault took too long between deciding to recommend an emergency order to protect the owls and taking it to cabinet. The federal government announced earlier this month that it would not go ahead with the order, despite Guilbeault’s recommendation.

# Clearcut logging leads to more frequent flooding, including extreme floods

SCIENCE, HEALTH & TECHNOLOGY  
Aug 2, 2023 | Lou Corpuz-Bosshart

Study also shows that larger, intact watersheds reduce flood risk more effectively

Loss of forest cover is associated with more frequent extreme flooding, as well as more frequent floods of any size, according to new UBC research.

While it's widely thought that loss of forest cover is strongly linked to increased flooding, most studies have suggested that the impact is limited to smaller floods. But the study, focused on two snow-dominated regions in British Columbia, the Deadman River and Joe Ross Creek watersheds, argues otherwise.

"When only 21 per cent of trees in the watershed were harvested, using clearcut logging, the average flood size increased by 38 per cent in the Deadman River and a staggering 84 per cent in Joe Ross Creek," says first author Robbie Johnson, who conducted the research as part of his master's in applied science in forestry at UBC. "As well, floods that used to happen only once every 10, 20, 30, 40 and 50 years are all becoming much more common."

Senior author and UBC forestry professor Dr. Younes Alila explains that clearcut logging affects the way snow melts. "Reduced forest cover leads to more snow on the ground and more solar radiation reaching the snowpack. With much less forest cover to catch and shade the snow, more of it melts faster, causing larger floods."

## Impact of local watershed conditions

The researchers also found that the impact of clearcutting on floods is influenced not only by the total size of the logged area, but also by specific local conditions including the size of the watershed, topography, exposure to the sun, storage areas such as lakes, and the location of cut blocks (areas of land with defined boundaries that are authorized for harvest), all of which control the flow of water.

For example, Joe Ross Creek, which has a smaller-sized watershed, higher elevation and mainly south and west exposure, had larger increases in flood size compared to Deadman River, which is about eight times larger, more diverse in exposure to radiation from the sun, and dotted with small lakes.

Despite this, analysis showed that clearcut

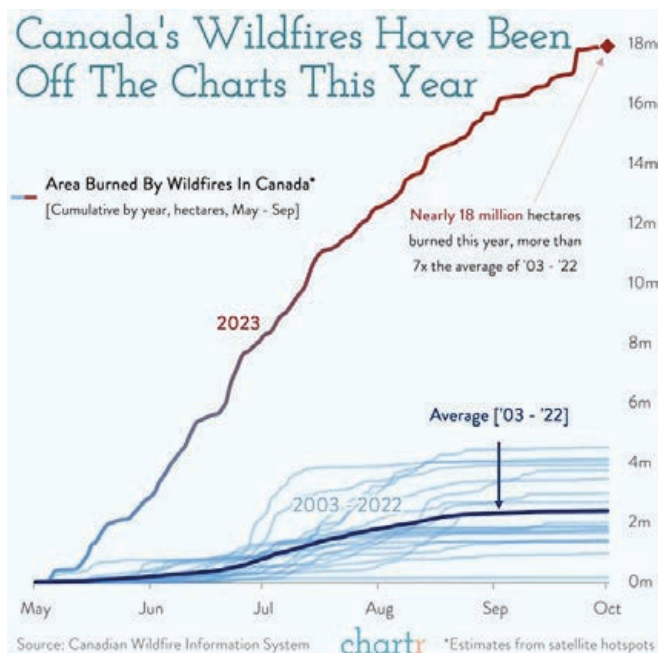
logging induced similarly large increases in the frequency of the biggest floods. The authors say this is the first study to demonstrate how forests' ability to mitigate flood risk increases with the size of the watershed.

## Improving forest management

The authors used a novel method that isolates the effects of logging from those of the volatile climate background. "This allows for more realistic evaluation of harvesting effects on flood risk in a watershed. It's an approach that can be applied to any other watershed in the Interior and on the coast of B.C.," observed Johnson.

The study provides a vital step forward in our understanding of the intricate relationship between land cover changes and flooding, said Dr. Alila.

"These results emphasize how much the power of forests lies at the watershed scale, especially since replanted forests in the cut blocks are not capable of providing the same hydrologic functions for decades. We hope these insights help to better manage our forests to reduce potential risks to communities and the environment. The way forward is to sustainably reduce clearcutting and, most importantly, consider ecosystem-friendly alternative logging practices, such as thinning and selecting individual trees for harvest."



