International Interdisciplinary Conference on
Predictions for Hydrology, Ecology, and Water Resources Management:
Using Data and Models to Benefit Society

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POLITICAL PRESSURES

in

WATER RESOURCES MANAGEMENT

Do they influence predictions ?

(Key-note lecture presented on September 15, 2008)

Ladies and gentlemen, friends!

The society we live in can be regarded in a similar manner as the atmosphere surrounding us: an ocean from which we cannot escape and whose influences we cannot avoid. The dynamics of both these oceans is driven by processes whose most conspicuous manifestations are pressure fluctuations – atmospheric pressure in one, and political pressures in the other. And, since water resources management is a social activity, perhaps the question is not whether predictions (explicit and implicit) on which it relies are influenced by political pressures, but how we cope with them.

We all are used to coping with fluctuations in atmospheric pressure: if a HIGH is in the forecast we prepare a lunch for an outdoor picnic; if a LOW is on the horizon we take our umbrella (as I did this morning); if a hurricane is about to hit we try to hide or run. With political pressures people cope in a similar way: during periods of calm they go to work and pursue their hobbies; in times of unrest they board up their doors and windows; when revolutions and wars threaten they often run.

And - based on our 20-year experience with life under "socialism" and on our implicit prediction for the future 20+ years - this is what our family did when a political hurricane in the form of the Soviet invasion swept over Czechoslovakia in 1968.

Here you see us on our run, at the Vienna airport, exactly 40 years ago to the hour, on the afternoon of September 15, 1968, just before boarding an Air Canada charter taking the first 203 Czech and Slovak refugees from the Russian "fraternal help" to Toronto.

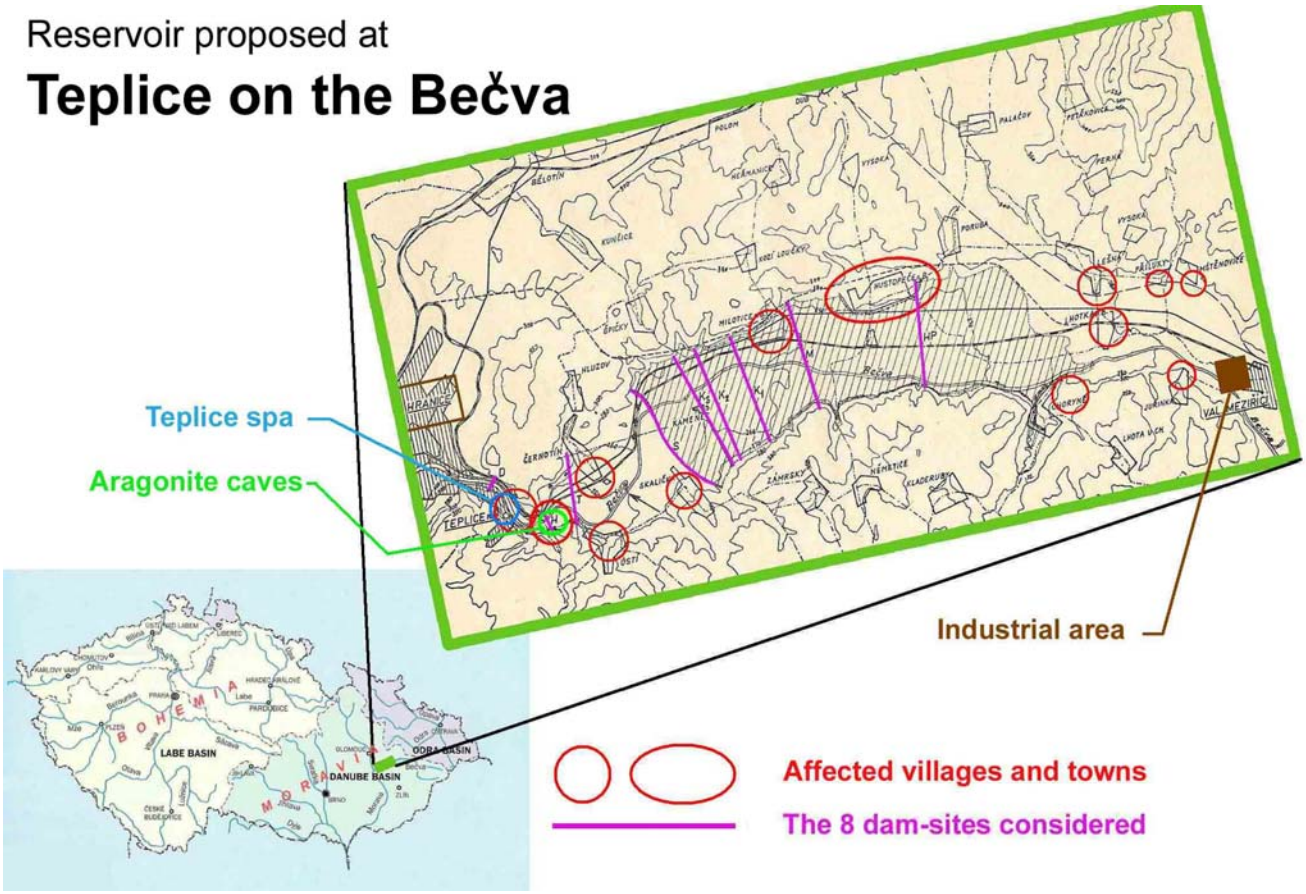
I don't want to pretend that political pressures in water resources management (in my case) or in the educational system (in my wife's case) were the main reason for our decision. But they did play a significant role.

Before proceeding to give you an example, I would like to state one crucial difference between atmospheric and political pressures:

Unlike in the former case, political pressures often set the agenda for what is to be (or not to be) predicted, and sometimes even try to impose the prediction result thus transforming prediction into prescription.

My example takes us into the Czechoslovakia of the mid-1950s when the Communist regime has already consolidated its power and started exerting pressure "to build socialism" in the earnest. The collectivization of agriculture was one of its highest priorities. As a result, production dropped and people were queuing in long lines for food-stuffs, from meat to vegetables to milk to butter. The regime could not admit that the collectivization was the cause and had to invent (to use the current jargon) a more politically correct one: Drought! – in particular in Southern Moravia, one of the country's largest bread-baskets. And the prediction/prescription was issued that large-scale irrigation will solve the problem and the country will once again be a "land overflowing with milk and honey" as an ancient saying described it.

For irrigation one needs lots of water and for that one needs large reservoirs. The one chosen in this case was to be on the Bečva river, with the dam right at the spa Teplice-on-the-Bečva. Its realization was assigned to the Brno Water Authority and I was charged with the preparation of its first-stage project, the so-called Investment Proposal.



The reservoir location was a brutal choice. The valley was densely populated, its best arable land would be flooded, hundreds of people would have to be resettled, long sections of the main railway and highway lines relocated. If the dam were built

in the valley's east narrow canyon as originally directed (for there the structure would be the cheapest), the spa, the unique aragonite caves (apparently only two caves of this kind are found in Europe) and a cluster of villages would be flooded, not to mention the unpredictable effect of the flooding of the local karst region[1]; if the dam were moved west it would have to span a 2 km wide valley, encroach upon an industrial area and on another cluster of villages. Naturally, there was wide-spread resentment against the dam, both among the locals and in the resort ministries on whose turf the project would be trespassing.

