ARCTIC BLUE DESERTS

FLATLINING THE ARCTIC'S PULSE

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INTRODUCTION

We all should recognize and understand that the burning of fossil fuels is without doubt today's leading cause of air pollution and has direct atmospheric warming implications.

However, if we are to successfully fight climate change, then we need to have a conversation about the evidence presented in this book. This book documents how mega reservoir hydroelectric dams are a major, if not the driving, source of heat warming the Arctic and the regional northern climates of Canada and Russia, as well as their river continuums and coastal waters. The constructions of these mega dams have also imperiled every level of the marine ecosystem, from silica-encased diatom phytoplankton to fisheries and marine mammals, such as the North Atlantic right whale.

The relationship between mega dams and declining diatom populations is most alarming. These silica-encased microscopic plants have evolved as nature's most efficient biological pump for permanently sequestering carbon in the ocean depths and reducing atmospheric carbon dioxide (CO_2) levels.

The word flatline, which appears in the title of this book, is a medical term rather than a scientific term. It means a patient's electrocardiogram has flatlined. In other words, the circulation of blood flowing through the body has stopped and the person is technically dead.

Similarly, mega reservoir hydroelectric dams stop the natural spring pulses of rivers and their tributaries from flowing downstream into estuaries and coastal seas. The huge amount of energy generated by water flowing down from mountaintops has been reduced to zero by these immense human-made lakes.

When these mega dams are in operation, the natural spring pulse—or the freshet—of the river is flatlined and its natural flow is lifeless. It, too, is dead.

These natural spring freshets were the lifeblood of the oceans, and they have been flatlined in Canada's north and the Arctic by Canadian and Russian mega reservoir hydroelectric dams.

> *"The chemical, thermal and physical changes which flowing water undergoes when it is stilled can seriously contaminate a reservoir and the river downstream. The extent of deterioration in water quality is in general related to the retention time of the reservoir – its storage capacity in relation of the amount of water flowing into it. Water in a small headpond behind a run-of-river dam will undergo very little or no deterioration; that stored for many months or even years behind a*

major dam may be lethal to most life in the reservoir and in the river for tens of kilometers or more below the dam." (McCully, 1996)

Patrick McCully is an associate editor of *The Ecologist*. His book *Silenced Rivers* focused on the environmental damages mega reservoirs cause to our rivers. *Arctic Blue Deserts* is focused on the environmental damage these same mega reservoirs have had on estuaries and coastal waters.

The residence time of the stored waters in these mega, human-made lakes can be as high 8.1 years, such as behind the 702-foot high, Daniel-Johnson Dam on the Manicouagan River in Quebec

Conversely, hydroelectricity generated by a run-of-river dam with a small headpond—not a large reservoir behind it—is clean and renewable energy.

The definition of renewable is "not depleted when used."

Hydroelectricity generated by mega reservoir hydroelectric dams that flat-line and deplete the natural spring pulse with regulated discharges, is not renewable energy.

I believe it is misleading to call this energy either renewable or clean, and I will document why in this book.

Let us explore this further.

The energy and velocity of the human-regulated discharges from these dams during the spring months are typically 50 to 75 percent less than the energy and velocity of the natural spring freshet.

Since being dammed, Quebec's Manicouagan River's regulated spring discharge is at least 75 percent less than its natural spring pulse, and the regulated winter discharge has increased the very low natural river flows by more than 1,000 percent (10 times). (See figure 2b in Chapter 2)

Since being dammed, northern Quebec's La Grande River's spring run-off has been suppressed by 70 percent, and its winter flows have increased by 800 percent. (Harper 1992 and McCully 1996) It is not surprising that similar data is not readily available on pre-dam natural river flows and post-dam regulated discharges for rivers in northern Russia and Siberia.

However, one can theoretically assume that the Russians have had to make the same radical alterations to natural river flows in order to produce the necessary warm thermal mass in its reservoirs to fuel its hydropower plants during the long Arctic winters. Extrapolation of the available data supports this assumption.

There are 71 reservoirs in the world with a surface area of 200 square miles or larger. Only four of them were built before 1950. Since 1950, 13 have been built in Canada and 11 in Russia. (Wikipedia: List of Reservoirs by Volume)

Did you know that the freshwater discharge from the world's 16 largest rivers equals almost 50 percent of the annual global riverine flow into the world's oceans?