## Quotes of Interest

"While the conditions that produced the 2021 heat dome are rare — and should happen only once every 10,000 years, according to a study in the journal *Geophysical Research Letters* — other weather phenomena, such as periodic El Niños, and climate change itself are increasing the likelihood of extreme heat events in the Northwest." Editorial, *The Herald*, Everett: July 1, 2023

Definition: EPIBENTHOS means 'Flora or fauna living on the surface of the bottom of a sea or lake.'

Sentence: 'If the Ogoopogo exists it is probably an epibenthos.'

*Canada's Wildfires Have Been Off the Charts* – This chart compares the 2023 Canadian Wildfire season (May to September) with other years since 2008. Note that fires burned well into October this year. Unfortunately, there is not a comparison with other Octobers provided. Chart courtesy of Canadian Wildfire Information System.



# B.C. clear-cut logging makes 100-year flood 10 times more likely, study finds

## Logging impact on floods

STEFAN LABBÉ

Glacier Media - Aug 2, 2023

Clear-cut logging in the upper reaches of two B.C. rivers led to a massive increase in downstream flood size and frequency, raising further questions over the influence tree harvests may have as climate change makes flooding worse, a new study has found.

The research, published in the peer-reviewed *Journal of Hydrology* Wednesday, examined Deadman River and Joe Ross Creek, two nested tributaries of the Thompson River whose watersheds climb roughly 60 kilometres north and northwest of Kamloops, B.C.

Borrowing techniques from climate attribution science and streamflow data going back to the 1960s, the authors used computer models to compare two scenarios: one where clear-cut logging did occur and one where it didn't. Then they filtered out the effects from climate change. The first of its kind study in B.C. offers a glimpse into how logging impacts flooding at a large scale in forested watersheds.

At Deadman River, the models showed log-



*Deadman Falls, a popular hiking destination near Kamloops, B.C., before a wildfire decimated the area in 2021. Even before the fire, a new study found logging is making floods along the Deadman River more severe and more common. Photo: Mastermind Studios.*

ging only 21 per cent of the watershed led to a 38 per cent increase in mean flood levels; at Joe Ross Creek, the same amount of logging spiked flood levels by 84 per cent.

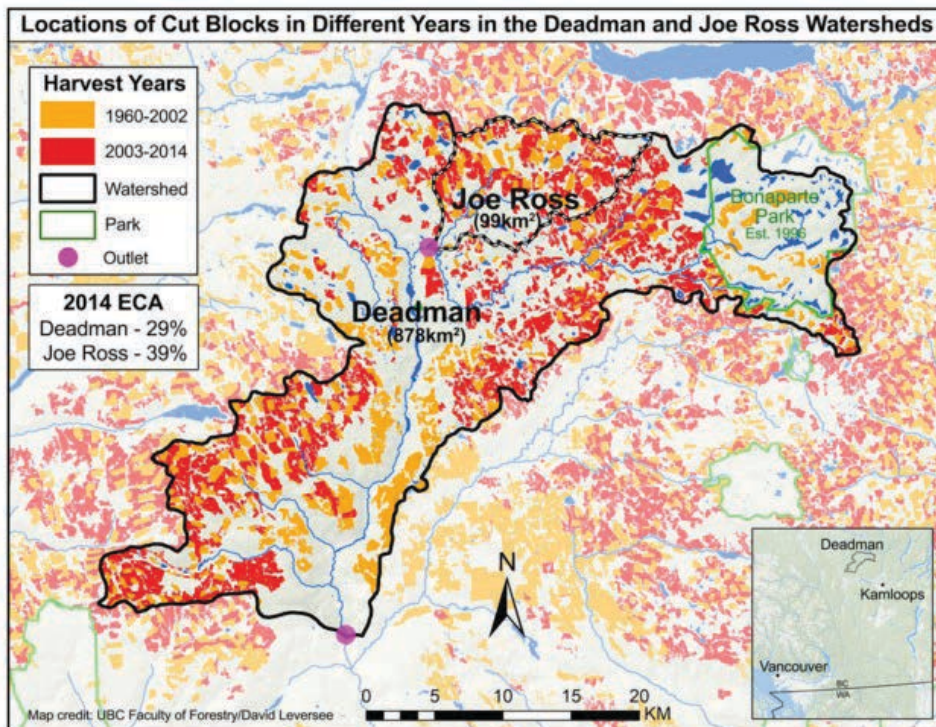
But the biggest surprise, said to Younes Alila, a professor at the University of British Columbia's department of forest resources

management, was how frequent small, medium and big floods were expected to return when clear-cut logging occurs.

In both rivers, seven-year and 20-year flood events became twice and four times more frequent. Fifty-year flood events were found to occur six times more often. And floods so rare they happened once in a 100 years increased in frequency 10 fold, meaning a flood of that size would return once every decade instead of once a century.