In my capacity of conducting various on-site surveys, I was the only person visibly associated with the dam, so I became the lightning rod for the complaints and frustrations, including a letter from one village council to the President pleading to intercede on their behalf because "engineer Klemeš wants to build a dam that would flood most of our village and fields thus making it impossible for our newly formed cooperative to effectively contribute to the socialist agriculture" (the letter eventually landed on my desk with a note to prepare a draft for President's reply).

So there was a lot of pressures which kept me juggling with the dam-site up and down the river to accommodate as many main objections as possible, until finally settling for the *S*-shaped variant shown in the above diagram, which sort-of minimized the problems and whose main obstacle of flooding the largest village in the valley – Hustopeče – I proposed to solve by excluding it

from the reservoir by a combination of levees and pumping stations[2] (how I "saved" the spa has been related elsewhere[3]).

However, the case of the most blatant piece of political pressure in my professional career – and I might say its defining point - occurred about half way during my work on the project.

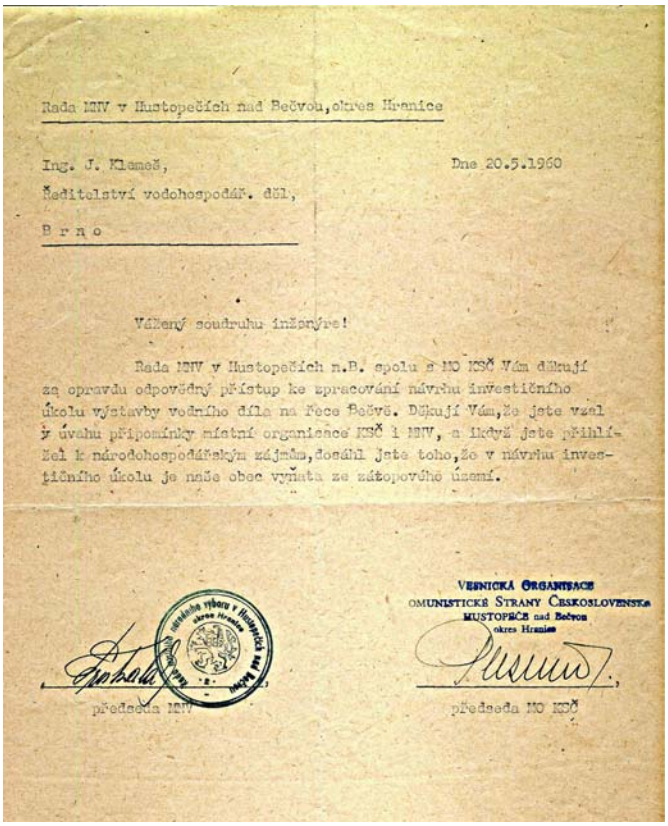
One morning, around 9 o'clock, my boss walked into my office and said
"Vít, by quarter to eleven I need the cost for the Teplice project".
It took a couple of seconds to sink in before I responded in disbelief
"But this is impossible! You know that we have eight variants on the table, don't know whether the dam will be 200 or 2,000 meters long, concrete or earth-fill ...".
"I know all that", interrupted me the boss dismissively waving his hand, "but if you don't give it to me by quarter to eleven I will have fifteen minutes to produce it myself – for at eleven I am ordered to call it to the ÚV [the Central Committee of the Communist Party] because the dam will be included into the next Five Year Plan which will be released next month".
With that he left my office.

What can one do about an impossible request like that? The command of the professional ethics is clear: Refuse to cooperate, period! But in the 1950s in the communist Czechoslovakia where people were disappearing without trace? Where the gallows, worn out by the recent "liquidation of the enemies of the people", were being diligently

repaired; where a shade of hesitation could mean "sabotaging socialism", be sent to the mines to "regain the confidence of the working class", or at best lose the job and be black-listed for any job except window washing or street sweeping? With two kids and the predictable firing and black-listing of my wife?

I made my choice: by quarter to eleven I gave my boss the figure – 713 million Czech crowns. This figure has been haunting me ever since and I made a resolution NEVER AGAIN! – which our move to Canada has made easier (though not painless) to keep.

By the way, a few years later I received this letter from the Village Council of Hustopeče, thanking me for excluding the village from the flooded area. Ironically, on its right-hand side the letter bears the stamp of the local Communist Party Council with the signature of its chairman – to my credit, this is the only positive reference ever made to my name by any Communist Party organization.



Rada MNV v Hustopečích nad Bečvou, okres Hranice

Ing. J. Klemeš, Dne 20.5.1960
Ředitelství vodohospodář. děl,
Praha

Vážený soudruhu inženýre!

Rada MNV v Hustopečích n.B. spolu s MO KSČ Vám děkují za opravdu odpovědný přístup ke zpracování návrhu investičního úkolu výstavby vodního díla na řece Bečvě. Děkují Vám, že jste vzal v úvahu připomínky místní organisace KSČ i MNV, a ikdyž jste přihlížel k národohospodářským zájmům, dosáhl jste toho, že v návrhu investičního úkolu je naše obec vyňata ze zátopového území.

předseda MNV

ZÁKLADNÍ ORGANISACE
KOMUNISTICKÉ STRANY ČESKOSLOVENSKA
HUSTOPEČE nad Bečvou
okres Hranice

předseda MO KSČ

But the Teplice dam eventually fell victim to a shift in political pressures and was never built.

Now, let us move 20 years forward, across the ocean, to a country with a different social system – the United States of America. In the wake of the increasing air and water pollution, acid rain, ozone hole, etc., there was political pressure in the 1970s to clean up the environment. To assist the authorities in this laudable task, models for environmental quality management started to proliferate. Their state of the art, summarized by a group of leading practitioners in a book, revealed a dismal picture: most of the models were based on arbitrary assumptions, inadequate data, and typically lacked any verification and validation. The book was reviewed by my old friend, Peter Rogers of Harvard, who was astonished by its findings and commented sarcastically that, rather than being applicable for the management of the hazardous toxic substances, the models themselves would be "hazardous to use for practical applications or policy decisions"[4].

And I read with a sense of *déjà vu* his observation and question I copied in this figure:

"The engineering and the scientific community are expected to perform analyses and prediction without a proper scientific base... [the decision makers] sorely need to be told the truth about models and the current lack of scientific certainty..."

...

