Environment Canada

Environnement Canada

Canada Centre For Inland Waters

Centre Canadien Des Eaux Intérieures

ENVIRONMENT CANADA DOCUMENT

ON

PARTICIPATION IN PALEOCLIMATOLOGY: A CANADIAN INVOLVEMENT

UNPUBLISHED REPORT
RAPPORT NON PUBLIÉ

Prepared by: Environment Canada
Environmental Management Service
Atmospheric Environment Service

Date: November, 1975

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SERVICE GOALS

The Goal of Environment Canada (Environmental Management Service and Atmospheric Environment Service) relative to national and international Paleoclimatology should be (1) to develop techniques whereby it will be possible to (2) provide data of sufficient quality which (3) will allow for the quantitative documentation of past climates as required to meet service and departmental programs and objectives of the future in some of the following areas, including those as outlined in the EMS Green Paper: food production (see Appendix I), shelter, mineral resource development, transportation, employment, population displacement, and ecosystems. (4) To develop a continuing liaison between other Services (for example EMS already has a liaison with F & MS) within the department as well as with other departments within the Federal Government (O&AS, EMR, Ag.). The studies are to concentrate on the Holocene time interval (last 10,000 years).

In the following documentation reference and implication is made which may imply a possible deterioration in climatic regime. This viewpoint is used to illustrate why research, of the nature proposed, is important, and to indicate the possible extent and ramifications implicit in climatic deterioration.

It is well recognized, however, that there is no solid proof that climatic deterioration will take place within the immediate or foreseeable future. There exists, instead, a body of qualitative - interpretive material suggestive of a changing global climatic regime which would possibly result in deteriorating conditions for much of Canada.

We are therefore faced with a number of possible climatic "scenarios".

1) No essential change from the present.
2) Essentially the same general climatic regime but with greater variability and frequency of extremes.
3) A trend towards a warmer climate.
4) A trend towards a cooler climate.

(Although climatic change is expressed here by temperature change it must be recognized that rainfall, cloud cover, wind field and other factors will similarly respond).

It is considered that a trend towards a cooler climate may represent the most unfavourable development; however, any other forms of change may also lead (both regionally and locally) to significantly less favourable conditions.

In such light, therefore, the paleoenvironmental research proposed will incorporate consideration of all such possible situations. One should bear in mind, also, that even data strongly supportive of the continuation of existing conditions will be of major importance in planning the future development of this country.

PROGRAM GOALS

1. Environmental Management Service
   Inland Waters Directorate
   Canada Centre for Inland Waters
   Process Research Division
   Paleoenvironmental Research Section

   A. To develop a "quantitative" paleoclimatic interpretive system using fossil shelled invertebrates (ostracodes - freshwater seed shrimp, molluscs - freshwater snails, clams and terrestrial snails). See Appendix II.

   B. With the implimentation of an effective paleoclimatic interpretative technique EMS will determine paleoclimatic data from fossil shelled invertebrates obtained from cores retrieved from selected lakes or ponds throughout Canada. Each core site will then become a point source meteorological station for time series analyses of selected climatic parameters.

C. To develop interaction with other groups within EMS. To expand existing cooperative research programs with other groups within EMS, such as the Glaciology Division, Water Resources Branch and their studies of Baffin Island and the Penny Ice Cap.

D. To utilize paleoclimatic and paleolimnologic knowledge as it relates to our fundamental knowledge about the development of lakes and lake processes, the availability of nutrients and their natural aging processes.

E. To exploit paleoclimatic knowledge as it relates to social and demographic impact of climatic change which could radically alter our water use and protected land use development.

2. Atmospheric Environment Service

Atmospheric Research Directorate
Atmospheric Processes Research Branch

Central Service Directorate
Meteorological Applications Branch

A. To determine the grid size or spacing of paleo sampling network that is required by related meteorological program.

B. To determine the climatic parameters needed to provide an optimal paleoclimatic interpretation based upon different spatial and time references.

C. To collaborate in the exploitation of meteorological data files for use by EMS in their quantitative interpretive system.

D. To exploit paleoclimatic knowledge in the development of climatic models, in the evaluation of the effect of prehistoric events on man and the environment, and in the development of prediction techniques.

3. Combined AES and EMS Goals

A. To utilize paleoclimatic data to help understand the Milankovich astronomical theory and to uncouple the CO_2 - particulate matter theories relative to their effect on the development of prediction techniques.

B. To compare and correlate proxy information derived from glacial continental, marine, and ice core data obtained from national and international sources such as: WMO, WHO, Lamont, Institute of Arctic and Alpine Research (U.S.A.), Lake Biwa studies (Kyoto University).

4. Schedule

Recent consideration of 1977/78 "B" budgets by EMS and support in receiving resource "approval" for paleoclimatology, indicates strong favour of such a program by senior levels of management. For this reason, the following schedule is provided.

Year I

EMS

1) Development work on the paleoclimatic interpretive system.
2) To expand existing cooperation research programs within EMS as well as other institutes within Canada and the U.S.A.