"This research is showing you that all these events — small, medium, large, very large and biblical — are becoming dramatically more frequent," said Alila, who co-authored the study with his graduate student Robbie Johnson.

"The larger the events, the more frequent it becomes as a result of this level of logging."



*Modelling using more than 50 years of streamflow data at B.C.'s Joe Ross Creek and Deadman River found clear-cut logging could be making flood events more powerful and more frequent. UBC*



## How forests limit flooding

The researchers suspect the increase in flooding occurs because logging operations diminish a forest's ability to limit snow accumulation, which later turns to meltwater when temperatures climb.

An intact forest captures snow in its boughs, where it can evaporate back into the atmosphere. What snow does fall through the canopy is shaded by the trees around it, only subjected to filtered light from the sun. A clear-cut forest block, on the other hand, accumulates deeper snowpacks, and when spring comes, that snow tends to melt without the attenuating effects of forest cover.

But every river system is different — clear-cut watersheds facing south will get more sun, leading to spikes in meltwater as seen at Joe Ross Creek. The upper reaches of Deadman River face a different though just as risky scenario. A cut block sitting at the same elevation, such as a flat plateau, can accumulate deep snowpack that will eventually melt all at once. Downstream, all that meltwater pours into a river at once, driving up flood levels.

Those differences matter to help calculate the individual risk and frequency that a river will flood. But Alila says the effects of clear-cut logging across B.C.'s streams and rivers needs to be considered at scale. Joe Ross Creek flows into Deadman River and through the Thompson River. Both their waters pour into the Fraser River, the province's largest.

### Floodwaters pumping silt downstream raise risk of dike breaches

Alila says the accumulation of bigger and more frequent floods across the tributaries of the Fraser River could have drastic impacts on Metro Vancouver, where it empties into the sea. That's because bigger and more regular floodwaters will scour sand and silt from the high reaches of river systems feeding the Fraser.

Suspended in the rushing water, silt particles will rush thousands of kilometres downstream. As the river slows near the sea, they will eventually sink, creating deep sand banks next to some of B.C.'s densest urban areas.

The small headwaters where heavy logging



*Deadman Falls after a wildfire decimated the area in 2021. Even before the fire, logging in the surrounding Deadman and Joe Ross watersheds led to a spike in flood severity and frequency. Mastermind Studios*

has taken place may be far from the downstream populated urban area. But eventually, those floodwaters will carry and deposit the fine sediment next to the dikes protecting communities.

Wildfire can accelerate those effects (a major reason why Alila and Johnson ended their study in 2014 before fire ripped through the area).

When a forest burns, it tends to create an impermeable ground layer of waxy residue, which acts like a slide for runoff to flow downhill and into rivers at a rate orders of magnitude larger than the effect of conventional logging, says Alila. Last year, a B.C. company that helps make sense of satellite data says it found a correlation between the 2021 wildfires and several bridges and sections of highway washed away during 2021's powerful floods.

"It does not allow the snow to melt or rain to infiltrate into the soil, and therefore, the landscape acts as a parking lot," he said.

Still, said Alila, logging has a powerful impact, and the combined effect of clear-cutting and wildfire could lead to a different kind of flood risk far from Interior rivers like the Deadman or Joe Ross Creek.

Part of that is due to inadequate infrastructure. In 2016, the Fraser Basin Council reported two-thirds of the assessed dikes in

the Lower Mainland scored as poor to fair, while 18 per cent were classified as unacceptable to poor.

"Few of the dike segments assessed meet current provincial standards, and no dikes fully meet provincial standards," stated the report.

Five years later, and just months before catastrophic flooding hit much of B.C. in 2021, the council released a commissioned report warning that there are "no guidelines" and "limited information" when it comes to channel maintenance. And when it came to dikes — the failure of which led to widespread flooding in places like the Sumas Prairie region of Abbotsford — the report found "many known gaps" remain.

"The current model for flood risk governance in B.C. is broken," concluded the report.

Alila says a big part of the risk comes from scoured sediment already building up alongside dikes at the river's mouth. Like placing too many ice cubes in a full glass of water, the Fraser's waters will eventually have nowhere to go but over or through a breached dike.

"We are basically in a vicious circle," he said.

### Logging-triggered floods already bringing victims compensation

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Alila has spent the past two decades investigating the impacts of logging on flood risk. But he said this is the first study that demonstrates that the power of the forest to mitigate against flood risk dramatically increases as the scales get bigger.

“The larger the catchment, the more powerful is the forest at mitigating flood,” said Alila.

B.C.’s reliance on clear-cut logging is already having clear and present impacts on people’s homes and lives.