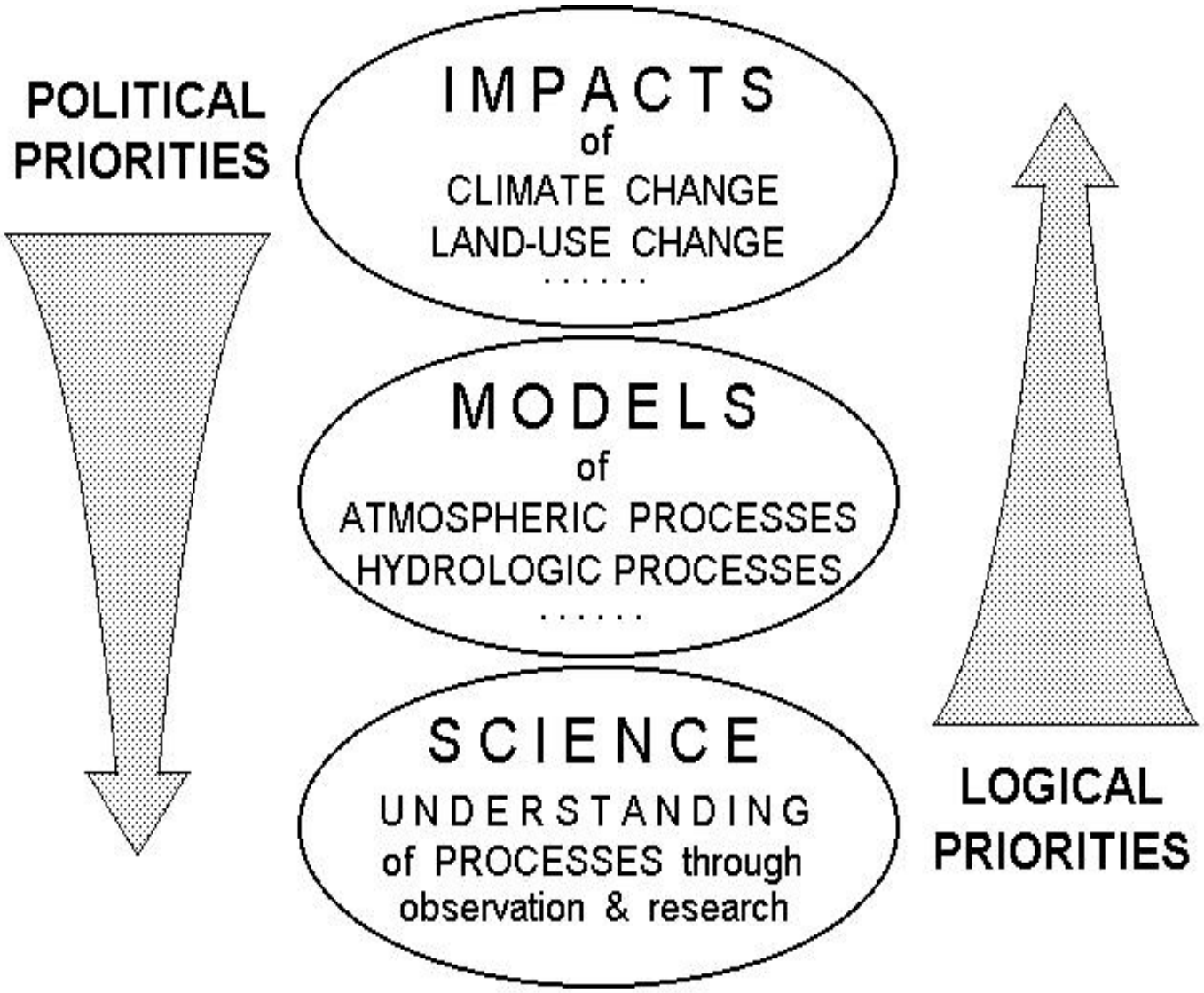
"Why did the scientific community not refuse to collaborate with requests that are patently impossible?"

Why indeed? It was not for fear of ruining their careers, being accused of sabotage or worse but, as Rogers acknowledges, in a sincere effort to help a Good Cause and "do the best they could under the situation". Nevertheless, his verdict was uncompromising: "this was a great error!". Good intentions are no excuse for compromising professional and scientific integrity because, in the end, it backfires and leads to harm instead of benefit. This of course is nothing new; the saying

The road to hell is paved with good intentions

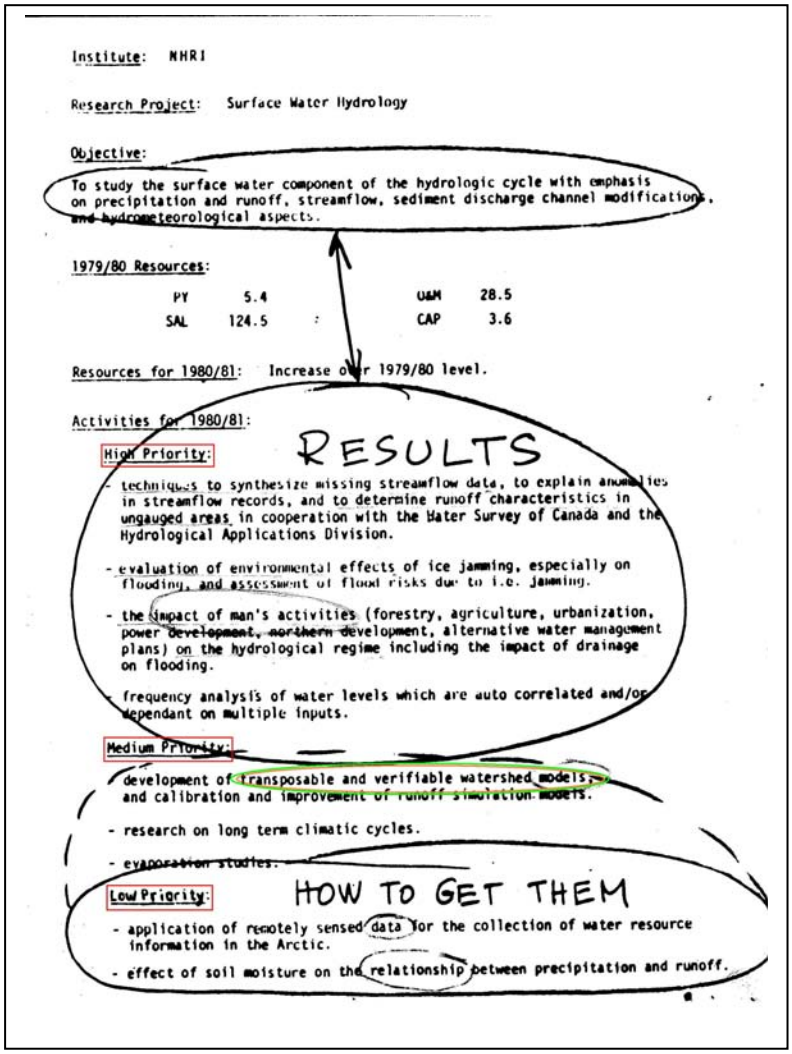
says it all. On the other hand, it is one thing to stick to high principles for a tenured Harvad Professor, and quite another for common folks in less benign situations.

Contemplating this problem, I had long ago formulated the dichotomy between politics and science as the following principle (which I have since heard being mockingly referred to as "Klemeš Law"):


POLITICAL PRIORITIES
IMPACTS
of
CLIMATE CHANGE
LAND-USE CHANGE
. . . . . .
MODELS
of
ATMOSPHERIC PROCESSES
HYDROLOGIC PROCESSES
. . . . . .
SCIENCE
UNDERSTANDING
of PROCESSES through
observation & research
LOGICAL PRIORITIES

Law or no law, I realized that this principle has a general validity which spans political regimes, continents and ages; and its dichotomy cannot be conjured away: the politician wants to know results – impacts - on which he could act (or at least pretend he would), and he is not much interested in how they have been arrived at. The scientist, on the other hand, first needs the data and understanding of a process (basic research); only on this basis a credible model can be formulated (applied science); and finally, using such model, possible impacts can be estimated or predicted (engineering).

What inspired me to formulate this 'law' was the research plan of the former National Hydrology Research Institute of Environment Canada (known as the NHRI) for the period 1979/80 reproduced here. It struck me that even in this facility, mandated to do *basic research*, RESULTS had the highest priority while HOW TO GET THEM the lowest!



Institute: NHRI

Research Project: Surface Water Hydrology

Objective:

To study the surface water component of the hydrologic cycle with emphasis on precipitation and runoff, streamflow, sediment discharge channel modifications, and hydrometeorological aspects.

1979/80 Resources:

PY	5.4	O&M	28.5
SAL	124.5	CAP	3.6

Resources for 1980/81: Increase over 1979/80 level.

