<u>Snow in Education or Vice Versa</u>

by

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<u>Abstract</u>

Snow, both in the air and on the ground, is an environmental phenomenon of great popular interest and importance. As an easily available material which reacts quickly and visibly to changes in its environment, it is a unique medium for demonstration, experimentation and observation in various subject areas taught in schools and universities, some entirely unrelated to snow itself. Some work is being undertaken to develop the potential of snow in education in Ontario. Progress will be reported.

Many professional associations are now taking a serious interest in the dissemination of knowledge from their area of competence to the public at large and throughout the various levels of the formal educational system. Their motives for doing this are at the same time altruistic and selfish--they see it as their duty to pass on the special experience which they have gained and they see the passing-on process as a part of a continuous effort to raise the level of competence of their profession.

The common interest of the members of the Eastern Snow Conference is a phenomenon, snow. This phenomenon is studied through the methodologies of an unusually wide variety of academic disciplines and forms a basis of the work undertaken by a wide variety of professions (especially branches of engineering). A measure of the diversity of interests in snow can be obtained by considering some of the common aspects of snow which are treated by engineers--they include, avalanche control, hydrological implications of many sorts, thermal implications of snow, control of falling snow, over-snow travel, visibility problems of snow etc. etc. A similar variety of interests could be cited for physicists and in my own subject, Geography, papers on snow range from topics within Physical Geography (including snow and glaciers, etc.) through Urban and Agricultural studies to work on the perception of snow as a hazard in the urban environment.

This range of interests in snow is an indication of the great significance of this phenomenon in our environment. At risk of being accused of trying to convert the converted, I would like to elaborate a little on the many roles of snow in our physical and cultural environment.

Snow is a form of precipitation, a form of ice and as such is a form of water. Falling snow is, among other things and according to your point of view, the principal form of the solid phase of atmospheric moisture, a visibility problem, a hazard to travel and to trees and an important factor in the physiological effects of cold. On the ground, again among other things, it is a very efficient and important temporary reservoir for water, an important control of the regimes of our streams, a hazard and expense to man, a boon to small animals and plants but a hazard to larger animals, an insulator of the ground and houses, the resource base of multi million dollar industries, a building material and the form of ice from which glacier ice is derived. Articles in the Proceedings of the Eastern and Western Snow Conferences reflect these roles of snow.

It is not difficult to argue that snow is the most striking characteristic of winter which is the dominant season of the year in eastern North America. As such it has highly significant effects on our cultural as well as physical environment and is of great popular interest in our society. Yet another example of the great relevance of studies of snow was presented earlier this morning in the paper by Falconer & Hogan(1) in their discussion of the role of snow in the study of atmospheric pollution--a highly topical area of interest today. The increasing recognition of the critical role of snowcover in management of our water resources (2) is another example of the same thing.

We in the Eastern Snow Conference are therefore, for our region, the custodians of an area of knowledge and expertise about a phenomenon of the greatest importance. As such, I submit, we have a duty to spread our knowledge to the public at large and in particular through the entire formal education system. If education is to be relevant, education in snow should be a part of it. I submit that such a procedure can only be beneficial to us as the quality of recruits to the various disciplines interested in snow can only be improved by it. More education in snow will improve the understanding of snow in all our professions.

Today, I would like to discuss snow and education in the primary and secondary schools, putting aside the questions of popular education and university education. It seems to me that the popular coverage of snow by the media is improving as interest in winter sports and environmental problems mounts. In the universities, considerable advances in snow education have been made in recent years, particular as a result of IHD work. Two of the papers in the Proceedings of the IHD Workshop on Snow and Ice Hydrology in 1969(3) bring out developments at the graduate and undergraduate levels including new courses dealing wholly or in part with snow, special conferences, guest lecture series, exchanges of faculty and professional people, establishment of field stations, development of library and data centres etc. Such progress can be cited both in the U.S. and Canada including here at the University of New Brunswick.

I would like today to discuss snow in education and education in snow in the school system, with particular reference to Ontario where the range of grades involved is from Kindergarten to Grade XIII. I will tend to stress the use of snow in Geography teaching as it is my own field of interest.

All of the points which I made, (and more) about snow as a highly significant part of the environment make it a worthy object of study in school from the points of view of many of the standard disciplines--geography, geology, biology, economics, history, social studies etc. But, in addition and perhaps more important to school teachers in an even wider variety of disciplines, snow is a teaching aid which is delivered each winter, in the midst of the school year. It is a material which can be touched, seen and at certain times even smelled and heard while in the air or on the ground. It is a material which reacts relatively quickly and visibly to changes in its environment which changes are all within the normal span of fluctuations in our environment. Hence it provides an extremely useful medium for observation, demonstration and experimentation. Its own importance as a part of the environment heightens its value in this regard.