In 2022, Alila successfully acted as an expert witness in a lawsuit brought by a family against a logging company and the province after their home flooded. The Smithers couple had claimed the province was negligent in its failure to take reasonable care to ensure their property in northwestern B.C. would not be damaged by the logging.

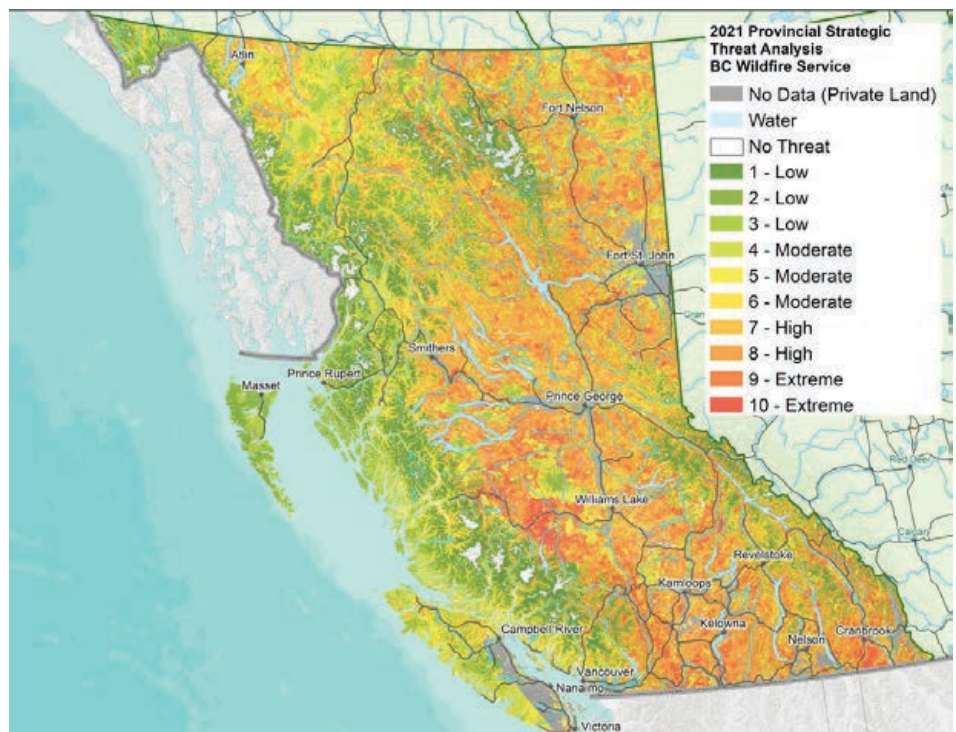
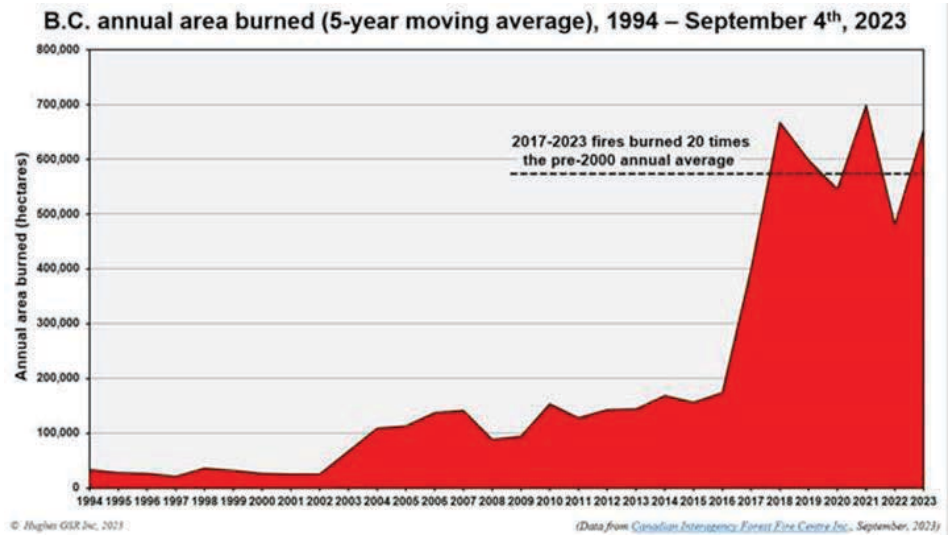
Hired by the couple, Alila prepared a 70-page report outlining his conclusion that clear-cutting “supercharged” flows in the watershed, with snow and snowmelt the key factor.

At the time, Alila described the evidence that logging was the culprit as a “slam dunk.”