AES

1) Determine the grid size of the core sampling network.
2) Determine the climatic parameters needed to provide optimal paleoclimatic interpretations.
3) To collaborate in the exploitation of meteorological data files.

Year II

EMS

1) Testing the paleoclimatic interpretive system.
2) Initiate the collection of cores.
3) Development of a spatial-time model for deducing paleoclimatic parameters.

AES

1) Assessing the results obtained from the testing of the paleoclimatic interpretive system.

Year III to X

EMS

1) Collection of, analyses, and interpretation of cores.
2) Testing and using the spatial-time model.

AES

1) Assessing the results obtained from the testing of the spatial-time model.
2) To develop prediction techniques and models using climatic proxy data.

APPENDIX I

Ecosystems - e.g. The members of a biological community react with the physical and chemical features of the environment. If through a change in climate, either physical and/or chemical features of the environment change, then there is a great likelihood that some members of the community will change either by addition of new members, displacement of existing members, and/or local extinction. The size of the organism or its intellectual capacity is of no importance in this system save its elasticity or capacity to change. Environment Canada's role here is to be able to predict changes which may take place in the environments which may effect the ecosystems.

Population displacement - e.g. A possible deterioration of the Canadian climate in the future could effect food production, shelter, mineral resource development, and energy availability and could have the combined effect of eventually displacing the population to the southern regions of Canada. The migration of people for such reasons would place a gradual but tremendous strain on resource utilization, shelter and employment. The role of Environment Canada is to be able to predict changes which may take place in the environment of the future which may affect population displacement.

Food production - e.g. Deterioration of the Canadian climate will force existing marginal producing lands out of production (e.g. a drop of $3^{o}C$ in mean annual temperature would allow only 20 to 33 percent of existing agricultural areas to produce food), in those areas where many types of crops are grown, e.g. Niagara Peninsula, there could be a decrease from 90 to 9 crops with a decrease in mean annual temperature of $2^{o}C$. Environment Canada's role here is to be able to predict changes which may take place in the environments of the future which may affect food production and land utilization. Conversely climatic changes which might bring about an increase in temperature (or other effects) would raise other but equally important problems.

Shelter - e.g. Many of the existing buildings in Canada are built for the climate of today. Continuous declines in the mean annual temperatures (through longer winters) would make these buildings inadequate. The advent of permafrost developing further south from its existing position would seriously affect services to existing buildings. The role of Environment Canada is to be able to predict changes which may take place in the environments of the future which may affect shelter and construction procedures not only of new buildings, but also existing buildings.

Mineral resource development - e.g. The development and exploration of mineral resources will be greatly affected by permafrost caused by decreasing mean annual temperatures. e.g. Development of the tar sands; the Athabasca tar sands are located some 50 miles south of the permafrost limit, a decrease of $3^{o}C$ would place the tar sands in the "widespread permafrost" zone with permafrost thicknesses varying from 40 to 900 feet. The technology for excavating the tar sands from permafrost would be much different than at present. Environment Canada's role in this area is to be able to predict changes which may take place in the environments of the future which may affect the development and exploration of mineral resources.

Energy - e.g. The bulk of the electrical energy produced in Canada at the present time is from hydroelectrical sources. Not only would the deterioration of temperatures affect the construction of hydroelectrical dams, but the duration and thickness of ice cover would seriously affect the efficient production of hydroelectric power. Simultaneous decreases in precipitation would also affect the dam's efficiency. The mining and transportation of uranium ores for use as an energy source would also be affected. The role of Environment Canada in this area is to be able to predict changes which may take place in the environments of the future which may affect the development of energy sources.

APPENDIX II

Quantitative interpretation here refers to a numerical interpretation based on factual knowledge of where, why, and how the modern represent-

ative of the organism lives; qualitative interpretations are based on intuitive knowledge rather than on factual knowledge of where an organism lives.

For example, a paper recently submitted for publication by Delorme et al. shows that in the northwest corner of the Northwest Territories near Sans Sault Rapids, the mean annual temperature around 6800 years ago was 1.2°C as compared to -7.0°C at the present time, annual precipitation was 18.7 inches (475 mm) as compared to 15.7 inches (400 mm) at the present time, the potential evapotranspiration was 20.6 inches (525 mm) as compared to 18.9 inches (480 mm) at the present time, the mean summer temperature was 15.1°C as compared to 14.5°C at the present time. All of the interpreted values have been derived from field data collected by the authors on shelled organisms which are living today in various parts of Canada, and applied to the same fossil organisms obtained from the sediments deposited near San Sault Rapids, N.W.T. A study conducted by Ritchie and Hare (1971), near Inuvik, N.W.T., gives an estimated increase in the mean summer temperature during the same period of time, as mentioned in the previous study, at about 5°C higher than at present based on their recovery of fossil pollen and spores. Their interpretation is not based on factual knowledge of the mean summer temperature for the fossil plant species involved but rather a qualitative estimate based on intuition.

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