Activities for 1980/81:

RESULTS

High Priority:

- techniques to synthesize missing streamflow data, to explain anomalies in streamflow records, and to determine runoff characteristics in ungauged areas in cooperation with the Water Survey of Canada and the Hydrological Applications Division.
- evaluation of environmental effects of ice jamming, especially on flooding, and assessment of flood risks due to i.e. jamming.
- the impact of man's activities (forestry, agriculture, urbanization, power development, northern development, alternative water management plans) on the hydrological regime including the impact of drainage on flooding.
- frequency analysis of water levels which are auto correlated and/or dependant on multiple inputs.

Medium Priority:

- development of transposable and verifiable watershed models; and calibration and improvement of runoff simulation models.
- research on long term climatic cycles.
- evaporation studies.

Low Priority:

HOW TO GET THEM

- application of remotely sensed data for the collection of water resource information in the Arctic.
- effect of soil moisture on the relationship between precipitation and runoff.

This example can also serve as a graphic illustration of how – even in the benign political climate of Canada - political pressures can not only raise "priorities" of a given issue, but even transform them into "prescriptions". Note that development of transposable and verifiable watershed models has a medium priority in this work plan. But, under an increased political pressure to cut government spending, and the subsequent finding of an "internal audit" that the institute was not delivering "dollar-for-dollar" value, the priority of this project shot up and became an explicit prescription (for a nominally basic research institute at that!): To develop a transposable watershed model capable of simulating and predicting river flows in the Canadian Arctic, so that stream-gaging could be discontinued there thus saving millions of dollars.

Luckily, we were not ordered to deliver the model by "quarter to eleven" but were given a generous deadline of two years! – and yes, we failed to deliver. Pity! Had we been successful, this morning's session on PUB [Prediction in Ungaged Basins] could have been cancelled and replaced by a no less rewarding excursion to the pubs of Prague.

Nowadays, our society finds itself in an era of political pressures dominated by the issue of *Climate Change Impacts* (CCI for short) and swept in a maelstrom of CCI models.

I was in the danger of being swept along in the early 1980s when the WMO [World Meteorological Organization] commissioned me to assess the results of one of the earliest studies of CCI on streamflow[5] in terms of the reliability of water supply from hypothetical reservoirs[6,7]. The study presented scenarios of impacted streamflows on two American rivers, simulated by one of the best current hydrological models for a dozen of different combinations of up-and-down changes in temperature and precipitation. Its general logic was theoretically sound but I soon realized the danger of using the methodology in real-life water management situations: practically the same danger as was to be pointed out a year later by Rogers in connection with contemporary environmental quality models: the scenarios did not reflect responses of the watersheds but merely of the mathematical algorithms of the model.

For a model itself makes no judgments: it blindly and obediently processes the imposed temperature and precipitation (and other) changes whether their combinations are physically consistent or not, whether they tell the whole story, or whether or not the model, calibrated on the historic conditions, can credibly perform under the imposed changes, i.e. whether it is "climatically transposable"[8]. I minced no words about this in my report; and the authors accepted my criticism and

admitted it helped them improve further work. With one of them we even subsequently published a realistic reassessment of the matter[9]. I have never seen this our paper cited, while the paper that I had originally criticized has become widely cited and itself became a model for a whole generation of similar models.

But, to my surprise, my 1985 WMO report caught the eye of the then Chairman of the COMMITTEE ON CLIMATIC CHANGES AND THE OCEANS who sent me a copy of his letter he had distributed to all committee members, which I am reproducing here in full:

Intergovernmental Oceanographic Commission *Scientific Committee on Oceanic Research*

COMMITTEE ON CLIMATIC CHANGES AND THE OCEAN

September 4th, 1985

All CCCO Members

Dear :

I came across a couple of sentences in a document issued by the World Climate Applications Programme called "Sensitivity of Water Resource Systems to Climate Variations" by V. Klemes, National Hydrology Research Institute,Environment Canada. The sentences are

"The modelling technology has far outstripped the level of our understanding of the physical processes being modelled. Making use of this technology then requires that the gaps in the factual knowledge be filled with assumptions which, although often appearing logical, have not been verified and may sometimes be wrong".

I rather feel that these sentences should be pinned on our walls, to remind us that there is still an awful lot of work to be done in observations, analyses and interpretation.

Yours,

R.W. Stewart
Chairman

RWS/mgn

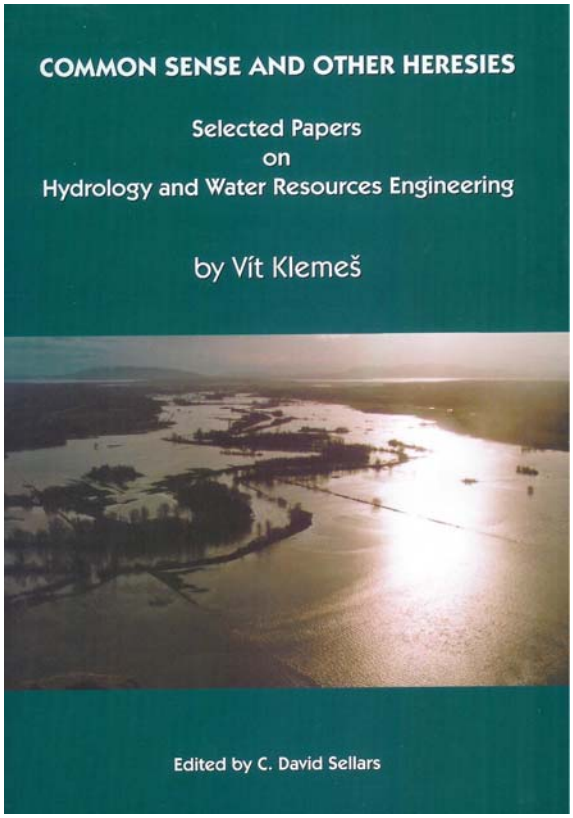
c.c. V. Klemes
P. Morel
B. Thompson

I have read your article with interest. I think you may be amused by the comment I am circulating.

Well, I surely was amused, but I never saw the quoted sentences of mine "pinned on any wall", certainly not in offices of Environment Canada. So I am taking the liberty to pin them at least on this screen, despite the inescapable reality that, with the next push of the button, they will vanish and become just an echo of a voice crying in the wilderness.

"The modelling technology has far outstripped the level of our understanding of the physical processes being modelled. Making use of this technology then requires that the gaps in the factual knowledge be filled with assumptions which, although often appearing logical, have not been verified and may sometimes be wrong".