Three of these 16 rivers, the Yenisei, Lena and Ob, are in Siberia and discharge into the Arctic Ocean. Two others are in Canada; one is the Mackenzie, discharging into the Arctic's Bering Sea and the other is the St. Lawrence, discharging into the Gulf of St. Lawrence and the North Atlantic.

It should be noted, one third of the world's largest reservoirs and rivers, as defined above, are located in Canada and Russia. Mega dams reverse the natural run-off cycle of the rivers they control by hoarding the waters of the spring pulse (freshet) in huge reservoirs for release the following winter, when river flows would be naturally locked up in ice. The concept of river flow being locked up in ice may be hard for the reader to believe, so I offer as evidence the graph below (also figure 5 in Chapter 4).

The Nizhnyaya Tunguska River in Siberia is the seventy-second largest river in the world and is a tributary to the Yenisei River, the eleventh largest river.

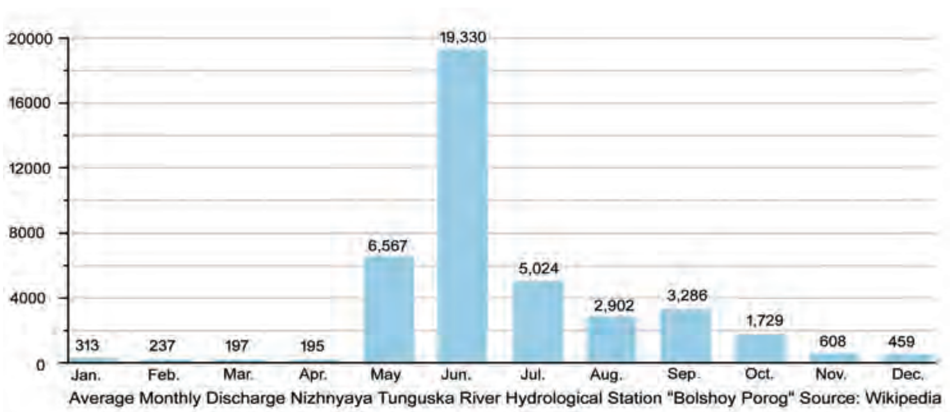

Fig. 1a: (for reference only; identical to figure 5) Mean values of monthly average discharge of the Nizhnyaya Tunguska River, calculated on the base of a 52-year-long period of observation at hydrological station Bolshoy Porog. (Nizhnyaya Tunguska at Bolshoy Porog Archived 2009-11-24 at the Wayback Machine, UNESCO: Water resources; Toungouska inférieure; Wikipedia)

Looking at the Nizhnyaya Tunguska River's natural flow rates between November to April in figure 1a, it is obvious that the natural river flows in this region are locked in ice for six months of the year, and the vast majority of a river's annual discharge occurs in the other six warmer months. The spring pulses are immense.

The Nizhnyaya Tunguska River's June spring pulse is 19,330 cubic meters per second, which is equal to a river flow of 682,600 cubic feet per second. To help visualize this, consider that the annual average daily flow of Niagara Falls is 85,000 cubic feet per second; the volume of the Nizhnyaya Tunguska River's June spring run-off is equivalent to eight Niagara Falls flowing for 30 days during the month of June.

I estimate that the Yenisei and Ob's spring pulses pre-dam were equivalent to 37 and 46 Niagara Falls, respectively, flowing into the Kara Sea for 30 days in the month of June.

Fig. 1b: (for reference only; identical to figure 14) Watersheds and ocean areas above 40 degrees north, depicted by the red line (Arctic Portal)

A. Yenisei River
B. Angara River
C. Nizhnyaya Tunguska River
D. Ob River
E. Irtysh River
F. Lena River
G. Vilyuy River
H. Kolyma River
I. Mackenzie River
J. Yukon River
K. Urengoy Natural Gas Field
L. La Grande River
M. Manicouagan River
N. James Bay
O. St. Lawrence Estuary
P. Gulf of St. Lawrence
Q. Gulf of Maine

In this book, I have defined the boundaries of the North Atlantic water cycle to include ocean areas and watersheds above 40 degrees north, as shown by a red line on the map in figure 1b.

The Nizhnyaya Tunguska, Yenisei and Ob rivers are identified by the letters C, A and D on the map.

To put the size of this region in perspective, consider that the watershed (catchment basin) of the Yenisei and Ob rivers equals the surface area of the lower 48 United States.

There are seven other Arctic rivers identified on the map, plus the Manicouagan and La Grande rivers, which flow into the St. Lawrence Estuary and James Bay, respectively.

The Gulf of Maine is identified as point Q on the map in figure 1b, and has six large rivers flowing into it.