More recently, he has been advising the provincial government on a future flood management strategy. He says his latest study points to a need for government to integrate those plans with how it manages forests.

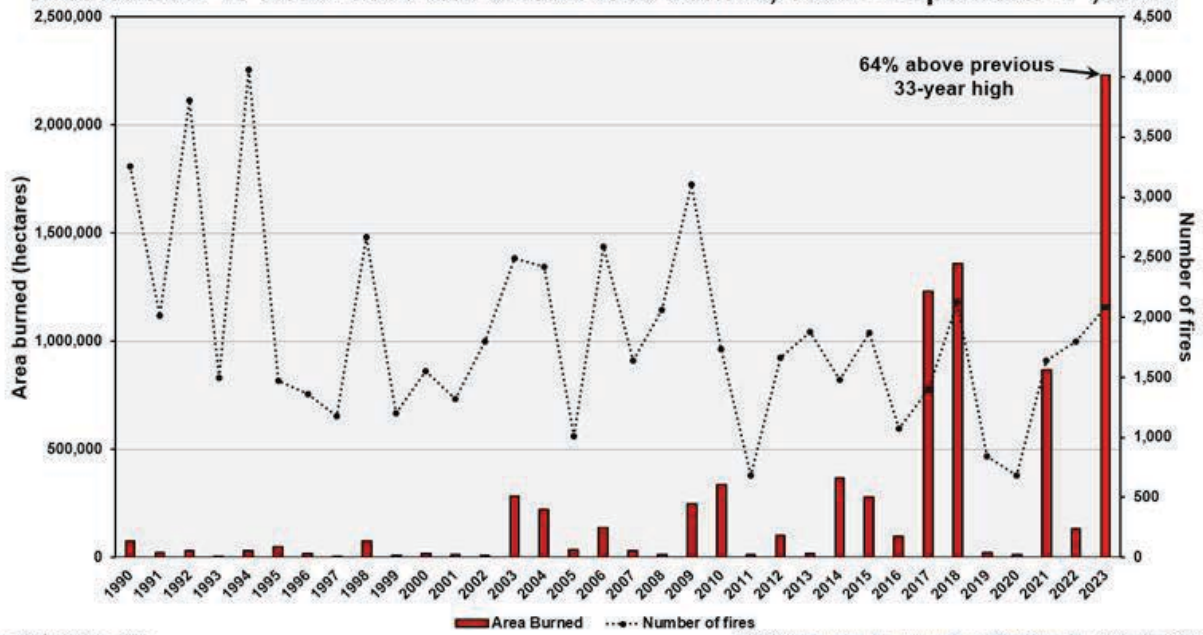
“The entire province is at the crossroads deciding right now on how to manage the timber supply area over the next five to 10 years,” Alila told Glacier Media. “All of our landscape, with no exception, is sitting at a much higher risk than we were led to believe by the government and the industry.”

“And you can blame that on the conventional clear-cutting.”





