

CANADIAN PARTICIPATION IN THE INTERNATIONAL HYDROLOGICAL DECADE

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Introduction

Hydrological research in Canada has been somewhat neglected, until recently, because of the apparent tremendous abundance of available water in its various forms. It must be remembered that 90 percent of our population lives within 200 miles of our southern border while 60 percent of our surface water flows northward and therefore is not readily available to present demand centres. Hydrology is now emerging as a science in its own right to provide the answers to problems raised by this contrasting distribution of people and water.

Interest in hydrology on a world-wide scale has received similar stimulation by the research programs of the 97 member states participating in the UNESCO sponsored International Hydrological Decade. The 10-year period was selected in recognition of the tremendous amount of work required to bring this science abreast of current needs. Sufficient time had to be allowed not only for expansion of hydrometeorological networks and gathering of a wide variety of other hydrological data but also for upgrading of educational facilities to provide the people required to do the research based on the data collected.

Canadian efforts in this international venture are coordinated by a 26-man National Committee, under the leadership of Major General H. A. Young, composed of: representatives of the ten provincial water agencies; technical specialists from seven of Canada's leading universities; senior executives from four major research and data collecting agencies of the federal government; a representative from the National Research Council; the Secretary-General of the Canadian Council of Resource Ministers; and the Secretary-General of the Canadian National Commission for UNESCO. This level of coordination makes possible a comprehensive program which can be practically carried to fruition. A full time Secretariat has been established in Ottawa to handle the day-to-day administration of the national program. Each provincial representative has a similar committee to assist him in organizing and coordinating the provincial IHD program.

Status of the Canadian Program

Prior to commencement of the Decade period, the Coordinating Council suggested, for ease of future reference and discussion of program segments, that national programs be reported under the self-explanatory headings of: basic data; inventories and water balance; research; exchange of information; and education and training. Canadian studies are underway in each of these sections and the national program has evolved to include 185 projects which collectively will examine in detail all aspects of the hydrologic cycle. However, the diversity of these studies is too great for complete description at this time, and, therefore, a generalized description of the Canadian Program will be given in very broad terms under the headings of: basin studies; groundwater studies; lake studies; studies of the influence of man's activities;

snow, ice and glacier studies; and programs insuring effective exchange of information. Emphasis is placed on snow and ice studies involved in each of these categories. A report on the status of all Canadian IHD projects entitled "Canadian Program, 1967" is now completed and copies are available for limited distribution.

Basin Studies

Representative, experimental, and benchmark basins represent major centers of activity in the Canadian IHD program. Representative basins (34 presently active) are situated in typical areas of the country where natural conditions are expected to remain comparatively stable for long periods of time. By intensive data collection and studies within these natural laboratories, knowledge of the behavior of water under actual field conditions is increased and models are developed that can be used to predict conditions in similar areas with a minimum investment in labor and instruments. Also they provide ideal sites for related studies requiring the same background knowledge. Experimental basins (11 presently active) are similarly chosen to be representative of some particular conditions and are even more intensively studied and instrumented. The difference arises in that some manipulation of the cover of the basin will be undertaken in order to evaluate the hydrologic effect of man's activities. Benchmark basins (14 proposed) are being chosen in areas where there will be an absolute minimum of man made change. In these the major hydrological parameters will be recorded in perpetuity to provide data on long term changes.

To assist the sponsors of basin projects to plan, organize and implement research investigations, the Canadian National Committee has published "Guide Lines for Research Basin Studies". This forty-four page report, which summarizes the proceedings of a national seminar on this subject, outlines the minimum instrumentation and study program which it is felt should evolve over the initial years of any research basin.

Canada's research basins have been chosen to be representative of the major different hydrological regimes from the humid west coast and the highly variable Cordilleran belt through the semi-arid Prairies to the humid continental and maritime areas in the east and north to the arid Arctic islands. With a considerable portion of the precipitation falling as snow, studies of how this accumulates and melts are an essential part of every basin study. The intensity and emphasis of snow studies varies with the requirements. For example, snow is a minor importance in the Nicomekl-Serpentine basin south of Vancouver, B. C., but in the North Nashwaaksis basin near Fredericton, N. B., the snow melt process is the major objective of the study.

Groundwater Studies

Emphasis in this component of the hydrologic cycle, at this point in time, is on methods and techniques to determine the groundwater flow systems and to relate these to both their geologic and hydrologic environments. Groundwater projects in the Canadian program deal with various topics such as: inventories, tritium dating, reconnaissance methods, geophysical techniques and equipment (seismic, gravimetric and electromagnetic) for both land and airborne operations to locate and delineate aquifers, hydrogeochemical studies,

computer techniques, the application of these techniques to flow system studies, and detailed studies of various types in research basins.