Each of these rivers used to have a large natural spring pulse powering its own haline (salt density) ocean current and feeding the fisheries of Georges Bank and the Scotian Shelf, which are numbers 8 and 13 respectively, on the map in figure 1c.

The spring run-off of these six Maine rivers typically reached their peak flow during March. The Manicouagan, La Grande and the Arctic rivers reached their peak flows in April, May and June, respectively.

In the year 1800, there was a natural water cycle in the North Atlantic with large to huge spring pulses flowing into the Gulf of Maine, Gulf of St. Lawrence, James and Hudson Bays, Labrador Sea, Arctic Ocean and the North Atlantic, over a four-month period. These natural spring freshets were the lifeblood of the North Atlantic fisheries—the greatest fisheries the world has ever known—and were the source of energy that fueled the regional and global haline ocean currents.

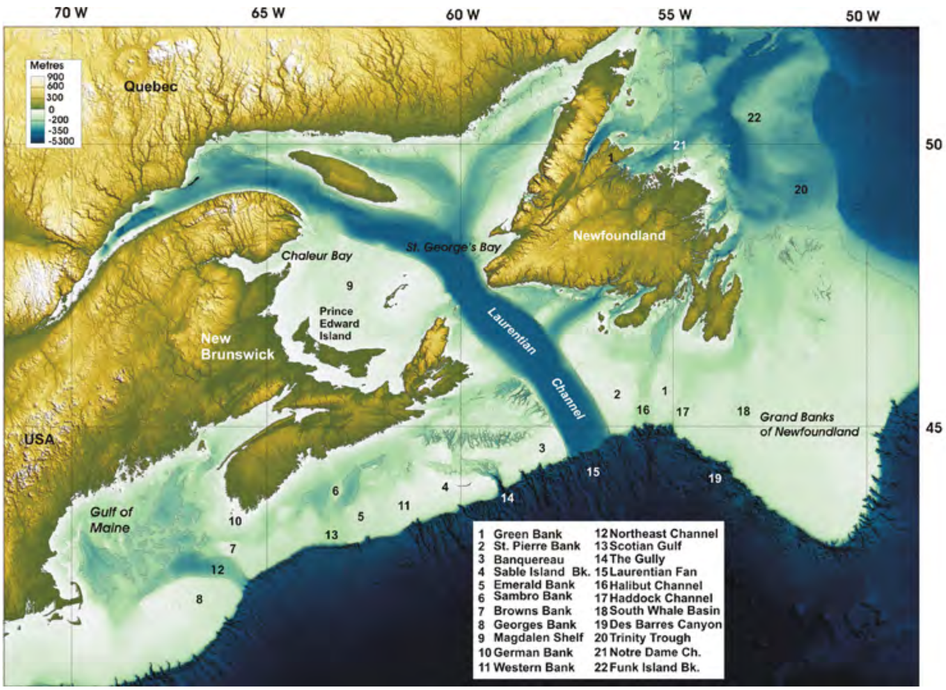

Fig. 1c: (for reference only; identical to figure 18) Map depicting Gulf of Maine in relation to the North Atlantic Ocean. (Shaw, Geological Survey of Canada)

Through out the 1800s, the March spring pulses of the six rivers flowing into the Gulf of Maine were being flatlined by dams engineered to provide uniform, average monthly river flows for Maine's large manufacturing industry.

The natural April spring pulse of the Manicouagan River, which flows into the St. Lawrence Estuary, was extinguished and stored behind the Daniel-Johnson Dam when the dam's construction was completed in 1970. The natural spring pulse of the St. Lawrence River had already been flatlined due to the St. Lawrence Seaway in 1959.

The May spring pulses of the Eastmain and the La Grande Rivers flowing into James Bay were suppressed by the construction of dams by Hydro-Quebec in the 1980s.

The May spring run-off of the Churchill River in Newfoundland and Labrador, flowing into the Labrador Sea, was extinguished by Hydro-Quebec in 1974.

The June spring pulses on the Ob, Irtysh and Angara Rivers were flatlined in the 1960s and on the Yenisei, Vilyuy and Kolyma Rivers in the 1970s through to the 1990s. The magnitude of these Russian hydroelectric reservoirs is immense. For example, the Angara is a 1,100-mile long tributary of the Yenisei and has four mega reservoirs flooding a total of 799 miles of the Angara's riverbed and valley.