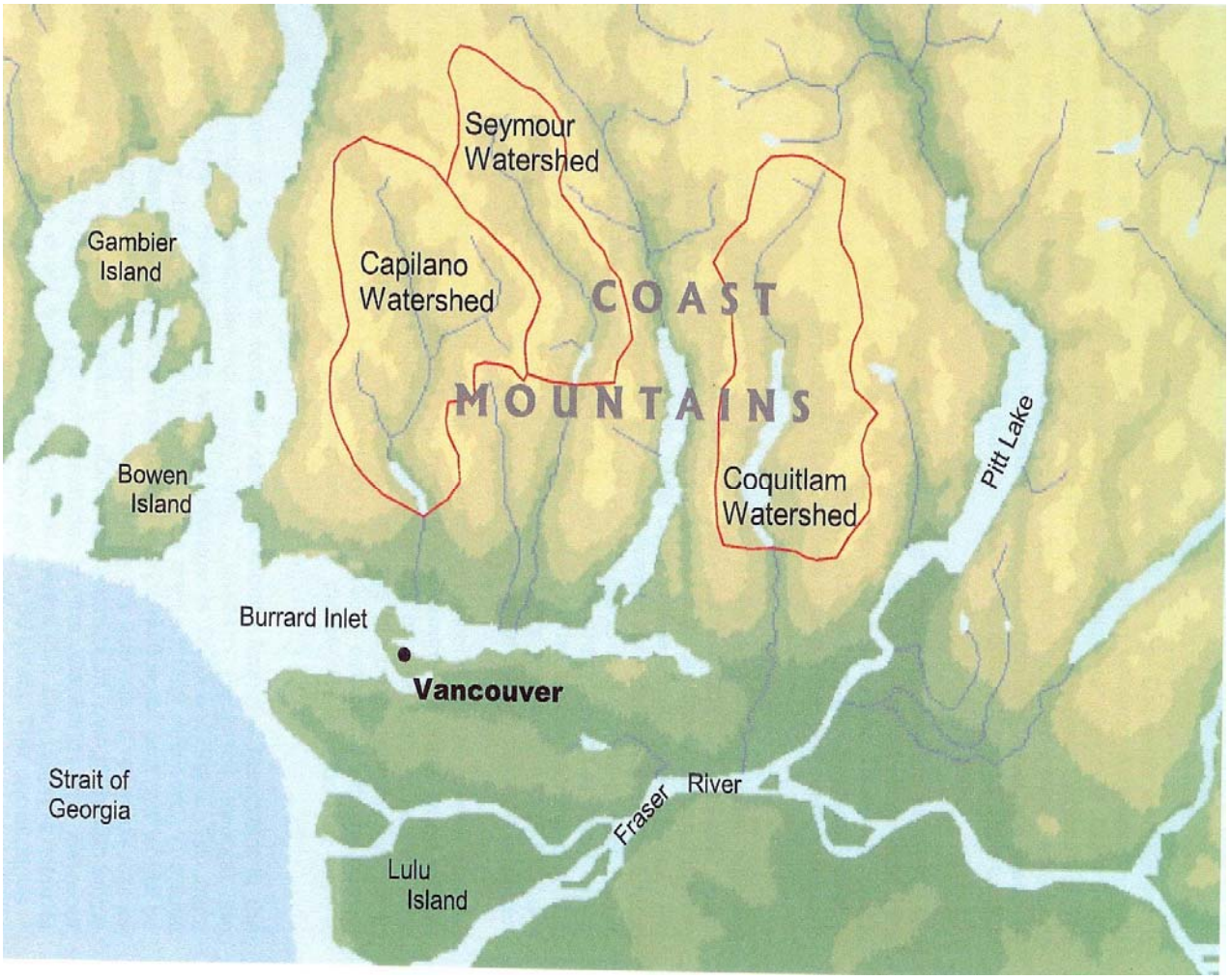
In 2001, a consultant sympathetic to my views to the extent that he had asked me for permission to publish a selection of my "heretical" papers (including three critical of the modeling of CCI on hydrology) under his editorship, obtained a lucrative contract from the Greater Vancouver Regional District for reassessment and optimization of the operation of the Vancouver water supply system[10].



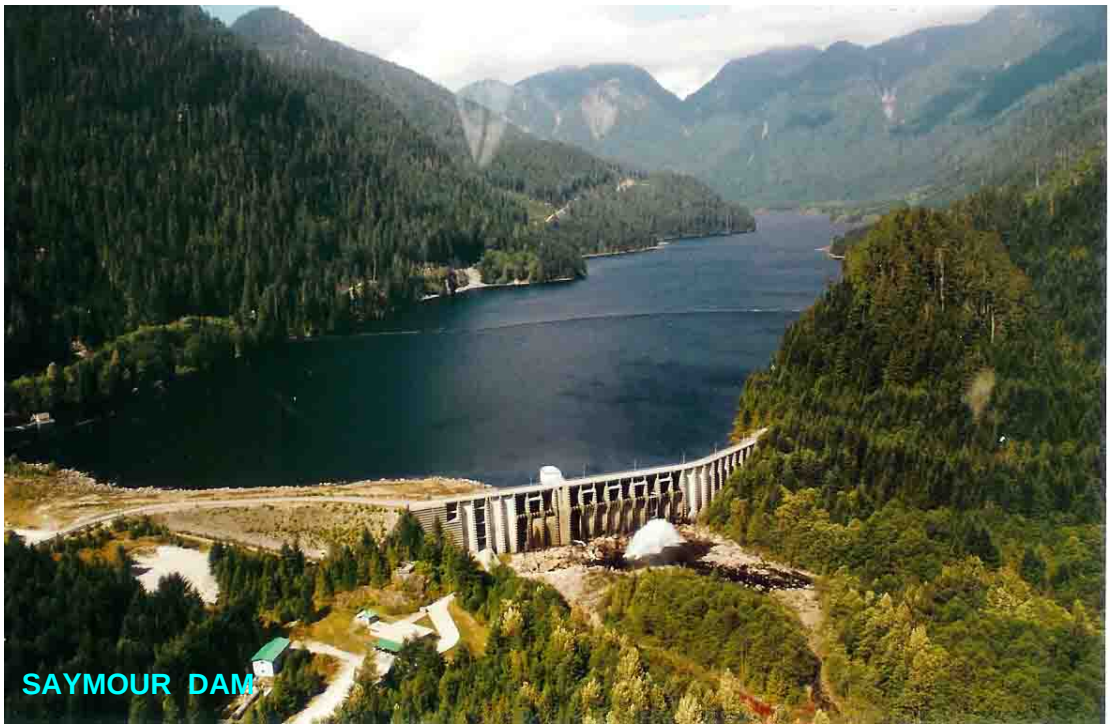
Ironically, an essential component of the study was to be – you guessed it! – assessment of the impact of climate change on the future operation of the system (in 2030 and 2050). I did not advise my friend to "refuse to collaborate" with this "patently impossible request", to use Rogers's words. After all, he was not supposed to act as a scientist but as an engineer and his professional obligations did not go beyond applying the currently available and scientifically sanctioned methods and techniques of the day. Moreover, it was clear that if he refused, many other consultants would be only too happy to step in. In

his case, while delivering the required "CCI pirouettes" to be enacted half a century later, he could at least include the necessary caveats and propose some sound specific measures to be implemented without delay; and I agreed to help him with both.