Both soil moisture and groundwater studies have shown that there can be infiltration and recharge beneath snow packs even before the main snow melt period and an understanding of this process is of particular importance, for prediction of soil moisture on the Prairies and for prediction of runoff and flood forecasting.

Lake Studies

Lakes are uniquely difficult to deal with, hydrologically speaking, because precipitation on and evaporation from large water surfaces cannot be measured accurately using present techniques. Increased knowledge of Canada's numerous lakes is being sought by such studies as: an area inventory of fresh water lakes, thermal regime of large lakes, energy budget techniques for evaporation and ice formation on the Great Lakes, and a chemical energy budget of a small lake in British Columbia. One project which might be of particular interest to this group is the use of airborne radiation thermometers to gather quantitative information on surface water temperatures and ice conditions on a number of northern Canadian lakes. It is anticipated that this information will prove useful in improving estimates of freeze-up and break-up dates, evaporation and heat fluxes and will assist in evaluating the water volume of lakes. Airborne infra-red scanning devices are also being used to provide qualitative information on lake currents and groundwater inflow.

Canada is also participating with the United States in a highly complex study - the International Field Year on the Great Lakes - which will investigate through an integrated and fully coordinated group of research programs a number of basic unsolved, or only partially solved, physical problems associated with the hydrology, meteorology, physical limnology and geology of Lake Ontario and its drainage basin. The joint U. S.-Canadian Coordinating Committee has set up four working groups to organize the program under the following headings: Working Group on Energy Balance, Working Group on Terrestrial Water Budget, Working Group on Water Movement and Working Group on Lake Meteorology. Planning is proposed for 1967-68; instrument and personnel procurement for 1969; the field year from April 1, 1970, to September 31, 1971; and analyses and study reports from 1971-72.

Influence of Man's Activities

The effects of water management projects on natural environment and conditions may vary according to the nature and size of a project, but they are usually sufficient to require taking into account when the project is being designed. Research into the effects of changes in land use on related hydrologic parameters is the prime object of all experimental basin studies. Other related subjects being studied in this area are: the hydrology of tile drained areas; effects of variable releases from a large reservoir (Gardiner Dam, Saskatchewan) on ice formation, breakup and jamming; effects of water table changes in irrigated areas; and effects on the thermal regime of an aquifer from warm water return flows.

Perhaps one of the greatest effects of man's activities on the hydrologic cycle is his ability to change the rate of snow melt by removing the cover. Studies of this problem involve a major part of the program in 8 research basins.

Snow, Ice and Glaciers

As development of Canada moves north, it is hindered by a lack of data on, and understanding of, such subjects as: snow, ice, glaciers, and permafrost as they effect agriculture, navigation, water supply, sewage disposal, highway construction, etc. Over 50 percent of Canada has mean annual temperatures below 32°F and over 50 percent of Canada's land area is underlain by permafrost. In addition, approximately 60 percent of our surface waters flow northward and hence are subject to extended periods of ice cover and nearly all the remainder have some form of ice problem.

The location and titles of the IHD projects involved with snow and ice studies are shown on the map and list at the end of the paper. Research basins have been included, as snow course surveys and snowmelt calculations must be done to arrive at an overall water balance. Plot and basin studies of the time distribution of snowmelt and subsequent streamflow, in addition to infiltration characteristics of frozen soil and soil moisture migration in a freeze-thaw cycle under shallow snow packs, have commenced and will provide insight into the relative effects of these parameters on winter and spring runoff. Information is being sought on the fundamentals of surface and frazil ice formation and breakup, and on improving operating procedures for regulation projects.

One interesting project being carried out by the Meteorological Branch of the Department of Transport is that of evaluating weather satellite data for hydrologic purposes. Satellite photographs cannot only delineate cloud patterns, but can also show ice cover on large water bodies and snow cover on large basins. The use of satellite snow cover photographs to improve forecasts of spring runoff will be studied. Closely connected with this type of study is the mountain transect project being studied on Vancouver Island. This is a study of the variation of precipitation across a mountain range and obviously the upper portions of this must consider all the problems involved in studying the water content of deep snow packs.

Another large undertaking in the Canadian program is the inventory of Canada's ice fields. Initial inventory studies have shown that there are 79,000 square miles of glaciers but considerably more work is required before it will be possible to give a figure for the volume or the changes. As well as this national inventory, there are several projects in the Northwest Territories, on Baffin, Axel Heiberg and Ellesmere Islands, and five glacier basin studies in the Western Cordillera in which mass balance studies are being conducted. All of these glacier studies are included in the three international globe circling glacier chains. One of these runs from Alaska to South America and the other two circle the globe at approximately 50°N and 66°N.