Over the past 60 years, the cumulative impacts of Hydro-Quebec's and Russia's mega reservoir hydroelectric dams have transformed the North Atlantic's natural water cycle into a regulated, industrial water cycle. These industrial waterworks have been engineered to provide enough warmed thermal mass to keep tens of thousands of miles of Canadian and Russian rivers and their tributaries from locking up in ice during the prolonged winters.

The mushrooming global number of dams and regulated discharges have crossed a threshold, inhibiting the natural mechanisms that maintain the climate in its dynamic equilibrium. The earth's natural water cycle has been radically altered, and the effects of these hydroelectric mega dams are discussed throughout this book.

If there is no acknowledgement that the natural water cycles on the world's largest rivers have been replaced by a regulated cycle that has flatlined the spring pulses, then we can never adequately address the cause and effect of climate change.

This failure to assemble and adequately analyze in climate modeling the mechanisms of the natural water cycles before these huge dams existed, could be the main reason why the Arctic is warming much faster than scientific models have predicted.

It is probably also why even today's model predictions have greatly underestimated the rate of Arctic sea ice melt, global climate change and sea level rise.

The following hypotheses and predictions were based on a **measurement-based study** in 1963 by Neu, and have proved to be valid over the recent decades:

> *"As the seasonal flow of fresh water is modified for power production, the strength of this circulation is altered and with it upwelling, mixing, flushing of the system and near coast water masses, and the composition of the water with respect to salinity and temperature.* ***The changes must result in climatic modifications which influence the heat budget and therefore the ice conditions."***

and

> *"It can, therefore, be concluded that seasonal discharge regulation, as implemented in the St. Lawrence for power production since the turn of the century, has imposed large-scale modifications upon the*

ecosystem of the Estuary, Gulf and coastal zone. ***This applies to any other system in which similar conditions prevail."***

and

"To regulate the natural flow of rivers is to interfere with the hydrological cycle, that is, the circulation of water between the ocean, the atmosphere, the land and its return to the ocean. It is this last link of the cycle which is principally affected by regulation." (Neu, 1976; emphasis by S. Kasprzak)

Neu's 1963 study is discussed in great detail in Chapters 18-20 and 23-25 of this book. I want to remind the reader again that this study is as valid today as it was in 1970, when Neu was finally able to release some of it to the public.

These Canadian and Russian mega reservoir hydroelectric dams have interfered with the North Atlantic natural hydrologic (water) cycle by flatlining the spring pulse on most of the major rivers flowing into the Gulf of St. Lawrence, James Bay, Hudson Bay, the North Atlantic and the Arctic Ocean.

We do not need to conduct expensive studies over a period of decades to answer the five questions in the Preface of this book and to understand why the following events are happening:

1. The northern Quebec and the entire Arctic region are warming much faster than the rest of the earth.

2. Sea ice and permafrost in Hudson Bays and the Arctic are rapidly melting.

3. The Labrador and East Greenland currents have lost energy and become warmer.

4. The Atlantic Meridional Overturning Circulation is measurably weaker.

In his 1973 book *Can Man Change the Climate?,* Petr M. Borisov provided the following blueprint to the world on how Russia would engineer the necessary heat to melt the ice-locked Siberian rivers:

"The north of the Atlantic Basin may be compared to a bathtub into which cold water is poured from two taps (the Labrador and East Greenland currents) and warm water (the Gulf Stream) through one. ***By regulating the taps, we can change the thermal balance of the Atlantic and with it the climate of the surrounding continents.*** *The recognition of the important role of the ocean currents in forming the climate has determined regional*

improvements of the climatic regime since the end of the last century by changing the direction of the warm and cold currents. ***At the same time extensive hydrotechnical measures have been devised to regulate and transfer the river run-off."*** (Borisov, 1973; emphasis by S. Kasprzak)

When Petr M. Borisov wrote his book in 1973, he knew that the three Russian mega reservoir power stations, which became operational in Siberia in 1960, created the necessary thermal mass in the reservoirs to provide enough heat to moderate the regional climate and deliver heat polluted river flow downstream. He had to be fully aware that the size of the reservoirs and their thermal temperature were the key to continuously fueling and operating hydropower projects in the frigid Siberian winter.

In fact, there was so much heat being released in the regulated discharges that the natural rivers were not freezing up as far away as 190 miles downstream from the dam.

The *"extensive hydrotechnical measures,"* which Borisov described in his book, are the three mega reservoir hydroelectric power stations mentioned above. By *"regulating the taps"* (discharges from these power stations) Russia began changing *"the thermal balance of the Atlantic and with it the climate of the surrounding continents"* in 1960.