### B.C. number of forest fires and annual area burned, 1990 – September 4<sup>th</sup>, 2023

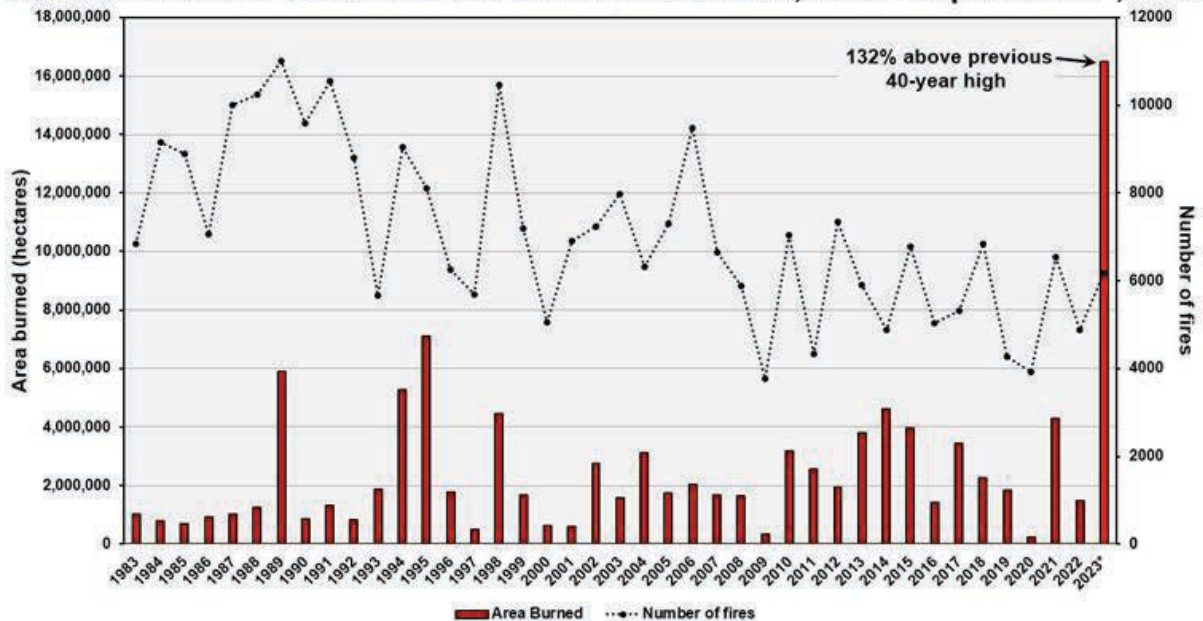


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(Data from Canadian Interagency Forest Fire Centre Inc., September, 2023)

**Area Burned B.C. and Area Burned Canada** – The graphs indicate the number of wildfires and the areas that they burned since 1990 in the province of B.C. and the whole of Canada respectively. Note that the totals in B.C. contribute to the Canadian total. Graphs courtesy of David Hughes

### Canada number of forest fires and annual area burned, 1983 – September 4<sup>th</sup>, 2023



© Hughes GSR Inc, 2023

(Data from Canadian Interagency Forest Fire Centre Inc., September, 2023)

# June Extremes Suggest Parts of the Climate System Are Reaching Tipping Points

*Research shows heat domes, wildfires and vanishing polar ice are the symptoms; unabated greenhouse gas emissions are the cause.*

BOB BERWYN

Reporter, Austria • July 4, 2023

June 2023 may be remembered as the start of a big change in the climate system, with many key global indicators flashing red warning lights amid signs that some systems are tipping toward a new state from which they may not recover.

Earth's critical reflective polar ice caps are at their lowest extent on record in the satellite era, with the sea ice around Antarctica at a record-low extent by far, spurring worried scientists to share dramatic charts of the missing ice repeatedly. In the Arctic, the month ended with the Greenland Ice Sheet experiencing one of the largest June melt events ever recorded, and with scientists reporting that June 2023 was the hottest June ever measured, breaking the 2019 record by a "staggering" 0.16 degrees Celsius.

"With the record warmth in June, 2023 as a whole is now the odds-on favorite to be the warmest year on record," climate scientist Zeke Hausfather wrote on Twitter.

Globally, the oceans set records for warmth on the surface and down to more than 6,000 feet deep throughout the month, with temperatures so far above the norm that the conditions elicited more graphs showing the anomaly. They've been shared thousands of times by scientists, policymakers and the public. And in Canada, forest areas about the size of Kentucky have burned, choking huge swaths of central and eastern North America with acrid wildfire smoke, with some of the haze even reaching Europe.

There was record-breaking heat on nearly every continent during the month, according to independent climate statistician Maximilian Herrera. Along with the deadly late June heat in Mexico and the South-central United States, extreme readings have been widespread in remote Siberia, with

hundreds of daily heat records, including readings higher than 95 degrees Celsius close to the Arctic Circle. "The heat will just get worse," he posted on Twitter.

Herrera also tracks notable regional extremes, like a historic mountain heatwave in Iran, where temperatures in late June spiked to between 100 and 120 degrees Fahrenheit at elevations between 1,500 and 5,000 feet above sea level that are normally far cooler. During the first week of July, temperatures in Iraq are forecast to breach 120 degrees Fahrenheit.

"These extraordinary extremes could be an early warning of tipping points towards different weather or sea ice or fire regimes," said University of Exeter climate researcher Tim Lenton. "We call it 'flickering' when a complex system starts to briefly sample a new regime before tipping into it. Let's hope I'm wrong on that."

In the meantime, the tropical Pacific Ocean is shifting into the warm El Niño phase of a two- to seven-year Pacific Ocean cycle that can boost the average global temperature by 0.2 degrees Celsius, enough to stoke the planet's fever to a dangerous new high.

"The onset of El Niño will greatly increase the likelihood of breaking temperature records and triggering more extreme heat in many parts of the world and in the ocean," said World Meteorological Organization Secretary-General Petteri Taalas. "Early warnings and anticipatory action of extreme weather events associated with this major climate phenomenon are vital to save lives and livelihoods."

"I expect a step change to higher global mean temperatures starting this year," said atmospheric scientist Kevin Trenberth, a distinguished scholar at the National Center for Atmospheric Research and honorary faculty at the University of Auckland. "And next year will be the warmest on record, either 1.4 or 1.5C above pre-industrial."