Exchange of Information

The objective of the IHD is to increase knowledge in all aspects of the hydrologic cycle; completion of the various research projects themselves is only a first step along the way. As important as the sponsorship of hydro-

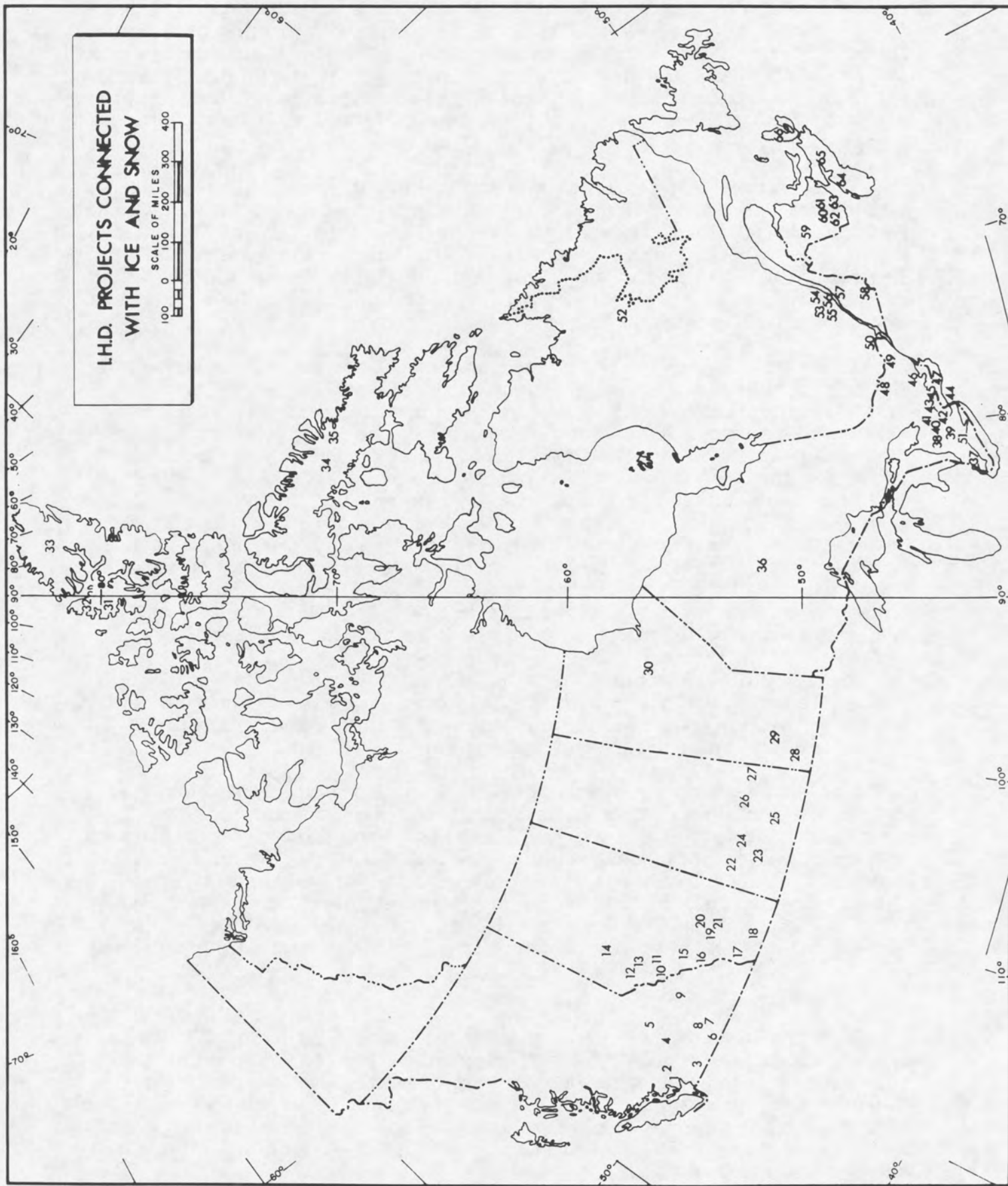
IHD Projects Involving Snow and Ice

1. Sentinel Glacier - Representative Basin
2. Place Glacier - Representative Basin
3. Militza Lake - Experimental Basin
4. Analysis of Trend of Regional Snowline from B. C. Coast to Eastern Rocky Mountains
5. Bonaparte Basin - Representative Basin
6. Mount Kobau - Representative Basin
7. Okanagan Basin - Representative Basin
8. Trapping Creek - Representative Basin
9. Woolsey Glacier - Representative Basin
10. Peyto Glacier - Representative Basin
11. Ram River Glacier - Representative Basin
12. Cache Percotte - Experimental Basin
13. Tri Creek - Experimental Basin
14. Spring Creek - Experimental Basin
15. Deer Creek - Experimental Basin
16. Marmot Creek - Experimental Basin
17. Streeter Creek - Experimental Basin
18. Irrigated Basin - Experimental Basin
19. Threehills - Representative Basin
20. Ghostpine - Representative Basin
21. Kneehills - Representative Basin
22. Bad Lake - Representative Basin
23. Evaporation and Transpiration from Crop, Soil and Snow Surfaces
24. Effect of Variable Releases from a Large Reservoir in Winter on Ice Formation, Breakup and Jamming
25. Magnitude and Frequency of Prairie Snowpack Accumulation
26. Quill Lake - Representative Basin
27. Good Spirit Lake - Representative Basin
28. Oak River - Representative Basin
29. Wilson Creek - Experimental Basin
30. Little Kettle Lake - Representative Basin
31. Glacier Mass Balance
32. Assessment of Ice Masses of Axel Heiberg Island
33. Glacier Mass Balance
34. Barnes Ice Cap Studies
35. Decade Glacier - Representative Basin
36. Surface Temperature and Ice Formation on Northern Lakes
37. Merlin Basin - Representative Basin
38. Monkton Basin - Representative Basin
39. Evapotranspiration from Vegetated Areas and Snow Surfaces
40. Speedvale Basin - Experimental Basin
41. Blue Spring Creek - Representative Basin
42. Oakville Creek - Representative Basin

References

- J. P. Bruce (1966), Weather and Water, Canadian Geographical Journal, Vol. LXXII, No. 1.
- R. H. Clark, J. F. Fulton (1966), The Canadian IHD Program, Proceedings of the Western Snow Conference, April, 1966.

Canadian National Committee for the International Hydrological Decade (1967), Canadian Program 1967.



logical studies is, so is the establishing of means to facilitate communications between researchers in different areas of the country and to distribute technical information to interested personnel in the scientific and development fields. To ensure that all researchers appreciate this, the Canadian National Committee has directed that one of the requirements for projects accepted in the IHD program is that all data collected must be maintained in open files.