If Russia only wanted electricity to promote the industrial development of Siberia, they could have built electric power plants fueled by natural gas. Russia has enormous natural gas reserves—in fact, 26 percent of the world's natural gas reserves—and one of its largest reserves is in the watersheds of the Yenisei and Ob rivers.

I have included 14 Chapters in Section II and III documenting how Russia's 100-year strategy of an ice-free Northwest Sea Route has evolved.

The Arctic Ocean and its coastal seas have many estuarine features, and some scientists describe it as a very large estuary to the Atlantic Ocean.

Neu's 1963 study was conducted over the 200-mile long St. Lawrence Estuary, and he claimed many of his findings would be applicable to other water systems in which similar conditions prevailed. Neu's study in the St. Lawrence is certainly similar to the impact of Canadian and Russia' s own Mississippi sized rivers, controlled by their mega dams, and discharging into the Arctic's shallow coastal seas.

The St. Lawrence Estuary is a salt wedge estuary with a two-layer flow system, as measured by Neu and shown in figure 30, Chapter 20. This haline ocean current extends for over 900 miles to Georges Bank, off the coast of Maine, as measured by Neu in figure 43, Chapter 23 and figure 45, Chapter 25.

It was Neu who concluded and warned in the 1970s, that modifying fresh-water inflows to the estuaries of Hudson Bay and the Arctic Ocean would weaken their circulation and "*that the hydrological balance of our globe would be threatened.*"

From the 1960s through the 1980s, Neu was a respected scientist. His knowledge on the North Atlantic was unsurpassed as documented by the following quote from Chapter 22 of this book:

> *"Hans Neu… is the undisputed authority on the Atlantic's moods. Since 1968, Neu and his staff have compiled wave charts every 12 hours from information radioed by 1,500 vessels at sea on any given day."* (McConachle, 1982)

I have estimated that pre-mega dams, the cumulative total of the spring pulses on only the largest rivers and their tributaries flowing into the Arctic's coastal seas was equivalent to at least 178 Niagara Falls flowing for 30 days in June.

Today, there are no significant natural spring pulses from Canadian rivers flowing into the North Atlantic. The St. Lawrence River's pulse, as mentioned earlier, has been extinguished by the St. Lawrence Seaway.

Flatlining and reducing the spring pulses on these Canadian and Siberian Arctic rivers and their tributaries have weakened the Labrador and East Greenland Currents, which has strengthened the Gulf Stream's influence on the Gulf of Maine, the Gulf of St. Lawrence and the North Atlantic.

However, the impact of Russia changing the Labrador and East Greenland Currents has crossed another threshold. The natural mechanisms that sustained the Atlantic Meridional Overturning Circulation (AMOC) in its dynamic equilibrium can no longer be maintained.

The following **Opinion** was written on the AMOC by the Editorial Board of *The Washington Post*, March 26, 2021:

> *"Global warming may be endangering this crucial circulation. Scientists are accumulating evidence that climate change is disrupting a major section of the conveyor belt, running from the tropics up to the North Atlantic and back south, slowing this piece of the system to its weakest pace in more than 1,000 years, according to a study published in the journal Nature Geoscience. By*

> *changing the atmosphere's chemistry at a breakneck pace, humanity is conducting a massive, unprecedented experiment on finely tuned planetary systems, with consequences that range from predictable to speculative, and what experts know about Earth history offers little comfort for what awaits."*

and

> *"A group of scientists from Britain, Germany and Ireland studying the Atlantic Meridional Overturning Circulation—that is, the circulation pattern that warms the North Atlantic—have sought to compare how it is behaving now with its recent past. Experts only began directly measuring the pattern in 2004, so they looked for clues in seafloor sediments and ocean temperature patterns, which suggested how the currents behaved before. The clues present a consistent picture: The circulation has weakened in a way that is unprecedented in the past 1,000 years, said Niamh Cahill, a statistician from Ireland's Maynooth University. The scientists believe the ultimate cause is global warming."* (The Washington Post, 2021)

I agree with these scientists that the AMOC has "weakened in a way that is unprecedented," but since it is consistent with Russia's strategy of hoarding spring run-offs, it is my opinion that this was caused by the proliferation of Russia's and Canada's mega reservoir hydroelectric dams during the past 70 years.

These dams have changed the chemistry of not only the atmosphere, but also the fresh and saline waters of the North Atlantic natural hydrologic cycle.