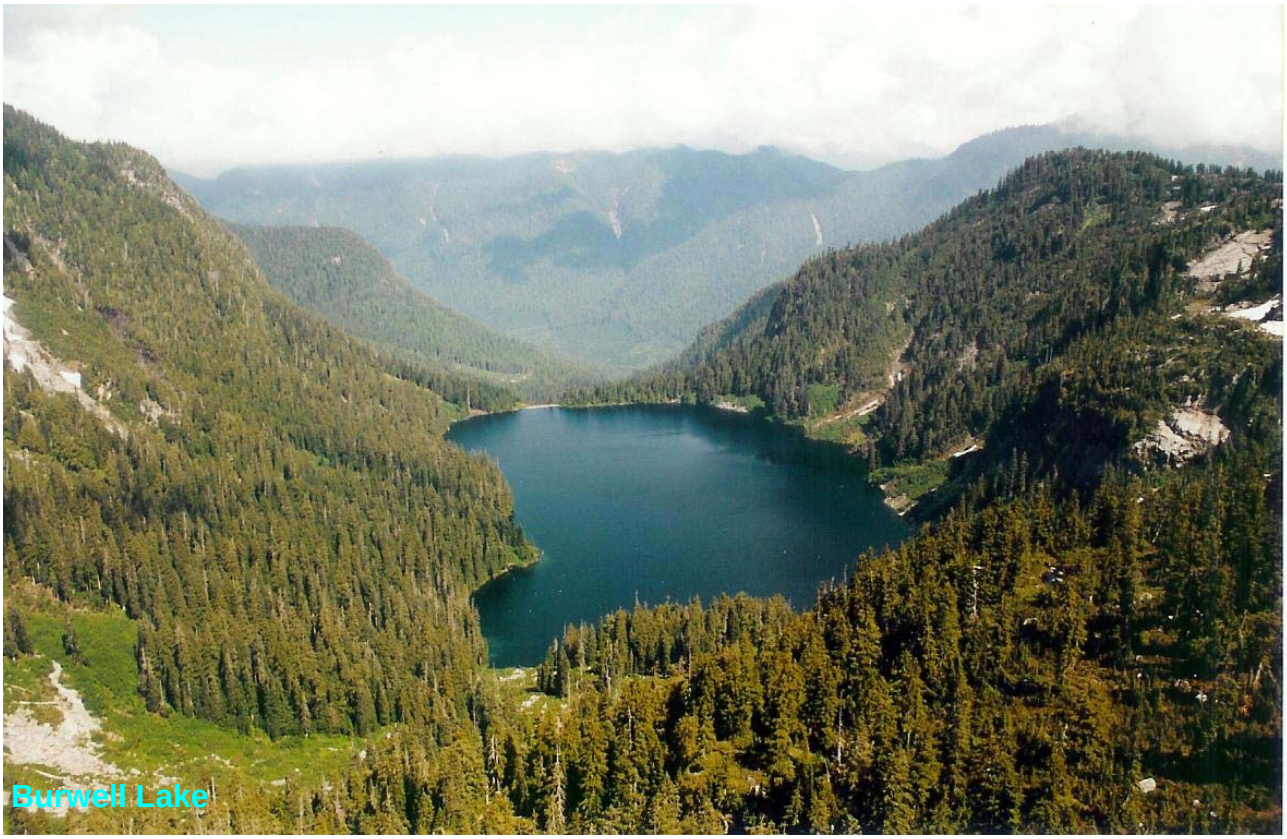
As a reward for your patience with my exhortations, and an excuse for giving you a glimpse of the natural beauty of British Columbia, I shall briefly sketch the system. Its hydrological basis are the three watersheds north of Vancouver shown on the map (c.f. ref.10).

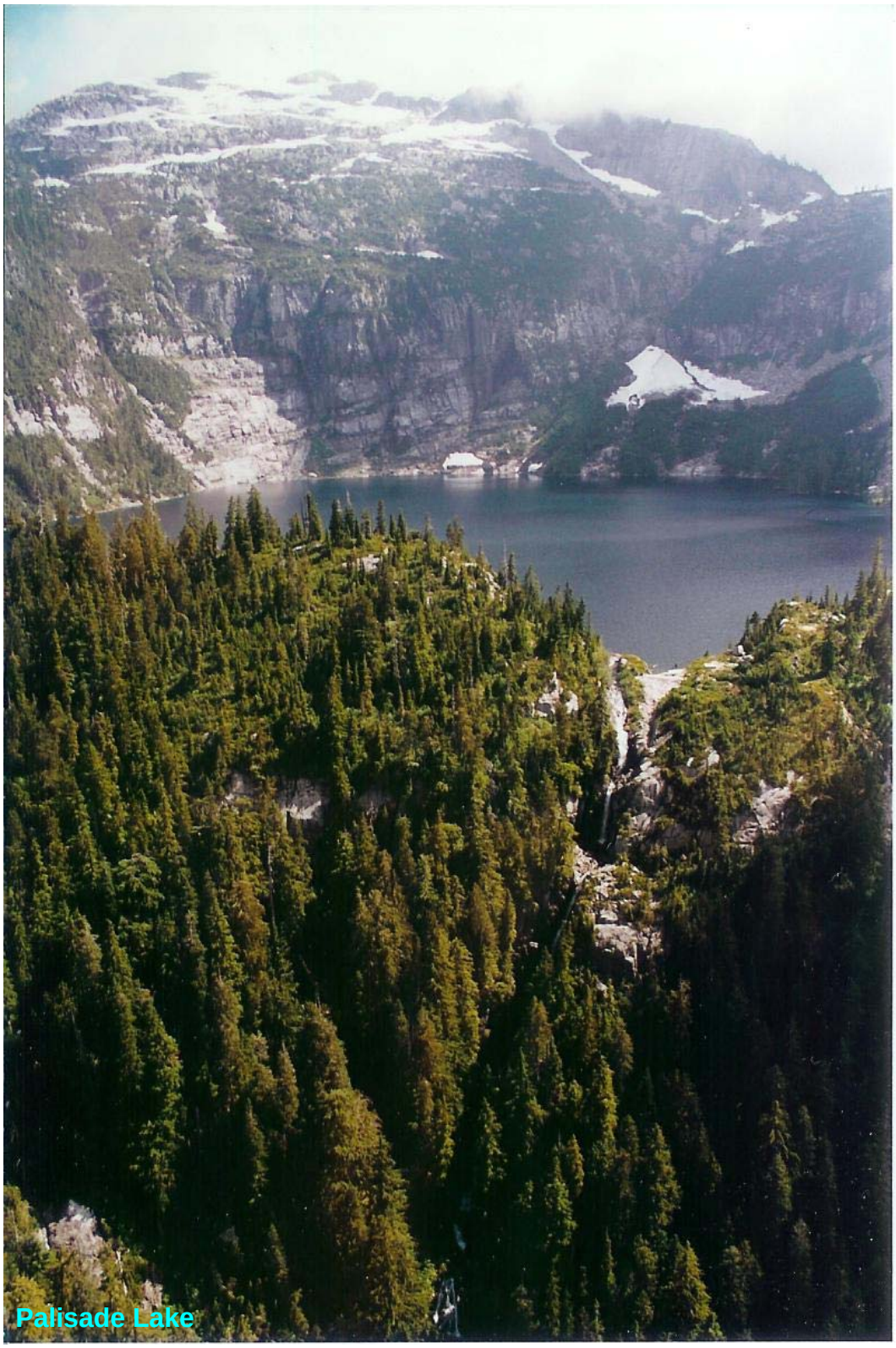


Each of them is controlled by a dam, two of which are shown below (all the following photos were shot by my fried during our helicopter reconnaissance trip).

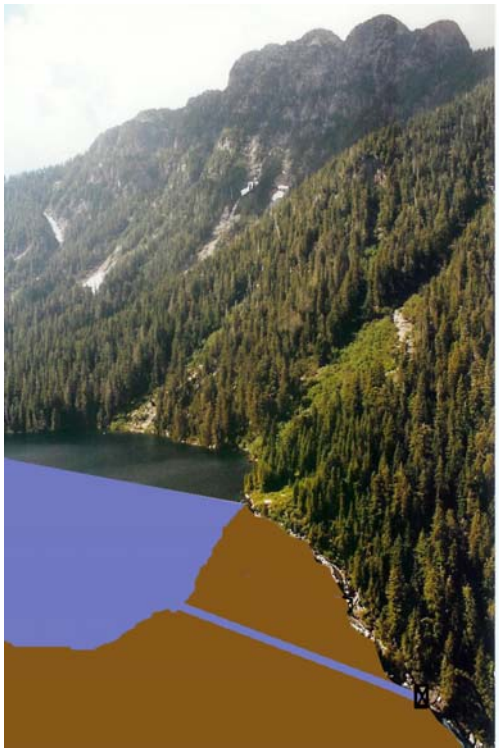


In the upper reaches of these watersheds are several so-called Alpine lakes which are quite large (each of the order of 10 million m^3) and three of them, shown below, are used to supplement water supply in dry seasons. Their natural outlets are spills at the lowest points of the rock barriers clearly visible in the pictures.