To assist workers in all parts of the country to know what research studies are being undertaken and what data are being collected, the Canadian National Committee publishes from time to time a report on the Canadian program (i.e., "Canadian Program - 1967"). Also, a semi-annual bilingual Newsbulletin is distributed free; this highlights national and international activities of the IHD and lists symposia, technical publications and other news of particular interest to hydrologists.

Four week long Familiarization Seminars, sponsored by the Canadian National Committee, provide an opportunity for workers trained in diverse disciplines related to hydrology to gain a common understanding of the science of hydrology. Two such seminars have been held, one at Saskatoon, Saskatchewan, 1966, and one at Guelph, Ontario, 1967; with one more scheduled for this summer at Halifax, Nova Scotia. Workshop Seminars, of 2 or 3-days duration, are held every spring and fall of the Decade dealing with each of the major components of the hydrologic cycle. The CNC publication "Guide Lines for Research Basin Studies" evolved from one such seminar held in Ottawa, Ontario, in January 1966. Two workshop seminars which might be of interest to this group are: Ice Formation and Breakup in Lakes and Rivers, held in Quebec City in November 1966; and Snowmelt Hydrology, being held in Fredericton, New Brunswick, this February.

The Canadian National Committee has established a Standing Lecture Committee which arranges for foreign hydrologists to visit Canadian centres to see our activities and lecture on technical subjects and on the organization and administration of their water resource agencies.

As well as meeting national needs for the communication of ideas and the exchange of data, Canada, as a member of the Coordinating Council, is cooperating internationally with UNESCO in the provision of technical data on representative and experimental basins, on sediment programs, on monthly flows at Canada's 68 Decade stations, and on monthly measurements of the tritium content of six of Canada's largest rivers. Also, in cooperation with UNESCO, the National Film Board of Canada has prepared a documentary film on water, Element 3, for distribution to states participating in the IHD.

Conclusion

Progress in Canadian hydrology has been greatly stimulated by the advent of the IHD. It has brought to the forefront the need for increased numbers of specialists needed in the various aspects of hydrology. While it is hoped that Canada can contribute much to the success of the IHD which will be of benefit to Canadian and international hydrologists alike, we expect to reap benefits far beyond those due to our own efforts from the many projects being carried out by other member states.