Before discussing the use of snow in schools as a part of the instructional programme of specific subjects, let us consider the particular problems of teachers of the field sciences in general in our part of the continent. Field sciences require fieldwork--looking at a picture of the landscape is no longer enough. The problem is that the school year is winter and, as a result, fieldwork is usually packed either into a short period at the beginning of the academic year, when the students know little, or into a short period at the end of year when academic pressure is off and the vacation looms large. It is extremely difficult to integrate fieldwork of this type into a course and, as a result, such work often degenerates into mere sight-seeing or is abandoned. The recent increased recognition of 'relevance' in education has resulted in the development of out-of-school education outside the traditional 'field' subjects so that the problems presented by winter are now more widely felt.

The answer to this problem lies in the development of real interest in winter (school year) phenomena and snow provides a particularly suitable case. Meaningful outdoor activities related to snow can be developed for all ages in the system and for a wide variety of subject areas.

Still keeping to the fairly general case, rather than dealing with particular subject areas, snow provides, in the outdoors, unusually fine opportunities for the development of measuring skills which have a general relevance in the sciences. One of the functions of laboratory subjects in school is to develop a meticulous, careful approach to measurement problems as well as to convey to the students information resulting from the particular experiment which he is performing. This includes the development of skills at what might be called the technique level but extends over into the general methodological area of experiment design and assessment.

Examples of work that can be easily undertaken here include the observation and measurement of the shape, size and condition of snow crystals and snowflakes, the development and assessment of snow gauges, the problem of extrapolating from point snowfall measurements. The technical and methodological problems of measurement in these areas can be treated literally at any level in the school system and beyond (in Peterborough schools, by the way, snow was until recently most treated in Kindergarten and Grade 1 and in the Intermediate Grades) with the most modest equipment meeds. In many cases the work can be undertaken very close to a school.

Once on the ground, snow forms a remarkably accessible component of the environment from the teaching point of view. The properties of snowcover (depth, density, water equivalent, porosity, permeability, grain size and shape, texture, strengths, etc., etc.) are a focus of interest for many disciplines. Again snow on the ground provides a useful material for experimentation and demonstration and, the significance of the material itself in the environment makes such work even more meaningful. To note a particular example, an understanding of density is particularly easily conveyed by means of snow as a result of the significance of water in the cgs system. The gaining of an appreciation of the great importance of density as a basic property of snowcover greatly enriches a simple general demonstration of what density is.

I would now like to consider the relevance of snow in the teaching of specific subjects, especially my own, Geography.

Geography is a subject concerned with the study of various aspects of the surface of the earth--with the physical and cultural landscape. All branches of Geography are concerned with areal association and differentiation or the processes of spatial interaction. Geographers are concerned with spatial variations in the landscape (including those over time) and with the explanation of those variations. In Physical Geography the concern is with the phenomena of climatology and geomorphology and with distributional aspects of Biology. In Human Geography, the concern is with the same phenomena, as they affect man, and with cultural aspects of the landscape. Snow is a physical phenomenon which has great cultural implications.

Perhaps the most valuable aspect of snow from the point of view of Geography teaching is that snowcover provides a tangible, visible, example of a complex areal distribution. Variations in a snowcover are the result of a complex interaction of processes which vary spatially. An end result of the spatial variations of the interactions is visible and measurable in snowcover. An added advantage is the fact that developments within a snowcover occur over usefully short periods of time, so that patterns change and hypotheses concerning the original distribution can, to an extent, be tested.

Snowcover can be used to demonstrate something which is of general significance in various branches of Geography. The problem of establishing trend surfaces from point measurements is a basic one in Geography. Valid sampling of the spatial variations of landscape phenomena or processes (whether they be densities of population, air temperatures or rates of urban sprawl) is desirable in all branches of the subject. The problem is the same as the point-area problem of precipitation measurement mentioned above. From the teaching point of view, the implications of a sampling procedure over an area are more easily demonstrated in the case of snowcover than in the case of a less tangible variable. The distribution which the sample represents can be <u>seen</u>.

At the same time, the snowcover itself is of great interest to the Physical Geographer as a phenomenon of the environment, particularly as one which can be used to demonstrate the interrelatedness of elements within the earth-atmosphere system. The properties of the cover are the result of the interaction of processes in the atmosphere, at the earth/atmosphere interface and beneath the earth's surface and variations in snowcover result from spatial and temporal variations in those processes.