I believe the key driving mechanism weakening the AMOC is the flatlining of the Arctic's spring pulse by Canadian and Russian mega reservoirs.

I repeat, for emphasis, that in his 1963 study, Neu measured a two-layer conveyor belt circulation in the St. Lawrence Estuary fueled by the spring pulse of a group of rivers, which included the Manicouagan, Bersimi and Outardes Rivers. This current traveled seaward over 900 miles to Georges Bank by the Gulf of Maine.

In 1970 on the Manicougan River, Hydro-Quebec flatlined the last major spring pulse of 3,950 cubic meters per second flowing into the St. Lawrence Estuary. This volume of flow was equivalent to the annual average flow of about 1.6 Niagara Falls.

When one compares the volume of flow in the St. Lawrence Estuary to the volume of flow in the Arctic, taking into account the cumulative impact of the Arctic's many spring pulses, the comparison is dramatic. I estimate the Arctic's volume of flow is at least 100 times greater than the pulse of this group of rivers on the St. Lawrence. Today, these natural spring pulses in the Arctic have been severely weakened to fuel winter hydropower generation.

As aforementioned, I believe the flatlining of the spring pulses of the Arctic's rivers and disrupting the Arctic's natural water cycle is the major, if not the primary, driving force weakening the AMOC.

In this book, I also address the starvation of many ocean fisheries. We will never be able to restore cod and other fisheries in the North Atlantic by simply implementing moratoriums on fishing. Nor will reducing fossil fuel consumption bring the fisheries back. The major anthropogenic disruption of the region's natural hydrologic cycle by Canadian mega dams has crossed a biological tipping point that today, continues to impede the recovery of these east coast fisheries.

In 1992, Canada implemented a moratorium on cod fishing. The moratorium remains in effect today, along with other fisheries moratoriums, including many also by the government of the United States.

The natural spring pulses into the seas and oceans were the lifeblood of fisheries and the siliceous diatom phytoplankton. In the short span of 20 years, between 1969 to 1989, the spring freshet of eight Canadian rivers in the Northwest Atlantic watershed were flatlined, and the ecosystems and fisheries that depended on the spring pulses were sacrificed for what the electricity industry refers to as "clean energy."

Populations of cod, salmon, shrimp and other fish and mammal populations in the coastal systems affected by these impounded rivers, have typically declined by 90 percent. We would also expect diatom populations in these systems to have declined by a significant amount. There are scientific findings to support this claim. In a recent NASA study published in *Global Biogeochemical Cycles,* the authors concluded the global diatom populations have declined by one percent per year from 1998 to 2012.

For our quality of life and the survival of future generations, the following two questions must be answered:

1. Is the increase in carbon dioxide (CO_2) levels in the atmosphere over the past 50 years only due to increased CO_2 emissions from fossil fuel combustion?
2. Or, has the increase in CO_2 concentration also occurred as a result of a significant reduction in the annual removal and sequestration of CO_2 in the oceans by diatom phytoplankton due to the impounding of rivers and the heated reservoir waters and flatlined flows?

I believe the five questions asked in the Preface have answers, but the answers would be self-incriminating to the hydroelectric industry and would reveal their dams are a major, if not the primary driving force warming the climate and starving the western North Atlantic fisheries.

Forty-five years ago, when these mega reservoir hydroelectric dams were being built in northern Quebec, the corporation owners admitted: "*no one is sure just what its impact on the environment will be,*"

and later

> *"The head of James Bay Energy Corporation's environmental department said that even if there were severe environmental problems caused by the project, it would not be curtailed,"* from the article, **James Bay seen as test on environment** published in *The Star Phoenix,* January 6, 1976.

We now know that the negative environmental impact and monetary damages from these mega reservoir dams have been immense. The rapid warming in the Arctic due to these dams is being felt across North America and beyond. Their impact knows no boundaries. The world needs to refocus and further develop renewable energy such as solar, wind and hydrogen, as alternatives to our dependency on energy sourced from these hydroelectric dams.

I would suggest that these reservoir dams could be changed to "run of the river" operations or decommissioned, if that fails. Governments working together and a body such as The International Energy Agency, of which Canada is an active member, could help develop these processes. But that story is perhaps a conversation for another time.

If the world wants to **reverse** the rapid warming of the Arctic, **rescue** the fisheries of the North Atlantic and **reduce** CO_2 levels by **restoring** natural oceanic carbon sequestration, then removing mega hydroelectric dams and restoring the spring freshet is the most expedient and cost-effective way to meet these goals.