The higher of those levels is the amount

to which the United Nations' 2015 Paris Agreement aspired to limit climate change, but the continued upward trajectory of global temperatures could make that goal impossible to reach.

"I expect it then to oscillate about that value and not come down again," he said.

The El Niño temperature nudge comes against a backdrop of record-high carbon dioxide concentrations in the atmosphere, he said, adding that the rate of increase is as high as it has ever been and continues to accelerate.

"In other words, there is no bending down of the CO2 record, as should happen with all the new actions being taken in the U.S. and elsewhere," he said. "The problem is that China and India are accelerating their coal-fired power stations and overwhelming all other cuts."

## Antarctic Sea Ice Decline Has a Cascade of Impacts

The persistence of the startling Antarctic sea ice decline may be one of the most puzzling and worrisome of the recent cluster of climate extremes. Until recently, researchers expected less sudden changes in Antarctica, because it's such a vast reservoir of coldness, and surrounded by a continual swirl of ocean currents and winds that have buffered the continent to some degree.

But at the end of June, getting into the heart of the Southern Hemisphere winter, an area of ice about the size of Texas and Alaska, nearly 1 million square miles, was missing. As the Southern Hemisphere's winter set in, the sea ice grew more slowly than ever observed in the satellite era.

Sometimes, anomalies are just a one-time regional snapshot, but the Antarctic sea ice extent has been far below average at least since January, when Antarctic climate expert Ted Scambos, a senior scientist with Earth Science and Observation Center at the University of Colorado, Boulder, called the conditions extreme. "Frankly, we are still working to understand it," he said.

But nearly every new study implicates human-caused warming, as measurements



of winds and ocean currents show how the global temperature increase has pushed the Antarctic wind belt poleward, which also shifted relatively warmer water closer to the icy edges of the frozen continent.

Other recent research shows that the Southern Ocean encircling Antarctica and extending northward to 60 degrees south latitude, stored a disproportionately large percentage of the heat trapped in the atmosphere by greenhouse gases and then absorbed by the world's oceans between 2005 and 2017. The study showed the Southern Ocean took up 45 to 62 percent of the heat absorbed by the world's oceans, even though it makes up only 6.25 percent of the global ocean surface area.

In the absence of its reflective sea ice cover, the darker-colored ocean can absorb even more heat, potentially leading to earlier and more extensive melting during the next Austral summer. And as the fringe of ice around Antarctica gets smaller, warmer ocean water can more easily flow toward the floating ice shelves that buttress vast areas of inland ice that could start flowing into the sea faster to speed sea level rise.

There are also ecosystem impacts. The abundance of certain types of plankton and krill, at the base of the ocean food chain, is linked with the Antarctic sea ice. A disruption to those organisms ripples up through the ecosystem, because the feeding and breeding cycles of many other species, including seals and seabirds, is closely linked with sea ice.

### A Heat Dome Settles on North America

Climate scientist Michael Mann, director of the Center for Science, Sustainability & the Media at the University of Pennsylvania, said there is probably a global warming fingerprint on the deadly dome of stagnant, hot air that is baking large parts of Mexico, the Southwestern and central United States and Canada.

"Also playing a role in the extreme weather we're seeing, including the (south-central U.S. heat dome and the Canadian wildfires) is what appears to be another resonance event," he said, referencing research that shows how the warming climate favors planetary atmospheric wave patterns that "can give rise to

persistent summer weather extremes. In this case, it is likely behind many of the extreme conditions we're seeing right now in North America and Eurasia."

Another part of the heat dome settled over Canada, where wildfires had released 160 million tons of carbon by the end of June, the highest annual total estimated emissions for Canada since satellite monitoring began in 2003, scientists with the EU's Copernicus Atmospheric Monitoring Service reported. And there's also new research suggesting links between vanishing ice and snow in the planet's polar reaches and climate extremes in the mid-latitudes, where most people live.

"The pile of evidence linking a rapidly warming Arctic with extreme summer weather events continues to grow," climate scientist Jennifer Francis wrote on Twitter on June 30, sharing a link to a new peer-reviewed study in Nature Communications that solidifies the hypothesis that changes in the Arctic can lead to a wavier jet stream that can trap heat domes in place.

In recent years, those patterns have sometimes persisted for months with only short pauses, including last summer, when a heat dome over Europe lasted several months and fueled that continent's hottest summer on record.

### Earth's Energy Imbalance Disrupts the Climate System

At the top of the planet, scientists have been watching an extreme ocean heat wave in the North Atlantic just as carefully, because it could be a symptom of disruption to the Atlantic Meridional Overturning Circulation, a critical part of the global climate system that transports cold and warm ocean water between the poles. Sea surface temperatures about 9 degrees Fahrenheit above average in the region could also contribute to heatwaves over adjacent land areas.