Falling snow is also of interest in Physical Geography as an element of climate and weather. From the teaching point of view, it is one climatic element for which effectively complete annual records can be obtained within the school year. In addition, the form of falling snow can be used to develop and convey interesting information about conditions in the atmosphere through which it fell. Variations in types of snow can be used, for example, to clearly convey the change in conditions associated with the passage of fronts. Another point is that the behavior of snow as a falling precipitant can be easily observed so that the turbulence of the atmosphere and limitations of conventional precipitation measurement of all types can easily be brought out. As most of our precipitation either is ice or was originally ice, it is not illogical to overstress snow in a consideration of climate in our schools.

In non-physical aspects of Geography, the great cultural and economic importance of snow makes it a very vital area of study in North America. It sharply affects our way of life both beneficially and detrimentally through its influence on , among other things, on communications, clothing, housing, water and power supply, recreation etc. etc. Aspects of snow as a hazard (see, for example, 4) and as a resource can be easily and meaningfully treated in our schools.

Moving into what might be described as the area between Geography and Geology, it might be argued that no amount of over-emphasis on snow in the school curriculum can really overcome the fact that winter conditions prevent field observation of surface geological features at appropriate times during course work.

But snow does provide some possibilities for overcoming these disadvantages. The conscious use of the 'model building' approach to the conceptualization of reality is now widespread as a disciplined approach to research and learning both in the sciences and elsewhere. In teaching, the use of static hardware models such as styro-foam volcanoes, maps and other diagrams, etc. etc. are standard pedagogical techniques; dynamic hardware models such as wave tanks, with their higher potential for experimentation, are becoming more common. The use of mental models, particularly analogies, is simply good teaching practice.

Examples of the use of snowcover in teaching geology and geomorphology include the following. Snowcover is a good analogy for sedimentary rock and some of the metamorphic processes in snow form a useful basis for comparison with rock metamorphism. Ice is, of course, a mineral and the properties of snow crystals can be used to convey the properties of rock-forming crystals. Variations in grain size, compaction etc. of snow are often more clearly visible than they are in rocks. As the metamorphism of snow is rather rapid, the significance of changes resulting from the processes involved is more easily grasped. It is true that there are no snow equivalents of such features as drumlins but there are clear ripple effects and dune formations in snow. The processes of deflation and its effects can be observed in a snowcover. Although glacial landforms are naturally concealed by snowcover in winter, the development of snowcover

over a winter does shed light on the development of glaciers and the behaviour of snow on a slope and of streams within a spring snowcover do have value for instruction in the behaviour of glaciers and their associated run-off. It is in fact odd that glacial geomorphology was, at least until recently, taught through the consideration first of the landforms produced by glaciers and only secondly of the glaciers which produced them.

Consider also the profile of a snowcover as an analogue model for a soil profile. Implications of grain size and shape, texture, compactness, moisture content, layering etc. etc. are easily demonstrated. Many of the measurements and observations are more easily made in snow. The behaviour of snow on a slope is comparable to that of soil or other material on a slope and rates of change may be usefully rapid.

One of the beauties of the analogue approach in both teaching and research is that analogies, by definition, are not the real thing. In the case of snow and soil for example, the mode of profile development is clearly different, (the roles of water and air in the two media are, for example, very different). Another difference between snow and soil is that the density of snow increases when it is moved while that of soil decreases. This is a fundamental difference which has great implications in, for example, avalanches. Such differences often bring out a point better than similarities.

I am not attempting to say that we should go to great lengths to keep students from the real thing. Rather the study of snow by analogy, undertaken at a time when for example, soil is being treated in a course, makes the end-of-year visit to a soil profile more meaningful.

The use of physical analogies to social and cultural phenomena and processes is becoming quite widespread. (The treatment of traffic systems as analogues of stream systems is an example, 5.) Snow provides many possibilities here. For example, the effects of aspect, clearly demonstrated in the pattern of differential melting of a snowcover can give real meaning to a distribution of apple orchards observed on maps or on a summer tour (of course, this is not to say that the correlations between aspect and the melt pattern or between aspect and the orchard locations are simple--see, for example, (6)). What about, for example, a comparison between the role of a snow fence in a large open space with the role of the Rhine as a permanent physical barrier in the history of Europe?

Snow fences are, by the way, a remarkably simple and cheap experimental device. They provide a good example of the way in which snow can be used as an experimental medium as distinct from simply being the subject of observations. Almost all schools have sufficiently large grounds for an outdoor laboratory which can include a snow fence or two.

Biology is a subject which seems to have suffered particularly from a lack of meaningful fieldwork during the school year. Studies of relationships between snow and vegetation and soil are, in fact, very easily undertaken and some education in snow is most desirable for a biologist working in our type of climate. Possibilities range from consideration of the micro climates produced for plants and animals by snowcover to the role of snow in the life cycle of small and large animals and to the study of the habits of animals and birds from tracks and droppings in the snow.