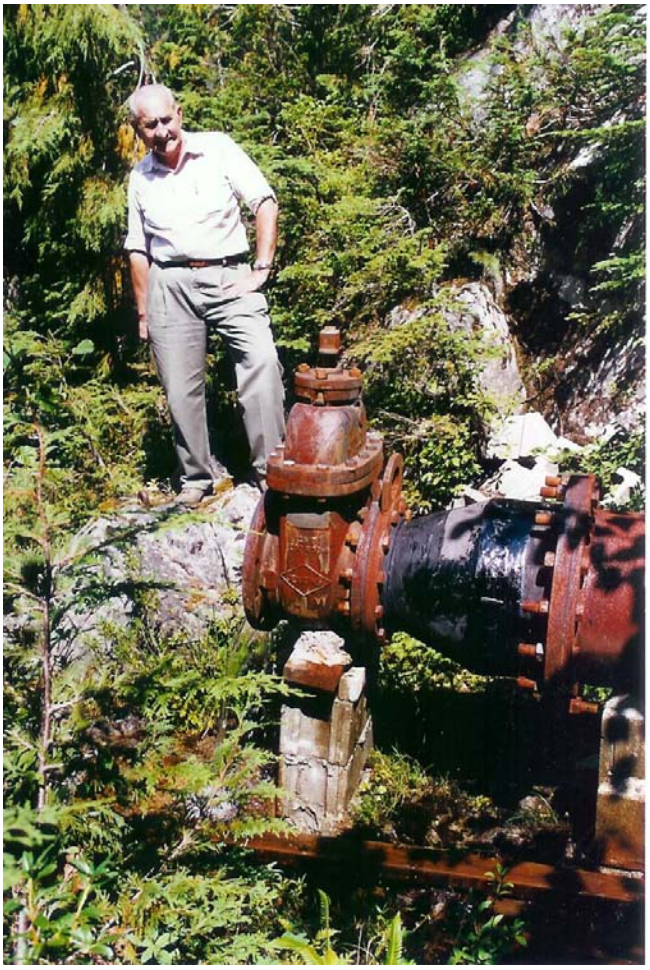

Burwell Lake

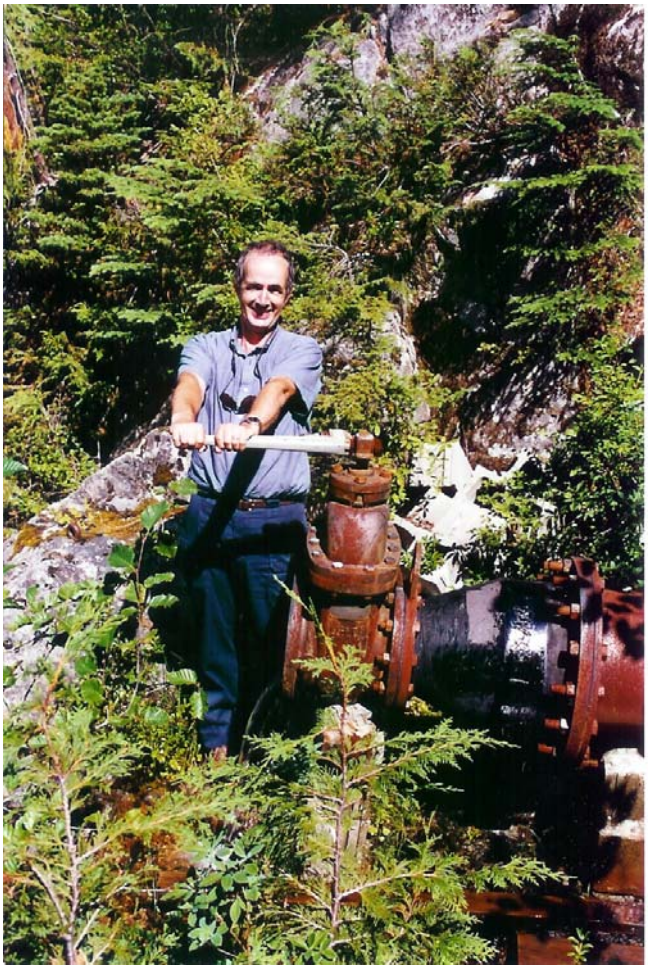

Palisade Lake

For water supply purposes they were developed in 1926 by constructing outlet works through tunnels into the lake beds to access storage below normal lake water levels as schematically shown opposite for the Burwell Lake.



Releases are made by manually-controlled valves at the tunnel outlets and, as my friend and I have found out on the spot, their operation is no child's play.





This was not surprising given the fact that the valves are operated on an closed-and-open basis; this means that they remain closed throughout the whole rainy winter season which does not enhance a smooth functioning of their mechanisms.

At this point I would like to make a few comments about the operation of the Vancouver water supply system as I understood it at the time.

Since the management was so concerned about its efficient and reliable operation 30 and 50 years in the future, one would assume that this concern would be at least as great for the present operation – and a superficial impression from the information at the commencement of the WMC study seemed to confirm this: permanent restrictions on municipal water use were in place, reliability was claimed to be close to the target level of 98%, and the performance was monitored by continually updated computer models.

But these were some of the facts behind the facade: out of the system's six reservoirs only one had a long enough (86 years at the time) continuous record of inflows adequate for a rough estimation of reliability (for all the other five the inflows had to be estimated by dubious correlations); the residential water use was not metered; leakage losses in the network were anybody's guess; water from the Alpine lakes (needed in the driest seasons) was released into the sun-scorched river beds like the one shown in the next figure, and nobody knew how much of it was lost before reaching the main reservoirs –

so that the overall water budget was a matter of a pyramid of assumptions and, with the help of the standard stochastic prestidigitations, the "reliability" could easily be "tuned" to match the desired "targets".

There apparently was no shortage of funds for the constantly to be upgraded computer hardware and software and for analyzing the never-ending supply of "scenarios" that kept busy half a dozen engineers and other analysts. In fact, the chief of this group accompanying us on the reconnaissance trip confessed that he has been so busy that this was the first opportunity during his six years on the job (if I remember correctly) to actually see the modeled watersheds "in the

flesh". But there seemed to be no funds available for - among other simple things - upgrading (replacing) the 80 years old valves with remotely-controlled hydraulic mechanisms allowing to release water only when and how much was needed (the manual "open-or-shut" operation is hardly a mark of efficiency in an age when every kid on the block has remotely-controlled toys and a satellite-driven "mobil"); for installing water meters in the city; overhauling the distribution network and fixing its leakages; for connecting the Alpine lakes outlets directly to the distribution network by a few kilometers of pipes; for installing permanent streamflow gages on inflows to all reservoirs; for establishing in the water-supply basins and their surrounding area a permanent and comprehensive observation network of all the main climate elements necessary for any credible climate modeling (the WMC study had to rely on one point of the 400 km grid on which an Environment Canada General Circulation Model was based); for ...

Well, how anybody in his right mind could propose wasting precious resources on such petty things when political pressures command their use for the noble cause of saving the planet from Climate Change? But, could it not be that the present climate-change-impact models and all sorts of Al-Gore-ithms aimed at helping this noble cause will repeat the history of the noble causes of the past, like the previously mentioned environmental quality models or the ill-fated "socialist model" meant to save the planet by imposing a "climate change" on the social fabric itself?