Record-breaking ocean temperatures in regions around the globe are not surprising Trenberth, who specializes in ana-

lyzing deep ocean heat content, down to more than 6,000 feet below sea level, where more than 90 percent of all the heat trapped in the atmosphere by carbon pollution has been absorbed.

That heat is measured as energy rather than as a temperature value, and it's equivalent at this point to the energy of five nuclear bombs exploding in the ocean each second, or about 100 times more energy than all the electricity produced in 2021 globally.

For Trenberth, that global energy imbalance, building steadily since the start of the fossil-fueled industrial age, is the best measure of how humans have affected the climate, because the energy balance isn't affected by seasonal or annual variations, or by shifts in regional climate patterns.

And if the heat building that energy imbalance in the oceans was to stop, many of its impacts would rapidly decrease, even though the water is warmer.

"It is not global temperature that matters but Earth's energy imbalance. If you have a pot of water on the stove, while heating, convection occurs," he said. "Ultimately it boils off water as steam. But as soon as you turn off the heat source, all that behavior stops. The temperature is the same, but the heating is no more."

*Bob Berwyn an Austria-based reporter who has covered climate science and international climate policy for more than a decade. Previously, he reported on the environment, endangered species and public lands for several Colorado newspapers, and also worked as editor and assistant editor at community newspapers in the Colorado Rockies.*



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## What Is a 'Flash Drought'? And How Did It Contribute to the Deadly Maui Fires?

*In the aftermath of the Maui fires, government now looks to better understand the conditions that led to the disaster.*

As the island of Maui continues to sift through the rubble of the most devastating wildfires in Hawaii's history, many residents say they never saw it coming. The disaster, however, wasn't entirely without warning, said the John L. Newcomb Professor of Engineering in University of Virginia's Department of Civil and Environmental Engineering, Venkataraman Lakshmi, who is also president-elect of the hydrology section of the American Geophysical Union.

Major news outlets, including The Associated Press and Reuters, have sought Lakshmi's hydrology expertise to help explain how the Maui fires spread so quickly. The fires, he said, were a result of the overgrowth of non-native grasses and severe weather conditions, including one in which Lakshmi is expert – a "flash drought." The professor said the phenomenon happens when the land surface dries out very quickly over a short period, usually within two to four weeks. "The streams go from running water to no streamflow at all," he said. In the process, the grasses and soil, too, get sucked dry. "The grasses introduced for forage in Maui are invasive species and have taken over vegetation, dried out and became flammable." The

conditions were due to a combination of low or no rainfall, high air temperatures and active winds that increase water's uptake into the atmosphere, he explained. The normal water cycle essentially gets stuck.

"In May, the island was 'normal' with respect to conditions. By August, some drying had occurred – not too much," he said. "But between Aug. 1 and 8, the whole region was under abnormally dry conditions or worse." Winds from Hurricane Dora, along with some source of natural or human ignition, caught the grasses on fire and "advanced them very quickly."

The extremes of how flash droughts affect the landscape can be observed even after the fires. "You can see in pictures of Maui that some of the taller trees are still green and standing and the fires went around them and destroyed homes, automobiles and took precious lives," Lakshmi said. "The taller trees were higher and may have been healthier and 'wetter' than the grasses and did not burn as easily."

Scientists named and began to focus on flash droughts – inspired by the more familiar "flash floods" – about 20 years ago. Since then, the phenomenon has been on the rise, and it's only going to increase due to climate change, Lakshmi said. "With the increase in hydrological extremes, they will occur almost everywhere," he said.

Lakshmi said though understanding the rapidly changing factors behind flash droughts may result in better future responses, "We cannot predict ignition. Just because there's a flash drought doesn't mean the grass has to burn. We can, however, predict the dryness of the soil and vegetation." Maui's inferno is just one of a number of major fires across the globe this year – including blazes in Chile, Greece and, ongoingly, in Canada and California.

Droughts and the fires that sometimes follow are related to other natural hydrological changes, the professor said. These can include flooding, landslides, permafrost thaw and hurricanes. Maui's next worry is landslides and runoff, because the burnt soil prevents water infiltration. "They're called compound hazards, and they don't bode well for the people who live there," Dr. Lakshmi said.

Currently, Lakshmi has a project funded by the Army Research Office. His team will look at data from previous U.S. flash droughts and apply artificial intelligence machine learning tools to extrapolate to how watersheds in Africa and Asia, such as the Nile River, may be affected in the future. "These include watersheds that run between countries that could cause conflicts due to low availability of water," he said.