In Southern Ontario, there has been a considerable increase in interest in snow in the schools during the last two years. One county board of education at least, (7) has issued a manual on ice and snow to its teachers with major subheadings such as "Melting Snow", "Amounts of Snow", "Appearance of Snow", "Temperatures in the Snow", "Tracks in the Snow", "Sound of Snow and Ice", "Making Ice", "Characteristics of Ice". Under, for example, the title 'Melting Snow' the topics include "Size of Snowballs and speed of Melting" and "Underlying Surfaces and the Speed of Melting". The 'Amounts of Snow' section deals with the measurement of precipitation and the mapping and form of snow drifts. The section 'Temperatures of Snow' includes basic considerations of ice and water temperatures as well as the fluctuations of temperature in a snowcover. Both outdoor work and indoor work are suggested.

Many school boards in Ontario are establishing centres for outdoor education, some of which are giving serious attention to the problem of meaningful winter activities and are developing an interest in snow--one manual is entitled 'Winter and Man', another deals with the physics of tobogganing (8).

In the general vicinity of Peterborough, interest in snow is now widespread among teachers of most grades. The Grade XIII students in one high school have a short course in snow stratigraphy, making use of a time profile site. A kit of equipment for stratigraphic measurements is now available to schools on loan. This kit is based on the old Canada NRC Kit (9); most items in it are cheaply reproduced.

One Intermediate School (grades 7-9) devoted six weeks last winter entirely to the study of snow in all its possible ramifications (10). On the physical side, they developed an outdoor laboratory close to the school in which they carried out time-profile measurements of stratigraphy and temperature, maintained a weather station with a programme of observations geared specifically to snow and erected a couple of snow fences and observed the development of drift patterns. In the general vicinity of the school, they studied the distribution of snow with reference to various factors through probe surveys of depth and water equivalent, and studied various aspects of Biology. On the cultural side, one group made a detailed study of the principles and organization of the local snow control programme, another obtained information on the operations of firms involved with snow (snow tire, snowmobile, ski manufacturers etc.). The work extended to a consideration of the role of snow in History including Hannibal in the Alps ('avalanches then and now') and the effects of snow in Canadian history (snowshoes and other forms of travel, effects on pioneer life etc.). The Physical Education department of the school went deeply into winter sports and snow.

These are examples of the remarkable potential of the phenomenon in which this Conference is interested in as a vehicle for "education". I personally look forward to the day when every school in Ontario has a simple outdoor field station devoted to snow as a standard part of its equipment whether it be in the city or the country. It is important that the average citizen has some understanding of this phenomenon which plays such an important part in his life.

I would urge that the Conference give serious consideration to the establishment of a committee devoted to developing snow in education and education in snow. This could be a contribution to one of the objectives of the IHD, the improvement of education in Hydrology. Perhaps the venture could most efficiently be undertaken as a joint project with our colleagues in the Western Snow Conference?

References

1. Falconer, R.E. and A.W. Hogan 1971. Capture of Aerosol Particles by Ice Crystals. Proc. 28th Eastern Snow Conference, Fredericton, N.B., February.

2. An example of the literature is the article by Hare F.K. and J.E. Hay, 'Aspects of the Large-Scale Annual Water Balance over Northern North America (in press) in which the limitations of existing snow measurements are discussed.

3. Meiman, J.R. (Ed.), 1969. Proceedings of the Workshop on Snow and Ice Hydrology, Colorado State University, August, 142 p. (The articles mentioned are: the report of the panel discussion on Cooperation in Research and Education, p.39-55; Heindl, L.A., Teaching of Snow and Ice Hydrology in North America p.91-98).

4. Ralph, E.C. and S.B. Goodwillie, 1968. Annotated bibliography of snow and ice problems, Natural Hazard Research Working Paper No. 2, University of Toronto.

5. Bunge, W., Theoretical Geography, Gleering.

6. Helleiner, F.M., Changing Orchard Distributions in the London Region since 1970, M.A. thesis, University of Western Ontario, 1966.

7. Halton County Board of Education, Ontario. Snow and Ice (mimeo manual).

8. Ontario Department of Education, Winter and Man (mimeo manual).

9. Klein, G.T., B.C. Pearce and L.W. Gold, 1950. Method of Measuring the Significant Characteristics of a Snowcover, Canada NRC, Technical Memo, No. 18.

10. M.J. Hobbs Senior Public School, Hampton, Ontario, Snow Project (mimeo manual).