As for the impact of climate change on water resources, the "Vancouver case" did not surprise me – it was just one example of a situation I had sketched ten years prior to it in the closing paragraph of a short piece written on invitation of Canadian Water Resources Association[11]. Here I am reproducing its main points (with emphases added) to which I have nothing substantial to add.

... at present, the only scientifically supported information about climate change that concerns policy making in a specific geographic location can be summarized thus: **"Beware, the climate may get worse, possibly within a couple of decades or so"** (should it get better, policy makers need not worry, I suppose). This message can be readily translated into impacts on water resources, **with no need for models, scenarios, deep analyses and esoteric jargon**. It boils down to a possibility that there may be

* **less water available**
* **greater extremes and fluctuations in general**
* **less advantageous seasonal distribution of precipitation and/or runoff.**

The only feasible way of taking them into account is treating them as an increase in uncertainty in water-related decision making.

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flexible plans, robust solutions, inclusion of contingency measures into projects to cope with situations outside the range of design parameters, etc.

The current preoccupation with pseudo-scientifically constructed impacts which may or may not take place some fifty years from now ...is a very **convenient...distraction from the difficult present problems**, both **theoretical** (e.g., interactions of water within the biosphere, feedbacks across scales, predictability of extreme events) and **practical** (e.g., the wide-spread surface and ground water pollution, acid rain, soil erosion) .... **[the theorists] find it easier to play trivial scenario-generating computer games while the [managers] find these games much easier to finance ...**
And so, by a happy collusion of interests, an impression is created that "something is being done for the future" while the real problems are quietly allowed to grow through neglect of the present.

Early in this talk I mentioned Peter Rogers' warning that decision makers "sorely need to be told the truth about models and the current lack of scientific certainty". That referred to the environmental quality models and was said in 1983.

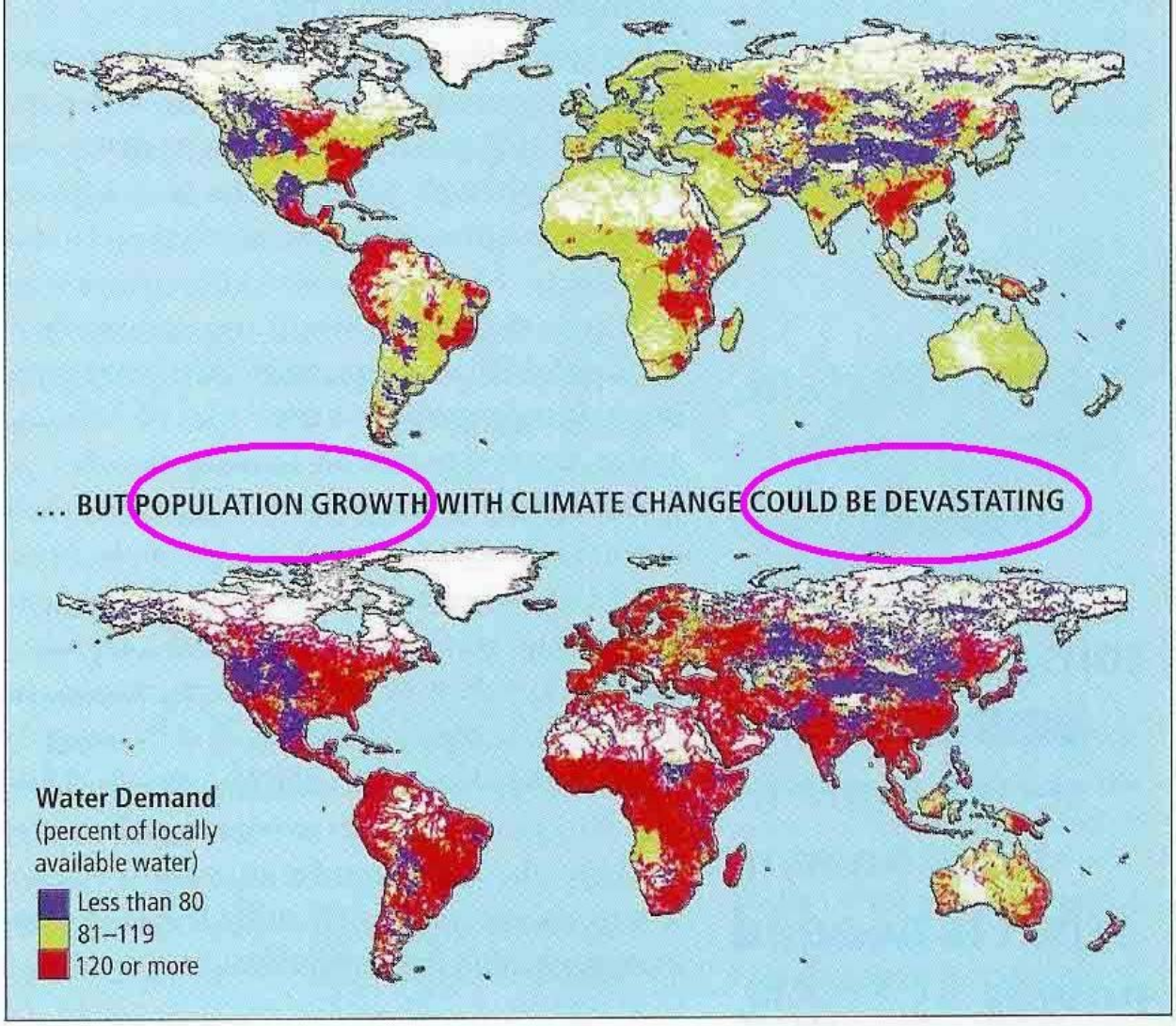
In 1985 I received a letter from his colleague, the late Myron Fiering[12], which said among other: "Peter Rogers and I are continuing to push on our campaign to re-humanize our brand of engineering, but in effect climbing on the bandwagon which you initiated some years ago".

And I would like to end with acknowledging Peter's still continuing push in the same direction, most recently in this August issue of *SCIENTIFIC AMERICAN* where he wrote an excellent article on *Facing the Freshwater Crisis*[13]. Alongside a thoughtful analysis of the problem, he proposed five simple things that *could be done right now* to mitigate against the threatening crisis. As for the future, he points out that while climate change will have a negative effect, the impact of population growth "is even more dangerous". This can be readily seen by comparing the upper world map with the lower one in his figure reproduced below (the emphases indicated by purple ellipses are mine)- it does not take much imagination to see that, even without climate change, population growth alone can cause a drastic water crisis already in about 15 years.

[A LOOMING CRISIS]

Pressure from Climate and Population Growth

Models examining the effects of climate change and of population and economic growth on water availability by 2025 indicate that climate change alone will bring scarcity to many places (*top*). Population growth, however, is even more dangerous. In the absence of concerted action to save water, the combination of population growth and climate change (*bottom*) will create scarcity far and wide.



From P. Rogers, Facing the Freshwater Crisis, Scientific American, Aug.2008

It is ironic that the same political pressures (now of a Nobel stature) that are concentrated on "saving the planet" by fighting climate change are often blocking, and even suppressing, information about the danger from population growth which can lead the planet to hell well before its salvation from climate change has a chance to materialize.

Peter Rogers's warning may be just another voice crying in the wilderness, but better a voice in the wilderness than no voice at all.

Thank you for your attention and have a pleasant stay in Prague.

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